

CENTRO SUPERIOR DE ESTUDIOS
DE LA DEFENSA NACIONAL



ANIVERSARIO 1964-2014

Strategic Dossier 166 B Energy and Geostrategy 2014

Spanish Institute of Strategic Studies
Spanish Committee of the World Energy Council
Spanish Energy Club



MINISTRY OF DEFENCE

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MINISTERIO DE DEFENSA

SPANISH OFFICIAL PUBLICATIONS CATALOGUE
<http://publicacionesoficiales.boe.es/>

Edita:



<http://publicaciones.defensa.gob.es/>

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NIPO: 083-14-176-4 (paper edition)
ISBN: 978-84-9781-975-6 (paper edition)
Legal deposit: M-20442-2014

Publication date: September 2014

Printed by: Spanish Ministry of Defence



NIPO: 083-14-175-9 (e-book edition)
ISBN: 978-84-9781-976-3 (e-book edition)

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CONTENTS

	Página
Preface I	
<i>Miguel Ángel Ballesteros Martín</i>	
Preface II	
<i>Arturo Gonzalo Aizpiri</i>	
Prologue	
Time to reassess energy cards	15
<i>Christoph Frei</i>	
This is a time of unprecedented uncertainty for the energy sector	15
The pressure and challenge to further develop and transform the energy system is immense	15
Business as Usual is not an option	16
The energy transformation is the backdrop of a changing energy map	16
Introduction	
<i>Claudio Aranzadi</i>	
Definition	19
The “trilemma” amongst objectives in global energy strategy. Competition and cooperation	21
Managing the trade-offs between objectives in the European Union.	22
The global dimension of the greenhouse gas abatement policy	25
Energy security	30
Energy factors: global energy and competitiveness	32
Competition and cooperation	34
The articles contained in this publication	36
Chapter I	
Geostrategic and geopolitical considerations regarding energy	45
<i>Francisco José Berenguer Hernández</i>	
Some considerations about the “energy security” concept	46
Concept	46
Attention and Concern	47

	Página
Validity of the concept	48
Energy security in global strategic thinking	51
<i>Spain</i>	52
<i>The European Union</i>	53
<i>The North Atlantic Treaty Organisation</i>	54
<i>United States of America</i>	54
<i>The United Kingdom of Great Britain</i>	55
<i>France</i>	55
<i>China</i>	56
<i>The Russian Federation</i>	56
<i>Conclusion</i>	57
Energy in geostrategy	57
Energy in geopolitics at the start of the XXI century	63
General Trends	63
The continuous thrusting of the emerging economies	63
Greater political instability and uncertainty in high production zones	65
Search for new zones for the exploiting of hydrocarbons	67
Diversification of routes	68
Redefinition of nuclear and renewable energies	70
Unconventional techniques of extracting hydrocarbons	72
USA strategic retraction-expansion	74
Partial conclusions	76
Points of potential regional friction	77
Strait of Ormuz	77
The Caucuses	79
The Caspian Sea	80
The China by-pass towards the Indian Ocean	82
The succession in Algeria	83
The future of Egypt, Syria, Tunisia or Libya	84
The Strait of Malacca	85
The eastern Mediterranean. Israel as an energy power	85
The legal insecurity in populist governments	86
The excess strengthening of Arabia, Qatar and the Arab Emirates in the international context	88
The role of Russia	89
Conclusions	90
 Chapter II	
Spanish energy security in a changing scenario	93
<i>Gonzalo Escribano</i>	
Introduction	94
An international, fragmented and transitional regime	94
Physical security vectors: dependency and vulnerability	102
Economic security sectors: Energy intensity and competitiveness	115
Conclusions	121
Acronyms	123
 Chapter III	
Cyber security in the emerging systems of the electrical sector	125
<i>Jorge Cuéllar Jaramillo</i>	
The smart distribution grid	127
The threshold of the third industrial revolution	127

	Página
Forces that lead to Smart Networks	128
Supply security	128
Ecology and the protection of the environment.....	129
The market	129
Optimisation of the distribution system operations	129
What are Smart Grids?	130
The current electrical supply system	132
Architect and characteristics of the current system	132
Reliability	133
ICT security requirements in the electrical supply	136
Integrity	137
Privacy.....	137
Confidentiality.....	139
Availability	139
Cyber security rules in the current electrical supply system	140
Stuxnet	141
Stuxnet relatives: Flame, Duqu, Gauss and Madi	142
Other attacks on SCADA centres and on the Smart Grid	143
Other attacks on the infrastructure of the ICT environment	145
The role of icts in smart grid	146
The characteristics of Smart Grid	146
ICT Security in the Smart Grid of the future	148
Security Measures in Smart Grids	150
Facilitate the security processes.....	150
Build secure systems	152
Evaluate the security and the processes	152
Respond	152
Challenges	153
Technical aspects of operation and of infrastructure	153
Operating aspects of the infrastructure and related processes	155
Education, dissemination and awareness rising.....	155
Information exchange	156
Standards, guides and regulation	157
Research and development of new solutions	157
Protection of the privacy of personal data	157
Conclusions	158
Bibliography	159
 Chapter IV	
Geopolitical impact of the development of unconventional hydrocarbons	163
<i>Mariano Marzo</i>	
Introduction	165
Unconventional oil	166
Preliminary technical considerations	166
What does unconventional mean?	166
Main types of unconventional oil	166
Estimate of resources and their production costs (without internalising the CO ₂ .costs).....	168
Geographical distribution of the resources. The unconventional ones as a counterbalance to the Middle East	172
Oil production between 2012 and 2035. Non-conventional as a temporary alternative to the hegemony of OPEC and the Middle East	176

	Página
Oil production has already peaked. Unconventional oil gains prominence.....	176
The production from the non-OPEC countries increases until the late twenties and it then stagnates and declines.....	177
The revolution began in the U.S. LTO spreads to other countries but loses steam from the early thirties.....	179
Middle East grows in significance in OPEC. Venezuela maintains its position thanks to extra-heavy oils.....	181
Ten-years ahead, OPEC will again occupy a key position and the Middle East will stand as the only source of cheap oil.....	182
Iraq, Brazil, Canada, Kazakhstan, USA and Venezuela will be key in ensuring global supplies.....	183
Uncertainties. The case of Iraq as an example.....	184
<i>The reorganization of the global trade in oil between 2012 and 2035. Its implications for the security of global supply</i>	185
The new geography of demand. Decline in the OECD, growth in Asia and the Middle East.....	185
The balance between production and demand. Imports move from the OECD to Asia. Unconventional fuels make North America a net exporter.....	187
The overall flow of oil veers from the Atlantic basin, with the exception of Europe, towards the east of Suez, particularly to China and India.....	189
Security implications of the global oil supply.....	190
Unconventional gas	191
<i>Preliminary technical considerations</i>	191
What does unconventional mean?.....	191
Main types of unconventional gas.....	191
Estimation of resources and production costs (without internalizing the CO ₂ costs).....	193
<i>Geographical distribution of resources. The unconventional gas as a counterweight to the Middle East and Russia</i>	196
The case of shale gas.....	197
<i>Production of natural gas between 2012 and 2035. The unconventional gas revolution expands beyond the U.S. and Canada</i>	201
In just over two decades unconventional gas could represent more than a quarter of the global production of natural gas ...	201
U.S. production and Canadian production continues to grow in the next decade and it is then stabilised. Mexico comes onto the scene.....	203
China and Australia burst onto the world stage in the production of unconventional gas.....	204
The potential of Argentina.....	205
The incognita of Europe.....	206
<i>The reorganization of the global trade in natural gas between 2011 and 2035. New pipelines and new players in the market of LNG</i>	207
The new geography of demand. China and the Middle East are growing rapidly, although the U.S. will remain the largest market.....	207
Balance between production and demand. Unconventional gas makes Australia and the USA and Canada net exporters. Imports are moving from the Atlantic basin (except Europe) towards the Asia-Pacific.....	209
Europe increases its dependence on imports.....	210
The increased production in China and India is not enough to offset the increased demand.....	211

	Página
Transport by pipeline from Russia to Europe stagnates and it is to be redirected toward China. Azerbaijan and Turkmenistan take centre stage.....	212
The trade in liquefied natural gas (LNG) is reorganized due to the increasing domestic consumption in the Middle East and the emergence of new sources of supply from Australia, U.S. and Canada.....	213
Conclusions.....	214
<i>Key conclusions regarding unconventional oil.....</i>	<i>214</i>
<i>Key conclusions relating to unconventional gas.....</i>	<i>216</i>
<i>A final thought. Unconventional hydrocarbons and energy dependence: The divergent paths of the U.S. and Europe.....</i>	<i>218</i>
Bibliography.....	219
 Chapter V	
The rise of china and its energy supply.....	221
<i>Ignacio García Sánchez</i>	
The rise of china and its energy supply.....	223
Introduction.....	223
<i>China in the global energy scenario.....</i>	<i>227</i>
<i>China's energy voracity. Asia: the market of the future.....</i>	<i>231</i>
<i>China, a key geopolitical factor in the energy panorama. The geo-strategy of the future.....</i>	<i>234</i>
<i>The change of energy paradigm. From the supply to the demand approach.....</i>	<i>238</i>
The strategic triangle of energy supply security.....	240
<i>The geographical scenario. The Chinese model of relations.....</i>	<i>242</i>
<i>The rationalization of the means of supply. The political commitment....</i>	<i>244</i>
Coal.....	245
Oil.....	246
Natural gas.....	250
<i>The diversification of energy sources. A promising future.....</i>	<i>254</i>
The challenges to security of supply.....	259
<i>Fossil fuels. Difficult political decisions.....</i>	<i>260</i>
<i>The irresistible access to the golden age of unconventional gas. A revolution yet to arrive.....</i>	<i>265</i>
<i>The deterioration of the environment. The Climate Change on the horizon.....</i>	<i>270</i>
<i>The technological revolution. A dream at a distance.....</i>	<i>273</i>
<i>The challenge of nuclear security after Fukushima.....</i>	<i>276</i>
Conclusions. A SWOT analysis.....	279
Strengths.....	280
Weaknesses.....	280
Opportunities.....	281
Threats.....	281
Abbreviations and Acronyms.....	282
Bibliography.....	283
<i>Books.....</i>	<i>283</i>
<i>Documents, articles.....</i>	<i>284</i>
<i>Web pages.....</i>	<i>287</i>
Composition of the working group.....	289
Strategic Dossier.....	291

Miguel Ángel Ballesteros Martín
Brigadier General. Director of the Spanish Institute for Strategic Studies.

Preface I

Ensuring an electrical supply that is sufficient, efficient, sustainable and respectful of the environment is today, not just one of the most important strategic interests of any nation, but it is also a strategic requirement for the security of any country. The well-being and progress of the citizens depends on energy availability. This means that it has become an interest that fully falls within the category of what is crucial for nations.

In Spain, its heavy dependency on resources from overseas makes our country one of the most vulnerable ones. For this reason, the geopolitical and geostrategic elements of the international energy panorama take on great significance in Spanish strategic thinking.

By virtue of what has been stated, when Arturo Gonzalo Aizpiri proposed to the Spanish Institute for Strategic Studies (SISS) the form this publication should take, this seemed to be an excellent idea to us. So we were able to meet a team of experts led by Claudio Aranzadi who, from his experience as the minister responsible for the sector, has coordinated and provided coherence to the project.

The SISS is pleased to submit this publication, carried out with the assistance of the Spanish Committee of the World Energy Council and Enerclub. This seeks to offer a reflection on the geostrategic energy panorama, both to the experts of the different energy-related sectors, and to Spanish society as a whole. This provides a mixed view, in which contri-

butions of the academic, business and military worlds are combined. In this way, it thus provides for the cross-sectional nature of the interest and concern about the energy aspects it gives rise to.

This publication would not have been possible without the assistance provided by REPSOL, CEPSA and ENAGAS. All of these companies are of recognised standing, not only of a strategic nature for our country. The publication does not seek to be an end in itself or a finished project. The SISS considers that it is hugely important to do an ongoing analysis of the geopolitical aspects of energy and its bearing on security, in the broadest sense of the term, in a sector that is subject to constant changes in an unprecedented period of uncertainty.

Lastly, I would like to thank Arturo Gonzalo Aizpiri for this superb initiative. The reflection of this in this publication has been possible thanks to the excellent work of Marta Camacho and the authors, of course. I trust this publication will be of interest to the reader.

Arturo Gonzalo Aizpiri
Chair of the Spanish Committee of the World Energy Council.

Preface II

When we invited General Miguel Ángel Ballesteros to take part in the annual event of the Spanish Committee of the World Energy Council, WEC Spain, in 2011, the interest awakened amongst the audience, when speaking about international conflicts and the geostrategic panorama, led us to realise the broad range of cooperation that could be developed between our institutions. Listening, sharing other viewpoints and other topics, hugely enriches any field of activity. How is this not going to be done nowadays for two related fields such as energy and geostrategy?

We find ourselves at an exciting time in the energy sector. The challenges that are placed on us by an increasingly demanding society, in its consumption parameters, and that is growing exponentially in its global middle class, are hugely testing. The emergence of this extensive middle class with legitimate aspirations of well-being, contributes in a decisive way to energy demand growing in a very intense way, with a 33% increase in the 2035 horizon, according to the International Energy Agency. Of this total increase, 93% corresponds to non-OECD countries. At its last three-yearly congress at Deagu in 2013, the World Energy Council concluded that the increase in energy demand in the coming years could not be exclusively met by low-carbon energy sources. All sources of energy will be needed to meet the rapid increase in global energy demand.

The appearance of unconventional sources in the energy panorama in non-OPEC countries such as the United States or relevant players coming into play, as is the case of China or other non-OECD countries means that the geostrategic scenario, including international relations, is being redrawn and new trading relations and new strategic alliances are being created.

As we will see, the change in the energy world in itself is the context that we are working in and we have to know how to adapt ourselves to our society's requirements within this new framework. Additionally, we should not overlook the fact that we find ourselves in a panorama that should move in a three-axis graph, that of security of supply, that of responsible and fair supply and that of an increasingly environmental demanding context.

For all of these reasons, publications such as this one, become excellent frames of reference for understanding the impact that energy has on geostrategy and geostrategy on energy by means of analysing the most relevant topics of the time. This is also useful to us as a knowledge tool, so as to be able to respond to the current and future challenges in advance, as companies and as global players.

We would not like to let the opportunity pass without thanking General Ballesteros and his team for their marvellous willingness and enthusiasm with which they took on this partnership project. In the same way, I would like to thank Claudio Aranzadi for having contributed his experience to the work of coordinating this chapter.

I also thank Cepsa, Enagás and Repsol, member companies of the WEC Spain, for their financial assistance, without which we would not have been able to successfully complete this edition.

Last, but not least, I would like to mention the work of the Secretary General of WEC Spain, Marta Camacho who, with her tenacious endeavour, has contributed to the success of this project.

Time to reassess energy cards

Christoph Frei
Secretary General of the World Energy Council.

Prologue

This is a time of unprecedented uncertainty for the energy sector

Energy demand will continue to increase, driven by non-OECD economic growth. According to WEC's latest 2050 scenarios demand growth will not be fully covered by CO₂-free energy supplies and fossil fuels still grow in absolute terms from today's 10 mtoes to between 10 and 16 mtoes. The outlook for individual fossil fuels types is however very different. Natural gas may double by 2050 while on the oil side we see an outlook uncertainty of plus/minus 15% over the same time horizon, compared to today's output. The range of uncertainty is much higher in coal with a plus/minus 40% outlook.

The pressure and challenge to further develop and transform the energy system is immense

With current technologies, policies and extrapolated rates of innovation we see the World failing climate objectives. Energy access will not be solved by 2050, but the number of energy poor will continue to decrease from today's 1.2 billion to between 300 and 500 million and mostly reside in the African continent. Further, we expect emerging risks including the increased water

stress, the accelerating energy-water-food nexus, extreme weather events or cyber risks to challenge our current understanding of infrastructure resilience and the need to adapt our energy systems to a new normal.

Business as Usual is not an option

The share of renewables will continue to grow (solar electricity by a staggering factor of between 100 and 200 between now and 2050) and drive increased requirements for storage and backup capacity, enhanced regional interconnection, more decentralized production, a greater need to manage data, which also come with a greater exposure to cyber risks. These developments will challenge current market designs and lead to the emergence of new business models. Also, with decreasing renewable technologies prices the renewables deployment will further shift beyond Europe or North America to emerging and developing countries.

The energy transformation is the backdrop of a changing energy map

large amounts of unconventional oil & gas are produced outside OPEC producers, (notably in North America); the renewables supply is building up in sun-rich Middle East and Africa; the global demand centre is shifting from OECD to Asia; and, technology at competitive costs is produced in countries with low labour costs including China and other emerging economies. International institutions related to energy, trade, or safety no longer reflect this new reality and will either adapt or become irrelevant as they will fail to deliver on the objectives they were created to pursue. As an example, China will ask for a place at the head table of what it will consider legitimate institutions. This changing energy map has profound regional and geostrategic implications.

First, the US has potential to be energy self-sufficient by 2035, but will remain exposed to global oil price volatility. Hence, the exposure to global market disruption risks remains high unless there is a full decoupling of WTI/Henry Hub and Brent markets. Such decoupling does not seem plausible in the long-run given the potential to derive benefits from arbitrage between the two. Meanwhile, moderate but increasing LNG exports to Europe and Asia will lower the dependency of Europe from Russian gas and create opportunities for new partnerships between North America and Asia. The moderate European gas market outlook and the increased competition in international LNG markets will also drive Russia's focus east and enhance Asian opportunities for *upstream* partnerships.

Second, China's agenda is shifting to address its environmental problems after a decade with a focus on energy security. China's continued capacity

to deliver strong economic growth will depend internally on its capacity to mitigate environmental stress and internationally on its capability to satisfy its thirst for additional resources. In particular, China's demand for non-coal energy resources cannot be satisfied domestically for a foreseeable future and international acquisitions will remain of strategic importance, yet slowed down by local content and protectionist national agendas. The latter drives increased Chinese interest towards international institutions indirectly promoting its trade and acquisitions agendas.

Finally, Europe's lack of own cheap energy sources has already started to weaken its competitiveness against North America. In the absence of low cost labour and energy Europe's success to globally compete will critically depend on its capability to train and attract high-quality skills that drive technology and systems innovation on the one side, and on its capacity to maintain strong institutions and infrastructure that deliver high political, economic and energy security with positive effects on capital costs on the other side. None of these come without clear political focus, consensus and cooperation. A litmus test will be the question whether phase II of the German Energiewende can be embedded in a well-functioning European framework and market concept.

The unprecedented uncertainty, the need to redefine infrastructure resilience on the basis of emerging risks, the expectation of changing market designs and evolving business models, and the changing geopolitical balance as a result of the shifting energy map place energy among the top geostrategic issues globally at least for the decade to come. Cards are not evenly distributed in and where cards are weak the need to play smart is even greater. Clearly, energy is a game that no country can afford to lose. It is time now to reassess own cards, evaluate options, and get on top of smart strategies.

Definition

Geostrategy and geopolitics are fields of analysis with imprecise profiles and that partly overlap. Clearly, the same thing happens when referring to the energy sphere. One way of differentiating the meaning of both terms is to have regard to the specific content of the studies published with each denomination¹. Another way is to make use of the express definitions, being aware that any of these that are the chosen ones may be disputed.

In any event it may be useful, at least as a point of reference, to attempt to characterise both concepts. J. Black² defines the concept of geopolitics as the “relationship between political, principally the composition and use of power, and geographical factors, especially space, location and distance”. He adds that “geopolitics calls attention to the context in which national

¹ See, for example, F.J. BERENQUER (2010 a). “Energy geostrategy” - “*Energy geostrategy*” and F. J. BERENQUER (2010). “Geopolíticas de la energía” - “*The geopolitics of energy*”, in “La nueva geopolítica de la energía” - “*The new geopolitics of energy*”. Essays of the CESEDEN -*Superior Centre for National Defence Studies*. Ministry of Defence. In this article included in this publication, F.J. Berenguer subscribes to Brzezinsky’s geostrategy concept: “the geostrategic management of geopolitical interests”. He selects two factors as the basic influences in the geopolitical reality of energy: territory or land or sea communication routes that makes it possible to connect product with consumers.

² J. BLACK (2009). “Geopolitics”. The Social Affairs Unit

security decisions are made and issues of war and peace are decided, and, more particularly, the relationship between strategy and geography". Conversely, L. Freedman³ defines the concept of strategy as that referring "about maintaining a balance between ends, ways, and means; about identifying objectives; and about the resources and methods available for meeting such objectives". Freedman moreover, states that "strategy comes into play where there is actual or potential conflict, when interests collide and forms of resolution are required. This is why a strategy is much more than a plan". It is sufficient to add the geographical factor to this definition, so as to obtain a characterisation of the concept of geostrategy. As Freedman points out, on the other hand, his definition of strategy is applicable to both the military sphere, and the political or business one.

This breadth of the term "strategy" partly explains the choice of the title, "Energy and Geostrategy", to group together the five studies that are included in this volume. Of course, this is also due to the fact that the denomination "energy geostrategy" best fits in with what may be considered to be one of its essential components, national, regional and global energy policies. The range of analysis does not exclude other economic policies, diplomatic action, security and defence policy or the business strategies that are related to the world of energy.

"Energy geostrategy", like all strategic studies in general, can effectively use the conceptual framework that is offered to it by techniques that are fundamentally developed in economic theory, such as cooperative or non-cooperative gaming theory, or the theory of real options⁴. However, there is a *trade-off* between the analytical rigour of these disciplines in decision-making modelling and the realism and practical relevance of the conclusions in very complex environments. States, coalitions of states or companies that interact in the global energy resources map must, in addition to sophisticated formal decision models and geographical factors (space, location and distance), take account of other extremely relevant factors such as technology, geology, institutions, history and particular ethnic features. "Energy geostrategy" hence requires an inter-disciplinary approach and a balance between the using of quantitative techniques and knowledge that is hard to quantify.

The "energy geostrategy" concept furthermore reflects a two-way causal relationship between the two terms of its definition. Specifically, energy-related factors have a bearing on the global geopolitical and geostrategic scenario in the same way as the general geopolitical framework places conditions on the parameters that define the energy environment.

³ L. FREEDMAN (2013). "Strategy: A history". Oxford University Press

⁴ H.T.J. SMITH and L. TRIGEORGIS (2004). "Strategic investment. Real options and Games". Princeton University Press.

The influence of the Middle East geopolitical scenario on the oil market is surely the one of the most studied of the causal relationships mentioned (impact of geopolitics on the energy environment). One example of causality in the opposite direction is offered by the development of hydrocarbons in the USA which will lead to this country becoming self-sufficient in gas supplies in the medium term, and also practically in oil in the long run⁵. Perhaps, therefore, there will be a possible review of the designing of its Middle East diplomacy and security and defence policy, bringing about possible variations in geopolitical equilibriums in that geographical area. China's new international role provides another example of this two-way causality. The change in its political scenario, brought about by Deng Tsiao Ping's leadership, has led China to strong and sustained economic growth in the last two decades. This will be foreseeably extended to the medium and long-term, albeit with a more modest profile. Given the scale of this country (with a few short five-years spells, its G.D.P. will exceed that of the USA, in absolute terms), a shifting of the weight in energy demand towards Asia is now taking place that will become more acute in the medium and long-terms (with the additional pressing of India). This entails a profound modification in the international movements of fuel and a re-orientation of the transport infrastructures and investments. Conversely, China's energy security challenge is inducing significant changes in the global economic scenario, leading to that country's increasing international penetration, by targeting the guaranteeing of covering its huge energy needs in a stable manner. Up to now, this penetration has preferably been developed by means of a commercial and investing strategy. However, in the long run, it will inevitably take the form of greater political pressure⁶.

The "trilemma" amongst objectives in global energy strategy. Competition and cooperation

Global energy objectives can be defined in the same way as those that are continuously repeated for national or regional energy policies (European Union): competitiveness (minimising the cost of the energy supply), safety and sustainability (environmental protection). Taken together, these objectives considered make up a "trilemma"⁷, given the evident trade-

⁵ World Energy Outlook. 2013. I.E.A.

⁶ In this publication, I. GARCÍA SÁNCHEZ's article analyses China's boom and its energy supply.

⁷ The objectives of the energy objectives trilemma" are not precisely defined in the same way in all energy forums. For example, M. CAMACHO (2012), in his article "El Trilema Energético" - "The Energy Trilemma"- (Energy Journals, Spanish Energy Club), quoted in his article in this publication by I. GARCÍA SÁNCHEZ, analyses the studies of the World

offs that exist between them. The definition of global objectives, however, realistically proposes nothing similar to a global energy policy. Geopolitical reality does not contain the necessary cooperative bases. The asymmetries between states providing energy resources, localisation, technology, economic and institutional development, demography, etc. make up a mosaic of energy interests that frequently contradict each other. In addition to these potential conflicts there are the rival antagonisms that constitute the networks of the equilibrium of international power. The configuration of these may change in the medium and long term, but it is hard to see this leading to a sufficiently cooperative global structure.

The absence of sufficiently sound cooperative bonds so as to facilitate a global energy policy does not mean that this cannot be dealt with in regional settings, or that even agreements to act cannot be reached, which are aimed at achieving partial worldwide objectives. The attempt to develop a Common European policy in the European Union is one example of the political willingness towards convergence in a regional area. Then again, it is also an example of the difficulties in carrying this out. On the other hand, the progress, still insufficient, towards building a global policy to tackle climate change, constitutes one example of cooperative intent on an international scale, with a reasonable likelihood of success of attaining a highly-significant, but limited, objective.

Managing the trade-offs between objectives in the European Union.

The decades in which the European Union has been functioning, with its common institutions and its progress in the configuring of a common citizenship have made it possible to dispense with the barriers, mentioned above, which constitute the political antagonisms, so as to undertake a common energy strategy. The 20/20/20 targets (Saving and efficiency, penetration of renewable energies and abatement in CO₂ emissions) for 2020 and the regulations orientated towards building an internal market for gas and electricity are the form that is taken for a European energy policy that is aimed at moving forward in the threefold target stated above (competitiveness, security, sustainability) in the horizon 2020. There is also the added intention (already specified in the deliberation and discussion processes) of continuing in that direction with longer-term horizons (2030 and 2050). This cooperative process on energy matters between states –without parallel in any other regional area– nonetheless presents limitations and inconsistencies that illustrate the difficulties in achieving international agreements in the energy field, even though these targets are shared. Firstly, in the European Union, in spite of the high degree of political, economic and institutional homogeneity of the member coun-

Energy Council and he indicates that the elements of the trilemma are energy security, social fairness and the mitigation of the environmental impact.

tries, asymmetries between them remain that are translated into interests concerning energy policy that do not fully coincide, and the assigning of sovereignty to the common institutions regarding energy matters is limited. Secondly, managing the trade-offs” between the objectives of the energy policy, both by the common institutions and by the member countries, have led to unwanted effects.

The restrictions imposed by the community targets of a quantitative nature, the specific regulations concerning energy and the European Union’s competition policy leave extensive room for discretion by the member countries on energy policy. The regulatory competences in the electrical and gas sectors essentially pertain to the national authorities in the same way as the decision-making capacity to make investments in essential infrastructures and, even more clearly, the energy security policy⁸. This fragmenting of competences, together with the asymmetries in the energy supply policy as a result of the difficulties in geographical localisation and trade history impedes making use of economies of scale that should facilitate a foreign energy security policy for the Union. In the same way, the construction of the energy interconnection infrastructures map in Europe has clearly followed a less than optimum path, both from the perspective of building an interior energy market and the European energy security challenges.

The fragmenting of competence regarding energy security moreover grants the member states a significant capability to intervene in the energy business sector. This is done, for example, by means of maintaining public shareholding control in energy companies, the possible introduction of “poison pills” in private companies or governmental mediation in the processes of merger and acquisition between community companies from different countries. The protectionist policies of some member states as regards the corporate control of exchange rate transactions, whose origin is a company of another member state, also produce another type of argument. The justification of these protectionist initiatives is based upon the importance that some countries attribute to the “headquarters effect” (which is appraised as being notably different in the distinct member states, with France and the United Kingdom probably representing two poles of reference). The asymmetry existing in the corporate control market, above all due to public shareholding (which is wholly compatible with the freedom of movement of capital) makes a consistent response of community policies difficult (specifically, on competition policy). The Treaties codify non-discrimination between companies on the basis of the shareholding ownership (public or private). This impedes all possible

⁸ G. ESCRIBANO deals with this issue in his article in this publication

community action with respect to the shareholding of the State as a corporate control of exchange rate barrier⁹.

The difficulties that are put forward in the European Union policy concerning managing *trade-offs* between competitiveness, security and sustainability are unrelated (other than in a specific case such as the policy on coal) to reconciling the interest of the different member states. This problem is also broached, albeit with different profiles in each case, in the energy policy of non-European countries, and it is probably the hardest one to solve. In the European case, the security (increase in energy self-supply) and sustainability (environmental protection) challenges justify the restrictions imposed by means of the penetration targets of a 20% reduction in CO₂.emissions by 2020 (as well as the even more restrictive ones that are still being discussed for 2030, of 30% for renewable and 40% for CO₂.emissions). Progress in meeting these targets, as well as being hard to make compatible with the standard design of the interior energy market (as far as this concerns the electrical sector) that the particular community institutions are pressing for, is provoking an increase in energy costs. This is hard for public opinion to take on board (it is not well-enough informed about the security and sustainability restrictions that entail an excess cost) and furthermore, it is creating a growing breach in competitiveness with other geographical areas (specifically with the USA).

The explanation for the competitiveness gap with the USA that could induce the differential in energy costs (gas and electricity) lies in both regulatory and technological factors. The US has not approved any mechanism at the federal level that leads to setting a price for the CO₂.released (neither cap and trade or tax), something that does occur in Europe (with the current cap and trade mechanism). For European consumers, this represents an excess cost that will be reflected in both the gas price and in that for electricity (as the gas and coal is used as a fuel in generation). On the other hand, the excess cost of the growing penetration of renewable energies that energy consumers almost fully bear in the European Union is covered to a significant degree in the US by its federal budget (the federal incentives to introducing renewable energies is fundamentally implemented through tax credits). Recently, moreover, the mass extraction of unconventional gas (accompanied by keeping the prices of liquid hydrocarbons high) has made it possible to attain natural gas prices in the US market that are around a third of those currently applying in Europe. A medium and long-term extrapolation of the current situation would lead to a general loss of competitiveness of the European economy

⁹ C. ARANZADI and C. SOLCHAGA (2013). "Reglas y discrecionalidad en la política económica" - "*Rules and discretionality in economic policy*". In M. LUCENA and R. REPULLÓ (Coord.), "Ensayos sobre economía y política económica. Homenaje a Julio Segura" - "*Essays on economics and economic policy. Homage to J. SEGURA*". (A. Bosch, editor)

and growing offshoring (towards the US) of energy-intensive European countries. The regulatory standards relating to the price of CO₂ in the US, and the system of providing federal incentives for renewable energies will probably be maintained in the long-term. Natural gas prices, however, will tend to become aligned with the average costs of extracting unconventional gas in the medium-term (not including the effect of the remuneration from liquid products). Therefore, the differential with European prices will be reduced (although this will be kept at a relevant sum)¹⁰. In the long-term, there is plenty of uncertainty, owing to the effects of the second round provoked in the international gas market by the self-sufficiency of the US and the impact of the gradual replacement of contracts in Europe that are very long-term and indexed to the price of oil or oil products and the progressive development of the organised gas markets (hubs) in European territory.

The global dimension of the greenhouse gas abatement policy

The most decisive and urgent international agreement in the sphere of global energy policy is that which should lead to a global decarbonation strategy. This corrects the potentially devastating long-term effects of climate change that would be caused by the current trend in CO₂ emissions continuing. The decarbonation policy is the main vector of one of the three goals of energy policy (sustainability), but unlike the other two (competitiveness and security), it only makes sense if it is tackled in a global sense since the climate change phenomenon is global. However, since the negotiations about the Kyoto protocol where (essentially for industrialised countries apart from the US that did not ratify the Protocol) quantitative targets for reducing greenhouse gases by 2012 were set, there has only been one quantified international commitment: the 2009 Copenhagen agreement (adopted by statute in Cancun the following year). This limited the increase in the planet's temperature to less than 2°C at the end of the century, which would require the developed countries to reduce their greenhouse gases by about 80-95% by 2050¹¹. Of course, as has already been stated, the European Union has set the target of reducing carbon emissions with the horizon 2020, by means of a cap and trade mechanism and the operation of an emission rights market, initiated in 2005 and that entered its third phase in 2013. The European effort doubtless has an exemplary effect, but its global quantitative impact is insufficient (European greenhouse gases represent 12.5% of total number of green-

¹⁰ See the paper of M. MARCO in this publication, where he analyses the geo-political impact of the development of unconventional hydrocarbons.

¹¹ Ch. EGENHOFER (2.013). "The growing importance of carbon pricing in energy markets". In, "The Handbook of global energy policy". (E. A. GOLDTHAU). (Wiley-BLACKWELL).

house gases, while those of the US and China, which have not assumed any quantified commitment, respectively represent 23.5% and 17.5%)¹².

On the other hand, focusing on the 2°C heating limit as the basis for a possible international agreement is perhaps not the right methodology. The M.I.T. professor, R. S. Pindyck¹³ does a radical critique of the reliability of the most commonly-used products integrated assessment models in order to estimate the social cost of CO₂ emissions. This is used as the basis for an assessment of alternative greenhouse gas abatement policies. “These models have crucial flaws that make them close to useless as tools for policy analysis: certain inputs (e.g., the discount rate) are arbitrary, but have huge effects on the social cost of carbon estimates the models produce; the models’ descriptions of the impact of climate change are completely ad hoc, with no theoretical or empirical foundation; and the models can tell us nothing about the most important driver of the social cost of carbon, the possibility of a catastrophic climate outcome. Integrated Assessment Models based analyses of climate policy create a perception of knowledge and precision, but that perception is illusory and misleading”.

Pindyck’s scepticism as regards the usefulness of the most-commonly used models for evaluating the social cost of CO₂ emissions does not mean that he considers this cost to be irrelevant. On the contrary, he is of the opinion that the effects of heating could be catastrophic. But, in demonstrating the low degree of reliability of both “climate sensitivity” models (that associates CO₂ concentrations in the atmosphere with temperature increase) and the “damage function” (that associates temperature increase with reductions in G.D.P., consumption, etc.), Pindyck invalidates *fine-tuning* methodology so as to evaluate the different alternatives of climate policies that are presumably guided by the non-existing precision of sophisticated models. Conversely, he proposes a simpler alternative methodology consisting of “come up with rough subjective estimates of the probability of a climate change sufficiently large to have a catastrophic impact, and then some distribution for the size of that impact (in terms, say, of a reduction in GDP or the effective capital stock)”. On these bases, Pindyck conceives of a greenhouse gases abatement policy “as a form of insurance: society would be paying for a guarantee that a low-probability catastrophe will not occur (or is less likely)”. The conceiving of the greenhouse gas abatement policy as an insurance policy against low-probability events (e.g. 7 - 8° C increases in the temperature by the end of this century), but one with potential catastrophic effects,

¹² European Commission (2013): “E.U. Energy in figures”

¹³ R.S. PINDYCK (2013). “Climate change policy: What do the models tell us?” Journal of Economic Literature (September)

furthermore invalidates a considerable part of the sceptics' arguments on climate change, focused on the uncertainty of the *fine tuning* policies.

There are to be considerable multiple obstacles to an effective international agreement on tackling climate change. Generally speaking, the costs of the greenhouse gases abatement policy are perceived of in the short-term, while the effects of failing to adopt these (potentially catastrophic) will take place in the very long term. This tends to induce public opinion to be reticent when faced with short-term severe measures (if an inter-generational lack of solidarity predominates and discount rates are high, a cost-benefit analysis would rationally justify this position). The impact of this phenomenon, common to all countries, has nonetheless had a very different political translation between them. It is enough to compare the climate change policies in the European Union and the US. It is possible that this relative insensitivity of the public opinions is being corrected insofar as a reasonably-reliable correlation can be established between the global warming that has already taken place and the extreme weather phenomena that we are experiencing, even though this raising of consciousness will foreseeably be gradual. On the other hand, the social cost of CO₂ emissions reflects negative externality, which provides incentives for the trend of states they behave like free-riders. Also, in this case, we can highlight the European counterexample, although pronouncements against a strict greenhouse gas emissions policy are increasingly extending in the European Union, which are not accompanied by an analogous strategy of other large polluters. The resistance of some countries towards signing an agreement also reflects the influence of economic interests (business or state) that are associated with consumption or the production of fossil fuels. Furthermore, in amongst the challenge of sustainability such as the greenhouse gases abatement policy and the security and competitiveness targets, there is a measure associated with the trade-offs that differs between different countries. Bordoff and others¹⁴ point to coal as an example of this trade-off. This offers a lower security risk than oil or gas, in spite of being a greater CO₂ emitter, or the development of "coal-to-liquid" technology that would improve the security standard (above all, in countries with considerable coal resources) by reducing oil consumption. Then again, it would have a more negative impact on climate change. In general, those countries whose self-supply is based upon fuels with high levels of CO₂ emission (coal above all) will undermine their energy security (or, at least, made costlier by a sustained control of emissions). It is true that the commercial exploitation of decarbonated technologies (above all, CO₂ capture or confinement) would radically alter this scenario, but that threshold has

¹⁴ J. BORDOFF, M. DESHPANDE and P. Noel (2010). "Understanding the interactions between Energy Security and Climate Change Policy" and C. PASCUAL and J. ELKIND (Ed.), "Energy Security". (Brookings Institutions Press)

not yet been exceeded. The differences between countries as regards the trade-off between climate policy and competitiveness are also significant, but the competitiveness differential between countries (or regional areas as the European Union), which undertake ambitious greenhouse gas abatement policies and countries that do not do this (thus avoiding the excess energy cost associated with this policy) is fundamentally recorded. Lastly, it is understandable that developing countries, which are not responsible for CO₂ concentration (and that of other greenhouse gases) in the atmosphere caused by the economic development of industrialised countries over the course of the last two centuries, are pursuing a differentiated form of treatment in a possible international agreement so that it does not significantly put the brakes on their economic development programmes.

Every international agreement on CO₂ emissions abatement policy implies the acceptance of an excess energy cost. Pindyck¹³ mentions the broad variability in the estimated social cost values of CO₂ emissions (from \$ 12 per Tn of CO₂ in an estimate by W. Nordhaus to \$200, which would be the figure that N. Stern considers to be in line with the necessary abatement of greenhouse gases), and he suggests the proposal (updated) made by the US Interagency Working Group of \$33/Tn as an approximate acceptable value. This would be used as a basis for setting a tax or a cap on greenhouse gases, consisting of a shadow of this amount. The choice of the mechanism used is not a matter of indifference. Although a cap and trade model provides greater security when it comes to meeting the quantitative targets of reducing greenhouse gases and this represents, at least in theory, a more efficient allocation of emission rights, the experience of the functioning in the first two phases of the European emission rights market (in which prices have recorded wide fluctuations that has made them invalid as an indication for investments with lives longer than thirty years) would make the balance tip towards utilising taxes. An intermediate model could be inspired by the British electrical system reform proposal that sets a floor for CO₂ prices. It is rather unlikely that there will end up being one single worldwide model (whether a universally applicable tax or a global cap and trade mechanism with an international emission rights market and one sole price) but the different mechanisms that are established should imply a similar excess cost for the group of industrialised countries. It should also include instruments (e.g. by means of assistance for technology transfer) that reduce the excess energy cost for developing countries.

The probabilities of a global agreement with quantified commitments would be noticeably increased if there is an understanding between Europe, the US and China (which currently represent 53.7% of worldwide greenhouse gas emissions). The political availability of the European Union is complete, because it has unilaterally assumed, and it will con-

tinue to assume, ambitious greenhouse gas abatement policies. China, although it has officially declared itself to be in favour of establishing a greenhouse gases control policy, is facing up to the problem of replacing a coal-focused energy system (almost 80% of electrical generation uses coal as a fuel, and the proportion of this in total energy consumption is greater than 60%). In a country with strong growth in expected energy demand, a drastic change in the CO₂ emissions profile would not therefore take place because of the penetration of nuclear energy and renewable energies, but rather because of coal being replaced by natural gas in electrical generation, if the current estimates of recoverable resources of shale gas (with 1.115 trillion cubic feet in 2013, the highest in the market)¹⁵ are translated into extraction projects that are viable from the economic, locational (water availability), environmental and institutional viewpoints. There is no doubt that the US is amongst the greatest polluting countries and it is the one that displays the greatest political division. It did not ratify the Kyoto Protocol and neither did it complete the congressional approval of the Waxman-Markey legislation in 2009-2010, which envisaged the setting-up of a cap and trade system and a target of reducing greenhouse gases by 17% by 2020, as compared to 2005¹¹. In 2013, President Obama presented his Climate Action Plan with a set of initiatives for the Federal Administration, but without Congress's support. As D. Robinson¹⁶ states, although the proposed measures are heading in the right direction (in fact, there are in line with the regulations that were ultimately not passed in 2009-2010), the lack of legislative approval reduces their effectiveness and, above all, it undermines the political weight of the USA in its negotiations on the U.N.F.C.C. (United Nations Framework Convention on Climate Change), which should have led to an agreement before the end of 2015. Domestic political difficulties in reaching a consensus on a greenhouse gas reduction programme that obtains Congress's approval are as paradoxical as the target of a 17% reduction by 2020 (which appears in the Waxman-Markey regulation, in the targets assumed in Copenhagen in 2009 and that is repeated in Obama's 2013 Climate Action Plan) being easily attainable (largely due to the intense replacement of coal by natural gas associated with the exploitation of unconventional gas in the US).

The CO₂ reduction policy, as the main vector of the sustainability target of a global energy policy, will foreseeable open the way up, in the form of a global agreement sponsored by the U.N.F.C.C.C., in spite of the countless differences set out above. This is not the case with the other two components of the triple energy policy targets. Nothing similar to an international agreement that shapes what the global targets would be on the

¹⁵ L. HORNBY and E. CROOKS (2014). "A new frontier". Financial Times (8 January)

¹⁶ D. ROBINSON (2013). "President Obama's Climate Action Plan". Oxford Institute for Energy Studies

energy security and competitiveness policy can be imagined. However, of course, there have been energy-related institutions that reflect coalitions of interests (International Energy Agency, OPEC, etc.) or energy-related global agreements that are associated with security guarantees in the broadest sense (e.g. the Nuclear non-proliferation Treaty). Strictly in the energy sphere, it will be difficult, as regards the behaviour of the different states, as far as security and security targets is concerned, to see this taking the form of cooperative processes such as that which would foreseeably lead to a global climate change policy agreement. On the contrary, the scenarios of competition between states and coalitions of states will predominate. In many cases these translate into diplomatic and military conflicts.

Energy security

The energy security objective¹⁷ is traditionally defined as a guarantee of continuity in energy supply (probability of interruption below an economically and politically acceptable level) at certain stable and reasonable prices (stability and reasonableness are also defined in terms of their political and economic acceptability). So, energy security is a crucially-important strategic variable in the agenda of both the diplomatic action of states and in their security and defence policies. This is the reason why some states resist assigning responsibilities in that field to multinational institutions, even when these have attained a certain degree of political integration (such as in the European Union). Energy security policy is also, consequently, a risk management policy that entails both physical assuring of the supply and the coverage of price risks. The strategy of minimising the risk of the energy supply being interrupted obviously moreover depends on the policies of a domestic nature aimed at promoting the reliability of the national energy system (infrastructures planning, the diversification of the fuels and technologies mix and a suitable regulatory framework) regarding the extent of self-supply, the geographical diversification of the supplies, the political stability of the suppliers and the solidity of the diplomatic relationships with these.

Given the traditional energy dependency on fossil fuels (essentially, oil), energy security foreign policy has been focused on controlling the supply risk of that hydrocarbon (and increasingly gas as well). It is therefore not surprising that the Middle East situation has been considered to be the major geopolitical factor. This is the main oil-supplying region which, moreover, records chronic instability. This goes a long way to explaining

¹⁷ Department of Energy and Climate Change U.K. (2012). "Energy Security Strategy". F.J. BERENQUER and G. ESCRIBANO tackle this issue in their articles of this publication from complementary perspectives.

the high degree of diplomatic and military presence of the US in that geographical region.

For this reason, the radical change in the degree of self-supply of gas and oil that the development of unconventional hydrocarbons is going to facilitate in the US is considered to be an event that could cause a greater breach in the global geostrategical scenario. As stated in the W.E.O. 2013 by the International Energy Agency, the USA could become a net exporter of natural gas in 2017 and, together with Canada, form a self-sufficient geographical oil region before 2030. In the medium and long-term, therefore, a fundamental parameter for energy security in the US (the degree of self-supply) will be radically altered. This will bring about a reduction in the strategic value of the main oil-producing region in the world (the Middle East) and, in general, of its potential overseas suppliers. To what extent this new scenario will lead to less North American involvement diplomatic and military matters in the Middle East is difficult to anticipate. Firstly, self-sufficiency in hydrocarbons does not mean isolation from the international market, especially in the case of oil, for which the market is globalised. Potential supply shocks (whether in the Middle East or at other points on the planet) will consequently have an impact on prices (whose stability and moderation are also an element defining energy security) and, of course, in so far as these may precipitate an international crisis of supplies (even though this does not directly affect the US), that country would be economically affected. On the other hand, as the International Energy Agency states (W.E.O. 2013), while the US is the greatest contributor to the increase in oil production in the 2012-2020 period (notably greater than the whole of the Middle East), the US will reduce its production between 2020-2035, and the Middle East will clearly assume the leading role in contributing towards the increase in oil production in that period. That is to say, in the 2020-2035 period, the Middle East would reinforce its strategic position as an essential region in the world's oil supply. In addition, geopolitical factors –some of which are energy-related (risk of nuclear proliferation in the region) and others associated with the role of the US as the global superpower (or at least as one of the great world powers in the long term) - make it difficult to see signs of a significant reduction in the US economic, diplomatic and military presence in that geographical region.

The development of unconventional hydrocarbons in the US is not the only relevant effect of technological innovation in the worldwide energy security scenario. As has already been said, the exploitation of unconventional oil ("oil sands") in Canada will make a decisive contribution towards self-sufficiency in that fuel in north America and the deep-water oil extraction in Brazil will make that country the second-placed supplier (after the Middle East) for the additional production of oil in the 2012-2035 period, as the International Energy Agency envisages. The Agen-

cy furthermore anticipates that Brazil will not only be a net oil-exporter in 2035, but it will also be self-sufficient in natural gas. As has already been stated, of the viability of the exploitation of a significant part of shale gas in China is confirmed, a significant parameter of its energy security would be profoundly altered. The profound changes in the degree of energy self-sufficiency in areas such as north America and Brazil not only affects the factors determining their particular energy policies, but they also favour a global map of resources that facilitates the energy security strategies of the net consumer countries. This is clearly manifest in the case of gas, whose medium and long-term supply will notably increase its geographical diversification, decreasing the strategic advantages of the current large international suppliers. This will mean, for instance, Europe will have lesser strategic dependency on Russian gas, in spite of the fact that will carry on being a central company in terms of global gas supply. Of course, the translation of this international re-shaping of the gas supply into greater security standards for the net consumer countries will depend on an adequate transport infrastructures programming (whether gas pipelines, or liquefaction and gasification installations for L.N.G. supplies), as well as the storing of these.

Another factor that will have a technological impact on global energy security comes from the medium and long-term changes envisaged in the end energy demand structure (an increase in electrification) and in the electrical generation mix (increasing penetration of renewable energies). The development of electrical vehicles (or hybrid ones that can be connected to a network) mainly represents a decisive boost to the electrification of transport (and a reduction in the utilisation of oil products in the sector). The advances made in this process will be closely associated with technological improvements (the sustainability target), but also in the energy security of countries that are net fuel importers, increasing their degree of energy self-sufficiency. In the long-term, this trend, complemented by a foreseeable growth in the investments promoting energy efficiency, points towards an energy sector structure that is increasingly capital-intensive and less intensive in fuels. Insofar as the evolution becomes consolidated, the energy vulnerability of the different states (whether or not they are net consumers) will be reduced: there will be fewer barriers and risks that have a bearing on the international movements of capital and technologies that impact on the global movement of fuels.

Energy factors: global energy and competitiveness

Competitiveness, whether of companies or of countries, is an eminently relative concept. The competitiveness of companies depends on a set of factors that determine their competitive advantages as compared to other companies in the market that are already highly globalised. The com-

petitiveness of companies depends on the conditions created so as to assist the competitive advantages of its companies through its differential availability of physical, human, technological and institutional resources. The search for competitiveness therefore requires strategies that are essentially competitive rather than cooperative, whether these are between companies, states or coalitions of states. This is even more the case with energy security. It is therefore unlikely that cooperation processes will develop in a global energy policy aimed at increasing worldwide competitiveness (a concept, conversely that does not make sense). Of course, improvements in variables can be achieved whose overall definition makes sense, such as efficiency and productivity, which are constructed in the economic and institutional environment that prevails in the world. These results will foreseeably be more than the result of competition rather than cooperation.

The energy policy initiatives targeted at promoting energy security and sustainability (e.g. the CO₂ reduction policy) usually implies an excess cost for energy supply and consequently, they negatively affect competitiveness. Inasmuch as that excess cost reflects negative externalities, energy security and sustainability policies are economically rational, but the differences between states in assessing these externalities or in the instruments used to internalise them, lead to results that are different in terms of competitiveness. For example, different estimates of the social cost of CO₂ emissions would take the form of different amounts (relating to the t. of CO₂ emitted) if the imposing of these is the mechanism chosen to reduce emissions, or in differentiated required quantitative targets of the reduction mechanism is of the cap and trade type. The excess costs of the different alternatives would be different and the same would happen with the impacts concerning competitiveness. A second example, which has already been mentioned, is that offered by the differential effects in competitiveness of the use of different instruments to provide incentives for the use of renewable energies (an essential vector of the security and sustainability policies). The utilisation of a framework of incentives, as predominantly occurs in the member states of the European Union, in which the excess cost of the penetration of renewable energies falls on consumers as compared to the use of instruments such as tax credits that are used by the US federal government is conducive to a penalty relating to the competitiveness of the European countries as compared to the US. In Europe, the companies will bear an excess cost that is imposed on taxpayers in the US.

The availability of energy resources with different costs is obviously a fundamental factor explaining the differences in the competitive advantages associated with the energy environment. The impact on the relative competitiveness between Europe and the US regarding the low costs of natural gas in the latter country deriving from the exploitation of uncon-

ventional gas has already been stated elsewhere. International price arbitration would only alleviate these cost differences with difficulty. Firstly, the development of organised markets (hubs) that would facilitate these forms of arbitration is very different in the three large regions into which the world gas market is fragmented (the US, Europe and Asia) and the replacing of very long-term and indexed contracts on oil and gas products will take time. Secondly, the costs of the liquefaction and transporting of the L.N.G. impose limits on the effects of price arbitrations between gas destinations that have very different locations when contrasted with the extraction centres. In any event, as the global markets and the ways of contracting the gas are being transformed, even though the differential impacts on competitiveness are not eliminated, the emergence of new gas producers (conventional or unconventional) in the world will tend to reduce income that some large gas suppliers currently enjoy (it is enough to think that the cost of extracting conventional gas in Russia is of the same order of scale as the gas price in the US in recent years).

The availability of low-cost energy resources is an important factor in competitiveness (although historically, the phenomenon of the “curse of resources” has manifested itself in a large number of countries that are rich in natural resources, where the high volume of income generated has induced institutional degradation that has put the brakes on economic development). In any event, as the US example shows, with the development of unconventional hydrocarbons, the availability of energy resources just not depend on the provision of natural resources, but rather on technical, regulatory and business initiative factors that can be replicated by a large number of countries. In addition, the promoting of renewable energies that represent a contribution towards security and sustainability targets within the reach of all countries (with the necessary assistance in developing countries) and the energy saving and efficiency policies represent instruments of the competitiveness policy that countries can put into practice, regardless of their provision of natural resources.

Competition and cooperation

In the preceding pages, it has been stated that the respective role of competition and cooperation between states in order to attain the energy targets (competitiveness, security, sustainability) on a global scale is different for each target. International cooperation is a necessary condition to attain the CO₂ emissions reduction targets that are compatible with an effective climate change policy. Global warming is a worldwide phenomenon and therefore, a policy of minimising the potentially catastrophic risks of excessive warming can only be effectively tackled with policy covering the planet that results from an international agreement. In the case of energy security, the result of a worldwide cooperative effort between states would doubtless be more advantageous for everyone. But

while in theory a potential international agreement would be possible, it is highly unlikely in practice. In all countries, energy security is thought to be a fundamental strategic factor that has to be essentially maintained under the control of each state's political institutions. This explains the resistance to giving sovereignty away to supranational institutions as far as energy security is concerned. This is shown by the limitation on the instruments of action of organisations such as the International Energy Agency or the common institutions of the European Union. Finally, competition is essentially the natural terrain of policies for improving competitiveness in each country. Every country strengthens its competitive advantages (in relation to other countries) by achieving the lowest energy supply costs, greater energy efficiency, the more rational incorporation of technological innovation, better infrastructures and better designed regulatory frameworks. Of course, technological cooperation agreements, the creation of common markets (such as the interior energy market of the European Union), or cooperation in the programming of connection infrastructures entail a cost reduction and energy efficiency improvement for all of the countries that work together on these initiatives. But the search for competitive advantage (of a relative nature, by definition) predominantly leads to policies of a competitive nature rather than cooperation strategies. On the other hand, the goal of cooperative projects of a partial nature (such as the coalition of countries with common energy interests that make up O.P.E.C.) has been precisely to interfere with competition in the global market.

The global geo-political framework and its foreseeable medium and long-term evolution does not appear to take the form of an environment that is favourable to more cooperative behaviour of the states in the energy field either. F.J. Berenguer, in his article in this particular publication, analyses a long list of points of regional friction that would require cooperative behaviour from the states involved. While progress may take place in some of these, it is rather unlikely that there will be a significant change in most of the cases, whose number will be moreover be swollen by new points of friction in the global energy environment, that substantially change will arise over the course of the C. XXI. As historical experience shows, the forecasts for the long-term evolution of the geopolitical scenario are hardly reliable. Yet it seems somewhat unlikely that the medium-long term trend of a China that equals the US in economic volume (with the subsequent effect that the convergent and military technology of the Asian country would have on US "standards") is going to lead to a global scenario that better favours cooperation. Neither are there sound reasons to think that the very long-term geopolitical framework, increasingly more uncertain and probably multi-polar, which would result from the economic strengthening –surely uneven– of the BRICS countries, is going to foster a global environment that better favours energy cooperation. In regional theatres, a geopolitical evolution towards more cooperative con-

figurations in the Middle East would have a hugely beneficial worldwide impact (essentially in the oil market). As has already been stated above, the I.E.A. foresees that, from 2020 onwards, the Middle East will regain its central position in the additional supply of crude oil (which the US would have the starring role in, in the 2012-2020 period). A reduction in the political tensions in the region would hence have a notably favourable impact in the short, medium and long terms. A stable arrangement in the region would even be reflected in the short and medium-term timeline. It is enough to point to the effect that such an agreement would have on the crude markets. This would facilitate the complete development of the hydrocarbon resources of Iran and Iraq. It follows from this that the consolidation of the optimistic scenario for the region is important; this could be commenced with the nuclear agreement with Iraq and a new framework of relations between that country and the US. As has been stated in the preceding pages, it is rather unlikely that the energy self-sufficiency of the US will notably alter the intensity of its diplomatic and military presence in that geographical region. Therefore, the configuration of a stable geopolitical scenario in the region will essentially continue to depend on that country's capacity to promote it.

The European Union doubtlessly continues being the most favourable geopolitical setting for developing energy cooperation strategies, despite the patch of political legitimacy that its institutions are experiencing as a consequence of the European public opinion's perception of its inability to articulate an effective response to its economic crisis. Some of the difficulties in developing a genuine common European energy policy, which does not yet exist, have been set out before. However, the cooperative practices between the member states and the unitary political thrust that developing some new policies that are adopted to deal with the economic crisis (in the fiscal and banking spheres, for example) are going to bring about will tend to lead to a political climate –as the movement out of recession becomes consolidated – that is more favourable to re-appraising the objectives of a European energy policy and to better management of the trade-offs between these in the new global energy arena. This re-considering of the European energy policy is as necessary as the degree of European reliance on gas and oil. This is notably high in contrast to other geographical regions, and according to the I.E.A., it will increase quite a lot in the long run.

The articles contained in this publication

Five articles have been selected in this volume, with the title of "Energy and Geostrategy" that are focused on a general presentation of the most relevant issues concerning energy geostrategy and geopolitics, energy security and their specific bearing on Spain, the development of uncon-

ventional hydrocarbons, a specific analysis of China's boom from the geostrategic energy strategy, and cyber-security in the electrical system.

F. J. Berenguer, in his article on "Geostrategic and geopolitical considerations regarding energy", examines the meaning of three concepts that are highly correlated: energy security and, on the other hand, energy geostrategy and geopolitics. He pays particular attention to the role that energy security plays in worldwide strategic thinking and its implications for national security and defence, given the potential for military conflict that those countries that have in the past to ensure their energy resources, and that they will still foreseeably have in the future. He does a study of the place that energy security is assigned in strategic thinking, in both Spain and in other countries (USA, the United Kingdom, France, China, and Russia) and the European Union and NATO. He concludes that the energy, its security or vulnerability, or even its use as one of the pillars of "soft power" of some countries – albeit this term soft is always arguable in this case- is and continues being one of the factors that are not only present, but rather are more determinant of the thinking and the international strategic panorama, maybe permanently.

F. J. Berenguer states that the geostrategy concept, which is traditionally exclusively related to the military field, has a much broader dimension today, leading to the study of large topics –military, economic, political- on a global scale, and not just in relation to the influence of geography. This is understood in its modern conception, not just its physical one. He subscribes to Brzezinski's geostrategy concept ("the geostrategic management of geopolitical interests"), consequently stating that the geostrategic dimension of energy is directly related to geopolitics, to the extent that they mutually have an influence and place conditions on each other, with the borders between both disciplines in this sphere being blurred.

The article states that the factors that influence the geopolitical reality of energy find their place in its strategic interaction at the highest level, based upon two different facts. The first factor, closely associated with the concept of territory, concerns a reality that endows energy with a genuinely strategic dimension. This relates to the irregular geographical distribution of energy resources or of the possibility of obtaining them by means of technological application. The second one that arises directly from the previous factor is the need to transport the energy produced or the resources that make it possible to obtain it and move it from some locations to others. This thus focuses on the land or sea communication routes that make it possible to connect producers with consumers.

This article undertakes an extensive analysis of the main trends that are going to characterise the relationships between energy and geopolitics at the start of the XXI century: the push of emerging economies (above all China and India), the political instability and uncertainty of the regions

of high hydrocarbon production (the Maghreb and the Middle and the Far East), the search for new regions for extracting hydrocarbons (Sub-Saharan Africa, the north American sub-continent, possibly the Arctic), the diversification of the land and sea transport routes, the re-definition of the role of nuclear energy and renewable energies, the development of unconventional technologies for extracting hydrocarbons, and the foreseeable retraction-expansion of the USA. In the same way, the article does a sweeping review of the situation of the different points of regional friction: the Strait of Ormuz, the Caucuses, the Caspian Sea, the China Bypass to India, the Strait of Malacca, and the future political scenario in Algeria, Egypt, Syria, Tunisia and Libya, and political insecurity in populist governments. The study concludes that with a series of summarising reflections on the main issues dealt with in detail in this article.

In his article, "Spanish security in a scenario in transition", G. Escribano explores the Spanish model of energy interdependence from the perspective of energy security. Firstly, the nature of a changing global energy regime, which is fragmented and tending towards polarity, is set out, presenting some of the geopolitical change factors. He then analyses the main vectors of Spanish energy security from the perspective of the physical security of storage, so as to then go on to analyse the vectors related to economic security. Finally, G. Escribano concludes with some energy security implications for Spain.

The article describes the main features of this fragmented international energy regime that is in transition. He points out that, unlike what happens with other international affairs; worldwide energy governance does not have effective international institutions in managing energy security that is increasingly more cooperative as the globalisation of energy markets moves forward. Its negative impact on cooperative energy security is furthermore reinforced by the emergence of a multi-polar world, or more specifically in the case of energy, with a trend toward inter-polarity. This transitional international energy scenario has been dominated in recent years by the unconventional revolution in the US and Canada, whose narrative seems to have imposed itself over the European renewable alternative. In any event, the global energy presence is still concentrated in conventional producers and there are barely any changes for Spain in the period analysed, 2005-2012. For this reason, the article considers that probably the greatest challenges to Spanish energy security in an inter-polar and fragmented governance scenario will come from the regions that maintain or increase the intensity of their energy interdependence with our countries and in which the most complex thing is the corporate governance of energy security. Existing forecasts and projections would point to the argument that the energy hierarchy, based upon the inter-dependence of the hydrocarbons market, will tend to be maintained for Spain in the sphere of its traditional conventional supplies.

In examining energy security in Spain, G. Escribano makes use of the most common classification consisting of distinguishing between physical security, (security of access to energy sources) and economic security, which lies in the hypothesis of the prices of that energy being compatible with the ultimate goals of society (well-being, development, etc.). The article analyses the limitations on the concept of energy dependency as an element in the energy security strategy, placing greatest value on reducing vulnerability through diversification. Both these two variables and those that reflect the political risk of the potential suppliers are examined in depth. In the same way, he analyses two vectors of an energy nature that are decisive for economic security: energy intensity and competitiveness. He reaches the conclusion that –as regards energy security and despite a high dependency rate– Spain displays an energy interdependence model that is quite well diversified in terms of sources and suppliers, and the distribution of risks is reasonable in comparative terms. The article ends with a series of conclusions and recommendations concerning future strategic actions.

M. Marzo, in his article on the “Geopolitical impact of the development of unconventional hydrocarbons”, initially examines the meaning of the term unconventional as this is applied to hydrocarbons. He further details the different products, both in the case of gas and of that of oil, to which this denomination applies. M. Marzo states that there is no universally accepted definition of what is understood by conventional or unconventional in the oil and gas industry. In general, at one particular time, this latter term is applied to any accumulation of oil or gas that requires production technologies that are considerably different from those that have mostly been used until now. In the long run, as a result of the technological evolution, the term unconventional takes on the category of conventional from the time at which an extractive technology ceases to be an exception and becomes the norm. Unconventional oils include oil shale, light oil (L.T.O.), oil sands, extra-heavy oils and liquid hydrocarbons deriving from coal and natural gas (coal-to-liquids and gas to liquids). In the case of gas, Mariano Marzo states that industry classifies unconventional gases as those that are in rocks, in very unusual crystalline substances, from which it is hard to extract the gas, whether due to the low permeability and porosity of the rocks or because of the way in which the gas is lodged. It is also defined as that it cannot be extracted in a financially profitable way using the commonly-utilised technology and whose production requires special perforation and stimulation techniques to be used. This entails an excess cost and, in general terms, it means that producing unconventional gas very much depends on market gas prices. As the I.E.A. says about unconventional gas, this includes shale gas, tight gas, coal-bed methane (C.B.M.) and methane hydrates, as well as those known as “poor gas” and “acid gas”.

The article then goes on to present an estimate the resources at the global level, at the same time as evaluating their potential production costs. Once the abundance of these and the economic viability of extracting them (without internalising the costs associated with the CO₂ emissions generated) has been confirmed, the article goes on to focus on the geographical distribution of the unconventional oil and gas resources. The aim is to find out whether their geographical location may represent a counterbalance to the current concentration of the conventional resources in certain regions of the planet. Subsequently, he moves on to analyse the prospects for production during the next two decades, identifying the potential leading players and evaluating the possibility of unconventional resources, which constitute a real and long-lasting alternative to the current hegemony of OPEC and the Middle East, in the case of oil, and of this latter region and Russia in the case of gas. An assessment is made of the change that producing unconventional hydrocarbons could introduce in the current exporter-importer balance sheet of the different countries and regions. In this way, he seeks to recognise changes in the direction of the commercial movement of oil and natural gas, as well as the possible trends of re-organising the current map of world trade and the possible implications that such a reorganisation could have on the security of global supply routes. The author of the article states that the methodology used to cover the objectives of his studies basically consisted of the detailed study and a summary of the data and conclusions presented in several recently-published reports of the International Energy Agency. The article concludes with an extensive presentation of conclusions relating to both unconventional oil and unconventional gas and it features a final reflection on unconventional hydrocarbons and energy dependency, applied to examining the different paths that the US and Europe will foreseeably follow in the medium and long-term.

In his article, "The rise of China and its energy supply", I. García Sánchez asserts that there is no doubt that China has become the fundamental geostrategic factor for understanding the geopolitical context of the first half of XXI century. From the energy viewpoint, following A. Sieminski, he maintains that institutions should "accommodate" China's energy growth potential without generating geopolitical friction that could lead to a crisis that provokes situations in which the realistic trends towards a "zero sum" scenario predominate. The article analyses the evolution of the economic growth in China within the international context. He states that in a scenario in which it economic development continues, energy will become the backbone of its growth, and so the country will have to face up to a radically new scenario. This will consist of a new energy framework of the Asia-Pacific region, being initially configured with a clear distribution of this in self-sufficient energy islands, with the vital characteristic of the porosity of a regional market. China, with its strong growth rate, is going to provide the Asian market with its continental element, in some

sense in the same way that Europe plays this role in the Atlantic region, diversifying and connecting its main sources of energy consumption, Japan, South Korea and Taiwan. At the same time, and in global terms, the Asian market is configured at the same level as the European and American one, with a clear trend towards exceeding both their supply needs. In addition, following the Fukushima nuclear plant accident and the consequent sudden nuclear development stoppage, the regional capacity to act autonomously is clearly weakened, changing radically the nature of the region's energy, from being extreme, isolated and autonomous, to conform a central element in the global energy scenario.

The article analyses the evolution of Chinese energy consumption and its coverage by the different primary energy sources, setting out the strengths and weakness of the different energy alternatives that may possibly be adopted with a view to the future. He continues by framing China as a key geopolitical factor in the energy panorama, within the historical evolution of the international geopolitical scenario. In this context, from the China perspective, it would be considered necessary a depth reform of the current global structure of energy governance, with a full review of the premises and limitations on the possible choices of the past. This could lead to a new form of international governance characterised by multi-polarity and the diversification of objectives. In this way it promotes a change in the energy paradigm, more focused on consumption, which would favour an energy security outline that is global, regional and local at the same time. The great challenge for Chinese authorities is to avoid the shortfall in energy provision that could endanger its economic growth targets, at the same time as setting the bases for the new phases of its development. These will dramatically change an energy scenario in which the intolerable levels of pollution cast doubts on the sole leadership of the Communist Party. The central element of the Chinese geostrategic vision would reside in the need to maintain the framework of international peace and stability that has assisted its growth policy, based upon a clear preference for it opening up to the overseas market.

I. García Sánchez's article moreover carries out an extensive study of China's energy resources in coal, natural gas and oil (including an examination of its potential exploitation of conventional hydrocarbons), of the demands for the supply of those fuels, of the possible routes and the necessary transport infrastructures. It also examines technological factors of special strategic value for China (such as, for example, the possible development of CO₂ capture and confinement technology, which would enable clean exploitation of Chinese coal resources) and the new post-Fukushima nuclear security scenario that has a bearing one of the vectors of its decarbonation policy and boosts the integrating trend of the energy structure in the Asia-Pacific region.

J. Cuéllar, in his article, "Cyber-security in the emerging systems of the electrical sector", analyses the use of information and communication technologies in designing smart grids, essential for integrating the new intermittent and distributed sources of energy into the electrical system. The electrical supply is one of the most important critical infrastructures to be maintained and the making the network's reliability secure is one of the most essential challenges, so the security of the cyberspace associated with the network will be crucial. The purpose of this article is specifically to present the panorama of the security of information and communication processes and those of personal data in that context, discussing the uses of smart grids in the network of the future, the risks that these entail, the security requirements and the measures necessary to provide these.

The article starts with a short historical presentation of the evolution of the characteristics of the electrical distribution network since it was created in 1882, up to the current situation that is characterised by a series of technological advances that had already been started in the middle of the last century in the field of ICTs (transistors, television, computing, robotics, Internet, etc.). J. Cuéllar examines the forces that are currently compelling the re-design of the architecture and the functioning of the electrical network and that lead us to a Smart Grid. These comprise the security of the supply, the protection of the environment, the liberalisation of the distribution system. He continues with an explanation of the characteristics of the Smart Electrical Grid, whose function would be that of undertaking the smart coordination of the actions of generators, distributors, consumers and prosumers (which perform the two roles of producing that consuming energy) in a way that is efficiently sustainable, economical and secure. Thus it facilitates the dynamic integration of generators that are ecologically beneficial to preserve the environment, getting users to actively participate in optimising the operations of the system, and offering consumers better information and possibilities of choice. The Smart Grid uses information and communication technologies (ICTs) in both innovative services and in smart technologies for monitoring, control, communication and auto-regeneration. Using these technologies makes it possible to carry out tasks that are vital for the electrical system, from acquiring and processing signals, to the technical control of the dynamic system of electrical energy flow and the integration of the actions of all of the players in one single coherent system.

The article continues by analysing the architecture and characteristics of the current system, the demands for it to be reliable and the requirements that these impose on ICT security in the electrical supply. ICT security covers different properties with many nuances, a large quantity of technical mechanisms that could be implemented in hardware or in software and a series of processes that must be followed during the

entire cycle of the system, from defining the requirements to using the system and its upgrading or correcting. The four aspects that are considered to be the most relevant ones for computer security: "confidentiality", "integrity", "availability" and "privacy". As far as distribution grids are concerned, there is no question that the most vital security property is "integrity". This is defined as the set of rules that determine how it can create or modify data (generated by sensors or introduced through users or by interfaces with other systems) and under what conditions. The four security requirements (integrity, privacy, confidentiality and availability) are top-level requirements and are independent of the devices available and the technology they are going to be implemented with. In order to guarantee these requirements, it is necessary to systematically reduce them to some more particular and specific ones, which it is then necessary to implement. Some examples of these particular requirements are: alarm systems, intrusion or attack detection, mechanisms for resisting intrusions or attacks and for recovery if this is necessary, methods of identification, authentication, authorisation and access control, as well as protocols to protect communication, the distribution of cryptographic passwords and systems for calculating the reliability of the system's elements.

The article further extensively sets out the cyber-security problems in the current electrical supply system, the role of the ICTs in the Smart Grid, and ICT security in the Smart Network of the future. Concluding, he asserts that the electrical supply Smart Grid will become a reality, given that there are a lot of pressures on modern society that compel it to follow that technological development, which has been humanity's biggest engineering endeavour. The use of information and communication technologies (ICTs) is essential but it will entail new security hazards. It is largely impossible to calculate the actual likelihood of a serious attack to the electrical supply system of a developed country taking place, now or in the future, or to know what are the functions or pieces of equipment that would be the target of those attacks. The most important thing is not to try to build completely secure systems, but rather to have a holistic concept of security that determines which processes to follow to prevent the attacks or to make them difficult, which tools to use to respond to and recover the normal functioning in the shortest possible time and before it wreaks havoc.

Geostrategic and geopolitical considerations regarding energy

Francisco José Berenguer Hernández

Chapter I

Abstract

This chapter analyses the peace and conflict aspects of the concept of “energy security” its importance in the strategic architecture of the major nations, as well as the main geopolitical factors of the current energy panorama.

Key words

Energy Security, National Strategies, Energy Interests, Geopolitics of Energy.

Some considerations about the “energy security” concept

Concept

The concept of energy security has been present in publications for a certain number of years, including the press and non-trade media, but it is apparently a recent one, or at least one that has not enjoyed the popularity of others such as road, workplace, social or even air security.

However, it has taken on such importance nowadays that it deserves a specific section in the highest-level strategic documents of practically all of the nations in our environment, as will be seen in a later section. This is somewhat different from the form of security of other sectors that include the following in more generic terms: “well-being and progress of society”, “ensuring the life and prosperity of citizens” and other similar expressions, with the exception of economic security. The latter, as a consequence of the long and deep recession that numerous nations, including Spain, have been suffering, has strongly emerged in more recent strategic thinking. Consequently, it is worth wondering the reason for this relevance and leading role of energy security in the concerns of the highest authorities and institutions of the nations.

The definition of the term “security” leads us to the “*quality or state of being reliable*”¹, which in turn is defined as:

“Unlikely to disappear, be lost, be stolen, go down, unduly commence, or fail in any other way”².

We can deduce from this that in its most simple form of acceptance, but wholly in line with the purpose of this chapter, energy security in its national dimension would be defined as the sufficient and continuous supply of the energy necessary for carrying on the life and activities of the nation, both individual and collective. Hence, from the contrary viewpoint, energy security is attained by stopping the energy supply failing, being interrupted or having its contribution reduced below the minimum necessary levels.

However, this basic concept –while it may be true– does not fully define the factors that are concurrent with a current concept of energy security, which is much more complex than that which has been stated before. In addition to this classic conception –focused on supply– it is necessary for there to be at least two extra crucial elements, as Andres says³. Both the environmental aspects relate to the extraction, transporting, processing and use of different energy products. This includes both the environmen-

¹ María MOLINER, *Dictionary of Use of Spanish, second edition*, Gredos, Madrid, 1999

² Ibid, author’s underlining

³ Richard B. ANDRES, *Energy and Environmental Insecurity*, JFQ – Issue 55, 4th Quarter, St. Louis, 2009

tal aspects relate to the extraction, transporting, processing and use of different energy products, and, in a very notable way, the sustainability of a nation's energy architecture. This is understood as being the entirety of the installations, staff, organisation, procedures, financing and policies, business and public, that take part in the energy mesh.

This comes about as the result of a concept that encompasses a huge diversity of the national capacities and even supranational ones. As this chapter will seek to show, this also has implications in the security and defence spheres.

Attention and Concern

Energy security is an earlier concern, which has already the reason for research in Spain on dates on which the economic take-off and the generalised social mobility of the population had barely commenced. In addition, in the context of conceiving national security and international relations that are very different from the current one, that vulnerability is fundamentally associated with the possible deficiencies associated with the country's defence and security functions.

In this respect, Guijarro⁴, a decade before the 1973 oil crisis, placed that uncertainty in a scenario of a possible total war with the Soviet block, as seemed natural at that time. But in essence the concept is now at least as valid as in a context of growing insecurity, even conflict, with respect to some of the most significant regions producing energy resources, chiefly, but not exclusively, hydrocarbons.

But this issue manifestly goes way beyond the availability of enough fuel for the Armed Forces and the State Security Forces and Corps. This, on the other hand, is a fundamental factor that is usually overlooked in modern analyses of the energy problem. In reality, it refers to practically all activities, at least in advanced societies.

The direct relationship between coal and the Industrial Revolution and the subsequent movement to electricity and liquid fuels led Schmidt to consider, as early as 1936 that "*energy is the fundamental pillar of the economy*"⁵. Since then, the unstoppable increase in energy consumption per capita, mainly in the so-called First World, which numerous nations joined in with increasingly quickly, ended up by giving rise to certain societies that were strongly "energy-poor". Despite the diversification of

⁴ L. GUIJARRO Y AGERO, *Mobilización de recursos económicos a favor de la Defensa Nacional –Mobilisation of economic resources in favour of National Defence*, Gráficas Yagües, Madrid, 1963

⁵ Walther SCHMIDT, *Geografía Económica-Economic Geography*, p.17, Labor Publishing House, Barcelona, 1936

useful types of energy, these were to find an answer in the need to be provided with an entire security architecture based around it.

This scale of the problem has been maintained and has even increased one decade after another in Spain as well, until culminating in the National Security Strategy, which devotes one specific section to what it calls “Energy Vulnerability”⁶. This is significantly featured in the chapter devoted to the risks and threats to national security.

Validity of the concept

In spite of the complexity of the generalised security concept of energy security in the modern day and that has been considered above to be soundly established, what is true that it is essential to make some reflections on this. These basically consist of questioning the validity of a concept which, paradoxically, appears to be unquestionable in most of the literature concerning strategy in recent years, as will be seen later on.

It is effectively considered that the term “security”, in the way it is accepted in this text, is in fact constituted in the form of an unalienable right of societies or nations. Guaranteeing that this form of security that is compromised, threatened or openly assaulted could subsequently become a public asset to be defended, even within the scope of recognition of a just war, uses the classic terminology in the words of Francisco de Vitoria⁷. Alternatively, there is the more modern right to the legitimate use of force set out in the United Nations Charter. But this right, which could easily be considered to be inviolable as regards Human or Food Safety, could this equally be extended to Energy Security?

The answer to my question is negative. Article 55 of the Charter frames the purpose of promoting “*higher standards of living, full employment, and conditions of economic and social progress and development*”⁸. These conditions are fully applicable to energy availability as Esparraguera and Molina⁹ rightly establish in asserting that the expansion of the economy directly depends on the availability of sufficient and secure energy. However, article 51 limits the use of force to legitimate defence against an

⁶ Presidency of the Government, *National Security Strategy, a shared project – National Security Strategy, a shared project*, Government of Spain, Madrid, 2013

⁷ Antonio TRUYOL SERRA, *Los Principios del Derecho Público – The Principles of Public Law, in Francisco de Vitoria*, Ediciones Cultura Hispánica, Madrid, 1946

⁸ United Nations Organisation, *United Nations Charter*, web page <http://www.un.org/es/documents/charter/index.shtml>, consulted on October, 2013

⁹ José Luis ESPARRAGUERA MARTÍNEZ and Javier MOLINA FAJARDO, *El futuro de la energía en España y su problemática – The future of energy in Spain and its problems*, Studies of the Institute of Economic Development, Madrid, 1970

armed attack¹⁰; in any event this must take place “*against territorial integrity or the political Independence of any State*”, as set out in the essential article 2¹¹.

In conclusion, it is possible to ensure that energy security as a concept does not attain the utmost degree of recognition and protection that the international community endows, but that the consideration of this is framed within the scope of the strategic interests of nations and, hence, in the field of possible competition and negotiation.

This, which does not seem to relate to the tangible reality of the national interests, is probably due to the energy security concept being coined in a context of abundance, in which the necessities of relatively limited number of developed nations with large energy consumers, could be met with comparative ease.

However, on the other hand, the growing development and indeed very positive growing development of numerous regions and nations, generally represented under the concept of emerging powers, a profound change is taking place in the international energy scenario. The extraordinary increase in energy demand of players such as China, India, Brazil, etc.¹², but also the considerable growth in consumption of numerous countries in Latin America, Africa and Asia, which is at around 70% up to 2040, as is shown in the illustration¹³,

¹⁰ United Nations Organisation, United Nations Charter, web page <http://www.un.org/es/documents/charter/index.shtml> consulted on October 2, 2013

¹¹ *Ibíd*

¹² CARPINTERO SANTAMARÍA, Natividad; *Geopolitics de la Energía I – Geopolitics of Energy I*, in *La Nueva Geopolitics de la Energía – The New Geopolitics of Energy*, Essay of the CESEDEN –*Superior Centre for National Defence Studies* no. 114, Ministry of Defence, Madrid, 2010

¹³ Energy Information Administration of the Government of the United States, Non-OECD energy consumption by country grouping, 1990-2040, <http://www.eia.gov/forecasts/ieo/world.cfm>, consulted on October 31, 2013

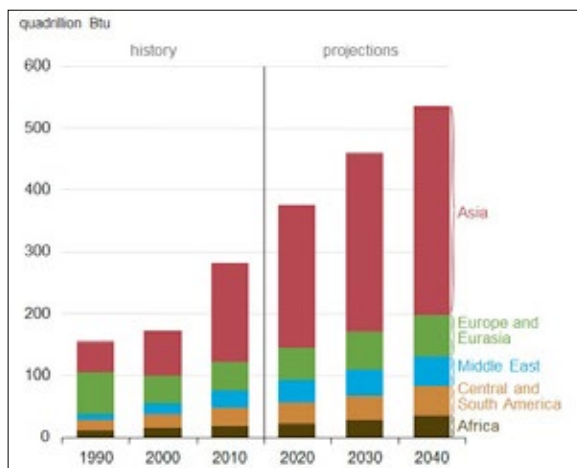


Illustration 1.

This configures a panorama of greater demand, an increase in competition and, in short, an increasingly tougher scenario in which it is necessary to even contemplate a future of relative scarcity. Above all, this applies on all matters concerning hydrocarbons. In the long run these are still expected to be essential and inalienable energy sources¹⁴.

Should this be the case at any time, in addition to the logical effect on prices, with all of the economic consequences that may arise from this, then this reality, along with the firm establishing of the energy security concept in national strategic thinking, leads us to consider the particular concept as an element that could potentially lead to military conflict.

Therefore, it is considered that energy security, as we understand this today, has been valid insofar as production has been capable of meeting the different national demands. Yet this is a high-risk doctrine¹⁵ in the not so distant future. This means that the past considerations relating to the so-called "oil-wars"¹⁶, regardless of whether these are more or less justified, cannot just hark back to that past, but also they have an outlook of concern in the future.

¹⁴ Energy Information Administration of the Government of the United States, *International Energy Outlook 2013*, http://www.eia.gov/forecasts/ieo/liquid_fuels.cfm, consulted on December 31, 2013

¹⁵ BERENGUER HERNÁNDEZ, Francisco José; África, la última reserva estratégica mundial – Africa, the last global strategic reserve, in África: riesgos y oportunidades en el horizonte de 2035 Africa: risks and opportunities in the horizon 2035, Essay of the CESEDEN - Superior Centre for National Defence Studies no. 134, Ministry of Defence, Madrid, 2013

¹⁶ Eduardo GIORDIANO, *Las guerras del petróleo : geopolitics, economía y conflicto – The oil wars: geopolitics, economy and conflict*, Icaria, Barcelona, 2003

The foreseeably most effective alternative for reversing this trend, which on the other hand is very similar as far as it concerns the rest of the genuinely strategic resources, or at least alleviate it until it is possible to maintain it within the parameters governed by the laws of trade and diplomacy, is what is usually known as “energy efficiency”¹⁷, but which should more properly be called responsible consumption. This is what Esparraguera and Molina defined as the “*rational use of internal resources*”¹⁸. However this applies not just to the particular resources, but also the rational use of all of the energy resources used, also and chiefly, the imported ones.

Only a high degree of responsibility in energy consumption could support the international efforts of a nation, or group of nations, in their policies aimed at achieving energy security. Should things work out differently, these efforts and actions performed will lose credibility and, above all, legitimacy.

Going beyond that, regardless of the new resources that are located – the seabed in the Middle East, the Arctic, etc. – the concept of energy security has to transcend its national nature, so as to become established as a supranational and global paradigm. This means that, in addition to the factors included in it and that have already been described above, there is that of responsible consumption and that of international complementary action and coordination. Who knows if it is only in this way will it be possible to avoid a return to other times in which the prevailing eagerness in men and, ergo, in the societies made from them, was the struggle for the more basic resources¹⁹, even in the form of inter-states conflicts, which are now not so common and seen as unlikely.

Energy security in global strategic thinking

In any case, and regardless of the concept that is specifically adopted by one international player or another, what is true is that energy is one of the cornerstones on which modern strategic thinking is established. Consequently, it is worth reviewing how the energy sphere is considered in some of the nations around us and even in others with significance in

¹⁷ Enrique SORIA LASCORZ, *Escenarios Energéticos – Energy Scenarios*, in Energy and climate in the field of security and defence, Security and Defence Documents of the CESEDEN --Superior Centre for National Defence Studies- no. 58, Ministry of Defence, Madrid, 2013

¹⁸ José Luis ESPARRAGUERA MARTÍNEZ and Javier MOLINA FAJARDO, *El futuro de la energía en España y su problemática –The future of energy in Spain and its problems-*, p.136, Studies of the Institute of Economic Development, Madrid, 1970

¹⁹ Jesús JIMÉNEZ, *Los primeros conflictos bélicos – The first military conflicts- In la Península Ibérica –The Iberian Peninsula*, in Military History of Spain – Prehistory and Antiquity, coordinated by Martín Almagro-Gorbea, Ministry of Defence, Madrid, 2009

the international community which, away from that area, conceive of their strategies in a different way.

Spain

As a framework in which to set the rest, it is said that the treatment of energy documents in Spain in the highest-level strategic documents is continuous. Thus, in the *Spanish Security Strategy, everybody's responsibility*, of 2011²⁰, in defining Spain's vital interests, it specifically cites, amongst others, well-being, development and economic security. Although the word energy does not appear, nonetheless, their influence on the three concepts stated is decisive, as is obvious.

So, albeit indirectly, it can be considered that energy security is considered to be a vital interest for the country. This constitutes the top level in categorising national interests. Besides, chapter 4, devoted to the threats, risks and responses that have a bearing on national security, makes express mention of *Energy Vulnerability*²¹ as one of these. In developing this theme, it underlines the need for the diversification of the sources of and the provision of energy, energy saving and efficiency, the liberalisation of the markets and the development of the infrastructures, at the same time as stressing the priority that controlling maritime space represents for Spain, as this is the route whereby most of our energy imports come in.

In chapter 3 of the most recent *National Security Strategy, a shared project*, devoted to the risks and threats, includes and continues with the concept and the terminology; speak again about *Energy Vulnerability*²², placing emphasis on the small degree of interconnection regarding this with Europe. This aggravates the risks of our excessive foreign dependence. In considering the different risk factors that have a bearing on this vulnerability correct, it introduces elements such as the political stability of hydrocarbon producing regions or even terrorism against energy production elements or transport elements.

Following that, in chapter 4, devoted to strategic lines to dealing tackling the threats, the energy vulnerability up to 11 of these lines are spelt out, with a leading role for supplying, distribution and consumption, including the necessary efficiency and sustainability²³.

²⁰ Presidency of the Government, *Spanish Security Strategy, everybody's responsibility*, Government of Spain, Madrid, 2011

²¹ Presidency of the Government, *Spanish Security Strategy, everybody's responsibility*, p.59 Government of Spain. , Madrid, 2011

²² Presidency of the Government, *National Security Strategy, a shared project*, p.29, Government of Spain, Madrid, 2013

²³ Presidency of the Government, *National Security Strategy, a shared project*, p.45, Government of Spain, Madrid, 2013

In summary, current Spanish strategy values the nation's vulnerability appropriately as regards energy, and the importance of carrying out active policies aimed at safeguarding this vital interest- somewhat more than strategic- of our country. It is to be expected the strategy's development is to be implemented, and that the new national security architecture, currently under construction²⁴, entails the creation and regular functioning of a permanent energy sector committee which the strategy itself, in chapter 5, calls Specialist Committees, such as the Support bodies for the National Security Agency²⁵. There is no doubt that this energy sector is very necessary.

The European Union

In the absence of a more up-to-date document, it is necessary to make reference to the *European Security Strategy, a secure Europe in a better world*²⁶. Notwithstanding its age and the fact we are necessarily dealing with a consensus-based document, it is fair to acknowledge that behind its well-intentioned subtitle, there lies a valuable document, in which it is stated that:

*"Energy dependency is a reason for particular concern in Europe, which is the world's largest importer of oil and gas."*²⁷

It goes on to state that a large part of European energy imports come from the Persian Gulf, Russia and north Africa. However, later on, in the short chapter devoted to the threats, energy vulnerability does not appear as such. Possibly, the previous express allusion to Russia and other nations does not lead to recommending including this concept as a threat. However, the sense of the text leaves no room for doubt, placing energy at the same level of concern for all of the Union as Spanish strategy does.

The document mentioned, colloquially known as the Solana Strategy 1, was followed years later by the Solana Strategy 2, actually called the *Report on the application of the European Security Strategy, offering security in an evolving world*²⁸, which, *de facto*, constitutes an updating of European

²⁴ At the time of writing this chapter, the Statutory National Security Act, the first and most important development of the National Security Strategy, is currently being drafted.

²⁵ Presidency of the Government, *National Security Strategy, a shared project*, p.57, Government of Spain, Madrid, 2013

²⁶ European Union, *European Security Strategy, a secure Europe in a better world*, Brussels, 2003

²⁷ European Union, *European Security Strategy, a secure Europe in a better world*, p.3, Brussels, 2003

²⁸ European Union, *Report on the application of the European Security Strategy, offering security in an evolving world*, Brussels, 2008

Strategy, including the energy sector in the section on *Global Challenges and Main Threats*²⁹.

The North Atlantic Treaty Organisation

NATO does not have a security strategy as such. However, its highest-level document, the Strategic Concept³⁰, goes a long way towards performing the same function, as happened in the previous case of the EU. It is a document that is very hard to prepare, both because of its multi-national nature and due to the fact of having the approval of each and every one of the members of the organisation.

In this Concept, consideration is given to energy vulnerability, including it as part of other difficulties relating to the environment and resources. In fact, the Alliance has the Energy Security Section of the NATO Emerging Security Challenges Division, which clearly demonstrates not just the allied concern in the issue, but also the direct connecting of energy with security and geopolitics.

However, both that connection and the great diversity of NATO members NATO – and hence of situations and interests – mean that energy is not yet an essential topic in the Alliance’s political activity, as Rühle declares³¹. Nonetheless, we need to take account of the fact that the energy factor has been present in many of NATO’s actions in recent years. It is enough to look at the recent case of Libya as a clarifying example.

United States of America

In the same way as with the Spanish model, when it comes to defining the United States interests at the highest level, known as “permanent” in this case, it is called a strong and prosperous economy, but not as regards energy as such. The same reasoning is used as in the point devoted to Spain so as to ensure that what is said in the American document is equivalent to placing energy security at this top level.

²⁹ European Union, *Report on the application of the European Security Strategy, offering security in an evolving world*, p.3, Brussels, 2008

³⁰ NATO, *Active Engagement, Modern Defence*, Strategic Concept for the Defence and Security of the Members of the North Atlantic Treaty Organization, 2010

³¹ Michael Rühle was director of the aforementioned Energy Security Section of the NATO Emerging Security Challenges Division in 2011, http://www.nato.int/docu/review/2011/Climate-Action/Energy_Security/ES/index.htm, consulted on October 9, 2013

Subsequently, in dealing with the threats and risks³² it sets out how energy dependence is one of these, which can only be curious for a country that is walking straight in the direction of energy self-sufficiency. In fact, no specific reference is made to energy in a strategic document that is coincidental but extremely interesting, which is called *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*³³, published in 2012, but rather something much more generic in relation to the movement of merchandise and free trade. This means that the new edition of the National Security Strategy, planned for 2014, will be a good indication of the new American perception of its energy reality and –and this is the most interesting thing– of the international energy scenario that will take the form of the aforementioned self-sufficiency of the leading world power.

The United Kingdom of Great Britain

In a similar way to that of Spain, the United Kingdom identifies energy vulnerability as a risk to national security, even though it formulates this in a much more explicit way, directly making reference to the interruption of the oil and gas supply or price instability³⁴. In addition to this, there is the declaration of financial and economic insecurity, directly influenced by energy availability, as the most important challenge that the country is facing. Energy vulnerability is again the biggest step of the concern of a relevant nation in the international panorama.

France

The terminology used is the French strategy, which takes the form of a different document, the *White Paper on Defence and National Security of France*³⁵, of 2013, is the same as in the Spanish case, including energy vulnerability as a threat. On the other hand, in the same way as with the British case, it especially highlights the hazardous nature of the economic and financial instability.

The French case, within its great similarity with the other documents studies and the specific nature of the French energy model, barely stands out for its insistence on the need to maintain a suitable “energy mix”,

³² The White House, *The National Security Strategy of the United States of America*, Washington, 2010

³³ The White House, *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense*, Washington, 2012

³⁴ Her Majesty's Government, *A Strong Britain in an Age of Uncertainty: The National Security Strategy*, London, 2010

³⁵ Presidency of the French Republic, *Livre Blanc Défense et Sécurité Nationale – 2013*, Direction de l'information légale et administrative, Paris, 2013

boosting the national energy transport grids system, as well as energy saving, efficacy and sustainability.

China

In the conclusions section of the White Paper on China's Energy Policy³⁶, it states that "*Energy is the vital material base for China to modernize and build a moderately prosperous society*"³⁷. This constitutes a sentence that is sufficiently resounding in itself. But in the case of this country, given the complexity of its diplomacy and of its particular internal dynamics, the facts are more revealing than these words. In a very notable sense, within these facts we can highlight the set of actions aimed at guaranteeing its energy supply, which Marketos³⁸ considers are made up of large investments in explorations and prospecting all over the world, its participation in trans-national oil and gas pipeline projects, the establishing of a considerable strategic oil reserve strategy, an ambitious oil-refineries building plan, the development of its own natural gas industry and finally, the opening up to foreign companies for the exploitation of resources in its own territory.

Manifestly, this set of actions show the maximum prioritising and a dimensioning of energy to the highest strategic level. In fact, along with the rest of the most important strategic resources at one step immediately below, it seems that energy constitutes the main Chinese strategic concern. This is currently framed in the growing attention of the United States towards area that are close to its territory, and that Peking considers essential for its energy security, as Ríos rightly points out³⁹.

The Russian Federation

Although it is in a situation that is very different from the other nations or organisations presented in this short list, it is also interesting to look at how energy is considered in the strategic documents in an energy giant such as the Russian Federation.

³⁶ Government of the People's Republic of China, China's Energy Policy 2012, English version at http://www.gov.cn/english/official/2012-10/24/content_2250497.htm#

³⁷ "*La energía es el recurso vital esencial para modernizar y construir una sociedad razonablemente próspera*" – "*Energy is the essential vital resource for modernising and controlling a reasonable prosperous society*", author's translation

³⁸ Tharassy N. MARKETOS, *China's Energy Geopolitics*, Routledge, New York, 2009

³⁹ Xulio RÍOS PAREDES, *China: poder y civilización en el siglo XXI – China: power and civilisation in the XXI Century*, in *Las Potencias emergentes hoy: hacia un nuevo orden mundial – Today's Emerging powers; towards a new world order*, Strategy journal of the SISS no. 151, Ministry of Defence, Madrid, 2011

It is clear how the Russian strategic culture has evolved from its 2009 National Security Strategy. This shows it moving away from a traditional use of force, and determinedly moving towards an increase in the use of its growing economic and diplomatic power.

The conclusion –and signs of this have been seen in its recent past- is that Russia considered energy to be one of its main advantages for achieving its strategic objectives⁴⁰. This includes its coercive use of energy, as some European nations have already experienced. However, this reality should be played down as compared to other large producers, as will be seen.

Conclusion

Many more examples are possible. All of these concern nations with influence in the international panorama, but the short simple analysis included is more than enough to conclude that energy, its security and vulnerability, or even its use as one of the pillars of soft power of some countries –even though in this case the term soft can be extensively argued about- is and will continue being one of the factors that is not only present, but also decisive in the thinking and the international strategic panorama, perhaps permanently.

Energy in geostrategy

The concept of geostrategy, which is traditionally exclusively related to the military field, has a much broader dimension nowadays, aimed at the study of the large topics – military, economic, political – on a global scale, and not just in relation to geography. This is understood in its modern conception, not just its physical one, in these topics. In Brzezinski's words "*it is the strategic management of geopolitical interests*"⁴¹. Consequently, the geostrategic dimension of energy is directly related to geopolitics, to the point at which they mutually influence and place conditions on each other. The limits for both disciplines are diluted in this sphere.

The factors that influence the geopolitical reality of energy are based around two different facts, in its geostrategic interaction at the highest level. The first of these, closely associated with the peace and conflict studies concept of history, deals with a reality which is that confers a genuinely geostrategic dimension to energy. This concerns the irregular geographical layout of energy resources or the possibility of obtaining them by means of

⁴⁰ Norbert EITELHUBER, *The Russian Bear: Russian strategic culture and what it implies for the West*, In Connections, the Quarterly Journal, volume IX, No. 1, The PFP Consortium Editorial Board, 2009

⁴¹ Zbigniew BRZEZINSKI, *The Grand Chessboard: American Primacy and its geostrategic imperatives*, Paidós, Barcelona, 1998

applying technology. This is a circumstance that may be considered to have a bearing on the different manifestations of energy that are known, to a greater or lesser extent. Even in the eras prior to industrialisation, different societies enjoyed disparate stocks of firewood or different wind systems, looking at the two main energy sources at that time.

However, it is true that the different types of energy currently being exploited suffer from the effects of this non-uniform distribution in a different way.

Thus, for example, oil is distributed in a very irregular fashion, being plentiful in the sub-strata of some regions or countries and yet practically absent in other zones or territories. In the continental distribution below, or by extensive geographical regions, we can see the data about tested reserves in 2013, in hundreds of thousands of barrels. In spite of the lack of data on North America, as a consequence of the non-availability of those corresponding to the United States, it is enough to look at the figures of Europe and the Middle East so as to confirm a form of distribution that is now not just irregular, but unbalanced in the extreme⁴².

North America	NA
Central & South America	325,92957
Europe	12,01863
Eurasia	118,886
Middle East	802,15706
Africa	127,58911
Asia & Oceania	47,22352

Illustration 2.

This fact, together with the existence of large consumer areas –while these are different from those of the largest producers in many cases – is one of the geostrategic factors that has had the biggest influence in the XX century, possibly the chief one, and that is going to continue doing so in the XXI. Already, back in 1936, Schmidt considered that:

*"oil... is the essential goals of those contained. Its geographical distribution will determine the direction and intensity of the potential lines of geopolitics for decades"*⁴³

⁴² US Energy Information Administration, Government of the United States of America, <http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=5&pid=57&aid=6&cid=regions&syid=2013&eyid=2013&unit=BB> [visited: 14/10/2013].

⁴³ Walther SCHMIDT, *Geografía Económica – Economic Geography*, p.23, Editorial Labor, Barcelona, 1936

His words were very much on the mark, because besides decisively setting the conditions for the main campaigns of World War II, largely on the Russian front and in the Pacific, oil would largely take a leading role in the tensions and disputes of the second half of the XX century, above all after the 1973 oil crisis, as a direct political consequence of the Yom Kippur War⁴⁴.

As regards the influence of oil in the crises and conflicts to come in the XXI century, nothing seems to detract from its influence at this time, but rather quite the opposite, until it definitively declines and is replaced by other energy sources, a very far-off scenario.

This same outline is repeated, with growing significance, if we consider natural gas and even the minerals that are conveniently refined and constitute the fuel of nuclear plants. To a lesser extent coal, which in bygone days was the source of territorial ambitions in the XIX century and first third of the XX century. This, while being highly significant in the global energy panorama, does not mean that there are comparable tensions over hydrocarbons now. Therefore, this joins the other energy sources that are not directly associated with producing zones, but rather the availability of suitable technology and the financial capacity to use it on a large scale.

Amongst the latter, we can talk about wind energy, solar energy, and hydraulic energy, those which come from bio-mass, wave energy and geo-thermal energy. While always taking account of the fact that it is impossible not to associate zones that are more or less favourable for each one of these. Evidently, the potential as far as solar energy is concerned, the countries of southern Europe in comparison with those of the north of the continent, Iceland's special condition in relation to geo-thermal energy or the inability to make use of the hydraulic energy of nations with very dry climates, are clear examples of this association. Then again, it can be considered that in the foreseeable future, the potential for military conflict of these types of energy is very low or nil.

The second fact, which derives directly from the previous one, is the need to transport the energy produced or the resources that make it possible to obtain certain locations over others. It is thus focused on the land or sea communication routes that make it possible to connect producers with consumers.

The conjunction of both levels sketches out the energy geostrategic scenario. Oddly enough, the two biggest modern day fields of thought in this field, which are apparently exclusively contrary and mutually exclusive come together, and their presence is manifest now.

⁴⁴ Albert FORT NAVARRO, Enrique Martínez Ibañez, *El conflicto palestino-israelí – The Israeli-Palestinian conflict*, Editorial Diálogo, Valencia, 2002

Effectively, the control of the terrestrial areas that mainly produce hydrocarbons and uranium, take primary in the energy equation. This reality is wholly signed up for the idea of the driving idea of Mackinder work⁴⁵, with the particular feature of passing on the concept of "heartland" to these zones, which appears as illustrated in the map below⁴⁶ concerning the main areas of oil supply.

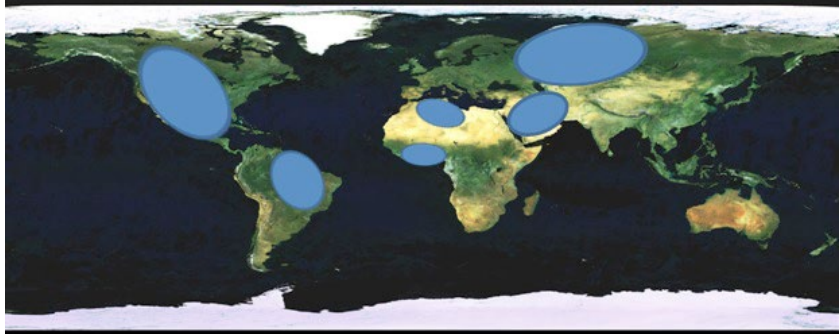


Illustration 3

As regards natural gas, the resulting map is similar⁴⁷.

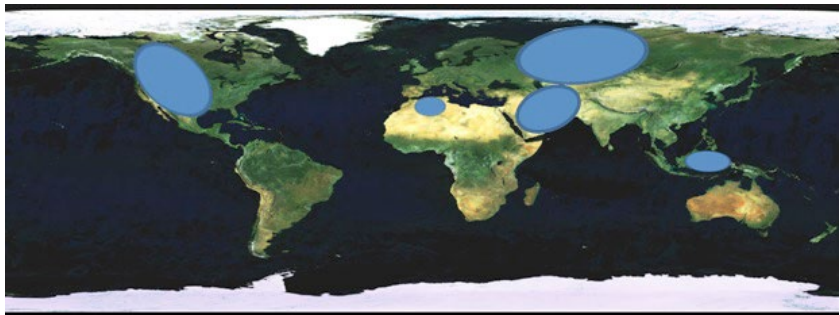


Illustration 4

⁴⁵ Haldford J. MACKINDER, *Democratic Ideals and Reality*, National Defense University Press, Washington, 1942

⁴⁶ Author's illustration, based upon the satellite map, courtesy of NASA. <http://www.zonu.com/fullsize2/2009-11-04-10810/Mapa-Satelital-del-Mundo.html>

⁴⁷ *Ibíd*

However, the one corresponding to the main uranium producers incorporates additional regions to those that have hydrocarbons, such as Australia, part of the Sahel and the southern African cone⁴⁸.

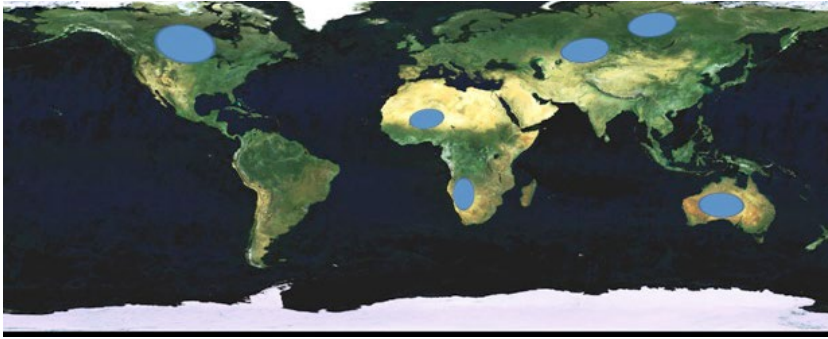


Illustration 5

From this it can be seen that the energy that, as set out above and according to the criteria adopted in this chapter, are more associated with specific territories and hence bring about geopolitical tensions, there is a global map in which large geographical extents in the seven continents are recorded. These constitute the current energy *heartland*.

On the other hand, both with respect to the extracting of offshore hydrocarbons⁴⁹ and, as is very much the case, in the extremely heavy sea traffic of energy products, Mahan's theories are currently being applied. These state that "*the use and government of the sea is and always has been a great factor in World History*"⁵⁰. This effect, which is generally valid, is moreover reinforced in nations such as Spain, in which a very considerable part of the energy resource imported come by sea to our ports.⁵¹

For this reason, a large part of the attention on and concern about the international strategic is focused on the control of sea routes and, more specifically, on the ability to keep them open and free from unlawful interference that negatively affects free movement of merchandise, and very notably, of oil, gas, uranium, coal, etc. So, it is not strange to observe

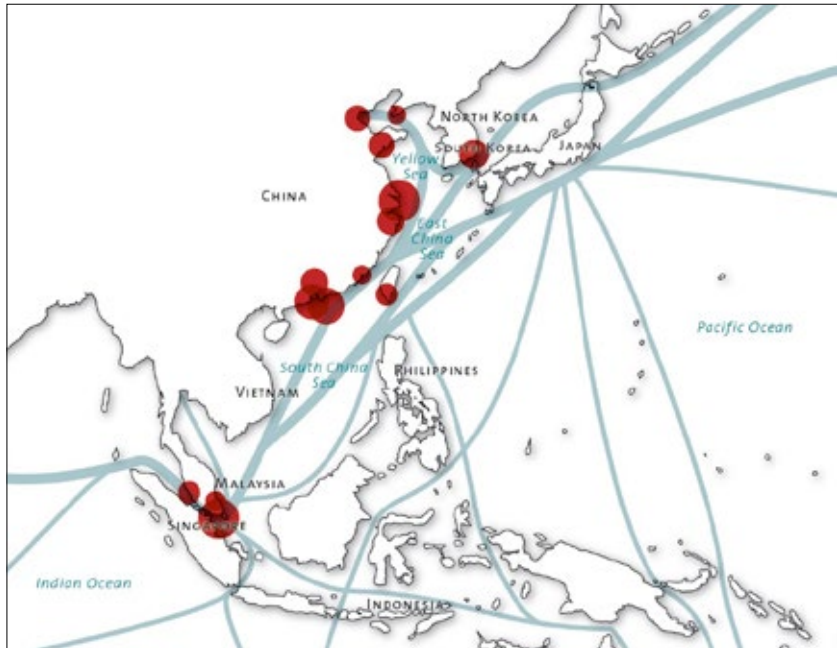
⁴⁸ *Ibíd*

⁴⁹ At sea, away from the coast, by means of platforms fixed to the seabed

⁵⁰ Alfred THAYER MAHAN, *Influencia del Poder Naval en la Historia –Influence of Naval Power in History*, critical review by Gonzalo Parente Rodríguez, p.69, Ministry of Defence Madrid, 2007

⁵¹ Soledad SEGOVIANO MONTERRUBIO, *España ante el reto de la seguridad energética – Spain and the challenge of energy security*, OPEX work document, http://www.SISS.es/Galerias/fichero/colaboraciones/2011/EspanaSeguridadEnergetica_OPEX.pdf, consulted on November 21, 2013

multiple contemporaneous studies that take up the space of the growing disputes and tension in the Indian Ocean and the seas near China. These, in addition to a certain number of incidents, are provoking an unprecedented naval step-up in the region.



Main sea routes and ports in the Far East⁵²

This situation, in addition to which there are pirate activities and concern that the Iranian nuclear programme and its potential consequences in relation to the Strait of Ormuz, mean that the Indian Ocean and its adjacent seas can today be considered to be the angular sea space in the energy square. However, the other routes that circumnavigate the planet and whose sensitive points are the well known chokepoints⁵³, such as the aforementioned Ormuz, Bab el Mandeb, Suez, Panama, Dardanelles, the straits that close off the Baltic Sea, etc. cannot be overlooked.

Thus, following a short reflection concerning the two great trends in geo-strategic thinking, we can do no else but conclude that, nowadays, and in

⁵² UNCTAD Review of Maritime Transport 2012 and Hofstra University Department of Global Studies & Geography, at the Center for Security Studies, *Strategic Trends 2013*, Zurich, 2013

⁵³ In the maritime sense of the word, mandatory narrow points of passage that communicate seas and oceans and that are affected by a high density of sea traffic.

the long-term future as well, energy is a geostrategy and one of the most important factors, if not the primary one, is geostrategy.

Energy in geopolitics at the start of the XXI century

Following the reflections of the previous points, and having established the energy issue in geopolitical interests, the strategic thinking and, in short, the interest of nations and even the particular ones of individuals, the only thing left is to conduct a short review of the main focuses of attention, either globally or in a regional dimension, that could make up the energy geopolitical panorama.

General Trends

The continuous thrusting of the emerging economies

In spite of the inevitable fluctuations about the economic growth data of the main economies, in a long-cycle perspective, it seems inescapable that the strong demand for energy resources from the emerging economies have been maintained. The forecasts of the movement of the global GDP tilt towards Asia⁵⁴, very particularly focus on this trend there.

This is because, as very clearly happens in the case of China, this is not just a question of how much is consumed, but also what type of it is. The recent publication of the White Paper on Energy Policy of this country in 2012 that has already been mentioned⁵⁵ reveals some clues about the evolution of what is now the main global energy producer.

Faced with its voracious image as an importer, our attention is drawn to the fact that it is 90% self-sufficient. But this situation, which would represent a very satisfactory scenario for most European nations and Spain of course, conceals an unsustainable reality, As Hidalgo points out⁵⁶, coal takes up 70% of consumption and it makes this high degree of self-sufficiency possible, but it has meant that unsustainable environmental situations have been reached⁵⁷.

⁵⁴ PwC Economics, *World in 2050, The BRICs and Beyond: Prospects, challenges and opportunities*, http://www.pwc.com/en_GX/gx/world-2050/assets/pwc-world-in-2050-report-january-2013.pdf, consulted on October 22, 2013

⁵⁵ Government of the People's Republic of China, *China's Energy Policy 2012*, English version in http://www.gov.cn/english/official/2012-10/24/content_2250497.htm#

⁵⁶ María del Mar HIDALGO GARCÍA, *El Libro Blanco sobre la Política Energética de China de 2012 – The White Paper in China's 2012 Energy Policy*, http://www.SISS.es/Galerias/fichero/docs_analisis/2012/DSISSA53-2012_LibroBlanco_PoliticaEnergetica_MMHG.pdf, consulted on October 21, 2013

⁵⁷ Energy Information Administration of the Government of the United States, *China Analysis Brief*, 2013, <http://www.eia.gov/countries/analysisbriefs/China/china.pdf>, consulted on October 22, 2013

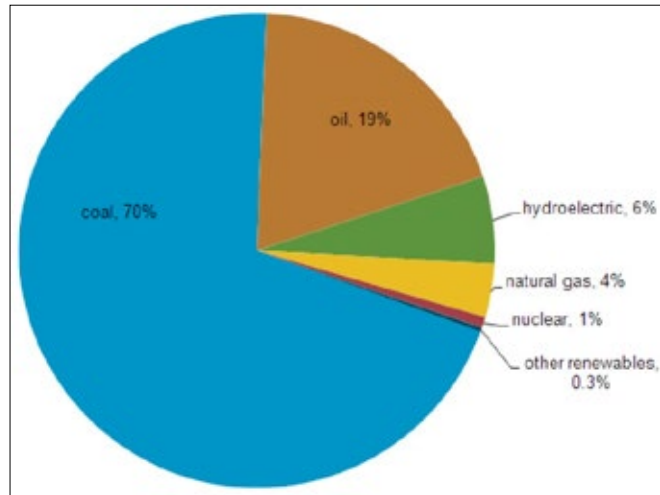


Illustration 6

Emphasis is placed on both energy efficiency and environmental preservation in both the 2011 Chinese Council of State document, *“Comprehensive Work Plan on Energy Conservation and Emission Reduction during the 12th five year period”*⁵⁸ and the White Paper that has been mentioned.

These policies, together with the rapid expansion of car-making, also for private cars, necessarily lead to a gradual reduction in the significance of nuclear, hydro-electrical and hydro-thermal energy and, without doubt, oil and natural gas. A greater dependency on imports and an increasingly pressure from Chinese demand in the international hydrocarbons market arise from the increasingly greater necessity of these two elements stated above.

In the case of India, this leads us to similar conclusions. The carbon impact of the fourth largest energy consumer in the case of India is lower than that of the other continental giant⁵⁹,

⁵⁸ *Ibíd*

⁵⁹ Energy Information Administration of the Government of the United States, *India Analysis Brief*, 2013, <http://www.eia.gov/countries/cab.cfm?fips=IN>, consulted on October 21, 2013

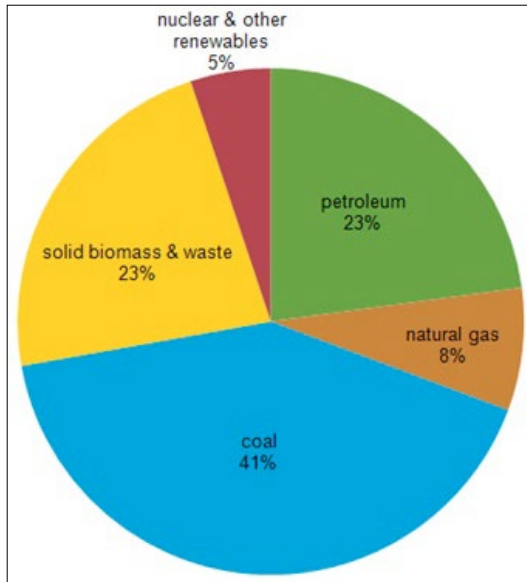


Illustration 7

but the country is strongly dependent on imported oil the consumption of natural gas is increasingly held at about 10% per year, mainly with a view to replacing the polluting coal in electricity production. The Indian government anticipates that gas imports will double in barely 5 years⁶⁰, mainly in the transporting of Liquid Natural Gas (LNG) via sea.

These two examples – the main ones in any case – are sufficient to observe the trend that the emerging economies are going to mark in the scope of study in this chapter. Since demand by developed countries is not going to notably decrease, and it will even increase considerably in the coming cycle of bonanza after the current recession, and furthermore there is the slow but continuous increase in the consumption levels of the economically less affluent countries- this augurs a future in which the pressure on the main hydrocarbon producing zones is going to be maintained and increase inexorably.

Greater political instability and uncertainty in high production zones

However, in addition to this circumstance, it is necessary to add another one that is not new, but which has worsened recently. Indeed, political instability in the Maghreb and, above all, in the Middle and Far East, has

⁶⁰ Ibid

always been a relevant geopolitical factor in the energy scenario. Periods of tension and conflict in this vital part of the world have immediately been echoed in the international markets, principally since 1973. Like the sword of Damocles over the principally western economies and the Japan of yesteryear, in a way that is practically global today, the successive events in a broad arc drawn from Algeria to Iran, has startled the treasuries of our countries time and again.

However, these crises have usually been in a short-term pattern and had a partial effect. This had made it possible to resolve risk episodes successively and, in short, in an acceptable way.

The generalised crisis scenario that is developing or that may start up in practically a majority of the region indicated, due to one main cause or another one – but all of these framed in the recently initiated processes of the political transition of Arab countries, partly coincidental and largely discordant, and of the Iranian nuclear crisis, as well as the ongoing Palestinian-Israeli conflict- leads to a period of regional uncertainty that has never been experienced before. Of course, the effect of this comes in different waves and conditions, on large gas and oil producers, and of both, and even with a significant effect on the provision of nuclear uranium, as in the case of Niger. In some cases this occurs by means of turbulent political processes that are underway, foreseeable in other cases – under this heading, the cases of the Gulf monarchies is clearly likely – and even with civil wars that are underway now or that may potentially break out.

In this way, the words of ambassador Moreno in stating that “*the Sahel Maghreb region is therefore a concern of the highest rank in all European chanceries*”⁶¹, can be extended to the entire region mentioned above, including its neighbouring seas, chiefly the Indian Ocean area. A concern that feeds into the range of instability is the new governments whose solvency remains to be proven, divided states where organised crime, piracy and terrorism prosper easily and territories in which they are seen to be affected, from the production to storage and the transporting of the energy. It even affects the physical insecurity of facilities and the staff of the energy sector. This all takes place within a set of political processes that are convulsing the entire region. It is right to fear that these are only at the beginning, and so the episodes of extreme complexity could be on the horizon.

In relation to this point, on April 2, 2011, President Obama very noticeably insisted on the need to reduce American oil dependency.⁶² In addition to

⁶¹ Ángeles MORENO BAU, Ambassador at the Spanish Special Mission for Energy Affairs and Cooperation, *Relaciones Internacionales en materia energética –International relations on energy matters*, in Energy Journals n. 38, Spanish Energy Club, Madrid, 2013

⁶² Francisco José BERENGUER HERNÁNDEZ, *La necesaria reducción de la dependencia del petróleo – The necessary reduction of oil dependency*, SISS, <http://www.SISS.es/Gale->

the reasons outlined, of economic and environmental natures, there were doubtless those arising from the geopolitical risk from the –at that time– very embryonic political transition movements in the Arab world.

But two objections can be raised to this stance. The first of these is that the United States energy horizon makes it possible to emphasise that desire and its transformation into effective policies, something that does not happen in most of the countries in our milieu.

The second is its lukewarmness –something that President Obama could not know about at that time or now– of the most extreme situations deriving from the “Arab springs”. This has not yet affected any of the major oil producers. Therefore, these have been able to largely cushion the biggest effects suffered by other countries, especially the Libyan civil war. But in the event of a major conflict taking place in any of these large producers, the effect on the global economy would be immediate and profound.

Search for new zones for the exploiting of hydrocarbons

Consequently, the issue is not to produce a disengagement from foreign oil, which is a utopia for many nations, but rather to reduce the percentage burden of the energy imports from the regions with the greatest geopolitical risk. But in moderation.

Indeed, the case of the Gulf monarchies is clear. The current ruling system in most of these is sustained in their societies thanks to the high level of profits from the exporting of hydrocarbons, which is generously distributed amongst the population. There is no doubt that in the event of that generosity being seen to become destined to end or to be drastically reduced, the internal tensions existing in those countries would flare up, in the same way as it has done in its neighbours that are not so blessed by the wealth of its subsoil.

So, it is necessary to blend the reduction of the dependency on these suppliers – which is considered necessary at this time – with maintaining the stability in these. This is because their collapse would give rise to the collapse of the global hydrocarbons market. In this respect, the discovery of new wells and seams in these potentially problematic suppliers are still necessary and convenient. Cases such as that of the A1-129/02 well, which falls within the explorations carried out by Repsol⁶³ in Libya after the civil war, are positive. But it is hard to overlook the fact that the most convenient policy consists of the greater diversification of the suppliers and, very notably, in the search for new zones that are complementary

rias/fichero/docs_analisis/2011/DSISSA10_2011ReduccionDependenciaPetroleo.pdf

⁶³ Libremercado, October 21, 2013, <http://www.libremercado.com/2013-10-21/repsol-realiza-en-libia-un-nuevo-descubrimiento-de-petroleo-de-gran-calidad-1276502281/>

to but do not replace the ones that are traditionally being exploited. In this regard, the most recent news is hopeful, because the identification of hydrocarbon reserves in numerous locations has multiplied. These will require some time to be made operational.

This is the position, together with the increase in the pressure on zones that have already been identified that are going through a time of greater stability and fewer tensions and disputes. The role of Sub-Saharan Africa, the north American sub-continent and possibly the Arctic, will take on a more significant role in coming times. There are also very positive expectations on the coasts of numerous countries of the American continent.

But also, going beyond a search outside their own territories, it is more necessary than ever to have the required development for the most beneficial exploitation of own resources.

Diversification of routes

Along with diversification at origin, making alternative routes operational for energy products, both land and sea, increasingly takes on greater importance. In a gradual but sustained way, we are immersed in a process of global entanglement of the piping of hydrocarbons. The main goal of this long and costly process has a lot to do with the creation of alternative routes, detours and interconnections that make it difficult to block the flow of oil or gas as a consequence of conflicts, terrorist attacks, natural disasters or any technical accident.

Making sea routes secure –despite the existence of the chokepoints referred to– is relatively straightforward, as is demonstrated by the containing of piracy in the Gulf of Aden or the Strait of Malacca. However, the land routes are virtually indefensible, apart from certain critical nodes, stations or facilities. Consequently, it is necessary to take their extreme vulnerability on board. Therefore, alternative routes must be available that make the blocking or destruction of specific stretches bearable. These blockages could affect just a few metres or the entire territory of a nation.

There is even the possibility of establishing land routes that are alternative to sea chokepoints and vice-versa. Examples of this policy –which is right any way we look at it– are the Abu Dhabi Crude Oil Pipeline, which connects the Persian Gulf to the Gulf of Oman and other projects interconnected with this that are shown in the map below.⁶⁴

⁶⁴ GlobalResearch, *The Geo-Politics of the Strait of Hormuz: Could the U.S. Navy be defeated by Iran in the Persian Gulf?* <http://www.globalresearch.ca/the-geo-politics-of-the-strait-of-hormuz-could-the-u-s-navy-be-defeated-by-iran-in-the-persian-gulf/28516>, consulted on October 22, 2013

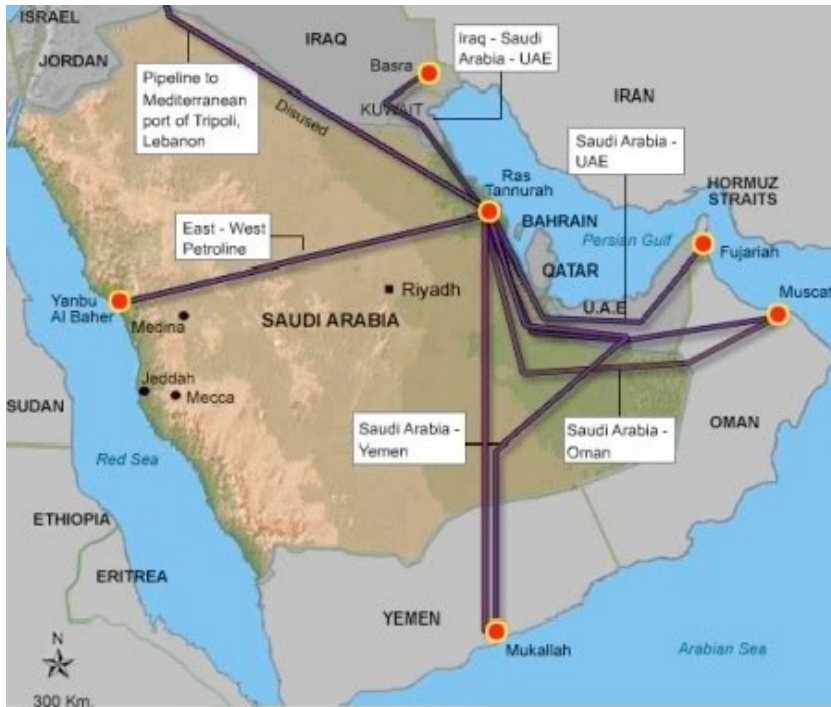


Illustration 8

These will manifestly seek to minimise the dependency on sea transport through the Strait of Ormuz as far as possible, as this has many times been threatened the Tehran regime⁶⁵.

With this regional mesh finally becoming operational, the unequivocal interconnection between geopolitics, geostrategy and energy, dealt with in the opening points of this chapter, will be fully demonstrated. This is because the construction of these routes is due to the geopolitical influence of the tense relationships between Iran and a large part of the international community. At the same time, their existence will considerably reduce the Iranian geopolitical influence in the region, by weakening one of the main advantages of exercising a coercive influence in the international energy market.

To put this in another way, energy is not just a major factor in geopolitics, but it also creates its own geopolitics. Perhaps the most recent example of this assertion is the evolution of the situation concerning the Arctic. This now stands out not only as a future zone for hydrocarbons

⁶⁵ Francisco José BERENQUER HERNÁNDEZ, *Fintas y Amenazas en Ormuz – Feints and Threats in Ormuz*, SISS, http://www.SISS.es/Galerias/fichero/docs_analisis/2012/DSISSA08-2012_FintasyamenazasenOrmuz_FJBH.pdf

extraction, but also as a new sea route that, as the current climate trends are confirmed, will represent a new region of huge significance in global geostrategy, with the corresponding litigation and tensions between the “coastal” countries^{66 67}.

Redefinition of nuclear and renewable energies

The main of energy sources other than fossils are at a time of doubt as a consequence of two facts, which are specific but that have considerable impact. They very well-known Fukushima nuclear accident, and the serious economic recession has affected the increasing and developing renewable energies, due to their higher cost.

So we are at a time for reflection as regards the future role of both sectors, but the analysis from an eminently geostrategic viewpoint offers few doubts about their positive influence.

Weighed down by political, ideological positions and those concerning security, at both national and international levels, it is true that nuclear energy –as far as the provision of combustible materials for the plants is concerned– is only partially affected by the regional instability that has been so much remarked on, mainly in the Sahel. On the other hand, significant exploitations of uranium are situated in locations such as Canada, Australia, Central Asia or the southern African cone, can be seen in the following table⁶⁸:

⁶⁶ Elena CONDE PÉREZ, *El Derecho Internacional ante el proceso de cambio climático en el Ártico. Especial referencia al Derecho del Mar – International law in the climate change process in the Arctic*, Security and Defence. Documents of the CESEDEN -*Superior Centre for National Defence Studies*” no. 58, Ministry of Defence, Madrid, 2013

⁶⁷ Gonzalo SIRVENT ZARAGOZA, *Nuevas rutas de navegación a través del Ártico – New navigation routes through the Arctic*. Documents of the CESEDEN -*Superior Centre for National Defence Studies*” no. 58, Ministry of Defence, Madrid, 2013

⁶⁸ World Nuclear Association, *World Uranium Mining Production*, July 2013, <http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Mining-of-Uranium/World-Uranium-Mining-Production/>, consulted on November 21, 2013

Country	2005	2006	2007	2008	2009	2010	2011	2012
Kazakhstan	4357	5279	6637	8521	14020	17803	19451	21317
Canada	11628	9862	9476	9000	10173	9783	9145	8999
Australia	9516	7593	8611	8430	7982	5900	5983	6991
Niger (est)	3093	3434	3153	3032	3243	4198	4351	4667
Namibia	3147	3067	2879	4366	4626	4496	3258	4495
Russia	3431	3262	3413	3521	3564	3562	2993	2872
Uzbekistan	2300	2280	2320	2338	2429	2400	2500	2400
USA	1039	1672	1654	1430	1453	1660	1537	1596
China (est)	750	750	712	769	750	827	885	1500
Malawi					104	670	846	1101
Ukraine (est)	800	800	846	800	840	850	890	960
South Africa	674	534	539	655	563	583	582	465
India (est)	230	177	270	271	290	400	400	385
Brazil	110	190	299	330	345	148	265	231
Czech Republic	408	359	306	263	258	254	229	228
Romania (est)	90	90	77	77	75	77	77	90
Germany	94	65	41	0	0	8	51	50
Pakistan (est)	45	45	45	45	50	45	45	45
France	7	5	4	5	8	7	6	3
total world	41 719	39 444	41 282	43 764	50 772	53 671	53 493	58 394
tonnes U ₃ O ₈	49 199	46 516	48 663	51 611	59 875	63 295	63 084	68 864
percentage of world demand*	65%	63%	64%	68%	78%	72%	85%	86%

Table 1

These are reliable zones at this time and many of them are even very difficult to destabilise, even in the very long-term. In addition to these there is the very considerable Russian production. So the supply of uranium minerals does not seem to be threatened –from a global viewpoint – although local situations could affect the interest of particular consumers, as has been the case with the French company Arevaen with the recent crisis in Mali. There, energy interests have been part of the problem. But there is no doubt that part of the solution lies in a very necessary military intervention led by France.

The group of energies referred to as renewables present even fewer problems with a geostrategic basis. These include the CO₂ capture and storage techniques, especially associated with the availability of technologies and sufficient financial capability.

Hence, taken as a whole, and from a geopolitical viewpoint, nuclear energy and renewables are positive, taking account of the fact that they are less subject to instability and tensions and disputes in the specific production areas.

Besides, many of the main infrastructures can be installed in the particular territory, although the transporting of the energy produced, essentially electricity, may be subject to risks that are similar to those described

for the land transportation of hydrocarbons, above all in the progressive international interconnections.

However, going even further beyond that, their nature as being cleaner forms of energy than those of fossil origin, above all in comparison with coal, contribute towards moving away from and reducing environmental risks. These are not just worthy considering in themselves, but this also because of their influence on other risks such as irregular migratory flows and even emergencies and disasters⁶⁹.

In short, and taking all of the factors above into account, the influence of the energy sources that are alternatives to fossil fuels, is decidedly positive. But, at the same time, it is necessary to define their portion and their contribution and to realistically design their cohabitation with coal, gas and oil. Reports such as "*100% Renewable Electricity – A roadmap to 2050 for Europe and North Africa*"⁷⁰ seem to be excessively optimistic, perhaps because it focuses on economic and market data and forecasts, as well as the fundamentally environmental ones. It neglects regional geopolitical factors that are rather less optimistic, but with a very notable capacity to influence the proposed projects and even, in certain circumstances, make them unviable.

We are fully aware of the impact on the security matters of our nations from the development aid to the potentially unstable countries, but we must also be aware of the contrary aspect, that is, the risk of providing disincentives to said development. As almost always happens, this is a question of applying balanced policies, which look at the problem from a comprehensive viewpoint.

As one example, it is enough to think of the scenario of social risk and instability that could be represented by an Algeria or a Libya that see their exports of hydrocarbon and their incomes considerably reduced.

Unconventional techniques of extracting hydrocarbons

Together with the preceding elements, as has been indicated, this is likewise the time to reinforce the exploitation of own resources, investing in explorations in the national territory and, above all, making progress in the usage of the new technologies that make it possible to make the resources located and available profitable.

⁶⁹ Presidency of the Government, *National Security Strategy, a shared project*, Government of Spain, Madrid, 2013

⁷⁰ Enrique SORIA LASCORZ, *Escenarios Energéticos – Energy scenarios*, in *Energía y clima en el área de la seguridad y la defensa – Energy and climate in the security and defence field*. Security and Defence documents of the CESEDEN Superior Centre for National Defence Studies no. 58, Ministry of Defence, Madrid, 2013

Geostrategic and geopolitical considerations...

In this field we can especially highlight the field of hydraulic fracturing and the extraction of shale oil and gas that this technology makes possible⁷¹, to the extent that its recent emergence has led to a significant change in the international energy panorama.

In the following map⁷² we can observe how a rather biased report from the United States *Energy Information Administration* sketches out a scenario that is more similar to that of the distribution of coal on the land surface than that of oil. That is to say, a more distributed presence that benefits a much larger number of regions and countries with its presence.

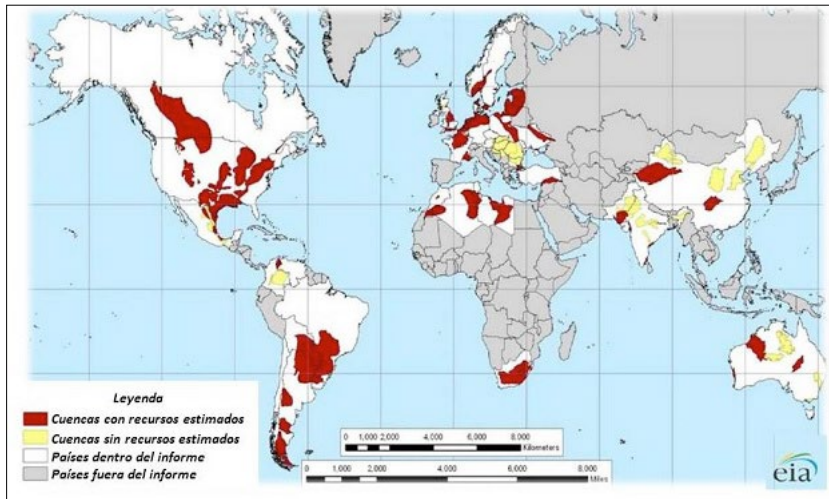


Illustration 9

If these observations will be extended to a larger number of zones, the unconventional extraction of hydrocarbons will soon be considered to be a factor in the geopolitical easing of tension, which combines with the similar effect referred to of nuclear energy and renewable energies.

Given the profits to be obtained, considering these from a comprehensive perspective, the doubts of an environmental and economic nature that these processes awaken deserve to be studied, stripping away preconceived ideas and considerations other than the scientific criteria that enable us to determine their viability and security.

⁷¹ Fernando Liborio SOTO SÁEZ, Shale gas and neo-strategy of the USA., SISS, http://www.SISS.es/Galerias/fichero/docs_opinion/2013/DSISS066-2013_NeoestrategiaEEUU_FernandoSotot.pdf, consulted on October 22, 2013

⁷² Energy Information Administration of the Government of the United States, *EIA World Shale Gas Resources; Technically recoverable reserves*, Washington, 2011

If these doubts are ultimately resolved, this “new” energy source would be provide very valuable resources that would enable us to move on towards future energy scenarios, then with reduced dependency on imported hydrocarbons, in a calmer way and with less potential for tensions and disputes.

USA strategic retraction-expansion

The over 17 trillion dollars of debt of the United States of America⁷³ are an example of the expansion of the United States’ role as a leading world power over many years. Following the ending of the ideological face-off with the Soviet Union, we can question the leading role of strategic interests concerning energy resources in the extensive and intensive exercising of that leadership, since about 1990.

The answer is not simple, since this is an intangible concept, which links economic interests that can be measured with political motivations and decisions that cannot be as well measured. This has been excessively simplified, with numerous authors and a large part of international public opinion considering that assuring the exporting of raw energy materials in regions as instable as north Africa, the Middle East or the Gulf of Guinea, regularly and with acceptable prices, has been the cause of a large part of foreign United States interventions in recent decades and, ultimately, the main motivation of its foreign policy.

Conflicts are seldom due to one single cause – they are polytelic in on Bouthoul’s terminology –, although economic interests almost inevitably arise in all of these. The causes are frequently confused with the economic effects and vice-versa. However, the aforementioned peace and conflict studies allows for economic causes to be the determining or ultimate reason for wars in the so-called “poverty wars”⁷⁴, although the limit on more simple or primitive societies, in which this is considered to be one of the biggest errors in the arguments of a very worthy author, on the other hand. Thus, asserting that “*When dealing with complex societies, it is hard to accept poverty amongst possible grounds for war*”⁷⁵, which is more questionable today. This applies above all when it refers to the poverty of energy resources, the driving force of the economy and well-being and, in the case of the absence of these, in turn causes all types of poverty that are apparently more primary, including that of food.

⁷³ Stephen DINAN, *U.S. debt jumps a record \$328 billion — tops \$17 trillion for first time*, The Washington Times, October 18, 2013

⁷⁴ Gaston BOUTHOU, *Tratado de Polemología –Teatise on Peace and Conflict Studies*, Ediciones Ejército, Madrid, 1984

⁷⁵ *Ibíd.*, p. 360

Oil poverty above all is thus accepted as more than just a main cause of numerous conflicts in which more advanced societies take a leading role. It is easy to include that, in fact, energy security has been one of the main causes and motivations of the American over-extending and excess effort –diplomatic, economic and military–, basically since the end of the First World War and, very particularly, since the end of the Second.

However, thanks to the unconventional hydrocarbons techniques, the United States is probably going to reach energy self-sufficiency between 2020-2030⁷⁶⁷⁷, to the extent that it will become a net oil and gas exporter, as shown by the recent and plentiful investments for converting regasification plants under construction in gas liquefying plants on the north American coasts. That is to say, an abrupt change in gas importing infrastructures in exporters. This, by the way could assist a country such as Spain, given our significant regasification capacity and the relatively low expected price of US gas

Thus, this would be a case of suspended poverty that has the capacity to produce substantial variations in the geopolitics of energy and, as a direct consequence, in the global strategic panorama.

The United States administration, ensuring that vital interest, is focusing on a nation building policy, which in the field of the defence and security issues entails general austerity and –as far as what really concerns with respect to the others – greater containment and selectivity when it comes to planning its overseas power. As has already been stated in previous papers⁷⁸, this trend does not mean it is abandoning its role as a leading power, but there is a certain strategic contradiction. This will necessarily translate into a more careful selection of the actions it gets involved in –and what is perhaps most interesting for the European allies – a reduction in the US capacities to contribute to those crises that do not directly affect its essential interests.

⁷⁶ KPMG, *Most Energy Execs Indicate Potential For U.S. Energy Independence By 2030, Some Say 2020: KPMG Survey*, <http://www.kpmg.com/us/en/issuesandinsights/articlespublications/press-releases/pages/most-energy-execs-indicate-potential-for-us-energy-independence-by-2030-some-say-2020-kpmg-survey.aspx>, consulted on November 21, 2013

⁷⁷ International Energy Agency, *North America leads shift in global energy balance, IEA says in latest World Energy Outlook*, <http://www.iea.org/newsroomandevents/pressreleases/2012/november/name,33015,en.html>, consulted on November 21, 2013

⁷⁸ Francisco José BERENGUER HERNÁNDEZ, *European Union, el necesario paso adelante en seguridad y defensa – European Union, the necessary step forward in security and defence*, SISS http://www.SISS.es/Galerias/fichero/docs_analisis/2013/DSISSA16-2013_UE_Seguridad_y_Defensa_FJBH.pdf

If we add in the fact that United States energy interests abroad are passing on from what is vital or essential to what is merely strategic, to the evidence that the planning capacities of European powers are much more limited than they have invariably required of the “United States umbrella” to be something rather more than testimonials, it must be concluded that the new United States energy reality is a fundamental factor when it comes to considering the energy security of the EU countries in the coming decades.

Nonetheless, this intention coincides with what is its well-renowned possible capacity, including the country’s energy exporting capacity. This could make the United States into the “perfect power” in the coming decades, given that its immense technological, industrial, demographic, food, diplomatic, military, etc. capacities would be combined with the disappearance of its Achilles heel of recent decades, its overseas energy dependency.

Should this highly likely circumstance be confirmed, the United States of America will be shown to be the most important hegemony in history. This would contribute towards reducing the already diminishing significance of Europe even further, Considering this as a whole, as much as the individual nations, without France, Germany, the United Kingdom, Italy or Spain, to name just the biggest ones, they could escape from irrelevance in the event of not going more deeply into the European Union project.

Partial conclusions

What Schmidt had already been considered to be an evident truth in 1936, “*fuel and its scarcity will continue being the decisive forces of the global policy*”⁷⁹, does not seem to be very different in the near future, in spite of the appearance of additional energy sources as relevant as nuclear and the so-called renewables since that time.

Consequently, the four main elements as regards hydrocarbons: the need to distribute a growing level of production amongst more consumers who are even more expansive, the exploitation of resources thanks to the new extraction technologies, the increasingly greater of various of the production zones with greater capacity and, finally, the relative decrease in US interest in those production zones, are probably going to sketch out the guidelines that are going to include the large energy-related topics in the coming years, above all in their geopolitical and geostrategic dimension.

Europe, and very particularly, the Spain that is very dependent on overseas also and very particularly must – in addition to others that for many reasons are not the subject matter of this publication – tackle security and defence

⁷⁹ Walther SCHMIDT, *Geografía Económica – Economic Geography*, p.51, Editorial Labor, Barcelona, 1936

reinforcement, for reasons related to its energy security. This reinforcement mainly takes place through genuine European convergence. The peremptory need for a capacity that can be planned and is credible for autonomous action by the EU, which does not exist now, which, together with its acknowledged financial and political capacity, may not be so far off as it may seem. This would contribute, amongst other relevant issues, to its future energy security. Maybe this need, which is completely opposite to the selfish national trends that the current crises has contributed towards reviving within the Union, could provide an impulse to the stagnant European Union project.

Points of potential regional friction

Given the diversity of energy products, its producers, consumers and transit routes, the points of friction potential at the regional level tend towards infinity, and so only those that are currently considered to be most relevant are included.

Strait of Ormuz

Of all of the points of passage that the extensive fleet of oil and gas ships –which largely guarantee the supply of hydrocarbons–, have to pass through, possibly one of the most problematic one, but just now, but also historically, is the Strait of Ormuz. All of the vessels that sail in it, at its exit point, enter the Arabian Sea and they are then divided into two main routes, one going eastwards and the other westwards.

The quantitative importance of this passage is, consequently, most of the chokepoints detected, with about 35% of worldwide oil, and therefore closing it, whether temporarily and regardless of the cause, would severally harm the global economy.

But its security lies precisely in the matter of importance. The chief risk, consisting of an interruption of traffic in direct Iranian action, within the context of its international confrontation as a consequence of its nuclear programme, is very remote. Both the West and the emerging Asiatic powers, inevitably with a leading role of the Chinese, are supplied through Ormuz. In this way, could Iran be allowed to severely and simultaneously damage the strategic interests of friends and those that are not friends alike? Can the main exportation route of its energy resources, thus extraordinarily aggravating its delicate economic situation be denied in itself? With this act, is it intentionally going to provoke a military confrontation with the United States and the rest of the West, plus Israel, which it has so curiously sought to avoid because of its more than probable military nuclear programme? In this way, is it going to endanger the very survival of a theocratic regime that sometimes shows itself to be more precarious than what it appears to be?.

A positive response to the previous questions seems rather unlikely and, in any event, as was stated in other documents⁸⁰ an Iranian blockage of the strait would be more the product of a reaction to an external attack targeted at neutralising its nuclear programme than a previous unilateral action by the Tehran regime. It would be a classic headlong rush towards a situation of extreme crisis and as a survival ploy by the particular regime.

In this case, Ormuz could be used as an economic-political weapon in a way that is similar to the reduction in production and price escalation caused by the Arab countries as a deterrent against supporting Israel in 1973⁸¹.

Therefore, the current climate of separation from the possibility of said preventative attack on its nuclear installations, the recent election of the new President Hassan Rouhani, is considered to be representative of the regime's moderate faction⁸² and an incipient thaw between Tehran and Washington that takes the form of a round of negotiations in Vienna with the P5+1 format⁸³, and the even-more-recent Geneva pre-agreement⁸⁴, seem to significantly reduce the blockading of the Strait of Ormuz in the foreseeable future.

The terrorist threat, which is more difficult to evaluate than the current attitude of the government of Iran, is real and potentially serious, given the relative fragility of oil tankers, and above all, gas carriers, in waters as shallow and narrow, together with its dense traffic, makes its routes not just predictable, but in practice they can be perfectly well determined and they are unchanging. However, the list of interests that would be damaged by an action of this type, headed by the Gulf monarchies –both in terms of their needs to sell their energy products and of others who buy them– followed by Iran itself, plus its main international clients, with China, India and even the United States at the to present a level of response for the terrorist group leading the action that the latter, a rational player at the end of the day, has to carefully weigh up the consequences of its action.

Furthermore, the control of the coasts surrounding the points that are most advantageous to attack are in the hands of nations that are directly

⁸⁰ Francisco José BERENGUER HERNÁNDEZ, *Fintas y amenazas en Ormuz –Feints and threats in Ormuz*, SISS, http://www.SISS.es/Galerias/fichero/docs_analisis/2012/DSISSA08-2012_FintasyamenazasenOrmuz_FJBH.pdf

⁸¹ Albert FORT NAVARRO, Enrique Martínez Ibañez, *El conflicto palestino-israelí – The Palestinian-Israeli conflict*, Editorial Diálogo, Valencia, 2002

⁸² Saeed KAMALI DEGHAN, *Iran: Hassan Rouhani wins presidential election*, The Guardian, June 15, 2013

⁸³ Simon HENDERSON, Olli HEINONEN, *The Need for Speed in Negotiations with Iran*, The Washington Institute, <http://www.washingtoninstitute.org/policy-analysis/view/negotiating-with-tehran-the-need-for-speed>, consulted on November 4, 2013

⁸⁴ Stefano MARCHI, *Acuerdo en Ginebra- sobre el programa nuclear iraní – Agreement in Geneva- regarding the Iranian nuclear programme*, El Mundo, November 24, 2013

interested in the daily movement of ships, which exercise control of the intense region, including the activity of their intelligence organisations, making it considerably more difficult to mount an attack.

Nonetheless, the conjunction of the geographical determinism that the strait represents and the notable Iranian military capabilities⁸⁵ to act in such a scenario that is limited and immediate to its bases, along with the potential terrorist action that cannot be discarded, mean that this threat is sufficiently credible and unpredictable in the future so as to fully justify the correct construction plans for pipelines that use Arabian *terra firma* so as to go around such a narrow and unpredictable chokepoint as far as possible.

The Caucasus

At the end of the Soviet Union, new relevant scenarios came to light for the international community within the scope of availability of energy resources, energy ones in particular, that had been encompassed in the giant dismemberment until that time⁸⁶. The most significant one of these is the geographical continuity –which is not now political– consisting of the Caucasus, the Caspian Sea and the central Asian republics.

In addition to its particular production capacities, the territories that make up the Caucasus have taken on great importance, as a consequence of its position as a land bridge that makes it possible to construct hydrocarbons transport lines from the offshore teams of the Caspian Sea and from the central Asian republics on their path to Europe. The need to avoid the Russian monopoly of these pipelines, repeatedly expressed by the EU, mainly after the successive episodes of crisis between Russia and the Ukraine and their repercussions on third countries, is the basis of this Caucasian geostrategic revitalisation.

Nabuco, the most significant and outstanding EU Project, in spite of many fluctuations, problems and doubts that may arise⁸⁷, the BTC⁸⁸ and the group of other projects that –from the Caucasian ports and through the

⁸⁵ The International Institute for Strategic Studies, *The Military Balance 2012*, Routledge, London, 2013

⁸⁶ Antonio ALONSO MARCOS, *Asia Central después de 2014: implicaciones de la retirada de Afganistán – Central Asia after 2014: implication of the withdrawal from Afghanistan*, SISS, http://www.SISS.es/Galerias/fichero/docs_marco/2013/DSISSM17-2013_RetiradaAfganistan_AntonioAlonsoMarco.pdf

⁸⁷ Alex JACKSON, *Nabucco Seeks to Rise Again*, Natural Gas Europe, <http://www.naturalgaseurope.com/nabucco-seeks-to-rise-again>, consulted on November 21, 2013

⁸⁸ BP, *BTC Pipeline – Project Description*, http://www.bp.com/liveassets/bp_internet/bp_caspian/bp_caspian_en/STAGING/local_assets/downloads_pdfs/xyz/BTC_English_ESIAs_Amended_Turkey_EIA_Final_incorporating_comments_Content_BTC_EIA_Volume_2_Section_4.pdf

Black Sea– reach territory of the Union. However, these are only partly useful in fulfilling their purpose, and they are not exempt from risk.

Firstly, a large part of the new regional mesh rests on the utilisation of Turkish territory as a means of direct passage to Europe or to Turkish ports from which the hydrocarbons depart. As Ruiz rightly points out⁸⁹, nobody can guarantee that Turkey will not use the advantage it has been given in due course in a coercive way. Moreover, as he rightly argues, since this is merely a country of transit, the benefits that it obtains, whilst significant, are very much fewer than those of the producer country. Therefore the temporary abandoning of these benefits is much more easily acceptable for the Turkish economy in a situation of crisis or a battle of wills in the producer companies, consumer companies, or both.

As well as the growing Turkish distancing from Europe, both institutionally and ideologically, together with its current border situation, whilst not being a scenario of instabilities and conflicts, mean that Turkey is progressively losing trustworthiness in its role as a safe energy bridge to Europe. In fact, when compared to the stability that the Russian Federation offers, and agreeing with Ruiz, it does not seem like the Turkish future ensures any advantage.

On the other hand, a Georgia that has barely started on its era following the unstable President Saakashvili⁹⁰ is not capable of guaranteeing the absence of Russian influence, as was demonstrated in the 5-Day War in August 2008. Hence, Russian financial muscle combines with the military one, with the small Caucasian republic taking the form of an essentially weak link in the energy architecture of this corridor.

The Caspian Sea

Further to the east, the Caspian waters and coasts are living through a less well-known conflict, but one that is worth considering. With an Azerbaijan that is a stable environment in a relative regional dimension, but with limited production levels⁹¹, are Turkmenistan and Kazakhstan, the leading producers –gas and oil respectively– of the region.

⁸⁹ Francisco J. RUIZ GONZÁLEZ, Reflexiones sobre la seguridad energética de Europa, SISS, http://www.SISS.es/Galerias/fichero/docs_marco/2013/DSISSM12-2013_SeguridadEnergetica_FJRG.pdf

⁹⁰ Pilar BONET, *Las elecciones en Georgia marcan el fin de la década de Mijaíl Saakashvili – The Georgian elections mark the end of Mikheil Saakashvili's decade*, El País, October 27, 2013

⁹¹ Energy Information Administration of the Government of the United States, Azerbaijan Analysis Brief Overview, <http://www.eia.gov/countries/country-data.cfm?fips=AJ&trk=m>

But the Caspian is a sea in litigation⁹². On the basis of the interests of the different coastal countries, these officially consider it a lake or Internal Sea, with its corresponding legal consequences, in which the possession of certain enclaves are disputed or they conceal with "environmental concern" what is no more than external interest with the objectives of interfering.

This situation is escalating slowly but in a sustained manner, to the extent of giving rise a small-scale naval race but one that is very considerable given the dimensions of the Caspian Sea. Thus, apart from Iran, which has always had considerable naval resources available in this area, the other coastal countries have been performing measures that are essentially of a coastguard role. However, the growth of the energy interests mentioned and the consequent territorial disputes and pushing forward the creation of genuine sea wars. Perhaps the most significant case here is Kazakhstan that is seeking to make use of Corvette warships, with specific anti-ship armaments, such as the Exocet surface-to-surface missile⁹³.

Specifically, it is Kazakhstan that is undertaking one of the biggest projects in relation to the exploitation of hydrocarbons. This is the artificial islands of Kashagan, at which five oil wells have already become operational. Located 80 km from the northern coast of the country, with reserves of 38,000 billion barrels⁹⁴, which constitute up to 40% of Kazak reserves.

Apart from what the setting underway of a exploitation with such potential represents for the market, which cannot be maximised at any time given the geological and climatic features of the region where the bourse is located, what is truly important is that Kazakhstan is adding, with even greater power, to the diverse oil enclaves –as is the case of some Sub-Saharan countries– that guarantee a growing level of production away from the more intense geopolitical convulsions that already exist, or that may come about, around the Persian Gulf.

Countries that are reasonably stable and secure such as Kazakhstan are increasingly necessary so as to provide security to large consumers. Both China and Europe are logically proving themselves to be very interested in this project, above all taking account of the fact that they are technolog-

⁹² Francisco J. RUIZ GONZÁLEZ, *Reflexiones sobre la seguridad energética de Europa-Reflections on Europe's energy security*, SISS, http://www.SISS.es/Galerias/fichero/docs_marco/2013/DSISSM12-2013_SeguridadEnergetica_FJRG.pdf

⁹³ Alexandre Calvo Cristina, *Kazajstán se suma a la carrera naval en el Caspio – Kazakhstan joins the naval race in the Caspian*, Atenea Digital, http://www.revistatenea.es/revistatenea/revista/articulos/GestionNoticias_2414_ESP.asp, consulted on November 30, 2013

⁹⁴ *Para qué ha ido Mariano Rajoy a Kazajistán – Why Mariano Rajoy has gone to Kazakhstan*, La Gaceta, November 19, 2013

ical suppliers that are craved by Astana's government. This is because of its need for equipment, infrastructures, transport, etc. that the country requires making its mineral wealth profitable and taking a leap forward with its definitive technology.

However, as has already been mentioned, the litigation and the ambitions of the different coastal States make it possible to prognosticate a local increase in tension, although nothing leads us to suppose that this cannot be contained by diplomatic and commercial means.

The China by-pass towards the Indian Ocean

Doubtless influenced by the naval power of possible competitors, as well as the much remarked-on necessity to diversify the routes of passage of energy products, about a decade ago China has embarked on the establishing of an energy corridor that carries part of its important imports from the Gulf to China by means of land pipelines that cross the territory of Myanmar, formerly Burma.

In this way, the gas and oil tankers will unload at the Burmese coast, specifically at Kyauk Phyu, where the product will combine with the offshore production of the Shwe Gas plant, so as to be carried onwards to China, as the map shows.⁹⁵



Illustration 10

⁹⁵ Shwe Gas Movement, Shwe Gas Projected Map, <http://www.shwe.org/shwe-gas-project-map/>, consulted on November 29, 2013

This installation, which is also co financed by India and South Korea, began sending its first gas to Peking at the end of 2013⁹⁶. It forms part of the projects of the emerging Asian countries in order to decrease its energy vulnerability, which contribute positively towards a greater form of regional interrelationship and integration. In this case this especially manifests itself between the Chinese and Burmese states, which had previously closely linked.

This may be a new example, this time in a positive sense, of how energy modifies regional geopolitics, contributing towards cooperation and integration and lowering the level of tension and characterisation of the strategic interests.

The succession in Algeria

In spite of President Buteflika's recent announcement, -who will stand for a new re-election in April 2014-⁹⁷, his physical condition, which has very much deteriorated following a seizure, make his succession inevitable, even if it is *de facto*. This all points towards what Cembrero points out in his article, concerning the actual exercising of power passing to Said, Buteflika's younger brother in the next legislature.

Accordingly, while it is true that the National Liberation Front apparently has the situation under control, it is no less true that the Arab uprisings have a particular impact on those nations in which a patrimonial transfer of power to the children or wives of dictators was being prepared. Therefore, the situation that comes to light represents a certain degree of risk of destabilising the country.

However, the bitter experience of civil war in Algeria seems to weigh more in the minds of its citizens, either those who know what can be expected of the militia or parties of a somewhat radical nature gaining access to power. This could inevitably lead to the overthrow -peaceful or otherwise- of the political system that has been established for some time. Besides, the perspective provided by considering the events of the neighbouring Libya or Egypt, not to mention Syria, are apparently moderating the approach of those the regime.

Therefore, whilst still giving rise to some doubts, the forecasts of events in the country that could alter the supplier role of Algeria, mainly for Spain, does not seem to be threatened in the medium term.

⁹⁶ China Daily, *Myanmar-China gas pipeline starts to deliver gas to China*, http://usa.chinadaily.com.cn/business/2013-07/28/content_16844673.htm, consulted on November 29, 2013

⁹⁷ Ignacio CEMBRERO, *Buteflika se presenta por cuarta vez a la presidencia argelina pese a estar enfermo - , Buteflika stands for the Algerian presidency for the fourth time, despite being ill*. El País, November 17, 2013

The future of Egypt, Syria, Tunisia or Libya

A good example of the pragmatism of the supplier–purchaser relations in the hydrocarbon field is Libya. With a pre-war oil production level of 1.8 million barrels/day⁹⁸, energy products represented nearly 95% of the exports and more than half of the national GDP⁹⁹. Following the inevitable incarnations of war –despite the sporadic exports of lesser quantities during the conflict– production levels have recovered rapidly. This is still significant, taking account of the chaotic situation of the country even at the time of writing these words.

The country's reconstruction and its subsequent development rest almost exclusively on the profits obtained from the commercialising of its hydrocarbons reserves, in the same way as happens in most large producers. This is despite the still recent efforts of some of these nations to diversify their economies.

Accordingly, in principle, the coming future of the Libyan internal policy, is a future that is framed within a government pertaining to political Islam, whether a more secular government or even the possible establishing of a regime that is close to a theocracy, there is no reason to suppose a risk for the exporting of its hydrocarbons.

Specific actions of a terrorist nature, or motivated by exclusively local factors of elements situated outside the established system of profits deriving from the sale of those products are possible, as they are in other locations. These could affect the security of the individuals or the facilities related to the energy business.

However, the specific type of actions referred to –in spite of their abundance– that falls into the figure of every year¹⁰⁰, have not to date meant a significant reduction in the exports of any of the international producers, regardless of the continent or the type of society they are located in, but then again in no way can their potential deadliness be overlooked.

These reflections are also applicable, albeit to a lesser extent, to those that taking leading roles in other episodes of the political transition processes of the Arab world. Small producers such as Egypt or countries that pipelines pass through such as Syria or Tunisia, to a lesser extent depend on the income from their exportation or the fees for them passing through their territories. However it is hard to give up the profits, which

⁹⁸ Energy Information Administration, official energy statistics of the United States government.

⁹⁹ World Bank

¹⁰⁰ Carlos ECHEVARRÍA JESÚS, *La seguridad energética en las relaciones hispano-argelinas – Energy security in Spanish-Algerian relations*, SISS, http://www.SISS.es/Galerias/fichero/colaboraciones/2011/DSISST01-2011_La_seguridad_energetica_en_el_Mediterraneo_SISS-IMDEP.pdf

are very significant. That this role nonetheless grants them. Above all, this takes account of their pessimistic economic situation that, as a precursor and a co-causal factor in the uprisings or revolutions, has done nothing else but worsen since that time.

The Strait of Malacca

A sea passage that is fundamental in the energy exports that head from the Gulf to the large consumers of the Far East. This chokepoint has been affected over a long period of time by a high level of insecurity and the piracy phenomenon, even more intensely and prior to the most recent and well known of that originating in the Gulf of Aden, and the western basin of the Indian Ocean.

However, maritime security in the region has increased thanks to initiatives and policies such as the *Regional Maritime Security Initiative* or the *Cargo Security Initiative*. But, above all, it has experienced a radical improvement in its medium-term perspectives. Not just because of the growing attention of this phenomenon mentioned, but also as a collateral consequence of a fact of a different nature.

The very-well known Chinese naval drive¹⁰¹ and its consequences, which some do not hesitate to class as a regional-naval arms race¹⁰²¹⁰³, is entailing a very notable development of the naval capabilities of the navies of the region. This is now –and in the not-too-distant future it will lead to– a major control capacity of the routes, and therefore, an increase in the consideration of regional maritime security. This is consequently a question of a focal point of decreasing concern.

The eastern Mediterranean. Israel as an energy power

Owing to its implications, not only as far as the energy status of nations as significant in the regional politics of the Middle East such as Israel or Syria is concerned, or its connections with the still-ongoing Cyprus

¹⁰¹ Alejandro MACKINLAY FERREIRÓS, *Las ambiciones marítimas de China – China's maritime ambitions*, SISS, http://www.SISS.es/Galerias/fichero/docs_opinion/2011/DSISS006_2011AmbicionesMaritimasChina.pdf

¹⁰² Ángel GÓMEZ DE AGREDA, Francisco MARTÍNEZ VÁZQUEZ, *Las Marinas India y China en la Geopolitics del Océano Índico – The Indian and China Navies in the Geopolitics of the Indian Ocean*, SISS, http://www.SISS.es/Galerias/fichero/docs_opinion/2011/DSISS058-2011MarinasIndiaChina.pdf

¹⁰³ Mario LABORIE IGLESIAS, *Tensiones en el Mar de China Meridional*, SISS, http://www.SISS.es/Galerias/fichero/docs_analisis/2012/DSISSA33-2012_Tensiones-MarChina_MLI.pdf

conflict, the discovery of seams such as those of Tamar, Leviatán, Dalit¹⁰⁴ and of others situated in the Eastern Mediterranean basin, constitute a significant milestones that has to be dealt with.

It is even plausible that the conditions arise in order for some of the parameters that have guided Israel's foreign policy to be altered. For example, evidently, the level of threat represented by the sustained jihadist actions in the Sinai, which have repeatedly damaged the arrival of Egyptian gas in Israel, would decrease until it becomes irrelevant in the energy sphere.

Conversely, it's a safe bet that these findings would entail a dynamisation of the regional naval policies which, in the same way as has been described in the previous point, would possibly bring a *de facto* increase in regional maritime security by the hand.

They also offer commercial opportunities that increase Israel's relationships of interdependence with some of its neighbours that have an energy shortfall, such as Jordan and mainly, the Palestinian territories. This fact would inevitably strengthen their mutual relationships, although in a parallel sense they would weaken Israeli-Egyptian relations, which are so essential in regional stability.

Lastly, it should be pointed out that this is good news for the energy-eager Europe, which could shortly become a nearby geographically gas exporter that is reliable, decreasing its dependency on other suppliers that display greater inconveniences from a geopolitical viewpoint.

In addition, the strain with Iran has barely begun, and there is the ending of the war in Syria, which equally is beginning to its show signs with the holding of Geneva 2 on January 22, 2014.¹⁰⁵ This could make it possible for Iranian products to arrive directly to the Mediterranean in a reasonable future period.

Ultimately, this is a question of potentially positive news, also for Spain.

The legal insecurity in populist governments

Although this is apparently of an exclusive nature associated with the internal policy of the nations, the proliferation of governments of this po-

¹⁰⁴ Elías COHEN, *Cuando Israel sea potencia energética – When Israel is an energy power...*, Libertad Digital, November 15, 2013

¹⁰⁵ EUROPA PRESS, The 'Geneva 2' conference will be held on January 22, according to Ban Ki Moon
<http://www.europapress.es/internacional/noticia-conferencia-ginebra-celebrara-22-enero-ban-ki-moon-20131125123526.html#AqZ16irfB1LympVi>, consulted on November 29, 2013.

litical movement also have an influence on international geopolitics and, within this, specifically in the energy factor.

This political trend, of such a broad spectrum that it is possible to find everything in them from neo-communist movements to extreme-right ultra-nationalist parties, is more a way of doing politics than an ideology, which presents certain risks for the stability of the energy markets.

Looking at the controlling elites of these types of regimes rather than at the common good, and urging the baseness of the less-formed classes of the nations where this type of political attitudes have installed themselves, the populist governments that may set themselves up in nations that export energy resources make use of tools such as compulsory expropriation or the over-emphasising of what is “national” in their relations with the foreign companies that are concessionaries of energy exports, as recently has happened in the case of Argentina with the Spanish firm, Repsol¹⁰⁶, or numerous occasions with the Bolivian natural resources for some decades¹⁰⁷.

In spite of the two examples mentioned and of the particular impact of populist governments in Latin America at present, there is no way that this phenomenon can be considered to be regional. In fact, we can observe a growth in parties with these characteristics in Europe. In some cases these already have a considerable parliamentary presence in their respective countries and, above all, a perspective of greater growth in future elections held.

On the other hand, the parties representing political Islam have flourished, with greater or lesser success, in the political transition processes that the Arab world is living through. Also, to a large extent, they are participating in many of characteristics that are particular to populist parties.

Consequently, should the number of governments that use this tactic to satisfy their national political aspirations is be maintained and even increase, there will always be a risk factor for the interests of the large importer nations and their companies in this sector. This risk, which can be summarised in the legal insecurity that populism fosters in their countries, does not nonetheless seem to be sufficiently wide-ranging to bring about situations of conflict. However, this would most likely entail a sporadic succession of events that are harmful to the global energy panorama.

¹⁰⁶ Francisco PEREGIL PECELLÍN, *Argentina expropia a Repsol su filial YPF – Argentina expropiates YRP subsidiary from Repsol*, El País, April 17, 2012

¹⁰⁷ Francisco José BERENGUER HERNÁNDEZ, *Geopolitics de la Energía II – Geopolitics of Energy II*, In the New Geopolitics of Energy, Essay of the CESEDEN -Superior Centre for National Defence Studies- No. 114, Ministry de Defence, Madrid, 2010

What is clear is that these practices, generally combined with the management difficulties that usually accompany these ways of doing politics, frighten off investments and impede the full development of the potential exporters from those countries.

The excess strengthening of Arabia, Qatar and the Arab Emirates in the international context

To some extent or other, the monarchies of the Persian Gulf have escaped the political convulsions that have led to the uprisings and subsequent political transformation processes in other Arab countries.

These particular monarchical institutions have been an element of moderation. However, there is no doubt that at present the authentic guarantee of political stability of these nations mainly rests on maintaining their capacity to subsidise a large part of their activities and the standard of living of the citizens of these countries using the profits from their hydrocarbons.

Given that these are regimes that are highly resistant to change and even, in some cases, markedly archaic, it should be asked whether what is stated above to maintain the status quo indefinitely. However to go further, this means that a future of oil and gas and oil production in decline in the distinct nations, or a progressive distancing from consumers depending on hydrocarbons as a consequence of technical evolution, could represent less stable situations in the Gulf region in the coming together of concurrent factors in these foreseeable future crises will dictate how far these will have a bearing on the energy market and, above all, on the national economies.

However in any case, this is a plausible perspective in which it will be necessary to plan measures to alleviate it. This should begin –and indeed it is already being done– from now. The instability of some of the main hydrocarbons producing zones is doubtless on the elements of the energy equation that could have most impact on the end result, which is none other than the energy security of our nations.

The diversification of regions and nations from which energy is imported has to be a policy which –going beyond all of that which has already been done– is to increase in the future. As has been remarked before, the expectations for being able to implement these policies are positive, but they should be done from the perspective of a search for an equilibrium.

Furthermore –in favour of this policy– a fact arises that is hard to measure. This concerns the disproportion of the capacity to influence –in short, of power– of several of these nations in the international panorama. This goes way beyond what their geostrategic positions, populations, etc. could mean.

In addition, this influence manifests itself, both institutionally and privately, in the expansion of ideologies, doctrines, superstitions and uses and practices that are very far from their western equivalents¹⁰⁸. Therefore, the excess strengthening of these nations referred to presents risks of a geopolitical nature in the long run. This fact reinforces the need for diversification, not just of energy sources, but also of the places of origin of the products.

The role of Russia

Specifically, and in light of what is referred to in the previous point, the huge efforts made internationally, and very notably by EU nations, to avoid gas and oil passing through Russian territory to Europe are paradoxical. It is true that Russian interests that do not wholly coincide from the western one, and it is no less true that Russia has made use and continues making coercive use of its massive power in the energy sector, as a soft power tool. On repeated occasions thus turns into *de facto* hard power, chiefly in order to influence the nearest nations surrounding them, as is the case of the Ukraine or the Baltic republics¹⁰⁹.

However, and in spite of these realities, what is true is that from a geopolitical viewpoint, Russia is potentially a main supplier that is more stable, reliable and similar to the large western consumers than the traditional ones located in the Gulf and the Middle East.

The European Union –not the nations that individually form part of it as unfortunately occurs– would do well to establish a more trusting relationship with Russia, which would obviously have to be two-way and genuine. The aim is to attain an equilibrium whereby the leading role of the Gulf as a supplier is somewhat reduced and to avoid strengthening the status of powers that follow a course that diverges from the European one too much, such as Turkey.

Ultimately this is an issue, at least as far as the energy aspects are concerned, of rescuing the essential idea of Karl Haushofer in his theory of great continental spaces¹¹⁰, back in the inter-war period of the XX century, so as not to oppose the United States and England, obviously, but indeed to establish a strategic synergy between the EU and the Russian Federation which not only – but very principally in the energy aspect– presents

¹⁰⁸ Khaled YACoub OWEIS, *Insight: Saudi Arabia boosts Salafist rivals to al Qaeda in Syria*, Reuters, October 1, 2013

¹⁰⁹ Francisco José BERENGUER HERNÁNDEZ, *La seguridad en torno a la energía y su defensa – Security concerning energy and defending it*, in the *New Geopolitics of Energy*, Essay of the CESEDEN -Superior Centre for National Defence Studies- no. 114, Ministry of Defence, Madrid, 2010

¹¹⁰ Edward MEAD EARLE, *Creadores de la estrategia moderna. III –Creators of the modern strategy III*, Military Circle, Buenos Aires, 1992

greater advantages that unsuitable in the medium and long-term, above all when contrasted to other options.

Conclusions

The capital importance of energy for our society is evident, even though it has never been sufficiently valued, at least from the viewpoint of general public opinion, which sometimes seems to demand all of the advantages deriving from an adequate energy supply but without considering the efforts and inconveniences that making this energy available entails. As an example of this importance, the words of the declaration of the General Assembly of the United Nations that Camacho sets out are revealing¹¹¹:

"...energy services have a profound effect on productivity, health, education, climate change, food and water safety, and communication services..."

This is going to continue being the case, in the same way as the dependency on hydrocarbons is going to be maintained for a long time yet. The geopolitical and geostrategic consequences that this dependency has generated are going to be maintained in the coming decades, although it is necessary to reflect on some points, which will probably introduce substantial changes into these consequences:

- I. The concept of energy security must transcend its national role in order to take on a transnational and cooperative dimension.
- II. To do this, it is essential to firmly establish responsible consumption in the entire process, from the State and the respective governments to the particular individual.
- III. Together with the energy efficiency mentioned, the diversification of energy types, producers and routes of passage, are essential tools for energy security.
- IV. The commercialisation of the hydrocarbon reserves discovered in numerous countries is to relieve the pressure on possible future scenarios involving a scarcity. However, it is necessary to establish stable legal frameworks that are observed by all of the players, in such a way that the market is strengthened with these new seams in a reasonable period.
- V. The power shares granted to certain nations as a consequence of the nature of their leading role in exporting hydrocarbons need to be reviewed, taking account of the fact that energy in-

¹¹¹ Marta CAMACHO PAREJO, *El trilema energético – The energy trilemma*, in Energy Journals (separate) no. 38, Spanish Energy Club, Madrid, 2013

terests, whilst being crucial, cannot be the only ones considered when it comes to selecting the volume of the imports from the different suppliers.

- VI. In that respect, the re-evaluation of the Europe-Russia relationship on this matter has to be undertaken from a viewpoint that draws a comparison with the geopolitical risks present in other large suppliers, especially in the Middle East.
- VII. Notwithstanding the risks of a geopolitical nature, the relative decrease in significance of certain countries in the energy market must be done carefully, searching for a reasonable balance and developing different and complementary economic sectors for those economies.
- VIII. It is also necessary to clearly define the role of nuclear energy and renewables in the coming decades.
- IX. In all of the matters above, it is essential to make significant progress in the European energy integration process.
- X. The strategic contracting of the United States, together with it possibly becoming established as a self-sufficient nation, and even a net exporter of hydrocarbons, could take the form of a scenario of the separation of European interests from the American ones, even though the commercial relations are more or less intense than they are now.
- XI. Consequently, Europe has to consider the need to considerably reinforce its capacity as regards security and defence, strengthening its integration on this matter, so as to be able to defend its energy interests in situations where there is a crisis far from its borders and that have a low priority in the scale of values of the US administration.
- XII. The example of the US in exploiting its own resources has to be carefully analysed in Europe, appraising the undoubted risks of investing in more secure technologies, but moving previous aspects of an ideological but not a technical or scientific nature away from the debate. It does not seem logical to have own resources available that contribute towards reducing the onerous energy bill of countries such as Spain, and getting lost in debates that are not very disciplined and of a short-term dimension as regards a subject of extreme complexity and long-term validity.
- XIII. Notwithstanding what has been stated above, with all of their light and shade, for Europe and especially for Spain, it does not seem reasonable to conceive of severe crisis scenarios in the

foreseeable future. There are even signs that would lend themselves to a certain degree of optimism, with probably scenarios for the oil and gas market with more moderate prices than currently exist.

Spanish energy security in a changing scenario

Gonzalo Escribano

Chapter II

Abstract

Spanish energy interdependence requires an adequate management in order to minimise risks stemming from some suppliers. This article contributes to such a task by analysing the Spanish pattern of energy interdependence, as well as the impact of a changing global energy landscape, characterised by fragmented governance. The analysis focuses in two separate dimensions of the Spanish energy interdependence pattern: the physical security of hydro-carbon supplies and the implications for economic security.

Keywords:

Energy Security, Supply Security, Economic Security, Spain

Introduction

Spain has a growing degree of energy interdependence with a relatively limited but changing number of oil and gas suppliers, which constitute the bulk of the Spanish imports of primary energy and aimed at mastering the energy security geopolitical analysis. Analysing such a complex interdependence requires developing an analysis that transcends the simplifications of the discourse about energy dependency. An independent energy system (in the event of this being possible) is not necessarily more secure than an interdependent one. It all depends on how this interdependence or this independence is managed. Moreover, the interdependence pattern is influenced by the evolution of an energy scenario in transition, although we do not know where it is going very well. Managing this is limited by the absence of a genuine overall framework of energy governance.

Amongst the recent transformation of the energy panorama, we can mention the impact of the unconventional revolution, the Arab uprisings or the deployment of renewable energies in emerging markets. In the European arena, we find ourselves with a community policy that is moving very slowly forward in integrating energy markets and the design of a common foreign energy policy, which does not only contain the Spanish energy security preferences. Finally, in the national sphere, the sector continues managing the impact of the economic recession on demand, successive energy reforms and its reaction to the global and community changes mentioned.

This article explores the Spanish energy interdependence pattern from the energy security perspective. Firstly, it sets out the nature of a global, changing and fragmented system that aims at interolarity, presenting some of its geopolitical change factors. Then an analysis is conducted of the main Spanish energy security vectors from the perspective of the physical security of supply, so as to thereafter analyse those related to economic security. The final section concludes with some energy security implications for Spain.

An international, fragmented and transitional regime

Unlike what occurs with other international affairs, global energy governance does not have international institutions that are effective in managing a form of energy security that is increasingly cooperative as the globalisation of the energy markets moves forward¹. From the perspective of international political economy, robust international systems

¹ G. ESCRIBANO (2013): "Fragmented Governance and Bounded Hegemony in the Energy Regime Complex", Background Paper of the EU-IANUS Project (The EU in an unsettled international system. Crisis, multipolarity and multilateralism), National R+D+i Plan, Ministry of the Economy and Competitiveness (CSO2012-33361)

arise when there are few conflicts of interest and, above all, when the power is concentrated. This is the case of the international systems that govern trade and the global financial aspects (the WTO, and the World Bank and the IMF, respectively), born from the American hegemony following the Second World War but with sufficient inertia and resistance so as to survive “after the hegemony”². On the other hand, when the power is fragmented, the hierarchy is diffuse and conflicts of interest abound. The small number of incentives to cooperate does not always facilitate the emergence of homogenous international regimes.

International energy governance furthermore displays an agenda that is continually expanding, where global energy security –understood in a deliberately limited manner as being supply security for consumers and demand for the producers– constitutes only one part, albeit doubtless a significant one. New topics, such as the good governance of energy resources, the fight against energy poverty, or not so new ones, such as climate change or the deployment of renewable energies, bring up some restrictions and dilemmas for energy security policies. The problem is that the group of these and other topics are not managed by one single international energy system, despite calls in favour of the creation of a Global Energy Agency³. For example, although the UN was successful in creating the IAEA in order to ensure the international governance of atomic energy, the different national governments have shown themselves to be reluctant in ceding sovereignty in other international energy aspects, leaving a normative and institutional vacuum in global energy governance⁴.

The result is a long way from constituting a robust and homogenous international system, based upon a well-defined energy power balance. Rather, it is more like a mesh of institutional arrangements that deal with the different aspects of global energy governance in a fragmented way and generally *ad hoc* responses⁵. For cases such as that of energy, whose governance does not take the form of a unique and homogenous international system, international political economy has created the category of regime complexes. These are defined as “a set of non-hierarchical in-

² KEHOANE, R. O. (1984): *Cooperation and Discord in the World Political Economy*. Princeton Univ. Press.

³ EL-BARADEI, M. (2008): “A global agency is needed for the energy crisis”, *Financial Times*, July 23, consulted on September 27, 2013: <http://www.ft.com/cms/s/0/b3630dd0-58b5-11dd-a093-000077b07658.html#axzz1Fw0w00rv>.

⁴ Karlsson-VINKHUYZEN, S.I. (2010): “The United Nations and global energy governance: past challenges, future choices”, *Global Change, Peace and Security* 22: 175–195.

⁵ FLORINI, A. and SOVACCOOL, B.K. (2009): “Who governs energy?, The challenges facing global energy governance”, *Energy Policy* 37: 5239–5248.

stitutions that partly overlap, and that govern a particular area"⁶. From their proposition, the concept has been applied to energy and associated topics, such as climate change⁷.

The adverse impact of the fragmenting of the complex of energy regimes on cooperative energy security is reinforced by the emergence of a multipolar world. Multipolarity means that only the international institutional arrangements that are able to reflect this can improve global energy governance and perform the leadership in providing global public assets related to energy, especially on a subject as sensitive as energy security⁸. The greater diversity of preferences that multipolarity involves also has a bearing on the difficulty of setting clear and objective specific priorities regarding global energy governance, eroding coordination possibilities⁹.

But the characterisation of the world as multipolar does not set out the global reality with sufficient accuracy. The trend, at least in some fields open to regulation by means of global or regional resources is rather towards interpolarity¹⁰. The global energy scenario is, in effect, characterised by both multipolarity and by a rapid increase in interdependence between energy markets. This degree of accuracy is not (just) an academic subtlety, but it also has political repercussions inasmuch as global energy governance has to move closer to it. These include managing interdependence in a relative contest of the redistribution of the balances of world power. Once again, this geopolitical reconfiguration has especially relevant implications for global and Spanish energy security.

Governance is fragmented in a regimes complex. But moreover hegemony is limited, because the different regimes interfere with others and limit their influence. Thus, the capacity for influence in oil markets OPEC producers' regime is limited, because the different regimes interfere with the others and restrict their influence. Thus, the OPEC producer regime has its capacity for influence limited in the oil markets by the capacity of the IEA to act in these. For example, this can be done by liberating strategic reserves as happened in the summer of 2011 so as to supposedly compensate for

⁶ RAUSTIALA, K. and VICTOR, D. (2004): "The Regime Complex for Plant Genetic Resources", *International Organization*, 58 (2), 277–309, p. 279.

⁷ COLGAN, J. D., R. O. KEOHANE and T. VAN DE GRAAF (2013): "Punctuated equilibrium in the energy regime complex", *Review of International Organizations*, 7 (2), 117–143; Abbott, K. W. (2012): "The transnational regime complex for climate change", *Environment and Planning C: Government and Policy* 30 (4), 571 – 590.

⁸ LESAGE, D., T. VAN DE GRAAF and K. WESTPHAL (2010): *Global Energy Governance in a Multipolar World*. Burlington: Ashgate.

⁹ DUBASH, N. K. and A. FLORINI (2011): "Mapping Global Energy Governance", *Global Policy*, Special Issue on Global Energy Governance, 2, Issue Supplement s1: 6–18.

¹⁰ GREVI, G. (2009): "The inter-polar world: a new scenario", Occasional Paper 79, European Union Institute of Security Studies, June 26. Accessed on November 20, 2013: <http://www.iss.europa.eu/publications/detail/article/the-inter-polar-world-a-new-scenario/>

the disappearance of Libyan production, but also in order to send the message to OPEC that the Agency was willing to intervene if prices carried on rising due to the geopolitical tensions related to the Arab uprisings.

The global energy scenario is hence in transition, but that transition features very specific characteristics that are very different from those that are indicated in other economic sectors. In recent years, the international energy scenario has been dominated by the unconventional revolution in the United States and Canada. The narrative of the unconventional 'hard power' of the United States seems to have imposed itself on the European alternative of the 'soft power' of renewables. This has brought about numerous and diverse readings of the strategic implications of the unconventional revolution¹¹. The most widespread geopolitical argument is that North American energy self-sufficiency ends up with conventional producers having a marginal role in the global energy scenario. Qualifications must be placed on this conclusion, at least for Spain and the EU, given the geopolitical centrality of the conventional producers and the uncertainties about the future possibility of receiving significant American gas exports in the medium-term. For the time being, the main vectors for conveying the unconventional North American revolution have been the diversion of American coal and gas from third-party suppliers to the European market and, above all, the impact on American industrial competitiveness that benefits from prices that are between 3 and 5 times lower than those in effect in Europe. This aspect is related to the TTIP that the EU is negotiating with the US. In principle, the US cannot apply restrictions to exporting to countries with which it has signed a Free Trade Agreement, but nothing would prevent their exports being regulated, restricting the authorisations to build the LNG export infrastructures. This is something that the EU cannot do anything about from the commercial perspective. Given that the unconventional revolution does not seem to be limited to North America in the medium term, the strategic priority for Spain continues to consist of ensuring the supply from its traditional suppliers and diversify towards emerging producers.

One way of assessing the changes in the global energy presence of countries is that provided by the Elcano Global Presence Index. Table 1 sets out the first 30 places in this. It shows that Saudi Arabia and Russia still hold the first two places in the energy presence ranking, a long way ahead of the producers behind them. The position changed for the other countries between 2005 and 2012, with the sharp rise of the United States being notable, as it moved from 16th to 5th place (although Canada also fell from 3rd to 7th place).

In any case, the global energy presence continues being concentrated on conventional producers and there are hardly any changes in the large sup-

¹¹ ESCRIBANO, G. (2012): "Shifting towards what? Europe and the rise of unconventional energy landscapes", Analysis of the Real Instituto Elcano, ARI 82/2012.

pliers of Spain: Nigeria goes from sixth to tenth; Iran from eight to ninth; Venezuela goes from tenth to twelfth; Algeria from no. 11 to no. 13; and Mexico from 13th to 18th. Note that, in the case of Spain, the imbalance between the energy presence index and global presence is high, reflecting the corresponding vulnerability relating to the Spanish global presence.

Table 1: Elcano Global Presence Index: EGPI and Energy, 2005 and 2012.

2005			2012				
	País	IEPG	Energía		País	IEPG	Energía
1	Arabia Saudí	79.3	840	1	Arabia Saudí	152.1	1592
2	Rusia	153.1	784	2	Rusia	243.7	1485
3	Canadá	134.3	383	3	Emiratos Árabes U.	82.3	709
4	Emiratos Árabes U.	43.5	375	4	Unión Europea	1088.3	688
5	Noruega	49.8	369	5	Estados Unidos	1012.3	680
6	Nigeria	25.2	287	6	Países Bajos	218.3	614
7	Unión Europea	763.1	285	7	Canadá	194.1	609
8	Irán	27.7	269	8	Noruega	80.2	568
9	Países Bajos	124.0	257	9	Irán	53.7	537
10	Venezuela	23.8	243	10	Nigeria	43.6	535
11	Argelia	19.9	238	11	Singapur	106.3	428
12	Reino Unido	246.8	191	12	Venezuela	36.8	410
13	México	49.9	168	13	Argelia	33.1	380
14	Singapur	49.2	147	14	Indonesia	63.1	362
15	Australia	81.8	143	15	Australia	149.4	361
16	Estados Unidos	771.7	139	16	Reino Unido	347.5	339
17	Indonesia	26.2	125	17	India	108.0	297
18	Bélgica	79.2	121	18	México	76.2	293
19	Alemania	275.3	111	19	Corea del Sur	146.1	279
20	Malasia	36.7	100	20	Bélgica	132.6	272
21	Francia	228.2	94	21	Malasia	71.4	212
22	China	144.7	93	22	Colombia	30.7	192
23	Corea del Sur	70.0	83	23	Alemania	390.7	175
24	Italia	118.6	67	24	China	308.4	170
25	India	45.4	55	25	Brasil	94.2	141
26	Colombia	9.0	44	26	Francia	297.5	140
27	España	105.0	44	27	Italia	171.5	130
28	Dinamarca	39.6	41	28	Japón	237.4	86
29	Brasil	38.2	37	29	Suecia	87.7	72
30	Argentina	20.5	35	30	España	162.8	68

Source: Elcano Global Presence Index (EGPI), various years.

A short overview of the main disturbances in European supply in recent years shows similar results: the great challenge of European and Spanish energy security fundamentally lies with conventional producers, traditional and geographically close suppliers. Starting with Russia, there is the cutting-off of the gas to the Ukraine, and in the last analysis to the EU, as well as the competition of the transportation routes of the Caspian Sea. As regards north Africa, the regional axial for Spanish energy security, the region is going through a convulsive period of time that has successively awoken fears about the future of the Suez Canal, and Egyptian gas exports; paralysing the Libyan production for months, including gas exports to Italy via the Greenstream gas pipeline; detaining any corridor project in the region, from the Syrian pains for building a gas pipeline to take Iranian gas to the Mediterranean to the prospects for exporting European gas to Europe via Syria and Turkey, moving on to definitively put the Algerian Trans-Saharan gas pipeline project in check; finally, the attack on the Algerian gas plant of In Amenas at the start of 2013.

This succession of disturbances shows that, at least for Spain and other countries of the Eastern Mediterranean, the great geopolitical frontier continues being the closest one: a north Africa spreading from the Persian Gulf to the Gulf of Guinea, and to a greater extent inasmuch as it has greater strategic depth owing to the accumulation of destabilisation vectors, both of Europe itself and of its neighbours on the southern coast of the Mediterranean. Something similar happens with the Persian Gulf, which still concentrates great levels of energy power. In the case of Saudi Arabia, in addition to this there is the significant idle capacity that it has that enables it to increase crude production quickly and to act as a kind of central banker for the oil world, compensating for the falls in production occasioned in other countries.

In this context, and in spite of the changes mentioned concerning new resources and technologies, the direct transformations of greatest importance for Spain for Spain will foreseeably derive from the evolution of the large conventional producers. That is to say, in an interpolar energy and fragmented governance scenario, the biggest challenges to Spanish energy security will come from the zones that maintain or increase the intensity of their energy interdependence with our country and in which the most complex one is the cooperative governance of energy security. Existing forecasts and predictions indicate that the energy hierarchy, based upon the interdependence of the hydrocarbons market, will have to be maintained for Spain within the scope of its traditional conventional suppliers.

Of course, this does not exempt new forms of energy cooperation with emerging countries and regions from development and from the existing one being maintained. While the ranking of Spanish suppliers may vary, places alternative between conventional producers. Above all because the transformations within that limited group of companies, which will be

identified in the next section of the article, promise to be significant and require active Spanish management.

The existing uncertainties include the extraction policies of a Saudi Arabia that are more fiscally demanding due to its need to pacify its population's socio-economic demands. This is something that, following the Arab uprisings, may spread to all of the Middle East producers and north Africa in particular for Spain; Iraq's capacity to meet expectations to increase its production disappointing until; the decision of the agreement with Iran and its impact on sanctions and on Middle East stability; the regional impact of the Syrian crisis¹²; the settling of the increasingly more diminished central Asian 'great game' and access to its resources or the Russian decisions about its gas production and supply policy; the denouement of the Chinese strategy for penetrating certain African and Latin American markets¹³; and in Latin America, the resolving of the tensions between energy nationalism and the opening up to international investment, which includes differential vectors for Spain. Examples of this include the future of the Mexican energy reform, the Brazilian capacity to exploit its resources with the current model of open nationalism, or the nationalising replicas in other producers of the region¹⁴.

Beside the transformers that the traditional conventional producers may experience, the appearance of new players transcends the unconventional revolution. For example, the embargo on Iran and Libya's difficulties have accelerated the Spanish diversification towards West Africa and Latin America. The North African geopolitical set-up now spreads wider in order to also cover the producers and transit routes from the Gulf of Guinea. As will be seen later on, the role of new suppliers such as Brazil, Peru or Colombia offers Spain a supply profile that is unique in the European Union. In addition to this, there is the role of potential produc-

¹² G. ESCRIBANO (2013): "La crisis Siria reafirma la centralidad energética de Oriente Medio" – "*The Syrian crisis reaffirms the central energy role of the Middle East*", *Comentario Elcano – Elcano Commentary* 53/2013 - 11/9/2013

¹³ ESCRIBANO, G. (2013): "Is China becoming a 'normal' oil player in Africa?", *Elcano blog*, 23 SEPTEMBER

¹⁴ The Elcano Royal Institute has a series of analyses about energy in Latin America. In addition to those that follow, there are several documents being prepared that are devoted to the geopolitics of energy in the region that will be published soon: Escribano, G. (2013): "El escenario energético de América Latina – *The Latin American energy cenari*", *Economía Exterior – Foreign Economics*, 65; Escribano, G. (2013): "Ecuador's Energy Policy Mix: Development versus Conservation and Nationalism with Chinese Loans", *Energy Policy*, 57: 152–159; ESCRIBANO, G. (2012): "La expropiación de YPF culmina el fracaso de la política energética argentina – *The expropriation of YPF culminates in the failure of the Argentine energy policy*" ARI Elcano 30/2012 - 23/4/2012; ESCRIBANO, G. (2013, at press): "Emergente y diferente: Brasil como actor energético global e implicaciones para España – *Emerging and different: Brazil as a global energy player and implications for Spain*", DT of the ERI.

ers which, in spite of their lower relative importance in terms of volume, involve relevant geopolitical connotations, such as the offshore gas resources discovered in the Eastern Mediterranean, and their implications for Israel, Egypt, Cyprus, Palestine, the Lebanon and Turkey.

As well as these cases, there is a new dimension that will reappear in the medium and long term: the geopolitics of energy renewables which, in the case of Spain, entails an added geopolitical profundity to North Africa. Note that, in a counter-intuitive but not contradictory sense if we examine this closely, greater interdependence in renewables with North Africa would not necessarily mean deterioration in energy security for Spain. There are several reasons for this¹⁵. The electricity generated from renewables –since it cannot be stored or redirected– does not make it possible to use the resources for political reasons, as happens with the so-called petro-policy (or that for gas. If a consumer's supply is interrupted, the energy that is not generated is lost forever and it leads to a loss of earnings that is hard to recover, even partially.

Furthermore, as it has a zero marginal cost because it does use fuel, its price is completely unrelated to that of fossil energy. As it has a decentralised nature, this fosters diversification and makes excessive politicised management difficult. In any event, access to an additional source, especially in a new supplier but also in a traditional one, diversifies the portfolio of energy supplies and geographical origins. This is because all diversification represents a reduction in vulnerability and an optimisation of the risks portfolio.

The energy geopolitical scenarios are hence in transition, with the appearance of new players and a re-balancing of the energy significance of the traditional players, but for Spain, these changes are not reduced but rather they reinforce the geopolitical significance of the traditional suppliers, which besides the conventional hydrocarbon reserves, host considerable unconventional resources yet to be exploited and renewable resources with great long-term potential. The following sections explore the nature of Spanish energy interdependence¹⁶. The first thing to be analysed is the physical security of Spain's supply, identifying the trends of the main vectors and the role of the key suppliers. The issue of economic security is then dealt with, emphasising the issue of the geo-economic impact on the competitiveness of the Spanish companies and the role occupied by the lack of integration of the European markets.

¹⁵ ESCRIBANO, MARÍN and SAN MARTÍN (2013): "RES and risk: Renewable energy's contribution to energy security. A portfolio-based approach", *Renewable and Sustainable Energy Reviews*, 26, pp. 549-559.

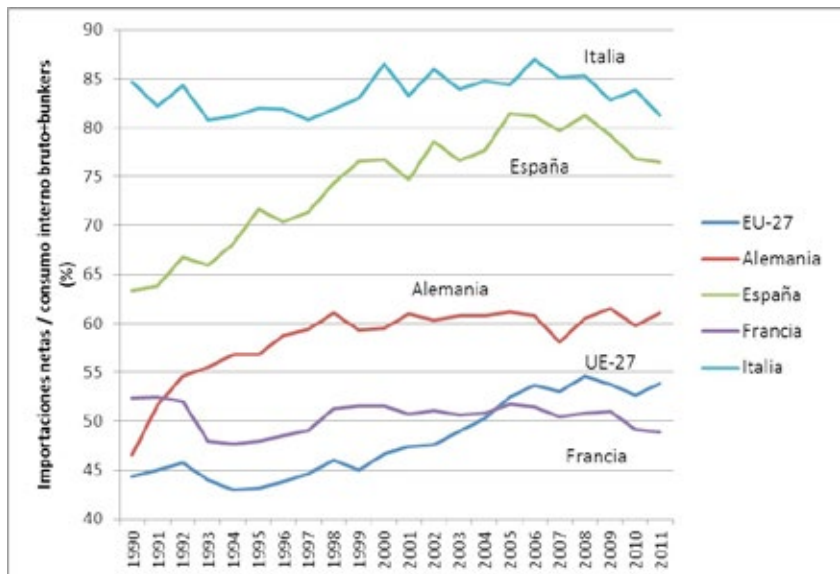
¹⁶ They both complete and develop the energy security dimensión of the analysis. It is more wide-ranging and hence less detailed. It is set out in the Elcano Work Document by the author's "La acción exterior española en un escenario energético en transformación" –"Spanish foreign action in a transforming energy scenario" of 2013.

Physical security vectors: dependency and vulnerability

The attaining of energy security may abate in several sectors. The most common classification consists of distinguishing between physical security, consisting of the security of access to the energy sources; and economic security, which derives from the fact of the prices of this energy being compatible with the society's ultimate economic aims (well-being, development, etc.). Within the policies related to the physical security of the supplies, the most common one is that of trying to reduce the rate of dependency on energy imports. This may be achieved in several ways in turn, not all of them optimum. Thus, imported gas could be replaced by national coal, although the cost in terms of competitiveness and sustainability would be high; or replace gas by renewables and assume almost structural losses in competitiveness.

Energy efficiency and the development of own resources predominate so reducing the energy rate is advisable, but not just at any cost in terms of the other two goals. Figure 1 shows the strong increase in the Spanish energy up to 2005, and its positive inflection. This is basically caused by the impact of the economic recession. Evidently, the high Spanish dependency rate is a considerable vulnerability and it would be important to keep on with the reduction experienced in recent years. Nonetheless, that strategy has certain limits that cannot be exceeded if it is not at the cost of competitiveness, especially in the context of a possible economic recovery.

Figure 1: Energy dependency rate

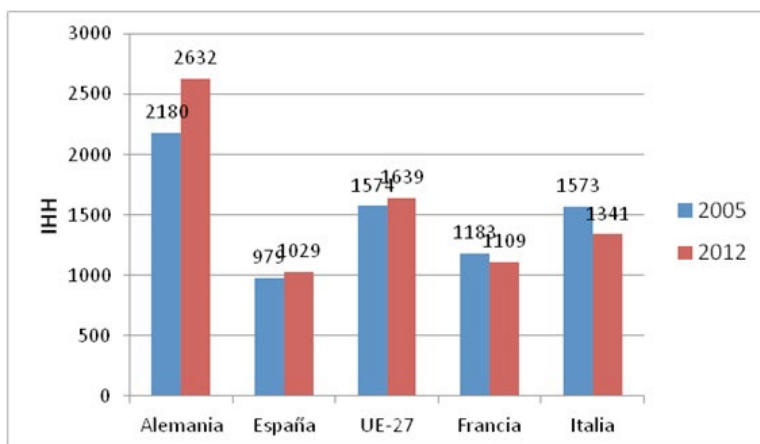


Source: Eurostat database

As regards the energy dependence concept, the most highly-valued energy security strategy is to reduce vulnerability through diversification. Diversification is a basic instrument in risk management, and Spain has a diversified energy supply, both in terms of its geographical origins and primary sources. There is no doubt that this is a question of one of the greatest Spanish assets in energy security matters. Few European countries enjoy such a complete electrical mix, which spans natural gas, nuclear energy, coal and, in turn, a diversified portfolio of renewables.

The geographical diversification of hydrocarbons supply is extremely high and it merits special attention. Figure 2 shows that Spain has a degree of diversification of the supply of crude that is notably higher than the European average, with a Herfindahl-Hirschman Index (HHI) that is stable and comparatively reduced, which claims to reflect a relatively small concentration of its oil imports. The degree of diversification has been reduced between 2005 and 2012. The same thing has happened with the entire EU, while France and Italy have managed to increase this significantly.

Figure 2: Herfindahl-Hirschman Index-HHI of crude supply.



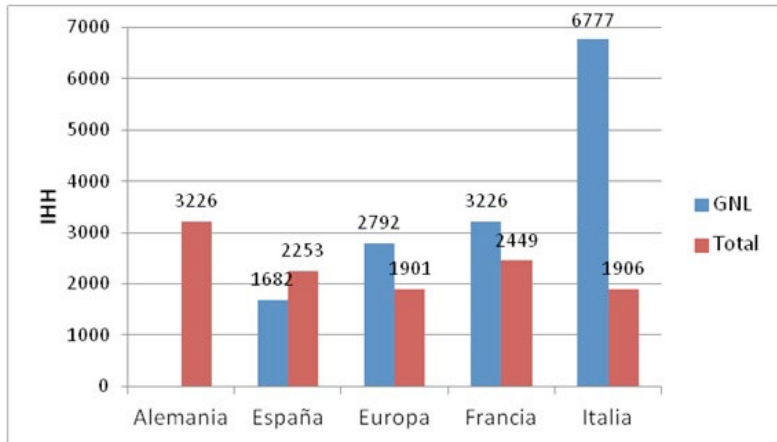
Source: Own elaboration with data from Comext database.

The greater HHI concentration of supply in fewer producers and hence with greater diversification; unless there is less diversification of the HHI.

The gas supply is also quite diversified, as shown in figure 3, although some additional qualifications need to be introduced. Considering the Natural gas liquids (LNG) imports separately, Spain is the most diversified country in Europe. The flexibility that LNG provides amplifies the impact of the diversification that is equally important in the total amount of imports (LNG and gas pipelines). The aggregated European Index is not relevant, because an extensive geographical space always tends to have more energy corridors. Spain finds itself in an intermediate position between

France and Italy (which benefit from gas pipeline supplies from Russia and North Africa), but with much greater diversification than that of Germany, marked by a concentration of imports from Russia and Norway

Figure 3: Herfindahl-Hirschman Index-HHI of the gas supplies



Source: Own elaboration with data for 2012 from BP Statistical Review database.

This is therefore a relatively well-diversified energy supply in terms of origins, sources, technologies, routes and modalities of transport, offering a varied range of energy corridors that facilitates an active risk management strategy. The fundamental issue is specifically whether that diversification is optimum from the risk management perspective. This analysis can be done in at least three dimensions: the comparative analysis with the EU, concentrations of political risk and, in the long run, the quality of the energy resources management of the suppliers of Spain.

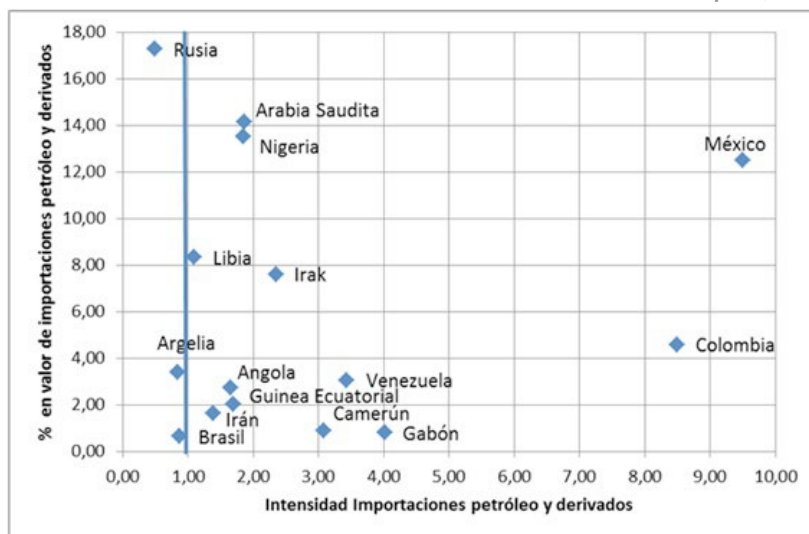
As regards the first dimension, inasmuch as Spanish energy interdependence pattern follows one that is similar to the EU one, the possibilities of the alignment of the Spanish energy preferences with the community ones and making best use of its instruments increase. On the other hand, in the cases of divergence in said pattern, it would be necessary to further develop the bilateral channels so as to prevent the impact of possible asymmetric shocks. Close examples are the embargo on Iran or the conflict in Libya, which has additionally affected Spain (and in general, some Mediterranean member states in very difficult economic circumstances) rather than other European countries.

The Spanish energy interdependence pattern differs rather a lot from the EU one and from its different Member states in several aspects. This does not constitute a Spanish exception. The convergence of the energy interdependence patterns within the EU does not produce one single model, but rather it leads towards differentiated models that group several countries together in a cluster that are well differentiated by the geo-illustrative pat-

tern of imports¹⁷. As regards the geographical distribution of its energy supplies, Spain would appear to be grouped in with the Mediterranean countries of the EU, which tend to import more hydrocarbons from North Africa and the Middle East than the other Member states, at the same time that this is barely interconnected with the rest of Europe. But even within that group, Spain has specific relevant features, as can be seen in figures 4 and 5.

Figure 4 compares the significance and the intensity of the oil and derivatives imports from the main oil suppliers to Spain in 2012. The countries that are placed on the right side of the blue bar of the figure are countries with which Spain maintains a high level of import-intensity compared to the rest of the EU. That is to say, an Import Intensity Index (III) than is more than on unit¹⁸: these are more important for Spain than for the EU as a whole, and they therefore represent contingent asymmetric shocks. It seems relevant to identify these suppliers and to reflect on the best way of approximating Spanish interdependence with these in a differentiated way.

Figure 4: Geographical intensity (III) and significance of the oil and derivatives imports, 2012



Source: Own elaboration with data based upon the Comext database, Chapter 33 of the SITC.

¹⁷ In this regard, please see: Marín, J. M., J. GARCÍA-VERDUGO and G. ESCRIBANO, (2011): *Energy Security for the EU in the 21st Century. Markets, Geopolitics and Corridors*. Routledge, New York/Oxon, Chapter 11.

¹⁸ Imports Intensity Index (III) = $(Me_j/Me)/(Mue_j/Mue)$; where Me_j are the Spanish imports from the "j" country, Me are the total Spanish imports, Mue_j the imports of the EU-27 countries and Mue are the total imports from the EU-27. An index of 1 means that the imports from the countries of reference are proportional to their significance in EU imports, while a higher (lower) index than the unit reflects imports of greater (lesser) importance than for the whole of the EU-27.

The most relevant particular feature is the Spanish specialisation in the imports of Latin American crude, above all those from Mexico and Colombia, which are nine times more important for Spain than for the EU; but also those Venezuela, with an IIT that is greater than 3. The case of Mexico is notable, since in 2012 it represented over 12% of the Spanish oil and derivatives imports, and at the same time it has increased its intensity by almost one point since 2005. The Colombian case is also noteworthy, above all as this concerns a recent phenomenon and it is one of the Latin American producers with a more open energy policy. Brazil, whilst its intensity is at a low level, has quickly emerged as a significant supplier and the prospects for the country as an emerging crude oil producer thanks to its pre-salt layers, together with the significance of the Spanish ethanol imports, has made it an important source of diversification for Spain. On the basis of a relatively limited level of significant and intensity, the potential for increasing its contributions to the range of Spanish of bio-fuel and crude imports is considerable.

Neither of the countries mentioned seem to raise problems of asymmetric shocks, since Spain maintains good relationships with both of them and it does not need to be facilitated by Europe. However, it could be possible to assess the facilitating of other instruments of foreign action, both Spanish and community. It is necessary to consider that the bilateral relations are dense and they are well-diversified at the regional, sector and even intra-sector levels, with Spanish companies being present throughout the energy chain, from the upstream to the downstream, and not just in the hydrocarbons sector, but also in electricity and renewables.

Venezuela is a different case, since Spanish imports are taking on significance and with a growing level of intensity, albeit to a lesser degree than with Mexico and Colombia. On the other hand, the bilateral relations are more complex, and the capacity for Spanish foreign reaction is more limited. Furthermore, Venezuela is a declining producer, unable not just to exploit its resources of ultra-heavy crude from the Orinoco Belt, which are very costly to extract, but also even to recover their mature fields with the technology that has been developed by international companies in recent years. Something similar is happening with Bolivia or Ecuador, but Spain does not import from those countries and their risks are of a business nature, not one of supply.

From a global perspective, the rise of unconventional oil (*tight oil*) is being maintained in the United States, and Latin America could release supplies and reinforce the Spanish specialisation in the region. If the process is further extended to Latin America, even gradually, that effect could be greater. It is relevant for Spain to maintain that specialisation in Latin America. Therefore all initiatives related to production in energy terms, should be accompanied by measures to assist better cooperative governance for energy security. Specifically, this is especially because the second group of countries with which Spain maintains a greater level of intensity of oil and derivatives imports are those from western Africa.

Figure 4 shows the intensities in the oil imports in zones close to 2 for Angola or Equatorial Guinea (both have been falling since 2005), of 3 for

Cameroon, and 4 for Gabon, a country that did not even appear in the list of main Spain crude suppliers in 2005. If Nigeria is added, with an III of 2, but it is the third-placed supplier of Spanish crude with nearly 14% of its imports, the whole of the region represents almost 20% of Spanish oil imports. In addition, Spain imports much more of this than the EU as a whole. But, unlike what is happening in Latin America, Spain foreign action has very limited outreach in the region. Considering this shortfall seems to be an urgent matter, given the region's situation, especially in the Gulf of Guinea, which presents a complex combination of piracy, conflicts over resources, the proliferation of armed groups and bad governance, which is especially hard for Spain to manage¹⁹.

Other asymmetric risks include the Middle East. Figure 4 shows a particular degree of intensity on crude imports from Saudi Arabia, the second-placed Spanish supplier in 2012 after Russia with over 14% of Spanish imports and whose intensity has doubled since 2005, going from an III of 1 to another of 2. Spain imports over 8% of its crude from Iraq and the III is over 2. Iraq is the great-unrealised promise of oil production. In spite of its great potential, the security situation and the internal tensions are obstructing the usual development of investment projects. Although Spain has good relations with the Persian Gulf producers, its capacity to influence the Iraq situation is very limited. In general, the security of Spanish (and global) security from the Middle East is in the hands of the United States, and so it is not a topic that even the EU can make plans about.

Iran also represents an asymmetric risk: the fall in Spanish imports due to the embargo first, and their full disappearance afterwards, entailed a genuine asymmetric shock for countries like Spain, Italy or Greece. The Iranian treats to block the Strait of Ormuz, whilst not being very credible, cannot be discounted, and this would affect all supplies plus those of LNG. The agreement reached with Iran should be ratified in the next six months, and only then will we see whether it translates into a relaxation of sanctions²⁰. Iran has traditionally been one of Spain's key suppliers, but while the embargo may be eased, the geopolitical risk in the region is still high. Israel's stance and the growing reticence of Saudi Arabia will not stop the geopolitical tension in the Middle East continuing.

Lastly, but closer to home and in a context of great uncertainty, lies North Africa. Algeria and Libya maintain their usual intensity levels of crude imports, although Libya's significance has been greatly reduced since the civil war in the country, and the deterioration of the situation in the summer-autumn of 2013 could make that decrease worse. Despite this, they represented 4% and 8% of Spanish oil imports respectively in 2012. In

¹⁹ ESCRIBANO, G. and F. ARTEAGA (2013): "Seguridad y recursos en el Golfo de Guinea: algunas implicaciones para España" – "Security and resources in the Gulf of Guinea: some implications for Spain", ARI28/2013 – 16/7/2013.

²⁰ ESCRIBANO, G. and F. ARTEAGA (2012): "Las nuevas sanciones a Irán: implicaciones energéticas y de seguridad" – "the new sanctions on Iran: energy and security implications", Analysis of the Elcano Royal Institute, ARI 54/2012 – 24/7/2012

addition to this there is their geographical proximity and the presence of Spanish companies in the region. This magnifies the homogenous commercial relationship with Europe: although the Ill is the unit, it conceals greater logistical and business interdependence.

Certainly, in 2012, Russia was Spain's leading oil supplier. But this does not represent a deviation from the pattern of European interdependence. In general, Spain could be perceived as relatively near Russia as compared to the stance of other Member states, but in practice, the European policy towards Russia, with all of its faults, seems to be consistent with Spanish preferences. In the same way as happens with gas –of which Spain does not import any from Russia– Spain does not have any interest in getting involved in geopolitical games, either large or small, either in Central Asia or in the Caucuses, which has so much attracted the attention of the outgoing European Commission energy commissioner.

The pattern described for oil is reinforced when consideration is given to natural gas imports, whose significance and intensity for countries is set out in figure 5. Algeria, which supplied 40% of the natural gas imported by Spain in 2012, in an increasing quota that further more records heavy intensity, has an Ill that quadruples the significance represented for the EU as a whole. It is clear that this situation requires special attention from Spain to its main energy supplier, and the Spanish preferences are not reflected in the degree of priority given to Algeria by the EU.

In fact, it has been suggested that Algeria's importance for Spain requires a more creative and determined focus, at both European and bilateral levels. That includes exploring complementary routes to traditional interdependence for balancing their symmetry, such as the undertaking of further joint projects, and facilitation measures of all types in order to the bilateral relations of gas monoculture²¹. This includes dealing with the security situation in an extended north Africa that runs down to the Sahel, and that is going through a very complicated time that has seriously upset supplies from Libya and Egypt, and cast doubt on Algeria's capacity to maintain the security of its installations²².

The axial country for Spain is Algeria, which has already been experiencing difficulties in supplying its increasing domestic demand, an insuffi-

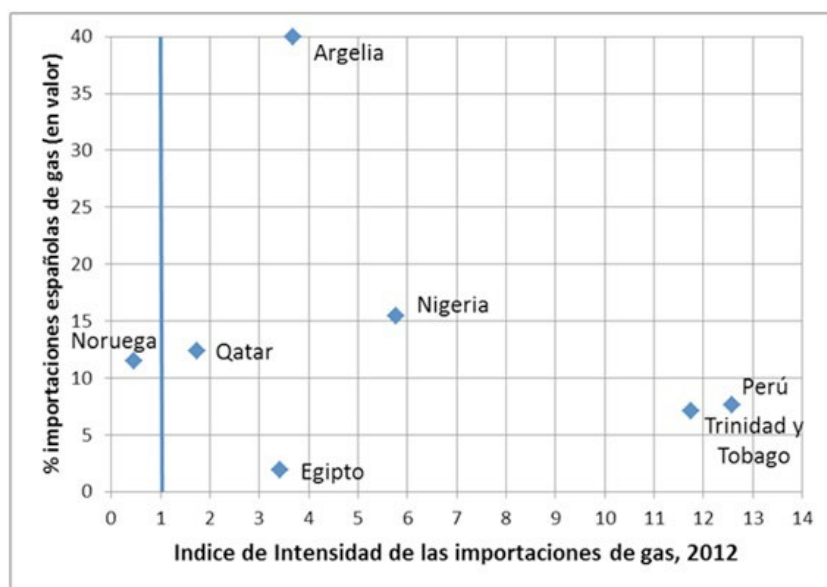
²¹ ESCRIBANO, G. (2012): "Gestionar la interdependencia energética hispano-argelina" – *"Managing Spanish-Algerian energy interdependence"*, Analysis of the Elcano Royal Institute, ARI 44/2012 - 20/6/2012.

²² Please see, respectively: ESCRIBANO, G. (2011): "Una agenda energética para Libia: seguridad, reconstrucción y gobernanza" – *"An energy agenda for Libya: security, reconstruction and governance"* Analysis of the Elcano Royal Institute 139/2011 - 17/10/2011; ESCRIBANO, G. (2013): "Egipto: primavera a oscuras" *"Egypt: spring falls into darkness"*, ARI 27/2013 - 9/7/2013; ARTEAGA, F. and G. Escribano (2013): "La ocupación yihadista de la planta de gas de In Amenas en Argelia: ¿consecuencia de la intervención en Mali o secuestro fallido?" – *"The jihadi occupation of the Amenas gas plant in Algeria: a consequence of the intervention in Mali or a failed kidnapping?"*, Elcano Commentary 8/2013 - 18/1/2013.

ciency of investments due small degree of tax and remuneration attractiveness, and a market which –with the European economic recession and the revolution in unconventional gas– has gone through a transition to a buyer's market. In the current context of tension that the region is living through, the Algerian government has adopted very expensive measures for the public budget that could make the country's economy deteriorate in the medium term. In addition to these uncertainties there is the chaos that Sonatrach is embroiled in, arising from cases of corruption, as well as the power struggles in the leadership vacuum created by the illness of President Bouteflika.

Imports from Egypt, which were considerable and intense up to 2012, (an III of higher than 3 and an imports rate of nearly 35; which was falling but still notable), disappeared in 2013 due to the failure of the gas supply from the Fenosa Natural Gas plant avt Damietta. This is another example of an asymmetric shock that could be aggravated should deterioration in the Egyptian situation affect the Suez Canal. This is something that is not very foreseeable but that cannot be discounted. It should be remembered that there was a failed attack on a ship that was passing through the Canal in the summer of 2013. Spanish gas imports from Qatar are also intense and considerable, with an III of nearly 2 and over 12% of the imports and these are equally sensitive to the developments in Ormuz and Suez. Norway has a relatively large share but a proportional one to that held by the whole of the EU, and does not pose energy security problems.

Figure 5: Intensity and significance of natural gas imports, 2012



Source: Own elaboration with data for 2012 from the *BP Statistical Review database*.

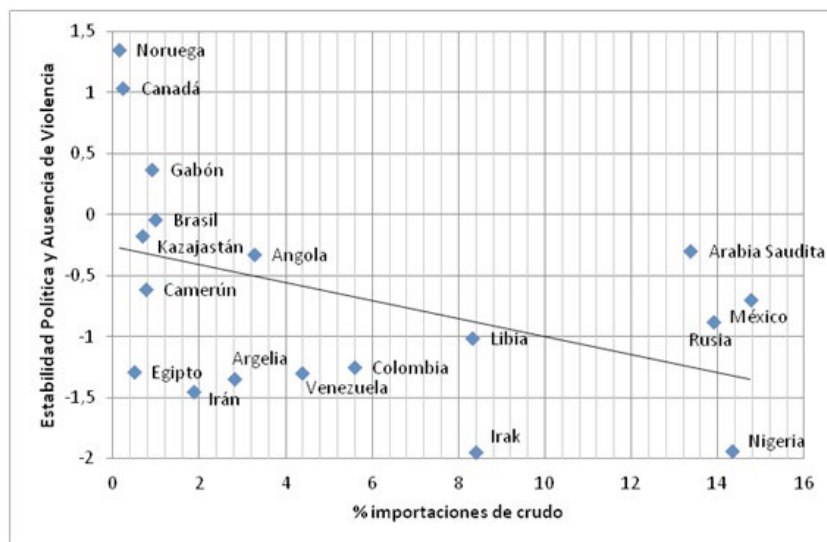
The most differential element is again the heavy level of intensity of the Spanish LNG imports from Trinidad and Tobago and, above all, from Peru, which has become a significant source of diversification for Spain in a few years. Each one of these represents between 7-8% of Spanish gas imports, which leads to significant relative interdependence, with an III rating of 12. The comments that have already been made in the paragraphs concerning oil are applicable in both cases. Finally, Nigeria has consolidated itself as the second-placed gas supplier to Spain, with over 14% of the imports and a significance that is seven times higher than higher than the EU 27 had, deepening the asymmetric risk –already described for oil– that the Gulf of Guinea represents.

The preceding data must also be complemented by other considerations, such as those relating to geographical proximity, the quality of the crude, the presence of Spanish companies or the existence of institutional frameworks for action. Without going into the details, that already contain the references provided on a particular scale, these considerations increase the strategic importance of crude and natural gas from North Africa and West Africa. This is due to their relative proximity, quality and adaptation to the stipulations of the Spanish refineries in the case of crude, and of gas pipelines in the case of gas. In addition to all of this there is the presence of Spanish companies in segments that are important for the value chain. Saudi Arabia continues being the supplier of last resort that is necessary to substitute for abrupt interruptions in the oil supply and they key player in the global market. And Latin America is offering a differentiated route of diversification as having a potential that can be enlarged upon the future. Adding in the potential of the Gulf of Guinea, the Atlantic basin has become an energy vector of growing importance for Spain.

The second element of its vulnerability, as well as dependence and diversification, is how far the distribution of the risk that the adequacy of the pattern of Spanish energy interdependence goes, in the sense that there are no excessive concentrations of political risk; or, when these do occur, there are measures to manage it in the different spheres of energy security, bilateral and multilateral. This is a question of assessing whether the diversification pattern spreads the risk in an adequate manner or if, on the contrary, and to what extent does to tend to import more from countries with lower risk levels, for example political ones. The first approach is therefore to analyse the levels of political risk of the leading Spanish suppliers.

This introduces the problem of including aspects that are hard to objectivise and quantify, which place limits on the usefulness of the exercise, but it offers an initial approach that usually alters little with the chosen political risk indices, since almost all of them tend to be very much correlated. In any event, figure 6 shows, it was to be expected that Spain tend to import a greater percentage of its crude from countries with high political risk indicators. The figure makes it possible to identify the countries with a greater level of instability and violence that at the same represents entail a greater burden on Spanish imports.

Figure 6: Crude imports (%) and political stability and absence of violence



Source: CORES and the World Bank, *Governance Indicators* 2012.

Amongst the large suppliers, Nigeria is the one that displays a situation of greatest instability. It is Nigeria, not the other West African suppliers that worsens the range of political risks of Spanish crude supplies, but the political stability relating to its large suppliers, such as Russia and Saudi Arabia, as well as the specialisation in Latin America, reduces this²³. In Latin America, Colombia is the case that merits a separate comment. Its low level of political stability and the absence of violence is due to the latter factor whose capacity to stabilise the country and interrupt supplies is increasingly limited.

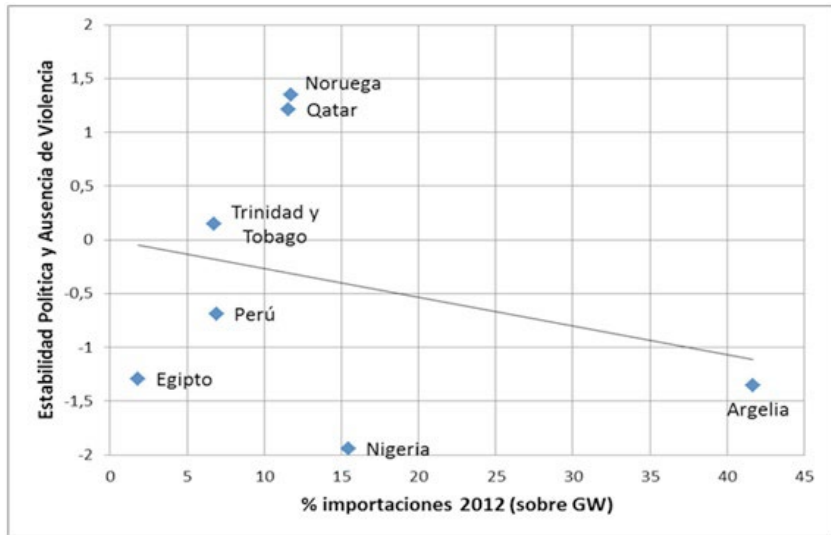
Countries such as Iraq, Libya or Venezuela display combinations of imports and instability that are important for Spain, while the other suppliers with low levels of political stability have a very limited degree of significance, which is compensated for by the contribution from very stable countries such as Norway and Canada. Figure 6 shows that any improvement in the political stability of the north of Africa, the Middle East and the Gulf of Guinea would have very considerable effects on managing the risks associated with Spain's crude imports.

Something similar – but perhaps more marked- can be seen in figure 7. This replicates the exercise for the case of natural gas. Algeria and Norway slant the political risks of the range of Spanish gas suppliers, Peru owes its position to violence and not to political instability, and Egypt shows a

²³ Sobre el papel emergente de América Latina como actor energético, puede consultarse ESCRIBANO (2013): "El escenario energético de América Latina", *Economía Exterior*, nº 65.

reduced percentage of imports which, during 2013 and for a foreseeable period, will be nil. On the other hand, while Russia offers greater stability to its European clients than Algeria, Spain compensates for that effect through its Latin American and Qatari imports. The importance of taking account of the political risks of both Algeria and Nigeria and the set of Persian Gulf states becomes clear when both hydrocarbons, gas and oil, are combined.

Figure 7: Gas imports (%) and political stability and absence of violence.



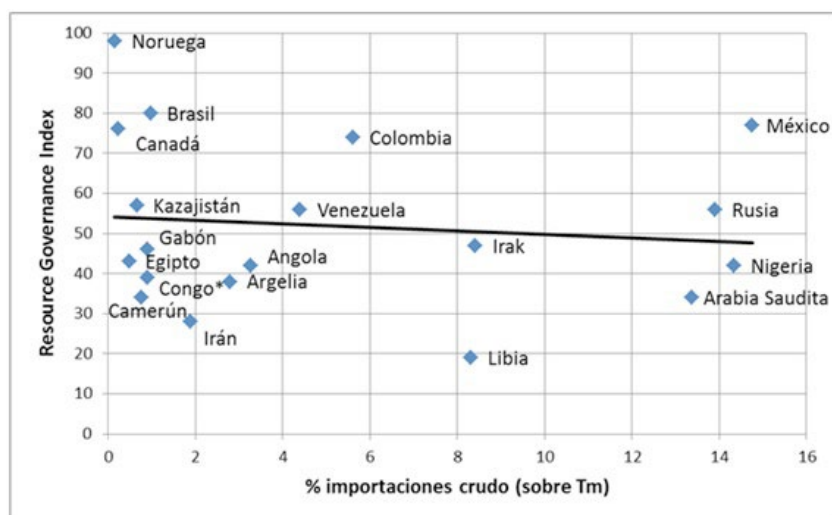
Source: CORES and the World Bank, *Governance Indicators* 2012.

Finally, in the medium and long term, it is worth wondering about the impact on the future energy security of the current diversification pattern, in terms of the governance of energy sources. If it is assumed that good governance of energy resources will have the long-term repercussion on risk reduction, improving this should form a significant part of foreign action, along with energy development and the fight against energy poverty. In those countries with a more defective situation of governance, good resources management could reduce the number of conflicts about these, as well as a more balanced and inclusive economic development pattern. In this way the risks of violence and political instability are reduced.

On the other hand, analysing the pattern makes it possible to appraise whether the Spanish imports pattern reflects a preference for the countries that better govern their natural resources. This is because this has an effect not just by reducing the current risks but also those long-term ones. In the same way as happens with political risk, the portfolio of

Spanish crude suppliers has countries in leading positions that have poor governance of their natural resources. These are basically the countries of North Africa and the Middle East and those of the Gulf of Guinea, as is set out in figure 8. Nonetheless, that relationship is weaker than that which was recorded for political stability and the absence of violence and also weaker than that which other European countries record.

Figure 8: Governance of natural resources and Spanish crude imports, 2012.

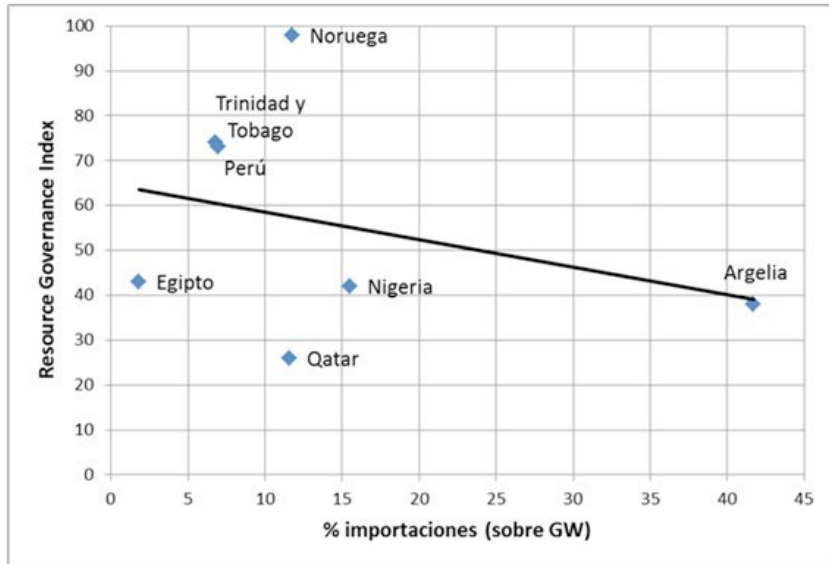


Source: CORES and Revenue Watch Institute, Resource Governance Index 2012.

But it is also possible to observe a group of key oil suppliers that record comparatively high levels of governance, above all Norway, but also the Latin American countries. In fact, in figure 8 we can trace an imaginary line of fit above that which can be traced that lines up Brazil, Colombia, Mexico (and Canada), which improve the governance of the portfolio of Spanish crude suppliers. Other leading suppliers, such as Russia and Venezuela, lie in intermediate situations of governance.

For gas, the negative relationship between imports and governance is marked by the importance of Algeria, and as such the pattern is more aligned. But generally speaking, it replicates the pattern for crude: Algeria, Nigeria, Qatar and Egypt below the line of fit and Norway and two Latin American countries, Trinidad and Tobago and Peru, above it. The aggregated oil and gas pattern suggests that the priorities related to improving governance are again located in the Gulf of Guinea, in the North Africa and in the Middle East. On the positive side of this, Latin American suppliers –in the same way as happened with political risk– improve the level of governance of the portfolio.

Figure 9: Governance of natural resources and Spanish natural gas imports, 2012.



Source: CORES and Revenue Watch Institute, Resource Governance Index 2012.

To summarise, despite a high dependency rate, Spain is maintaining quite a diversified energy interdependence pattern as regards its sources and geographic origins. In addition, despite the high dependence rate, Spain maintains an energy interdependence pattern that is quite diversified in terms of sources and geographic origins, and it displays a relatively suitable risks distribution. Moreover, the differential elements which, as regards the rest of the EU, mean that the Latin American supplies have good bilateral political coverage and, furthermore, it improves the aggregated risk level of the coverage. This all reduces its vulnerability to geopolitical risks and it compensates, albeit partially, for both its lack of interconnections with Europe and its high level of dependency on imported energy.

It is important to consolidate the dependency rate caused by the crisis and the development of a less intensive production model in terms of energy consumption.

However it is equally important to maintain a diversified energy mix made up of a varied portfolio of technologies and suppliers, including the development of own resources. That is where Spanish foreign action does not project as well, as in West Africa, it is necessary to tackle the issue of the means necessary to improve security, political security and the governance of energy resources. Where Spanish preferences are more intense than the European ones, as happens in North Africa, and to a lesser extent in the Middle East, this is based upon other Mediterranean countries within the EU and to reinforce and diversify bilateral relations.

The multilateral plane has to be used in order to promote global public assets such as good governance of energy resources, the fight against energy poverty and climate change, as well as the deployment of renewable energies. This involves objectives that are attained by aggregation and that have induced effects as regards the medium and long term energy security.

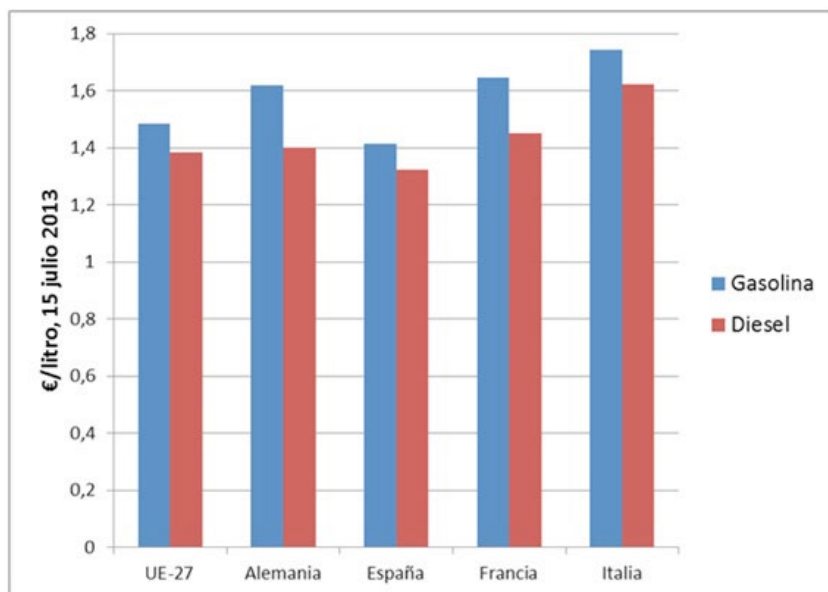
Economic security sectors: Energy intensity and competitiveness

Energy security is one of the vulnerabilities of the Spanish economy that is most mentioned. Some initial figures can put this concern in context: in 2012, Spain imported over 75% of the energy that it consumed; the net energy imports in that particular year are at around € 45 billion, representing 18% of the total Spanish imports and almost 150% of the deficit of commercial assets balance. Certainly, energy is one of the main interdependence of the Spanish economy with the rest of the world, dealing with hydrocarbons imports and the consequent impact of the price variations, but also the exports of technology and services, investments in Spanish energy companies abroad, and even the exports of derivatives.

The relative advantages described relating to supply security in the preceding section have a cost in terms of economic security. It is common for the business structure to argue, that especially the high energy costs in Spain, harm its competitiveness. That argument is usually limited to the dilemma between competitiveness and sustainability, and it seldom includes the exchange relationship (*trade off*) between competitiveness and security also has a cost in the form of idle capacity, redundant and support competitiveness, the diversification of sources, technological and original ones, the physical security of installations, maintaining strategic reserves or the particular nature of the contracts, where long-term supply security usually prevails, at least in gas.

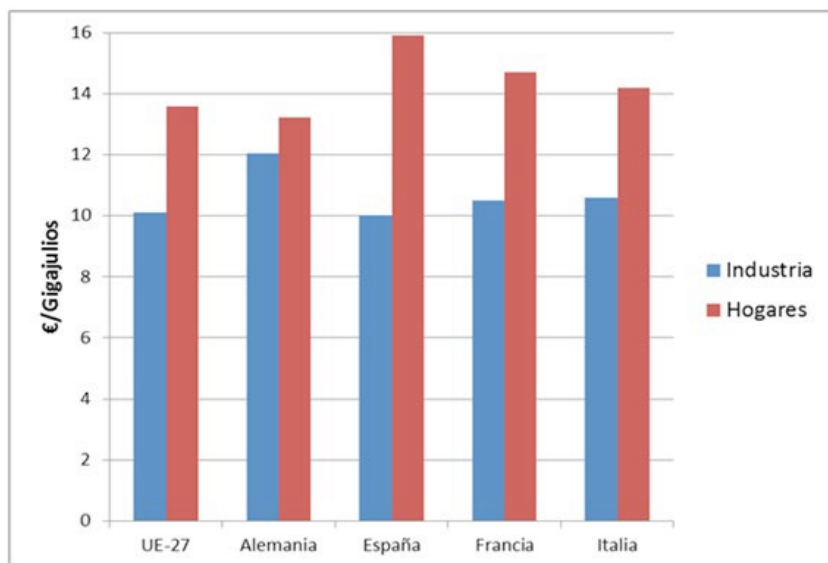
The first approach consists of comparing Spain's energy price levels with those of other European countries. This is a comparison that produces mixed evidence. As can be seen from figure 10, with data from July 2013, its petrol and diesel consumption prices are below the EU average and those of its main member States. While there is a significant debate about lower taxes rates and higher pre-tax prices, or about the suitability of the calculation methodology, the end price is still below the European average, even though it has experienced significant increases. This situation can be translated into lower tax collection. However, in a European perspective, this does not affect the competitiveness of Spanish companies in such a negative way. In any event, it would be important to have regard to the extending of competition as the best way to contain price escalation.

Figure 10: Fuel prices in the EU and selected member states, July 2013



Source: Eurostat Energy Statistics database.

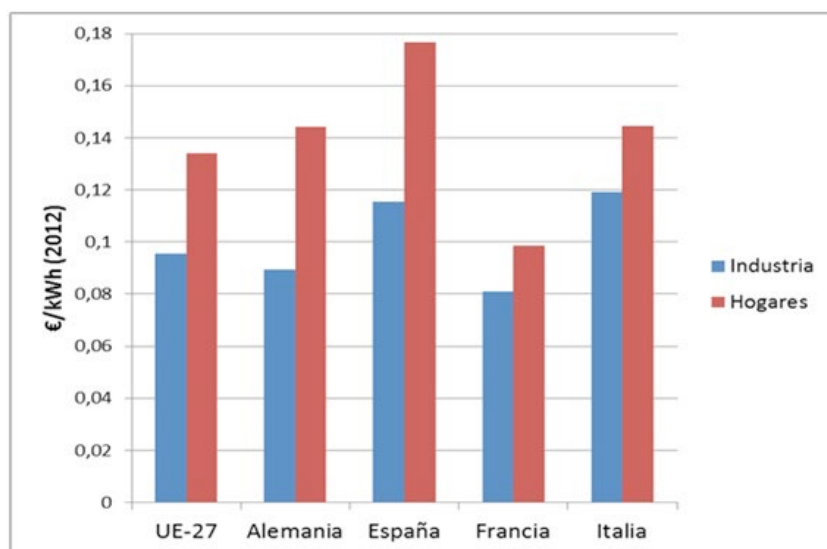
Figure 11: Natural gas prices in EU and selected member states, July 2013



Source: Eurostat Energy Statistics database.

Figure 11 shows the price comparison for natural gas in 2012. Spanish industrial prices were slightly below European prices, well below German prices and also lower than those in effect in France and Italy. On the other hand, the prices of electricity for the Spanish industrial sector do go well beyond the community average and the prices of Germany and France. Amongst comparable countries, only Italy records higher industrial electricity prices. For domestic consumers, the comparison is even more favourable: Spanish homes gas and electricity prices that are well above the community average and that of countries such as France, Germany and even Italy.²⁴ Furthermore, the gap between industrial and household prices is one of the biggest in the EU.

Figure 12: Electricity prices in the EU and selected member States, July 2013



Source: Eurostat Energy Statistics database.

Therefore, it is true that suffering a problem of high industrial and household prices, and those of domestic gas, where the increase in these has been significant. Although the industrial sector is tackling electricity prices that are higher than the European Union, the gap between industrial and household prices shows a clear propensity to favour industrial competitiveness. Conversely, in fuels for car-making, regardless of the national discussion about price formation, the end price is still below the European average.

When these data are contrasted with the relatively high-energy security level described in the previous section, including the deployment of own

²⁴ Eurostat data, Energy Statistics database.

resources, the cost of competitiveness is high, but not disproportional; and, in the cases of fuel for car-making and industrial gas, it is even moderate. Evidently, this does not mean that the necessary reforms for improving energy competitiveness should not be accommodated, but taking care that these do not disturb the balance attained in terms of security.

One key element is the role of renewable energies that falls in the middle of the debate between supply security and economic security. Certainly energy policy has committed regulatory and planning errors and excesses that have raised the economic cost of renewables beyond what is viable in the context of an economic recession. But, once deployed, the argument about the order of merit (giving priority to zero marginal cost energies and to renewables) is very solid.

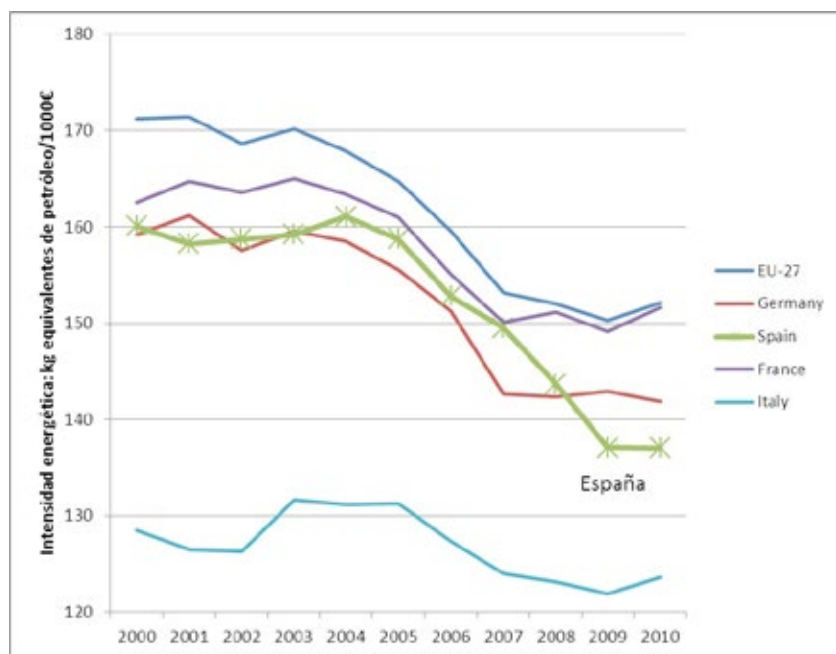
It should be remembered that Spain has exceeded the intermediate contribution target of the renewable energies set by the EU, and that it is ahead of the countries that are comparable in terms of size in attaining it. With 2011 Eurostat data, the contribution of renewables in Spain exceeded 15%, far from the 12% of Germany or the 11% of Italy or France. The significance of this is seen even further in electricity generation, which has gone beyond 30% in Spain, well above the percentages recorded in the countries mentioned (which are below 20%).

Renewables only contribute to the sustainability target, but also energy security, as was indicated in a previous section. Additionally, they offer an energy interdependence vector with new or traditional members, which complement the existing pattern, for example in North Africa, West Africa and Latin America. It is true that renewables (although not just these) increase electricity cost, but they also reduce the geopolitical cost for a given cost. In having a marginal zero cost and not depending on any type of fuel, the risk of this may be regulatory (as has been seen in Spain), but not a geopolitical risk. A good form of regulation should be easier to obtain than the geopolitical stability in regions that are more or less complex or far off.

In addition to a competitiveness-price, the Spanish economy displays a level of vulnerability that is somewhat more important. This means that the large amount of energy necessary to produce one GDP unit takes account of the country's production structure. The conjunction of high levels of energy dependency and intensity mean that a considerable part of our GDP depends on imported energy, and hence the price volatility affects the Spanish economy to a greater extent than some of its competitors. As is shown in figure 13, and in the same way as has happened with the dependency rate, Spanish energy intensity has been being significantly reduced since before the recession began, a pattern that is shared by the other European countries.

The recent evolution of the indicator for Spain is relatively favourable: in the year 2000, a greater energy intensity was recorded than the German one and close to the French one (despite the different industrial structures and climate conditions), but after it fell both of them. Evidently, this lower level of vulnerability, as happens with the dependency rate, is related to the economic recession and with the structural change that the recession has induced in the Spanish economy that concerns intensive energy consumption sectors, such as construction and the construction materials industry, but the entire industrial activity as well. The issue is whether leaving recession will actually happen, and this trend will respect Spain's energy intensity.

Figure 13: Compared evolution of energy intensity in the EU and in selected member states. 2000-2010.



Source: Eurostat Energy Statistics database.

It would be important to act on both fronts: improving competitiveness-price and carry on reducing the vulnerability that is involved in the relatively high level of energy. From the perspective of external action, there is a field of action in the community energy policy (making progress in integration and interconnection, and electrical above all) but also in the active management of the external energy interdependence pattern, along the lines of what has been already argued in earlier sections. This is not a question of politicising energy relationships: on the contrary, companies now have adequate mechanisms and more complete informa-

tion. But diplomatic facilitating and other vectors of externalisation are also important²⁵.

This point is where the most relevant repercussions of the unconventional revolution take place²⁶. Rather than in radical geopolitical alterations, the true shale gas revolution lies in the renewed industrial competitiveness of the United States, which enjoys gas prices that are very much lower than the European ones and assist with the incipient re-location of energy-intensive industries. This is an aspect that could, for example, be considered in the negotiations of a transatlantic free trade agreement. This new competitive Atlantic context makes it more urgent to optimise the use of particular European energy resources and those of the existing corridors with different suppliers in order to improve the competitiveness of the energy model.

Finally, at the European level, the contradiction of pursuing 'competitiveness without competitiveness' should be repeated; that is to say, without integrating European energy markets so as to make full use of comparative advantages and economies of scale and of network that foster an energy space as broad as the EU. The European dimension is again decisive, from the extending of the Community Treaty on Energy to the East and to the Mediterranean to the community mandates for infrastructures in third countries, going through the bio-fuel imports from Latin America²⁷. Greater competitiveness requires further integration of the markets and these being opened further, not just within the EU, but also with the main global energy players.

The paralysis that the EU is immersed in is also immersed in energy integration. For Spain, the interconnection with the European gas and electric markets is the external priority in the competitiveness field. If we make a contrast with a significant interconnection with the rest of Europe through France, Spain could become the energy hub that the potential of its energy situation provides for, capitalising its gas and renewables capacities that are currently idle. The latest example of this was the Communication between infrastructures that barely reflects Spanish interconnection preferences, identifying only 6 projects of common interest in Spain²⁸.

²⁵ The term 'geopolitical facilitation' is used to overlook the legal debate between diplomatic assistance and protection.

²⁶ ESCRIBANO, G. (2012): "Shifting towards what? Europe and the rise of unconventional energy landscapes", Analysis of the Elcano Royal Institute, ARI 82/2012.

²⁷ As regards Spain and the make-up of an external energy policy of the EU, please see Escribano and Steinberg (2012): "La europeización de la política de seguridad energética y sus implicaciones para España" – "*The Europeanisation of the energy security policy and its implications for Spain*", *Economía Industrial – Industrial Economy*, no. 384, pp. 23-32.

²⁸ ESCRIBANO, G. (2013): "The short-sightedness of the EU's long term energy infrastructure vision", Elcano Expert Comment 65/2013 - 23/10/2013.

On the other hand, the primacy of national markets inhibits the optimum design of the European energy markets. The attaining of an internal energy market worthy of such a name would be a crucial energy transformation for Spain. Moreover, it would be the first step in being able to design a coherent external European policy. In any event, the anchoring of Spanish energy policy to the European one is a fact, inasmuch as its goals and its regulatory content is approved. Evidently, although in a limited way, Spain has room for manoeuvre and its own particular features that would lead to recommending a different focus. The central focus of European energy policy would doubtless cover the attention of the Spanish energy authorities, but as we have attempted to show in these pages, there is a field outside the EU for a consistent external energy policy.

Conclusions

Energy is one of the main interdependence principles that associate Spain with the rest of the world, in an inter-polar global energy framework that is fragmented and has limited hegemonies. This is dynamic interdependence that is transformed with the changes experienced by the global energy scenario, from the unconventional revolution to the Arab springs, going through the embargo on Iran or the energy emergence of the Atlantic basin. This is also done in a global energy governance vacuum that is particularly prejudicial for mid-ranking powers such as Spain that lack the necessary influence to pursue their overall goals outside effective international regimes. The particular national energy panorama has radically changed with the economic recession and the need to take on the preceding global changes.

In recent years, the international energy scenario has been dominated by the narrative of the 'soft power' of the unconventional revolution in the United States and Canada. This is more attractive in times of crisis than the European alternative of 'soft power'. Nonetheless, the strategic priority for Spain continues being to assure the supply from its traditional suppliers and diversifying towards emerging producer. The Iranian embargo and the Libyan situation have accelerated the Spanish diversification towards West Africa and Latin America, where the role of suppliers such as Brazil, Peru or Colombia offers Spain a profile of sole supplier in Europe.

As regards the energy security objective, and despite a high dependency rate, Spain shows a pattern of energy interdependence that is quite well diversified by sources and suppliers, and the distribution of results is reasonable in comparative terms. Supplies from Latin America in particular substantially reduce the geopolitical vulnerability. Maintaining the fall in the dependency rate and moving on towards less intensive ener-

gy-consumption activities could notably increase security in the middle term. It is also necessary to maintain an energy mix that is diversified in terms of sources, technologies and suppliers.

Properly managing that interdependence leads to the recommendation of prioritising bilateral political relationships and accompanying them with other complementary of external action with the key suppliers. In the regions in which Spanish external action has fewer resources, such as the Gulf of Guinea, the means necessary to improve security, political security and the governance of energy resources should be considered. On the other hand, where the Spanish preferences are less intense than the European ones, such as in North Africa and, to a lesser extent, the Middle East, supporting itself on other Mediterranean countries within the EU and reinforcing bilateral external action.

Economic security is the final step of the remaining energy goals, basically security and sustainability, in the sense that these preferences always end up being reflected in the costs. Companies tend to be prejudiced by the smaller amount of attention that competitiveness receives in relation to sustainability, but seldom as compared to security costs. There is no free breakfast and energy security is not one either. The issue is what the optimum energy security level is and what price should be paid for it. The problem is that the security of supply is a factor that places limits with an asymmetric effect, because the absence of this entails a scenario of economic paralysis, and restricting this is a supply shock that has historically nearly always led to recession.

At the European but also the national level, it is hard to attain competitiveness without competition, that is, without integrating the European energy markets in order to exploit the comparative advantages and economies of scale and of network of the European energy space. In the community sphere, the interconnection with the European gas and electrical markets is the external priority for Spain, which could become the energy hub that the potential of its geographical situation endows it with, capitalising its gas and renewables capacities.

Lastly, the absorbing task of following the evolution of European energy negotiations makes it hard to maintain the active management of the external energy interdependence in the bilateral plane, at least not with the key suppliers. Spain has three possibilities in order to manage this asymmetric interdependence pattern:

- I. Project its preferences towards the EU so that the latter can incorporate them by seeking allies that share similar preferences (the case of Mediterranean Europe in terms of supply), but not just geographical ones (for examples, to assist the development of European interconnections with the support of member States from Eastern Europe;

- II. Act bilaterally, developing strategic alliances with key suppliers, but also with key energy players in consumption such as the Spanish energy companies' investments in large markets and increasing energy demand;
- III. Multilaterally, working for the establishing of clear rules of the game for better global energy governance, as corresponds to a mid-ranking power that lacks the weight to model this unilaterally.

An integrated approach to these three action vectors could be the most suitable way of managing Spanish energy interdependence.

Acronyms

IEA: International Energy Agency

IMF: International Monetary Fund

LNG: Liquefied Natural Gas

IAEA: International Atomic Energy Agency

EGPI: Elcano Global Presence Index

HHI: Herfindahl-Hirschman Index

WTO: World Trade Organisation

UN: United Nations

TTIP: Transatlantic Trade and Investment Partnership

Cyber security in the emerging systems of the electrical sector

Jorge Cuéllar Jaramillo

Chapter III

Abstract

There are many forces that have led modern societies to embrace a new concept for the production and distribution of electricity in the future: the smart grid. They include the scarcity of fossil fuel and the ecological impact of current energy sources. The intelligence of the future grid will depend on the use of technologies of information and communication. Indeed they will be indispensable to meet the challenges of the new energy sources which are intermittent and distributed. The energy supply infrastructures are among the most critical for the modern world, and the reliability of the distribution is the most important requirement to be met. This implies that ensuring the IT security of the smart grid will be of pivotal importance. But this will only be feasible with a demanding and large effort to cope with the security issues, conducted in a determined way by the different sectors of our society, including government authorities and private organizations, research groups and in particular all the different actors that will take part in the new electric grid.

The purpose of this article is to provide an overview of the security landscape of processes related with the management of command and control information and personal data in the context of the Smart Grid. Without entering into technical details that would distract us, we will discuss the purpose and use of smart technologies in the future grid, the risks asso-

ciated with them, the security requirements that they must meet, and the means to implement them. We conclude that it is crucial to understand and treat the risks. This endeavour will convey a set of new challenges that our society will have to face.

Keywords:

IT Security, Technology, Information, Communication, Threats, Strategy, Attacks, Grid, Internet, Cyber-security, Vulnerabilities, Critical Infrastructures, SCADA, Cyber threats, Smart Grid

The smart distribution grid

The threshold of the third industrial revolution

It was already clear to the inventor Thomas Edison that the creation of new individual electrical solutions, such as the electric light bulb or energy generators, was not enough to have a large-scale impact on society. It is also necessary to build an energy distribution system in order to place these advance within the reach of the general public. Hence, their efforts were not restricted to creating individual electrical systems, but also to the transmission of electrical energy to private homes. The first energy distribution grid started in 1882. This rapidly led to the practical utility of the technological advances and an explosive increase in their use. However, it used direct current (DC), which turned out to be only useful for transmitting energy over short distances.

Nikola Tesla discovered that alternating current was capable of going beyond the limitations on energy transmission and it was more suitable for electrical transmission over long distances. In 1895, George Westinghouse used this technology to connect a generator at Niagara Falls and transfer electrical alternating energy to the city of Buffalo, some 35 kilometres away, thus beginning what Marshall McLuhan called the Electricity Age.

Since then, the structure of the distribution grid has maintained the same basic architecture: generation does not have to be close to consumption and electricity flows unidirectionally, with centralised distribution from the generator plants to the end consumers, whether households or industry. The system's reliability is assured by an excess of capacity (reserves) in order to respond to potential demand at practically any time. Electrical systems were designed and constructed in times in which primary energy was relatively plentiful and cheap thus not having the imposing need to save energy, or to optimise consumption at all costs. The abundance of electrical energy has been an extremely important factor in the industrialisation and development of Spain, Europe and, of course, the whole world.

The information society and the third industrial revolution have been in the making since the second half of the last century, with the electrical and ICT advances such as the transistor, television, computing, robotics, Internet, etc. But there are several authors, such as Jeremy Rifkin who consider the Smart distribution Grid to be the door to the third industrial revolution ("The Third Industrial Revolution", New York, Macmillan, 2011). The five pillars of the third industrial revolution, according to Rifkin are:

- I. The replacement of the conventional energy sources by renewable energies.

- II. The transformation of the buildings and houses in power micro-plants that can access sources of local renewables recourses.
- III. The installing of energy storage technologies, such as those for the creating, storing and processing of hydrogen. These technologies will be used in buildings, houses or cities in order to effectively use the intermittent or surplus energy at times of demand troughs.
- IV. Use information and communication technologies, and Internet in particular, so as to create hub grids having locally generated energy, negotiate prices and sell surpluses to the local or global grid.
- V. The replacing of the existing conventional transport fleets by electrical vehicles, which can store energy and thus purchase it at times of elevated supply and sell it at times of greater demand.

The use of information and communication technologies will make it possible to decentralise both production and control. It will allow the optimization of electrical energy distribution in a way that is unprecedented and radically different from today's, geared toward the centralised generation of electricity in large electrical plants.

Forces that lead to Smart Networks

There are many reasons that currently make it essential to re-design the architecture and functioning of the electrical network and that lead us to Smart Networks. We sub-divide these into reasons of security supply, of the protection of the environment, changes in the market and the need for new grid optimisation mechanisms.

Supply security

Fossil fuels –coal, oil and natural gas- are limited, oil particularly is now close to its production zenith. Since before the first energy crisis in 1973, fuel prices have been rising in waves and times of great shortfalls in the supply of oil, electricity and other energy resources have appeared. These crises adversely affect the rest of the economy, increasing the likelihood of recession: as energy costs raise the costs for all industries also go up, while the price of petrol leads consumers to reduce their costs and to less confidence in the economy. Oil-dependent countries have great motivation to save energy and search for and integrate alternative sources. None of these will be as cheap, as convenient or as simple to transform in energy terms as oil, but they will be necessary to assure the energy supply.

Ecology and the protection of the environment

Many reasons have led us to become aware of the need to preserve the environment and oblige us to look for renewable low-emission energies that have few harmful residues. Two examples are: the growing atmospheric pollution, as for example, has been observed so drastically in China in recent years, and the increasingly imminent risk of climate change that could turn out to be disastrous in the field of nuclear technology security, as Fukushima showed. The great difficulties that Japan faced with nuclear plants following the tsunami have been the main reason why the German government decided to opt for energy transition ("Energiewende").

The market

One of the stimuli for this change in the system is the de-regulation and privatisation of the markets, as well as the re-structuring of industry in general and the electrical sector in particular. Many governments are expecting growth in innovation and competitiveness, as well as a reduction in prices and supply efficiency. Even nowadays, energy grids are still mostly handled by generating and transmitting monopolies, but these structures are evolving towards a large network of many competitive energy producers and other participants in the system.

Optimisation of the distribution system operations

On the other hand, the necessity of making use of alternative energy sources leads to greater investment costs and production cost. This naturally incites the search for optimal methods of using energy generation surpluses. It will be possible to maintain such high reserves, which cover the existing demand at any time: alternative energy is mostly *intermittent*, that means, there is a huge fluctuation in energy, depending on the state of the weather (wind and sun), the waves, of the quantity of rainfall, etc. In order to resolve this problem, it will be necessary for end consumers to actively participate in optimal energy usage, levelling out demand curves. It would be ideal if users take less energy from the grid at times of low production. This is achieved using *demand response (DR)* mechanisms, providing incentives to the general public to reduce electricity usage at times when demand is high. It will also be necessary for users not just to consume, but also to produce and store within the same grid.

Another consequence of the use of renewable energy sources will be that electricity grids will stop being unidirectional. Depending on the climate conditions in the different regions, electricity could, for example, flow from north to south. In order to adapt the grid and achieve a situation in

which the system remains stable, it is necessary to have very detailed information about the electrical characteristics as well as meticulous supply and demand forecasts.

What are Smart Grids?

Briefly, the functionality of a Smart Grid is the distributed, quasi-optimal coordination of the actions of generators, distributors, consumers and prosumers (which perform the dual roles of producing and consuming energy) in an efficient, sustainable, economic, and secure way, that facilitates the dynamic integration of regenerative energy sources, beneficial to the environment. For this purpose it is necessary that consumers actively participate in optimising the operations of the system, and the system must offer them greater amounts of information and the opportunity to interact. Smart Grids use information and communication technologies (ICT) in both innovative services and in smart technologies for monitoring, control, communication and auto-regeneration.

We begin by saying the Smart Grid is not a static concept, but rather a *vision* with the goal of handling energy resources in an efficient way. This proposal is specified in the use of innovative technologies, many of which are still being developed, in order to efficiently manage the generation, distribution, measurement, storage and consumption of electrical energy, responding to needs of growing energy demand and of creating a sustainable energy base that is capable of reducing the climate and ecological impact. To do this, it is absolutely essential to use ICT, entrusted with vital tasks at all of the levels of the system, from the acquisition and processing of signals, up to the technical control of the dynamic system of electrical energy flow and the integration of the actions of all of the players in one single coherent system.

Many authors consider Smart electrical distribution Grids to be humanity's largest technological project. An endeavour of such magnitude cannot be undertaken in one single strike. Constructing Smart Grids will have several stages, investments will increase over time and the profits obtained will gradually become visible. Smart Grids will not be developed at the same pace everywhere. On the contrary: bit by bit, smart local management and distribution islands are appearing, called micro-grids, at universities, industrial or commercial centres, etc. These grids use small energy sources, which are relatively cheap and reliable, such as micro-turbines, photovoltaic panels, and fuel batteries, fitted in client's premises. A micro-grid operates as a controllable module, connected to the global network, with the aim of supplying electrical power and local heating, reducing the maintenance of local voltages, achieving greater efficiency in using residual heat and reducing total emissions.

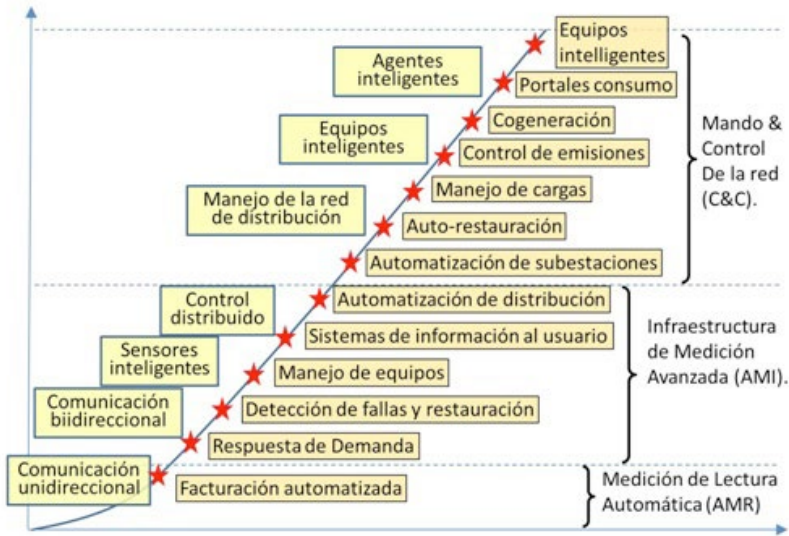


Figure 1. Stages of network construction. Both investments in technology and infrastructure (left boxes) as well as the system features and benefits as returns investments (right boxes) will occur over time (horizontal axis). Some of these concepts will be discussed in Section: THE ROLE OF TIC 's IN THE INTELLIGENT NETWORK. The intelligent network features.

Figure 1 shows the three main phases of implementation of the grid: the introduction of automatic ways of measuring, the introduction of advanced measurement and the infrastructure of command and control mechanisms, including the provision of tools for electronic energy markets. The illustration also shows the return on investment that will be achieved in the different steps, according to the main architect of the first micro-grid in Canada, Professor H. Farhangi¹.

Smart Grids will cover the entire electrical energy business chain, and they will integrate other players in adjacent areas, such as water and gas. Moreover, they will cross geographical and political borders. This is because in many cases it will be necessary to complement the generation and storage services of the different countries. For example, it is easier to generate solar energy in southern Europe. In Scandinavian countries, the energy is stored in hydro-electrical reservoirs. Even more so with functions that go beyond energy supply, including the supervising of transport, the distribution of assets, the well-being of the inhabitants, the quality of water and many more. There are already a large number of projects that are building these Smart Grids, in particular in the context of smart cities.

¹ Hassan Farhangi: The Path of Smart Grid, SISS Power & Energy Journal, Jan 2010, Vol 8, No 1.

The current electrical supply system

Architect and characteristics of the current system

The electricity supply system covers a set of useful resources for generating, transporting and distributing electrical energy. Figure 2 shows the current electrical distribution system in a very schematic way. The current network is unidirectional and divided into several parts that operate with a certain degree of independence between each other, controlled by pieces of SCADA equipment that share any information in a very limited way. All of these grid characteristics will change in the future grid.

This system is fitted with a supervision system that acts in real time, comprising control, security and protection mechanisms whose priority goal is to maintain the quality of service, balancing generation with users' demand and compensating from the possible incidents and faults that may appear. It is not easy to maintain this balance because electricity flows nearly at the speed of light and cannot be easily stored in a profitable or immediate way. Therefore, it has to be used at the time it is produced. Electricity flow cannot be controlled as is the case with liquids, opening or closing valves, nor does it stop like telephone connections. Electrical energy moves freely through all of the other paths, being divided in accordance with the physical rules of impedance.

On the other hand, the network is fitted with a business management and administration system consisting of mechanisms for forecasting resources planning and managing trade, including both energy auctions such as invoicing and remunerating the different market agents.

These two, the supervision and control system and the business management, are both distributed and largely depend on information and communications technologies.

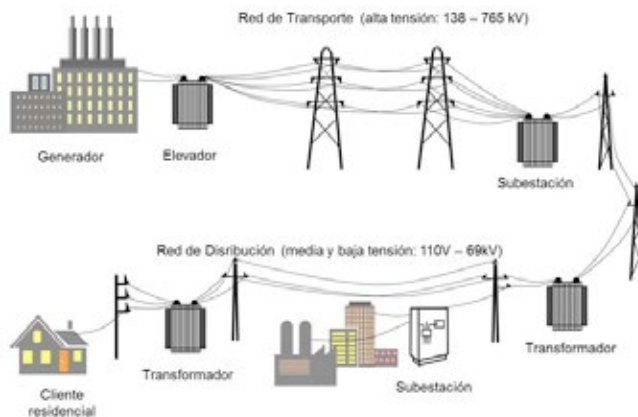


Figure 2. The current electrical distribution system (simplified diagram).

Very often, different parts of the system are operated and run by distinct companies. Therefore, the control system is of a distributed and hierarchical nature: the controlling equipment at the generating plants, in the transport network, in the sub-stations the sharing network and the distribution grid, and supervised and controlled by stand-alone pieces of equipment, but these communicate between each other so as to achieve overall equilibrium.

Sub-stations or transformers frequently have Remote Terminal Units, better known as RTUs, devices fitted with micro-processors, which obtain the signals from processes with integrated sensor equipment or, for instance, by means of phase measurement units. The RTUs send the accumulated information to a remote site where SCADA equipment is located. This processes the information from a large number of signals from different places, with accuracy measured in terms of milli-seconds. SCADA systems, the acronym for the Supervision, Control and Acquisition of Data, make it possible to monitor, control and supervise remote electrical distribution processes, automatically controlling the processes. In addition, these pieces of equipment are connected with control rooms, making it possible for the visualising of the state of the grid and the entry of control commands, with the field devices feeding back data in real time.

With the Smart Grid already having been announced, transmission and distribution lines are being fitted with smart devices that locally control sensors and triggers. One example is provided to us by measurement and protection relays, capable of calculating the operating conditions of the circuits and hence, detecting and locating the faults and, depending on its level of intelligence and conditions, it can even diagnose the type of fault, and activate smart switches when problems are detected. These switches are necessary in order to isolate pieces of equipment and networks. In this way it can protect them and minimise the number of users affected when outages take place.

We can conclude that ICT is already essential nowadays to maintain the stability of the electric supply system.

The business administration and management systems related to the electric system also rely hugely on ICT. But these systems are rather less interesting for our purposes, for two reasons. First, they are less critical because the stability of the grid does not depend on them and because they are easier to keep redundant. Second, they are similar to those that are conventionally used in the diversified commercial world, where the problems of cyber security have been well studied.

Reliability

Infrastructure is considered critical, when serious supply problems occurs due to an error of it.. The 8/2011 Act for the Protection of Criti-

cal Infrastructures, defines these in the following way: a service is called *essential*, if it is necessary for the maintaining of basic social functions, health security the social and economic well-being of citizens, or the effective functioning of the state. A set of grids, installations, systems,-physical and ITC equipment on which the function of an essential service rests, is called *critical infrastructure*, if its functionality is indispensable and does not allow for alternative solutions. Therefore its disturbance or destruction would have a severe impact on essential services.

Reliability is the most prioritized demand of modern society for any of the structures used in critical infrastructures.

The frequency of the electrical energy sector infrastructure is frequently considered. This encompasses both electrical generation and transmission as the most critical of the infrastructures. When the latter stops working, all of the others are paralysed as well. This includes the distribution of comply-used goods, the health service in hospitals and clinics, public communication networks, etc. For example, the damage to the Auckland electrical system in New Zealand in 1996 forced 60,000 of the 74,000 employees in the areas affected to work from home or from alternative offices, while most of the residents of the 6,000 apartments affected were compelled to move while a solution to the problem was sought out.

The electrical system's reliability can be defined in terms of the system's capacity to deliver electrical power to consumers in an accepted way and in the quantities established and desired.

The North American Electrical Reliability Corporation (NERC) divides reliability into two categories, suitability, or static reliability, and security, or dynamic reliability.

Suitability means that the necessary resources are present and accessible to generate, operate, transmit and supply electricity in the planned way, and in accordance with the quality requirements for continuously expected waves. This includes the cases of very high demand, during routine repairs or when there are faults, contingencies, or foreseeable problems, such as those due to heavy electrical storms in the area. Amongst these resources, we can find demand response programmes which, as we shall see, reduce energy demand peaks.

Security, on the other hand, is the system's capacity to bear unexpected disturbances, such as short circuits or the loss of elements due to natural causes, as well as intentional and unintentional attacks, either physical or cybernetic, of non-malicious consumers, internal workers, competitors, terrorists or enemies. In particular, security means that the system as it is will be intact after discharges or other faults occurring in the equipment. Security includes the capacity to recover from the problems when

they appear in the swiftest possible way, restoring the provision of the service and the performance of the elements.

NERC has developed a method and several standards in order to ensure the reliability of the electrical supply based upon various fundamental principles. The most important as already mentioned, is to continuously balance demand and supply and to keep the system stable, in spite of the contingencies or faults that may appear. The demand goes to a certain predictable point, and this is also the case with the expected statistical deviations. The demand curves are analysed and constantly updated. Above all, the danger of this imbalance between supply and demand lies in the frequency of alternating current (50 or 60 Hz, normally), which can be substantially affected, rising if there is less demand, or going down if there is higher demand. Small variations in the frequency are not problematic, but if it rises too much, the speed at which electricity generators turn starts to fluctuate, causing vibrations that could damage them. Low frequencies are automatically handled by means of cuts of the energy supply in towns or in districts, each one in turn, so as to avoid a complete outage. An imbalance could also be the effect of unexpected contingencies, and when parts of the grid are isolated, could lead in turn to a cascade effect. Another threat lies in the loss or rising of voltage, which could damage motors or provoke instabilities in the network, it can also exceed the capacity limits of the insulators and cause disruptive discharges and very dangerous electrical arcs that happen when electricity bursts jump from one electrical conductor to another one. Instability problems could appear in the matter of fractions of a second. In North America, in August 2003, a part of the Eastern interconnection system became destabilised, leading to a very big blackout in a very large area.

Maintaining the reliability of the electrical network is a continuous and complex process that requires very skilled and highly trained operators, specialised smart equipment and extremely careful planning, design and development. It is interesting to understand, how despite the possible problems and dangers that could appear in the energy system, the system remains relatively stable. The reasons for this are: firstly, there is a standardised and rigorous system, in order to maintain and check operation plans, including long-term systematic evaluations, the analysis of contingencies, and quite detailed plans, on the short, medium and long term. Secondly, the system is always made ready for all of the potential simple contingencies (where only one pieces of equipment fails), even in the worst of cases. Thirdly, the system is made ready to provide swift responses if there are multiple faults. Lastly, the system has extra capacities for all of its functions, such as for example, redundant equipment, but also reserves in the production and transmission capacities.

What we have to ensure is, that these security and reliability processes are also applied in the Smart Grid, adapting them to the cyber security

needs and the threat to information and communication technologies that the future distribution grid is going to require.

ICT security requirements in the electrical supply

ICT security is a very broad concept, which covers different properties with many qualifications, a large quantity of technical mechanisms that can be implemented in hardware or in software and a series of processes that have to be secure throughout the entire system cycle, from the definition of requirements to the use of the system or its upgrading or correction. Wikipedia limits the concept of ICT security (http://es.wikipedia.org/wiki/Seguridad_informática), in such a way that it is wholly insufficient for us: "Computer security spans [...] everything than an organisation values (assets) and it entails a risk if this confidential information reaches the hands of other people, converting itself, for example, into privileged information". While generally speaking it is true that *confidentiality* is one of the most important aspects of computer security, there are a further three properties which are even more important for smart distribution grids: *integrity, availability and privacy* (the latter concerns the protection of the personal information of an individual or a group of them. Privacy is very close to confidentiality and they are sometimes seen as synonyms, but for our purposes it is convenient to consider them separately. In this context, any information related to private individuals, which can be used together with other sources of information, in order to identify, contact or locate that specific person directly or indirectly, is called Personally Identifiable Information, or PII, which is predominant in the United States).

As far as distribution grids are concerned, the most crucial security property is undoubtedly *integrity*. In the common sense of the word, this concept is related to *completeness* (the state of not lacking any of its parts), *coherence, or the state of being impeccable*. The technical sense of the expression in the context of ICT –while being quite precise– covers many different aspects. In a Smart Grid, a large quantity of data is generated, by sensors or by users inputting data or by interfaces with other systems. These data can be modified, and they will be read at any time, for the purpose of processing, accumulation, filtering or analysis. The rules that determine who can create or modify data, and under what conditions, are the rules of *integrity*. The rules that define who can read the data is the rules of *confidentiality*. The rules that govern the use of personal data, the valid purposes for using them, the third persons to who they can be distributed, are the rules of *privacy*. *Availability*, in its ICT security aspect, is the system's resistance to the so-called denial of service attacks, which will be discussed later on.

The four security requirements –integrity, privacy, confidentiality and availability– are top level requirements and they are independent of the

devices made available and the technology that is going to be implemented. In order to guarantee these requirements, it is necessary to systematically reduce them to certain more particular and specific ones. Some examples of such specific requirements are: alarm systems, intrusion or attack detection systems, mechanisms for resisting intrusions or attacks and recovery if this is necessary, methods of identifying, authenticating, authorising and controlling access, as well as protocols to protect the distribution of cryptographic passwords and systems to calculate the reliability of the elements in the system.

This article will not try to discuss how or with what technologies it is possible to guarantee these requirements.

Integrity

In order for the grid to function correctly, it is necessary for the data processed by the system to be complete and for them to correspond to what is expected. This means they have to be consistent with the values of the sensors with parameters that are inputted by the administrators, with user's input and with the data that come from other systems, such as data from weather forecast systems, e.g., the intensity of the winds and the volume of the water.

This property, expressed precisely, is the integrity of the system. In order for this to be completed, it is necessary that the data cannot be modified without authorisation when it passes through the communication channels, or when it is in a databank or in another memory, temporarily or permanently. These aspects of integrity can be implemented using cryptographic methods, such as digital signatures. The two difficulties in this context lie in the need to use such mechanisms in processors that have little computer capacity (such as sensors) and in the need to distribute the passwords that are necessary to protect them against attackers. Another aspect of integrity is that the data is solely generated by the authorised entities. To do this, it is additionally necessary to have access control methods which, at least in theory, are well understood and do not present great difficulties, except for the large quantity of elements that work in the system. The next aspect of integrity is the hardest one to ensure: using the correct process that create, modify or communicate the data. It is no use to make sure that only one very reliable administrator is capable of changing the system configuration, if the programme that is used to do administration is malicious and it performs in an unexpected way.

Privacy

Before anything, the protection of privacy means respecting the limits set by law for the compiling and utilisation of personal data. The text of reference within the European context in this regard is the European

Directive 95/46/EC. This directive defines the main guidelines and the principles of orientation for data protection. The member states have implemented this kind of directives as well as independent national bodies that are responsible for supervising the protection of the private data; they set the terms for judicial appeals in case that privacy rights are not respected. In Spain, this controlling body that is responsible for complying with the Spanish Data Protection Act is the Spanish Data Protection Agency (SDPA), which was created over twenty years ago. The directives and the legislations are not only applied to the data processed by computerised ICT, but also those that are dealt with on paper in traditional files.

The privacy of a piece of information provided, in a given moment, may take on different levels of importance, depending on the particular situation, the practices and the culture of the individuals in question and of the society in which they live. This is especially valid for that information that gives away the practices, activities, convictions, family status, etc. of an individual. For a person in a particular social context it is not problem to disclose that someone is a Muslim or his family has 6 children, but for someone else, in another context, this situation could be very delicate.

There are two reasons why this is pertinent for Smart Grids: first, the person himself who is interested is entitled to oppose certain forms of handling his data, the way it is used in, or the level of detail that is contained. Second, the personal details that are processed with a Smart Grid can provide information about matters that are really personal to the individual. There are already rather a large number of doubts nowadays concerning privacy of personal information of consumers, with the appearance of smart meters. Data about the electrical consumption in a family –should they be very detailed and taken very frequency– can offer a lot of details about the family life: at what time a device was switched on or off, e.g, the television, the oven, the washing machine, etc.. It is possible to know if the family is not at home or if they have guests, if a shower was taken hurriedly or if there was breakfast, etc. Data from an electric car can show evidence about the places the user has visited, and this could maybe be evidence of related activities. If users access the system remotely, the data could perhaps indicate whether they are on holiday and where.

To put this very briefly, the basic principles of privacy are as follows: the data have to be compiled and processed for certain purposes which are particular and legitimate, and only for them. The interested person has to know the way his data is handled; he is entitled to access his data and must have given his consent to it being used; certain categories or types of data (that could reveal something about his racial or ethics origin, his political convictions, religious or philosophical persuasions, his membership of a

trade union, the state of his health, his sexual orientation or activity, or his personal or family situation) cannot be collected, or special permissions and provisions are required; the competent authorities must receive information about the unlawful, alteration, dissemination or unauthorised access to personal data. Lastly the data has to be handled in a secure system that offers confidentiality.

In this list we can clearly see the difference between confidentiality and privacy: privacy presupposes confidentiality, but the former covers a lot more.

Confidentiality

In general terms, confidentiality is the property that the data stored in information systems or that is transmitted by communication networks are not within the reach of people who do not have the authorisation to read the data. In the case of the supply network, there is quite a large quantity of data that needs to be protected in this respect. For example, details about the physical architecture are important to secure because they could bring about a physical attack if they fall into the hands of terrorists. Similarly, the data about contingency plans, production or transmission reserves, consumption forecasts, economic data about the system, etc. must also be protected. Personal data about the users, about their consumption and their accounts have special important value for reasons of privacy, as we have discussed above.

Availability

Availability is the property that the systems are at the disposal of the users or those that can access them at the times when they need them. In this general sense, this is practically the same as the system's reliability. But there is a very particular sense of the word, related to the security requirements of information and communications technologies. This means that such systems have to be immune or highly robust when faced with the so-called denial of service attacks. One typical form of attack is that of saturating the communication networks service, blocking that service with a huge number of requests or overloading the network with artificial messages that make legitimate access difficult or impede it. There are other more sophisticated ways of putting the system availability at risk, attacking its integrity, for example, changing the credentials that it uses. There is a broad range of mechanisms that that can be implemented in the ICT infrastructure: the use of systems with redundancy, fixing disks, high-availability equipment, mirror servers, virtualisation, data replication, storage networks, redundant links, etc. The suitable solution depends on the services or that have to be protected, and the service level that it is necessary to provide.

Cyber security rules in the current electrical supply system

Here is not the place to discuss the attacks that have been discovered in the electrical distribution system in depth. Going beyond casual attacks, the ones that make us concerned are those that are called Advanced Persistent Threats, which are advanced ways of clandestinely gaining intelligence about a company, a sector, a critical infrastructure or a particular group of individuals, continuously and persistently.

It is necessary to understand what the dangers are in general terms, how advanced attacks work and what needs to be done to lessen the relevant risks, without going into a discussion about the techniques that are used. In very general terms, an advanced attack is achieved in the following stages: Firstly, relevant information for the initial attack is compiled. Attackers search for information on Internet and in other media that is provided for public access to in order to know which employees of the different electrical companies or the associated company can be attacked. To complete this information so-called social engineering methods are employed. For instance, this entails asking for data by telephone, pretending to be somebody who is authorised to have the information. Now, attackers have got a list of their first victims, of their positions, work environment, the names of their colleagues, etc. Then they send them fraudulent electronic messages, which are fake but appear to come from their boss, from a work colleague, from a centre that arranges conference of professional interest, of companies that provide protection systems etc. This type of e-mail fraud is used in order to obtain further information, or to steal the victim's credential and so be able to enter servers where the victim has access. On certain occasions, it is possible to use these fraudulent e-mails in order to inject a malicious code into the victim's system. This method of using malicious messages that are constructed for certain people in particular, and then sent to a pre-established target is called *spear-phishing*. This enables the stealing of credentials, secret passwords or codes in order to manage to *impersonate an identity*. Once inside the organisation, they look for new passwords, vulnerable programmes, communication or administration services that could be abused. They inject malicious codes within the programmes that already exists and known, trying to conceal their true character and intentions. This malware usually has capacities to contact a malicious server that controls it or guides it and opens up a channel so that the attacker can "enter" in the compromised system. This is known as a *Backdoor*.

Other Trojans are commonly injected into the more important files for the computer's operating system, until they manage to make the attack succeed. In this way, even though the computer is re-started, the Trojan, having infected files from the operating system, remains present. It can

now spy on the activities of the administrators and even read what is written on the keyboard (known as *keyloggers*) or send messages to other computers, searching for cryptographic passwords, etc. In the meantime, it is waiting for the right time for the final attack, maybe coordinating itself with other malicious programmes by means of the malicious server, and it can carry on selecting information about the physical defence or cybernetic systems, the structure of SCADA systems, and the logic programmes, relevant documents, peoples' names or e-mail addresses, parameter values, etc. In certain cases, the malware could even stay inactive for weeks or months before starting the internal attack that it was designed for.

Stuxnet

Stuxnet is the name of the malicious code (Trojan, or malware), discovered in July 2010 due to a functional anomaly that caught the operators' attention. There is recent evidence that preliminary versions (version "0.5") had already appeared in 2005. This was the first malicious code found that reprogrammed control systems and the supervision of SCADA programmes, as well as the programmable logic controllers (PLCs) connected to these. The malware analysis took many months, because it uses different type of coding and very advanced obfuscation. The software can spy, affect and damage the critical infrastructures that are infected, without the administrative staff being capable of recognising the damage in time.

Stuxnet is a piece of software that has never been seen before, which certainly required a very complete team of expert programmers, with very detailed knowledge about different programming techniques, the equipment that the attacks are targeting and the industrial processes that they want to manipulate. The scale of this endeavour means, that it must have been very costly to programme and that the construction of it most likely had the support of a large organisation or a state body of some country. Stuxnet employs four vulnerabilities in the Microsoft Windows operating system which were unknown until then, in order to penetrate the Siemens SCADA system. In addition, Stuxnet can generate digital signatures with two genuine certificates stolen from certification authorities.

There are a lot of indications that Stuxnet was specifically designed to delay the start-up of the Bushehr nuclear plant in Iran. For example, most of the computers contaminated by Stuxnet are found in that country.

Since many of the pieces of industrial control equipment cannot be accessed via Internet, Stuxnet has the ability to infect using USB memory sticks. Moreover, it is capable of using other means of communication, and it has the capability to upgrade itself when necessary.

Until March 2011, a total of 24 Siemens' clients in the industrial sector had been notified worldwide, which had been infected by the Trojan. It was possible to eliminate the malicious code in all of these cases. Siemens is providing programmes to detect the presence of Stuxnet for public access on Internet (<http://support.automation.siemens.com>) as well as a list of steps and tools to eliminate the Trojan.

Stuxnet relatives: Flame, Duqu, Gauss and Madi

Flame, also called Flamer or sKyWIper, is a modular malware that was discovered in 2012 that is highly complex and of a very substantial size. The organisations that have studied it, like the cryptography laboratory of the Budapest University, and Kaspersky agree that it is one of the most complex pieces of software and that it is very hard to fully understand. This is because of the fact that it has various obfuscation methods, various particular file formats, and at least five encrypting mechanisms. It also uses special methods to inject code into its victims.

Flame has a very advanced form of functionality in order to steal information, to store and communicate it, in addition to advanced mechanisms that spread it from one computer to another. It is capable of practically intercepting all of the computer's interfaces including USB sticks, the keyboards cameras, Bluetooth, microphones, and internet connections. Therefore it can record conversations and Skype conversations, capture the images from screens or keystrokes from the keyboard, etc. This data together with the stored documents are sent to one of various malicious servers spread around the world. The programme then waits to receive new instructions from those servers, and download additional modules that extend its functionality.

The programme has been used to carry out cyber-espionage attacks in Middle Eastern countries and it has infected 1,000 machines. In June 2012, the Kaspersky published evidence that reveal that Stuxnet and Flame authors had been in contact and they had worked together on at least the first stage of development. One example of this collaboration between the two groups of attackers was the USB infection mechanism code, which is identical in Flame and Stuxnet.

Duqu is a variant of Stuxnet, appearing at the end of 2011, which contains a variety of software tools that offer different types of services to attackers including the theft of sensitive information, such as cryptographic certificates and private passwords. Using these allows signing for malignant software and passing it off as upgrades of the systems under attack. Furthermore it has kernel (or core) controllers and tools for injecting code into existing programmes and read keystrokes. Duqu searches for information that could be handy for attacking industrial control systems

although it seems that its objective is not to directly destroy, but rather to spy. It is possible that the information extracted is then used to create very specialised attacks. In personal computers it has indeed been observed that Duqu destroys information that is stored on drives.

Duqu is still being analysed by security experts, who have not been able to decipher all of the code and understand exactly how the Trojan works and, in particular, how it is distributed and multiplied. It seems that the code eliminates itself after about a month, which makes it harder to identify.

Duqu has been found in a limited number of companies, including those engaged in building industrial control systems, such as SCADA. The information extracted can maybe be used as a basis for designing and perpetrating new attacks such as the Stuxnet one.

Gauss, discovered at the end of 2012, is able to spy on bank transactions, steal information about access to social networks or electronic mail and attack critical infrastructures. Gauss is a complex set of cybernetic espionage tools, highly modern and apparently related to Flame. It contains encrypted binary code, which is not yet understood. It is activated in certain system configurations. Gauss would seem to have been used to steal authentication information from people in the Middle East, the Lebanon in particular.

Kaspersky and Seculert further studied the "Madi" Trojan. They identified over 800 victims in various countries, such as critical infrastructures in Iran and Israel, financial institutions, Middle Eastern engineering students, but also think tanks and governmental agencies, some of them in the electrical sector, and foreign consulates in the United States. The attackers use social engineering methods to identify specific people and pieces of equipment in which –once they have been compromised– Madi is capable of searching for, and stealing the information stored in files, of reading electronic mails and instantaneous messages and even of recording keystrokes, reading what the user is writing on his keyboard for example codes and passwords. It sends all of this information to a spy server. It is also capable of upgrading itself to new versions.

Other attacks on SCADA centres and on the Smart Grid

In its edition of April 8 2009, the "Wall Street Journal" reported that the American electrical network had been penetrated by spy countries that put Trojans in place, capable of disturbing the system, according to the report security officers, who did not offer details. The same year, an update of a piece of software in a Georgia (USA) nuclear plant initiated an unexpected energy stop at the plant's SCADA control and supervision system.

It is even possible that attacks on the Internet in general or on certain types of systems that are not directly associated with the energy supply affect the SCADA sectors. This had happened both in 2004 with the SQL Slammer worm and with the Conflicker virus in 2009.

It is hard to know how many attacks there actually are against SCADA servers, especially those that are targeted at one system in particular and are of an advanced nature. It is easier to calculate how often the indiscriminate attack attempts on SCADA servers take place. In 2013 TrendMicro reported on an investigation which, a few hours after activating a SCADA system that was not very well-defended with the sole purpose of watching cyber-attacks, demonstrated such continuously. The final statistics showed 28 days of continuous attacks with a total of 39 different attacks coming from 14 countries. At the Black Hat 2013 conference it was proven, that it is possible to take control over PLC control units so as to turn them on and off in a simulate situation.

However it is important to mention that although the SCADA controllers and the associated computers have vulnerabilities that are easy to find if one has direct access to the equipment, taking benefit of these vulnerabilities remotely and crossing the protection measures that are usually used is rather more difficult. In many cases, the continuous monitoring of these systems stops an attack that gaining information by means of trial and error. In contrary, a malicious code such as Stuxnet proves that the current measures are insufficient, if an attacker is very sophisticated.

In Smart Grids, the so-called *attack surface* is growing: both the quantity of Internet connections and the number of vulnerabilities in the connected systems is going to increase. There are 53 million smart meters in the United Kingdom, and in Spain, there are currently about 28 million energy consumers that will receive smart meters between now and 2018. Very often, the users' devices that are utilised for smart measurement are connected between themselves via wireless networks and with the energy supplier. The wireless networks are often easy for an attacker to access. He will be able to intercept, capture, record, repeat and handle the information in two directions, altering both the billing and consumption messages sent to the supplier, such as commands, the prognoses and supply prices in the energy market. In certain smart devices it is possible to extract the secrets from the memory, enabling the manipulation of the communication with all of the meters of the particular supplier that use these same factory pre-set secrets. The attacker could remotely disconnect homes, offices, and large-scale buildings by wired or wireless (GSM) connections. The current security of smart meters and of other equipment for the users and consumers leaves a lot to be desired, the protection of these devices does not have preventative security measures and there is no system for responding to eventualities in the case of attacks.

Other attacks on the infrastructure of the ICT environment

There are more indirect ways –which are no less effective– of attacking the energy supply infrastructures. If infrastructures are infected, which systems' production or the global communication or the sources of trust in Internet depend on, and then the doors will be open to very serious attacks on the energy supply.

One scenario would be to infect an equipment manufacturer, breaking its production systems and introducing Trojans into the machines that are used in order to design, develop or fit out the equipment used in security systems or the control of critical infrastructures. If an attacker manages to get in there, the software patches, the files and the producers' compilers would be the perfect mechanism for dismantling an installation. In the eighties of the XX century, an already-classic article from the ACM (Association for Computing Machinery) written by Ken Thomson, the winner of the re-named Turing prize, demonstrated how it is possible to maliciously modify a fundamental compiler in such a way that the operating system's authentication and authorisation systems are completely open to the attacker.

A second scenario is provided by attacks on the sources of Internet trust (trust anchors). If it is possible to attack those that distribute codes, passwords, certificates and equipment used to identify, authenticate or authorise equipment or people, it is then easy to enter into any part that depends on the relevant security services. One example of these attacks was the intrusion of the RSA company in 2011, which began with e-mails to employees with a relatively low-profile, with a malicious Excel file. In the end, the attack was successful in extracting information related to the authentication products of two SecurID factors of the company's servers. These attacks seem to be connected to at least 64 infiltrations that have invaded approximately 100 identified victims, remaining stealthy for many months, stealing secret information that may probably be used for attacks on critical infrastructures.

These attacks are massive, but not impossible to counteract. One example has been a reaction of Lockheed Martin in this emergency. The security team of this company has invested a large amount of time in setting up a methodology to recognise the attacks, monitor its activities and prevent the theft of important information.

A year later on, a team of experts in cryptography found another attack on RSA SecurID, due to some subtle cryptographic faults, managing to compromise existing cryptographic devices, including smart cards and an information credential issued by Estonia. Similarly, faults were found in a large number of smart cards of different companies.

Other attacks on credentials suppliers and certifying authorities, such as the cases of Comodo and Diginotar, have received a great deal of attention in the media.

A third type of scenario is attacking communications networks (such as the GSM system) or the Internet pillars, such as path tables, domain name servers, etc.

The role of icts in smart grid *The characteristics of Smart Grid*

Figure 1 depicted many characteristics of the grid:

- I. Automated billing with a unidirectional grid. This system offers relatively detailed billing by time slots, making it possible for consumers to watch and understand their consumption patterns and choose the most favourable hours of these. This is a rudimentary demand response mechanism, which, as we shall see in a memento, ensure the provision of the best use of the grid's capacity, meaning that end consumers lower their demand in response to the price differences of the different time slots. In order to offer users the information, it is necessary to have the information storage and processing at the customer's premises or, in the absence of this, the communication channels that make it possible to pass the consumption data in the server's desired granularity.
- II. Demand response with a bi-directional grid. A reliable operation of the electronic systems requires a suitable balance between supply and demand in real time. "Demand response" can be defined as a set of actions and measures, that aim to influence the electricity consumption habits of the end users. More specifically, raising the energy prices at times when there is usually more demand, or even modifying them in real time, depending on the supply and demand, will allow to have an influence on the time at which a well-informed user, or one fitted with smart equipment, consumes energy, helping to balance the system. Demand response will help to save energy in its entirety, but the importance of this lies in "moving" demand from certain times to other less critical ones, thus levelling out the difference between the curves of available reserves and the consumption that is demanded. It is usually expected that a user will reduce his consumption when the prices are high, switching off lights or equipment when they are not functioning, or transferring some of their peak-demand hour operations to times of low demand. In the future moreover, consumers will be able to

opt to generate their own energy or to buy it to store, supplying it to the local or global network. For example, the local or global grid can be supplied in electric vehicles so it can later be used or sold. In any event, it is necessary to provide consumers with interfaces with information and communication systems so as to notify it in real time about current and forecast prices, consumption amounts, etc. However, it will not be possible to force consumers to be present in every energy consumption decision. The users must set rules (also known as their "preferences" or "policies") that will have to determine the actions of a smart decision-making system. This automation works, with no human intervention, controlling the smart equipment or domestic appliance in accordance with the users' preferences. The demand response measures are not limited to managing the quantity and the time of consumption, they also include for example, subsidies for re-integrating locally generated energy into households, etc. The mechanisms require the continuous compiling of data, as well as the processing and the communication of large quantities of information, both that relate to consumption by the different pieces of equipment in their homes, such as expected prices, etc.

- III. Detection of faults and restoring of equipment using smart sensors. The distribution grid today is "blind" in many cases. The energy operators and companies have got very scarce information about the state of the grid, and in many cases they are unaware of the existence of supply problems, until a client calls to complain about a lack of service. Using the Advanced Measurement Infrastructure system (AMI), the distribution companies will quickly know about any fault in the system. In addition, the network will be fitted with a larger number of smart electric devices that are capable of directing and resolving problems locally and of communicating with the highest supervision and control units in the hierarchy.
- IV. Information systems for users and portals for consumers. Users will be able to supervise and administer the electrical apparatus both locally, from their homes, and remotely. This presupposes the availability of detailed information about the status and the activities of domestic appliances. Furthermore, it is necessary to have a systems so that users can define their policies (rules) that represent their necessities or preferences, and according to which, the service of a piece of apparatus is turned on or turned off, or its parameters are changed. They key will be the development of intuitive information systems for users which, in order to be broadly accepted, must

comply with the personal information security and protection requirements.

- V. Distribution automation. The infrastructure of the future will be capable of identifying and dynamically integrating new energy sources, regardless of the form of generation or of localisation in the grid. In the cases of excess charge it will be possible to recharge reserves, ensuring that the grid maintains an efficient and trustworthy supply level.
- VI. Self-healing. Self-healing is a topic of investigation that may be considered one of the critical branches for the undertaking of the Smart Grid. The concept is really a euphemism, under which techniques are grouped together, which seek to provide the grid with the autonomous capacity to detect, analyse and isolate faults, and to find compensatory measures in order to recover the service immediately. The implementation would imply increasing the maintaining of the system's stability and reliability, even if the missing number of components rises.

ICT Security in the Smart Grid of the future

One global trend for information and communication systems in critical infrastructures and very much in particular, for those that are pertinent to the electrical supply system, is that these are opening up, being connected to the outside world and to the global Internet.

Going back a decade or two, the general model was –and in many cases is still– that of medieval castles or fortresses; with deep moats, high walls, secure gates that are constantly under guard surveillance, and secret passageways that are only known to a small set of very select and reliable people. Specifically, the electrical supply supervision and control systems in this model are practically isolated from external systems. They have control centres where only completely-trusted individuals can enter, and where very communication with the outside world is subject to highly-scrutinised. But it is notable that it is impossible for the systems to really be isolated from everything. This is because it is necessary to update programmes put new computers in, connect external data banks, or to coordinate the production or distribution of energy with of the control centres. The security depends on the so-called perimeter protection. It is not vital, within the control centre's internal system, that the computers do not have vulnerabilities. What is important is that nobody authorised can access them.

This model is gradually disappearing and, with Smart Grids, the model will have substantially changed. It is now just the energy companies that are the ones interested in protecting their own information, but also that

the general public is also the owner of sensitive information, not only its consumption data but also its energy consumption policies, its commands to the equipment of their private residences, etc. There will still be multiple players involved that provide and read information of all types and rely on their integrity, confidentiality and/or availability.

The model of medieval fortresses has become a group of residents in an apartment building of a modern city. Soon –with Smart Grids– this model will be mutate into that of a shared flat: the different participants have certain common security interests and other different one and they are compelled to reach agreements that determine in which way which objects value are going to be protected. In the case of Smart Distribution Grids, the different participants have a clear common interest: the integrity of the global system. Besides, each one needs its own personal or commercial information to be protected. Although the participants' different requirements do not contradict each other, they do, in any case, compete with the system's efficiency and they are costly to install and supervise. Even more so: in order for a server to offer a participant, it is often necessary to have personal information about this and the better, more accurate and more abundant that information the better the service that it can offer is. Thus, in addition to the tension between security, on the one hand, and efficiency and cost on the other hand, there is also tension between privacy and functionality.

Thus, as the people who share a flat have to agree on certain basic rules, which objects are kept under lock and key and who can enter it, with a future electrical network it will be necessary to negotiate the security rules that the system has to impose. Owing to the large number of participants and the system's dynamics, this leads us to the need for every party to write down its security or privacy *policies* in a language that can be automatically processed. Thus, a smart system can analyse the preferences of the participants and find suitable compromises.

It is important to remember that it is impossible to build a complex system, based upon information technologies, which are completely secure. What we need is for it to be reliable enough, that we have credible evidence that a set of requirements is going to be complied with. Security is not a static subject. If we find method today to protect us from attacks such as the Stuxnet one or another particular one, using programmes that verify certain conditions in the memory or in the programmes that can be run, it is possible to think that the future versions of the Trojan first attack our defence security systems, the detection and monitoring programmes, and they then attack the system of interest. In such a case, it will be equally possible to build defences against that attack and so on, successively. The security risks that organisations confront are being sorted out but new ones are equally appearing, which are very often more complex. Security requires continuous processes of making it secure, monitoring, scru-

tiny, verification and much more. In an open system in particular, such as Smart Grids will be, it is necessary to involve all of the participants, including the general public, in the security processes. So as to protect it against intruders and thieves, it is not enough to duly close all of the gates with all types of padlocks, but no window can be left open either. Like a thief that comes in through a bathroom window, he could go through to the living room or the bedrooms, a cybernetic intruder can come in through a computer, search there for passwords or codes, and move on to another more important one and then to another one that is perhaps vital.

Security Measures in Smart Grids

The security of an information processing system is implemented with a set of *preventative* measures that try to shield and protect both the particular information, and the information processing services, as well as *reactive* measures that help to recover the correct state in the case of a critical event. For all of the protection that we take, is important to take account of the fact it is impossible to avoid all of the security defects or faults, which is the vulnerabilities. If an attacker finds ways of accessing these, the attacks are going to be inevitable and it is necessary to take measures to make the risks manageable.

The security cycle can be separated into four tasks: first, to facilitate the security process that involves defining a security strategy, policies and rules, roles and responsibilities, processes, education and training; second to build secure systems, use adequate protection technology, define a security architecture, implement and configure this with a secure coding and good practices; thirdly, evaluate both the security processes and the individual security of the systems and, in particular, the presence of vulnerabilities and faults, for example by using penetration tests (pen-tests); and fourth, to respond, detecting and analysing security incidents and reacting quickly so as to establish the usual functioning and minimise the impact of the incidents.

Facilitate the security processes

The first task, that of facilitating security processes, corresponds to the bodies and the functions of business (or corporate) governance. Within each company that takes part in the electrical supply, there must be one unit that has the commitment of the company management and its financial support. This unit, and its head in particular, a top level executive, the CISO (chief information security officer) is responsible for following tasks:

- I. Define control roles and responsibilities. It is necessary to define who is the person responsible for the information and for the company's relevant processes.

- II. Define the internal policies. The policies outline the conduct of all of the players that have direct or indirect access to the system and, in particular, the critical data or processes. Those people in charge of the running and management have to take part in treating the security checks that must be applied to its systems.
- III. Provide feasible and proven action plans and resources. The security policies and processes defined must be crystallised in the form of specific plans where the administrators, system proprietors, the security staff in the organisation and, in particular, the emergency response team all participate. The physical and economic resources, as well as the teams of experts and the support services, have to be properly confirmed by the risks analysis, and once these have been justified, they must be furnished.
- IV. Establish a continuous analysis and risks management process. As well as establishing the process, the security governance also has to decide what is the right way of handling the risks. In order to determine the risks, it is necessary to conduct a detailed study of the system's facilities, the consequences that the attacks may have on the physical processes and the integrity of the elements, functions and services of the system, as well as the information flows, that is to say, how the relevant information is identified, captured or measured, and the data that need to be protected. In addition, it is necessary to determine realistic attacker models, and it is necessary to decide what is the right reaction, e.g. avoid, mitigate or accept the risk. In very general terms (when the organisation dispenses with the possibility of exposure to the risk, avoiding the reason that gives rise to it), mitigate (the consequences of the risks can be lessened to some degree by security measures), can be transferred (for example, the costs resulting from a risk acceptable to insurance companies are transferred), or these are responded to (in the case of an incident, the resulting risk may be minimal, if the response to the incident is adequate). The decision has to be characterised by the recognition of the existence of the risk, and the agreement to assume the losses involved.
- V. Determine the methods to evaluate the effectiveness of the checks and of the monitoring. It is necessary to know how adequate are the existing security checks and tools, the intrusion detection processes, regarding vulnerabilities and incidents. We should recall that we have seen malware that has spent several years undetected.
- VI. Guarantee the reporting of each step in every general security process. In order to be able to learn from the security events,

whether these are findings of violations of policies or the presence of vulnerabilities or of incidents, it is necessary to protocolise in detail not just the corresponding situation, but also the analyses that were attained during and after the event, the measures that were taken, etc. Also it is regularly necessary –with no particular reasons– to describe the processes used and the results obtained.

- VII. Continuously identify opportunities to improve security. The regular reports, discussion via security groups such as the Computer Security Emergency Response Team (CSERT), must be scrutinised in the search for improvements to security or the evaluation.
- VIII. Define a revised and approved legal strategy. Security incidents may have various consequences, and even criminal ones on many occasions. Security planning has to be developed with members of the legal consultancy team. The legal consultancy has to have knowledge about the legal consequences of a violation, the value and the hazards of a client's personal information, medical or financial procedures. The local state or federal regulations will at least partly dictate the methodology to carry out the post-mortem analysis.

Build secure systems

Organisations have to adopt a comprehensive set of security checks so as to protect their information and information systems. The purpose of the security architecture is a holistic vision of the system's security requirements, of the mechanisms that make them secure and how they are integrated into the global architecture.

Evaluate the security and the processes

In order to comprehend the effectiveness the evaluation methods, it is convenient to use profound and far-reaching tests in controlled laboratories for systems that are highly important, intrusion tests (penetration test) and white box tests, both automatic and systematic reviews of the source code, using so-called honeypots, software or hardware that is meticulously monitored, whose intention is to attract attackers, simulating being productive systems, and comparing the risks calculated with the actual incidents observed. It is important to compare these with external evaluation methods so as to help the local team, participate at laboratories that work together in studying vulnerabilities.

Respond

The impossibility of avoiding all types of security defects or faults makes it essential to create a computer emergency response team,

as well as draft an incidents response plan. This will not only minimise the effects of an intrusion or attack, but the same applies for adverse publicity. An incidents response plan must have the support of and participation of the entire organisation and it must be frequently tested. The response plan has to recognise security incidents, that is, those unexpected or undesirable situations as compared to the system protection targets. However, its priority aim is to be detecting the incident, immediately restoring the expected state and the resources affected and limiting the damage throughout the organisation. Given that, in the case of an incident, there is very little space for errors; emergency actions have to be quickly and swiftly taken. One important element is the forensic analysis that facilitates the recognition of the attack or intrusion process and of the vulnerabilities, faults or neglect that led to the incident. This analysis is increasing the experience of the security team and of its capacity to respond to adverse conditions in a swift, formal and opportune manner, on the basis of the experience acquired. Lastly, it is necessary to give appropriate instructions for treating the causes and reporting the incident via suitable channels.

Challenges

There are many challenges related to the protection of future energy networks, and there are a lot of steps to be taken by the different parties that are involved or interested: the equipment manufacturers or vendors, the energy production and distribution infrastructures operators, the companies that provide information services and other ancillary or additional services, the security system vendors, the security investigators, the standardisation organisations, the state organisations, etc.

We divide these challenges into seven different groups: the technical operation and infrastructure aspects, the operating aspects of the infrastructure and its related processes, the education, dissemination and awareness raising, the exchange of information, the creation of standards, guides and regulation, the research and development of new solutions and the protection of the privacy of personal data.

Technical aspects of operation and of infrastructure

The equipment manufacturers and the operators must work together so as to find and define technical incidents prevention solutions. This has to result in a collection of security mechanisms that are to be implemented and integrated during the production of the equipment, and additional mechanisms and the configuration of parameters, passwords, etc. during the deployment of the systems.

- I. Definition of a security architecture. The operators, together with the vendors of security services and equipment, will analyse in detail all of the risks, and accordingly design a "security architecture" that is suitable for the operating systems.
- II. The implementation of security programmes for industrial control systems that are open to Internet networks could be very costly. Many operators make use of controls that compensate for the lack of intrinsic control mechanisms, so as to prevent the investment of large sums of money in renewing equipment, old devices, operating systems and general software. The two requirements for facilitating this route are: on the one hand, it is necessary to create versions of products with limited functionality and that offer few but sufficient options for some specific SCADA systems. On the other hand, it is necessary to design a deep defence architecture, that is, the inclusion of multiple layers of protection and overlapping security mechanisms, which act as various barriers against attackers. This focus constitutes a good route for protecting industrial control systems.
- III. A fundamental aspect of the security architecture is provided by the systems' remote access protection mechanisms. Remote access for control systems by the vendors or management staff for maintenance tasks exposes some aspects of the architecture to external manipulation.
- IV. Secure programming. The hardware and software manufacturers of industrial control systems must apply the right methodologies and rules of secure programming during the system's development cycle.
- V. Analysis of the security requirements throughout the entire life cycle of the systems. Security requirements must be included from the outset, in the specifying and analysis of the system. In other words, security must accompany the development of the system and not become a set of additional mechanisms for compensating for the security defects found that are due to a lack of foresight.
- VI. Consideration of the system's lifecycle. The software and hardware for offices has a lifecycle of between three to five years. In industrial control systems, which are designed for a very specific purpose, the lifecycle could last much longer. This is why it is hard to ensure the components of the industrial control systems continuously throughout the lifecycle against new security attacks. Thus, it is necessary to have detailed plans so as to be able to modify the systems being produced.

Operating aspects of the infrastructure and related processes

We include the systems operators' activities here. This includes the provision of physical security, the governance of security (in particular: definition and application of roles and responsibilities), crisis management and risks management. The education of rising of awareness of the employees and users is considered to be a separate issue here. This is because it is an activity that is not the operators' responsibility, but also the system's protagonists.

- I. Establishing of comprehensive security programmes. The operations of transmission and distribution networks have to set up comprehensive security programmes, which include all of the processes and equipment, of both the desktop and commercial and control computing of the industrial systems. Many organisations have designed cyber security programmes for commercial computing systems, but the security management practices are not properly adapted for the industrial control systems.
- II. Hardening. During the installation of equipment, it is necessary to eliminate the modules and services that are unnecessary, select the most secure configuration of parameters and SW versions that are best suited. This is fundamental for reducing the surface area of attacks and, hence, the risks.
- III. Changes control management. As internal or external incidents reports appear, as well as the vulnerabilities discovered, or SW patches, it is necessary to review the system configuration, the parameters of SCADA systems and programmable logic controllers (PLC), the versions of firmware, properties, files or any other programme or application. Adequate management is especially important with the aim of preventing interruptions or serious problems in industrial control systems.

Education, dissemination and awareness rising

All of the protagonists at all levels have to take part in the work on education and raising awareness, including the top ranks of the companies involved.

- I. Education awareness raising and conscientiousness campaigns. It is imperative to create a culture that is conscious of the topics pertinent to security, above all achieving a certain level of profundization of the necessary knowledge, above all concerning the risks, the recognised procedures that encourage security, as well as the practices that endanger it. With this aim in mind it is

necessary to define and implement education programmes for the staff of industrial control systems, and campaigns of raising awareness and conscientiousness for end users and the services providers.

As we have seen, many attacks could be avoided if the staff and other protagonists in the system act by imposing rules of conduct that are not always evident. For example, spear-phishing tries to mislead the victim with a piece of information (a link to a web site or an attachment in an electronic message) that is apparently interesting to him. It is not just that the company has to have policies on the reactions in such cases, but also the employee who has to know about such rules and understand their value in protecting the system.

Information exchange

It is not easy for critical infrastructures operators to cooperate in detecting attacks and to share information about incidents. The European Community is looking for new ways of incentivizing this form of cooperation, studying the possibility of creating test banks and a *Computer Emergency Response Team* for industrial control systems (CERT) for coordination, going beyond the diversity of capacities that the different countries and organisations of the community have, as well as legal, strategic and private interest problems.

- I. Creation of evaluation groups. Industrial control systems incidents have to be used as the basis for updated evaluations of risk, of possible corrective measures and those of re-assigning resources. Both manufacturers and operators need to tackle the challenge of creating analysis committees that meet up regularly so as to discuss security risks and re-evaluate the risks. Those teams also have the requirement –in addition to the expert security staff and the procedural engineers– of people in middle management posts and must have the unconditional support of the senior management.
- II. Information exchange. New vulnerabilities are discovered every day in the software of industrial control systems. The operators need to be ready to face up to these new problems. At the same time, the manufacturers of industrial control systems have to offer swift and effective responses for the need to create and distribute patches and vulnerability reports. Business, and academic and independent research need to work together, making it possible for the manufacturers to correct their systems before making the information public.

Standards, guides and regulation

- I. Incentives, rules, legislation and regulations. The European Community studies ways of compelling or at least of motivating operators to adjust themselves to inspections of industrial control systems and risk analysis. The North American regulation is led by the organisations FERC and NERC.
- II. Auxiliary guides. In addition to the previous rules, it is necessary to define auxiliary guides, which include a set of security and good practices controls, which are compensatory alternatives and supplementary processes. Examples of the topics included in these guides may be: account management, separation of functions, the principle of minimum privilege, concurrent control sessions, remote access, contingency tests and plans, changes of control, maintenance instruments, remote maintenance, protection against malicious codes, tests methods, etc.
- III. Standardisation. It is necessary to define and standardise flexible and elegant solutions for the specific purposes of Smart Grids and to analyse whether it is necessary to define a set of basic secure communication protocols, adapting a suitable cryptographic system for the requirements, but allowing for the introduction of new algorithms when necessary.
- IV. Certification. The three preceding points can –and in many cases they ought to- be accompanied by certification processes, either mandatory or optional, which confirm the conformity with the corresponding guides.

Research and development of new solutions

- I. New solutions. Security investigators have to develop new techniques and solutions for control and supervision systems and other elements of Smart Grids. This has to include forensic methods, automatic techniques that are non-intrusive and provide for real time monitoring that makes best use of the unique type of systems used. It will also be convenient to define communication and cryptographic protocols, as well as compensatory controls that are adapted to the needs of future energy distribution, for both large pieces of equipment that are specific and for devices with few computing, storage or battery resources.

Protection of the privacy of personal data

- I. Privacy. In today's world, it has already been demonstrated in medical or commercial systems that ensuring user privacy is an

immense difficulty. One particularly relevant challenge in Smart Grids will be that of having to administer an unprecedentedly huge amount of data, and at the same time to ensure the anonymity and the privacy of many of these.

Conclusions

Electrical supply Smart Grids will become a reality. There is heavy pressure in the modern world that force us to follow this technological development, which has been described as humanity's largest engineering endeavour. The use of information and communications technologies (ICT) is essential but this will entail new security risks. It is practically impossible to calculate the actual likelihood of a serious attack taking place today, now or in the future, on the electrical supply system of a developed country, or know what the equipment or functions are that will be targeted for attacks. The most important thing is not to try to build completely secure systems. This would be an unattainable ideal and a futile enterprise. Instead, it would be better to have a holistic concept of security that determines which processes to follow in order to prevent the attacks or make them difficult, which tools to use in order to swiftly recognise them, and which actions to take in order to respond to and recover normal functioning in the shortest possible time, and before wreaking havoc. The security challenges are great but possible to manage. They are a call of coordinated and determined action by our society.

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Geopolitical impact of the development of unconventional hydrocarbons

Mariano Marzo

Chapter IV

Abstract

Unconventional oil and gas resources are abundant and their production is economically viable. In addition, the geographical distribution of these resources helps to diversify the traditional sources of supply currently highly concentrated in the Middle East and Russia. Stagnation and imminent fall in production of crude oil will make unconventional oil to gain prominence in the future. Over the next decade, its increasing extraction, particularly in the United States and Canada, will help to temporarily weaken the hegemony of the OPEC which nevertheless will regain control of the market shortly after the mid-1920s. Meanwhile, the production of unconventional gas will extend in the future from North America to other parts of the world, consolidating its contribution to the global supply of gas on a long-term basis. The change in the geography of demand, whose centre is moving towards Asia, along with the changes introduced by the unconventional hydrocarbons production in the current balance between exporting and importing countries, will incur a reorganization of the trade flows of oil and natural gas, with implications upon the security of the global supply routes. The United States, which thanks to unconventional oil, achieves the auto-sufficiency in the case of natural gas as well as a low degree of dependence on crude oil imports, is the big beneficiary in the medium term of the so-called unconventional revolution. The European Union, by contrast, will see an increase on its imports and external dependence.

Key words

Unconventional hydrocarbons, OPEC, Energy Self-sufficiency, Energy Dependence

Introduction

The objective is to analyse the geopolitical impact of the development of unconventional oil and natural gas resources.

To do this, as a preliminary step, after clarifying the meaning of the expression unconventional and going on to define and list the main categories of these types of hydrocarbons, an estimate of resources at the global level, at the same time as the potential production costs that are evaluated.

Once their abundance and the economic viability of extracting them have been recorded (without internalising the costs associated with the CO₂ emissions generated) the analysis focuses on the geographical distribution of unconventional oil and gas resources, with the aim of finding out whether their geographical location could represent a counterbalance to the current concentration of conventional resources in certain parts of the planet.

Later on, it is possible to analyse the production prospects during the next two decades, identifying the main players and evaluating the possibility the possibility of that the unconventional resources constitute a genuine and lasting alternative to the current hegemony of OPEC and the Middle East, in the case of oil and this latter region and Russia in the case of gas.

Finally, the changes that the production of unconventional hydrocarbons that could be inserted into the current exporter-importer balance sheet of the main countries and regions, so in this way to try to recognise changes of direction in the commercial flow of oil and natural gas, as well as the possible trends in reorganisation of the current map of world trade and the potential implications that said reorganisation could have on the security of global supply routes are valued.

The methodology used to cover the objectives mentioned above basically consisted of a detailed study and summarising of the data and conclusions presented in several recent reports published by the International Energy Agency¹.

¹ We should recognise that this is an autonomous body, with its HQ in Paris, as a consequence of the 1973 oil shock, within the context of the Organisation for Cooperation and Economic Development (OECD). Its objective is to design and carry into practice an international energy programme. THE IEA is made up of the following countries: Germany, Australia, Austria, Belgium, Canada, South Korea, Denmark, Spain, the United States of America, Finland, France, Greece, Hungary, Ireland, Iceland, Italy, Japan, Luxembourg, New Zealand, Norway, the Netherlands, Poland, Portugal, the United Kingdom, the Czech Republic, the Slovak Republic, Sweden, Switzerland and Turkey. The Euro Commission also takes part in the IEA work.

It is opportune to highlight the fact that, as happens in any study in which prospecting issues and the estimating of sub-soil resources are dealt with, the figures set out during the course of this paper, although they come entirely from sources of recognised standing, they should not be taken to be exact values, but rather more as orientations that make it possible to identify certain trends.

Unconventional oil

Preliminary technical considerations

What does unconventional mean?

There is no universally accepted definition of what may be understood by conventional or unconventional in the oil and gas industry. In general, at a determinate time, this latter term is applied to any accumulation of oil and gas that requires production technologies that are significantly different from those that have mostly been used until now. Doubtless, this acceptance is imprecise and to associated with the time factor. In the long run, as a result of technological evaluation, unconventional takes on the category of being conventional from the time at which an extractive technology stops being an exception to become the norm.

Main types of unconventional oil

According to the International Energy Agency (IEA), unconventional oil includes the following categories (figure 1):

- I. Kerogen shales or oil shales². This is a type of fine-grained sedimentary rocks (mainly made up of clay or silt-size particles) and with very low permeability that contain a mixture of solid organic components known as kerogen. On the basis of this, by means of heating (up to some 500° C), hydrocarbon liquids (kerogen oil) can be obtained. Kerogen shales are immature source rocks that have not managed to produce oil because, during their burial, they have not been subject to the minimum temperature conditions required for the genesis of oil or gas.

² In the original Spanish version of this paper, the term shale was not translated. The reason for that lies is that the two Spanish terms used designate metamorphic rocks which, by definition, do not contain organic or hydrocarbons materials. Shales are fine-grained sedimentary rocks that are preferably stated in the original to be a sedimentological word (*lutitas – lutites*) that is not well known but that is technically the most correct one. [Note: This is translator's comment that does not strictly correspond to the original].

- II. Light tight oil or LTO. This refers to light crude trapped in sedimentary rocks with low levels of permeability and porosity (lutites, sandstones and limestones). These are mature hydrocarbons rocks, rich in organic materials, which after undergoing a suitable thermal maturing process have generated oil. Part of this is still in the rock, although another part of it may have migrated vertically, being accumulated in conventional reservoirs. Since the fluids cannot move easily via low-permeability rocks, commercial oil production that it contains require advanced techniques such as hydraulic fracturation (or “fracking”) and the drilling of multi-lateral horizontal wells.
- III. Oil sands or tar sands. These are sedimentary rocks that are unconsolidated and mostly made up of sand-sized particles, melded by a dense and extremely viscous variety of oil, technically known as bitumen. There are several technologies of extracting the bitumen from the sands. When these are near the surface, they are exploited using mining, huge shovels and dumper trucks. The bitumen is then extracted using hot water and caustic soda, and it is finally treated using a process (“upgrading”) that gives rise to a synthetic crude that is sent to a refinery. When the tar sands are at greater depth (over 75 m) in the subsurface, it is necessary to drill horizontal and vertical wells, and inject hot water. Most reserves and resources of tar sands are concentrated in Canada, mainly in Alberta.

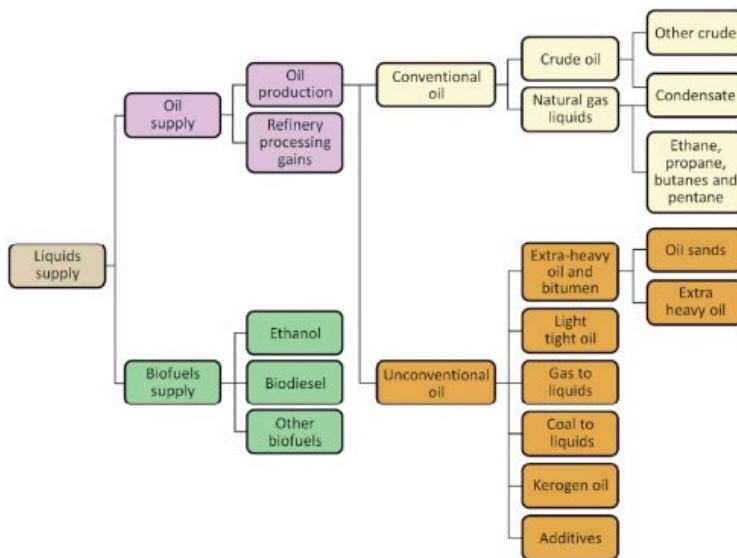


Figure 1. The supply of liquid fuels and the classification diagram of these are used by the International Energy Agency (IEA, WEO 2013).

- IV. Some experts use oil density criteria, or API gravity, so as to differentiate conventional from unconventional oils. Thus, all of the oils with API gravity below 20 °, that is, with a density of greater than 0,934 grammes per cubic centimetre, are considered to be unconventional. This category –besides the tar sands mentioned before– would include the so-called extra-heavy oils. Diverse advanced drilling techniques are used that manage to reduce viscosity enough so that the oil can flow to the surface. The greater accumulation of extra-heavy oil is concentrated in the Orinoco Belt in Venezuela.
- V. Coal and natural gas liquids (coal-to-liquids or CTL and gas-to-liquids or GTL). This includes synthetic fuels (synfuels) derived from the conversion of the coal or the gas using the Fisher-Tropsch reaction.

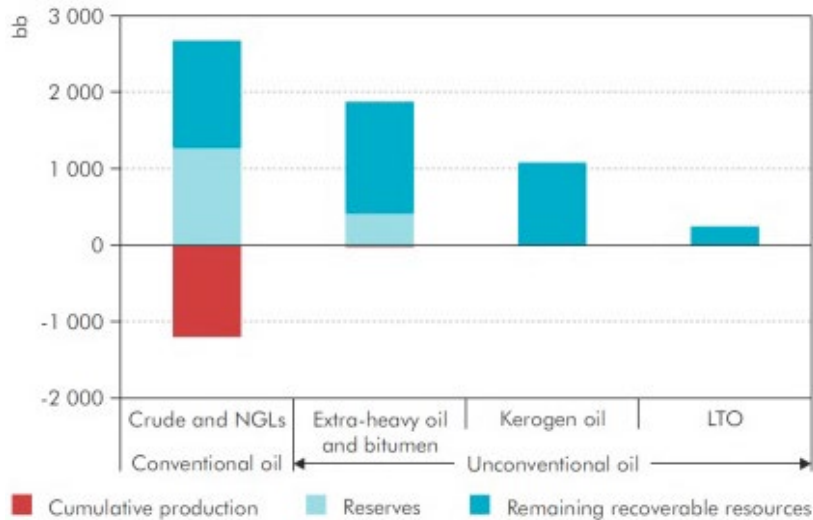


Figure 2. Accumulated production, reserves and resources of oil to be exploited that can be recovered, both conventional and unconventional, at the end of 2011 and on a global scale. Figures in billions of barrels (bb). (IEA, WEO 2012).

Estimate of resources and their production costs (without internalising the CO₂.costs)

At the end of 2011, without including the coal and natural gas liquids (CTL and GTL), the estimates of reserves and resources³ of unconventional oil that can be recovered were, in general terms, at about 3.2 x 10¹² barrels

³ The proven reserves are those ready to be extracted in a profitable way with the existing technology and prices on one particular date, while recoverable resources are estimated volumes that are based upon different hypotheses, waiting for confirmation

(figure 2, table 1). A volume that slightly exceeds that of the conventional oil reserves and resources, although the calculations about unconventional oils are less reliable than that because, in general, the latter have been studied and explored less intensely and there is less experience about how to exploit them. In addition, it is worth being aware that the commercial production of this requires going beyond considerable technical, environmental, political and economic barriers.

	Conventional			Unconventional				Total
	Crude oil	NGLs	Total	EHOB	Kerogen oil	Light tight oil	Total	
OECD	318	99	417	812	1 016	101	1 929	2 345
Americas	253	57	310	809	1 000	70	1 878	2 188
Europe	59	31	91	3	4	18	25	116
Asia Oceania	5	11	16	0	12	13	25	41
Non-OECD	1 928	334	2 261	1 069	57	139	1 264	3 526
E. Europe/Eurasia	352	81	433	552	20	14	586	1 019
Asia	95	26	121	3	4	50	57	178
Middle East	982	142	1 124	14	30	4	48	1 172
Africa	255	52	306	2	0	33	35	341
Latin America	245	32	277	498	3	37	538	815
World	2 245	433	2 678	1 880	1 073	240	3 193	5 871

Note: EHOB = extra-heavy oil and bitumen.

Table 1. Technically recoverable resources of oil to be exploited, by types and regions, at the end of 2011. Figures in billions of barrels (bb). (IEA, WEO 2012).

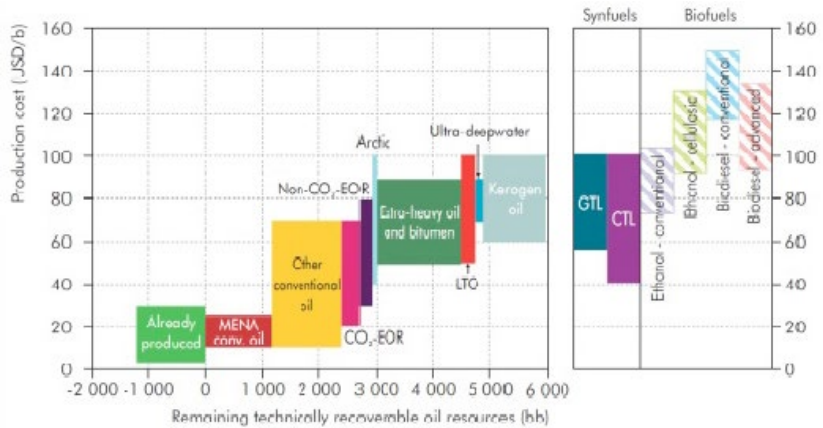
According to the International Energy Agency (IEA, "Resources to Reserves", 2013) the production costs of the nearly 1.2×10^{12} barrels of conventional oil extracted up to now have not exceed 30 dollars. What could be the production costs of other categories of oil resources that are technically recoverable waiting to be exploited?

Figure 3 tries to answer this question in summary form. The potential volume of technically recoverable resources is represented in the horizontal axis⁴ as these being exploited in the long-term, other than in the case of synthetic fuels derived from bio-fuels and coal (CTL) and natural gas (GTL), because the former come from the transformation of renewable resources, while the two latter ones are summarised on the basis of

by probes and production tests. This means that the estimates of resources always, by definition, display a high degree of uncertainty.

⁴ Technically recoverable resources are estimated volumes on the basis of different hypotheses (waiting for confirmation using probes and production tests) and they could be extracted from the subsoil with current technology, leaving aside considerations of an economic nature.

raw materials, coal and gas, which are very plentiful and it is considered that only a small fraction of these will be actually used in the conversion process. The vertical axis informs us about the ranges of costs estimated for the production (exploration, extraction and upgrading) of the end liquid hydrocarbon on the basis of the different categories of resources. It is worth stressing that these costs do not internalise the costs of the CO₂ emissions associated with the production process.



Notes: unless otherwise indicated, all material in figures and tables derives from IEA data and analysis. CO₂ = carbon dioxide; MENA = Middle East and North Africa. "Other conventional oil" includes deepwater. No carbon pricing included. Synfuel resources are difficult to assess due to competition with other natural gas and coal uses. Biofuels are renewable and, in theory, not resource constrained. Biofuels production costs have been credited with a "refiner's margin", using the ratio of gasoline and diesel spot prices in the United States compared to the West Texas Intermediate crude oil price. The ratio was, on average, 1.3 for gasoline and 1.35 for diesel between 2007 and 2012.

Figure 3. Production costs of liquid fuels (in dollars per barrel) and volumes that are technically recoverable in the long-term for some resources of oil, conventional or unconventional (in billions of barrels). (IEA, Resources to Reserves, 2013).

In the case of the conventional oil resources, the IEA study cited (IEA, Resources to Reserves, 2013) makes the following considerations:

- I. The entirety of the conventional oil resources and reserves of the Middle East and North Africa can be produced at relatively cheaper costs than in other regions, although the increase in the investments in exploration and production necessary for the development and improving of field that are already mature and these are being translated into certain more expensive production costs than in the past. Conventional oil resources in the Middle East and North Africa amount to 1.12 x 10¹² barrels and the production costs are estimated at between 10 and 25 dollars per barrel.
- II. Production costs of the resources and reserves of conventional oil from other regions are highly variable. From a technical standpoint, some Russian fields are as easy to exploit as the

deposits from the Middle East and North Africa, being placed at the bottom of the production costs band. The top of this would be represented by fields on land or in sea waters (excluding ultra-deep ones) that are technically more complex. Oil resources in this category amounted to 1.22×10^{12} and production costs were between 10 and 70 dollars per barrel.

- III. The use of enhanced oil recovery techniques or EOR can achieve up to 0.5×10^{12} barrels of which 0.3×10^{12} barrels could come from techniques based on CO_2 injection and other thermal stimulation techniques (such as steam injection) or chemical ones. The estimated costs for the production using these techniques are highly variable and depend on the specific parameters of each field. These costs range from \$ 20 to \$ 80 per barrel. The cheapest are those related to CO_2 injection techniques that would be even more competitive if production costs incorporated a price for CO_2 emissions since this technique would benefit from the carbon credits obtained by the net sequestration of CO_2 in the sub-soil.
- IV. The recoverable conventional oil in ultra-deep water (more than 1.500 m of water depth) could represent some 0.16×10^{12} additional barrels, with a production cost of 70-90 dollars per barrel.
- V. According to the latest estimates from the U.S. Geological Survey, the region north of the Arctic Circle could 90.000×10^6 barrels of crude and further 44.000×10^6 barrels of natural gas liquids, with certain production costs of the order of 40 to 100 dollars per barrel.

In the case of the unconventional resources, the International Energy Agency in its study, assumes the following points:

- VI. There is great potential resource of extra-heavy oil and oil sands, with about 1.88×10^{12} barrels, mainly concentrated in Venezuela and Canada, but also in other countries such as Russia and Kazakhstan. Production costs in the new facility, including the "upgrading" of the oil and mitigating the environmental impacts, although no mitigating CO_2 emissions are between the 50 to 90 dollars per barrel mark.
- VII. Oil production from kerogen shales and light tight oil or LTO, is still in an early stage of development, except in the U.S. where LTO production has progressed dramatically (see *the LTO revolution started in the U.S. spread to other countries but loses steam from the early thirties*). The estimated cost of future large-scale production is not easy to ascertain. In the case of kerogen oil, such costs could be around 40-100 dollars per barrel and technically recoverable resources could reach 1.07×10^{12} barrels. The technically recoverable LTO resources are at the figure of around 0.24×10^{12} barrels and production costs are at between 60 and 100 dollars per barrel.

VIII. The technologies for the production of synthetic fuels from coal (CTL) and natural gas (GTL) are based primarily on the Fischer-Tropsch reaction, so this means that the main costs to consider are those associated with the construction of the installation and the costs of the raw material used in the conversion process. It is estimated that the production costs of CTL range from \$ 45 to \$ 105 per barrel of oil equivalent (boe). If only 10% of the world's resources of coal and lignite was used in this process, up to 4.5×10^{12} barrels could be obtained, which is the equivalent of synthetic fuel oil. In the case of GTL production costs in the most modern plants, these range from \$ 60 to \$ 105 per boe and if 20% of the global resources of natural gas are used as a raw material, this could result in obtaining up to $1,7 \times 10^{12}$ barrels of synthetic fuel oil equivalents.

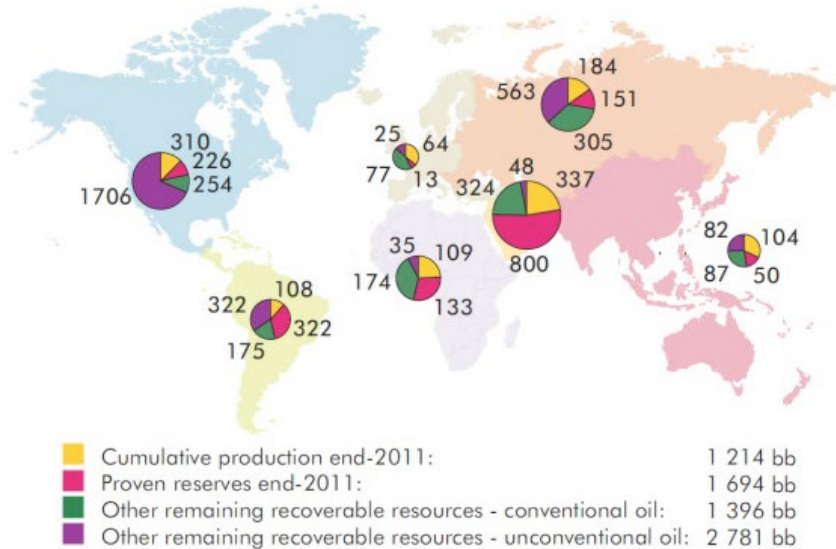


Figure 4. The oil in the world in 2012. Regional distribution of cumulative production, proven reserves and recoverable resources by exploiting both conventional and unconventional. Figures in billions of barrels (bb). (IEA, Resources to Reserves, 2013).

Geographical distribution of the resources. The unconventional ones as a counterbalance to the Middle East

As shown in table 1, without accounting for resources of coal derived liquids (CTL) and natural gas (GTL), the industrialized countries of the OECD, only hoard 15.6% of the total resources of technically recoverable oil and natural gas liquids, containing 62% of unconventional oil resources. The figures also show that unconventional resources that are recoverable as recorded in late 2011 (table 1, figures 4 and 5) are preferably located in North America, Eastern Europe-Eurasia and Latin America, thereby counteracting

the importance of the geopolitics of the Middle East, a region that accounts for 42 % of the reserves and resources of conventional oil. The production and development of unconventional oils is more advanced in North America, which may be explained in part because current estimates attribute the highest volume of resources to this region. However, it is possible that in the future other, regions that have so far received little attention for their large conventional resources such as the Middle East and Africa, will look in the future to significantly increase their estimates of unconventional resources.

- I. Extra-heavy oil and tar sands: these categories of unconventional oil are preferably located in Venezuela (in the so-called Orinoco Belt) and Canada, respectively. The amount of in-situ oil of the oil sands of Canada is estimated at 1.845×10^{12} barrels of which 0.8×10^{12} barrels could be recovered (IEA, WEO 2010).

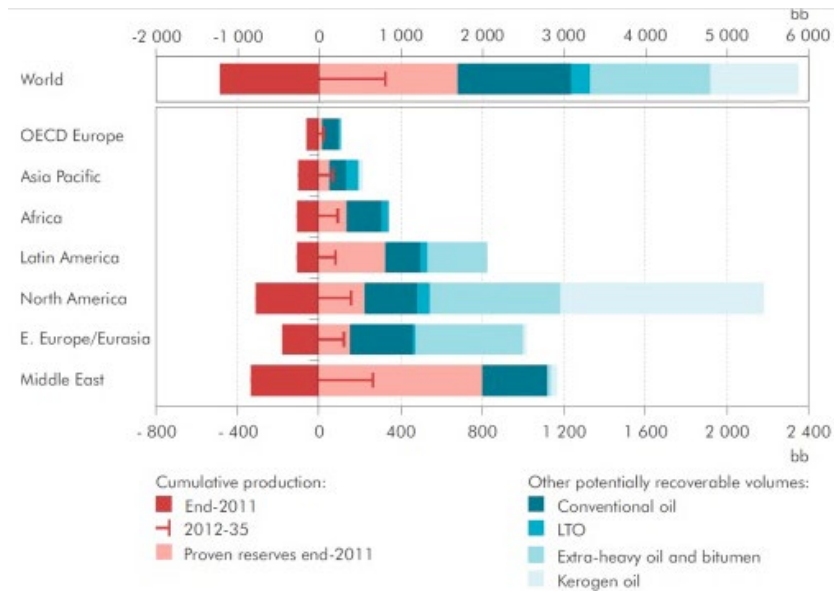


Figure 5. Cumulative production, proved reserves and potentially recoverable oil resources by type and by region, in the New Policies Scenario (IEA, WEO 2012). Figures in billions of barrels (bb). Note the different scales for the world (above) and regions (bottom).

With regard to extra-heavy oil, we would be talking about around 1.36×10^{12} barrels in situ, with nearly 0.5×10^{12} recoverable barrels (USGS, 2009). In addition to Venezuela and Canada, it is believed that there are significant resources of the two types of unconventional oil analysed in Russia and Kazakhstan, as well as more modest volumes in Angola, Azerbaijan, China, Madagascar, Middle East, UK and the U.S, which

taken together could mean a further 0.6×10^{12} recoverable barrels. Apart from Canada and Venezuela, the forecasts of the International Energy Agency (WEO 2013) the horizon 2035, including some production only in Russia (Tatarstan) and China, countries in which production projects or plans are already well advanced.

- II. Light tight oil or LTO: in recent years the exploitation of such unconventional oil has reached a commercially significant scale, particularly in the prospecting parts of Bakken and Eagle Ford in the U.S. In this country, the government agency Energy Information Administration (U.S. IEA) recently estimated the resources at some 58.000×10^6 LTO barrels, well above that estimated in 2012, which is 32.000×10^6 barrels (U.S. IEA, 2013B). And as more data become available, this review might not be the last one. The IEA (IEA, WEO 2012) estimated that nearly 240.000×10^6 barrels of the world's resources in LTO are technically recoverable and other private consultants talk about a figure of between $100,000$ and $600,000 \times 10^6$ barrels. In June 2013, the USIEA published a study (U.S. IEA, 2013a) on a large number of sedimentary basins in the world, estimating that the technically recoverable resources of LTO could approximate 350.000×10^6 barrels, distributed mainly among Russia, USA, China, Argentina, Libya, Australia, Venezuela, Mexico, Pakistan and Canada (see table 2 for details).

Country	Areas assessed	Technical recoverable LTO resources
Russia	Bazhenov shale	76
United States	Bakken, Bone Springs, Eagle Ford, Granite Wash, Niobrara, Spraberry, Wolfcamp, Monterey and Woodford shales	58
China	Sichuan, Yangtze, Jiangnan, Greater Subei, Tarim, Junggar and Songlia basins	32
Argentina	Neuquen, San Jorge, Magallanes and Parana basins	27
Libya	Ghadames, Sirte, and Murzuq basins	26
Australia	Cooper, Maryborough, Perth, Canning, Georgina, and Beetaloo basins	18
Venezuela	Maracaibo basin	13
Mexico	Burgos, Sabinas, Tampico, Tuxpan and Veracruz basins	13
Pakistan	lower Indus basin	9
Canada	Horn River, Cordova, Liard, Deep, Alberta, Windsor basins, Duvernay, Bakken, Utica shales	9

Source: US EIA (2013a).

Table 2. Top ten countries in light oil resources of compact rocks. (Light tight oil or LTO). Figures in billions of barrels. (IEA, WEO 2013).

- III. Kerogen shales or oil shales currently, oil from kerogen (kerogen oil) is produced in very small quantities in Estonia, China

and Brazil. Kerogen shale is easier to exploit through mining techniques are those that are near the surface, but deeper accumulations by injecting hot water into the subsurface can also be exploited. The first type of resources are enormous. The largest known to date are located in parts of Utah, Colorado and Wyoming in the U.S. These, which have been studied in detail by the U.S. Geological Survey (USGS), could contain some resources equal to 4.285×10^{12} barrels oil, of which just under a quarter corresponds to deposits that most likely to be commercially exploitable (USGS, 2012). Worldwide, the existing resources in geological formations of kerogen shales near the surface could reach at least a minimum of 1.1×10^{12} barrels. Apart from the USA, other resources are found in Jordan (30.000×10^6 barrels), Australia (12.000×10^6 barrels), Estonia and China (4.000×10^6 barrels each) and Israel, Morocco and Brazil (with nearly 3.000×10^6 barrels each). Australia had planned to undertake a big project in "the Stuart Shale" training in the 90's, but this was abandoned, mainly due to environmental considerations. This same country has recently approved a new pilot scheme with the initial goal of producing 40.000 barrels a day. Currently, Jordan, Israel and Morocco have a number of projects under consideration at the study phase.

- IV. Coal-to-liquids or CTL: coal resources that are the raw material for this process are very broad and, in fact, using only 10% of proven reserves in the world would obtain 275.000×10^6 barrels of liquid hydrocarbons. Clearly, the coal resources available do not constitute any limitation on the development of the CTL techniques. In all likelihood, countries like China and India with large coal resources that are extractable at a relatively low cost, and they are highly dependent on oil imports will lead the investments in this technology, which already has extensive operational experience in South Africa. China has announced plans to produce to 600.000 barrels a day of synthesized fuels using CTL technology in 2020. However, environmental concerns, including emissions and access to water, together with spiralling costs, have led the Chinese government to impose stricter standards for the construction and operation of CTL plants. In the U.S., they have announced several CTL projects totalling more than 300.000 barrels a day, but these projects are still under study. Australia and Indonesia are also interested in developing this industry
- V. Gas-to-liquids or GTL: untapped resources of recoverable natural gas, the raw material capable of being transformed into liquid hydrocarbons by GTL technology are around 810×10^{12} cubic metres (see the section on *Estimating resources and production*

costs (without internalizing the costs of CO₂). The transformation of 10% of this volume by GTL technology could yield 280,000 x 10⁶ barrels liquid hydrocarbons. Currently, three countries, Qatar, South Africa and Malaysia, monopolize most of the existing production capacity in the world from the GTL technology. These could be joined by the U.S. and Nigeria.

Oil production between 2012 and 2035. Non-conventional as a temporary alternative to the hegemony of OPEC and the Middle East

Oil production has already peaked.
Unconventional oil gains prominence

In his scenario New Policies (IEA, WEO 2013) the International Energy Agency (IEA) forecasts that world oil supply will increase gradually from 89.2 x 10⁶ barrels per day (bd) in 2012 to 101.4 x 10⁶ bd in 2035. The aim of this growth in supply is to cope with increased demand that focuses exclusively on the transport sector in countries outside the OECD, with China itself grabbing about half of the increase commented on.

Moreover, the IEA expects total conventional oil production will fall slightly over the period 2012-2035, from about 69 x 10⁶ to 65 x 10⁶ bd⁵. This means that the share of total conventional crude oil production will fall from 80% today to 65% in 2035 (figure 6). That is to say, the growth in production necessary to meet the demand must come from other sources.

Among these, the forecasts are that the production of natural gas liquids is to grow about 40% to about 18 m db in 2035, so this date would represent around 20% of global oil production.

Another source of production growth is unconventional oil, whose contribution would increase from 5 x 10⁶ bd in 2012 to 15 x 10⁶ bd in 2035 (figure 7). These mainly come from unconventional supplies of light oil from compact light tight oil or LTO in the U.S., the oil sands of Canada and the extra-heavy oil of Venezuela. Between 2020 and 2035, rapid growth, mainly in Qatar and North America, the production of synthetic fuels deriving from natural gas (gas-to liquids or GTL) is also expected, as well as the production of liquid hydrocarbons from coal (coal-to liquids or CTL), mainly in China, but also to a lesser extent in South Africa, Australia, Indonesia and the U.S. With respect to oil deriving from kerogen shales or oil shales, despite the broad base of resources available, their production would remain marginal due to their high costs and environmental impacts.

⁵ A projection that should not go unnoticed because it is equivalent to saying that conventional crude oil production has practically reached its peak ("peak oil").

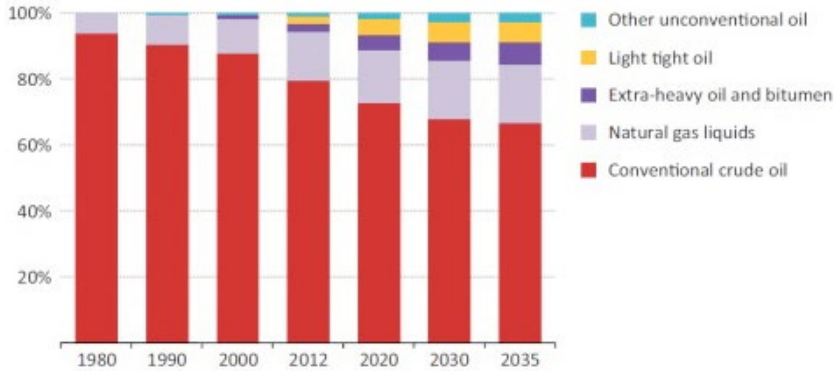


Figure 6. Percentage share of different types of oil, conventional and unconventional, in global production. New Policies Scenario (IEA, WEO 2013).

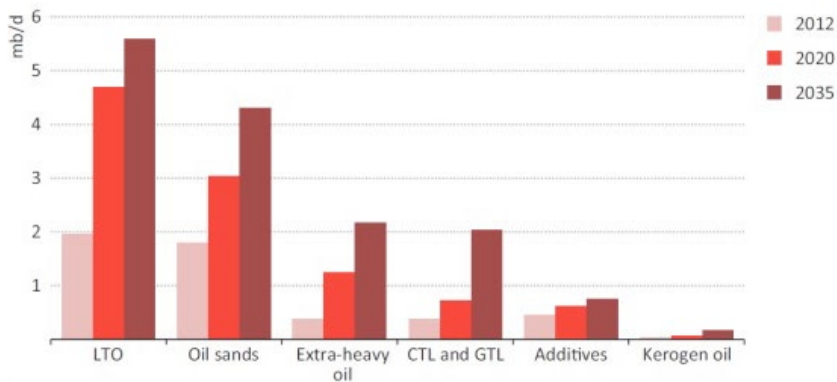


Figure 7. Projected growth in the production of various types of non-conventional oil. Figures in millions of barrels per day (mb / d). New Policies Scenario (IEA, WEO 2013).

The production from the non-OPEC countries increases until the late twenties and it then stagnates and declines.

In the New Policies Scenario of the IEA (IEA, WEO 2013) the oil production of all non-OPEC countries will maintain its upward trend experienced in recent years. It will then stagnate and subsequently start to decline in the late twenties, but in 2035, the production of this group of countries still exceeded that for 2012 by some 3.5×10^6 barrels per day (bd). In percentage terms, the share of the countries outside the cartel in global oil production would increase from 57% in 2012 to 59% in 2020, and lose ground gradually until 54% in 2035 (table 3).

During the first half of the period 2012-2035, both the production of conventional oil and the unconventional one, will increase, but the first peaks shortly before 2020, and it then declines a few years after that in such a way that even the increased production of non-conventional oil cannot reverse the downward trend. In fact, the total oil production between 2012 and 2035 falls in most countries non-OPEC, with the exception of Brazil, Canada, Kazakhstan and the U.S., although the production of the latter goes into decline by 2035. Table 3 summarizes the details of the report remarked upon.

	1990	2012	2020	2025	2030	2035	2012-2035	
							Delta	CAAGR*
OECD	19.0	19.9	23.2	23.1	22.8	22.4	2.5	0.5%
Americas	13.9	15.9	19.3	19.8	19.9	19.6	3.8	0.9%
Canada	2.0	3.8	5.0	5.3	5.7	6.1	2.3	2.1%
Mexico	3.0	2.9	2.7	2.6	2.6	2.6	-0.3	-0.4%
United States	8.9	9.2	11.6	11.8	11.5	10.9	1.7	0.7%
Europe	4.3	3.5	3.1	2.6	2.2	2.0	-1.5	-2.3%
Asia Oceania	0.7	0.6	0.7	0.7	0.7	0.7	0.2	1.1%
Non-OECD	22.7	29.5	31.9	32.0	31.4	30.6	1.0	0.2%
E. Europe/Eurasia	11.7	13.8	13.7	13.7	13.9	14.2	0.4	0.1%
Kazakhstan	0.5	1.6	1.9	2.5	3.2	3.7	2.1	3.6%
Russia	10.4	10.7	10.4	9.9	9.6	9.4	-1.3	-0.6%
Asia	6.0	7.8	7.7	7.4	6.8	6.0	-1.8	-1.1%
China	2.8	4.2	4.4	4.3	4.1	3.4	-0.8	-0.9%
India	0.7	0.9	0.8	0.7	0.7	0.6	-0.3	-1.7%
Middle East	1.3	1.5	1.3	1.1	1.0	0.9	-0.6	-2.2%
Africa	1.7	2.3	2.9	2.6	2.3	2.1	-0.2	-0.4%
Latin America	2.0	4.2	6.2	7.2	7.4	7.4	3.2	2.5%
Brazil	0.7	2.2	4.1	5.4	5.8	6.0	3.8	4.5%
Total non-OPEC	41.7	49.4	55.0	55.1	54.2	52.9	3.5	0.3%
<i>Non-OPEC market share</i>	64%	57%	59%	58%	56%	54%	<i>n.a.</i>	<i>n.a.</i>
Conventional	41.3	45.0	46.2	44.6	42.6	40.7	-4.3	-0.4%
Crude oil	37.6	38.4	38.3	36.4	34.3	32.3	-6.1	-0.7%
Natural gas liquids	3.6	6.6	8.0	8.1	8.3	8.3	1.7	1.0%
Unconventional	0.4	4.4	8.8	10.5	11.7	12.3	7.9	4.6%
<i>of which:</i>								
Canada oil sands	0.2	1.8	3.0	3.3	3.8	4.3	2.5	3.9%
Light tight oil	0.0	2.0	4.7	5.7	5.8	5.5	3.6	4.6%
Coal-to-liquids	0.1	0.2	0.4	0.7	0.9	1.2	1.0	8.3%
Gas-to-liquids	0.0	0.1	0.1	0.2	0.3	0.4	0.4	9.9%

* Compound average annual growth rate.

Table 3. Oil production in non-OPEC countries. Figures in millions of barrels per day. New Policies Scenario (IEA, WEO 2013).

Within this overall picture, it is of particular interest to note that the decline in oil production in Europe started long ago, continued during the 2012-2035 period. In 2012, the countries in the old continent that had been integrated into the OECD experienced a drop in oil production of some 300.000 bd, reaching a total of around 3.5×10^6 bd. The latter volume is that which shows itself to be 3.3×10^6 bd lower than the peak reached in the year 2000.

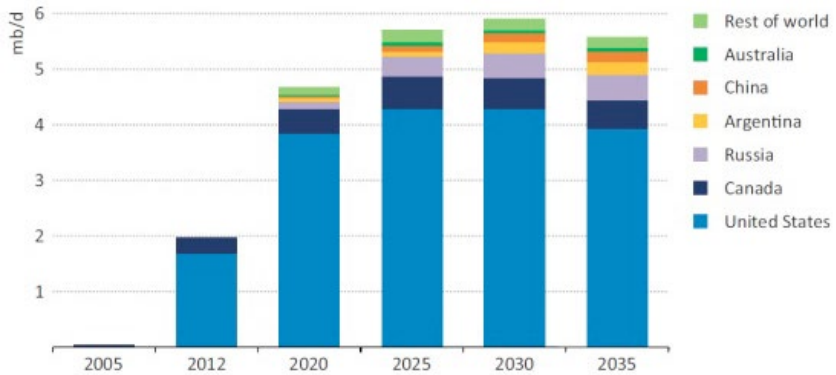
The revolution began in the U.S. LTO spreads to other countries but loses steam from the early thirties

In the U.S., oil production from light tight oil or LTO by hydraulic fracturing fracking techniques has gone from almost non-existent in 2005 to 2.3×10^6 barrels per day bd up to mid-2013. This is a complete success for the industry of the country, coupled with the increased production of shale gas (see the sections on: *Geographical Distribution of Unconventional gas resources as a counterweight to the Middle East and Russia* and *Natural gas production between 2012 and 2035. The unconventional gas revolution expands beyond the U.S. and Canada*), is having a profound impact internationally. Given this, reality we can ask about the prospects for the success we remarked on to continue, as well as the production potential of LTO in other parts of the world, particularly in countries for which the U.S. Energy Information (U.S. IEA, 2013a) estimated there would be great potential, such as Canada, Russia, Argentina, China and Australia, among others (see Table 2).

According to the IEA (IEA, WEO 2013), it appears that America, i.e., the USA, with a small degree of participation from Canada will continue to dominate global LTO production (figure 8). Elsewhere in the world, the IEA also predicts that many countries are seeking to replicate U.S. success, so that in 2035 production in Russia could reach 450.000 barrels per day (bd), while in Argentina it could reach about 220.000 bd and 210.000 bd in China. However, most likely, in other countries production will barely be the order of several tens of thousands of barrels a day, reflecting the regulatory barriers and the absence of an innovative and competitive atmosphere in its exploration and production sector, which would keep the extraction costs above conducive towards attracting significant investment levels.

The IEA forecasts (IEA, WEO 2013) show that the LTO production in all the areas in use in the U.S. will maintain their upward trends until 2025, and then thereafter, in the following five years, stabilise at around 4.3×10^6 bd, before starting a gentle descent which runs until 2035 and beyond (Figure 8). This decline would be the result of the increasing difficulty in identifying new drilling opportunities in the most prolific reservoir zones, thereby shifting the activity to the less productive areas and also due

to increased competition in terms of cost of the LTO production in other parts of the world.



Sources: IEA databases and analysis; Rystad Energy AS.

Figure 8. Light oil production light tight oil or LTO in several key countries (see Table 3). Figures in millions of barrels per day (mb / d). New Policies Scenario (IEA, WEO 2013).

The IEA warns that, in reality, it is still too early to reliably predict the course of the LTO production curve LTO in the U.S., a country that is used to overcoming its challenges in production and which could still discover more resources that will help to keep production at higher levels and for longer than is expected. This is one possibility that does not seem to be remote if oil prices remain high, technological advances continue at the same rate as they have done to date and environmental concerns dissipate.

In any case, neither does the IEA hide a number of risks that could vary its forecast for U.S. LTO production downwards. Firstly, extraction might be more difficult in some of the new prospecting areas, and more expensive than was experienced in other areas such as prolific the Bakken (North Dakota) or Eagle Ford (Texas). For example, the shales deposits of Utica (Ohio) which were initially considered to be very promising, turned out to be good for the extraction of gas but not for LTO (possibly because the oil trapped in the rock does not move). The production could also be affected by limitations in the supply chain or refining infrastructure, although both factors would bring about a delay rather than a complete shutdown of the process. Moreover, it must be remembered that there, as in the case of the exploitation of shale gas, there are widespread social and environmental concerns regarding the use of the hydraulic fracturing (or fracking) technique and if we would like to avoid problems in the exploration and production business, these concerns should be properly addressed and resolved. Finally, it cannot completely rule out the possibility of a fall in oil prices adversely affecting the economic viability of extraction. Most estimates range between 60 and 80 dollars per barrel, which is the equi-

librium price for LTO production in the U.S., so that it would be enough for there to be a relatively modest drop as compared to today's prices that brings it near to the upper limit of that range.

	1990	2012	2020	2025	2030	2035	2012-2035	
							Delta	CAAGR*
Middle East	16.4	26.7	27.3	29.2	31.1	33.6	6.9	1.0%
Iran	3.1	3.5	3.3	3.6	3.8	4.2	0.7	0.8%
Iraq	2.0	3.0	5.8	6.7	7.3	7.9	4.9	4.3%
Kuwait	1.3	3.0	2.4	2.5	2.7	2.9	-0.1	-0.1%
Qatar	0.4	2.0	2.0	2.2	2.4	2.6	0.6	1.1%
Saudi Arabia	7.1	11.7	10.6	10.9	11.4	12.2	0.5	0.2%
United Arab Emirates	2.4	3.5	3.3	3.3	3.5	3.7	0.3	0.3%
Non-Middle East	7.5	11.0	10.5	10.7	11.2	11.6	0.6	0.2%
Algeria	1.3	1.8	1.7	1.7	1.7	1.8	0.1	0.1%
Angola	0.5	1.9	1.6	1.5	1.4	1.4	-0.4	-1.2%
Ecuador	0.3	0.5	0.4	0.3	0.3	0.3	-0.2	-2.3%
Libya	1.4	1.5	1.6	1.7	1.8	1.9	0.4	1.1%
Nigeria	1.8	2.6	2.4	2.5	2.6	2.8	0.2	0.3%
Venezuela	2.3	2.7	2.8	3.0	3.3	3.3	0.6	0.9%
Total OPEC	23.9	37.6	37.8	39.9	42.2	45.2	7.5	0.8%
<i>OPEC market share</i>	36%	43%	41%	42%	44%	46%	n.a.	n.a.
Conventional	23.9	37.0	36.2	37.9	39.7	42.4	5.3	0.6%
Crude oil	21.9	30.9	29.4	30.1	31.2	33.0	2.1	0.3%
Natural gas liquids	2.0	6.1	6.8	7.8	8.5	9.3	3.2	1.9%
Unconventional	0.0	0.6	1.6	2.0	2.5	2.8	2.2	6.9%
<i>of which:</i>								
Venezuela extra-heavy	0.0	0.4	1.2	1.5	1.9	2.1	1.7	7.5%
Gas-to-liquids	0.0	0.1	0.2	0.3	0.4	0.4	0.3	5.1%

* Compound average annual growth rate. Notes: Data for Saudi Arabia and Kuwait include 50% each of production from the Neutral Zone.

Table 4. Oil production in OPEC countries. Figures in millions of barrels per day. New Policies Scenario (IEA, WEO 2013).

Middle East grows in significance in OPEC. Venezuela maintains its position thanks to extra-heavy oils.

As regards OPEC (table 4 and figure 9), the New Policies Scenario of the IEA (IEA, WEO 2013) concludes that most of the increased production will come from the Middle East (Saudi Arabia, Iran, Iraq, Kuwait, Qatar and the United Arab Emirates) which together in 2035, have experienced an increase that contrasts with the 7×10^6 barrels per day (bd) as compared to the 2012 levels. This is an increase that contrasts with the roughly 0.6×10^6 bd for all of the other countries of the cartel (Algeria, Angola, Ecuador, Libya, Nigeria and Venezuela). The subsurface of the Middle

East hosts the largest number of conventional resources and, usually, it involves the development of the lowest costs in the world due to its favourable geology and existing infrastructure.

The WEO 2013 considers (table 4 and figure 9) that natural gas liquids are the major contributor to the growth in OPEC production, accounting for nearly 3×10^6 db, a volume that widely outstrips the 2.1×10^6 bd provided by conventional crude. From the point of view of non-conventional oil, we should stress the role envisaged by the extra-heavy oil in Venezuela, whose production would increase by about 1.7×10^6 bd during the 2012 to 2035 period. Also, within the field of non-conventional products, the IEA estimates a growth in the contribution of liquids derived from natural gas (GTL) near to 0.3×10^6 bd from the Qatar and Nigeria plants.

Ten-years ahead, OPEC will again occupy a key position and the Middle East will stand as the only source of cheap oil.

From the discussion in the preceding paragraphs, it is clear that until the early twenties, the global oil market could be seen to be less dependent on OPEC, to the extent that the production from some countries outside the cartel would be sufficient to deal with much of the increased demand expected for the 2012-2020 period.



Note: Share of OPEC is for the end of the interval shown, i.e. for 2012 in the first column, for 2015 in the second, and so on.

Figure 9. Changes in global oil production and participation percentages: OPEC vs. non-OPEC. The figures on the left in millions of barrels per day (mb/d).New Policies Scenario (IEA, WEO 2013).

This is a fact that can be explained by the new resources made commercially viable by means of the technological innovation undergone in the field of exploration and production. Two prominent examples of this trend are unconventional oil production and the expansion of the production of conventional oil in deep ocean waters. Thus, the blurring of OPEC's role

that is expected in the medium term, would be based on the rapid growth of oil production in low permeability rocks (LTO) in the U.S., increasing the contribution of oil sands in Canada, in the oil extraction from off the Atlantic coast of Brazil and in obtaining natural gas liquids (GTL) in various parts of the world.

In any case, the IEA warns that the situation discussed will be a temporary phenomenon and that, from the mid-twenties onwards, OPEC will occupy a key position in the global oil supply. From that date to 2035, the production in the ultra-deep waters of Brazil and of LTO in the U.S. will lose steam, and the Middle East will stand as the only source of relatively cheap oil in the world and Iraq will become the largest contributor to overall output growth.

In summary, as shown in Figure 9, the IEA (IEA, WEO 2013) finds that OPEC's percentage share in world oil production will fall by an average of 43% in 2012, to something a little over than 40% in 2015. Then, after five years of relative stability, this will climb up to 44% on average in 2030 and eventually reach 46% in 2035.

Certainly, in the light of these data, it would be unwise to send wrong messages to the producing countries of the Middle East, in the sense that, given the expected increase in the production of unconventional oil in some countries outside OPEC (see table 3 and figure 10), the industrialized countries will increasingly need their oil. This is a statement that, as well as being false, could encourage the investor passivity of those countries, which may neglect its efforts to increase their production capacity, which would have very negative consequences for global oil supply in the medium term.

**Iraq, Brazil, Canada, Kazakhstan, USA and Venezuela
will be key in ensuring global supplies**

The developments in oil production (conventional and unconventional) provided by the IEA for some of the major producing countries during the period 2012 to 2035 (New Policies Scenario, IEA, WEO 2013) are summarized in Figure 10.

With regard to conventional oil, we can highlight the large increases in daily oil production that are expected in the case of Iraq, Brazil and Kazakhstan, as well as increased the production of natural gas liquids in Russia, Qatar, Saudi Arabia Kazakhstan, United Arab, Brazil, Iraq, Azerbaijan, Kuwait, Venezuela, Argentina and Oman. From a negative perspective, we should emphasise the large declines in oil production in Russia, China, Venezuela and the U.S., with more moderate declines in Norway, the UK, Oman, Canada, Azerbaijan, Argentina, Kuwait, Saudi Arabia and Qatar. In the case of the production of natural gas liquids, the falls in production falls are confined to OECD countries such as Canada, the USA, the UK and Norway.

As for unconventional oil, the IEA forecasts huge growth in the production of light tight oil or LTO in the U.S. and to a much lesser extent, in Russia, China, Canada and Argentina. The Canadian oil sands and the extra-heavy oil in Venezuela also contribute significantly towards the growth in world production of unconventional oil, which likewise would be further supplemented by other, less significant contributions from China, Saudi Arabia and Qatar.

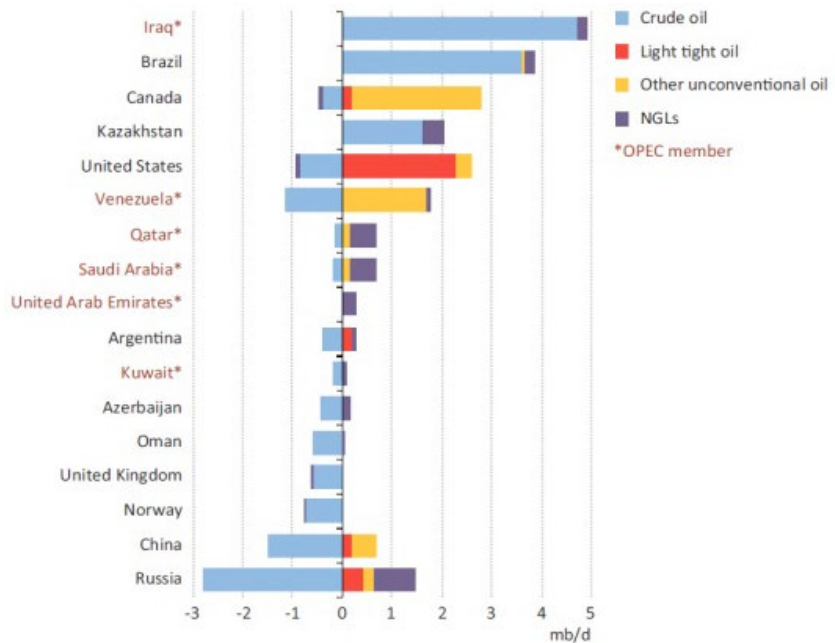


Figure 10. Changes in oil production, by types, in some key countries in the 2012-2035 period. Figures in millions of barrels per day (mb/d). New Policies Scenario (IEA, WEO 2013).

Overall, considering both conventional and non-conventional oils, the balance of production during the period 2012-2035, is clearly favourable to Iraq, Brazil, Canada, Kazakhstan and the U.S., while at the opposite end would be located Russia, China, Norway, UK, Oman, Azerbaijan, followed distantly by Argentina and Kuwait. Moreover, Venezuela, Qatar, Saudi Arabia and the United Arab Emirates would remain at an equilibrium position.

Uncertainties. The case of Iraq as an example.

From the discussion in the preceding paragraph and from looking a figure 10, which shows the evolution of the production during the 2012 to 2035 period for a number of key countries in the oil market, we can see the huge importance that the IEA (IEA, WEO 2013) grants to Iraq, Brazil and Kazakhstan in the conventional crude oil production, as well as Canada,

USA and Venezuela in unconventional oil. However, we must not forget the great uncertainties underlying this forecast. These have already been briefly discussed in section: *"The revolution began in the U.S. LTO spreads to other countries but loses steam from the early thirties"*, regarding the future production of light tight oil or LTO in the U.S. Another interesting example to consider is the case of Iraq.

According to the IEA (IEA, WEO 2012) Iraq, the world's seventh largest exporter and the fifth largest OPEC producer in 2011 - could double production by the end of this decade, reaching 6.1×10^6 barrels per day (bd), and then go on to reach 8.3×10^6 bd in 2035. In the less optimistic case (Central Scenario) that the said report provides, another scenario (Optimum Case) is contemplated, in which the previous two figures become 9×10^6 and 10.5×10^6 bd in 2020 and 2035, respectively. We are talking about certain volumes at the end of the period considered would allow Iraq to contest and even in the most favourable scenario, make sure that it is the second-ranked producer, ahead of Russia and immediately behind Saudi Arabia.

The main uncertainties that could mean that the IEA forecasts are not met have nothing to do with sub-soil or geology, but with so-called "surface factors." Apart from the chronic political instability in the Middle East and the sectarian conflict, often violent, between the Shia and Sunni communities, such factors include: tensions over the exploitation of existing oil resources between Baghdad and the Kurdistan Regional Government, the corruption and bureaucracy that make it hard for foreign oil companies operating in the country to achieve their targets and finally the OPEC quotas system- which Iraq is currently exempt from- ends up being applied, which would limit production.

The world does not care about expectations about Iraq being frustrated. The increased oil production expected in this country between 2012 and 2035 could, depending on the scenario considered, cover about 40-57% of the growth in world demand during the same period. Without such action, the global oil market would go through a very complicated situation, with supply constraints, high prices and extreme volatility that would harm the global economy. In the Central Scenario, the IEA (IEA, WEO 2012) predicted that a price of a barrel of oil would stand at around \$ 125 (2011) in 2035. If Iraq fails, this amount would have to add at least \$ 15 more, as a minimum.

The reorganization of the global trade in oil between 2012 and 2035. Its implications for the security of global supply

The new geography of demand. Decline in the OECD, growth in Asia and the Middle East

In the New Policies Scenario of the IEA (IEA, WEO 2013) oil demand grows from 87.4×10^6 of barrels per day (bd) in 2012 to 101.4×10^6 bd in 2035,

although the rate of increase gradually slows, from an average annual increase of 1×10^6 bd during the 2012-2020 period, to another one of 0.4×10^6 bd in the course of the 2020-2035 period. This slowdown mainly follows the new efficiency policies and changing types of fuels in the industrialized countries of the OECD, which would experience a significant decline in oil demand (figure 11, table 5). As a result, in 2035, the percentage share of OECD countries in global oil demand falls to about 32%, as compared to 46.6% in 2012.

In China, however, the use of oil suffers an increase of nearly 6×10^6 bd, reaching 15.6×10^6 . This means that, from 2030, the country will move ahead of the U.S. as the chief global consumer. India also emerges as a key oil consumption centre, especially between 2020 and 2035, during which the country will experience the highest growth in global demand.

A relevant issue from a geopolitical perspective is that the Middle East (figure 11, table 5) will become the third largest centre of oil demand, reaching approximately 10×10^6 bd in 2035. According to the IEA (IEA, WEO 2013) this increase in consumption is going to be driven by a rapid increase in its population and the generous oil subsidy policy applied by its governments (about \$ 520 per person in 2012). By sector, the growth demand is concentrated in transportation and petrochemicals, while the use of oil for electricity generation falls to the extent that the high cost (\$ 200 per megawatt hour) of this makes other technologies competitive.

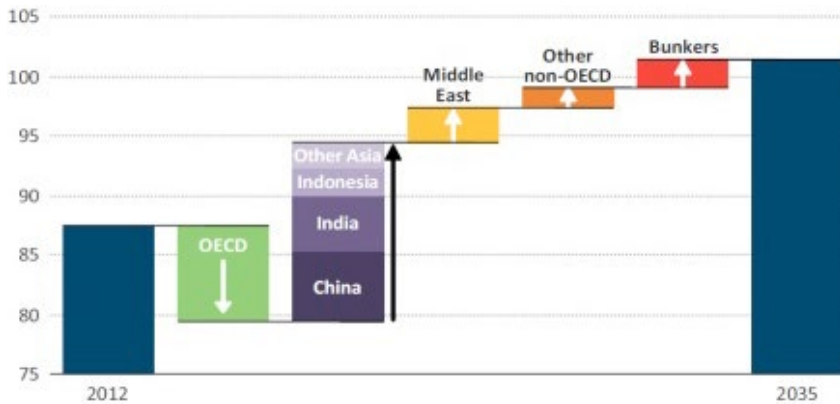


Figure 11. Growth in global oil demand by region. Figures in millions of barrels per day (mb/d): New Policies Scenario (IEA, WEO 2013).

Globally, the IEA expects that oil consumption is going to be concentrated in two sectors during the 2012-2035 period: transport, where the use of oil grows by nearly 12×10^6 bd up to a volume of about 60×10^6 bd in 2035, and that for petrochemicals, which for the same date would have experienced growth of about the 3×10^6 bd, standing at around 14×10^6 bd. According to the WEO 2013, improvements in efficiency would con-

Geopolitical impact of the development of...

tribute significantly towards reducing the growth in oil demand, while the alternative fuels to this would gain some ground, particularly in the sea and road transport, in which the percentage share of natural gas as a fuel would reach 5.6%, as compared to 3.8% today.

The balance between production and demand. Imports move from the OECD to Asia. Unconventional fuels make North America a net exporter

According to the IEA (WEO 2013), in the next two decades, the changing geography of oil production and consumption (see the sections on *Oil production between 2012 and 2035. Unconventional fuels as a temporary alternative to the hegemony of the OPEC and the Middle East and the New Geography of demand. Decline in the OECD, growth in Asia and the Middle East*). Will lead to a dramatic reorganization of global trade, with implications in international cooperation as regards supply security. In this sense, the figures for net oil imports by region for the 2012-2035 period (figure 12) are very illustrative of how the fate of the global oil trade is shifting its centre of gravity from the OECD countries to the large emerging economies of Asia.

	2000	2012	2020	2025	2030	2035	2012-2035	
							Delta	CAAGR*
OECD	44.6	40.8	39.4	37.3	34.9	32.8	-8.0	-0.9%
Americas	22.7	21.3	21.9	20.8	19.6	18.4	-2.9	-0.6%
United States	18.7	17.1	17.5	16.4	15.1	14.0	-3.1	-0.9%
Europe	13.7	11.7	10.9	10.2	9.4	8.9	-2.9	-1.2%
Asia Oceania	8.2	7.8	6.7	6.3	5.9	5.5	-2.2	-1.5%
Japan	5.3	4.7	3.6	3.3	3.0	2.8	-1.8	-2.2%
Non-OECD	26.5	39.6	48.3	52.3	55.8	59.2	19.6	1.8%
E. Europe/Eurasia	4.2	4.7	5.1	5.2	5.3	5.4	0.7	0.6%
Russia	2.6	2.9	3.1	3.1	3.2	3.2	0.3	0.4%
Asia	11.5	19.3	24.8	27.6	30.1	32.5	13.2	2.3%
China	4.7	9.6	12.9	14.1	15.0	15.6	6.0	2.1%
India	2.3	3.6	4.7	5.7	6.9	8.1	4.5	3.6%
Middle East	4.3	6.9	8.2	8.7	9.3	9.9	2.9	1.6%
Africa	2.2	3.4	4.0	4.2	4.4	4.6	1.2	1.3%
Latin America	4.2	5.3	6.2	6.5	6.7	6.9	1.5	1.1%
Brazil	1.8	2.4	2.9	3.1	3.3	3.4	1.0	1.6%
Bunkers**	5.2	7.0	7.8	8.3	8.8	9.3	2.4	1.3%
World oil	76.3	87.4	95.4	97.8	99.5	101.4	14.0	0.6%
European Union	n.a.	10.9	9.9	9.1	8.3	7.7	-3.2	-1.5%
World biofuels***	0.2	1.3	2.1	2.7	3.4	4.1	2.8	5.0%
World total liquids	76.5	88.7	97.6	100.5	102.9	105.5	16.8	0.8%

* Compound average annual growth rate. ** Includes international marine and aviation fuels. *** Expressed in energy-equivalent volumes of gasoline and diesel.

Table 5. Oil demand by region. Figures in millions of barrels per day. New Policies Scenario (IEA, WEO 2013).

Thus, the net import requirements of the Asian countries that are not members of the OECD will grow by almost 15×10^6 barrels per day (bd) between 2012 and 2035, reaching approximately 15×10^6 bd on the latter date, representing over half of all inter-regional trade. The increase most remarked upon is attributable to China (the country's imports will grow by almost 7×10^6 bd), India (4.8×10^6 bd) and the ASEAN (3×10^6 bd). China is poised to overtake the U.S. as the top net importer as the world, and it seems that, by 2020 imports will also exceed those of the entire European Union.

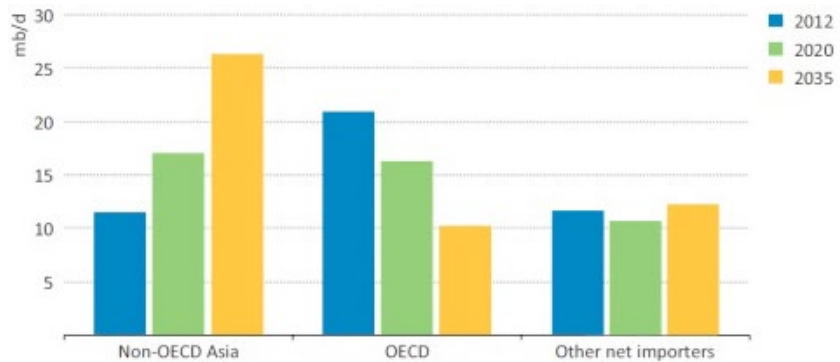


Figure 12. Net oil imports in the OECD, Non-OECD Asian countries not members of the OECD and elsewhere, during the period 2012-2035 period. Figures in millions of barrels per day (mb / d). New Policies Scenario (IEA, WEO 2013).

As regards the OECD countries (which have traditionally been the major importers of oil), the IEA (IEA, WEO 2013) predicts that all of them will reduce their imports. Overall, the percentage of participation in the inter-regional trade will fall from about 50% today, to only 20% in 2035. The decline in imports is relatively gentle in the Asian and European OECD countries, but it is very pronounced in North America, which happens to be a net importer region now, with 5.1×10^6 bd in 2012, to it becoming a net exporter, with 1.7×10^6 bd in 2035 (figure 13).

This shift of 6.8×10^6 bd is attributable in part to an increase of 3.8×10^6 bd in oil production, which comes almost entirely from unconventional sources (see the sections entitled *Crude oil production has already peaked. Unconventional oil gains prominence, The production of non-OPEC countries will increase until the late twenties and then stagnate and decline and LTO revolution started in the U.S. will spread to other countries but loses steam from the early thirties*, as well as a reduction in consumption, which decreases by 3×10^6 bd. Interestingly, the decline in imports in North America increased almost equals the same figures in China.

Geopolitical impact of the development of...

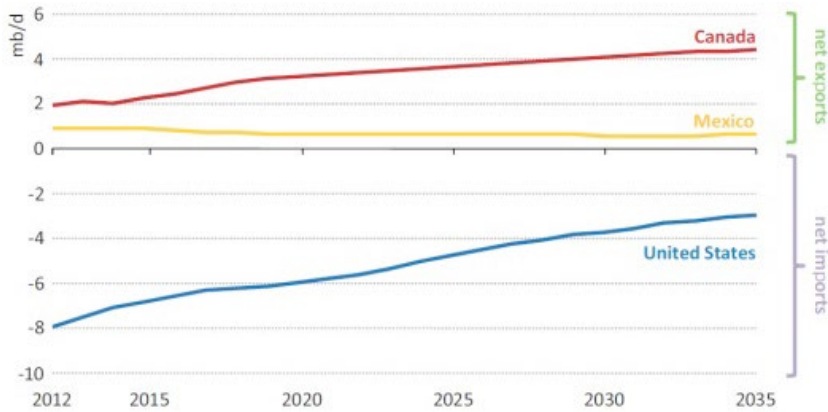


Figure 13. Net imports and exports in North America's trade balance. Figures in millions of barrels per day (mb/d). New Policies Scenario (IEA, WEO 2013).

The overall flow of oil veers from the Atlantic basin, with the exception of Europe, towards the east of Suez, particularly to China and India.

One analysis of inter-regional trade that is exclusively focused on crude (which accounts for the majority of global trade) shows a form of evolution that is similar to what has been discussed in the preceding two sections. According to the IEA (IEA, WEO 2013), the commercial flow of oil veers significantly from the Atlantic basin in the next two decades, whereby Europe remains the sole importer market. This flow moves to the region to the East of Suez, the name by which the Middle East and Asia is best known to commercial oil analysts.

The east of Suez region, as a whole, has come to be the major exporter of oil to the world, mainly from the Middle East to Europe and North America. For example, in 2000, the east of Suez region exported 7 x 10⁶ barrels per day (bd).

However, since that date, increased refining capacity in the region, reflecting a growth in domestic demand for petroleum-derived products has been translated into a decrease in the exporter flow to the world. This meant that in 2012, the export balance in the east of Suez region was practically nil, because net exports of crude oil from the Middle East were equivalent to the net importing needs of Asia. Obviously, the Middle East also exports crude to other regions such as Europe and North America, which makes Asia need to import roughly equivalent volumes from other sources, such as Russia, the Caspian region and West Africa.

Looking ahead, from here to 2035, the IEA expects that oil exports from the Middle East will only increase only, because the increase in refining capacity that is scheduled in this region absorbs most of the production

growth. Furthermore, while increased import requirements are expected in Asia, as a result of the growth in refining capacity and a fall in production, it seems that the east of Suez region will experience a growing deficit the export-import balance sheet of crude.

This is a completely different situation to that expected for North America where a sharp decline in crude oil imports, as a result of falling demand (see *The New Geography of demand. Decline in the OECD, growth in Asia and the Middle East*) and an increased level of production in light oil from compact rocks (light tight oil or LTO) and hydrocarbons deriving from Canadian oil sands (see *oil production between 2012 and 2035. Unconventional fuel as a temporary alternative to the hegemony of OPEC and Middle East*).

The consequence of this is that oil from other exporting regions will flow, on an unprecedented scale to the east of Suez region, which in 2035 will have to cover net import needs of near of 8×10^6 bd.

Since some exports from the Middle East will still have to go to the West, mainly to Europe (although at a lower rates than today's volumes), the flow of crude from the rest of the world to the east of Suez region should be even higher than the figure above, exceeding 9×10^6 bd in 2035. In this context, the IEA (IEA, WEO 2013) predicts that imports from the Asian markets, or sea or gas pipeline from Russia and Kazakhstan, will increase to 2.3×10^6 bd. This still leaves a volume of 7×10^6 db that must be transported by tankers from the ports of European Russia, West Africa, Latin America and Canada (figure 14).

Overall, the IEA forecasts indicate that during the 2012-2035 period, the inter-regional trade in crude oil will increased by 3.9×10^6 bd, representing a percentage close to 10%, although the volume traded by sea and oil tankers will increase by 18%, since the sea supply routes is longer on average.

Security implications of the global oil supply

The IEA projections discussed require a re-assessment of the security policies regarding oil supply. In this regard, it is appropriate to note that in 2035, the world's two largest oil importers will be China (with $11,7 \times 10^6$ bd) and India ($6,8 \times 10^6$ bd), while the percentage of U.S. involvement in inter-regional trade in crude declines from 27% now, to 15%. This situation means that the Asian countries mentioned should get more involved in anticipating and managing the effects of potential supply disruptions.

Also, changes in the global flow of oil will have implications for the relative importance of some strategic steps ("choke points") in the maritime supply system. For example, according to projections by the IEA (IEA, WEO 2013), the flow of oil through the Straits of Malacca will increase from 13×10^6 barrels per day bd in 2012 to $17,5 \times 10^6$ db in 2035. Undoubtedly, the most import-dependent Asian countries should be actively involved and

increase their efforts to strengthen the security of this waterway. This is a task which, in any case, requires international cooperation because all of these countries are interested in importing so as to mitigate the possible effects of a disruption in their oil supply, given the potential impact that such an event could have on oil prices and the global economy.

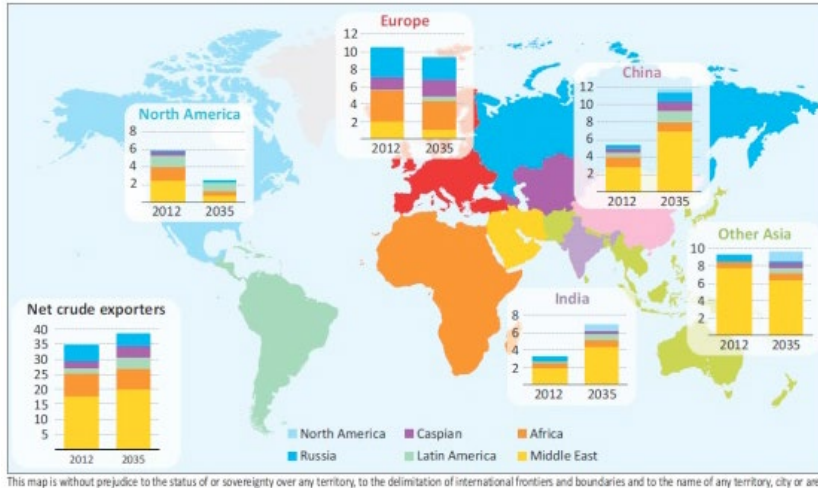


Figure 14. Crude imports by region and source. Figures in millions of barrels per day (mb/d). New Policies Scenario (IEA, WEO 2013).

Unconventional gas

Preliminary technical considerations

What does unconventional mean?

In the case of natural gas, industry classified as unconventional as being that gas which is present in rocks or in unusual crystalline substances, from which it is difficult to extract the gas, either due to the low level of permeability and porosity of the rocks or the manner in which the gas is kept. It is also defined as a gas that could be extracted in an economically profitable way by commonly used technology and whose production requires the use of special technical drilling techniques and stimulation technology. This represents an additional cost and, in general terms, the production of unconventional gas becomes very much dependent on gas prices in the market.

Main types of unconventional gas

According to the International Energy Agency (IEA), unconventional gas includes the following five categories:

- I. **Tight gas.** This is natural gas trapped in sedimentary rocks (sandstones and limestone) with very low levels of permeability (typically less than 0.1 millidarcys) and low porosity. Practically speaking, this gas can also be defined as one that cannot be extracted profitably from its reservoir rock using conventional vertical wells. This type of unconventional gas may contain condensates (gaseous hydrocarbons in conditions of pressure and sub-surface temperature but that condense to liquids at the surface).
- II. **Shale gas.** This is natural gas trapped in sedimentary fine-grained rocks (mainly consisting of clay or silt sized particles) of low permeability and rich in organic matter. Because it very low in permeability and because of the porosity of these rocks, some authors consider them to be a subcategory of tight gas. These are hydrocarbons source rocks after being subject to a maturation process will generate convenient thermal gas. Part of this is still in the rock. However, another part may have migrated vertically and this is accumulated in conventional reservoirs. As the fluid cannot move them easily through low-permeability rocks, the commercial gas production requires advanced techniques such as the hydraulic fracturing (the fracking) and the drilling of horizontal multilateral wells.
- III. **Coalbed methane.** This is the absorbed methane within coal seams in the rock matrix. Most of the coal reserves in the world are at the depths at which mining work is impossible. The CBM is the methane contained in coal beds, due to its depth or poor quality, which cannot be exploited by mining. In the exploitation of coal mines, the associated methane gas is considered to be a hazard or a source of environmental problems if it is vented into the atmosphere. However, the CBM can be exploited using technologies similar to those used in the search and exploitation of conventional oil drilling, although production may be very difficult if the formations containing it are very compacted and have low permeability levels, in which case, then various techniques are to be used such as hydraulic fracturing to improve well productivity. In this case, the injected water that goes into the pore spaces has to be removed prior to gas extraction, which complicates the production process, increasing costs and creating environmental problems.
- IV. **Methane hydrates or gas hydrates.** These are natural solids, with a snow-frosted appearance, characterized by a "clathrate" (or cages) structure formed by a crystalline lattice of water molecules trapped inside molecules, mainly methane gaseous hydrocarbon. Within the "ice cage", methane molecules are com-

pressed by a factor of about 164, so that atmospheric pressure and temperature to one cubic metre of gas hydrate releases 164 cubic metres of gas for 0.8 cubic metres of water. This concentration factor gives special importance to the sediments containing gas hydrates, both from the point of view of its energy potential, as well as from the perspective of the geological hazards and climate change. Gas hydrates are stable under high-pressure conditions and moderately low temperatures. These conditions, along with the presence of the water and gas necessary for the genesis of gas hydrate are provided both on land, in the permafrost of the Arctic regions, and in the sediments located in the deep ocean and other large bodies under water.

Estimation of resources and production costs (without internalizing the CO₂ costs)

Knowing the amount of in-situ gas that is hosted by the unconventional reservoir rocks is a difficult task, due to the heterogeneous structure of these rocks as the production profiles differ significantly from those observed in conventional wells.

With these cautions in mind, regardless of gas hydrates, it is estimated that the reserves and recoverable resources⁶ of unconventional gas are around 343 x 10¹² cubic meters (cm), compared to approximately 468 x 10¹² cm of conventional gas (figure 15, table 6), representing an approximate total amount of 811 x 10¹² cm, equivalent to over 230 years of production at current rates.

The potential contribution to the overall supply of natural gas that each of the different types of conventional and unconventional gas (excluding gas hydrates) could provide in the long term is summarised in figure 16. This figure also illustrates production costs (box on the left) and transport (box on the right) in 2008 (IEA, WEO 2009). Gas hydrates are not included because there is still no commercial gas production from these compounds and they are not expected to occur in the immediate future.

The total long-term potential of all commercially exploitable gas resources as of today is approximately 811 x 10¹² cubic meters (cm). The volume extracted and partially-burned (flared) or vented directly into the atmosphere, is situated around 100 x 10¹² cm with top production costs of \$ 8 per million BTU (MBTU)⁷. For comparison, on the basis of the same energy content, these costs with oil (see *Estimating resources and pro-*

⁶ See note at end of page two

⁷ \$ 1 per million BTU ("British Thermal Units") equals approx. \$ 0.035 per m³.

duction costs (no internalize CO₂.costs) should know that \$ 8 per MBTU is equivalent to about the equivalent of \$ 46 per barrel of oil.⁸

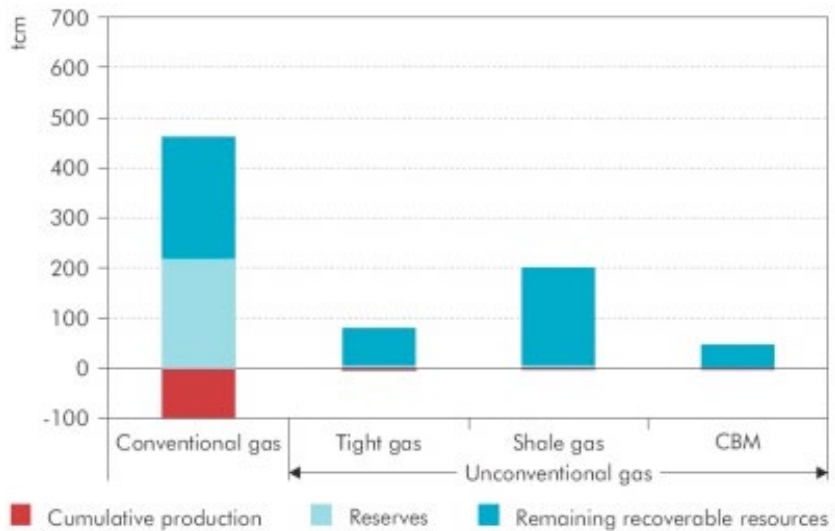


Figure 15. Cumulative production, reserves and recoverable natural gas resources by exploiting both conventional and unconventional fuel, in late 2011 and globally. Figures in billions of cubic meters (bcm). (IEA, WEO 2012).

Production costs for the associated gas (gas that occurs in an oil exploitation operation) are generally lower than those of non-associated gas (the one extracted from a natural gas field). This applies most particularly in those areas where the infrastructure to extract oil existed before the intention to exploit the gas resource did. However, even today, significant amounts of gas are burned because to treatment and subsequent transport of the gas to market is not economically viable. Thus, only in the last decade, have burned more than 1.5 x 10¹² cm. of gas worldwide, a volume equivalent to more than 5% of the marketed production.

The most accessible portion of conventional gas resources to be exploited are around 220 x 10¹² cm, with production costs that range between 0.20 to \$ 9 per MBTU. Other conventional resources include those from the Arctic or deep water. Firstly, this could reach 30 x 10¹² cm. and production costs would be between \$ 4 to \$ 12 per MBTU. The latter could represent a 50 x 10¹² cm with a production cost of between \$ 5 to \$ 11 per MBTU⁹.

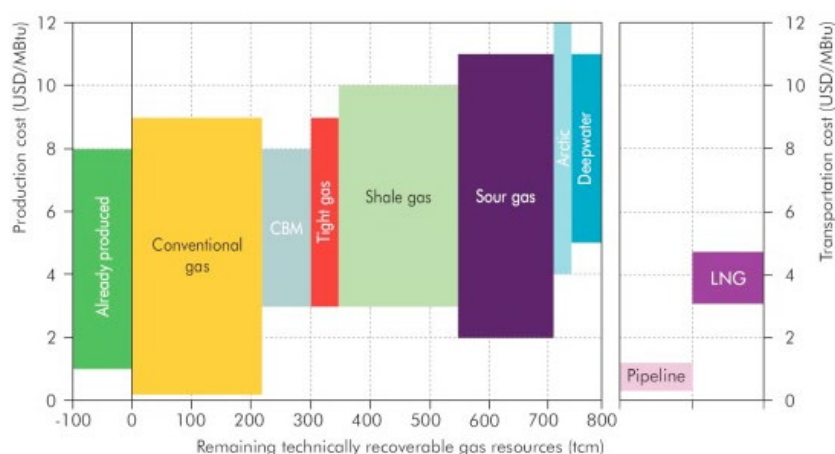
⁸ \$ 1 per million BTU ("British Thermal Units") equals \$ 5.8 per barrel of oil equivalent

⁹ There is a clear discrepancy in the numbers of volumes of technically recoverable conventional natural gas between (table 8) and figure 20. Probably, this is because in the latter end of 2008 the data is tabulated, while the table shows data from late 2012.

	Conventional	Unconventional			Sub-total	Total
		Tight gas	Shale gas	Coalbed methane		
E. Europe/Eurasia	143	11	15	20	46	190
Middle East	124	9	4	-	13	137
Asia-Pacific	44	21	53	21	95	138
OECD Americas	46	11	48	7	66	112
Africa	52	10	39	0	49	101
Latin America	32	15	40	-	55	86
OECD Europe	26	4	13	2	19	46
World	468	81	212	50	343	810

Notes: Remaining resources comprise known reserves, reserves growth and undiscovered resources. Unconventional gas resources in regions that are richly endowed with conventional gas, such as Eurasia or the Middle East, are often poorly known and could be much larger. Sources: BGR (2012); US EIA (2013); USGS (2000); USGS (2012a and 2012b); IEA databases and analysis.

Table 6. Technically recoverable natural gas resources to be exploited, by types and regions, in late 2012. Figures in billions of cubic meters (bcm). (IEA, WEO 2013).



Notes: CBM = coal-bed methane; LNG = liquefied natural gas; Pipeline costs refer to costs per 1 000 km; MBtu = million British thermal units; tcm = trillion cubic metres.

Figure 16. Production costs in 2008 (in dollars per million of BTU) and long term technically recoverable different resource categories of natural, conventional and unconventional gas (billions of cubic metres) in volume. The box on the right shows the costs for natural gas in dollars per million of BTU (and 1000 km in the case of transport by pipeline). (IEA, Resources to Reserves, 2013).

Commercially exploitable unconventional resources now total 343 x 10¹² cubic meters (cm.), which correspond to 212 x 10¹² cm of shale gas, 81 x 10⁹ cm of tight gas and 50 x 10⁹ cm of coal bed methane or CBM - with production costs of between 3 and 10 dollars per MBTU. The resources of sour gas and lean gas that some authors include within the category of unconventional gas

(see the section on *Main types of unconventional gas* would provide additional 160 x 10¹² cm with a cost production of between \$ 2 to \$ 11 per MBTU.

One key factor to consider in the cost of natural gas is transportation. In the case of gas pipelines this is \$ 0.30 to \$ 1.2 MBTU every 1000 miles, depending on whether the segments are on land or under the sea and depending on pipeline capacity and the age of the facility. For liquefied natural gas (natural liquefied gas or LNG) the total cost of liquefaction, transportation and regasification vary from \$ 3.10 to \$ 4.70 per MBTU, depending on plant size and the distance involved in transportation.

The estimation of the global volume of gas hydrates is about 2.1 x 10¹⁶ cm. Other more conservative estimates lower the previous figure by an order of magnitude, but even these reveal the existence of a planet in the huge volume of gas that is "caged" in hydrates. We are talking about between 3.4 x 10¹⁸ cm and 3 x 10¹⁷ cm mc gas contrasted with the 811 x 10¹² cm discussed in the second paragraph of this section.

Geographical distribution of resources. The unconventional gas as a counterweight to the Middle East and Russia

From the number of unconventional gas resources mentioned in the second paragraph of section "*Estimation of resources and production costs (without internalizing the CO₂ costs)*" (343 x 10¹² cubic meters) approximately 27.7% are located in the Asia-Pacific, 19.2% in the USA and Canada, 16% in Latin America, 13.4% in Eastern Europe-Eurasia, 14.2% in Africa, 5.5% in European countries integrated into the OECD, and only 3.8 % in the Middle East (table 6 and figures 17 and 18).

This geographical distribution helps to balance the excessive concentration of conventional reserves and resources in Eastern Europe-Eurasia (mainly in Russia) and in the Middle East. Both regions respectively recorded about 30.6% and 26.5% of the reserves and the technically recoverable¹⁰ resources of the conventional natural gas in the world. However, it is possible that, in the future, the Middle East and other regions, such as countries bordering the Caspian, which so far have received little attention due to their large conventional resources, will see a substantial increase in their estimates of unconventional resources.

Figure 19 summarizes the volume of recoverable resources of unconventional gas for different countries, breaking it down into three categories: gas from compact rock tight gas, shale gas and coal-bed methane "or CBM. It follows, without any doubt, the geopolitical importance of shale gas resources. In late 2012, these accounted for approximately 61.8% of the total of the outstanding operating resources, as compared to 23.6% of

¹⁰ See footnote on page no. 4.

low permeable rock-gas and 14.6% of coalbed methane that is technical-ly recoverable from unconventional resources (table 6).

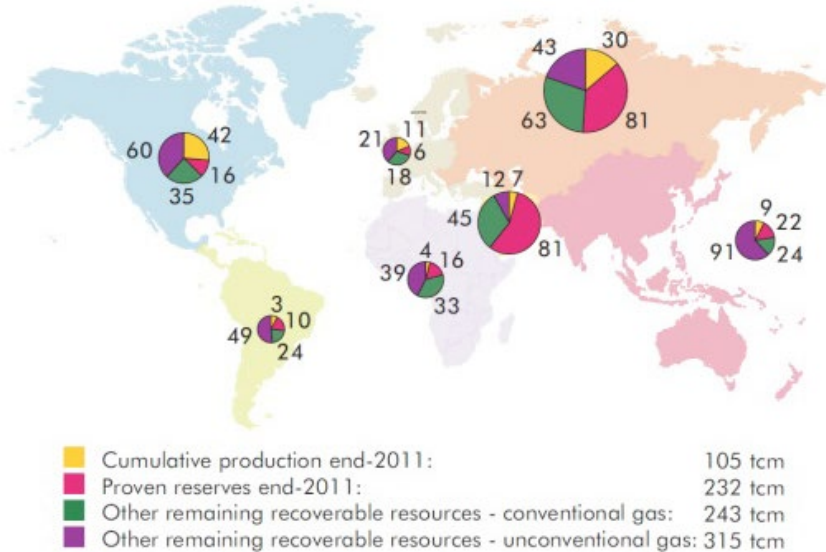


Figure 17. The natural gas in the world in 2012. Regional distribution of cumulative production, proved reserves and recoverable resources by exploiting both conventional and unconventional fuel. Figures in billions of cubic metres (bcm). (IEA, Resources to Reserves, 2013).

The case of shale gas

In a report published in early June 2013 (*Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States, 2013*), the Energy Information Administration (IEA) of the Government of U.S. had increased by 10% as compared to the previous estimate (U.S. IEA 2011), on a global scale of the technically recoverable shale gas resources. The new estimate is about 204.4×10^{12} cubic meters (cm). This figure far exceeds the 185.2×10^{12} cm. according to the latest report from BP (*Statistical Review of World Energy, June 2013*) formed in late 2012. This proved the reserves of natural gas in the world and that the rate of extraction of the same year, ensure the availability of this fuel for nearly 56 years.

Of the 204.4×10^{12} cm. cited, 31.2×10^{12} would correspond to China, which is ranked first in a list of 42 countries analysed in the report, followed by Argentina, Algeria and the U.S., with 22.5×10^{12} 19.8×10^{12} and 18.6×10^{12} cubic meters (cm), respectively. The other countries that occupy the top ten rankings are Canada (16×10^{12} cm), Mexico (15.3×10^{12} cm), Australia (12.2×10^{12} cm), South Africa (10.9×10^{12} cm), Russia (8×10^{12} cm) and Brazil (6.9×10^{12} cm).

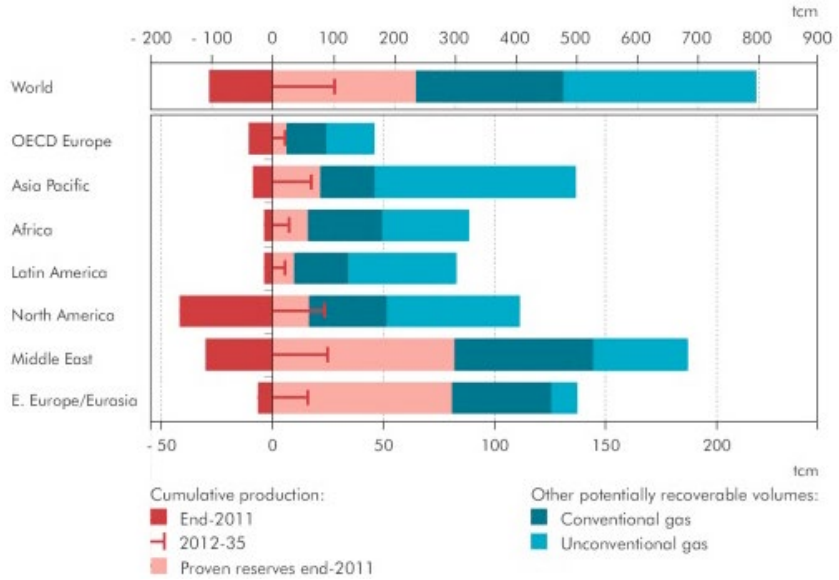


Figure 18. Cumulative production, proven reserves and potentially recoverable gas in the New Policies Scenario (IEA, WEO 2012). Figures in billions of cubic meters (bcm). Note the different scales for the world (above) and regions (below). The figure contains an error: the length of the light blue bar for the unconventional gas in Eastern Europe-Eurasia actually corresponds to the Middle East and vice versa (compare with table 8). (IEA, WEO 2013).

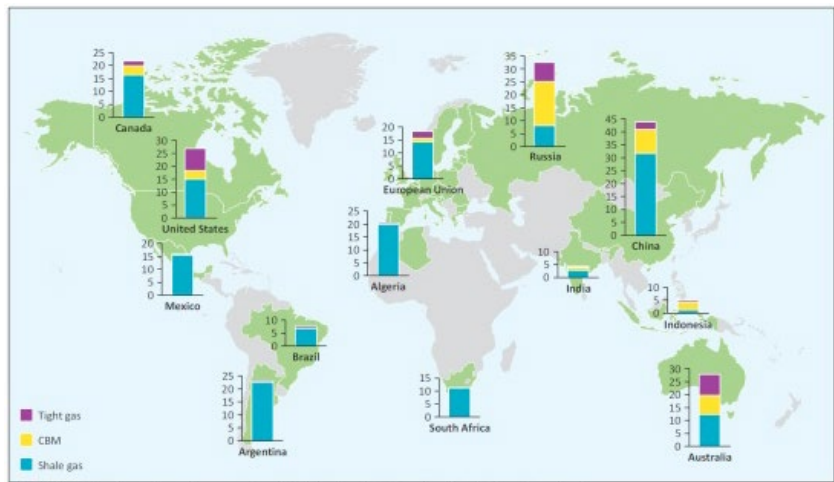


Figure 19. Recoverable unconventional gas resources by type and country in late 2012. Figures in billions of cubic meters (bcm). (IEA, WEO 2013).

The report (U.S. IEA, 2013a) finds that more than half of the global shale gas resources located outside the U.S. focus on China, Argentina, Algeria, Canada and Mexico. Without doubt, the new figures produced are of great economic and geopolitical interest, given the enormous potential of the resources located beyond U.S. borders, but it remains to be seen whether these resources can be economically exploited as being feasible, such as the U.S. That is a country in which the production of gas from shale has grown so much that today, this already represents 40% of all natural gas extracted.

With respect to Europe, the estimates of technically recoverable shale gas resources in 11 countries conducted throw together a rough figure of 13.2×10^{12} cm representing 6.4% of the estimated total for the 42 countries analysed. This overall figure puts Europe in seventh place in the world rankings, behind Mexico and ahead of Australia. 60% of the total amount of resources from the old continent would be located in Poland and France, with 4.1×10^{12} and 3.8×10^{12} cm, respectively, leading the European ranking. These are followed far behind by Romania (1.4×10^{12} cm) Denmark (0.9×10^{12} cm), the Netherlands and the UK (with 0.7×10^{12} cm each). Spain¹¹, with 0.22×10^{12} cm occupies tenth place, behind Bulgaria and Germany (0.48×10^{12} cm each) and Sweden (0.3×10^{12} cm). According to data from BP (its Statistical Review of World Energy, June 2013), the consumption of natural gas in the European Union was about 0.44×10^{12} cm in 2012, so technically recoverable shale gas resources could cover up to 30 years of consumption multiplied by a factor of 7.6 as compared to the current proven gas reserves in the EU.

The IEA (IEA 2013a U.S.) also report some decline in their previous estimates, such as Norway, Poland, South Africa, China and Mexico. What happened in the case of the two European countries clearly illustrates some of the reasons behind such sales, underlining the precautionary step that must be handled with any resource estimate. In this connection, we must not forget that the U.S. and Canada are the only countries in the world

¹¹ The AIE report (US AIE, 2013a) shows the new development of including for the first time an estimate of the technically-recoverable resources of shale gas for Spain. Specifically, the Basque-Cantabrian and Ebro basins are analysed. In the first case, for technical reasons, the study only considers some shale formations from the Jurassic Age to be potentially beneficial. For these, an in-situ accumulation of 1.18×10^{12} cu.m. is calculated, of which only around 0.22×10^{12} cu.m. could be recovered. The report does not quantify the possible technically-recoverable resources from the Ebro basin, because it considers that the existing Palaeozoic and Eocene shale formations in the sub-soil of that basin do not meet one of the basic geo-chemical requirements to generate appreciable quantities of hydrocarbons: the organic matter (TOC) in those formations is low. For all of these reasons, whilst awaiting new studies, the AIE report concludes that the technically-recoverable reserves of shale gas in Spain are 0.22×10^{12} cu.m. This figure is very below other estimates recently made public, would make it possible to cover the natural gas combustion of Spain for rather more than 7 years, assuming the consumption figures published by BP (*Statistical Review of World Energy*, June 2013).

that currently produce shale gas and oil shale in commercial quantities. For Norway the technically recoverable shale gas resources of 2.3 x 1012 cm fell to zero in 2011, due to the disappointing results obtained after Shell drilled three wells in The Alum Shale formation. These three wells were drilled in Sweden in 2011 in part of the less complex formation cited from the geological point of view, which drastically reduces the prospects of success in Norway where the geology is much more complicated.

	1990	2011	2020	2025	2030	2035	2011-2035	
							Delta	CAAGR*
OECD	881	1 195	1 358	1 403	1 430	1 483	288	0.9%
Americas	643	859	1 000	1 041	1 063	1 114	255	1.1%
Canada	109	160	184	189	186	194	34	0.8%
Mexico	26	49	50	56	68	81	32	2.1%
United States	507	649	764	792	807	837	188	1.1%
Europe	211	277	249	237	225	215	-62	-1.1%
Norway	28	101	121	118	115	111	10	0.4%
Asia Oceania	28	59	109	125	143	155	95	4.1%
Australia	20	51	103	120	139	152	101	4.6%
Non-OECD	1 178	2 188	2 599	2 919	3 216	3 492	1 304	2.0%
E. Europe/Eurasia	831	882	911	986	1 094	1 164	282	1.2%
Azerbaijan	10	16	23	33	43	47	30	4.5%
Russia	629	673	667	692	757	808	135	0.8%
Turkmenistan	85	67	83	100	117	132	66	2.9%
Asia	130	419	566	625	694	769	350	2.6%
China	15	103	178	218	266	317	214	4.8%
India	13	46	62	73	85	98	52	3.2%
Indonesia	48	81	108	118	129	139	57	2.3%
Middle East	92	519	624	720	766	823	304	1.9%
Iran	23	150	143	165	180	207	56	1.3%
Iraq	4	6	39	71	79	83	77	11.5%
Qatar	6	151	187	214	227	237	86	1.9%
Saudi Arabia	26	86	112	121	128	136	50	1.9%
UAE	20	52	58	61	62	65	13	0.9%
Africa	64	200	280	333	378	428	228	3.2%
Algeria	43	77	106	115	123	132	55	2.3%
Libya	6	8	17	21	24	30	22	5.7%
Nigeria	4	36	42	35	30	31	47	3.6%
Latin America	60	168	218	255	285	308	140	2.6%
Argentina	20	42	49	65	80	91	49	3.3%
Brazil	4	17	38	60	78	92	76	7.4%
Venezuela	22	29	36	43	52	63	38	3.9%
World	2 059	3 384	3 957	4 322	4 646	4 976	1 592	1.6%
European Union	233	185	135	122	114	104	-80	-2.3%

* Compound average annual growth rate.

Table 7. Natural gas production by region. Figures in billions of cubic metres New Policies Scenario (IEA, WEO 2013).

In Poland, the technically recoverable gas from the Lublin Shale formation resources declined from 1.23×10^{12} cm. in 2011, to 0.25×10^{12} cm. in the report of 2013, as a result of the application by the IEA of more stringent criteria to define the quality of the formations that contain the gas. This review involves the estimation of shale gas resources for the whole of Poland, with falls of 5.2×10^{12} cm. in 2011 to 4.1×10^{12} cm. in 2013.

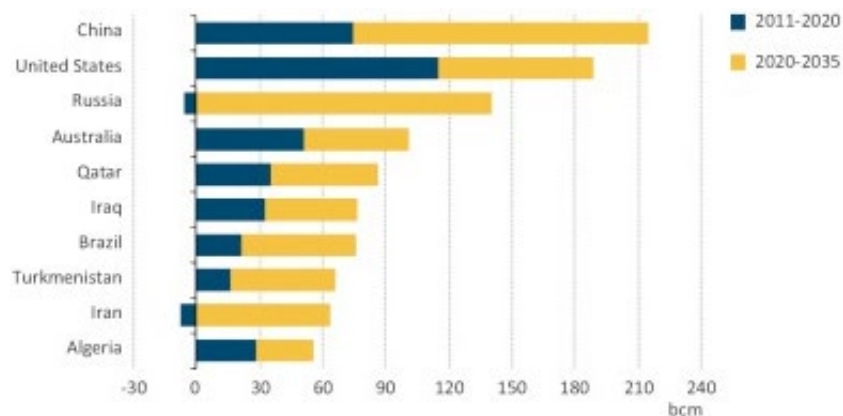


Figure 20. Changes in the production of natural gas in key countries for the period 2011-2035 period. Figures in billion cubic meters (bcm). New Policies Scenario (IEA, WEO 2013).

It should be stressed that in any case, the report commented on (U.S. IEA 2013a) cannot be regarded to be complete as it excludes many shale formations of prospective interest, such as those that underlie the major oil fields of the Middle East and the Caspian region.

Production of natural gas between 2012 and 2035. The unconventional gas revolution expands beyond the U.S. and Canada

In just over two decades unconventional gas could represent more than a quarter of the global production of natural gas

The IEA predicted in its New Policies Scenario (IEA, WEO 2013), the consumption of natural gas in the world will grow from about 3.4×10^{12} cubic metres (cm) in 2011 to just under 2035, 5×10^{12} cm, with 40% of this increase being attributable to the electricity generation sector. We are talking about an average annual growth rate of 1.6%, although this rate has varied widely by region, so that would be three times faster than in countries outside the OECD than in more mature markets of the industrialized countries that are integrated into this organization.

In the discussed scenario, the IEA projected that between 2011 and 2035, natural gas production will grow in all regions, with the exception of Europe (with a fall of 22.4%) and the increase in production in Norway (10%), which will not be enough to offset the decline in other mature fields in the North Sea and the Netherlands. As shown in table 7 and in figure 20, China, the USA, Russia and Australia (in that order), followed by Qatar, Iraq, Brazil, Turkmenistan, Iran and Algeria, are the countries that would experience a greater increased production. Although the U.S. and Australia would account for significant increases in its production (29% and 198%, respectively), with both becoming net exporters, the non-OECD countries would account for about 81.75% of production growth.

The IEA (IEA, WEO 2013) considers that the total increase in production expected in the New Policies Scenario (1.5 x 10¹² cm., approximately) 52% would be contributed by unconventional gas, while the remaining 48% come from unconventional sources (table 8). Forecasts are that from 2020, the development of unconventional gas production extends beyond North America (U.S. and Canada), thus making China and Australia the largest contributors to global output growth followed by other countries such as Argentina, India, Algeria, Mexico and Indonesia and the European Union set slightly above the latter three countries (figure 21).

	2011	2020	2025	2030	2035	2011-2035	
						Delta	CAAGR*
Shale gas	232	402	513	627	745	513	5.0%
Coalbed methane	78	148	202	261	315	237	6.0%
Tight gas	250	281	285	276	269	18	0.3%
Total	560	832	999	1 165	1 328	769	3.7%

* Compound average annual growth rate.

Table 8. Production of unconventional natural gas by type. Figures in billions of cubic metres. New Policies Scenario (IEA, WEO 2013).

For the IEA (IEA, WEO, 2013), unconventional gas, which in 2011 accounted for about 17% of the total world production of natural gas, could reach 27% in 2035, with about 1.3 x 10¹² cm. The historical development of unconventional gas production from 2000 to 2035 is summarised in Figure 22. It follows from the observation of this figure, which the revolution that began with the shale gas in the U.S.A. and Canada, expands beyond the borders of these countries, maintaining an average growth rate of 3.7% between 2011 and 2035.

In any case, it noted that the IEA warns that its predictions about the global production of unconventional gas are uncertain and they depend, to a large extent, on governments and industry being able to develop a regulatory framework and good practices enabling them to obtain a "social license" to operate, thus satisfying the existing great public concern

about the environmental and social impacts that are associated with such operations.

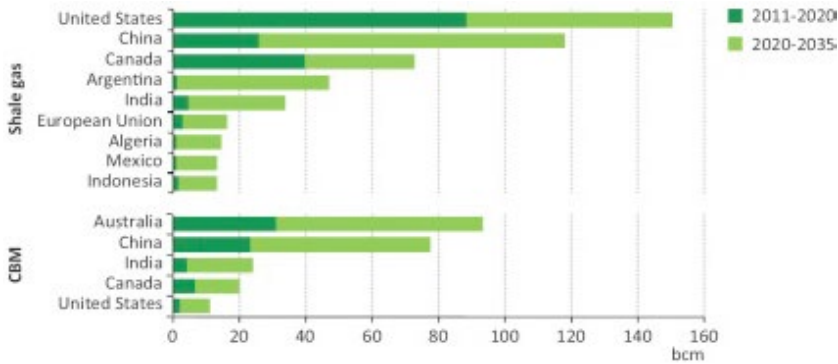


Figure 21. Growth in unconventional gas production by type in some key countries and regions during the 2011-2035 period. Figures in billions of cubic metres (bcm). New Policies Scenario (IEA, WEO 2013).

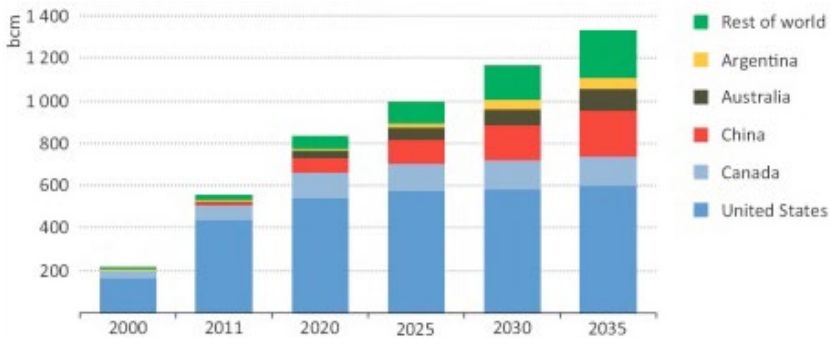


Figure 22. Production of unconventional gas in key countries for the 2011-2035 period. Figures in billions of cubic metres (bcm) New Policies Scenario (IEA, WEO 2013).

U.S. production and Canadian production continues to grow in the next decade and it is then stabilised. Mexico comes onto the scene

In the New Policies Scenario of the IEA (IEA, WEO 2013), until 2020, more than half of the growth in global unconventional gas production comes from two major current producers, USA and Canada, which in 2011 accounted for about 90% of the total. Towards the end of this decade it is expected that this latter percentage will to 80% decay, reflecting the start-up of production in China and Australia, which will be added to later on by Argentina and other countries (figures 21 and 22).

The increased production of unconventional gas, especially shale gas in the U.S. has slowed slightly in 2012, to the extent that the very low gas

prices have caused a decline in drilling activity. However, the IEA projections assume that, over time, the gas price will increase in such a way that total production in the U.S. of unconventional gas could reach 600.000×10^6 cubic meters (cm.) in 2035, although there is no indication of a similar decline discussed in section "*The revolution began in the U.S. LTO spreads to other countries but loses steam from the early thirties*"; (figure 8) as regards light tight oil or LTO decline.

In Canada, the current production of unconventional gas, gas that is mainly composed of tight gas together with minor amounts of shale gas and coal-bed methane or CBM, is around the 70.000×10^6 cm. However, forecasts suggest that this figure could increase to 2035. 140.000×10^6 cm. that is basically driven by shale gas.

In the long term, in North America, it seems that Mexico will join U.S. and Canada as an unconventional gas producer country. In the New Policies Scenario, the IEA (IEA, WEO 2013) estimates that extraction could reach 30.000×10^6 cm, in 2035. Pemex, the state oil and gas company in the country, has launched a program to invest \$ 200 million over three years in the exploration of gas shale, starting with the extension in the northern part of Mexico of the Eagle Ford geological formation, currently in production in neighbouring Texas, and in the U.S., and it is believed that these could hold about half of the total resources. However, commercial production could be limited by the scarcity of water in some resource-rich regions so the priority is accorded to Pemex projects generating export earnings and the difficulties in keeping development costs to levels capable of competing with gas imports from the U.S. Anyway, the power sector reform adopted in Mexico could mean a big boost for the exploitation of unconventional gas resources in the country, to the extent of opening up the oil and gas sector to foreign companies would provide the technology necessary and large capital investments.

China and Australia burst onto the world stage in the production of unconventional gas

In Australia, the IEA (IEA, WEO 2013) points out that the production of coal-bed methane has been so far the main source of unconventional gas production and this may increase rapidly after the completion of three liquefied natural gas (LNG) in Gladstone (Queensland) that will be powered by unconventional natural gas from coal beds in the Surat basin. The projections of the New Policies Scenario (figure 21) provide for the production of coalbed methane in Australia increase of about 6000×10^6 cubic meters (cm.) in 2011 to almost 100.000×10^6 cm. in 2035. To achieve these goals, operators should pay special attention to water management, given the general scarcity and the high dependence

of some the regions of groundwater and artesian water on farming and grazing. In this regard, the decision of New South Wales in early 2013, to prohibit the development of coal-bed methane within a radius of two kilometres in residential areas and some rural areas is a wake-up call for the industry.

According to the IEA (IEA, WEO 2013) in China, the commercial production of coal-bed methane reached the 10.000×10^6 cm. in 2011. But production is growing less rapidly than expected, so that it will be difficult to achieve the objective of 30.000×10^6 cm. set for 2015. The projections of the New Policies Scenario contemplate that this target will be delayed to 2020 (figure 21).

As regards shale gas, China's potential is immense (see *The case of shale gas resources*) but production projects are mostly at an early stage of exploration, particularly in the region of Sichuan. Foreign companies can participate in exploratory activities as minority partners of Chinese companies and, in some cases, such as operators, with the important implications of this for technology transfer. Anyway, it seems unlikely that the commercial production of shale gas in China will reach the government targets set at just under 6.500×10^6 cm. in 2015. The projections of the New Policies Scenario of the IEA (IEA, WEO 2013) envisage the production of shale gas in China to rise slowly until 2020, then accelerate and reach nearly 120.000×10^6 cm. in 2035 (figure 21). The main uncertainties in this regard are geological (e.g. in many cases, the rock formations of interest are deeper than in the U.S., thus increasing development costs) and accessibility (the most promising resources are in mountainous areas). Also, the limited availability of water, particularly in the Tarim and Ordos basins, together with the absence of pipelines, processing capacity and other infrastructure are factors that could hinder the development of shale gas resources in China.

The potential of Argentina

In a recent U.S. government report (U.S. IEA 2013a), Argentina ranks second in the world rankings in shale gas resources (see section on *The case of shale gas resources*). The most interesting geological formation is Vaca Muerta in the northern Patagonia. According to the IEA (WEO 2013 IEA) from a geological point of view of production prospects are positive, but, in practice, fiscal, contractual and political obstacles could slow their development. Apart from that, it is expected that companies will focus their activity preferably in areas that are rich in oil and liquids rather than those containing dry gas resources. One factor that has so far been delayed investments has been offering low prices for production. YPF, the new state company, has approved an investment programme of \$ 6,500 million, which is intended to increase gas

production by 8% during 2013-2017, with about 60% of the increase coming from gas production from tight gas and shale gas. Also, YPF has announced partnerships with foreign companies to develop unconventional resources such as Vaca Muerta. In the New Policies Scenario, the IEA (IEA, WEO 2013) assumes that if these partnerships fructify the production of unconventional gas in Argentina in 2035 could reach a volume to 50.000 x 10⁶ cm. (figure 21), to which must be added other 40.000 x 10⁶ cm. of conventional gas.

The incognita of Europe

As discussed in the sections *The production of natural gas between 2012 and 2035*, The unconventional gas revolution expands beyond the U.S. and Canada and *In just over two decades unconventional gas could represent more than a quarter of the global production of natural gas*. Europe has substantial resources of the three types of unconventional gas analysed (figure 19), but large-scale development must overcome a series of geological constraints (the complexity is higher than in North America) as well as the public and political exploitation of unconventional gas opposition in many countries, particularly in Western Europe. At the moment, it is uncertain to what extent such forecasting social and environmental concerns will condition a tightening of the regulations at the European level. Therefore, in the New Policies Scenario, the IEA (IEA, WEO 2013) adopts a conservative position when making forecasts on production during the period 2011-2035 period, which could reach just under the 20.000 x 10⁶ cm. (figure 21)

In this volume, the highest percentage corresponds to Poland (8.000 x 10⁶ cm.), which is the country that has been considered to be the most promising one in Europe for the production of unconventional gas. However, until September 2013, after more than 50 wells have been drilled, the results have not lived up to initial expectations of the industry, although it is still early to judge the extent and quality of the exploitable resources since they still have to drill more wells around 200 between now and 2016.

The IEA also believes that by 2035 the UK will be able to produce 3,000 x 10⁶ cm. of unconventional gas. In June 2013, the British Geological Survey revised the potential of this country upwards, doubling the previous resource estimate made for the main prospect domain of the United Kingdom (Bowland Shale).

Outside the European Union, the IEA expects that in 2035, the production of unconventional gas in Ukraine to increase to levels similar to those of neighbouring Poland, although the outlook for the troubled political situation in the country is clouded and the associated investment climate is uncertain.

The reorganization of the global trade in natural gas between 2011 and 2035. New pipelines and new players in the market of LNG

The new geography of demand. China and the Middle East are growing rapidly, although the U.S. will remain the largest market

The International Energy Agency (IEA) predicts in its New Policies Scenario (IEA, WEO 2013) that the markets for natural gas between 2011 and 2035 will experience the fastest growth levels that are located outside the OECD (table 9). Countries outside the organization will be responsible for over three quarters of the growth in demand during that period, with the highest growth in absolute terms focusing on China and the Middle East. In the new geography of demand. China and the Middle East are growing rapidly, although the U.S. will remain the largest market.

By contrast, in OECD countries, although consumption is increasing, the growth rates are lower due to market saturation and the effects of penetration of renewables in the electricity sector in Europe. However, the OECD markets remain comparatively large, so that, for example, in 2035, demand in the U.S., which continue to be the world's largest consumer, will be 50% higher than China.

	1990	2011	2020	2025	2030	2035	2011-2035	
							Delta	CAAGR*
OECD	1 036	1 597	1 707	1 778	1 827	1 885	289	0.7%
Americas	628	869	957	988	1 016	1 044	175	0.8%
United States	533	696	749	769	781	789	93	0.5%
Europe	325	525	537	568	584	605	80	0.6%
Asia Oceania	82	202	214	222	227	236	34	0.6%
Japan	57	120	119	123	122	124	3	0.1%
Non-OECD	1 003	1 773	2 249	2 541	2 815	3 086	1 313	2.3%
E. Europe/Eurasia	738	703	732	756	785	817	114	0.6%
Caspian	100	117	127	134	139	144	27	0.9%
Russia	447	476	493	504	523	544	68	0.6%
Asia	84	410	669	816	949	1 088	678	4.2%
China	15	132	307	396	470	529	397	6.0%
India	13	61	87	114	140	172	111	4.4%
Middle East	87	399	504	577	645	700	301	2.4%
Africa	35	111	153	170	187	204	93	2.6%
Latin America	60	149	190	221	248	277	128	2.6%
Brazil	4	27	45	61	75	90	63	5.2%
World**	2 039	3 370	3 957	4 322	4 646	4 976	1 606	1.6%
European Union	371	492	494	523	537	554	62	0.5%

* Compound average annual growth rate. ** The world numbers include gas use as an international marine fuel.

Table 9 Demand for natural gas by region. Figures in billions of cubic meters New Policies Scenario (IEA, WEO 2013).

According to the IEA (IEA, WEO 2013), despite relatively low prices, the maturity of the gas market in the U.S. and Canada, will limit the possibility of rapid demand growth in North America, even though the price difference with other fuels could stimulate the expansion of the use of gas to new sectors, such as transport. Forecasts of the New Policies Scenario of the IEA (IEA, WEO 2013) for the entire region (including Mexico experiencing rapid growth) is for the demand to increase by over 0.86×10^{12} cubic metres (cm.) in 2011, rather less than 1.04×10^{12} cm. in 2035. A particularly interesting fact is that the IEA forecasts suggest that in the U.S., as a result of abundant supply and low prices, natural gas surpassed oil in the energy mix of the country, thus becoming the first primary energy source.

In all European OECD countries, the demand for natural gas fell to just over 0.5×10^{12} cm. in 2012- marking the second consecutive year of decline, down 10% compared to 2010) reaching 2003 levels. The situation is similar in the EU, mainly because of the weak economy and high gas prices, but also to a lesser degree, to a combination of low coal prices, the collapse in the price of CO₂ in the emissions market, the great expansion experienced by renewables and the implementation of cost saving measures and efficiency. In the New Policies Scenario, the IEA (IEA, WEO 2013) predicts that the demand in European OECD countries will recover very slowly, returning in 2025 to the levels of 2010, and then, in 2035, to slightly above 0.6×10^{12} cm.

Russia, the world's second largest consumer of gas, faces an uncertain future regarding its domestic demand resulting from structural inefficiencies and doubts about the speed and the direction in which the prices reform scenario will evolve. The "New Policies Scenario" predicts growth from just over 0.47×10^{12} m³ in 2011, to near the 0.54×10^{12} m³ in 2035.

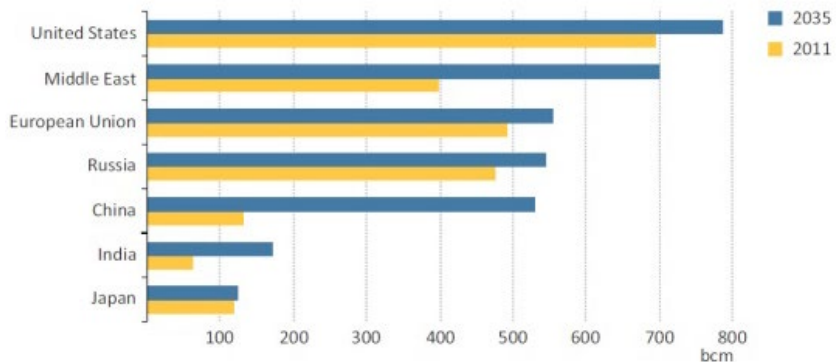


Figure 23. Development of demand naturally in some countries and regions during the period 2011-2035 period. Figures in billions of cubic meters (bcm) New Policies Scenario (IEA, WEO 2013).

According to the IEA (IEA, WEO 2013) China will be the country that will experience the greatest increase in the demand for gas, quadruplicating to spend 0.13×10^{12} cm in 2011 to 0.53×10^{12} cm in 2035, while the Middle East and India also experienced a significant increase, rising during the same period, from 0.4×10^{12} to 0.7×10^{12} cm. and 0.06×10^{12} cm to 0.17×10^{12} cm respectively. Interestingly (figure 23) shows that if the demand for these forecasts comes true then, in 2035, this will mean much higher demand in the Middle East than that of China and the whole of the European countries integrated into the OECD and the EU, ranking second place in the world rankings, just behind the U.S. In fact, the forecasts suggest that demand for gas in the Middle East will exceed the EU from 2020.

Electricity generation will be the main driver of gas consumption worldwide, although consumption trends will be very sensitive to the impact of the energy policies enacted by governments as well as the competitive pressure from coal and renewables. In the New Policies Scenario the use of gas for electricity generation grows at around 42% during the 2011-2035 period. This increase is especially noticeable in the Middle East (which doubles), China (where it multiplies by six) and India (where it is multiplied by more than three).

Balance between production and demand. Unconventional gas makes Australia and the USA and Canada net exporters. Imports are moving from the Atlantic basin (except Europe) towards the Asia-Pacific

The inter-regional natural gas trade has increased by 80% in the past two decades and in the New Policies Scenario the IEA (IEA, WEO 2013) projects that it will continue to grow, increasing by about 0.4×10^2 cubic meters (cm) during the 2011-2035 period, to achieve slightly less than 1.1×10^2 cm. in 2035 (table 10). This means that this is a very dynamic period in the international gas trade market, during which increasing relevance collected some new players, such as Australia, the USA, Canada and some countries of East Africa, which together posed a competitive challenge classical exporters like Russia and Qatar.

According to the IEA, during the 2011-2035 period, we will also see a continued shift in the direction of the international trade of natural gas importers whose focus will move from the Atlantic basin (with the notable exception of Europe that will remain the main importing region in the world) to the Asia-Pacific, which raised new dilemmas for farmers dependent on the Eurasian pipeline infrastructure to access markets. IEA also glimpsed signs that these terms that will govern international trade, particularly in the case of liquefied natural gas (LNG) will be much more sensitive to the conditions in the short-term market, with innovative pricing mechanisms and fewer destination clauses, which will favour the interconnections between different regional markets and that will facilitate worldwide changes in pricing mechanisms.

	2011		2020		2035	
	Trade (bcm)	Share of demand or output (%)*	Trade (bcm)	Share of demand or output (%)*	Trade (bcm)	Share of demand or output (%)*
OECD	-402	25%	-349	21%	-402	27%
Americas	-11	1%	43	4%	69	6%
United States	-47	7%	15	2%	48	6%
Europe	-248	47%	-288	56%	-390	87%
Asia Oceania	-143	71%	-105	52%	-81	40%
Japan	-117	97%	-117	108%	-123	125%
Non-OECD	415	19%	351	13%	407	12%
E. Europe/Eurasia	179	20%	179	20%	347	30%
Caspian	58	33%	76	37%	143	50%
Russia	197	29%	174	26%	263	33%
Asia	9	2%	-103	16%	-319	31%
China	-29	22%	-130	41%	-212	40%
India	-14	24%	-25	28%	-74	39%
Middle East	120	23%	119	19%	123	15%
Africa	89	44%	127	45%	224	52%
Latin America	19	11%	29	13%	32	10%
Brazil	-10	38%	-7	20%	2	2%
World**	685	20%	804	20%	1 092	22%
European Union	-308	63%	-360	77%	-450	107%

* Imports as a share of primary demand for importing countries; exports as a share of production (output) for exporting regions/countries. ** Total net exports for all WEO regions, not including trade within WEO regions. Notes: Positive numbers denote exports; negative numbers imports. The difference between OECD and non-OECD totals in 2011 is due to stock change and statistical discrepancies.

Table 10. Net trade in natural gas, pipeline and liquefied natural gas (LNG) by region. Figures in billions of cubic meters New Policies Scenario (IEA, WEO 2013).

Europe increases its dependence on imports

Despite a relatively modest increase in demand over the 2011-2035 period (see *The New Geography of demand. China and the Middle East are growing rapidly, although the U.S. will remain the largest market*, Table 9, European import requirements of natural gas are growing strongly Table 10, due to the generalised fall (except Norway) in production on the continent (see *in just over two decades unconventional gas could represent more than a quarter of the global production of natural gas*, Table 9. In the case of the European Union, the New Policies Scenario of the IEA (IEA, WEO 2013) provides that import requirements of gas increase of just over 0.3 x 10¹² cm in 2011 to 0.45 x 10¹² cm. in 2035 (Table 10, figure 24).

The IEA believes that Europe is well placed to ensure this supply from diverse backgrounds. In addition to the countries that supply the international market for liquefied natural gas (LNG), the suppliers include both some traditional exporters such as Norway (which in 2012, became the main supplier of natural gas to the EU), Russia and Algeria, as new ship-

pers looking to connect to Europe by pipeline, such as Azerbaijan and perhaps Iraq, through Turkey and the rest of south-eastern Europe, via the "southern corridor" (see *Transportation by watertight pipeline from Russia to Europe redirected to China. Azerbaijan and Turkmenistan take centre stage*).

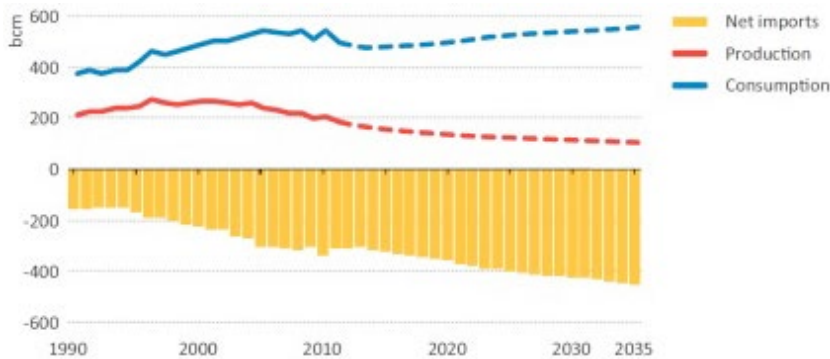


Figure 24. Balance of demand-production and net imports of natural gas into the European Union. Figures in billions of cubic meters (bcm). New Policies Scenario (IEA, WEO 2013).

The increased production in China and India is not enough to offset the increased demand

According to the IEA (WEO 2013), the Asia - Pacific region will be called upon in the next two decades, to undergo the most profound changes in the global natural gas markets, although the rate and extent of these changes are subject to a high degree of uncertainty. Apart from Japan and Korea, which can currently be considered to be mature markets, the IEA said that the region has great potential to increase its gas consumption, especially in those countries seeking to diversify their energy mix and address the issues of air quality and local pollution that are associated with coal combustion. However, the Asia - Pacific region is currently paying higher prices for internationally traded gas prices (a situation that according to forecasts by the IEA, shows few signs of changing in the future). This raises questions about its ability to purchase and whether it will be possible for the policy objectives to be imposed on economic factors, at least in some countries.

Japan, Korea and Taiwan, the traditional LNG importers in Asia, have been joined by China, India, Indonesia, Thailand and more recently, by Malaysia and Singapore. The IEA's forecasts suggest that increases in gas imports will be targeted at these new consumers, led by China (Table 10, figure 25), with certain import requirements that go from about 30.000 x 10⁶ cubic metres (cm) in 2011 to 212,000 x 10⁶ cm. in 2035, followed by India

during that particular period, which will increase its imports by 60,000 x 10⁶ cm. (Table 10). Part of these imports will be transported by pipeline to China, but most of it will be sent via tanker, as happens with LNG.

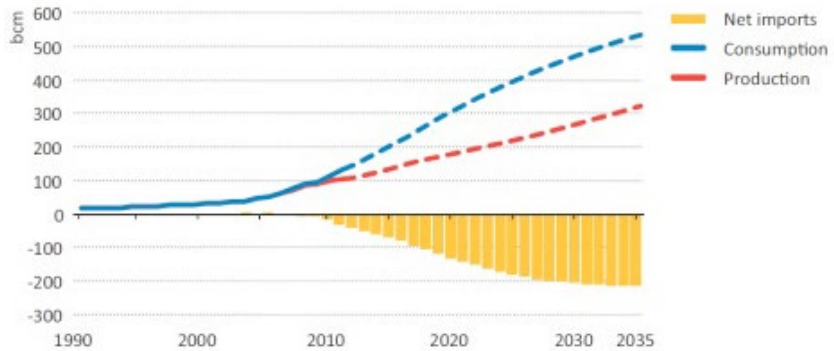


Figure 25. Balance-demand production and net imports of natural gas in China. Figures in billion cubic meters (bcm) New Policies Scenario (IEA, WEO 2013).

Transport by pipeline from Russia to Europe stagnates and it is to be redirected toward China. Azerbaijan and Turkmenistan take centre stage.

In the New Policies Scenario, the IEA (IEA, WEO 2013) thinks that the increase in the international trade in gas expected for the 2011 to 2035 period (close to 0,4 x 10¹² cubic meters, see Table 10), just under half of which will be shipped via pipeline. This flow will not be affected by the developments in producing unconventional gas that were commented on in "Production of natural gas between 2012 and 2035. The unconventional gas revolution expands beyond U.S. and Canada."

In the field of exports by gas pipeline, the IEA predicts that the major developments will be focused on Eurasia. For European markets, it is relevant to take note of the announcement made by the consortium involved in the second phase of development of the Shah Deniz field in Azerbaijan, as regards the chosen route to market. The preferred option is that after crossing Turkey via the "Trans-Anatolian Gas Pipeline" (or TANAP), the exports from Azerbaijan should be routed towards Greece and Albania, and then it will go to southern Italy via the "Trans-Adriatic Pipeline" (or TAP). It will have a possible diversion from Albania towards Montenegro, Bosnia, Herzegovina and Croatia. Once the pipeline has completed, by 2020, it is expected to channel a flow of close to 10.000 x 10⁶ cubic metres (cm) towards the south of Europe, with the possibility of this later on to be able to expand to the 20.000 x 10⁶ cm. per year. The opening of this "southern corridor" for the 2011-2035 period enables an expansion of the exports from Azerbaijan, whose production could increase from its

current 17.000 x 10⁶ cm. to 47.000 x 10⁶ cm. in 2035, and perhaps those from other countries, the most notable of which Iraq. The volumes channelled through the "southern corridor" are still very small compared to the European natural gas demand, but in any case, this is a step forward in the goal of the diversification and security of supply.

As regards the exports by pipeline from Russia, the IEA (IEA, WEO 2013) provides for the New Policies Scenario to increase only modestly during the 2011-2020 period, despite the potential increase in its export capacity which would result from the so-called "South Stream" and "North Stream" pipelines. The IEA believes that export growth via pipeline will be constrained by Russia's position with regard to the pricing mechanism in Europe, as the stubborn defence of a price indexed to oil could mean a loss of its market for Russia. However, from 2020 onwards and up to 2035, the IEA predicted a further expansion of Russian exports by pipeline, to the extent that trade changes orientation in this easterly direction and new connections between the gas fields of Eastern Siberia and China are opened up.

The latter, could also increase its imports via pipeline from Central Asia, where the current connection with Turkmenistan could be expanded to reach an annual capacity that is close to 60.000 x 10⁶ cm and from Myanmar, a country with which China inaugurated a connection with an approximate capacity of 12.000 x 10⁶ cm. per year in 2013.

The trade in liquefied natural gas (LNG) is reorganized due to the increasing domestic consumption in the Middle East and the emergence of new sources of supply from Australia, U.S. and Canada.

The IEA (IEA, WEO 2013) found that while the natural gas trade by pipeline will still be dominated by a few producers, located mainly in Eurasia (see preceding paragraph), the group of LNG exporting countries will undergo a major reorganization.

According to the IEA, some existing LNG exporters are already experiencing rapid growth in their domestic demand, which places limits on the annual turnover that they have available for exports. This trend is particularly noticeable in the Middle East, where Oman, the United Arab Emirates and Abu Dhabi could leave the ranks of LNG exporters, so that by 2020 there would only be Qatar and Yemen left, which could perhaps be joined by Iraq). Other countries that, for the same reason, may no longer be exporters are Egypt and Trinidad and Tobago.

Conversely, the market will see new players emerge and some of the existing ones will increase their market share. According to the IEA, globally, there are currently twelve LNG export plants under construction with a combined capacity of close to 130.000 x 10⁶ cubic meters (cm) per year.

The plans are that this new capability will be ready for operation between 2015 and 2018, although the final date is highly conditional on what happens in Australia where seven of the twelve terminals mentioned and construction projects are located and these have been subject to delays and significant increases in costs.

Besides Australia, the new source of supply of LNG could be North America. According to the projections made by the IEA (IEA, WEO 2013), in the U.S. production is being called on to exceed domestic consumption, so that by 2035, the net exports from this country would reach almost 50.000 x 10⁶ cm (table 10). If we add to these volumes, the ones that come from Canada, this would mean that North America would be in a position to export a volume of LNG that will be close to 50.000 x 10⁶ cm. in 2020 and 75.000 x 10⁶ cm. in 2035. In any event, the IEA noted that these projections are very sensitive to small changes in the forecasts of production and demand, so that small changes in these could have a major impact on the final balance of trade.

Along with the increase in exports of LNG from Australia and North America, the IEA projections included several new projects in East Africa, as well as expansions in capacity in some of the existing LNG exporters, among which Russia is included. The expansion of capacity in the latter country could have a special meaning if, as seems possible, the Rosneft and Novatek companies manage to get the rights to export LNG to Asian markets assured. This would constitute the first breach in the export monopoly that Gazprom has. During the 2011-2035 period, the IEA assumes the largest LNG import prices will be in the markets of the Asia-Pacific region, so this would be the most sought-after destination for most of the exporters of LNG, which would leave Europe in the role of the region that acts as the market balance.

Conclusions

Key conclusions regarding unconventional oil

- I. At the end of 2011- excluding liquid fuels derived from coal and natural gas (CTL and GTL) - the estimates of the reserves and recoverable resources of unconventional oil that are available globally slightly exceeded the volume of conventional oil reserves and resources.
- II. Without counting CTL and GTL resources, the industrialized OECD countries, only hold 15.6% of the technically recoverable oil and natural gas liquid global resources, which contain 62% of non-conventional oil resources. In late 2011, these were preferably located in North America, Eastern Europe, Eurasia and Latin America, counteracting the geopolitical importance of the

Middle East. This is a region that accounts for 42% of the reserves and resources of conventional oil. In any case, it should be noted that the potential of the conventional resources of the latter region remains unexplored.

- III. During the 2012-2035 period, the share of total conventional crude oil production is to fall from 80% to 65%. Therefore, the increase in the level of production needed to meet the demand must come from other sources. These, along with natural gas liquids, include unconventional oil, whose contribution could multiply threefold in that period. These mainly come from the unconventional supplies of light tight oil in the U.S., the oil sands of Canada and the extra-heavy oil of Venezuela.
- IV. The oil production levels of all of the countries outside OPEC will be maintained until approximately 2020, which represents an upward trend. Both the production of conventional oil as well as unconventional oil will increase, but the first peaks shortly before 2020. But then a few years later, these will decline in such a way that even the increased production in unconventional oil will fail to reverse the downward trend. The total oil production between 2012 and 2035 will fall in most of the countries outside OPEC, with the exception of Brazil, Canada, Kazakhstan and the U.S., although the latter's production level will go into decline before 2035.
- V. From the mid-twenties onwards, OPEC will again occupy a key position in the global oil supply. From that date until 2035, light tight oil production in the ultra-deep waters of Brazil and the U.S. will lose steam, the countries of the Middle East will assert themselves as the only source of relatively cheap oil in the world and Iraq will be developed on the largest contributor to overall production output growth.
- VI. With regard to both conventional and unconventional oil, the balance of production during the 2012-2035 period, is clearly favourable to Iraq, Brazil, Canada, Kazakhstan and the U.S., while Russia, China, Norway, UK, Oman and Azerbaijan would be found at the opposite end, followed distantly by Argentina and Kuwait. Moreover, Venezuela, Qatar, Saudi Arabia and the United Arab Emirates would remain in a position of equilibrium position.
- VII. In 2035, the percentage share of OECD countries in terms of global oil demand will fall to about 32%, as compared to 46.6% in 2012. In China, however, oil use has been increasing rapidly, so that, from 2030 onwards, that country will displace the U.S. as the main global consumer. India will also

have emerged as a key centre for oil consumption, especially between 2020 and 2035, during which the country will experience the highest growth in global demand. Another relevant issue is that the Middle East will become the third largest centre of oil demand.

- VIII. In the next two decades, the changing geography of the production and consumption of oil will lead to a major reorganization of global trade. The fate of the oil flow moves from the OECD area, where Europe will remain as the sole importer market, to Asia. In 2035 the world's two largest oil importers will be China and India, while the percentage of U.S. involvement in inter-regional trade in crude will decline from the 27% now to 15%. This reorganization of trade flows will require a re-assessment of the security policies for the oil supply. The big Asian countries should engage more in preventing and managing the effects of any potential disruptions in global crude supplies.

Key conclusions relating to unconventional gas

- I. Regardless of gas hydrates, it is estimated that the reserves and recoverable resources of unconventional gas are equivalent to about three quarters of that of conventional gas. In late 2012, shale gas was representing approximately 61.8% of the total technically recoverable unconventional resources pending of exploitation, as compared to 23.6% for tight gas and 14.6% for coal-bed methane.
- II. Approximately 27.7% of unconventional gas resources are located in the Asia-Pacific region, 19.2% in the U.S. and Canada, 16% in Latin America, 13.4% in Eastern Europe, Eurasia, 14.2% in Africa, 5.5% in European countries integrated into the OECD, and only 3.8 % in the Middle East. This distribution helps to balance out the excessive concentration of conventional reserves and resources in the Eastern Europe-Eurasia region (mainly in Russia) and the Middle East, which accounted, respectively, about 30.6% and 26.5% of the reserves and technically recoverable resources of conventional natural gas in the world. However, the volume of unconventional gas resources in the Middle East has not yet been evaluated.
- III. Between 2011 and 2035 natural gas production will grow in all regions, with the exception of Europe, where the increase in production in Norway will not be enough to offset the decline in other mature fields. China, USA, Russia and Australia (in that

order), followed by Qatar, Iraq, Brazil, Turkmenistan, Iran and Algeria, are the countries will experience a greater increase in their production levels. Although the U.S. and Australia accounted for significant increases in production thanks to their unconventional gas resources, with both of them becoming net exporters. Thus, the countries outside the OECD would be responsible for about 81.75% of production growth.

- IV. Regarding the increase in natural gas production that is expected in the world between 2011 and 2035, 52% would be contributed by unconventional gas while the remaining 48% would come from conventional sources. The forecasts are that from 2020 onwards, the development of unconventional gas production extends beyond North America (U.S. and Canada), turning China and Australia into the largest contributors to global output growth followed by other countries such as Argentina, India, Algeria, Mexico and Indonesia and the European Union, which is placed slightly above the latter three countries. Unconventional gas, which in 2011 accounted for about 17% of total world production of natural gas, could reach 27% in 2035.
- V. The natural gas markets between 2011 and 2035 that will experience the fastest growth rates are located outside the OECD. Countries outside the organization will be responsible for over three quarters of the growth in demand during that period, with the highest growth in absolute terms being focused on China and the Middle East. In the OECD countries, although consumption will increase, the growth rates will be lower due to market saturation and the effects of the penetration of renewables in the electricity sector in Europe. However, the OECD markets will remain comparatively large, so that, for example, in 2035, demand in the U.S., -which continue to be the world's largest consumer- will be 50% higher than that of China.
- VI. The inter-regional natural gas trade will continue to grow over the 2011-2035 period. During that period, on the basis of the exploitation of unconventional resources, some new exporters such as Australia, USA and Canada will take on greater relevance, and these will pose a certain degree of competitive challenge to the classical exporters like Russia and Qatar. During the 2011-2035 period, we will also see a continued shift in the direction of international trade in natural gas. The importer focus of this will move from the Atlantic basin (with the notable exception of Europe, which will remain the main importing region in the world) to the Asia-Pacific region.

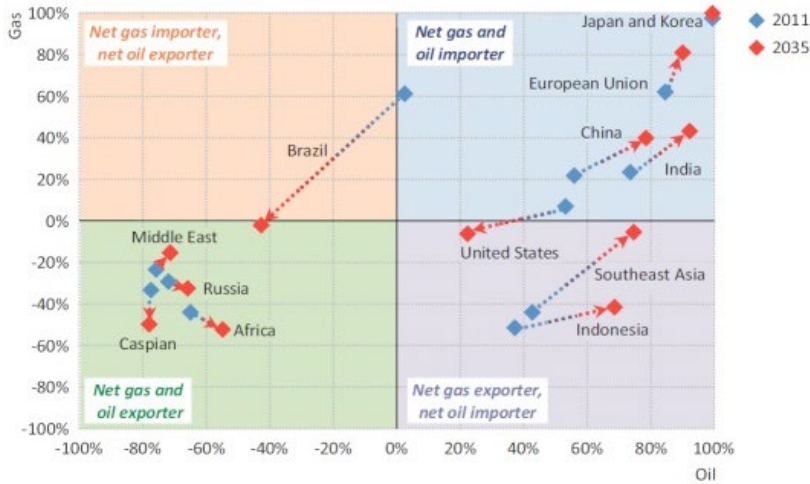
- VII. The increase in international trade in gas that is expected for the period 2011-2035 period will see just under half of it carried out via pipeline. This flow will not be substantially affected by advances in the production of unconventional gas and the major developments there will focus on Eurasia.
- VIII. While the trade in natural gas via pipeline will continue to dominated by a few producers, located mainly in Eurasia (Russia, Azerbaijan and Turkmenistan), the group of exporting liquefied natural gas (LNG) will undergo a major reorganization. Some of the current LNG exporters are already experiencing some rapid growth in their domestic demand which sets limits on the volume they have that is available for export. This trend is evident in the Middle East, so that by 2020, only Qatar and Yemen (which could perhaps be joined by Iraq), will remain as exporters Other countries which, for the same reason, may no longer be exporters are Egypt and Trinidad and Tobago. Moreover, the market will see the emergence of new players, among them Australia, the USA and Canada, as the major producers of unconventional gas. Likewise, Russia could expand its share of the market, targeting leading LNG exports to Asia.

A final thought. Unconventional hydrocarbons and energy dependence: The divergent paths of the U.S. and Europe

Future changes in the New Policies Scenario of the IEA (IEA, WEO 2013) about the exports-imports balance of oil and gas in various countries and regions during the 2011-2035 period are summarized in Figure 26.

It clearly follows from this that one of the consequences of the rise of oil and unconventional gas in the U.S. is that during the period referred to, this country could achieve self-sufficiency and become a net exporter of gas, while potentially reducing its dependence on oil imports to 20% of its total consumption. This is completely opposite to the trend of other countries and regions, with the exception of Brazil, which is also experiencing a net positive development that is based on the exploitation of unconventional hydrocarbon resources.

In contrast to the United States, the European Union is undergoing particularly negative development, as its dependence on gas imports will increase from 60% in 2011 to 80% in 2035, while the dependence on oil imports during the same evolutionary period will go up from 80% to nearly 90%. Apart from the implications for the security of supply, these data imply an energy price in the European Union that is much more expensive. This undoubtedly will be a heavy burden for the competitiveness of their industries and a serious loss of purchasing power of their citizens.



Notes: Import shares for each fuel are calculated as net imports divided by primary demand. Export shares are calculated as net exports divided by production. A negative number indicates net exports. Southeast Asia, i.e. the ASEAN region, includes Indonesia.

Figure 26. Evolution over the 2011-2035 period in the percentages of net exports and net imports of oil and gas in some countries and regions. New Policies Scenario (IEA, WEO 2013).

China and India and other Asian countries and regions show something similar to the trend of the European Union in their degree of dependence on imported oil, although theirs is less dramatic, while the large conventional hydrocarbons producing countries of the Middle East, Russia, Africa and the Caspian region, barely vary their places.

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The rise of china and its energy supply

Ignacio García Sánchez

Chapter V

Abstract

This chapter aims to go into one of the events with most geostrategic significance of the first half of this century that undoubtedly will shape the geopolitical future of its second half.

The international community follows and discusses in detail the plans and actions of the Chinese authorities to solve the “energy trilemma: ensuring competitive energy supply, while providing universal access to energy and promoting environmental protection”, with a clearly marked target, “the Chinese dream”, the socio-economic welfare to the medium-level developed countries in 2049, the centenary of the foundation of the People’s Republic of China.

To achieve it, the Chinese government faces two basic challenges, economic continuous development and social unrest by environmental degradation. Both have a common element, energy supply, thus becomes a key factor for the survival of the one party model, the Chinese Communist Party that requires the stability of an international scenario that must adapt and accept, peacefully, the appearance, to stay, of the new geopolitical giant.

This work intends to analyse this exciting geostrategic challenge, recognizing the limitations of space and time, but hoping to put into the geo-

litical discussion one of those major events “bearers of the future” for the international relations.

Keywords

China, Energy, Geopolitical, Geostrategic, Development, Climate Change, Technology, Conflict.

The rise of china and its energy supply

"...Prudence and patience are part of China's imperial DNA. But China is also ambitious, proud, and conscious that its unique history is but a prologue to its destiny. No wonder then that in a burst of candour an astute Chinese public figure, who obviously had concluded that America's decline and China's rise were both inevitable, not long ago soberly noted to a visiting American: "But, please, let America not decline too quickly..."¹

Introduction

"Today, power in the world is distributed in a pattern that resembles a complex three-dimensional chess game. On the top chess-board, military power is largely unipolar and the United States is likely to remain supreme for some time. But on the middle chess-board, economic power has been multipolar for more than a decade, with the United States, Europe, Japan, and China as the major players, and with others gaining in importance... The bottom chessboard is the realm of transnational relations that cross borders outside of government control, and it includes non-state actors... This chessboard also includes new transnational challenges such as pandemics and climate change. On this bottom board, power is widely diffused, and it makes no sense to speak here of unipolarity, multipolarity, hegemony, or any other such clichés that political leaders and pundits put in their speeches.

Two great power shifts are occurring in this century: a power transition among states and a power diffusion away from all states to non-state actors... successful economic performance such as that of China can produce both the hard power of sanctions and restricted market access and the soft power of attraction and emulation of success."²

China, without any doubt, has become the fundamental geo-strategic factor for understanding the geo-political framework of the first half of the 21st Century. The policies of the Asiatic giant attract the immediate attention of all chancelleries, international organisations and the media in all social spheres. At the same time, as official statistics and estimates of all kinds are analysed down to the tiniest detail, a dilemma is made clear, which will accompany us throughout this chapter, the transparency

¹ ZBIGNIEW, Brzezinski. "Strategic Vision. America and the Crisis of Global Power". 2012. Basic Books. New York. Page 81

² NYE Jr, Joseph S, (2011). "The future of power". New York, United States by Public Affairs. Pages: XV&22. Professor Nye has coined the terms: "soft", "hard" and "smart power."

and reliability of data which aim to show an unstoppable rise, and which project harmonious development in a stable and peaceful environment.

A progress which began with the reformist policies of Deng Xiaoping in 1979, making a break with the revolutionary dynamic and the economic stagnation imposed by Mao Zedong from the triumph of the Communist Party and the consequent creation of the People's Republic of China in 1949. Deng Xiaoping began the path to growth of Chinese society on a social base which was traumatised due to the successive revolutionary policies designed by the "great helmsman" in his obsessive search for revolutionary purity. The historical intersection of a people in continuous revolutionary tension with a highly ambitious, centralised and firmly directed economic liberalisation is benefitting from a great window of opportunity. The evolution of the western economies towards service and consumer societies which leave a large scope of action to the industrial development of a society which is hungry for progress, in a unique symbiosis, which even today surprises political and economic analysts due to its intensity and duration.

But, as Marta Camacho Parejo³ rightly points out: "*the protagonist of the progress, development and growth of our societies, from both an industrial and social point of view, is energy, which acts as an element of centrality.*"

In the above-mentioned document, a synthesis is made of the studies which the World Energy Council has been publishing since 2008 and which have been known since 2012 as:

*"...the energy trilemma... [referring] to the complicated objectives which face governments to ensure competitive energy supply, encouraging in turn universal access to energy and promoting environmental protection. It therefore deals with three fundamental aspects of energy: security of supply, social equity and the mitigation of the environmental impact."*⁴

³ CAMACHO PAREJO, Marta. Secretary General of the Spanish Committee of the World Energy Council. "*El Trilema energético*". Offprint of no. 38 of the Energy Notebooks. 2012. Spanish Energy Club. Spanish Energy Institute.

⁴ Ibid., page xx.

- *Energy security: understood as the effective management of energy supply from national and external sources (both for net importers and exporters of energy), reliability of the energy infrastructure and the capacity of energy firms to satisfy current and future demand (for countries that are net exporters of energy, this also refers to the ability to maintain income from the markets for foreign sales);*
- *Social justice: which refers to the accessibility and attainability of energy supply for the whole of the population;*
- *Mitigation of environmental impact: energy efficiency and saving (from the point of view of both supply and demand) and development of the supply of renewable energies and other low-carbon sources.*

Into this context, the geopolitical reality of China (see table 5.1)⁵ shows a country whose energy consumption per capita is today similar to that of the United States in 1955. A reference which brings us to a geo-strategic vacuum to be developed, full of unimaginable possibilities which leave all institutions in suspense as they try, as Adam Siemininski⁶ recently said, “to accommodate” China’s energy growth without generating geo-political frictions which could lead to crises, in which the realist tendencies of a “zero sum” scenario predominate.

		MUNDIAL	CHINA	UE	EEUU	RUSIA
Area km ²		Area km ²	9.396.861 (48)	4.324.782 (78)	9.826.673 (38)	17.098.242 (18)
GDP (PPP)		GDP (PPP)	12.618 \$ (38)	15.978 \$ (18)	15.948 \$ (28)	2.333 \$ (78)
Agriculture		Agriculture	10,1%	1,8%	1,1%	4,2%
Industry		Industry	43,8%	23,8%	19,2%	37,3%
Services		Services	44,6%	72,9%	79,7%	58,3%
GDP - per capita -		GDP - per capita -	9.300\$ (1228)	35.100\$ (408)	30.700\$ (138)	18.000\$ (788)
GDP - real growth		GDP - real growth	7,8% (238)	-0,8% (1828)	2,2% (1188)	3,4% (1008)
Population - growth		Population - growth	1.349.383.838-12	309.365.627-38	316.668.967-48	142.900.482-108
			0,46%	0,21%	0,9%	-0,02%
Age structure:	0-14	26,0%	13,0%	15,41%	20,0%	16,0%
	15-55	57,4%	66,3%	53,70%	53,8%	57,4%
	55-OVER	16,6%	20,7%	30,89%	26,2%	26,6%
Urban population - growth		Urban population - growth	30,6%-2,85%	76%-0,74% ¹	82%-1,2%	73,8%-0,13%
GINI index		GINI index	47,4 (298)	30,7 (1128)	45 (418)	41,7 (328)
Life expectancy		Life expectancy	74,99 (1008)	79,86 (378)	78,62 (318)	69,83 (1528)
Internet users		Internet users	389M (18)	340 (28)	243M (38)	40,83M (108)
Mobile cellular		Mobile cellular	1.100M (18)	629M (28)	310M (38)	261,9M (38)
Poverty line		Poverty line	13,4% ²	0,7%-2,4% ⁴	1,3,1%	12,7%
Military: % PIB		Military: % PIB	2,6 (498)	1,6 (888) ²	4,6 (198)	3,9 (238)

Table 5.1

The new geo-strategic atmosphere, dominated by a scenario which Joseph Nye presents as a three-dimensional chessboard⁷, offers a unique opportunity to “accommodate” that potential growth, in such a manner that the second half of the 21st Century evolves in a gradual and progressive manner from a geo-strategic environment dominated by cooperative security towards an comprehensive vision of the reality and smart management of the environment via the concept of dynamic security (see figure 5.1)⁸, necessary for with the adaptation to the speed imposed by the information society in which we live, into a reality in constant change in which the objective is to achieve a set of geo-strategic pattern in line with the idealist “win-win” game.

⁵ Prepared by ourselves. Translation by the author. Information from: “The World Factbook”: <https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html>

⁶ Administrator of the U.S. Energy Information Administration (EIA). Presentation from “EIA. International Energy Outlook 2013”.

⁷ See the quotation which introduces the first point.

⁸ Prepared by the author



Figure 5.1

A scenario in which the winner is sustainable human development (see figure 5.2), which, as was indicated by the Secretary General of the United Nations in 2012, the year of sustainable energy⁹ requires the international commitment of governments, civil society and the private sector to achieve: “Sustainable Energy for All by 2030... energy that is accessible, cleaner and more efficient... and paves a path out of poverty to greater prosperity for all”. According to the document:

“The historic energy transitions – first from human power to animal power, and then from animal power to mechanical power – were major shifts in the human journey toward greater productivity, prosperity, and comfort. It is unimaginable that today’s economies could function without electricity and other modern energy services. From job creation to economic development, from security concerns to the status of women, energy lies at the heart of all countries’ core interests... Countries

⁹ UN Sustainable Energy for all, <http://www.sustainableenergyforall.org/>. Fact Sheet: *The world currently invests more than \$1 trillion per year in energy, much of it going toward the energy systems of the past instead of building the clean energy economies of the future [while one-fifth of humanity currently lacks access to electricity]. The Secretary-General’s Sustainable Energy for All Initiative [2030] has three complementary objectives:*

- Ensuring universal access to modern energy services.
- Doubling the global rate of improvement in energy efficiency.
- Doubling the share of renewable energy in the global energy mix.

such as China, India, Nepal, Brazil, and South Africa are also leading the way with national initiatives".¹⁰



Figure 5.2

China in the global energy scenario

*"... the overriding reality... in Madeleine Albright's description that China is in its own category, too big to ignore, too repressive to embrace, difficult to influence, and very, very proud."*¹¹

Energy security is a global issue. Few countries can secure their energy supply without international cooperation. The achievements of China in energy development are inseparable from its friendly cooperation with other countries. Its future development in the energy sector will need more understanding and support from the international community. China, with a population of more than one billion, is exploring and practicing a new way in the history of energy development to ensure its

¹⁰ For a complete and systematic panorama of the most important data of the imbalances in access to energy in the world see: A Vision Statement by Ban Ki-moon, Secretary-General of the United Nations. "Sustainable energy for all". November 2011. Facts

¹¹ KISSINGER, Henry (2011). "On China". New York, the Penguin Press. Page 477.

*sustainable energy development. China did not, does not and will not pose any threat to the world's energy security. Abiding by the principle of equality, reciprocity and mutual benefit, it will further strengthen its cooperation with other energy producing and consuming countries as well as international energy organizations, and work together with them to promote a sustainable energy development around the world. It will strive to maintain stability of the international energy market and energy prices, secure the international energy transportation routes, and make due contributions to safeguarding international energy security and addressing global climate change.*¹²

It seems that the crossroads of destiny again favours the sustainable growth, of Chinese economy. In the latest reports of the International Monetary Fund, the great recession in the developed world appears to be starting to recede, with practically imperceptible, but much more stable and balanced, growth taking its path for the future (see table 5.2)¹³.

	2011	2012	Projections	
			2013	2014
World Output¹	4.0	3.2	3.3	4.0
Advanced Economies	1.6	1.2	1.2	2.2
United States	1.8	2.2	1.9	3.0
Euro Area	1.4	-0.6	-0.3	1.1
Germany	3.1	0.9	0.6	1.5
France	1.7	0.0	-0.1	0.9
Italy	0.4	-2.4	-1.5	0.5
Spain	0.4	-1.4	-1.6	0.7
Japan	-0.6	2.0	1.6	1.4
United Kingdom	0.9	0.2	0.7	1.5
Canada	2.6	1.8	1.5	2.4
Other Advanced Economies ²	3.3	1.8	2.5	3.4
Emerging Market and Developing Economies³	6.4	5.1	5.3	5.7
Central and Eastern Europe	5.2	1.6	2.2	2.8
Commonwealth of Independent States	4.8	3.4	3.4	4.0
Russia	4.3	3.4	3.4	3.8
Excluding Russia	6.1	3.3	3.5	4.6
Developing Asia	8.1	6.6	7.1	7.3
China	9.3	7.8	8.0	8.2
India	7.7	4.0	5.7	6.2
ASEAN-5 ⁴	4.5	6.1	5.9	5.5
Latin America and the Caribbean	4.6	3.0	3.4	3.9
Brazil	2.7	0.9	3.0	4.0
Mexico	3.9	3.9	3.4	3.4
Middle East, North Africa, Afghanistan, and Pakistan	3.9	4.7	3.1	3.7
Sub-Saharan Africa ⁵	5.3	4.8	5.6	6.1
South Africa	3.5	2.5	2.8	3.3

Table 5.2

In this scenario, China manages to restrain the accelerated growth of its economy, based on investment and exports with low productivity, in

¹² White Paper: "China's Energy Policy 2012". October 2012, Beijing. State Council

¹³ IMF. World Economic Outlook, April 2013. Hopes, realities and risks.

which the only sector open to investment for the incipient middle class is the real estate and where private property rights in land are subject to the discretion of local government. At the same time that global perspectives support China's adaptation to a more balanced desirable scenario, in which internal consumption, services and private and foreign investment in sectors considered strategic up to now, and therefore only open to state-owned companies, make it possible to advance towards the "Chinese dream". Xi Jinping has created from the vision¹⁴ of a renewed Chinese society, structured and supported by an ever more prosperous, educated and demanding middle class.

In the search for that scenario, China is facing its unquestionable reality.

"If the latest strategies of national security have included the economic dimension as one of their essential elements, in the Chinese case, the model of development features as the fundamental element of its national security. In this regard, it roundly declares that it is a demand of its citizens and a need which all countries must support. The strategy declares that the planned objectives have been achieved in their first two stages: doubling 1980's Gross Domestic Product (GDP) to attend to the basic needs of the population and increasing it fourfold at the end of the last century so as to achieve a basic level of prosperity. The third objective, which is set for the middle of the century, on the centenary of the foundation of the People's Republic of China (1949), would be the achievement through general prosperity and the modernization of the country of a harmonious State.

In this regard, China declares itself as a developing country and describes the base from which it is starting, both from the internal point of view and in its international relations.

From the internal point of view, it considers the objective titanic, bearing in mind the basic national conditions, which the document defines as a numerous population with a weak economic base: 20% of the world population, 7.9% of the agricultural land and 6.5% of the drinking

¹⁴ "It is our mission to fulfil the desire of [our people] for a happy life. It is only hard work that creates all the happiness in the world. In order to fulfil our responsibility, we will rally and lead the whole Party and the people of all ethnic groups in China in making continued efforts to free up our minds...and unwaveringly pursue common prosperity... our Party also faces many severe challenges, and there are also many pressing problems within the Party that need to be resolved, particularly corruption, being divorced from the people, going through formalities and bureaucracy caused by some Party officials..." Xi Jinping remarks on the Occasion of Meeting with the Chinese and Foreign Press by Members of the Standing Committee of the Political Bureau of the Eighteenth Central Committee of the Communist Party of China. http://www.china.org.cn/china/18th_cpc_congress/2012-11/16/content_27130032.htm Visited on 16th August 2013. Author's translation.

water... emphasizing the grave imbalances, the structural problems, the excessive dependency and vulnerability of the import of resources, and environmental problems.”¹⁵

In this context of sustainable economic development, energy becomes the backbone of growth, the vital blood flow of a body which has to grow continuously and balanced, facing a radically new scenario (see figure 5.3). An energy framework which, in the Asia-Pacific region, initially and very synthetically, could be considered as being made up of isolated energy islands without the vital characteristic of the porosity of a regional market, which is transformed by the amazing growth of the Asian giant and Japan’s new energy mix.

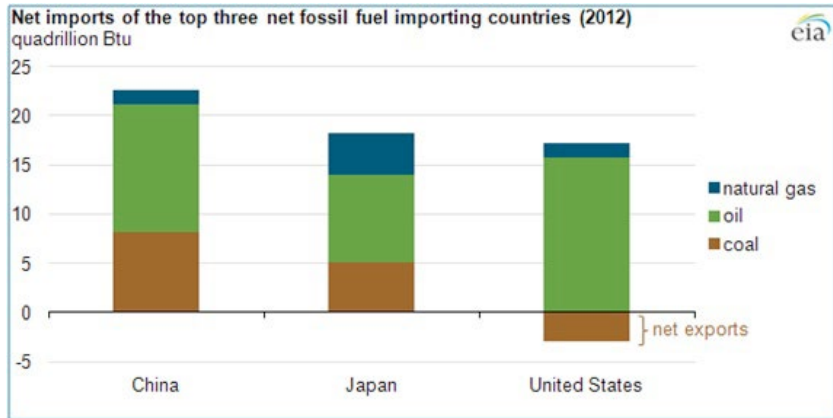


Figure 5.3

China gives the Asian market a continental character, in some ways with the same role that Europe plays in the Atlantic area, diversifying and strengthening its, main sources of energy consumption, Japan, South Korea and Taiwan. At the same time, and with a global nature, the Asian market is shaped just like the European and American ones, with a clear tendency to surpass both of them in their supply needs. Furthermore, and as a consequence of the accident at the Fukushima nuclear power station and the consequent halting of nuclear activity, the regional capacity to act in an autonomous manner is clearly weakened, changing radically the energy nature of the region, from being considered extreme, isolated and independent to becoming the center of gravity in the global energy scenario.

¹⁵ GARCÍA SÁNCHEZ, Ignacio. Analysis document of the ieee.es 028/11. "Análisis de Estrategia China de Seguridad". Review of ieee.es, "White Paper: China's peaceful development". September 2011.

China's energy voracity. Asia: the market of the future

"We do have certain assumptions on how the Emission Trade System are introduced... interesting India is one of the few countries that doesn't have to reduce emissions from now and 2017, in fact Indian emissions are allowed to grow 35%. So it is different situation... there are differences between the countries and the other countries are so small compare to China, China is really where we have to concentrate, just because the share of number of people, the share volume of its growth... China's emissions needs to fall by a half. They need to be cut half... if it doesn't happen it is no way we can reach the 2° Celsius scenario. No way we can make it, we are in trouble..."¹⁶

During the last three decades, the Chinese economy has grown at an average rate of 9.9%, and has since 2010 exceeded the GDP of Japan to become the third economic power in the world behind the European Union and the United States. Although this growth, once distributed among the population, \$9,300, keeps it at a discreet position, 122nd, in the country comparison ranking. Still a long way from the \$50,700 of the United States (14th), the \$30,500 of the EU (41st) and slightly below the world average of \$12,700. But this amazing growth, which has allowed to take out of poverty over 650 million people¹⁷, has been achieved by paying a high price in terms of excessive consumption of energy resources, basically fossil fuels, and therefore warning levels of contamination.

The current figures speak for themselves, but the forecasts are even more amazing. 2018 and 2020 will be significant years in terms of socio-economic development, according to the forecasts of growth with an annual average rate of 5.4%, as the per capita income would respectively exceed: the critical level of development of the democracies, \$12,000; and the average world per capita income, \$13,624 in China vis-à-vis \$13,065 as the world average¹⁸.

¹⁶ 17 July 2012. The CSIS Energy and National Security Program hosted Ambassador Richard H. Jones, Deputy Executive Director and Dr. Markus Wrake, Senior Energy Analyst and ETP Project Lead, International Energy Agency (IEA) to present the IEA's Energy Technology Perspectives 2012.

Energy Technology Perspectives 2012 (ETP 2012) looks at how technologies-- from electric vehicles to smart grids-- can make a decisive difference in achieving the objective of limiting the global temperature rise to 2°C and enhancing energy security.

¹⁷ In accordance with the data from table 5.1, the official number of Chinese citizens living in poverty, 13.4%, amounts to over 180 million people.

¹⁸ Reference scenario of

<http://www.eia.gov/oiaf/aeo/tablebrowser/#release=IEO2013&subject=0-IEO2013&table=42-IEO2013®ion=0-0&cases=Reference-d041117>, visited on 6th November 2013.

At nearly 5 trillion¹⁹ kWh, China is the world's largest producer and consumer of electrical energy²⁰, with the US in second position at a little more than four trillion kWh and the EU in third place with three trillion kWh.

China is the world's largest energy consumer with 115,500 trillion Btu²¹, 21.3% of the world total of 540,400 trillion btu, approximately equal to the consumption of all the OECD countries in America²², and way ahead of European consumption and the total of all other Asiatic powers. The problem is that in this consumption, the most important single source is coal, at 79,200 trillion btu, approximately equal to half of world consumption²³ and growing at a faster rate, 1.9% and 1.3% respectively, with the result that by 2040 it might have grown to reach 121,500 trillion btu (55.35% of the world total).

In 2013, a consumption of 11 million barrels of liquid fossil fuels a day is estimated, behind the 14 Mbl of Europe and 18 Mbl of the US, although with an annual average increase of 2.5%, it is expected that it will surpass the US in 2040, when China will become the world's largest consumer at 20 million barrels a day, which represents 17.4% of world consumption as opposed to 11% today.

One of the great weaknesses of Chinese energy consumption is natural gas. At 4.7 trillion cubic feet (4% of world consumption) it is at the level of Japan but far below Europe and the US, at 19.6 Tcf and 25.3 Tcf respectively. However, the interest of the Chinese authorities and the enormous potential growth, of up to 5.3%, above all talking into account the potential for unconventional gas use, would make it possible by 2040 to reach 17.5 Tcf (9.5%), which would still be below Europe's 24.5 Tcf and the 29.5 Tcf of the US.

China's great strengths, taking into account the serious environmental problem, are in the consumption of clean energy sources, such as hydro-electric energy and renewable energies, which amount to a total of 9.7 quintillion Btu²⁴ (15.5% of world consumption), above the 7.8 quintillion btu of the US and below the 11.9 quintillion btu of Europe. Furthermore, boosted by the 12th Five-Year Plan covering the period 2011-2015, China's renewables growth is greater than that for other countries

¹⁹ A trillion is one thousand billion, expressed as one followed by twelve zeros

²⁰ That of electrical energy is obtained from: 69.5% fossil fuels, 1.1% nuclear, 21.8% from hydro-electric plants and 7.6% from renewable sources.
<https://www.cia.gov/library/publications/the-world-factbook/geos/ch.html>, visited on 6th November 2013.

²¹ BTU: British Thermal Unit

²² Canada, United States, Mexico and Chile

²³ World consumption is 154,000 billion btu. (The figure expected for 2040 by the EIA of the US is 219,500 billion btu, with an average growth of 1.3%)

²⁴ Quintillion: one million of trillions, expressed with 1 followed by 18 zeros

at a 4% annual average, which would lead it to equal Europe in 2016 to achieve 26.2 trillion btu in 2040, 22% of the world consumption. Also, with the aim of reducing the CO₂ footprint, nuclear energy is one of the sources of energy with the greatest growth. At 190,000 million kWh, 7.3% of world consumption, its growth, at an annual rate of 10.2%, would lead it in 2040 to be the world's largest consumer of nuclear energy, with 1.289 billion kWh, almost a quarter, 23.5%, of world consumption.

Despite the great effort in renewables and energy efficiency, which would lead it to reduce its energy intensity at an annual average rate of -2.9 %, above the estimated world annual rate of -2%, the CO₂ emissions will continue to grow at an annual rate of 2.3 %, greater than the annual average of 1.3 %, essentially driven by the sustained growth that would lead in 2040 to a China's per capita income of \$35,573, with an estimated world average of \$23,330 and emissions of 14,911 million tons, one third, 32.8 %, of the world total.

China's economic development generates a dynamic growth in the entire Asia-Pacific area, which is global, reaching, the majority of the economies of sub-Saharan Africa and many Latin American countries (see figure 5.4)²⁵.

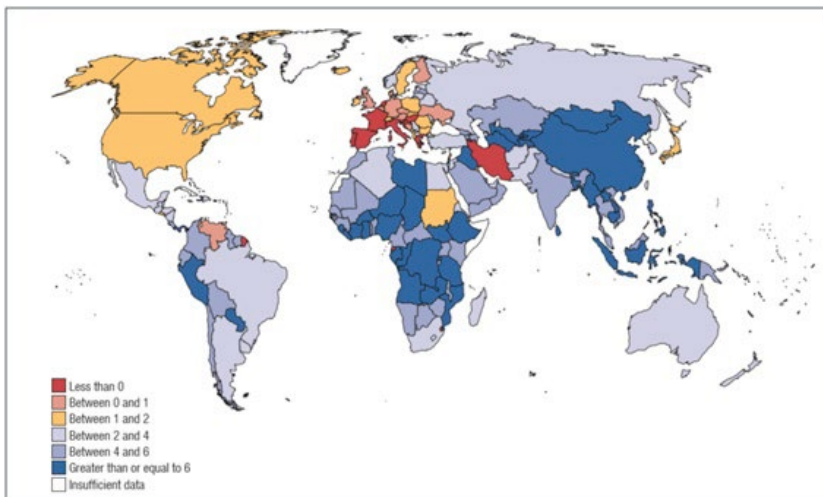


Figure 5.4

But this growth is also fundamentally affected by a dynamic which substantially alters the energy panorama. The halting of its nuclear power stations has obliged Japan to become a net importer of fossil fuels. With

²⁵ IMF. April 2013: "World economic outlook: hopes, realities, risks". In 2012, Asia grew by 5.3% and the forecasts for 2013 and 2014 are: 5.75% and 6% respectively.

only 15% of its consumption guaranteed with its own resources, it has become the third most significant oil importing country, at 4.6 million barrels a day, just behind China and the United States, the most significant in imports of Liquefied Natural Gas (LNG), with 37% of world consumption, and the second most significant importer of coal, used to generate 27 % of electrical energy²⁶.

In this scenario, while the coal and oil markets are of a global nature and the price, with slight variations, is the same in the different regional markets, the price of gas behaves in a different way, with a variation which is five times greater in Asia than in the United States, and twice as much as in Europe. This high price, which is modifying the export routes so as to supply the Asian market, endangers its expansion in the Chinese market. So much so that, for example, and although of a testimonial nature, Europe has seen an increase in the consumption of coal at the expense of natural gas, which goes to a more advantageous market, the Asian one.

China, a key geopolitical factor in the energy panorama. The geo-strategy of the future

"...a future that presents us with a security paradox. While the world is tending towards greater stability overall... the world is potentially more dangerous than ever before"²⁷

As the 40th anniversary of the first, and so far only, Arab oil embargo²⁸, has passed and its geo-strategic impact continues to reverberate, it puts into perspective a changing, heterogeneous and fundamentally different scenario.

The economic impact produced a severe recession which went on until 1975 in the United States, with a reduction of 2.5% in GDP and significant increases in unemployment and inflation. However, the geo-political con-

²⁶ EIA. 7th November 2013. "Japan is the second largest net importer of fossil fuels in the world". "Japan had been the largest global coal importer for three decades until 2011, when, according to World Coal Association estimates, China surpassed Japan by a narrow margin. By 2012, this gap widened as Chinese coal imports grew."

²⁷ Capstone Concept for Joint Operations: Joint Force 2020. (Joint Chiefs of Staff). Washington. 10th September 2012.

²⁸ On 6th October 1973, the Yom Kippur War began with the surprise attack by Syria and Egypt on Israel. On the nineteenth, when the U.S. Congress authorised an aid of \$2.2 billion to Israel, OAPC (the Organisation of Arab Petroleum Exporting Countries) together with Syria, Egypt and Tunisia, imposed a total oil embargo on the U.S. and a selective embargo on the other western countries and Japan. On 18th January 1974, Israel signed an agreement on a withdrawal from the eastern side of the Suez Canal, which was completed in March, when the ministers of the Arab countries, with the exception of Libya, announced the end of the embargo and an increase in production and export of crude.

sequences were deeper, changing radically the scenario of confidence in the non-use of a resource, considered vital, as a geo-strategic vector of dramatic consequences.

We have likewise seen the entry onto the strategy scene of new actors, Canada, the North Sea, the Gulf of Mexico... which have broadened the distribution of the enormous power involved in having the key to the most important energy source due to its calorific density, oil. There has also been a notable change in the industrial policies of the developed countries, above all Japan, with a great determination at any price to transform the model from industrial sectors that are highly dependent on oil to high-technology sectors as well as the search for alternative sources of energy such as nuclear energy.

Other geo-political lessons which have remained to the present might be synthesized as:

- the confirmation of the energy as the backbone of economic development;
- the palpable demonstration of the ever-growing economic globalization and integration of markets, where the recession in the western countries can be felt globally,
- innovation and more efficient use of energy resources, which has led to a progressive reduction in energy intensity at an average rate of 2%, with a continuous, although slight, progressive loss of the geo-political weight of so-called black gold. In this regard, the American Energy Secretary reminded us recently that the measures taken at that time about the efficiency standards for the car industry (CAFE, efficiency standards for cars) has led us to achieve, instead of the eleven miles a gallon then, twenty-five miles a gallon now, with the objective of over fifty in 2025;
- the accelerated development and deployment of alternative fuels and the withdrawal of price controls;
- the search for a system of global governance of energy, which led to the creation of the International Energy Agency (IEA) and the establishment of strategic reserves;
- the revitalization in the use of coal as a fundamental factor of National Security which, again in the words of the US Secretary of State, should lead us to think twice about the positions that are adopted in discussions on climate change, with regard to the policies of certain countries with circumstances that are not very different from those of the western countries at that time.

Thus began a traumatic geo-political journey, in which there have been continual crises and instability which have used a vital resource for de-

velopment and global prosperity as a key factor to of political pressure. This path has led to a strategic paradox, the lack of resources and the growing demand for them, which leads to two objectives which might be understood as exclusive, energy independence/autonomy and the search for global energy governance within a market which is more free, integrated and interconnected.

Another geo-political fact of great transcendence, which it is worth remembering from that time, is the opening up of China to the West with Richard Nixon's first visit to Beijing (1972), and the interview with an old and sick Mao in full revolutionary catharsis. A China with a gross domestic product which hardly exceeded \$100 billion, 2.7% of the world economy, far from the current 14.84%, and a per capita income of \$158, 2.3% of that of the US, 4% of Japan and 3.2% of Germany²⁹, while currently it is below the world average, but closer to that of the developed countries: 18.1% of the US figure, 25% of Japan and 23% of Germany.

Without a doubt, the sudden arrival of China as a great economic power, displacing the global geo-political centre towards the Far East, is the great geo-strategic challenge in the first half of the 21st Century. This shift of power, to which the growing economic and demographic importance of India, has three fundamental aspects, which have a significant effect on the future energy panorama:

- the Fukushima nuclear accident, which changes the traditional energy isolation of the other Asiatic giant, Japan;
- the renaissance in energy terms of the United States, which might become the largest world producer of oil and gas thanks to technological advances and a market system which has permitted unprecedented exploitation of unconventional oil and gas, which will allow it, in accordance with all forecasts, to reach 90 % self-sufficiency;
- and the phenomenon of climate change, a challenge of a truly universal nature, in which renewable energies and energy efficiency have an important role to play. Thus, now, the use of energy per unit of GDP is half of what it was in the 1970s.

But without a doubt, with the emergence of China, with its continental and maritime dominions like a new European Union in its infancy, in which the demographic factor is at the same time a heavy load and a formidable strength, the energy market is facing a world which is more dynamic and more strained. With growing demand, especially in the developing economies, the geo-political scene is experiencing an explosion of new local,

²⁹ http://es.kushnirs.org/macroeconomica/gdp/gdp_china.html Visited on 10th November 2013.

regional and global agents, new political alliances in various stages of progress, and a new ambit of interactions of supranational actors all indicators which know no frontiers, in which energy is the structural axis and the development-climate change factor is the most important challenge.

Thus, the market is getting more and more global, including the gas market thanks to the growing importance of LNG, and the institutions, such as the once all-powerful OPEC/OAPEC, which still has great influence, are multiplying and interacting with the important energy companies, both public and private, although all of them have a clear multinational character and with a more and more extensive and diverse business portfolio, both in the production and extraction sectors and in that of distribution and exploitation.

When we look to the future, China represents the new continental reality which feels hemmed in on its eastern maritime border due to the current hegemonic geo-political power, the United States. Its resurgence into the strategic panorama represents a gaze of hope, the Chinese dream, which needs to build new policies to effectively face the changing scenario which, inevitably and due to the new and different actors, will be more complex, difficult and dangerous.

In this situation, the challenge is formidable but the opportunities, if they are taken, may generate a framework of confidence, in which market forces act freely to establish a scenario of global development which will propitiate an atmosphere in which flexibility, adaptability, collaboration and prudence are the norm, and short-sightedness, with strident and inflexible conduct of a nationalist nature is the exception. A situation where new markets arise, mainly Asian but in which Latin America, Central Asia and Africa are getting more and more importance.

In this context, from the Chinese perspective, a profound reform of the current structure of global energy governance is considered necessary, with a complete review of the premises and the limitations of the possible political choices of the past. It is especially important, from the Chinese point of view, that the characteristics of the current multi-polar economic scenario, should be fulfilled with flexible and diversified objectives and, although it could not participate officially in the IEA, it should have the opportunity of intervening actively, together with other emerging powers, in all its activities so as to contribute to resolving the two fundamental challenges of that international governance, energy security and climate change.³⁰

³⁰ At the last ministerial meeting (2013) of the IEA held in Paris on 20th November, apart from the 28 member countries, the following also took part: South Africa, Brazil, China, India, Indonesia and Russia. For the first time, a joint statement was made public in which the mutual interest in achieving more intense and consolidated multilateral cooperation was expressed. There was also a separate statement, by the member countries, on the important role which the energy sector can play in limiting climate

This is especially true in areas such as: resource management and production; environmental regulation; industrial policies; critical infrastructures; taxation and subsidies; the size, disposal and management of strategic reserves; the exporting rules and restrictions; development of new technologies... But, in achieving a new framework of relationships, it is imperative to maintain the principles and objectives which contribute to preserving and improving a more integrated and legally secure global market, which promotes a more humane, secure and sustainable kind of development.

The change of energy paradigm. From the supply to the demand approach

"A broad range of other structural reforms will support the transition to more balanced and inclusive growth. Many of these, such as improved pricing of energy, land and water, are already proposed by the authorities. Allowing more competition in sectors currently considered strategic will boost growth and household income, and higher dividends from state-owned enterprises will improve financial discipline and provide additional fiscal revenue."³¹

When the energy scenario becomes more and more wide, global and interconnected, and therefore more stable, which does not mean more secure, as the joint American Chiefs of Staff reminded us, it does appear that there is a generalized consensus on the need to change the emphasis of the effort of policies at the state level. From the obsessive geo-political vision centered on guaranteeing the sources of supply, to a vigilant confidence that the market conditions may act in a free manner, so that: with the proper strategic reserves; the ever greater capacity of the diverse sources of supply to make production more flexible and modify the destination markets; and the variety of ways of generating energy; as well as its greater autonomy, these markets tend to act to maximize their value with greater efficiency, stability and security.

The paradigmatic example is oil, which, despite the continuous geo-political tensions on some of the most important exporting countries: Libya, Iraq, Iran, Nigeria, South Sudan, Yemen... with reductions in production of up to 3.5 million barrels a day, Saudi Arabia's capacity to balance the market, the growing importance of other supplying countries, as well as the sudden arrival of unconventional oil and the increase in refining

change. Chile and Estonia also took part in the meeting as aspiring members and over 30 leaders of companies from the sector. <http://www.iea.org/newsroomandevents/pressreleases/2013/november/name,44966,en.html>

³¹ "IMF Mission completes the 2013 Article IV Consultation Discussions with China", IMF, May 28, 2013. <http://www.imf.org/external/np/sec/pr/2013/pr13192.htm>.

capacity, ever closer to the production location, ensures the supply and maintains the price of the barrel in a stable band of \$80-120.

This price sustains a market with the capacity to invest in new forms of energy, making those new sources of energy viable and competitive which are currently rivals on the market, favoring the search for a new energy paradigm which must be focused on more efficient, clean and responsible demand. It is thus clear that oil, in all those sectors in which it enters into competition with other fuel types systems, loses ground.

In the search for this paradigmatic change, the IEA has launched a new publication which joins a series of traditional periodic market reports. The new installment: "*from hidden fuel to world's first fuel?*"³², on energy efficiency, shows us the evolution of the concept of energy security, stating that the first fuel, the most accessible and cleanest is the one that is not consumed.

The agency, which was created in 1974 by the OECD countries immediately after the 1973 oil embargo with the objective of opposing the disruptive policies of OPEC and guaranteeing the supply, has progressively changed the focus of its interests with a more and more global vision, integrating the three dimensions of the energy concept: the economy, its security and the environmental factor. At the same time it increases its area of interest towards those countries that do not belong to the OECD as they gain greater importance in consumption and supply.

China has maintained, for a long time a directed economic system, in which the energy management has been aimed at the sources of supply. The only objective of its authorities has been to guarantee an abundant supply of raw materials, while at the same time supporting economic development based fundamentally on the growth of its manufacturing industry and the reinforcement of its foreign trade. Energy efficiency and reduction in emissions were considered in a secondary place, when the most important task was growth. Thus, the improvement in per capita income was the fundamental objective of economic policy, taking advantage of the window of opportunity that the global market offered to its economy. But this leap forward, which has given rise to a grave socio-economic imbalance, is no longer seen as such but rather like a pathway that is opening up onto a horizon which is becoming more and more stable, which must now be balanced and consolidated.

However, the inertia of the situation tends to make the demand for energy consumption growing in an exponential manner. Even the policy of energy conservation and emissions reduction (ECER) is still not effective and lacks a system of implementation. Thus, the high growth in the consump-

³² From the unknown fuel to the world's first fuel? Translation by the author. IEA. Energy Efficiency Market Report 2013. "*Market Trends and Medium-Term Prospects.*"

tion of coal, oil and gas may, over the next few years, bring China face to face with a situation of external dependency, environmental degradation and increase in prices which will be difficult to manage.

The twelfth five-year plan opens up a period of strategic opportunity to modify the growth model³³. In order to achieve this, the indispensable element is to modify the energy demand management system from an obsessive fixation with guarantee of supply to a more balanced one where the efficient consumption becomes the great added value of its new development.

In this regard, it is necessary for internal reform for the organization of government, in which the National Energy Administration should fully exercise the functions of the regulatory organ of the system, with the category of Ministerial authority. In order to achieve this it should have as a subordinate organ the Department for the Conservation of Resources and Environmental Protection, currently part of the National Commission for Development and Reform. Also, in this role, it should control the Department of Conservation of Energy and Integral Application, currently attached to the Ministry of Industry and Technology. Thus, the new Ministry of Energy would be responsible for the whole of the energy sector in an comprehensive manner, giving it greater balance. In this way, the process of approval of large projects would be regularized while at the same time, improving transparency by means of a statistical and standardized information supply system.

This regularization should be established as well at the local level to achieve the detail of information necessary to permit the drawing up of more effective policies, as the assessment of the degree of implementation and the result of the policies. These policies should have efficiency objective in the use of energy, with clear goals of reduction of the energy intensity or, better, as the IEA report recommends, improving the index of energy productivity³⁴. Also, increasing the use of renewable energies, whit tax policies in covering the use of fossil fuels and incentives to favor clean energies, bearing in mind the specific characteristics of each region and province.

The strategic triangle of energy supply security

“Over the past thirty years, a remarkable continentalist transformation, as yet obviously incomplete, has begun quietly occurring in Eurasia. Open state-to-state warfare has largely ceased. Political barriers

³³ The new development programme approved on 14th March 2011 during the National Congress puts emphases on a high-quality growth.

³⁴ The energy productivity index aims to measure the number of units of GDP per unit of energy.

and historical antagonisms have been eroding, especially since the end of the Cold War, among such diverse nations as Russia, Turkey, China, and Korea. Transcontinental trade, driven by energy interdependence, has intensified, and interpersonal networks have depended. Most recently, a transcontinental oil and gas pipeline network has begun to emerge, with potentially significant geopolitical implications... With the coming of transcontinental pipeline, security dialogues, and summit conferences, the way is opening for more geopolitically significant collaborations as well, contrasting sharply with the mutual isolation of the Cold War past,"³⁵

The change of energy paradigm, from the supply approach to that of demand, rests on a structure which favors and supports an energy security scheme, which is at one and the same time global, regional and local. The current objective for the Chinese authorities is to consolidate and stabilize an energy supply which does not endanger the maintenance of sustainable growth of 7%³⁶. At the same time, it must permit the establishment of the conditions for the new development phase, more centered on social benefit than on economic one and which, therefore, must change dramatically the energy scenario.

One of the essential elements refers to a new international governance characterized by multi-polarity and the diversification of objectives, which establishes a new balance of power, in such a manner that no institution has a dominant position. Thus, the traditional influence and structures such as the IEA and OPEC, are being challenged by consumer countries and other producers. The International Energy Forum³⁷ is the only international organization which nominally includes both the advanced countries and developing ones³⁸, but its statistical information comes from six organizations: APEC³⁹, Eurostat, IEA, OLADE⁴⁰, OPEC and UNSD⁴¹. Furthermore, its scope of action is limited and well below the level of influence of the IEA, and even of the EIA. And, while multi-lateral cooperation is becoming more and more necessary, with China becoming more and more comfortable in these forums, bilateral cooperation will be the fundamental fulcrum on which international cooperation turns in practice.

³⁵ CALDER Kent E. *"The New Continentalism. Energy and Twenty-First-Century Eurasian Geopolitics."* (2012). New Haven and London. Yale University Press. Page xxix.

³⁶ The eleventh five-year plan established an objective of growth of 7.5%, while the real growth rate was 11%. In relation to the current plan, the analyses of the international organisations forecast growth which may exceed 8%.

³⁷ <http://www.ief.org/>

³⁸ 89 countries from six continents which offer 90% of the supply, and the demand for oil and gas, with a vision, global energy security through dialogue.

³⁹ APEC (Asia Pacific Economic Cooperation)

⁴⁰ OLADE (Organización Latinoamericana de Energía)

⁴¹ UNSD (United Nations Statistic Division)

From the Chinese point of view⁴², the importing countries should reduce their rate of growth in consumption with active policies which encourage efficiency and diversification, with special emphasis on clean energy sources. In relation to the market, it shows concern with what it considers to be a growing nationalism which limits the increase in investments and the internationalization of the market, which would favor the adoption and use of advanced technologies and a greater expansion of security. At the same time, China views with concern the social instability of some producing countries as well as the tendency towards the renationalization of the energy business in many countries. It also considers that the market linked to the North American currency and the regulation of trade in basic products, represented by oil, is controlled by the developed countries. The leadership of these countries and the cooperation with emerging countries would reinforce their control and regulation, avoiding the excessive financial attribute of oil which distorts the balance of the market and its price.

The central axis of China's geo-strategic vision resides in the need to maintain the security framework and international stability, which has favored the policy of growth based on a clear commitment to opening up to the external market. In this regard, China insists on two of the main principles of its external action, respect for national sovereignty and the use of dialogue to resolve differences and conflicts. Thus, it considers the existence of military alliances and the hegemonic postures of a regional nature to be prejudicial while, at the same time it advocates greater cooperation against terrorism and piracy, which allows the securitization of critical energy infrastructures as well as transport routes. In short, it considers that the international community has the obligation to create a secure geo-political framework for the global energy market.

The geographical scenario. The Chinese model of relations

"Energy and mineral resource exploitation is the major impetus for the economic booms of many African countries. In this area, Chinese enterprises have helped African countries establish an upstream-downstream-integrated industry chain, transforming resource advantages into economic growth opportunities, and actively participated in local public welfare infrastructure construction."⁴³

⁴² Energy Research Institute (ERI), National Development and Reform Commission. China Energy Outlook. Executive Summary. "Recommendation 9: The international community should establish a legal framework for the energy market and thus guarantee global energy security." Author's translation.

⁴³ White Paper. "China-Africa economic and trade cooperation". (August 2013). State Council. The People's Republic of China.

China's continental scenario and its openness to world trade through its maritime provinces establishing a framework like the European one which would allow it to occupy a highly-favorable geo-strategic position.

However, this privileged position is limited by the presence of the geopolitical Maritime Domain⁴⁴ which, together with the military power of the United States and its close links with Japan, South Korea, the Philippines and the special relationship with Taiwan, imposes a series of conditioning factors on its geographical scenario.

The Chinese model of relationship has its fundamental principles rooted in a historical and cultural tradition which is very difficult to modify, as is clearly established in the preamble to its Constitution:

*"The future of China is closely linked to the future of the world. China systematically maintains an independent foreign policy which adheres to the five principles of: mutual respect for sovereignty and territorial integrity; no bilateral aggression; no interference in the internal affairs of other countries; reciprocal equality and benefit; and peaceful co-existence... China is radically opposed to imperialism, colonialism and hegemony..."*⁴⁵

Thus, non-interference and non conditionality are characteristics which do not look as if they will be modified in the near future although current scholar about concerns the concept of "intervention", as an obligation of a moral, strategic and economic nature very much related to in its new status as a global power, in contrast to the concept of "interference", which is opposed to Chinese sentiment.

To this governmental relationship policy, others form of superimposed levels must be added; the first refers to the main state companies, which share all the characteristics of multinational companies, although with the added advantage of State support and the excellent China's political relationships; and the second level, interconnected with a pleyade of medium-sized and small companies outside government control although, they often have the support of the provincial authorities, as well as, the multiplicity of small traders who compete directly with local businesses.

⁴⁴ The three strategic domains, according to the work of COHEN, Saul Bernard. *Geopolitics: the geography of international relations.* Second edition (2009). Maryland, Rowman & Littlefield Publishers, Inc., are: "East Asia, which is dominated by China and includes North Korea, and a separate geo-political region, Indochina, which includes Vietnam, Laos and Cambodia; the Euro-Asian Continental Area... dominated by Russia... running like the interior of a half-moon from the Baltic, through Eastern Europe and the Black Sea, Central Asia and Mongolia, as far as the Korean peninsula; and the Maritime Domain, depending on commerce in the Atlantic and Pacific Oceans... dominated by the United States." Author's translation.

⁴⁵ Preamble to the Constitution of the People's Republic of China. 14th March 2004. Author's translation.

Another two fundamental characteristics of these relations refer to the capacity to establish integral, agreements, which incorporate aspects which only the support of the central authorities can guarantee. Among these elements are large credits for important infrastructure projects⁴⁶.

***The rationalization of the means of supply.
The political commitment***

"In Europe, despite the advances which have arisen from the strategic reflection of the Green Paper from the year 2000 (Towards a European strategy of security of energy supply), a common policy is still absent, and what there is of, it is guided by the interests and influence of the two main continental economies. The nucleus was the analysis of two very concrete points: the challenges for the security of supply and the potential weaknesses. The main risks were organized in four categories: physical risks (exhaustion of resources: North Sea oil or gas), economic risks (volatility of prices or price rises without any possibility of control), social risks (those deriving from shortages, above all of fuels) and ecological risks."⁴⁷

China presents on the global scenario, and more exactly on the Asia-Pacific scenario, a geo-political factor which is similar to that exercised by the European Union internationally and in its natural Euro-Atlantic scenario. But in the case of China, with strengths and weakness which make it different with regard to the European model.

Thus, China has a multinational reality, like the European one, and with a system of provincial authorities which enjoy wide autonomy. However, the capacity to legislate throughout the territory, with a political model of single party which as strongly hierarchical structure at all levels of administration, facilitates the ability to regulate the market, and the possibility of establishing a strategic vision and long-term programming.

Although, the absence of formal democracy imposes on its authorities the need to continually question themselves about their own legitimacy based on three fundamental premises: revolutionary credit, the moral superiority of the party and economic results; in a scenario which is challenged by a reality of, still, 180 million poor, on a halo of corruption and nepotism which is of special importance in the rich energy sector, as well as the social inequalities and the implacable

⁴⁶ One symbolic project is the new headquarters of the African Union in Addis Ababa, Ethiopia, with an estimated cost of approximately \$200M.

⁴⁷ MARÍN, Miguel et al, *"Propuestas para una estrategia energética nacional. Edición 2013"*, 2013, Madrid, FAES: Foundation for analysis and social studies.

deterioration of the environment. In this regard, the rationalization of energy supply is indispensable due to the physical, economic, social and ecological risks.

Coal

The use of coal, of which China has the world's third largest reserves, at 13%, behind the United States and Russia, as the main source of energy faces two fundamental challenges: the intensive use of its reserves⁴⁸ which will lead, in the long term, to the loss of its pre-eminent position on the international ranking (figure 5.5); and the growing demand for energy from the south-east of the country, which is developed and industrial, more and more diametrically opposed to the main sources of production,⁴⁹ which are located in the north-west, which is poor and de-industrialized.

The challenge of its transport, both by road, amounting to 10% of the world road traffic, and by sea, which represents a similar figure to all the international maritime coal trade. With another consideration, while the maritime transport of coal is highly efficient and its cost is very low thanks to the large fleet of over 200.000 dry cargo ships operating internationally, continental transport is highly onerous, not only as a result of the high price of gasoline but also due to the contamination and traffic jam of the roads. This internal transport, whether by road or by rail, due to its intensity, has some very critical social implications⁵⁰.

Thus, China, which has typically been a coal exporting country, has become a net importer, with over 200 million tons in 2011, 18% more than in 2010, through its significant ports in the south-east, coming from the rich deposits of Indonesia and Australia. In this regard, it is planned to reach 50% of the total consumption by the free international market at some very competitive prices and in a totally globalized and stable scenario as the best way of rationalizing its supply.

⁴⁸ "Coal production rose 9 per cent from 3.5 billion short tons in 2010 to over 3.8 billion short tons in 2011, making China the largest coal producer in the world." EIA. Country Report. China.

⁴⁹ In China, there are 27 coal-producing provinces, of which the leading one was Shanxi, close to Beijing, but which is reaching its limit of exploitation, with the most important mines currently being located in the autonomous regions of Inner Mongolia and Xinjiang Uigur.

⁵⁰ In order to have an index of magnitudes: "The cost of transport of one tone by land is 7 times more expensive than by sea, a proportion which is multiplied by 10, i.e. seventy times dearer, if it is by air". Speech by the Spanish Chief Naval Operations at CESEDEN on 4th November 2013.

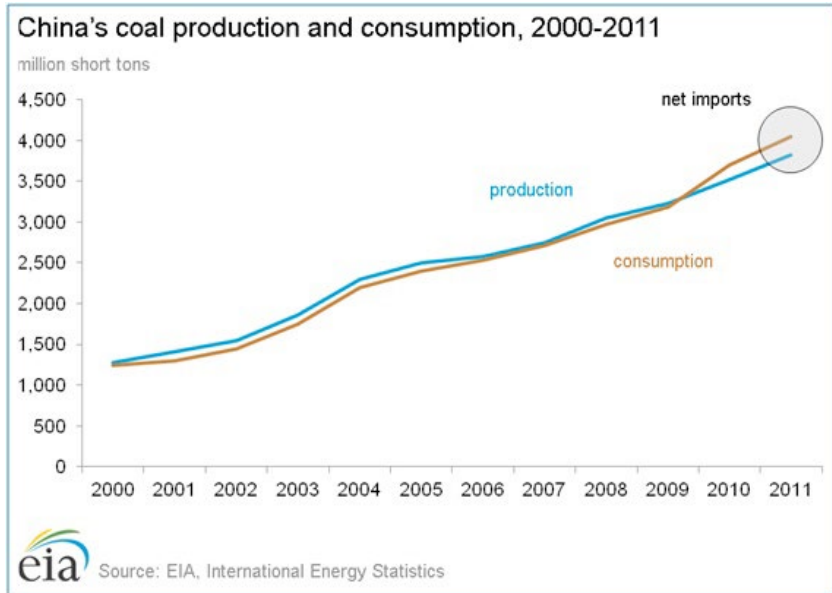


Figure 5.5

Oil

After experiencing annual growth of 7%, achieving a maximum of 4.3 Mbd in 2010, production has stagnated while oil companies are making an effort to increase production at sea to 15% and also to improve the use of new techniques (EOR, Enhanced Oil Recovery) so, to lengthen the lifetime of the production areas, as well as prospecting in new reserves in the north-west, in Xinjiang, Sichuan, Gansu and Inner Mongolia.

The increase in dependence on imports (see figure 5.6) makes it necessary to rationalize the supply and to develop technologies for the production of unconventional oil and to extend the useful lifetime of its oilfields⁵¹. One of the fundamental elements in order to achieve these objectives is investment by Chinese companies in international projects and the formation of strategic associations with international companies. In a scenario of economic crisis, China is using its important currency reserves, estimated at over 3,660 trillion dollars⁵², for the purchase of and taking

⁵¹ "EIA expects China to import about 75 percent of its crude oil by 2035 as demand is expected to grow faster than domestic crude supply". EIA. Country Report. China

⁵² "The People's Bank of China said the country does not benefit any more from increases in its foreign-currency holdings, adding to signs policy makers will rein in dollar purchases that limit the yuan's appreciation... China's foreign-exchange reserves surged \$166 billion in the third quarter to a record \$3.66 trillion, more than triple those of any other country and bigger than the gross domestic product of Germany, Europe's largest economy." <http://>

stockholdings in foreign companies in all continents except Europe, investing over 18 billion dollars in the oil and gas sector, of which 12 billion dollars were aimed at achieving greater access to LNG and unconventional gas. Thus, foreign production of oil with Chinese capital has grown significantly during the last decade from 140,000 Bld in 2000 to 1.5 Mbd in 2011⁵³.

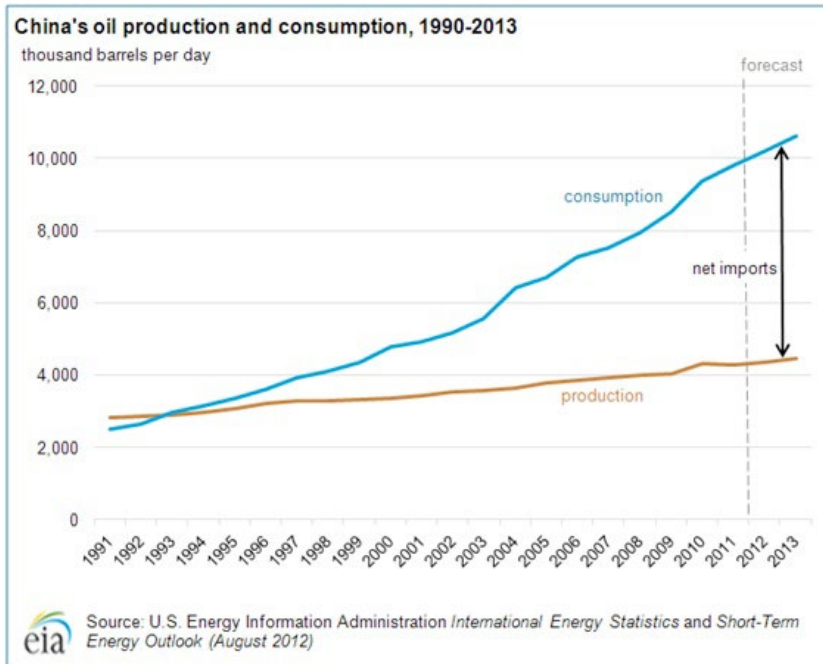


Figure 5.6

The Middle East is China's main source of crude (see figure 5.7), although with the objective of distributing and ensuring supply as far as possible, African countries and especially Angola are increasing their share. An interesting case is Sudan and South Sudan, one of its main suppliers of crude, and also target for of large infrastructure investments, whose continuing instability does not guarantee the important supply from the storage tanks that are the property of the CNPC (China National Petroleum

www.bloomberg.com/news/2013-11-20/pboc-says-no-longer-in-china-s-favor-to-boost-record-reserves.html

⁵³ "Since 2008, Chinese NOCs have secured bilateral oil-for-loan deals amounting to roughly \$100 billion with several countries in order to obtain hydrocarbon resources and mitigate lending risks with suppliers. China finalized oil-for-loan deals with Russia, Kazakhstan, Venezuela, Brazil, Ecuador, Bolivia, Angola, and Ghana - and a gas-for-loan agreement with Turkmenistan. Venezuela and China have signed oil-for-loan deals, including \$32 billion in exchange for 430,000 bbl/d of crude oil and products." EIA. *Country Report. China*

Corporation). Another case that test the flexibility of Chinese supply were the disputes between Sinopec, the main Chinese importing company and the Iranian state company, which led to a loss of 34% of its market share during the first quarter of 2012.

The main fulcrums which enable China to absorb the market imbalances are the countries of the Middle East, mainly Saudi Arabia, together with Venezuela, Russia and Angola. However, China will continue to make its sources of imports more flexible, so as to reduce the risk of interruptions in a geo-political panorama, which is a polyhedric structure whit many sides that could generate sharp edges and which stands out for its complexity, uncertainty and potential danger.

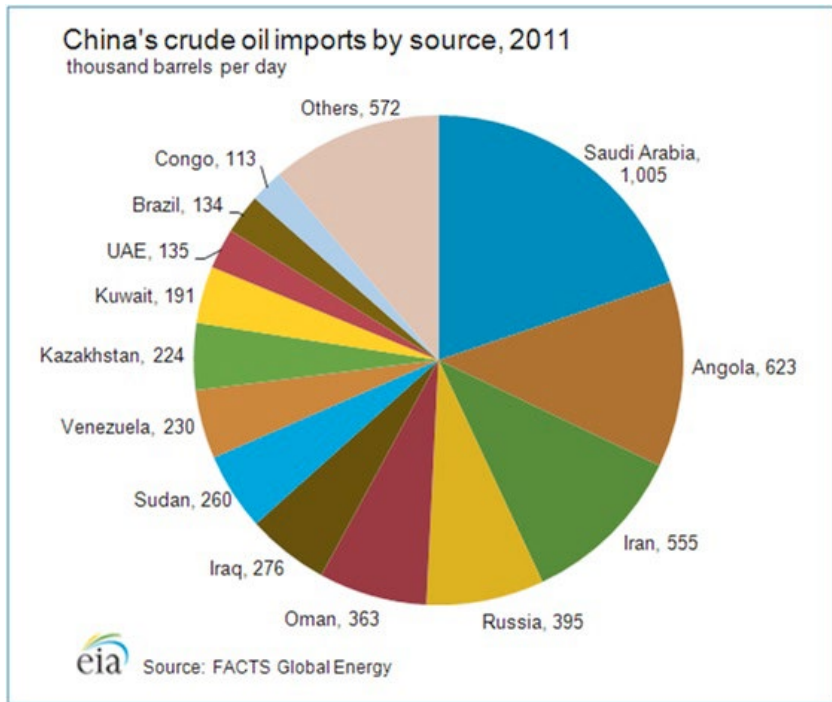


Figure 5.7

Another fundamental element in the rationalization of the means of supply is the improvement in the integration of the national network of oil and gas pipelines as well as the diversification of the network of international connections with neighboring countries to increase the oil supply routes. The over 20,500 kilometers of oil pipelines in the national network and the almost 13,300 kilometers of the local network should constitute a fundamental tool for social integration although, for the moment, they serve mainly the most industrialized provinces of the Eastern coast and the north-east region, close to Beijing. However, a number of routes un-

der construction aim to join together the new areas of supply and the refining facilities, as well as, in the opposite direction, the most distant markets. In the new five-year plan, up to 2015, it is planned to build over 10,000 kilometers of pipes for crude and another 10,000 kilometers for refined products.

China inaugurated its first transnational oil pipeline in May 2006, when it began to receive Russian and Kazakh oil from Atasu, in the north of Kazakhstan, to Alashankou on the Chinese frontier. This first oil pipeline has been extended towards the west until it reaches the oilfields of the Caspian Sea, while at the same time its capacity has been doubled, and is expected to reach 400,000 Bld in 2014.

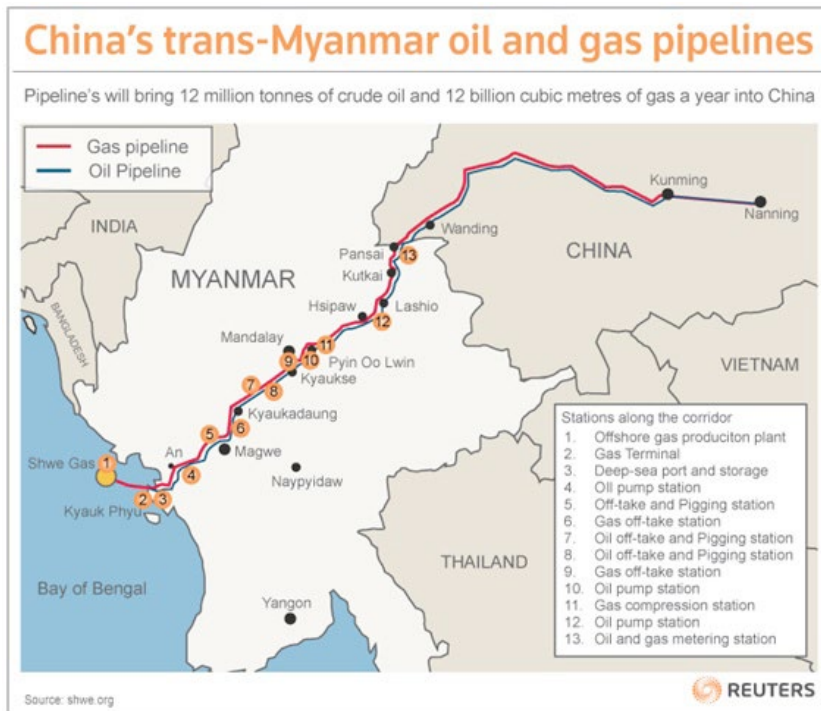


Figure 5.8

The second international oil pipeline is a branch of the ESPO (Eastern Siberian-Pacific Ocean), which aims to connect the Russian city of Taishet with the Pacific coast, at a distance of some 5,000Km. The branch of some 1,000 Km. built by CNPC joins the oil pipeline with the Daqing oilfield in northeast China.

The third international connection will joint the Bay of Bengal with the province of Guangdong, in southwest China. It will be an oil pipeline (see figure 5.8) designed to transport 22 million tons of crude, which will most-

ly run together with the gas pipeline completed in October 2013. The oil pipeline, bearing in mind the absence of oil production in Myanmar, will serve fundamentally to supply oil from Arab countries without needing to go through the Malacca Straits.

Finally, in the country's interior, the 1,850 Km. oil pipeline for refined and crude which connects the Urumqi refinery in the province of Xinjiang with Lanzhou in the province of Gansu will be progressively extended with regional branches such as Lanzhou-Chengdu-Chongqing and Lanzhou-Zhengzhou-Changsha, until it reaches the coastal regions.

Natural gas

Although the use of natural gas is growing rapidly, it still stands at around 5% of total consumption of primary energies and, with an increase of up to 10% in 2020, it appears to be the great challenge in order to alleviate the tremendous environmental problems caused by the massive use of coal. Furthermore, it has to constitute a fundamental element for the diversification of supply sources for final users above all in the case of the north with over 500 million inhabitants, where the need for heating is one of the key elements in coal consumption.

Despite having the second largest reserves of conventional gas in the Asia-Pacific region, and the world's largest reserves, according to EIA estimates, of technically-recoverable unconventional gas, China is aiming to rationalize its sources of supply from the areas where the main reserves are.

Consumption increased by almost 50% in 2011, with over 1 Bcf being imported by means of LNG and oil pipelines (see figure 5.9). Although the majority of gas consumption is in the industrial sector, 34% in 2011, its use is being extended more and more in the service and residential sectors, while for electricity generation nuclear or hydraulic energy is preferred. These last, furthermore, as they are large-scale and magnificent, offer a great opportunity for Party propaganda with the purpose of boosting the legitimacy and the authority of the politburo.

The EIA forecasts that gas needs will triple by 2035, growing at a rate of 5% per year. In order to satisfy this demand, China will continue to place its trust in the import of liquefied gas and a trident of oil pipelines which give it great geo-strategic flexibility: from the Russian Federation, with the immense reserves of Siberian gas: the re-baptized new silk route from the Caspian Sea; and the Bay of Bengal as the natural escape route which allows China to avoid the blockade of the first and second island chains⁵⁴.

⁵⁴ "... the situation for China, at the beginning of a phase of maritime and naval expansion, is very similar to that which existed almost throughout the 20th Century at the opposite end of Eurasia, a continental power which is trying to become a great naval power, surrounded

Also, in order to bring natural gas closer to its final user, above all in its use in the domestic area, it needs to increase its strategic reserves and to establish a gigantic internal network for its distribution and storage at local level⁵⁵. With nearly 50.000 kilometers of oil pipelines and with electricity companies increasing their connections at the local, provincial and state level, the government intends to increase the main arteries for the flow of natural gas by another 40.000Km in 2015, while an attempt is made to achieve the integration of the distribution network, which is currently controlled by different companies.

That network should be fed, apart from by the local production of gas, by a wide-ranging and well studied system of supply lines in order to avoid the problems which Europe had until recently in its supply as a large part of its territory depended on a single supplier and a single supply line. Thus, in 2006, CNPC signed a MoU (Memorandum of Understanding) with Gazprom to open up two points of access to Russian gas, one in the north-west to receive the gas from the Kovysta reserve in 2015 and another in the northeast from the Sakhalin Islands. The agreement has not been acted upon due to the lack of agreement over the price of the gas.

As the back bone of the new silk road⁵⁶, the CAGP (Central Asia Gas Pipeline) runs for 20.000Km. The first Chinese oil pipeline, in operation since December 2009, for the import of natural gas from Turkmenistan (South

by naval powers, in this case Japan and Korea, which in turn are supported by the American naval colossus.

The first challenge is the defence of the coastal regions, a problem which has been complicated because of Taiwan, which is located at a distance of about 100 miles off the province of Fujian and which divides China's maritime front in two interrupting naval movements between the north and the south. Furthermore, Taiwan forms part of the succession of islands which runs from the Philippines in the south to the Japanese archipelago in the north, which Chinese naval strategists call the "first chain of islands" and which includes the waters surrounding China, its "maritime buffer", thus permitting the country that controls it to contain Chinese naval activities and to impede its maritime commerce...The final stage in the evolution of Chinese naval thinking commenced less than a decade ago and led to a [Navy] with oceanic capacity to operate in the Western Pacific and the Indian Ocean, projecting its naval power in support of Beijing's international policy and in order to protect sea traffic in both oceans. This new strategic conception, adopted at the highest level, also establishes the need to control the waters to the west of the so-called "second chain of islands", which runs from Japan towards the south-east, including the Marianas and Guam and continuing towards the south as far as New Guinea." MACKINLAY FERREIRÓS, Alejandro. IEEE. Opinion document 06/2011.

⁵⁵ "China lacks gas storage capacity, causing it to consume almost all of the gas it supplies. The government intends to increase storage capacity from nearly 70 Bcf to 1,100 Bcf in 2015." EIA. Country Report. China

⁵⁶ "On the occasion of the G-20 meeting in Saint Petersburg, on 7th September 2013, the Chinese President visited four Central Asian countries proposing, at Nazarbayev University in Astana, closer cooperation between China and Central Asia to build an economic belt around the "Silk Road" to join the Pacific with the Baltic Sea and so as to promote a market of over 3,000 million people with an unprecedented potential." Quoted by GARCIA SAN-

Yolotan), Uzbekistan and Kazakhstan. At the same time, the Chinese companies are increasing their investments in the region to help the development and exploitation of its important reserves.

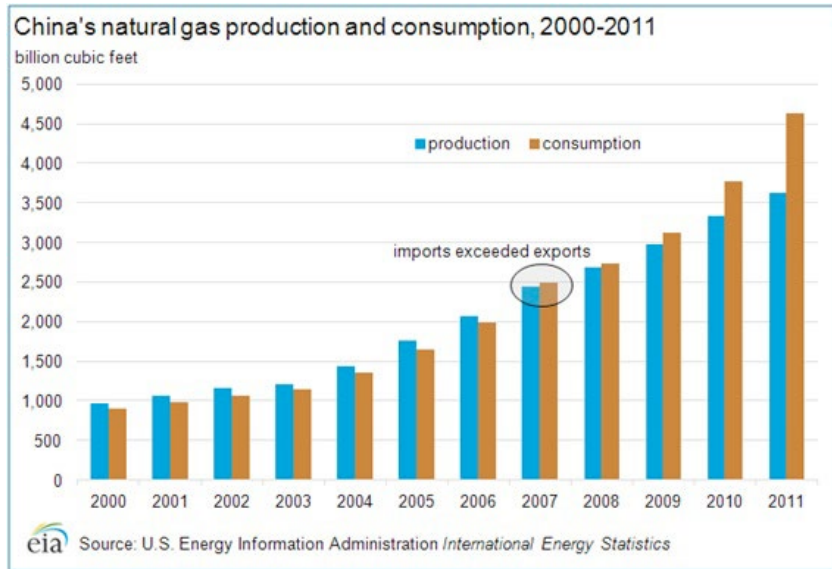


Figure 5.9

The third prong of the Chinese continental supply trident opens onto the Indian Ocean through the Bay of Bengal and is aimed at the Indian colossus. This important artery for energy supply⁵⁷ forms part of the ambitious “Shwe Project”, which consists of the exploitation of the natural gas deposits of the Bay of Bengal and joins the port of Kyaukpyu with the south-western provinces of China, Yunnan, Huizhou and Guangxi, which up to now have depended on the liquefied gas from the province of Sichuan, which had reduced its economic and industrial development. The construction, the result of the collaboration between the CNPC, Myanmar Oil and Gas Enterprise (MOGE), Daewoo International Corp, Korea Gas Corp, Oil India Ltd and GAIL India Ltd, runs for over 2,500Km of which almost 800 are on Burmese territory. Furthermore, it allows the Chinese state to boost its presence in that country, which is continuing its opening to the west since the bloody repression of September 2007, the controversial action of the government after the passage of the Nargis Cyclone and the elections of April 2012. A country with a per capita income of

CHEZ, Ignacio in the Geo-Political Panorama of Conflict 2013. Chapter XII. *The Chinese inner ring. A factor of strength or weakness?* IEEE.

⁵⁷ HIDALGO GARCÍA, María del Mar. *La finalización del gaseoducto Myanmar-China*. Visited on 22.11.13 <http://www.ieee.es/contenido/noticias/2013/11/DIEEEI28-2013.html>

\$1,200 which views with concern, due to the environmental impact, some of China's large projects, such as the great Myitsone Dam, one of the several hydraulic projects planned on the main aquatic artery of the country, the Irrawaddy River, of great commercial importance. The \$3.6B project was suspended in 2011 due to the public pressure as a result of the relocation of some 15.000 inhabitants of the region to be flooded, which would occupy an area similar to that of Singapore and of when the main beneficiary would be the Chinese province of Yunnan, which would receive 90% of electrical production, despite the fact that three quarters of myanmar do not have access to electricity.

But half the imports of natural gas reach the more industrialized areas of the China directly via the port terminals for LNG (figure 5.10)⁵⁸. The capacity in mid-2012 was of 1.000 Mcf, while another 2.000 Mcf are planned by 2015. It is foreseeable that this trend will continue in the medium term although the price on the Asiatic market is five times greater than the gas price in the USA and almost double that of the European market⁵⁹ and, of course, higher than that which is produced domestically and that imported using the continental gas pipelines. However, this is considered to be one of the main routes to ensure this vital geostrategic flow. In this regard, one of the latest reports of the IEA⁶⁰ dealt with the matter of supply of LNG in the Asian market highlighted of a large distribution center which might be located ideally in Shanghai, although significant reforms would be necessary to the financial system⁶¹, or in Singapore, to satisfy a region which, with Japan and Taiwan depending, fundamentally on this supply.⁶²

Currently, LNG reaches the country through five terminals belonging to the powerful CNOOC and CNPC, with another four under construction and

⁵⁸ IEA report: "Gas Pricing and Regulation, China's challenges and IEA experiences." 11 September 2012

⁵⁹ Approximate prices in 2012: Asia \$15Mbtu, Europe \$8Mbtu and USA \$3Mbtu. Coal \$4Mbtu.

⁶⁰ IEA report: "Developing a Natural Gas Trading Hub in Asia. Obstacles and Opportunities" February 2013

⁶¹ "China this Sunday took a new historic step in opening up its economic and financial system to the world with the official start of the Shanghai new free trade zone, an experimental area which is destined to be a revolutionary player in the international economy." http://economia.elpais.com/economia/2013/09/29/actualidad/1380468089_303040.html

⁶² *Ibidem*, page 23. "The two most mature natural gas markets in the Asia-Pacific region are Japan and Chinese Taipei; coincidentally, both markets are nearly exclusively supplied by LNG, as local production is practically non-existent. In 2011, these two mature markets consumed 87% of all LNG delivered into Asia. A marked shift in demand for LNG is expected, as mature markets such as Japan have limited potential for an increase in LNG demand, while demand growth in China (275%) and India (72%) is likely to be considerable."

several more which are awaiting government approval⁶³. The companies must ensure the supply before building a gasification terminal and must also compete with foreign companies, especially those of Korea and Japan. Thus CNOOC, PetroChina and Sinopec have signed contracts with other companies from Indonesia, Malaysia and Australia. QatarGas too has entered the Chinese market.



Figure 5.10

The diversification of energy basin sources. A promising future

“Energy is of vital importance to economic development and people’s well-being. In order to reduce conflicts and inequality brought about over access to energy resources, achieve a stable growth of the world economy and make the economic globalization lead to a balanced, universally beneficial and win-win development, the international com-

⁶³ “Several re-gasification terminals are in various phases of planning and construction. CNOOC is keenly interested in growing its LNG market as it has a competitive advantage thus far in the sector compared to the other NOCs. In addition, CNOOC is constructing 3 plants - Zhuhai, Zhejiang, and Hainan - and intends to expand the company’s three existing terminals. PetroChina/CNPC recently entered the LNG market and commissioned its first two re-gasification terminals, Dalian and Jiangsu, in 2011 and is building the Tangshan terminal. Sinopec anticipates entering China’s LNG market by 2014 with its Qingdao terminal.” EIA. Country’s report. China

munity should foster a new energy security concept featuring mutually beneficial cooperation, diversified development and common energy security through coordination. To jointly ensure global energy security, the Chinese government calls for international efforts in the following three aspects:

- *Strengthening dialogues and exchanges*
- *Carrying out effective energy cooperation*
- *Working together to maintain energy security”⁶⁴*

There are two factors which are pushing the development of new energy sources and greater investment, not only in the search for alternative methods, but also in the exploitation of the resources in the contraction phase in a more efficient manner, such as in the use of fossil fuels held in a range of geological formations. These two factors are without a doubt: the price of oil and the high level of contamination from coal.

The price of oil will remain stable, according to most analysts, within a band that the market considers reasonable, of between \$80 and \$120 a barrel. This price, which should tend downwards due to increased production, both conventional and unconventional, and the improvement in the distribution, integration and level of market reserves, and which, in the opposite sense, would be shaken by the growing geo-political uncertainty, tends to show a great structural strength which makes it possible to guarantee its stability in the medium and long term. This firmness in the level of prices makes possible, both in public and private terms, investments in new sources which are taking on ever greater market share in all sectors except transport where it will continue, for a long time to come, to be the dominant energy source.

At the same time, coal, which displaced biomass to become the driving force behind the industrial revolution at the beginning of the last century, and which lost its leading position as the primary energy source in the middle of the same century, has again become the platform on which the new industrial revolution of the developing countries is based with a clearly global character.⁶⁵ The paradigm is China, which, with its amazing economic development serves as a guide, not only for emerging countries but also for the new political⁶⁶ and economic awakening of the youngest

⁶⁴ White Paper: “China’s Energy Policy 2012”. October 2012, Beijing. State Council

⁶⁵ “In 1957 the demand for petrol exceeded that for coal. Currently, with a growth rate of 2.65% compared with 1.2% for oil, coal could again exceed oil in 2020. Over 90% of coal production is extracted domestically in China, which produces more energy than all the oil in the Middle East.” Extracts from the presentation: “Medium Term Outlook for Coal.” by Laszlo Varo, IEA, December 2012.

⁶⁶ “The ongoing dispersal of global power is furthered by the emergence of a volatile phenomenon: the worldwide political awakening of populations until recently politically passive

societies and countries on the planet. Coal, abundant and very widely distributed, with a global, stable and perfectly integrated market, is struggling against “*the evidence of climate change*”⁶⁷. In this discussion, China hoists the flag of the necessary differentiation between countries which depend on their specific characteristics and their degree of development. But at the same time it is preparing to play the new status of geopolitical power.

This is shown by the tremendous effort, without endangering the continuing economic progress, to achieve sustainable development, by means of the maximum diversification of energy sources, giving incentives for their use, for which a pilot experiment was started last June for trade in carbon emission rights (ETS, Emission Trading System) in Shenzhen, and which has now been extended to a total of seven cities: Shenzhen, Guangdong, Hubei, Beijing, Shanghai, Tianjin and Chongqing.

The effort for diversification of the sources of energy is a prior condition to the development of the economy with less energy intensity, and a reduced rate of greenhouse gas emissions. Apart from the logical evolution of the developed economies towards sectors of less energy intensity, such as services and technology; thus, China expects progressive changes in energy consumption, in such a manner that it becomes more and more efficient and with low-carbon sources taking precedence. It is in the industrial sector that a greater effort is expected, with the progressive displacement of coal by natural gas⁶⁸, above all in industries associated with the rapid real estate growth, especially the cement and metallurgical industries. Meanwhile, in the electricity sector, the effort will be directed towards boosting nuclear, hydraulic and renewable energies, among which wind and solar energies will be the most important, without forgetting other sources such as biomass, solid wastes and geo-thermal energy⁶⁹. In relation to hydraulic energy, China plans to use the natural possibilities as much as possible, while recognizing that there is a com-

or repressed... The world is now almost everywhere politically awakened—with millions stirring restlessly in pursuit of a better future... The younger generation of today is particularly responsive to political awakening because the Internet and cellular phones liberate these young adults... BRZEZINSKI, Zbigniew. “*Strategic Vision: America and the Crisis of Global Power*.” (2012) New York. Basic Books

⁶⁷ GARCÍA SÁNCHEZ, Ignacio. “5º informe del IPCC. La certeza de una herencia. El calentamiento global”. 1st October 2013. www.ieee.es

⁶⁸ IEA WEO2013: “*Market conditions vary greatly between the different regions of the world but the flexibility and environmental advantages of natural gas in comparison with other fossil fuels put it in a position to prosper in the long term. The increase will be greatest in the emerging markets, notably in China, where the use of gas will have quadrupled by 2035...*”

⁶⁹ *Ibid*: “*Renewable energies represent almost half the increase in world electricity generation up to 2035, and variable sources—wind and photovoltaic solar energy—constitute up to 45% of the expansion in renewables. China will record the greatest absolute increase in*

ponent of variability, as with solar and wind, which depend on climatic conditions. In this regard, in 2011 there was a notable reduction in electricity production due to the significant drought suffered by the country⁷⁰. However, on the other hand, the predictability of the prices of these clean energy sources is an advantage in contrast with the volatility of the price of fossil fuels.

Another two fundamental aspects which are of great importance as they are undergoing growth in parallel to economic progress, the more so if we bear in mind the geographical characteristics and the physical dimensions of the Chinese state, are: the consumption of energy by road transportation⁷¹ (see figure 5.11a) and the use of heating and air-conditioning in the urban environment. The use of bio-fuels, hydrogen, gas... and the final objective of the electric car, or hybrids, is one of the seven priorities of the twelfth five-year plan. While the natural gas sector enjoys intensive growth⁷², the objective is to extend its infrastructure at the same rate as demand so it will be necessary to make significant reforms in a sector dominated by CNPC, which is excessively rigid and vertically integrated without separation between transport and commercial activities.

generation from renewable energies; it will be greater than that of the European Union, the United States and Japan together".

⁷⁰ *"The abnormally hot weather and severe drought in Central and South China has affected hydropower production and may lead to a severe power shortage this summer. In East China's Anhui province, the power shortage is expected to reach as much as 25 million kilowatts at peak hours this summer, partly caused by low water levels for hydropower, said an industry insider."* Visited on 16th November 2013. http://www.china.org.cn/environment/2011-05/25/content_22635822.htm

"China which relies on coal to produce more than 70 percent of its electricity, may increase imports of the fuel by 1 million metric tons a week as drought conditions cut hydropower output... Hydropower capacity has fallen as much as 20 percent... The world's biggest energy user may face power shortages of 30 gigawatts during the summer as supply lags behind demand." Visited on 16th November 2013. <http://www.bloomberg.com/news/2011-05-05/china-coal-imports-may-rise-as-drought-saps-hydropower-ubs-says.html>

⁷¹ *"Car, truck and bus sales in China continue to soar and are expected to reach 20 million units this year. The US, the world's traditionally largest auto-market, expects vehicle sales to reach 16 million units in 2014. Given the huge size of the Chinese population and the low levels of car ownership today, it is evident that in the vehicle sector China will not reach saturation levels for years to come. The current rate of Chinese car ownership stands at 70 cars per 1,000 people and it is estimated that will take more than 20 years to reach 400 units per 1,000, a mark considered an upper level for the Chinese society."* <http://www.cgcs.co.uk/news/1023-chinas-oil-demand-to-2020> Visited on 10th November 2013

⁷² In 1990, the Chinese gas market was practically non-existent. Since 2000, it has increased in size five times, becoming the fourth largest market in the world, with an estimated growth, according to the IEA, of 13% annually over the next five years. The Chinese authorities want consumption to double by 2017, which seems an excessively ambitious goal.

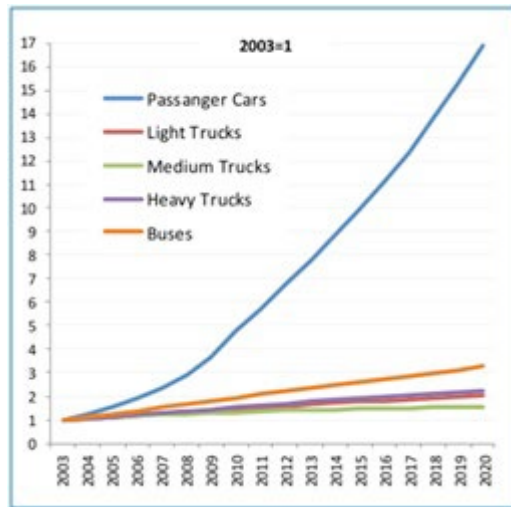


Figure 5.11a

Another fundamental element is the integration of the different sources of supply when we refer to the production of electricity. In this regard, the effort to develop intelligent networks to integrate and distribute electricity generation from diverse and complex sources into a single network is directed by the SGCC (State Grid Corporation of China). Thus, in one of its most recent provisions it limited the generation of electricity by private citizens and companies to six megawatts. Currently, the NEA (National Energy Administration) is carrying out demonstrations across the country of intelligent networks integrated in special areas of economic development, to encourage the private sector to invest in an industry which can generate a market value of \$1,600T, and create business opportunities in an indirect manner which will triple the previous figure. Also, and in line with what is occurring in the United States, above all in the State of California⁷³, the NDRC (National Development and Reform Commission) is insisting that the operators take the proper measures to facilitate connection to the network of family generators through companies in the sector.

⁷³ EIA. "Most new residential solar PV projects in California program are not owned by homeowners." 17th September 2013. According to the "solar initiative programme" of the over 55 megawatts installed in June 2013, only about 15 belonged to the owners of the house. The remainder, about 40, were the property of an electricity company which sold all the energy produced to the owner or which gave a monthly price. In both cases, the price paid by the owner is always less than what he would pay on his bill if he received mains electricity.

The challenges to security of supply

“The International Energy Agency (IEA) is an autonomous organization, created in November 1974. Its original mandate had, and continues to have, a double aspect: to promote energy security between its member countries by means of a collective response to the material interruptions of oil supply and to investigate and analyze in a reliable manner the possibilities of guaranteeing secure, accessible and clean energy for its twenty-eight member countries and for third parties.”⁷⁴

The IEA is the paradigm of security of supply and it was with this objective that it was created forty years ago, just after the first and only oil embargo that the west has suffered. Thus, the evolution of the agency offers us the clearest possible example of the new vision of energy security, and how this has become the fringe on what the balance of the system of global governance pivots.

China is not only part of this reality but is one of the key pieces of the energy *trilemma*: security, accessibility and the environment. In itself, it embodies, better than anywhere else, the challenges involved in the energy paradox:

- The emissions of greenhouse gases, environmental contamination and vulnerability to scarcity of water.
- The impossibility of access to modern forms of energy, me to the high cost, which makes this fundamental right inaccessible to over a fifth of the population.
- Oil, due to its calorific density and its facility for ease of handling will continue to be the central element of its energy security⁷⁵. The new geography of demand and supply implies a reordering of the commercial flows of oil towards the Asiatic markets, with implications for the efforts of cooperation to guarantee the security of supply⁷⁶.
- The high price of oil and the regional differences in the cost of natural gas and electricity, which have a direct effect on industrial competition and sustainable economic development.

⁷⁴ IEA. WEO 2013_ The IEA has set up an integral energy cooperation programme among its member countries, each one of which is obliged to maintain oil reserves equivalent to 90 days' net imports.

⁷⁵ Energy Research Institute. National Development and Reform Commission. *China Energy Outlook*.

⁷⁶ “The Asian imports will come not only from the Middle East (where total crude exports will begin to be unable to respond to Asia's import needs), but also from Russia, the area of the Caspian Sea, Africa, Latin America and Canada. The new refining capacity oriented towards exports from the Middle East raises the possibility that oil products will gain a greater presence in world trade instead of crude, but a large parte of that new capacity will ultimately serve to satisfy the growing internal demand of the region itself.” IEA. WEO 2013

- The efficiency, technological development and integration of the energy market globally and in a more competitive manner.
- The adaptation of the electricity market to generation from renewable sources⁷⁷ and the role of nuclear energy⁷⁸ after the nuclear crisis in Japan.

Fossil fuels. Difficult political decisions

"Speaking in Hong Kong last year, Dr. Li Junfeng, deputy director general of the Energy Research Institute in Beijing, argued that the 12th FYP with its ambitions to turn China into a model of low-carbon growth, was likely to have uneven results, due to differences in development. Local variations, he explained, were both predictable and necessary. <It's very difficult,> he said, <to have a goal for the entire country. We need local flexibility>".⁷⁹

The owners of coal mines in China have traditionally been highly fragmented, including large companies of a state-owned nature, companies belonging to the provincial governments and thousands of mines whose owners were the local or municipal authorities. The ten main companies nationally do not exceed 30% of total domestic production. The most important company in China, and the world, Shenhua Coal, only occupies 10% of China's internal market.

The most important problem of this fragmentation is that tens of thousands of small local mines are highly inefficient, due to the lack of investment in new equipment and safety systems, despite the fact that they are a considerable proportion of total production. The objective of consolidating the coal industry involves attracting greater investments in new

⁷⁷ EIA. Country report. "China has a goal to generate at least 15 percent of total energy output by 2020 using renewable energy sources as the government aims to shift to a less-resource intense economy. China invested \$264 million in renewable energy projects in 2011, and plans to spend \$473 billion on clean energy investments by 2015 as part of the latest Five-Year Plan."

⁷⁸ EIA. Country report. "China is actively promoting nuclear power as a clean and efficient source of electricity generation... [it] plans to boost nuclear capacity to at least 70 GW by 2020. As of mid-2012, China had 15 operating reactors and 30 reactors with over 33 GW of capacity under construction, about half of the global nuclear power capacity being built. Following Japan's Fukushima Daiichi nuclear accident in March 2011, China suspended government approvals for new nuclear plants until safety reviews are completed for current plants and those under construction (finished at the end of 2011), and a safety framework for all nuclear facilities receives final approval by the State Council. The safety reviews were completed in late 2011, and the State Council approved a safety plan for all facilities in May 2012 allowing for new plant approvals to resume."

⁷⁹ Hilton, Isabel et al. *China's Green Revolution Energy, Environment and the 12th Five-Year Plan*. China Dialogue. www.chinadialogue.net/reports

technologies, improving safety, the protection of the environment, and correcting a highly unfavorable reputation.

In order to control the excessive growth of production, the 12th Five-Year Plan sets a ceiling of 3.9Btm and a maximum capacity of 4.1 Btm in 2015. Also, in order to improve efficiency and safety in the mining industry, the National Energy Agency intends to concentrate 60% of production in ten large companies and ten medium-sized companies, while at the same time, limiting the total number of these at a maximum of 4,000, forcing alliances and acquisitions. Furthermore, despite the strategic status of the sector⁸⁰, it is more open to foreign investment, in an effort to introduce new technologies, and to modernize the methods of extraction from its large mines.

The most important efforts at investment and development are centered on two fundamental areas, internal transport, by means of liquefaction⁸¹ and the production of methane, as well as systems for reductions of emissions of CO₂ into the atmosphere.

The environmental problem surpasses the rest, above all in the north of the country at the beginning of the winter, when heating needs are added to industrial emissions. The images of entire towns with masks for breathing, the studies on effects on the fertility of the population, the differential in life expectancy from one region to another and cases such as the recent death of an eight-year-old girl as a result of pollution, according to her doctor,⁸² are putting the Chinese authorities under ever more intolerable pressure⁸³, and the system on which the amazing development and progress of the country is based. A palpable example of the

⁸⁰ While in the US the majority of power stations are reaching forty years of age, since they were created with the OPEC embargo, supplying some 20Gw with performance of less than 30%, in China, the super-critical modern power stations, with over 1Gw of power and less than 20 years' operation, supply electrical power of over 160Gw.

⁸¹ This procedure, put into practice during the war to prevent blockades, involves a large additional cost, a great deal of contamination and the use of a large quantity of water. China is the only place in the world which has a production facility, built in 2009, belonging to the Shenhua group and located in the autonomous region of Inner Mongolia, with a diesel production capacity of 24,000 Bld, and which it is apparently intended to increase to 240,000Bld in 2015.

⁸² http://sinosphere.blogs.nytimes.com/2013/11/05/an-8-year-old-girls-lung-cancer-is-blamed-on-air-pollution/?_r=0

⁸³ "Extensive development of fossil energy, particularly coal, has had a serious impact on the eco-environment. Large areas of arable land are taken up for other uses or even spoiled, water resources are seriously polluted, the discharge of carbon dioxide (CO₂), sulphur dioxide (SO₂), nitrogen oxides (NO_x) and toxic heavy metals remains high, and emissions of ozone and particles smaller than 2.5 micrometers (PM_{2.5}) are increasing. For a long time to come, fossil energy will continue to dominate the energy consumption mix, posing a growing challenge for protecting the environment and countering climate change. A more environment-friendly energy mix is urgently needed." White Paper: "China's Energy Policy 2012". October 2012, Beijing. State Council

importance of the political challenge of contamination is the existence of the Environmental Protection Ministry (EPM) when there is no Ministry of Energy.

The most recent steps taken in September by the State Council⁸⁴ concentrate on three areas: Beijing-Tianjin-Hebei, the Yangtze River Delta and that of the Pearl River⁸⁵, drastic measures to reduce the average level of particles in suspension⁸⁶, although the objectives have been considered to be not very realistic. Last June, the State Council restated its desire to achieve the objectives, and set down ten national measures which are divided so, as to complete thirty-five specific developments which are centered above all on the reduction of the consumption of coal and emissions from traffic road⁸⁷.

In 2017, the proportion of coal in energy consumption must be reduced to 65%⁸⁸ and the proportion of renewables has to reach 13%, of which 50Gw will be of nuclear origin. Furthermore, in the three special regions, the installation of new coal-fired plants is prohibited, and the consumption of coal must be reduced, which will affect the amount imported. Meanwhile, in those regions, in 2015, the vehicle registration certificate will not be renewed for any vehicle that is older than ten years. This

⁸⁴ The Plan of Action to prevent pollution was published on 12th September 2013, eight months after the grave episodes of contamination which affected almost a sixth of the territory. In the plan, the situation is considered serious and its influence on the health of the population is affecting social harmony and stability.

⁸⁵ "China's <three key regions>, the Beijing-Tianjin-Hebei region, Yangtze River Delta and Pearl River Delta, combined with the Shandong province, consume one third of all coal in China. Coal-burning is heavily concentrated around Beijing: one third of China's coal is burned within 600 kilometers of Beijing..." Greenpeace. "China clean air plan to slow coal consumption". September 2013

⁸⁶ "[The] deficient health systems would cease to be the main cause of premature death with that sad honour passing to atmospheric contamination due to the levels of particles in suspension, above all in certain Asian cities, which would amount 3.6 million deaths [2050], more than three times the current number which is estimated at a million." GARCIA SANCHEZ, Ignacio. "Los potenciadores de riesgo. El cambio climático". February 2013. Madrid. Strategy Notebooks. Ministry of Defence

⁸⁷ "Concern about air pollution has grown sharply in recent years, according to a Pew Research Center survey from this past spring. In that survey, 47% of Chinese said air pollution was a "very big" problem facing the country, up from 31% in 2008 and 36% last year. Air pollution ranked fourth out of 15 issues in terms of public concern, behind rising prices (which 59% of people cited as a very big problem), corrupt officials (53%) and the gap between rich and poor (52%)." The contamination of water, which in 2012 represented 33%, rose in 2013 to 40%. <http://www.pewresearch.org/fact-tank/2013/10/22/as-china-coughs-and-chokes-public-concern-about-air-pollution-rises/>

⁸⁸ The reductions in coal should be of 40Mt in Hebei, 20Mt in Shandong and 13Mt in Beijing. These three provinces consumed more coal in 2011 than the entire European Union. These provinces have increased their consumption by an average 6% annually, with the result that the objectives for reductions in absolute terms requires a dramatic change in the tendency of consumption.

measure, eliminating all vehicles registered before 2005, will be obligatory throughout the country from 2017.

These actions have been followed by the plans of local authorities⁸⁹, as in the case of Beijing, in which, among other measures, a maximum of six million vehicles authorized to drive in the city in 2017 has been set. Likewise, in order to stimulate these actions at the local level, the politburo will publish the ten best and ten worst cities in relation to air quality on a monthly basis.

Furthermore, the EPM has developed a more detailed plan for Beijing, Tianjin, Hebei, Shandong, Shanxi and Inner Mongolia, in which the following are worth emphasizing for their harshness: the closure of 1,200 highly contaminating companies in Beijing by 2017; the reduction in steel production capacity of 20 Mt in Tianjin, 6.7 Mt in Shanxi, 60 Mt in Hebei and 10 Mt in Shandong; the production of cement by 5 Mt in Tianjin and Inner Mongolia; 14 Mt of coal in Tianjin, as well as the fact that at the national level, an air monitoring system will be developed which will allow constant monitoring of the quality values, with a very demanding reduction in the levels considered tolerable.

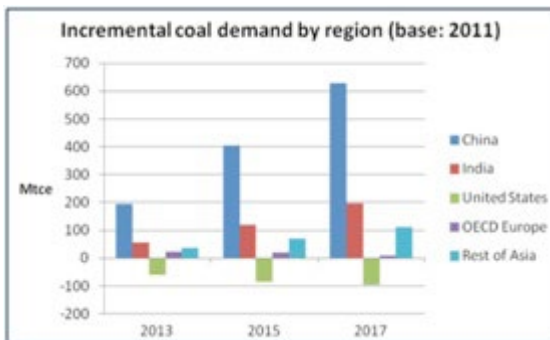


Figure 5.11b

Despite the efforts of the political authorities, the growth in demand in 2017, in accordance with the estimates of the IEA, will be eight times greater than the reduction that is forecast in the US (see figure 5.11b)⁹⁰. A battle, the reduction in the consumption of coal, which, as we have seen,

⁸⁹ The ceilings set up to now for Hebei, Shandong and Beijing require an absolute reduction in the consumption of coal of a total of 73Mt between 2012 and 2017. However, in comparison with the figures which would be achieved if current consumption continued, it means a reduction of over 150Mt, more than Germany's total consumption. The speed of the reductions required is quite high, approximately 2.5% annually, which is much more rapid than the rates of reduction of emissions of CO₂ than the industrialised countries made a commitment to at the Copenhagen climate conference.

⁹⁰ IEA. Medium Term Outlook for coal. 24th January 2013

is fought on all fronts, with wind and solar energy substituting for up to 100 Mt of coal, hydraulic energy up to 150 Mt, nuclear 80 Mt and natural gas about 100 Mt. It is in the natural gas substitute has where most of the effort is going to be done.

The main regions of production of natural gas are as follows: in the southwest, the province of Sichuan; in the northwest, Xinjiang and Qinghai; in the north, Shanxi; and in the northeast, Changqing. It is also produced in the shallow waters of the yellow sea and the southern sea, while at the same time explorations are taking place in deeper waters, and for unconventional gas with large multi-national companies. Although the great challenge is the regulation and integration of the internal market, where the local authorities still, in their territorial areas, exercise total control in gas distribution.

Other difficult political decisions refer to the assessed reserves in the deep waters of both seas, and the territorial disputes between all the countries in the area, which have, up to the present, delayed the study of their potential large scale development.

The oil reserves estimated in China's eastern sea are of between 60 and 160 Mbl⁹¹, with the result that it does not seem, in the medium term, the China will be a significant producer of crude. The extraction of crude from uncontested areas reached its maximum level in the 1990s, without ever exceeding 10.000Bld, while negotiations with Japan for the joint exploitation of several deposits, which began in 2008, were soon broken off as a result of the Chinese declaration of sovereignty over the proven deposits. The dispute, with demonstrations of strength by both parties has escalated recently with the unilateral declaration by China of an Air Defense Zone, which includes all the islands in dispute, and which has led the US to respond by exercising its right to strategic freedom of manoeuvre with two B-52 bombers overflying the area. Meanwhile, China is exercising its claimed sovereign right without, for the moment, escalating the conflict and endangering the stability and freedom of trade in the region.

In relation to gas reserves, the figures vary even more. While the EIA estimates reserves of up to 2,000 Tcf, Chinese sources reach 250.000 Tcf, the majority in disputed areas. The interest on the part of the Chinese authorities in bringing the area into production is very great, just as to be able to supply the important region of the Yangtze River delta.

In relation to China's southern sea, the disputes include the sovereignty of the Spratly and Paracel Islands, which has not prevented their exploitation by the countries of the area; although the progressive development of the region, and the growing need for domestic energy supplies, augmented by the high prices and the need to reduce the use of coal by

⁹¹ Reserves estimated by the EIA and Chinese sources respectively.

means of greater use of natural gas, is causing an increase of tension, with the presence of ships with in the disputed area, is causing more and more frequent incidents.

Although, it is difficult to determine the reserves due to the difficulty in carrying out explorations in the disputed areas, from the latest findings in the territorial seas, it is estimated that there may be up to 11Bbl of crude and 190,000 Bcf of natural gas. Apart from these estimates, the USGS⁹², in its most recent survey of 2010, evaluated the undiscovered reserves at between 5 and 22 Bbl and between 70.000 and 290.000 trillion cf, while the CNOOC, in November 2012, increased these estimates to 125 Bbl and 500.000 trillion cf.

However, the disputes about the sovereignty and the delimitation of the maritime boundaries in the area are not the principal problem for exploitation natural resources. Hence, the waters in dispute present some very significant technological and geological challenges due to the deep valleys and the strong underwater currents. Also, the region suffers seasonally from tropical storms and typhoons, a clear example being the recent and devastating passage of the typhoon Hayian through the Philippines, which, in accordance with the latest statistics, brought 5.632 dead, 26,136 injured and 1,759 missing, with close to eleven million people affected and damages of some \$700M. In order to reduce the scale of these challenges, Chinese companies are developing associations with international companies, above all American, Mexican and Brazilian ones, to incorporate the deep-water oil extraction technology used in the Gulf of Mexico and the Exclusive Economic Area of Brazil.

The irresistible access to the golden age of unconventional gas. A revolution yet to arrive

“China’s efforts to expedite the development of unconventional oil and gas resources are an important way to enhance its security of energy supply. It will speed up the exploration for and use of coal-bed gas, increase the proven geological reserves, and push forward the construction of industrial bases in the Qinshui Basin and eastern edge of the Ordos Basin. In order to accelerate the development of shale gas, the country will select a group of prospective areas and favorable exploration target areas, intensify efforts to solve difficulties in core technology, set up a new development mechanism, implement incentive policies for the shale gas industry, and improve supporting facilities. China aims to increase its annual output of shale gas to 6.5 billion cu m by 2015, and lay a solid foundation for the future rapid development of

⁹² USGS. U.S. Geological Survey. www.usgs.gov

*shale gas. In addition, it will strengthen the development of shale oil, oil sand and other unconventional oil and gas resources.*⁹³

The entry of the golden age of unconventional gas into China has some conditions to different those of the United States. Some of them deal with technological capacity of Chinese companies, to the property regime governing the land, its geological characteristics and the regulatory framework of the market. It is necessary to understand that US companies have been using these techniques for decades, favoured especially by the free market and the fact that, only since 2009, when the techniques used and the increase in the price of oil, encouraged by the commitments made to reduce CO₂ emissions at the Conference of the Parties (COP) in Copenhagen, have led prices to clearly diverge (see figure 5.12)⁹⁴, making these gas extraction techniques highly competitive.

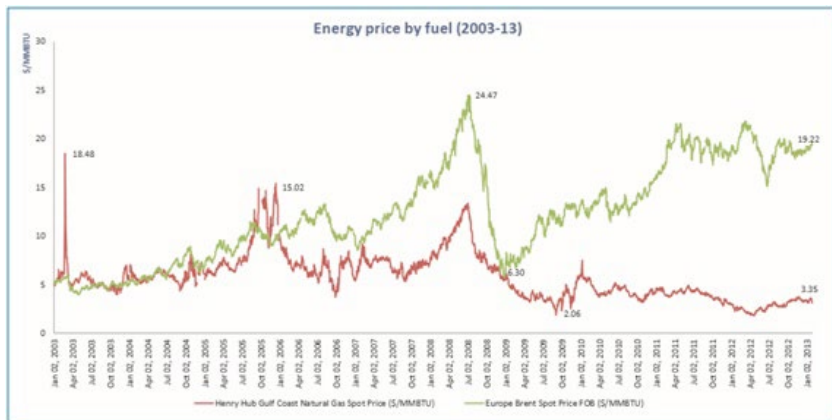


Figure 5.12

However, the relatively potential of clean energy that greater resources of unconventional gas can generate in the world, 1,275 quintillion cubic feet according to the EIA (see figure 5.13)⁹⁵, have impulse on the Chinese government, on the legal, commercial and technological framework, to boost the development of this new energy source. Thus, in March 2012, within the development of the five-year plan, 229.550Bcf by 2015 and

⁹³ White Paper: "China's Energy Policy 2012". October 2012, Beijing. State Council

⁹⁴ CSIS energy and national program. "Realizing the potential of U.S. unconventional natural gas". April 2013.

⁹⁵ EIA. "Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States." June 2013. KUSHKI-NA Ksenia. "Golden age of gas in China. Is there still a window of opportunity for more gas exports to China?" and CSIS energy and national program. "Realizing the potential of U.S. unconventional natural gas". April 2013. The left-hand graph refers to China and the right-hand graph to the US.

The rise of china and its energy supply

3,000 Tcf by 2020 were set as annual objectives, which would mean doubling the current volume of production of natural gas. The companies consider these figures highly optimistic, as they are at an initial stage from the technological point of view and regarding evaluation and testing. This reticence has been noticeable in the recent assignments of lots of land, where the main state and multi-national companies have been reluctant to present bids.

Table 6. Top 10 countries with technically recoverable shale gas resources

Rank	Country	Shale gas (trillion cubic feet)	
1	China	1,115	
2	Argentina	802	
3	Algeria	707	
4	U.S. ¹	665	(1,161)
5	Canada	573	
6	Mexico	545	
7	Australia	437	
8	South Africa	390	
9	Russia	285	
10	Brazil	245	
	World Total	7,299	(7,795)

¹ EIA estimates used for ranking order. ARI estimates in parentheses.

Figure 5.13a

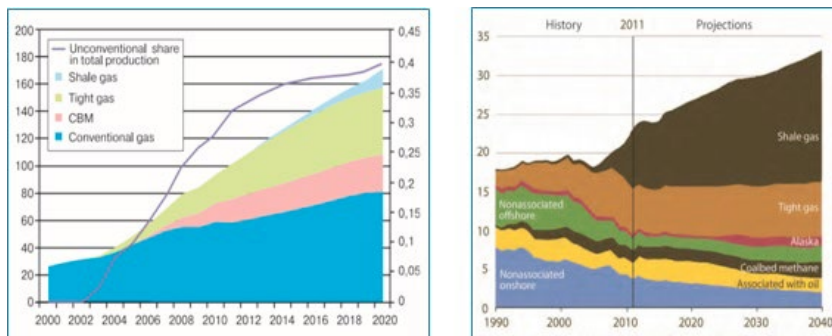


Figure 5.13b

Numerous challenges arise with this revolution which is changing radically the American energy map, and which looks as though it may reach other parts of the planet, although more slowly, and especially Asia and, more particularly, China. Thus, in China, the challenges complicate and slow down its commercial development, especially the tectonic complex-

ity of its main deposits, which are very young and therefore have many faults, which increases one of the main drawbacks in this kind of exploitation, seismic risks of hydraulic fracture, making them in some cases non-viable from a commercial point of view.

This problem has prevented greater exploitation of CBM⁹⁶ which, despite its potential, has stayed at 500 Mcfd after over 20 years' operation. Another no less important aspect is the transparency and availability of data, from open sources which are normal in other countries but in China are considered state secrets⁹⁷. This availability is an essential element for evaluation and prospective study of resources and their possible exploitation.

The four main areas evaluated (see figure 5.14) in the EIA survey include:

- The so-called southern corridor, a very large area which includes the Sichuan, Jiangnan and Subei basins, and the Yangtze platform, offers the greatest potential of reserves. However, while the quality of the rock is similar to certain North American deposits, the faults and structural complexity of the formation, as well as the excessive depth, signify considerable technological challenges to exploitation in the short and medium term.
- The Tarim basin, located in the Uyghur autonomous region of Xinjiang, China's largest sedimentary plateau, with an area greater than that of Spain and 1,000 meters above sea level. Although it is dry, the aquifers which underlie the region and its small population favor its use, as another of the great challenges presented by its commercial exploitation is the availability of abundant sources of water;
- The Junggar basin, of over 160,000 km², is located, like its neighbor the Tarim river basin, in the Uyghur autonomous region of Xinjiang, although it is less distant from potential markets and services, and also has better infrastructure, including the capital of the region, Urumqi, with three million inhabitants and the technological centre of the PetroChina company in Kelamayi. The region is undergoing a rapid development, thanks to the growing exploitation of its large oil,

⁹⁶ "China is estimated to have 10.2Tcf so far of proven CBM reserves in 2011, though estimates for recoverable reserves are much higher at over 350Tcf. Most of China's CBM volumes are from the basins in the North and Northeast, the Sichuan basin in the Southwest, and the Junggar and Tarim basins in the West... As part of the 12th Five-Year Plan, China's NEA has a target of producing 1,060Bcf/y by 2015. Another goal is to increase the utilization rates from less than 40 percent to over 60 percent by 2015, reducing the significant production waste. China's first commercial CBM pipeline became operational in late 2009, linking the Qinshui Basin with the West-East pipeline. Two additional long-distance pipelines have become operational, and several more are under construction." EIA. Country report. China

⁹⁷ EIA. ARI World Shale Gas and Shale Oil Resource Assessment. China chapter. 17th May 2013

The rise of china and its energy supply

gas and coal reserves, increasing its potential as a result of the geological and technological conditions and access to water. As a result of which there are already agreements with Shell and Hess to study its commercial exploitation.

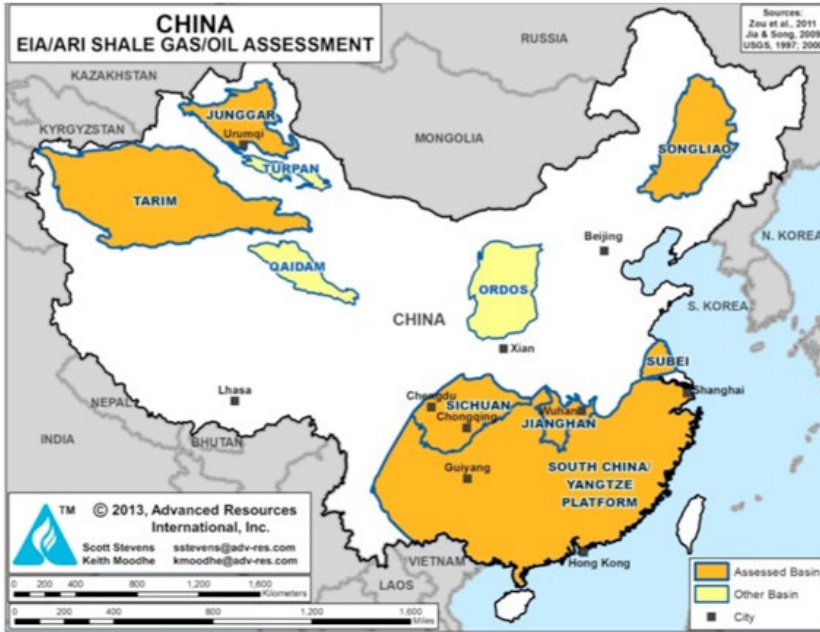


Figure 5.14

- The Songliao basin in the NE, with an area of close to 300,000 Km². has the largest oilfield, Daqing, at 800Bbld. Only recently has the potential capacity for natural gas production begun to be considered with new discoveries in relatively superficial locations. PetroChina has informed that it has already begun to produce unconventional oil, while it is studying the possible commercial exploitation of its reserves of gas with Hess, despite their structural complexity due to the sedimentary origin, which causes recurrent seismic movements.
- In the technological aspect, the companies in the sector are beginning to acquire the capacity to drill wells horizontally on a large scale, combined with massive hydraulic stimulation at different levels⁹⁸. Hence,

⁹⁸ "Sinopec's presentation at the 4th Annual Unconventional Hydrocarbons Summit 2012 described how China's 12th five-year plan calls for drilling 50 exploration wells, 150 production wells, and 990 water wells to verify 35.3 tcf geological and 7.06 tcf recoverable reserves by 2015. Thus far, 39 shale gas exploration wells and 12 production wells have been drilled in China, compared to about 35,000 wells that were drilled in

they are cautious when evaluating the capacity for progress of the sector, considering the objective of the ANE of 7,7Bcfd in 2020 ambitious. Of fundamental importance to achieving this aim are the agreements with foreign companies, which will allow them to overcome the significant technological challenges. Thus CNPC and Shell signed an agreement in March 2012 to exploit a deposit of unconventional gas in the Sichuan basin. Also, State Council is making prospecting rights more flexible for national companies of the sector in previously assigned sectors, allowing the Ministry of Land and Resources (MLR) to open auctions of extraction blocks to local companies and foreign investors, provided that the foreign ones from a joint venture part with a Chinese company.

The deterioration of the environment. The Climate Change on the horizon

*"The scientific assessment contained in the Working Group I report of the IPCC's Fifth Assessment Report released last September further reveals the authenticity of global warning and the urgency in addressing the challenge of climate change. Science and reality have shown us that climate change has become a real and severe threat to sustainable development, and that all countries should work hand in hand to tackle it through sincere cooperation."*⁹⁹

If climate change is the universal challenge of the 21st Century, and the energy sector is its main cause¹⁰⁰, China faces an even more fearful and complex challenge. The foreseeable consequences of its effects will have very severe effects on the Chinese ecosystem and, above all, on its sources of water¹⁰¹; apart from suffering locally the deterioration of the environment with prohibited contamination levels; and suffered by the region the devastating consequences of the more and more frequent and catastrophic extreme natural phenomena.

Thus, at the present stage of development, with a per capita energy consumption that is far below the objective set by the Communist Party for

the United States in 2006 alone. Additionally, among the shale gas wells in China, only nine have a daily output level of over 350 mcf, which is three to nine times lower in productivity when compared to an average U.S. shale gas well." NAKANO, Jane. "China Awards More Shale Gas Blocks although Much Remains to be Seen". 29th January 2013.

⁹⁹ ZHENHUA, Xie. Head of Delegation, Vice Chairman of the National Development and Reform Commission, People's Republic of China. *Speech on the High Level Segment of Warsaw Climate Change Conference*. 20th November 2013

¹⁰⁰ IPCC. Working Group I. Fifth Assessment Report. "Climate Change 2013: The Physical Science Basis."

¹⁰¹ See IEA. World Energy Outlook 2012. Chapter 17. "Water for energy. Is energy becoming a thirstier resource? Regional stress point. China". Page 518.

the celebration of its centenary, the systemic challenge of climate change looks formidable¹⁰². Socio-economic welfare, energy consumption and political legitimacy are opposing forces that the members of the politbu-ro put forward from an stance of global leadership. They acted as such at the Copenhagen conference in 2009, with over 300 heads of state, and so they participate together with the group of 77 in the discussions on climate change.

On this line of thought, the ERI¹⁰³, in one of the recommendations of its prospective study, emphasizes that China and the developing economies should have an active role in energy governance with special attention to energy security, climate change and technological innovation. However, ERI warns that China must improve its position as a leading country, through joining together with other developing countries so as to optimize the analytical systems on the reality and the statistics on energy data. A vision which transfers us to the ideological positions of the past century in the terrain of the challenges of the new century.

In this order of things, it considers that the international community should understand the rapid growth of energy demand of developing countries and especially emerging nations. Also, it should be considered that the unfavorable natural conditions of many of them and their technological backwardness oblige their governments to fight for *"the survival and development of their own people"*; thus, China is paying *"more and more"* for energy resources for the *"survival and development of its people, while it has to consume coal as a basic energy resource"*.

But the Chinese government knows that it is playing for high stakes. The survival of an inheritance: *"represented by the founding of the People's Republic of China by fighting a twenty-two-year war with the cost of more than twenty million lives, a war fought by the Chinese people under the leadership of the Communist Party... This is not an empty word. It is something which has been proven and tested over several decades of experience"*¹⁰⁴. And so, the efforts made by its authorities are formidable,

¹⁰² "Energy is the material basis for the progress of human civilization and an indispensable basic condition for the development of modern society. It remains a major strategic issue for China as the country moves towards its goals of modernization and common prosperity for its people... However, China's energy development still faces many challenges. The country's energy resource endowment is not high and its per-capita share of coal, petroleum and natural gas is low." White Paper: "China's Energy Policy 2012". October 2012, Beijing. State Council

¹⁰³ Energy Research Institute, National Development and Reform Commission. "China Energy Outlook". Executive Summary

¹⁰⁴ KISSINGER, Henry. "On China". (2011) The Penguin Press. New York. Kissinger quotes the words of Deng Xiaoping to the American envoy after the events in Tianan-

in the words of the IEA, it is as if there were a system of taxes for coal consumption in the shade which causes the movement of the market to improve efficiency and aim for its replacement with cleaner energy sources.¹⁰⁵

In this way, over the last eight years, energy consumption per unit of GDP has been reduced by 26.4%, which represents a saving of 980 Mtm of coal, 2.350 Btm of CO₂, and a reduction of 28% in the energy intensity of coal. At the same time, the percentage of non-fossil fuels in the energy mix grew to 9.6%, in which the proportion of renewable energies is the largest in the world.

Also, while the prospects of a competitive CO₂-capturing system (CCS, Carbon Capture and Store) recede from the immediate horizon, the Chinese government is making a remarkable effort to increase its forests, exceeding the initial objective of 1.3 Bm³ by almost 500 Mm³. Other actions are: mobilizing the social conscience by encouraging the people's participation, best practices and way of life by means of the "National Low Carbon Day"¹⁰⁶; and the start of the "Shenzhen Carbon Exchange" pilot project, which signals a decisive step in the development of a carbon emissions quota market.

In the international field, in order to encourage South-South cooperation, it has made \$10M available each year, between 2011 and 2013, for the development of capacities of adaptation in other countries, as well as courses in over 114 countries and a large number of donations of efficient systems, above all in the field of hydro-electricity and other renewables, in as many as twelve countries. And, on the way to 2020, with the commitment to reduce CO₂ emissions per unit of GDP by between 40% and 45% in comparison with the levels of 2005, it would be necessary, with eyes on the date in Paris in 2015, to increase the interest of the population in its importance, since in 2013 it only achieved 39%, 40% in the US, and 89% in Europe.¹⁰⁷

men Square. Page 419.

¹⁰⁵ "China's emissions in 2012 grew by one of the smallest amounts in a decade (300 Mt), as almost all of the 5.2% growth in electricity was generated using low-carbon technologies mostly hydro and declining energy intensity moderated growth in energy demand." IEA. "Redrawing the Energy-Climate Map". 10th June 2013.

¹⁰⁶ "Around 60% of the global savings in emissions are from the buildings sector [energy performance standards in buildings for lighting, new appliances, and for new heating and cooling equipment]. In countries where these efficiency policies already exist, such as the European Union, Japan, the United States and China, they need to be strengthened or extended." IEA. "Redrawing the Energy-Climate Map". 10th June 2013.

¹⁰⁷ <http://www.euractiv.com/climate-change/french-socialists-want-climate-c-news-531463>
Visited on 4th November 2013.

The technological revolution. A dream at a distance

*«God forbid, India should ever take to industrialisation, after the manner of the West, the economic imperialism of a single tiny island is keeping the world in chains – if an entire nation (India) of 300 million people took to a similar economic exploitation, it would strip the world bare like locusts».*¹⁰⁸

Human development has followed a path set by the technological revolution, allowing the supposed limits of progress to be systematically exceeded. In this regard, humanity has always felt itself to be supported by a creativity and inventiveness which has led it not to let any limit imposed by nature. Thus, economic, demographic and social projections which have been offered invariably by groups of scientists and ecological organizations, as warning signals to change the path to a more sustainable and balanced development, have been the subject of political debate, as well as critical elements to attain a more harmonious and balanced framework of security and development.

We may currently consider that we are at the verge of one of those choices. The fifth scientific report from the IPCC sets out unequivocally the fundamentally human nature of global warming, boosted by the growing energy consumption of fossil fuels; and, although the consequences are still to be determined, a new technological and industrial revolution is liberating millions of people from poverty, allowing an ever growing proportion of the population to have access to a middle class way of life.

Key for China, due to the need that it has to use fossil fuels, mainly coal, the cheapest source of energy and geopolitically highly stable. should be the development of a clean, efficient and accessible system which will make it possible to capture and store CO₂ emissions in a safe way.

However, the lack of progress in the technological development of CCS systems is upsetting as all the projections and models of sustainable future scenarios require its commercial deployment in electricity generation and industry. The CCS systems would be the technological frontier which would permit the industrial sectors, such as iron, steel, cement and the processing of natural gas, to reduce the rate of emissions so, its implantation in the future is critical. If a commercially viable system were not achieved, the basic cost to achieve the same level of reduction of emissions would increase by 40%, with an estimated total figure of \$2.000B over forty years. At the same time, the pressure on other options for reductions of emissions will also be greater.

Thus, China, in its twelfth five-year plan aims to duplicate the investments in CCS development, above \$65 M, which would allow it to attract nearly

¹⁰⁸ Mahatma Gandhi (1928)

\$400 M, over twice the capital invested between 2006 and 2010. Alstom SA, the third largest electrical equipment company, based in France, and Chian Datang Corp. signed an agreement to develop a prototype and store CO₂ in large oilfields, such as Levallois-Perret.

China with twelve projects at different stages of progress, compared with five in 2010, appears just behind the United States in research and development into these systems. In this line, a memorandum of understanding was recently signed in London¹⁰⁹ for the establishment of a wide network which would give an incentive to research and development in this area and, in the medium term, three or four years, to carry out demonstrations from a commercial point of view. In the same meeting, the British Minister of Energy and Climate Change and the Governor of the province of Guangdong signed an agreement to develop these technologies.

The second key technological aspect for China is the dependency of its transport and logistical sector¹¹⁰ on oil, a pivotal element for its energy security. Dominated by high prices and a geo-political environment considered from the Chinese point of view as a rising energy nationalism: *"... over the last 100 years it has evolved from the land to the sea and the polar regions, while countries face their energy security and attempt to protect their sovereignty and integrity. The main characteristics include: defense of sovereignty over their energy resources by all countries in all regions, disputes and complaints over areas reach in natural resources, and geo-political conflicts inherited from the past"*¹¹¹

Among the key aspects considered in its five-year plan, apart from the general objectives¹¹², there are other more specific ones such as: reaching 83.000 Km of motorway¹¹³ from the current 74.000 Km (in the United States and the European Union there are nearly 100.000 Km), constructing an airport in Beijing and going from the 175 airports in the previous

¹⁰⁹ The UK Carbon Capture and Storage Research Centre (UKCCSRC), Scottish Carbon Capture and Storage (SCCS), Guangdong Low-carbon Technology and Industry Research Centre (GDLRC) and the Clean Fossil Energy Development Institute (CFEDI) signed the ten-year Memorandum of Understanding (MoU) at Lancaster House, in London, witnessed by Governor Zhu Xiaodan of Guangdong Province, People's Republic of China, and Minister Greg Barker of the UK's Department of Energy and Climate Change (DECC)

¹¹⁰ The congestion and the low velocity of road traffic is a fundamental factor in the inefficiency of domestic transport and industrial logistics, with costs which represent 18% of GDP, compared with 8% in the EU and 9.5% in the United States. KPMG China. "Logistics cost as a percentage of GDP".

¹¹¹ ERI. *"China Energy Outlook"*. Executive Summary, 1st November 2012.

¹¹² Increase in the use of non-fossil fuels up to 11.4%, reduction in the energy consumed per unit of GDP of 16% and a reduction in emissions per unit of GDP of 17%.

¹¹³ For rural areas, the objective is to ensure that in 2015, all cities and 90% of villages are accessible with vehicles. At the beginning of the current five-year plan, 1,200 towns and 120,000 villages did not have asphalted roads.

plan to 220 in the current one, all of which, although inevitably increasing consumption, will improve efficiency and capacity in the transport and logistics sector. In this way, the efforts are multiplied to encourage clean traffic, putting special emphasis on the use and improvement of the internal waterways¹¹⁴, increasing the high-speed railway network up to 45.000 Km., and the links between cities of over 500.000 inhabitants. Also, the transport of coal by train, which amounts currently to 80% of the total, has a special treatment as strategic infrastructure. This last is a sector in which the use of liquefied gas in diesel motors is viewed with great optimism.

However, that important effort is tarnished by the current expectations for achieving the objectives set by one of the priority sectors in the five-year plan, "*clean energy vehicles*". Despite the fact that, in 2007 for the first time, a member of the cabinet, who was not a Communist Party member, was appointed¹¹⁵, a personality in the research of new batteries for cars, the development of electric vehicles continues to be disappointed and the cost continues to prevent its large-scale commercial use. The expectations for achieving two million electric vehicles in 2020 seem to be far from reality (figure 5.15)¹¹⁶. In order to achieve this, the Chinese authorities intend to boost and concentrate the production of electrical batteries in two or three companies with 10.BKwh of production capacity. The plan is to reduce the cost from \$0,33 to \$0,25 per kWh.

Despite the enormous progress in other areas, such as renewable energies, the fundamental problem in the auto sector is its fragmentation. This diversification arises from the importance that the automobile industry has in employment and in the economy of the different provinces, with the result that the local authorities do not wish to lose control over it. Thus, the production of electrical vehicles extends over 23 provinces which only reach the 45% of total units, with the result that it is very difficult to achieve a commercial product. Despite state incentives, which means as much as \$9,000, of the over one hundred thousand electrical vehicles which were expected to be put into circulation this year only ten thousand have been registered. Furthermore, the support infrastructure

¹¹⁴ China currently has up to 110,000Km of navigable waterways which amount to 67% of the total capacity transported by sea.

¹¹⁵ "...in 2007, the Chinese President Hu Jintao appointed the engineer, Wan Gang, a world authority in electrical vehicles, as Minister for Scientific Development, breaking for the first time with the tradition that all ministers must be members of the Communist Party." GARCÍA SÁNCHEZ, Ignacio. "*El Cambio Climático: Implicaciones para la Seguridad y la Defensa*". (2011) Ministry of Defence. Madrid.

¹¹⁶ Electric Vehicle Market Forecasts Global Forecasts for Light Duty Hybrid, Plug-in Hybrid, and Battery Electric Vehicles: 2013-2020: Hybrid electric vehicles (HEVs); Plug-in hybrid electric vehicles (PHEVs); Battery electric vehicles (BEVs).

in the large cities is scarce, such as Beijing which only has 64 charging stations.

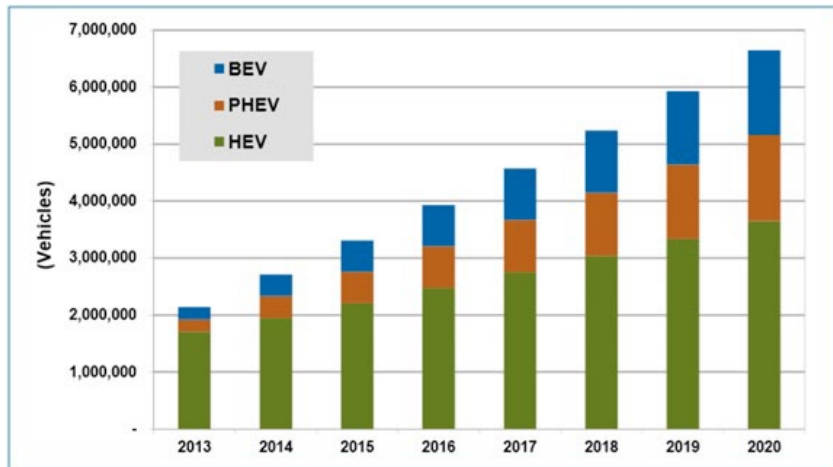


Figure 5.15

The challenge of nuclear security after Fukushima

“As North Korea threatened another nuclear test, the PRC Foreign Ministry, on January 14, 2013, shifted slightly to stress denuclearization in addition to stability. Xi Jinping then met on January 23 with an envoy of South Korea’s president-elect Park Geun-hye and stressed denuclearization on the Korean peninsula. At the same time, the PRC voted with all other members of the UNSC for Resolution 2087 to condemn the DPRK’s missile test over a month before, and impose travel bans and asset freezes on DPRK entities, including in the PRC... PRC media editorials, academic articles, and public opinion on the Internet called for toughening up on or abandoning North Korea. Official military news reported on the UNSC’s condemnation of the nuclear test and a drill in the Shenyang Military Region that involved a scenario of nuclear, biological, or chemical warfare.”¹¹⁷

Security and safety are of paramount in determining the development of nuclear energy in China. Thus, as a consequence of the nuclear accident in Japan, at Fukushima Daiichi in March 2011, the authorizations for new plants were suspended while the safety of the power stations in service were revised and of those under construction. The stress tests ended in December 2011 and the State Council approved a safety plan for all

¹¹⁷ KAN Shirley A. “China and Proliferation of Weapons of Mass Destruction and Missiles: Policy Issues”. Congressional Research Service. Washington. 11th March 2013.

installations in May 2012, allowing the planned nuclear development to continue.

Meanwhile, the privileged relationship of China with North Korea, Pakistan and Iran, the three countries on which the international community currently centers its main concerns in the field of the proliferation of nuclear armaments and launch vectors, make the geo-political giant a fundamental security actor on the international arena.

Also, the Chinese authorities are actively promoting nuclear energy as a source of generation of electricity which is clean, efficient, and stable with a useful lifetime of 40-60 years, which is longer than the power plants which use another type of fuel. In this regard, the twelfth five-year plan considers nuclear, together with wind and solar energy, one of the seven priority sectors. Thus, the politburo has approved ten new projects with an increase in capacity of 43 Gw in 2015.

Countries with rapid growth, such as China and India, need to use all possible sources of energy to support the rapid progression of their demand. The high prices of energy, the growing geo-political risks and the irresistible social pressure due to the deterioration of the environment make nuclear energy very attractive. Furthermore, modern nuclear technology is more and more efficient, safe and clean¹¹⁸.

In this regard, nuclear energy is one of the best alternatives, for the time being, to replace fossil fuels, especially coal, for the generation of electricity in an economical and practical manner. If no new reactor were to come into service in the OECD countries, and only half of those projected in the remaining countries, the additional cost for power in 2035 from other sources would involve an extra cost of \$1.500T, 10% of the total¹¹⁹. This cost would be especially hard to bear for those countries with few reserves of fossil energy of their own.

Starting from a small current capacity, 15 reactors and 12.5 Gw, which amounts to a little more than 1% of the installed electrical generating capacity, the Chinese government is planning a massive investment in new power plants to achieve, by 2020, a capacity of more than 70Gw (see figure 5.16)¹²⁰. Thus, in mid- 2012, there were 30 reactors with over 33Gw under construction, which involved half of the nuclear power under development around the world. Also, and in support of this nuclear capacity, China intends to increase its commercial and strategic reserves of uranium to the

¹¹⁸ For example, the reactors of the Fukushima power station were built before the accident at the "Three Mile Island" plant, in the American state of Pennsylvania on 28th March 1979, which led to a great improvement in the safety of designs.

¹¹⁹ "Low Nuclear Case" scenario of the IEA.

¹²⁰ EIA. Outlook 2013. Figure 5.16. Nuclear electrical generation capacity in the world, 2010, 2020 and 2014 in Gw.

same level through purchases in external markets, as well as domestic production in the autonomous regions of Inner Mongolia and Xinjiang.

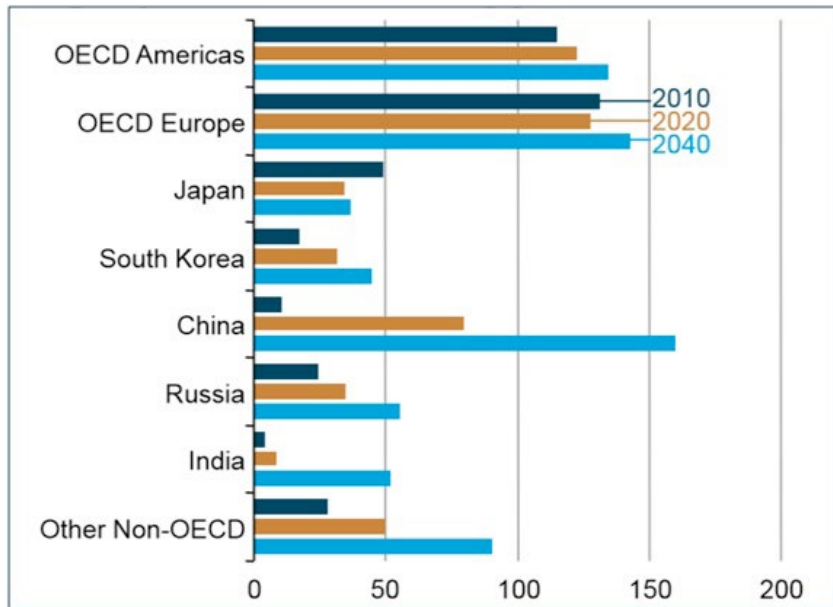


Figure 5.16

Led by China, nuclear energy will continue to be a vital component of the energy policies of many countries, especially developing countries with high growth rates. The expansion will quadruple the current nuclear plants by 2035, with eight countries in the Far East in the lead: China, Indonesia, Japan, North Korea, South Korea, Malaysia, Thailand and Vietnam. The capacity of the region is 77 Gw, 20.7% of the world total, with 33 power plants under construction of 64 around the world and 72 more of 160 planned. This proliferation of nuclear power plants in the region demands a high level of mutual confidence and cooperation. A relationship which does not have the political sensitivity of other subjects, and which due to its importance involves a significant improvement of the regional integration process.

One example is the “Top Regulators Meeting”, which on 29th November 2013 held its sixth trilateral meeting (China, South Korea and Japan), at which an agreement was signed for exchange of information in the case of a nuclear accident, as well as expert analyses and any additional technical information. Also, to check the effectiveness of the information exchange systems, exercises will be held annually directed by each of the three countries in rotation. Furthermore, joint research projects into nuclear safety will be encouraged and working systems by videoconference and online data exchange will be used.

It would seem to be advisable to integrate this mechanism into other regional mechanisms, such as the ASEAN+3 Nuclear Safety Forum, as well as with the multiple centers of excellence which exist in the region. China, with its robust nuclear programme, the good safety record, without any important accident over the last twenty years, and the diplomatic resources and commercial links in the region, should lead the cooperation effort in nuclear safety. In this regard, the experience of the Fukushima accident and the consequent stress tests, as well as the diverse strategies for disposal of used material, the supply of nuclear fuel or the creation of a fuel bank, such as that at Angarsk in Russia, are important subjects.

Thus, and against the criticisms of disproportionate development of nuclear programme associated with the traditional lack of transparency, cooperation with the International Atomic Energy Agency¹²¹, as well as the prudent reaction of the State Council of¹²² after the accident, must be a clear example of China's determination to avoid any accident in the future in anywhere in the world. Any breach of security would put its nuclear programme in grave danger, which is of enormous importance not only due to the economic investment, but also due to its great importance for improving the environment and strategic autonomy, with special influence on energy security.

Conclusions. A SWOT analysis

*"The Chinese dream, after all, is the dream of a people. We must realize this, because its realization will depend closely on the people. We must constantly transfer the advantages to the people. We must understand that the great renewal of the Chinese nation is the greatest dream of its modern history."*¹²³

China and energy are the two fundamental factors in the geo-strategic scenario of the first half of the 21st Century and, probably, for good of for ill, it will be decisive in the global geo-political panorama of the second half.

Energy is the flow of the life blood of development, it has been and will always be. But, as a necessary element for the survival and progress of

¹²¹ Cooperation with the International Atomic Energy Agency is specifically in its Training Centre and the numerous courses and seminars that it imparts.

¹²² "...The NSSA (National Nuclear Safety Administration) carried out inspection over 9 months and gave support to the subsequent deliberations of the State Council to announce the safety plan up to 2020, both documents were published on its web site for public comment and there was another four-month-long review process, including some revisions proposed by Taiwan ..." CHONG, Liu. "After Fukushima: China's Nuclear Safety". 29th May de 2013. Author's translation.

¹²³ Quotes from Xi Jinping. <http://www.xinhuanet.com/english/special/chinese-dream/>. Author's translation. Visited 18th August 2013.

any social group, its accessibility, affordability and security has caused and will cause geo-political competition and geo-strategic instability.

China has been the guest artist of the geo-political history over the last twenty years and, thanks to its audience ratings, will become, without a doubt, one of the stars in the geo-strategic script which must come on stage in the coming season. The evolution of the future scenario will depend on China's new role as a protagonist and on how the remaining actors adapt to the new story. Without any doubt, the only element of which we can be sure, right now, is that the plot will have large doses of intrigue and suspense. But whether it will develop into a tragedy, drama or comedy will depend in large part on: on the one hand, how his position as a star will affect the new actor and his adaptation to its demanding status; on the other, the attitude of the former leading actors and their adaptation to the new role which the course of the story will offer them.

If the two elements separately are factors of great geo-strategic importance, together they are one of those events which prospective analytical methodology would recognize as "*megatrends*"¹²⁴. Thus, as a summary, I intend to conclude the article with a SWOT analysis in which to set out the geo-strategic challenge which Chinese energy supply involves.

Strengths

The decisive commitment made towards clean energy sources with an incomparable capacity to carry out large projects which, due to the prestige they give, also help to legitimate the Communist Party. An effort, the strengthening of the one-party system, which has its effect on two key elements for the security of the energy supply: the great effort of political legitimization on the international stage helped by a financial liquidity at record levels, allows China's most important companies to become true multinationals diversifying their business portfolio which ensures external supply while, at the same time the anti-corruption campaign becomes even more intensified in the energy sector through the actions of President, the politburo takes advantage of the opportunity to follow the pathway of progressive energy market liberalization, with an ever-greater openness to international cooperation. In this way, it is intended to accelerate the technological development necessary to improve the capacity for the exploitation of China's own reserves and to optimize efficiency in consumption.

Weaknesses

Environmental degradation is without a doubt the great weakness that Chinese energy policy faces. The rapid economic development has been

¹²⁴ TORRÓN DURÁN, Ricardo, et al. "Prospectiva de Seguridad y Defensa: viabilidad de una unidad de prospectiva en el CESEDEN". (2007). CESEDEN monographs. Madrid.

carried out thanks to an unprecedented boost of manufacturing industry, with coal as a basic energy source.

Furthermore, the exponential growth of the urban middle class without a advanced gas infrastructure, together with the incipient incorporation of renewable energies in the electricity grid system and the slow development of clean transport means pose a great challenge in the efforts for the reduction of atmospheric pollution. But even more, the gas price level on the Asian market continues to be a very important factor which prevents a drastic reduction in the constant growth in the use of coal as a basic element of the Chinese energy mix.

Also, the political model, the administrative system, as well as the current laws related with the legal ownership of land, and the not-very-favorable geological conditions for the commercial extraction of unconventional gas, limit the possibility of following the pathway traced by the United States and, thus, benefitting from a truly free and efficient energy market with abundant gas at a low price.

Opportunities

The geo-political audience is watching China's historic development with perplexity and hope. The Chinese model, very far from the western standard, is natural and confident in its international relations, but without the messianic nature of other cultures. Its objective, the improvement of the standard of living of China's immense population, in which energy plays a central role, is the great challenge to the survival of the one-party state model. The ability to manage the great challenges presented by its achievement will dictate the success of the undertaking, at one and the same time historic and titanic and, in consequence, the continuity of the regime.

In this regard, climate change and the fossil fuel price differential open up a wide range of possibilities for development of an international nature. An opportunity for cooperation with a very demanding calendar, which requires a change of paradigm in the policies of energy supply with a displacement of the focus towards consumption. A paradigm which requires a truly global cooperative geopolitical effort in which innovation, participation and development are the main points of the new energy security framework.

Threats

Although the diversification of the supply routes, the multiplicity of available energy sources, as well as the great advances in the efficiency of consumption and the constant progress in leading-edge technologies, both in extraction and in consumption could lead us to think of a vague threat of a breakdown in energy supply, the reality is much more worrying.

The energy consumption necessary to maintain a growth rate capable of conserving the internal social stability and facilitating the slow recovery of the world economy is of such magnitude that: the situation of tension which is currently being experienced in the China seas, as well as the uncertainty in its continental neighborhood, with Afghanistan and Pakistan as hot points, together with the situation of chronic instability in the areas richest in hydrocarbons, with policies that are more and more nationalist, place the Asian colossus in a situation of special vulnerability. Likewise, the tendency to renationalize the energy business in the developed countries, and the practical absence of strategic reserves in the country might compromise the security of its supply in the future if there were a massive abandonment of the use of coal in favor of oil and gas.

Abbreviations and Acronyms

\$. US Dollar

DNA. Deoxyribonucleic Acid. The genetic material in a cell

IEA. International Energy Agency

ARI. Advanced Resources International

B. Billion. 1000 million

Bcf. Billion (1000 million) of cubic feet

Bl. Barrels of liquid fossil fuels

Bld. Barrels of liquid fossil fuels a day

Btu. British thermal unit

CBM. Coal Bed Methane

CCS. Carbon Capture and Store

Cf. Cubic feet

Cfd. Cubic feet per day

CIA. Central Intelligence Agency. United States

CNOOC. China National Offshore Oil Corporation

CNPC. China National Petroleum Corporation

CO₂. Carbon dioxide

CSIS. Center for Strategic and International Studies

EDA. European Defence Agency.

EIA. Energy Information Administration. United States

EPM. Environmental Protection Ministry

ERI. Energy Research Institute, National Development and Reform Commission. China

ETP. Energy Technology Perspectives

LNG. Liquefied natural gas

Gw. Gigawatt. A billion watts. 10^9 watts.

IPCC. Intergovernmental Panel on Climate Change

Km². Square kilometers

kWh. Kilowatt hour

M. Million. 10^6

MOU. Memorandum of Understanding

Mtm. Millions of metric tons

NOC. National Oil Company

OECD. Organization for Economic Cooperation and Development

OAPEC. Organization of Arab Petroleum Exporting Countries

OPEC. Organization of Petroleum Exporting Countries

GDP. Gross Domestic Product

PPP. Purchasing Power Parity. World Bank conversion factor. Amount in dollars necessary to purchase in the domestic market of the United States, the quantity of goods and services produced in each country.

Sinopec. China Petrochemical Corporation

PRC. People's Republic of China

RPDC. Democratic People's Republic of Korea

T. Trillion. 1000 billion

EU. European Union

UN. United Nations

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- <http://www.stats.gov.cn/english/>
- <http://www.sustainableenergyforall.org/>
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Strategic Dossier

- 01 La industria alimentaria civil como administradora de las FAS y su capacidad de defensa estratégica
- 02 La ingeniería militar de España ante el reto de la investigación y el desarrollo en la defensa nacional
- 03 La industria española de interés para la defensa ante la entrada en vigor del Acta Única
- 04 Túnez: su realidad y su influencia en el entorno internacional
- 05 La Unión Europea Occidental (UEO) (1955-1988)
- 06 Estrategia regional en el Mediterráneo Occidental
- 07 Los transportes en la raya de Portugal
- 08 Estado actual y evaluación económica del triángulo España-Portugal-Marruecos
- 09 Perestroika y nacionalismos periféricos en la Unión Soviética
- 10 El escenario espacial en la batalla del año 2000 (I)
- 11 La gestión de los programas de tecnologías avanzadas
- 12 El escenario espacial en la batalla del año 2000 (II)
- 13 Cobertura de la demanda tecnológica derivada de las necesidades de la defensa nacional
- 14 Ideas y tendencias en la economía internacional y española

- 15 Identidad y solidaridad nacional
- 16 Implicaciones económicas del Acta Única 1992
- 17 Investigación de fenómenos belígenos: método analítico factorial
- 18 Las telecomunicaciones en Europa, en la década de los años 90
- 19 La profesión militar desde la perspectiva social y ética
- 20 El equilibrio de fuerzas en el espacio sur europeo y mediterráneo
- 21 Efectos económicos de la unificación alemana y sus implicaciones estratégicas
- 22 La política española de armamento ante la nueva situación internacional
- 23 Estrategia finisecular española: México y Centroamérica
- 24 La Ley Reguladora del Régimen del Personal Militar Profesional (cuatro cuestiones concretas)
- 25 Consecuencias de la reducción de los arsenales militares negociados en Viena, 1989. Amenaza no compartida
- 26 Estrategia en el área iberoamericana del Atlántico Sur
- 27 El Espacio Económico Europeo. Fin de la Guerra Fría
- 28 Sistemas ofensivos y defensivos del espacio (I)
- 29 Sugerencias a la Ley de Ordenación de las Telecomunicaciones (LOT)
- 30 La configuración de Europa en el umbral del siglo XXI
- 31 Estudio de «inteligencia operacional»
- 32 Cambios y evolución de los hábitos alimenticios de la población española
- 33 Repercusiones en la estrategia naval española de aceptarse las propuestas del Este en la CSBM, dentro del proceso de la CSCE
- 34 La energía y el medio ambiente
- 35 Influencia de las economías de los países mediterráneos del norte de África en sus respectivas políticas defensa
- 36 La evolución de la seguridad europea en la década de los 90
- 37 Análisis crítico de una bibliografía básica de sociología militar en España. 1980-1990
- 38 Recensiones de diversos libros de autores españoles, editados entre 1980-1990, relacionados con temas de las Fuerzas Armadas
- 39 Las fronteras del mundo hispánico
- 40 Los transportes y la barrera pirenaica
- 41 Estructura tecnológica e industrial de defensa, ante la evolución estratégica del fin del siglo XX

- 42 Las expectativas de la I+D de defensa en el nuevo marco estratégico
- 43 Costes de un ejército profesional de reclutamiento voluntario. Estudio sobre el Ejército profesional del Reino Unido y (III)
- 44 Sistemas ofensivos y defensivos del espacio (II)
- 45 Desequilibrios militares en el Mediterráneo Occidental
- 46 Seguimiento comparativo del presupuesto de gastos en la década 1982-1991 y su relación con el de Defensa
- 47 Factores de riesgo en el área mediterránea
- 48 Las Fuerzas Armadas en los procesos iberoamericanos de cambio democrático (1980-1990)
- 49 Factores de la estructura de seguridad europea
- 50 Algunos aspectos del régimen jurídico-económico de las FAS
- 51 Los transportes combinados
- 52 Presente y futuro de la conciencia nacional
- 53 Las corrientes fundamentalistas en el Magreb y su influencia en la política de defensa
- 54 Evolución y cambio del este europeo
- 55 Iberoamérica desde su propio sur. (La extensión del Acuerdo de Libre Comercio a Sudamérica)
- 56 La función de las Fuerzas Armadas ante el panorama internacional de conflictos
- 57 Simulación en las Fuerzas Armadas españolas, presente y futuro
- 58 La sociedad y la defensa civil
- 59 Aportación de España en las cumbres iberoamericanas: Guadalajara 1991-Madrid 1992
- 60 Presente y futuro de la política de armamentos y la I+D en España
- 61 El Consejo de Seguridad y la crisis de los países del Este
- 62 La economía de la defensa ante las vicisitudes actuales de las economías autonómicas
- 63 Los grandes maestros de la estrategia nuclear y espacial
- 64 Gasto militar y crecimiento económico. Aproximación al caso español
- 65 El futuro de la Comunidad Iberoamericana después del V Centenario
- 66 Los estudios estratégicos en España
- 67 Tecnologías de doble uso en la industria de la defensa
- 68 Aportación sociológica de la sociedad española a la defensa nacional

- 69 Análisis factorial de las causas que originan conflictos bélicos
- 70 Las conversaciones internacionales Norte-Sur sobre los problemas del Mediterráneo Occidental
- 71 Integración de la red ferroviaria de la península ibérica en el resto de la red europea
- 72 El equilibrio aeronaval en el área mediterránea. Zonas de irradiación de poder
- 73 Evolución del conflicto de Bosnia (1992-1993)
- 74 El entorno internacional de la Comunidad Iberoamericana
- 75 Gasto militar e industrialización
- 76 Obtención de los medios de defensa ante el entorno cambiante
- 77 La Política Exterior y de Seguridad Común (PESC) de la Unión Europea (UE)
- 78 La red de carreteras en la península ibérica, conexión con el resto de Europa mediante un sistema integrado de transportes
- 79 El derecho de intervención en los conflictos
- 80 Dependencias y vulnerabilidades de la economía española: su relación con la defensa nacional
- 81 La cooperación europea en las empresas de interés de la defensa
- 82 Los cascos azules en el conflicto de la ex-Yugoslavia
- 83 El sistema nacional de transportes en el escenario europeo al inicio del siglo XXI
- 84 El embargo y el bloqueo como formas de actuación de la comunidad internacional en los conflictos
- 85 La Política Exterior y de Seguridad Común (PESC) para Europa en el marco del Tratado de no Proliferación de Armas Nucleares (TNP)
- 86 Estrategia y futuro: la paz y seguridad en la Comunidad Iberoamericana
- 87 Sistema de información para la gestión de los transportes
- 88 El mar en la defensa económica de España
- 89 Fuerzas Armadas y sociedad civil. Conflicto de valores
- 90 Participación española en las fuerzas multinacionales
- 91 Ceuta y Melilla en las relaciones de España y Marruecos
- 92 Balance de las primeras cumbres iberoamericanas
- 93 La cooperación hispano-franco-italiana en el marco de la PESC
- 94 Consideraciones sobre los estatutos de las Fuerzas Armadas en actividades internacionales

- 95 La unión económica y monetaria: sus implicaciones
- 96 Panorama estratégico 1997/98
- 97 Las nuevas Españas del 98
- 98 Profesionalización de las Fuerzas Armadas: los problemas sociales
- 99 Las ideas estratégicas para el inicio del tercer milenio
- 100 Panorama estratégico 1998/99
- 100 1998/99 Strategic Panorama
- 101 La seguridad europea y Rusia
- 102 La recuperación de la memoria histórica: el nuevo modelo de democracia en Iberoamérica y España al cabo del siglo XX
- 103 La economía de los países del norte de África: potencialidades y debilidades en el momento actual
- 104 La profesionalización de las Fuerzas Armadas
- 105 Claves del pensamiento para la construcción de Europa
- 106 Magreb: percepción española de la estabilidad en el Mediterráneo, prospectiva hacia el 2010
- 106-B Maghreb: perception espagnole de la stabilité en Méditerranée, prospective en vue de L'année 2010
- 107 Panorama estratégico 1999/2000
- 107 1999/2000 Strategic Panorama
- 108 Hacia un nuevo orden de seguridad en Europa
- 109 Iberoamérica, análisis prospectivo de las políticas de defensa en curso
- 110 El concepto estratégico de la OTAN: un punto de vista español
- 111 Ideas sobre prevención de conflictos
- 112 Panorama Estratégico 2000/2001
- 112-B Strategic Panorama 2000/2001
- 113 Diálogo mediterráneo. Percepción española
- 113-B Le dialogue Méditerranéen. Une perception espagnole
- 114 Aportaciones a la relación sociedad - Fuerzas Armadas en Iberoamérica
- 115 La paz, un orden de seguridad, de libertad y de justicia
- 116 El marco jurídico de las misiones de las Fuerzas Armadas en tiempo de paz
- 117 Panorama Estratégico 2001/2002
- 117-B 2001/2002 Strategic Panorama
- 118 Análisis, estrategia y prospectiva de la Comunidad Iberoamericana

- 119 Seguridad y defensa en los medios de comunicación social
- 120 Nuevos riesgos para la sociedad del futuro
- 121 La industria europea de defensa: presente y futuro
- 122 La energía en el espacio euromediterráneo
- 122-B L'énergie sur la scène euroméditerranéenne
- 123 Presente y futuro de las relaciones cívico-militares en Hispanoamérica
- 124 Nihilismo y terrorismo
- 125 El Mediterráneo en el nuevo entorno estratégico
- 125-B The Mediterranean in the New Strategic Environment
- 126 Valores, principios y seguridad en la comunidad iberoamericana de naciones
- 127 Estudios sobre inteligencia: fundamentos para la seguridad internacional
- 128 Comentarios de estrategia y política militar
- 129 La seguridad y la defensa de la Unión Europea: retos y oportunidades
- 130 El papel de la inteligencia ante los retos de la seguridad y defensa internacional
- 131 Crisis locales y seguridad internacional: El caso haitiano
- 132 Turquía a las puertas de Europa
- 133 Lucha contra el terrorismo y derecho internacional
- 134 Seguridad y defensa en Europa. Implicaciones estratégicas
- 135 La seguridad de la Unión Europea: nuevos factores de crisis
- 136 Iberoamérica: nuevas coordenadas, nuevas oportunidades, grandes desafíos
- 137 Irán, potencia emergente en Oriente Medio. Implicaciones en la estabilidad del Mediterráneo
- 138 La reforma del sector de seguridad: el nexo entre la seguridad, el desarrollo y el buen gobierno
- 139 Security Sector Reform: the Connection between Security, Development and Good Governance
- 140 Impacto de los riesgos emergentes en la seguridad marítima
- 141 La inteligencia, factor clave frente al terrorismo internacional
- 142 Del desencuentro entre culturas a la Alianza de Civilizaciones. Nuevas aportaciones para la seguridad en el Mediterráneo
- 143 El auge de Asia: implicaciones estratégicas
- 144 La cooperación multilateral en el Mediterráneo: un enfoque integral de la seguridad

- 145 La Política Europea de Seguridad y Defensa (PESD) tras la entrada en vigor del Tratado de Lisboa
- 145 B The European Security and Defense Policy (ESDP) after the entry into Force of the Lisbon Treaty
- 146 Respuesta europea y africana a los problemas de seguridad en África
- 146 B European and African Response to Security Problems in Africa
- 147 Los actores no estatales y la seguridad internacional: su papel en la resolución de conflictos y crisis
- 148 Conflictos, opinión pública y medios de comunicación. Análisis de una compleja interacción
- 149 Ciberseguridad. Retos y amenazas a la seguridad nacional en el ciberespacio
- 150 Seguridad, modelo energético y cambio climático
- 151 Las potencias emergentes hoy: hacia un nuevo orden mundial
- 152 Actores armados no estables: retos a la seguridad
- 153 Proliferación de ADM y de tecnología avanzada
- 154 La defensa del futuro: innovación, tecnología e industria
- 154 B The Defence of the Future: Innovation, Technology and Industry
- 155 La Cultura de Seguridad y Defensa. Un proyecto en marcha
- 156 El gran Cáucaso
- 157 El papel de la mujer y el género en los conflictos
- 157 B The role of woman and gender in conflicts
- 158 Los desafíos de la seguridad en Iberoamérica
- 159 Los potenciadores del riesgo
- 160 La respuesta del derecho internacional a los problemas actuales de la seguridad global
- 161 Seguridad alimentaria y seguridad global
- 161 B Food security and global security
- 162 La inteligencia económica en un mundo globalizado
- 162B Economic intelligence in global world
- 163 Islamismo en (r)evolución: movilización social y cambio político
- 164 Afganistán después de la ISAF
- 165 España ante las emergencias y catástrofes. Las Fuerzas Armadas en colaboración con las autoridades civiles
- 166 Energía y Geoestrategia 2014



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ISBN: 978-84-9781-975-6



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