



Energy and Geostrategy 2016

Spanish Institute for Strategic Studies

Spanish Committee of the World Energy Council
Spanish Energy Club



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Preface

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For one further year we are pleased to present what we can consider the third volume of “Energy and Geostrategy” with the firm conviction that the reasons that led us to embark on this project are more valid than ever. Indeed, the evolution of the geopolitical context reveals itself, year after year, as a vector whose understanding proves indispensable for the purpose of correctly interpreting the energy scenario we are immersed in.

In this edition we have tried to include some issues which are interesting to analyse, either because of the state of current affairs or because of the content itself. Thus, the low level of oil and gas prices brings an unexpected variable into play making it necessary to thoroughly analyse the geopolitical causes and consequences. Also along these lines, we want to provide a geopolitical outlook on the situation of liquefied natural gas (LNG) at global level. On the other hand, the persistent Jihadist threat further complicates the world energy panorama and brings to light the need to guarantee maritime routes used in world trade. As on other occasions we also believe it is relevant to include the analysis of an aspect with high impact on the development of society, such is the geopolitical influence of the so-called “Water, Energy and Food Nexus”.

We hope this new volume will contribute to keeping interest in questions that are so relevant in today’s international energy and geo-strategic scenario, and will be a useful tool for the people who use this collection in search of clues to interpret those questions.

Finally, we would like to thank the sponsoring companies - Cepsa, Enagás, Iberdrola and Repsol - for the continued support and commitment, year after year, that have contributed to the consolidation of this project.

Introduction

Claudio Aranzadi

The publication “Energy and Geostrategy 2016”

This new edition of “Energy and Geostrategy” comprises four articles dealing with issues that bear a fundamental relationship with the supply of hydrocarbons: “Geostrategic Overview of Energy Maritime Routes” (Gonzalo Sirvent), “The Impact of Jihadism on the Energy Sector” (Ignacio Fuente), “Oil Prices and Geopolitics” (Raúl Cardoso) and “Geostrategy of Liquefied Natural Gas (LNG)” (Enrique Locutura). The publication is completed, following the same lines as the previous edition, with an article about a decisive factor in economic development: “The Water, Energy, Food Nexus” (Mariano Cabellos and Lucila Izquierdo).

The attention paid to the geopolitics of hydrocarbons is justified. It is true that global decarbonisation strategies in the fight against climate change will demand throughout this century a strong reduction of the weight of fossil fuels in the primary energy resource mix, which will lead to an inflexion in the patterns of reflection concerning energy geopolitics. A world in which renewable energies are the dominant primary energy source will permit a high degree of self-sufficiency in terms of energy in all countries, transferring the emphasis on energy security requirements from the guarantee of an external supply of fuels to an efficient domestic management of a more widely electricity-based

and carbon-free intensive energy system. This gradual change in perspective is already now under analysis in the so-called “geopolitics of renewable energy”.¹

Nevertheless, this paradigm change which affects the restrictions entailed by energy security on the strategies of the different players operating in a global framework (companies or states) and the qualitative change in direction that this could entail in energy policies, diplomatic action and defence policies, will require a very long term to actually materialise. For 2040, in a scenario compatible with an increase in temperature no greater than 2°C compared to the pre-industrial period, the International Energy Agency² forecasts a weight of fossil fuels in the global demand for primary energy of 60% (16% coal, 22% oil, 22% natural gas); the world demand for oil is expected to reach 74.1 mb/d (83.4 mb/d including bio-fuels) and for natural gas is expected to remain at 4,000 bcm. These figures indicate that during the first half of the 21st century the supply of hydrocarbons will continue to be a central geostrategic factor and special emphasis must therefore still be placed on it in all geopolitical analyses of energy.

In this sense, the article by G. Sirvent (“Geostrategic Overview of Energy Maritime Routes”) tackles an essential factor in the global security for the supply of hydrocarbons (gas and oil): the guarantee of free maritime transit. G. Sirvent provides a detailed description of the specific structure of maritime transit of hydrocarbons, the current routes of oil and methane tankers and their foreseeable evolution. He analyses the strategic importance and the risks and threats that affect the main focal or throttle points (“choke points”) in different places around the globe, and examines the components of a global strategy of cooperation aimed at guaranteeing acceptable standards of maritime security. All the strategic challenges set out in the article by G. Sirvent will be valid in the mid and long-term. As the figures published by the I.E.A. indicate, the weight of hydrocarbons in the global demand for primary energy will continue to be high in the long-term, even in the most demanding scenario of decarbonisation policy considered by the Agency, and the inequality in the geographical distribution of production and consumption centres will also continue. Of course the map of international trade flows for hydrocarbons will keep being modified in accordance with the geographical changes of production and consumption (e.g. the higher importance of the Atlantic Basin as a production area and Asia as a consumer region), but the intensity of the maritime traffic of hydrocarbons will still be high and the need to protect maritime security (and more specifically the “choke points”) described in the article will still be a strategic priority, even though the international cooperation strategies to guarantee free sailing, both in diplomatic and military terms, could vary in accordance with the geopolitical changes and modifications to energy geography.

¹ See, for example: D. Ssholten and R. Bosman (2013), “The geopolitics of renewable energy: a new shift or landslide in energy dependencies?”, *Drift*.

² International Energy Agency (2015), “World Energy Outlook 2015”.

A decisive contribution to the dynamism of the maritime trade of hydrocarbons in the long-term is precisely sourced in the development of LNG, which is analysed in depth in the article by E. Locutura ("Geostrategy of Liquefied Natural Gas"). Natural gas is the only fossil fuel whose global demand will report an increase by the 2040 horizon, even in the most demanding environmental scenario considered by the I.E.A. ⁽²⁾, (although in this scenario the global demand tends to stabilise at the end of the twenties, as a result of progress made in decarbonisation policies), and as E. Locutura points out, the weight of LNG in the demand for natural gas will rise considerably from 10% today to 20% by 2040. This strong development of LNG will lead to important repercussions in energy geopolitics, since it facilitates traffic of natural gas over long distances, encouraging the convergence to a globalised gas market (currently fragmented in regional markets, essentially North America, Europe and Asia). This trend towards globalisation of transactions and more similar prices, permits a more efficient assignation of resources at international level (in some cases even permitting access to production or consumption by certain countries) and an increase in the levels of energy security through increased diversification options for producers and consumers alike (Europe could reduce its dependence on Russia with higher LNG imports from other sources, such as USA, but Russia could also benefit from the better export perspectives of LNG to diversify its offer). In his article, E. Locutura analyses the specific features (technical, economic, institutional and contractual) that explain the development potential of LNG., the risks (e.g. the evolution of investment costs of liquefaction plants), the technological innovations (e.g. floating plants) and their role in the gradual development (more advanced in the USA and developing in Europe) of spot markets and derivatives ("hubs") as well as new contractual models. The evolution of the different factors concerning LNG development examined by Locutura (more specifically the competitiveness of the LNG offer chain) will condition, in conjunction with other strictly geopolitical factors, the choice of the right mix (LNG / piped gas) in the supply of gas to consumer regions, but also the export strategies by producer countries.

The article by R. Cardoso ("Oil Prices and Geopolitics"), taking the current fall of oil prices (2014-2015) as the reference point, analyses in detail the interrelationship of the economic and geopolitical factors in determining oil prices. R. Cardoso, who examines in detail the fundamentals of the strategy of abandoning the role of "swing producer" by Saudi Arabia, leaves the so-called "conspiracy" theories aside (the use of low oil prices to fight against the allies of El Assad, Russia and Iran) and centres on the economic and energy rationality of the Saudi stance and the decision by the OPEC in November 2014 not to cut production in order to balance the market. The article reviews the effects of falling prices in displacing high-cost production, within OPEC's strategy to maintain the market shares as a priority objective versus securing revenues. He confirms that the reduction in production of non-conventional oil in the USA is being slower than the investment adjustments, and that the budget sacrifices by the production countries (particularly those that lack significant buffers in their financial assets) is

very remarkable. But even so, the continued reduction in high-cost production and the recovery of the demand will prove that OPEC's strategy is working. R. Cardoso also mentions factors that could delay a return to market balance (a higher offer from Iran consequential to the end of the sanctions, and a possible production increase in Libya). The article carries out a complete review of the complex geopolitical situation in the Middle East, and describes the fundamentals of a new strategic line in Saudi Arabia's energy policy aimed at converting the country in a major producer of electricity through renewable sources (solar).

In the article by I. Fuente ("The Impact of Jihadism on the Energy Sector"), the interrelations between the evolution of Jihadism from the turn of the century and the changing strategic role of the energy sector in the approaches and action by the main Jihad groups, firstly Al Qaeda and later Daesh (Islamic State) are examined in detail. Fuente delves into the ideological fundamentals of the Jihad energy strategy in publications and statements released by radical Muslims since 2004 and in specific action they have taken and how it is justified. wich affects to the period where Al Qaeda played the leading role, he shows the prevalence of a strategy to destroy oil infrastructures with the intention of affecting the economies of their targets or weakening their reputation. The principal geostrategic novelty, extensively analysed by I. Fuente, is the use of oil and gas resources by the regionalised, so-called "Islamic Caliphate", who since 2013 has controlled a large, hydrocarbon-rich territory in Syria and Iraq, as an economic weapon to finance their political project and military action. The author of the article examines the pragmatic attitude of Daesh in managing the oil and gas resources it controls (detailing its financial collaboration with other El Assad's opposition groups, but also with its military enemies, namely the Kurds and El Assad himself). Mr. Fuente also describes the differences between Daesh's strategy in both Syria and Iraq (centring on pragmatic exploitation of the energy resources it controls) and its franchise in Libya (until not presided by opportunism and purely destructive terrorist action), although he points out that the future evolution of the political and military situation could lead to radical changes in strategies in both scenarios.

The article by M. Cabellos and Lucila Izquierdo ("The Water, Energy, Food Nexus") provides a reflection on the barriers to access, particularly in developing countries, to three basic resources, which furthermore are closely related to each other. The authors provide many examples of how these resources are related to each other: agriculture as the productive sector with the highest consumption of water and energy as the industrial sector that uses the biggest amounts of water, the possible production of bio-fuel / production of food dilemma, the possible use of distributed electricity generation and renewable energy sources to help extracting water in isolated locations, and the promotion of more efficient, environmentally friend cooking techniques, etc. A comprehensive approach to the co-ordinated development of these resources permits a more efficient way to overcome the barriers preventing access to them, and consequently a more effective fight against poverty. As brought to light in the study on universal ac-

cess to electricity, by C. Sallé in the previous edition of “Energy and Geostrategy”, promoting the development of these basic resources is not just imperative for the sake of equity. Extreme shortage of these resources is also a source of political instability, forced migration and a potential cause for conflict, and therefore the “Water, Energy, Food Nexus” study calls for a geopolitical reflection. Let us recall in this regard the difficulties to agree on an efficient, fair mechanism for sharing water between the Israelis and Palestinians.³ On the other hand, as W. Kälin⁴ points out, the potential effects of climate change can negatively affect access to water and production of food, in turn triggering armed conflicts and violence. In general, processes involving a deterioration of the environment directly affect the water, energy, food nexus, and any alteration could be cause for geopolitical tension.

Trends in the energy geopolitical scenario

Previous editions of “Energy and Geostrategy” insisted on the difficulties of forecasting how the geopolitical energy framework would evolve, in the short and long-term. The intrinsic complexity of this framework was pointed out, with a complicated network of “feedbacks” among its most relevant factors and a proper bidirectional causality between strictly geopolitical factors and purely energy related factors. The quality of forecasts would not only be affected by the limitations inherent to the economic and energy models, but also by the added specific complexity from interrelations of geopolitical character.

Carlos Pascual⁵ develops an analytical framework that permits putting some order in the tangled universe of energy geopolitics. Through what he calls the “Rules of Six”, he classifies countries’ intervention in the energy markets (with geostrategic intentionality) into six types of tactics, whilst he also defines six types of prevailing market factors whose more or less correct application to intervention strategies explains their success or failure. The matrix of results stemming from these “Rules of Six” permits C. Pascual to clarify the diagnosis of a wide series of significant events in the history of energy geopolitics and to better understand the new events as they occur, but, even in the framework of this rather sophisticated analytical process, the forecasts on future evolution of the geopolitical energy scenario are still highly uncertain.

Since the close of the last edition of “Energy and Geostrategy” some highly relevant events have taken place in the field of energy geopolitics. Suffice it to mention the Paris Agreement between the UNFCCC parties (COP 21) in December 2015, the Agreement in July 2015 about Iran’s nuclear programme with the

³ D. Brooks and J. Trottier (2012), “An agreement to share water between Israelis and Palestinians: The Foeme Proposal”, EcoPeace/Friends of Earth Middle East.

⁴ W. Kälin (2008), “The climate change-displacement nexus” (Speech). Brookings.

⁵ C. Pascual (2015), “The new geopolitics of energy”, Columbia/Sipa (Center on global energy policy). September 2015.

member countries of the UN Security Council plus Germany (P5+1), or the persistent low level of oil prices throughout 2015. Another series of geopolitical events could also be added with indirect, although relevant, effects in the international energy scenario: the Minsk 2 Agreement concerning Ukraine (February 2015), the agreement in Geneva about a transition plan for Syria (November 2015), the political agreement about Libya in Skhirat (Morocco) driven by the United Nations, the political tension between Russia and Turkey, and of course the permanent tension in the Middle East. Despite the significant number of international agreements affecting the energy scenario that were signed in 2015, it is difficult to diagnose a reduction in the geopolitical risks in the energy sector at the year end, and even less so to predict how this variable will evolve in 2016. The short-term trends (and of course the mid and long term) of the relevant geopolitical factors in 2015, outlined above, all entail a greater or lesser degree of uncertainty.

Uncertainties concerning decarbonisation policies and the future of oil prices

Among the events mentioned as the most particular in 2015 from the energy geopolitical perspective, there are two that are especially relevant. The first one is the Paris Agreement at COP 21. For the very first time this agreement depicts a cooperation strategy at world level to tackle a negative global externality concerning the seriousness of climate change. Secondly, the continued low prices of oil brought about with the slump in prices since July 2014. This phenomenon is particularly relevant because some of its determining causes and effects include the most defining factors of the geostrategic panorama of energy. Therefore, exploring the uncertainties concerning the future of climate change policy and oil prices is particularly relevant.

In both cases moreover, the caution that must be exercised when managing the models used has been brought to light, whether for forecasting purposes or as auxiliary instruments for the economic policy. The inability of the most commonly used econometric models to forecast the great recession that started back in 2008 is a clear illustration of the limitations of these models.⁶ The econometric models are not good predictors of very infrequent events. Events that take place every half century can hardly be predicted using estimation models based on series of data from shorter periods of time. In these cases the most suitable analytical framework is the one afforded by economic history. In all cases, what is most problematic is the use (whether as a forecasting instrument or as support for the economic policy) of probabilistic models as if they provided an accurate explanation of a deterministic causality. All too often, above all during politi-

⁶ C.A. Sims (2012), "Statistical modelling of monetary policy and its effects", (American Economic Review), provides a clear explanation of the limitations of DSGE models to forecast events such as the recent recession, owing to statistical reasons inherent to the models and to shortcomings in its specification.

cal debates when referring to a forecast, only one figure is mentioned (usually the average of the variable in question), without taking the margin of error into account (e.g. with a measure such as the standard deviation). Not providing a measure of uncertainty in forecasts is politically relevant however, as it affects the bigger or lesser flatness of the statements and the degree of legitimacy of the proposals they are supposed to support.

Climate policy forecasts

A first example can be found in some of the discussions held about treatment of uncertainty in certain models used as analytical frameworks for the decarbonisation policy. These reservations are not from persons sceptical on the phenomena of climate change, but rather by experts who are clear advocates of a strict emissions reduction policy, trying to give a more consistent foundation to this policy. In the publication "Economy and Geostrategy 2014" (Introduction), the reservations that R.S. Pindyck⁷ expressed regarding the methodological soundness of Integrated Assessment Models (IAM), commonly used to estimate the "social cost" of CO₂ emissions, and regarding their use to produce a certain genre of scientific legitimacy were described.⁸ Pindyck,⁹ in a new article, takes up the subject once again and focuses his criticism on the reliability of said models, both those concerning "climatic sensitivity" (linking the concentration of CO₂ in the atmosphere and the temperature increase) and those of "damaging function" (that relate the temperature increase to falls in GDP, consumption, etc.). He believes that what is truly relevant about estimating the "social cost" of CO₂ emissions is the probability and possible impact of a catastrophic climatic effect (e.g. caused by temperature increases over 5°C), and that the IAM models are unable to explain such catastrophic effects. He proposes considering a plausible range of catastrophic effects (measured by the reductions in GDP) and the corresponding plausible probabilities assigned to each catastrophic effect (where "plausible" means what a sufficient variety of economists and climate scientists consider acceptable). On the basis of this data, the present value of the benefits resulting from avoiding said catastrophic effects or from reducing the probability of them occurring is calculated. If these benefits are sufficiently high and their estimate is considered sufficiently robust with regard to reason-

⁷ R.S. Pindyck (2013), "Climate change policy: What do the models tells us?", *Journal of Economic Literature*.

⁸ N. Stern (2013), "The structure of economic modelling of the potential impacts of climate change: Grafting gross underestimations of risk onto already narrow science models", *Journal of Economic Literature*, from a different perspective (it indicates the difficulty of specifying models that should forecast the effect of climatic phenomena affected by a major uncertainty, since they lack historical background, given that in the last seven or eight millennia temperature fluctuations have varied by 1°C/1.5°C from the average), it also indicates the limitations of the models used.

⁹ R.S Pindyck (2015), "The use and misuse of models for climate policy", NBER (Working Paper, April 2015).

able changes in the parameters used to calculate them, there would be a solid base to establish strict policies to reduce emissions; the next step would then be to estimate the reductions of CO₂ emissions necessary to avoid the catastrophic results and, with the data on the benefits and the required reduction in the volume of emissions, to calculate (through a simple division) the “social cost” of CO₂ emissions. As the previous approaches reveal, Pindyck⁽⁷⁾ would therefore conceive the emissions reduction 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)”. Compared to the use of unreliable, sophisticated models (that lead to very different estimates of the “social cost” of CO₂ emissions depending on the different hypotheses, whose selection - as is the case for example with the rate of discount used - is controversial), Pindyck⁽⁸⁾ considers his approach to be “simple, transparent and easy to understand”.

On the other hand, Pindyck’s approach is more consistent with the probabilistic forecasts made by the Intergovernmental Panel on Climate Change than with the postulates of “fine tuning” policies (which are implicitly based on a deterministic conception of causation relationships). As pointed out in the previous edition of Energy and Geostrategy, the IPCC (in the fifth working group report in 2014)¹⁰ considers that in order to reach the objective of limiting the temperature increase in the 21st century compared to the pre-industrial period by 2°C only (with a probability between 60% and 70%), global greenhouse gas emissions need to be reduced by between 40% and 70% by 2050. Pindyck’s approach would therefore permit harmonizing an adequate treatment of the uncertainties affecting the forecasts in the models used for climate change policies, with a more consistent (and simpler) foundation for these policies.

The uncertainty margins associated with the use of the aforementioned models are logically reduced when the objectives of the climate policy are put forward in terms of temperature increase ceilings, and not in terms of avoided damage. This is the case of the COP 21 Agreement where the established target is to achieve a global temperature increase significantly below 2°C and to continue the efforts to limit the temperature increase to only 1.5°C above pre-industrial levels. Even with this approach there is still a margin of uncertainty associated with the modelling of “climatic sensitivity”; in fact, as mentioned previously, the estimates by IPCC (which methodologically sustain the Paris Agreement) are of a probabilistic character. The Agreement implicitly considers a single emissions profile for each temperature limit (almost certainly selecting a specific probability hypothesis). Even though this is the only practical way to assess the impact from the “national commitments” aggregate (the intended national determined contributions) on the temperature in the long-term, sight should not be lost that estimates include uncertainty margins, a fact that could become politically relevant when the low correction amount is discussed for “national commitments” (that the Agreement considers will lead to temperature increases over 2°C) and

¹⁰ IPCC (2.014) “Fifth Assessment Synthesis. Report Approved Summary by Policy Makers”.

it will foreseeably be very demanding if the target is set at a maximum temperature increase of 1.5°C.¹¹

Whichever the case, the most relevant uncertainties do not concern the analytical framework used, but rather the political and institutional problems that the governance project introduced in the Agreement has left open. The Paris Agreement is a huge diplomatic success and the maximum political commitment that main emissions countries, like the USA, China and India could accept. With the Agreement having been signed by 195 countries, the relevance of the climate policy has been universally consecrated and the approach by climate change sceptics has been internationally isolated. But there are still many political question marks. Firstly this is a “legally binding” agreement that includes “national commitments” that are not legally binding for each country. To a certain extent, it is reminiscent of the penetration of renewable energy commitment for 2030, passed by the European Council on 23rd and 24th October 2014 (where it was agreed for these energies to represent 27% on binding terms for the Union, but permits the Member States flexibility in setting their national targets). In both cases, achieving the target will depend on the quality of the governance that is actually put into practice, which is much more complex in an agreement involving 195 signatory countries that in the management of an EU commitment, with a consolidated institutional machinery. It is true that the reviewing and transparency mechanisms (every five years) that the Paris Agreement envisages will represent a method of “moral pressure” similar to the one existing for compliance by companies with corporate governance codes, through implementation of the “comply or explain” principle, but persistent maintenance of a strict greenhouse gas emissions control policy in the mid and long term will be decisively conditioned by contingencies in domestic politics (something that is clear in the case of the United States).

Secondly, although we will have to wait for the next IPCC reports, we are able to anticipate that the commitments taken on are very demanding. Should the experts estimate that the “national commitments” submitted to COP 21 would lead to an increase in global temperature nearing 3°C, it would be reasonable to believe that the corrections down of those commitments would be important, particularly if the target of limiting the temperature increase to 1.5° is accepted. One just has to realize that the most demanding energy scenario, in environmental terms, contemplated by the International Energy Agency (corresponding to a decarbonisation policy of the energy sector compatible with a maximum global temperature increase of 2°C) requires radical progress in decarbonisation of the electrical sector, electrification or substitution of oil-based products by gas in transport, energy efficiency, etc.¹² Some of these requirements will be difficult

¹¹ The implicit acceptance by the 195 signatories of the Agreement of the IPCC authority as a common analytical reference will facilitate however the discussion processes.

¹² The IEA, which shows several scenarios in its annual publication “World Economic Outlook”, including long-term forecasts (2040) for the main global energy variables, calls this scenario, consisting of maximum warming of 2°C, scenario 450. It is foreseeable that, after the commit-

to undertake for the three major producers of CO₂ emissions (the USA, China and India). Thirdly, implementation of a global emissions reduction agreement should go hand in hand with harmonization of the mechanisms employed for its control ("command and control", "cap and trade", or tax) so that international competition is not distorted and new investments are efficiently implemented. Nevertheless, the progress towards a global institutionalisation of these mechanisms is still incipient, even at the level of its simple deliberation. There are many other questions that remain unanswered after the signing of the Agreement (e.g. instrumentation of financing for developing countries), which means that the political will and management capability by the different players (states and multilateral organisations) will condition the road map aimed to attain the agreed objectives. In this sense, a consistent leadership by the USA, China, India and the EU (who jointly account for more than two thirds of the emissions) will be fundamental for success.

Uncertainty in the forecast of oil prices

Oil prices are a fundamental self-explanatory variable in the economic evolution of producing and consuming countries. Furthermore, price behaviour is almost a paradigm of the type of bidirectional causation that characterises the relationship between geopolitical factors and purely energy related factors. A good forecast for the short, mid and long term future evolution of said prices should therefore be a part of the instruments required to elaborate strategies by operators within the global energy environment. Nevertheless, as was the case with the examples in the previous sections, the forecasting models used in this case do not lead to satisfactory results either. The surprise for most analysts for the strong fall in oil prices since July 2014 and the duration of the low price scenario is a clear example of the shortcomings of the models used for forecasting.

The most generalised explanation resorts to the fundamentals (excess offer higher than expected, essentially as a result of the high increase in non-conventional oil production in the United States and the weak demand resulting from the smaller economic growth of China, and subsequently of the emerging economies, as well as the almost stagnation of the European economy). This diagnosis is correct. Raúl Cardoso discusses it in detail in this issue. This is also the core of the explanation given by the IEA⁽²⁾ which also points out the appreciation of the dollar and the disappearance of individual factors (specifically in the refinery sector) that drove prices up in the period between 2008 - 2013. Of course, in this diagnosis a fundamental role for maintaining the excess offer of crude oil is assigned to OPEC's (more specifically Saudi Arabia) position, who in November 2014 confirmed his negative to rebalance the market. The more or

ments reached in the Paris Agreement, the International Energy Agency will draft a new scenario compatible with a 1.5°C temperature increase limit, which will logically include additional efforts to those demanded in scenario 450.

less appropriate character of this strategy is the subject of controversy however, as is its geopolitical undertone.

A diagnosis centring on the fundamentals concurs with the logics of economy and is consistent with the analysis of a large number of econometric models. For example A. Merino and R. Albacete,¹³ using their own model, prove that the inventories of crude oil by the OECD explain 53% of the evolution of oil price¹⁴ which indicates that the fundamentals have big explanatory power. Nevertheless, the predictive power of the most commonly used models to forecast the future evolution of oil prices is rather low, as demonstrated by the failure to predict the intensity and timeline of the current episode of low oil prices by a large number of experts.

C. Manescu and I. Van Robays¹⁵ analyse nine types of models and assess the accuracy of their predictions. Their conclusion is that, if the analysed period as a whole is considered, and the different forecasting horizons, the forecasts of the futures market prices or those that stem from the hypothesis of a time series, such as a “random walk” are not consistently improved by the forecasts that are obtained using more elaborate models. Given the fact that there are differences however in the predictive capacity of the models for individual periods of time or for specific forecasting horizons, the authors propose combining four of the considered models and so improve the accuracy of the forecasts. But, even with this procedure, they show caution about it remaining accurate in the future, owing to the changes in the patterns of behaviour of oil prices over time. A. M. Husain et al,¹⁶ points out the limitations of econometric models that do not include explanatory factors reflecting changes in expectations and strategies of the principal players in the market (including OPEC) and although they do mention the explanatory role of the fundamentals, they also highlight the failure to anticipate the intensity of the fall in crude oil price in the second half of 2015 by the futures markets and by most experts.

The degree of precision in the “spot” price forecasts of crude oil using futures market prices is a controversial matter. D. Nixon and T. Smith¹⁷ set out the reasons against using the futures market prices to predict “spot” prices. Firstly,

¹³ A. Merino and R. Albacete (2011). “Analysis of oil price: From the fundamentals to the expectations of the financial markets”, in “The New Energy Markets”. (Fundación de Estudios Financieros) [Financial Studies Foundation].

¹⁴ Financial activity, measured by the long positions of non-conventional investors, would explain 20%, the past values of crude oil price 14%, OPEC’s idle capacity 7%, and the model residues would explain the remaining 6%.

¹⁵ C. Manescu and I. Van Robays (2014). “Forecasting the Brent oil price. Addressing time-variation in forecast performance” (W.P. Series No. 1735. September 2014). European Central Bank.

¹⁶ A.M. Husain, R. Arezki, P. Brener, V. Haksar, T. Helbling, P. Medas, M. Sommer, and an I.M.F. Staff Team (2015), “Global implications of lower oil prices”, IMF Staff Discussions Note (July 2015).

¹⁷ D. Nixon and T. Smith (2012), “What can the oil futures curve tell us about the Outlook for oil prices? Research and analysis (Quarterly Bulletin 2012 Q1). Bank of England.

the existence of a “risk premium” which is difficult to assess, secondly, in the case of oil, since it is a physical asset, the existence of a “net convenience yield” (difference between the profit of withholding the ownership of the asset and the cost of storing it) which quantity is also difficult to estimate. Both effects can considerably modify the futures curve in relation to the theoretical curve for a non arbitration scheme (nevertheless, the authors point out the predictive value of changes in gradient of the futures curve). Whichever the case, it is obvious that, as mentioned earlier, the oil futures market did not anticipate the intensity of the fall in crude oil price in July 2014: the mid-term price (4 years) was held at 90/100 dollars per barrel practically until the OPEC correction in November 2014.⁽¹⁶⁾

In the aforementioned articles^{(15) (16)} it is pointed out that the changes in pattern in the strategic behaviour of the principal players in the crude oil market and in the geopolitical environment can curb the predictive power of the econometric models, unless they are properly incorporated into their specification. Although there are techniques to mitigate these insufficiencies (Manescu and Van Robays⁽¹⁵⁾ suggest the use of a combination of models), the same authors warned that even in this case nothing guarantees greater accuracy beyond the timeline sample used (the new strategic and geopolitical environment can show a substantial, unanticipated modification). A considerable number of experts coincide in considering that we are undergoing a structural change in these characteristics which needs to be taken into account, both when analysing the drifting of crude oil prices after the second half of 2014 and when trying to predict the evolution of these prices in the short, mid and long term. S. Dale¹⁸ points out that four principles that were assumed to be basic in the analysis of markets and crude oil prices need to be reconsidered: the exhaustible nature of oil, the low elasticity of the offer and demand curves, the east - west directional pattern of oil flows and the role of OPEC as a stabiliser of the oil market; a similar argument actually to the one presented by A. Halff.¹⁹

Conceiving oil as an exhaustible resource is now being questioned, due to the long-term restrictions imposed on the consumption of fossil fuels by the decarbonisation policy, through agreements to reduce greenhouse gas emissions (more specifically the commitments associated with the COP21 Agreement in December 2015 in Paris). Of course crude oil resources are finite, but technological progress has permitted increasing the volume of resources to a figure²⁰ that has started to lead to concern in production countries and companies, not

¹⁸ S. Dale (Chief Economist B.P.) (2015), “The new economics of oil”, The Oxford Institute for Energy Studies (October 2015).

¹⁹ A. Halff (2015), “OPEC’s Policy Challenge in the age of shale oil” (Commentary). Columbia/Sipa/(Center on Global Energy Policy). (December 2015).

²⁰ The International Energy Agency, in its World Economic Outlook (2013) places these resources (“remaining recoverable oil resources”) at nearly 6 billion barrels (55% of which are non-conventional resources) with demand for crude oil in 2040 estimated in the WEO (2015) for the scenario of highest environmental demand, at 74.1 mb/d.

because of a physical shortage, but rather because of a potential situation of over-abundance of oil in the long-term, caused by the limited demand resulting from decarbonisation policies. The International Energy Agency⁽²⁾ echoes this concern, which could materialise in heightened perception by production countries and companies of the risk that a significant part of their investments in developing new resources could become “stranded”. Nevertheless, the IEA considers that by 2040 most of the new investments will be aimed at substituting a very high percentage of today’s wells which will have completed their decline and whose production will be necessary to cover an oil demand expected to reach 74.1 mb/d by 2040 in a scenario compatible with a temperature increase limited to a maximum of 2°C. Perceiving the risk of stranded investments will probably worsen in the future, particularly when the new limitations on oil consumption required for compliance with the temperature increase limit of 1.5°C are quantified. In this sense A. Halff⁽¹⁹⁾ mentions the statements made by the Saudi Minister for Petroleum, Ali Naimi, in reference to a “Black Swan” oil market which would describe the risk Saudi Arabia could be in by 2030 or 2040 lying over a sea of valueless oil. Whichever the case, even if importance is not given to the possible stranded investments, as pointed out by S. Dale,⁽¹⁸⁾ this new perception of oil as a non-exhaustible resource would lead to a decrease in prices in the long-term.

The other three factors that, according to Dale, explain the structural change in the global oil scenario, are closely interrelated, although both this author and A. Halff highlight the central role that the development of non-conventional oil in the USA has played in this change, a development which has largely been a determining factor, both in the direction change of international flows in the supply of crude oil (and its geopolitical effects) and in the modification in the environment where the principal strategic players operate (essentially Saudi Arabia and OPEC). The rapid rate of increase in self-sufficiency in the supply of oil in the United States has accentuated the trend to an increase of the relative intensity of supply flows to satisfy demands in Asia. This trend will be maintained (beyond correction, partly temporary and partly structural, for the economic growth of China) with the long-term consolidation of China and increasingly India, as two essential centres of global oil demand. These directional changes in oil supply flows will affect the global pattern of maritime security and transport policies, as described in the article by G. Sirvent, leading to a higher degree of strategic implication, both diplomatic and military by the major powers in Asia concerning this task. The effect on the US foreign policy of the United States being more self-sufficient is more uncertain, and could lead to a reduction of the US diplomatic, but above all military presence in the Middle East a region that will still be in the long-term a central point for the world’s oil supply. Nevertheless, as already discussed in a previous edition of this publication, the progress the United States has made in supplying its own crude oil represents a significant change in the standards of energy security in this country, although it does not economically isolate the country from a fully globalised market as is the case of oil. Furthermore, unless an improbable isolating drift is consolidated in the

US foreign policy, a North American detachment regarding a region that will still be strategic for the global supply of oil (even if the direction of the supply flows could change) and one that is therefore fundamental for the world's energy security and stability, does not make any sense.

The development of non-conventional oil in the United States is also a decisive key to understand the alleged change in the strategic behavioural pattern by OPEC (and more specifically by Saudi Arabia), in 2014-2015. This analysis initially entails an added difficulty. As B. Fattouh et al. point out,²¹ after conducting a thorough literature review, there is no consensus when drawing up a model to explain the strategic behaviour of Saudi Arabia since the middle of the 80's. In fact, both S. Dale⁽¹⁸⁾ and R. McNally²² question the characterisation of Saudi Arabia's strategy of continuously, systematically exercising the role of "swing producer". They consider that the intervention by Saudi Arabia in the market, in 2008, to invert the sharp fall in prices, was more a policy of temporary action and that this type of action responds more to a hedging policy to cover emergencies than to a true "swing producer" strategy aimed at stabilising the market over prolonged periods. Regardless of what the right diagnosis actually is, the expansion of "shale oil" production in the United States is surely the most relevant variable to explain the pattern of strategic action by OPEC formally announced in November 2014 and confirmed in December 2015, beyond the explanation for Saudi Arabia's strategic behaviour as an attempt to politically use oil as a weapon (which, as B. Fattouh et al.⁽²¹⁾ recall, this country has never repeated since 1973).

The aforementioned authors concur, with different emphasis and nuances, in underlining the radical change in the strategic scenario of the oil market caused by the new technologies for extracting shale-oil, whose peculiarities, they point out: the new facilities feature an investment cycle and a period of decline shorter than conventional facilities, and a much higher proportion of variable costs out of the total costs (detrimental to the weight of fixed costs); their learning curve is proving to be steep, the average corporation size is much smaller than that of conventional crude oil production, and the financing structure is also different. For these authors the most decisive consequence from these differentiating factors would be the significant increase in flexibility of the offer in this segment of oil production compared to that of conventional production with high "sunk costs" (these entailing a slower adjustment of their production, whether up or downwards). Within the framework of their analysis of the trade-off between maximising revenue and maintaining the market share, B. Fattouh et al;⁽²¹⁾ show that the hypothesis of high flexibility in the offer is a relevant condition to justify the economic rationality of the Saudi strategy. Likewise, A. Halff,⁽¹⁹⁾ on

²¹ B. Fattouh, R. Poudineh, A. Sen (2015), "The dynamics of the revenue maximization market share trade-off: Saudi Arabia's oil policy in the 2014-2015 price fall", OIES Paper: WPMG1. Oxford Institute of Energy Studies. October 2015.

²² R. McNally (2015), "Welcome back to boom-bust oil prices (Commentary)", Columbia/Sipa (Center on Global Energy Policy). October 2015.

the basis of this higher flexibility in the offer (whether up or down) justifies the rationality of OPEC holding on its current policy until sufficient adjustment is achieved in the offer caused by the production of shale-oil, and then inverting this strategy once the market has balanced out, with production of shale-oil playing a relevant role in the new upward cycle, which could finally be consolidated in the mid-term with a market structure where the countries who will lose their market share will be those who are outside OPEC with high operating costs and conventional extraction technology.

If any version of these scenarios proves to be correct, the dominating diagnosis among experts (particularly the opinion Raúl Cardoso sustains in his article in this publication), considering the strategy by Saudi Arabia and OPEC to be “rational” from an economic point of view, will surely be proved to be right. The production of shale-oil (with a lag regarding investments) appears to be following the downward trend in terms of adjustments, that, in accordance with the preceding considerations, should be faster than that of conventional facilities, as should an upward trend be faster too once the market has been rebalanced. This new scenario, where the market re-balance depends on shale-oil production in the United States (not because of a political or strategic decision, but rather because of the pure market forces) will permit consolidation of Saudi Arabia’s strategy of not operating as a swing producer any more, and conserving its market share. Nevertheless, the stability of this strategy also entails uncertainties. The arrival on the market of a complementary offer of crude oil from Iran, once the sanctions have been lifted (an eventually higher than expected correction in the economic growth profile of China), will tend to prolong the current period of low prices. Saudi Arabia, owing to geopolitical imperatives, will be compelled to confirm its strategy and not facilitate the positioning of the new offer by its main rival in the region. On the other hand however, if the current scenario of low prices is prolonged excessively (caused by a surplus in the offer from Iran and perhaps from Libya), the budget problems of production countries (including Saudi Arabia) would lead to a review of the current strategy by OPEC.

As already indicated, the short, mid and long-term forecasts for oil prices entail a huge amount of uncertainty due to the insufficiencies of the models used and to the structural changes in the global scenario of the oil sector due to technological, geopolitical and strategic behaviour changes by the principal players. Of course prices are determined in the end by the fundamentals (excess offer or demand, and costs), but these factors will continue the current downward trend for an unknown period of time (the probable floor being the operating costs of marginal producers) as long as there is surplus offer, and once the market balance has been re-established, prices will move back somehow in line with the long-term marginal cost (the “break even price” by the producers with the highest costs). As the International Energy Agency⁽²⁾ points out, by 2040, despite the forecast increase in the OPEC’s market share, the countries outside the Organisation (where high-cost production is concentrated) will still represent nearly half of the world’s production and the sustainability of this offer structure

will logically require a long-term price level permitting marginal producers to recover total costs. Obviously, under this perspective a high degree of fluctuation is defined (nearly 100 dollars per barrel) within which the crude oil prices will foreseeably evolution in the mid and long-term, but with a temporary price profile that will be determined as earlier indicated by changing factors which, as history has proved, are difficult to fit into models.

Chapter I

Geostrategy Of Liquefied Natural Gas (LNG)

Enrique Locutura Rupérez

Abstract

The LNG industry was born in the second half of the last century in order to enable the transport of natural gas in its liquid form from the production centres to demand centres that are not accessible by gas pipeline. Developing this technology has meant that reserves from countries a long way from their markets (such as Qatar) are now able to be commercialized, it has also given access to this basic primary energy to countries that are not connected to gas pipelines (for example Japan, and formerly Spain). The growth rate of LNG more than doubles that of the rest of gas, and it is estimated that by 2050 its current quota of 10% of all gas marketed in the world will more than double. This fact will therefore consolidate its role in globalization of the energy market, and will contribute decisively to diversification and to the security of supply to many of the world's regions.

Keywords

Liquefied Natural Gas (LNG), Liquefaction, Regasification, Methane Tankers, LNG chain, Henry Hub, National Balanced Point (NBP), Oil Parity, Oil-Gas, Decoupling, Security of supply, Diversification.

Introduction

As a primary source of energy, the importance of natural gas has been undergoing growth since the middle of the last century. Coal was the main energy source in the 19th century and was the determining factor in the industrial revolution. In the 20th century petroleum became the main source of energy completely displacing all others in transport, both maritime and overland, and permitting the development of air transport. After the second half of that century, natural gas became consolidated with strong growth rates to become a source of energy with an ever increasing role based on the abundance of reserves, competitiveness in price and efficiency in utilisation processes and above all because of its decisive environmental advantages. In view of the essential need to reduce CO₂ emissions, gas has become a fundamental tool for the emission reduction strategy. Natural gas, along with renewables, will undoubtedly be the energies of the 21st century.

Natural gas took longer than the other fossil fuels to develop, despite the advantages described previously, owing to the difficulty of handling, transporting and storing it, which required the development of more sophisticated technologies than coal or crude oil, and major investment projects to be deployed. The gasification process in a country needs decades to be developed.

Transport and storage of natural gas can be done in the gaseous or liquid forms. In gaseous form gas is compressed, transported and distributed through gas pipelines from production centres to where it is consumed. The storage necessary for reserves is provided by former gas or oil fields, diapirs or other geological formations. This system, through which the gas industry was born and developed, is feasible when the gas fields are relatively close to where the gas is consumed, as is the case of the United States or central Europe (remember many European countries have had fairly important gas fields in the past, and the European Union is still 32% self-sufficient for gas). These limitations however make not possible for regions with huge gas reserves, such as the Middle East, the archipelagos of Indonesia or Trinidad and Tobago, to access the markets, and countries at great distance from gas reserves such as Japan and other islands, or those isolated from transport networks such as Spain, do not have access to such an important source of energy, with the subsequent loss of competitiveness. The development of liquefied natural gas (hereinafter LNG) has been therefore decisive for the energy development of many countries, both exporters and importers of gas. Today, LNG accounts for approximately 10% of the world's demand for natural gas, and 30% of the international market, this percentage being expected to grow in the fairly near future to exceed 50%.

The LNG Chain

The technology that permitted developing LNG began in the 1940's in the United States, with construction of small natural gas liquefaction plants with the ob-

jective of extracting the noble gases from it (mainly helium) which in some gas fields was present with the methane in significant proportions. Liquefied natural gas, in this case is a by-product of noble gas production, but it was soon realised that it could be used to store gas in its liquid state (with the subsequent reduction in volume), like in areas of the United States where the geological conditions were not suitable for conventional storage methods, and to cover for peak consumption with the so-called "peak shaving" plants. It was not until the decade of the sixties when the technology started to be used for maritime transport of gas in the so-called LNG chain. This chain comprises four items: Reserves, a liquefaction plant, methane tankers for transport and a regasification plant, with a fifth link in the chain being the buyer or buyers.

At the liquefaction plant natural gas goes through a complicated process of decompression, expansion and heat exchange similar to the classical refrigeration process, that convert it into a liquid at -162°C at atmospheric pressure where it is stored in atmospheric tanks to be later loaded onto tankers for transport, which is now feasible since the volume of the gas has been reduced 600 times. This is the most capital intensive part of the chain since it can account for over 80% of the investment in the chain. There are different technologies on the market, although there are some restrictions in force to acquire them. Although there are many companies that market the process, only four of them have proven experience in plants at a competitive scale. The two North American companies Air Products and Phillips account for 90% of the installed capacity, the North American administration imposing in practice serious limitations for their licensing. The German company Linde has limited experience and only one operating plant, and finally Shell who does not sell the technology, but grants licences only for projects that it develops or in which it participates. This has limited the possibility for some gas producers to be able to develop their LNG projects.

Since liquefaction plants are very capital intensive, the size of a plant is a determining factor for feasibility and profitability. A plant can have one or more trains. The first trains to be installed in the world, such as those in Arzew in Algeria (1964) had a production capacity of 0.3 MTPA or Mtpa (million metric tonnes per annum). Between the 70s and 1990 the economic capacity increased to between 1 and 2 Mtpa. In the 90s the technology took a major leap forward and capacity jumped to 3 Mtpa, around the middle of the 2000`s it increased to between 4 and 5 Mtpa and today the trains that are planned are within this range, although at the macro gas fields, such as those of Qatar, trains of between 7 and 9 Mtpa have been installed, the largest to date. At most plants in the design stage, the capacity is limited to 4 or 5 Mtpa, since the reduction in unit costs of the investment is set off against the higher risks that any investment increase entail, and because of the difficulty of assembling chains with such high capacities, which can only be justified in giant fields.

Transport of LNG is carried out in double hull vessels known as LNG carriers, which transport gas in atmospheric tanks at -162°C . The first transport took place in 1959. The transport cost has been substantially reduced by quickly in-

creasing the cargo capacity from a few thousand cubic metres at the start, to today's tankers with capacities over 100,000 cubic metres. Most of the tankers built in the last decade have capacity for around 140,000 cubic metres, and their dimensions permit them to use the main maritime routes and to load and offload at most terminals. The trend is still to build tankers with higher capacities. The biggest tankers built to date are the so called Qatar-max, which can transport up to 162,000 cubic metres. Many of the tankers currently under construction have higher capacities, up to 170,000 cubic metres, and the new tankers on order will have up to 180,000 cubic metres.

The regasification plants are the third item in the LNG chain. Built at maritime terminals suitable to receive LNG carriers, they consist of two elements: storage tanks where LNG is received and stored, and the regasification unit, where the gas is pumped from the tanks and is regasified through heat exchanging, before being injected into the natural gas distribution network.

A major part of the success of the LNG industry right from the start, has been its excellent track record in terms of safety. Despite natural gas being a potentially dangerous product, and with more than thirty-five liquefaction plants, more than three hundred and fifty methane tankers and more than one hundred regasification plants currently in operation, since the industry started in the 60s there have only been two relevant accidents: an explosion at a regasification plant in the United States in 1979 with one mortal victim, and an explosion in 2004 at the Skikda liquefaction plant in Algeria, which caused the death of 27 people and practically destroyed three of the plant's trains. These are very low figures considering the fifty years of this industry, making it one of the safest in the world.

Characteristics and Feasibility of the LNG Chain

To the question of why people talk about the LNG chain and not so much about the gas or crude oil chain, the answer lies in the big differences in the level of integration of the various economic agents who make it possible, and who participate afterwards in it over many years, as we will see later.

To compare, we will briefly analyse the structures of the petroleum and gas industries compared to LNG industry.

The petroleum industry is considered one of the most integrated, since some of the most important players, the major multinational oil companies, explore and produce oil and gas, contract transport (in the past they were also owners and operated a large part of the fleet they required), refine the oil, then distribute the products and finally sell them, either directly or through their networks of service stations, to end consumers. This integration, although very important, is nowadays economic rather than physical, and the economic feasibility of each stage is hardly ever determined by that integration. In general terms, the oil companies explore and produce oil all over the world with the objective of sup-

plying the market, not their own markets, disregarding if they have refineries or a final market in that geographical area. They will only process oil in their refineries if it is deemed convenient, but more often than not the oil is sold to other companies, which is similar to what happens in refining and marketing. The transactions are materialised through contracts or in the spot market, being binding for the parties during a short period of time only, and any eventual breach of contract do not pose a serious risk for the investment made. The structure of the industry, outside the OPEC, is fairly standard.

The gas industry (excluding LNG) is very different from the oil industry, and is also very different geographically.

The gas industry in the United States is one of the businesses with more government intervention, through regulation. Gas pipelines are subject to federal regulation, and the gas distribution companies are regulated at State level. Production and transport, by law, cannot be integrated, and in most states integration between producers and distributors of gas is not allowed. Wholesale marketing is liberalised, and producers can therefore participate in the market through this channel. Business relations materialise through long-term contracts only if the feasibility of a new investment can be guaranteed or in order to ensure the transport capacity, but the market is governed by mid to short-term contracts, and time goes by the volume of spot transactions has increased. Although, due to the size of the territory and the restrictions in the gas pipeline network, there are major regional differences, it is no doubt a relatively integrated market, unlike the European market as will be described later on.

With the exceptions of Holland and the United Kingdom, the rest of the European Union countries have been forced to secure their supplies through contracts basically with three countries: Russia, Algeria and Norway. In these three countries, both production and exports to Europe are in the hands of three national companies, Gazprom in Russia, Sonatrach in Algeria and Statoil in Norway. Until recently, development of the gas industry in EU countries was exclusively carried out through national strategies and initially with public monopolies (the original British Gas in the United Kingdom, Gas de France, ENI in Italy, Enagas in Spain, etc.) who were in charge of supplying gas to their respective countries, developing the transport network and ensuring the supply through supply contracts. Distribution of gas in each country was always different, although there was always significant public presence in the industry, either at state, regional or local level.

With the exception of Spain and Portugal, isolated from the European networks, the rest of the continental countries have been forced, under a strongly dependent relationship, to buy most of their gas needs from the three aforementioned producers, who have managed to keep the European market fragmented, with rigorous clauses restricting the destination of gas. In spite of the obvious imbalance between the parties, the system worked fairly satisfactorily right from the start. In spite of their deficiencies, monopolies were originally necessary to de-

velop the industry. The different Central European countries have to a greater or lesser degree coordinated themselves to develop a transport and strategic storage network that reasonably meets their needs. In the interest of both parties, business relations have been framed under long-term contracts, which have permitted planning and have made feasible the major investments needed by the producing countries and their clients in the EU, in order to ultimately provide Europe with a potential gas supply infrastructure similar to that of the United States. The three main suppliers have proved to be reliable over time, guaranteeing the supply at all times, while recent occasional problems stemming from relations between Russia and Ukraine have been solved to date without any significant consequences for the security of the gas supply.

From a price point of view, and given the structure of the industry and the situation of dependence mentioned previously, the average price level in the long-term in Europe has been higher than in the United States, but this has not substantially hindered the capacity of gas to substitute other energy sources.

The negative conditioning factors inherent to developing the European gas system (excessive foreign dependence, fragmentation of the market, excessive vertical integration and persistence of national monopolies, and consequently an excessive level of prices) have been the subject of a series of liberalisation policies and promotion of a single market by the European authorities. The restriction clauses concerning destinations were declared illegal by the EU, and in theory, once gas has entered the territory, the buyer can re-sell it or take it to any other destination. The big monopolies have been forced to disinvest part of their assets. In particular, steps have been taken to regulate the transport activity at European level (as is the case in the United States) and member states have been forced to separate, through so-called “unbundling”, first the transport networks and then the distribution networks, from production and marketing activities.

Although there are no concrete results yet, a programme has been sketched out to improve and optimise the main transport networks and to create new ones, such as the connection of the Iberian Peninsula with the European system.

These measures are being implemented, albeit slowly, and results can be seen even though there is still a long way to go, particularly in diversification of supply sources. There are two possible ways to achieve this: LNG, whose development in Europe will be discussed later, and materialisation of some of the projects to connect Europe, via gas pipeline through Turkey, with Asian countries with large reserves, such as any of the Caucasian countries, the coastal countries on the Caspian Sea or even Iran. These projects, the one with the most advanced definition to date being the Nabucco project, are still undergoing conceptual studies in the pre-feasibility stage, and although with time some of them will probably materialise, the complexity of these projects, the volume of the necessary investments and the uncertainty about the political stability of this region and how Russia -so far a very reliable supplier- will react, lead us to believe that Europe

will not be receiving gas via pipeline from that region of the world in the next twenty years. The only feasible diversification alternative in the short and mid terms is through LNG.

The LNG industry entails conditioning factors that clearly differentiate it from the oil and piped gas industries. When the interests of a producer with gas reserves that cannot be capitalised on in its own region, meet those of a gas consumer who cannot get gas supplied in its own territory, or does not want to increase its dependence on current suppliers, supra-regional cooperation relations are established, frequently between two different continents, which confers that industry the paradigm of globalisation.

Consequently, this industry as a whole is outside the bounds of national or community regulations and outside the control of the competition authorities. Hence, the purchase of BG (British Gas) by Shell, and the subsequent creation of a world LNG giant can take place without any kind of scrutiny.

For an LNG project to be feasible, the project developer needs to establish a five-link chain:

- Gas reserves and gas production facilities and a transport system to the liquefaction plant.
- Liquefaction plant.
- Fleet of methane tankers to transport the gas.
- Regasification plant or plants.
- Buyer or buyers who consume or market gas.

New liquefaction capacity will always be necessary for a chain to materialise, either through construction of a new complex (Grass Roots) or extending an existing one (Brown Roots). An investment in new LNG carriers is also usually necessary either by the seller or the buyer, depending on whether gas is bought at the regasification plant inlet (CIF purchase) or the liquefaction plant outlet (FOB purchase). In the case of the regasification plant, and depending on the destination of the gas, a new plant could be necessary, or the extension of an existing one, although today many destinations already have sufficient regasification capacity and this can also be contracted as a service.

The cost and complexity of these projects means that no company, however important it is, has sufficient strength to undertake them on its own, and therefore the chain materialises through long-term contractual agreements, normally between 15 and 20 years.

The different players in the chain can participate, in different proportions, in one or several of the different consortia setting up the chain, in practice each LNG chain is configured distinctly.

Relations go way beyond a customer/supplier relation in these contractual agreements. Relations are strategic. In LNG projects, partners “get married” and the consequences of a divorce are almost fatal. Any failure to comply by any of the partners poses a serious risk to the project during its whole life, and therefore if solvency and achieving objectives are very important. Risk assessment and potential measures to mitigate them are not less important, mutual trust being absolutely fundamental.

On the other hand it should be emphasized that in these projects, some or all of the links in the chain need to secure financing for their investments. Practically all the liquefaction plant projects have a Project Finance scheme, and therefore the financial consortia that are created to finance the project submit the agreements to a thorough scrutiny. In addition to mutual trust between partners therefore, all the participants in the chain must have the confidence from the financiers.

The most important among these agreements are the LNG purchase and sale contracts.

Apart from economic aspects, the most relevant part of these contracts is their duration, the final destination of the gas and the penalties for non compliance.

The aspects concerning prices are dealt with in the section on gas prices.

When negotiating the duration of contracts, sometimes determined by the volume of available reserves, adequate profitability of the different links in the chain need to be guaranteed. With a very cheap price of gas at the liquefaction plant inlet, it is possible to agree on shorter duration terms. In projects where the fundamental components of the chain are grass roots projects, mainly liquefaction plants, without any pre-existing port infrastructures, it is necessary to lengthen the duration of contracts. In this type of project, a twenty years duration contract is normal. In other situations, the duration terms can be shortened, but, except for contract renewals or capacity increases, which require smaller specific investments and hence lower recovery periods, contracts are usually signed for periods over 10 years.

Flexibility in withdrawn quantities is also important, particularly for the buyers who prefer the greatest possible flexibility since this is the party who has to face fluctuations in the ultimate demand, whereas the seller is interested in producing the liquefied gas in an as much uniform process as possible.

The destination clauses are also important. Sellers in general, particularly in the case of large producers, who want to protect their markets, prefer a destination as exactly defined as possible, in some cases even specifying the regasification plant intended for the gas sold. Buyers prefer freedom in terms of destination, since this allows them to better adapt to the evolution of demand (remember we are talking about contracts covering several years) and thus avoid penalties for failing to comply. At the same time, buyers can take advantage of situations to capitalise on significant price fluctuations, which as will be seen later on, are

fairly common in the LNG market, deriving the gas to other markets and so obtain an extra profit. In many contracts there is a clause by means of which this extra profit is shared between the seller and the buyer.

The penalty clauses for contract non compliance are an essential part of this capital intensive chain involving so many players; the most relevant commonly employed in the industry being those known as “delivery or pay” or “ship or pay” which penalise the seller if the contracted gas is not delivered, and “take or pay” penalising the buyer if the gas is not taken away. In Spain we had a problem with “take or pay” in the early eighties caused by a delay in the construction of the national gas grid owing to the severe recession the Spanish economy was going through at that time, and consequently we could not meet the purchase volumes of the first LNG contract that Spain had signed with Algeria. Algeria took Spain to international arbitration with the result of Spain having to pay severe financial penalties.

At liquefaction plants where several trains have been built, several chains coexist, and the final structure therefore is a hugely complex affair. As an example, let us look at the case of Atlantic LNG in Trinidad and Tobago, whose liquefaction train, Atlantic 1, which came into operation in 1999 with a capacity for 3 Mtpa, operated by a consortium of four companies, BP, BG (British Gas), Repsol, Cabot -a small North American company- and the national gas company of Trinidad, NGC. Three more trains were built later, the last being commissioned at the end of 2005, bringing the total capacity of Atlantic LNG to today's figure of 14.9 Mtpa. Repsol and Cabot recently sold their shares in Atlantic respectively to Shell and to the Chinese Corporation CNP, without the complex share and contract scheme being modified in any way, featuring the following composition:

- Train 1 (Atlantic 1): Nominal capacity 3 Mtpa, Commissioned in 1999.

Liquefaction plant partners: BP (34%), BG (26%), Shell (20%), CNPC (10%) and NGC (10%).

Atlantic 1 acquires 100% of the gas from a BP - Repsol consortium and operates as a merchant plant, therefore keeping the LNG sales margin and selling gas through long-term contracts to Gas de France Suez (60%) and to Gas Natural (40%).

- Train 2 (Atlantic 2): Nominal capacity 3.3 Mtpa, Commissioned in 2002.

Liquefaction plant partners: BP (42.5%), Shell (25%), BG (32.5%).

This train operates under a drawback regime, and therefore the commercialization margins are reverted to the gas supplier, although the LNG is formally marketed by Atlantic.

The gas suppliers are the consortium BP-Repsol (50%) and BG (50%).

The long-term gas sales contracts are signed with: BG (44%), Shell (20%), Gas Natural (21%), Gas de France Suez (10%) and BP (5%).

- Train 3 (Atlantic 3): Nominal capacity 3.3 Mtpa, Commissioned in 2003.

Liquefaction plant partners: BP (42.5%), Shell (25%), BG (32.5%).

This train is operated under a drawback regime similar to train 2.

The gas suppliers are the consortium BP-Repsol (50%) and BG (50%).

The long-term gas sales contracts are signed with Shell (43%), BG (24%) Naturgas (a branch of EDP) (23%) and BP (10%).

- Train 4 (Atlantic 4): Nominal capacity 5.2 Mtpa, Commissioned in 2003.

Liquefaction plant partners: BP (42.5%), Shell (25%), BG (32.5%).

This train is operated under a drawback regime. The gas is commercialized directly by the partners.

The gas suppliers are: BP (37.8%), Repsol (22.2%), BG (28.9%) and CNPP (11.1%), who ship out the LNG in proportion with their shareholdings.

Investments in the LNG Chain

Prior conditions to the launching of a project

In order to guarantee the success of an LNG project it is firstly necessary to account with sufficient gas reserves as to ensure the supply of the necessary volumes of gas throughout the life of the project, at a competitive gas price at the inlet to the liquefaction train. As in all capital intensive projects, a correct estimate of the necessary investment is vital, as it is vital too having the indispensable experience in the execution of very complex projects, both in the design and construction stage, in frequently remote areas short of infrastructures and therefore with much higher construction costs than normally expected. It is likewise necessary to secure partners suitable for marketing LNG at an early stage of the project, with sufficiently defined contract bases, and to secure financing as soon as possible. All this needs to be accompanied by an in-depth project risk analysis.

The foregoing may appear obvious, but as we shall see later, it has not been the case in many recent projects, as many of them have failed after they were started or have ended up with serious delays and cost overruns, sometimes in excess of 50%, which undermine the profitability of any project.

Investments in liquefaction

In the CAPEX of an LNG chain, the most important item, as it represents up to 80% of the investment, is the liquefaction plant, including the plant itself and the storage tanks and port infrastructure.

Geostrategy Of Liquefied Natural Gas (LNG)

The technology employed at natural gas liquefaction plants is relatively much younger. Since the early sixties when this technology was born, thirteen plants were built in the first thirty years, nearly all of them by one single process licensor (Air Products). At the end of the last century, there were only four engineering and construction contractors with proven experience, two North American companies (Bechtel and Kellogg), and two Japanese companies (Chiyoda and JGC), and a small number of plant owners and operators. Basically, there was not much accumulated experience, in spite of which, throughout that first stage and until the early years of this century, expectations in the experience curve were met and the specific investment costs in the period 2000-2006 were around 300 dollars per tonne, the investment in a 5 Mtpa plant being therefore in the order of 1,500 million dollars.

The situation changed radically after 2006 with an unexpected escalation of costs, which in the period 2007-2014 pushed the average unitary costs up to 550 dollars per tonne for construction of a new train in a pre-existing liquefaction plant (brown field project) and to 1,200 dollars per tonne in a grass roots plant, with the average investment for a new 5 Mtpa facility increasing to 6,000 million dollars.

The situation is not expected to change in the short-term, since the estimate for the average investment in projects to be commissioned in the next six years, i.e. between 2015 and 2020, according to information from the developers, is around 600 dollars per tonne for a new train (brown field project) and 1,400 dollars per tonne for a grass roots project, and therefore a new 5 Mtpa plant will cost around 7,000 million dollars on average. If we bear in mind that in projects of this type cost overruns are far more common than the opposite, it is highly likely for the final investment to be much higher. The investment planned for the only "Floating LNG" project currently under construction is around 1,800 dollars per tonne. A "Floating LNG" facility is a new concept, but one that is destined to play a fundamental role in the future of LNG, that we will discuss later.

Some very striking examples of plants that have been commissioned recently or that are still under construction, but which have suffered exorbitant cost overruns are the Snohvit and Gorgon plants. The Snohvit plant, with capacity for 4.3 Mtpa was built by a consortium of several Norwegian companies in the Barents Sea, with Statoil as the main shareholder and operator. Built on a border zone, owing to the climatic conditions, the plant began operating in 2007 after a considerable delay with a unit investment of 2000 dollars per tonne, this being the all time record for unit investment to date. The Gorgon plant in Australia is a gigantic plant, with capacity for 15.6 Mtpa. It is being built by a consortium of six companies, on one hand Chevron (47.3%) Exxon (25%), Shell (25%), i.e. three of the biggest oil companies in the world, with wide experience in LNG, and three Japanese electrical utilities who buy the gas, Osaka Gas (1.47), Tokyo Gas (1%), and Chubu Electric Power (0.42%). It is, as can be seen, a top class consortium. The first train will start operating in early 2016, with the two remaining trains

currently being at advanced stages of construction. In this case the investment is estimated to have a specific cost of around 1,800 dollars per tonne.

It is difficult to explain such an important escalation of costs in an industry as experienced as the oil and gas industry. With young, although established, technology it is more common for investment costs to decrease rather than increase, as the number of built plants grows and experience is accumulated. An excellent study about the causes of this phenomenon is the one published by the Oxford Institute for Energy Studies: *LNG Plant Escalation*, by Brian Songhurst, who also elaborates on what the industry could make to reverse this trend and reduce costs. We recommend anyone who wishes to research this subject further to read it.

One of the reasons analysed in the aforementioned study is that some of these plants have been built at very unfavourable sites, some of them on the frontiers of technology (with limit climatic conditions, such as Snohvit, or high local construction costs such as Australia today). In these cases the profitability of an LNG plant requires gas to be purchased very cheaply at the liquefaction plant inlet.

Investments in regasification

As is the case with the liquefaction plants, the investment costs in regasification plants have also increased substantially in recent years. Average costs, which had stabilised at around 100 dollars per tonne during the initial years, started to escalate sharply at the end of the decade, and now are considerably over 200 dollars per tonne, with costs at plants currently under construction being in excess of 300 dollars per tonne. Although price inflation has not been as high as at liquefaction plants, it has been driven by similar circumstances, a boom of new projects, a small number of construction companies with the necessary technology and experience to build storage tanks, and the fact that liquefaction plants are competing simultaneously for those services. The trend of using tankers with bigger capacities has also contributed to this in that the storage capacity at plants has been forced to increase for the same regasification capacity. The geographical factor has contributed for this cost increase to be more moderate, compared to liquefaction plants, since regasification plants are located in more developed areas, therefore entailing lower construction costs.

This fact, and the probable moderation of growth in the worldwide regasification capacity, as we will see later, with a wide over-capacity in most regions, leads us to forecast a normalisation of the cost curve over the coming years.

The expansion of the so called Floating Regasification Units will contribute to this trend of moderation; these units consist on the integration of an LNG carrier to which the evaporation zone of a regasification plant is added. This new concept that started in 2007 has permitted cheap, rapid access for countries such as Argentina in 2008 and Brazil in 2009 who were in a situation of urgent need to quickly import gas lacking the necessary infrastructures. This solution has quickly be-

come a port of entry for new importers of LNG, without entailing excessive initial costs, particularly for those who only need to import LNG seasonally, hiring the regasification plant during the months when gas is needed, so that the plant can later travel and set up at another site, usually in the other hemisphere, for the rest of the year. This could be the general solution for a country to take its first steps in importing gas. It does have limitations though, such as the low storage capacity, and that in some places, with adverse weather conditions and difficult seas, gas cannot be regasified when it is most required. As the demand for gas increases and LNG imports become permanent, these countries usually end up deciding to build a conventional regasification plant. Whichever the case, the first floating plants have proved to require a much lower investment than permanent plants, by being able to use obsolete LNG carriers that are no longer competitive for the transportation market, but which are still suitable for conversion to floating regasification units. Another advantage in investing in this type of plant, even for those that have been built *ex novo*, is their ability to benefit from the competitive advantages of shipyards, meaning that lower construction costs can be offered. A good example of the success of this new concept is that in just eight years to present, fifteen units of this type have been built.

Another novel concept that the market conditions have driven in recent years is to add a tanker loading system to a conventional regasification plant originally designed to receive LNG, which will permit the plant not only to import, but also to offer intermediate storage and subsequent export of LNG. Some plants have been adapted to be able to conduct load transfers from one methane tanker to another. This capacity to re-export LNG has opened, particularly in Europe, the possibility of compensating for falls in the demand sending the gas to more profitable markets. For example, the six Spanish terminals have been adapted to be able to re-export LNG.

Investment in LNG carriers

In the LNG chain, LNG carriers are the item that requires the least investment. As seen in Point 3 (Characteristics and Feasibility of the LNG Chain), depending on the type of contract, the responsibility can pertain to the buyer or seller of gas. Producers usually decide to have their own tankers, and therefore invest in the fleet. In the case of buyers however, this is more and more often subcontracted to specialised shipping companies under a "time charter" scheme, for the period of duration of the gas purchase and sale contracts, thus avoiding the investment and substituting it for operating costs.

Today there are around four hundred LNG carriers operating in the world, two thirds of which are less than ten years old, and they are therefore large capacity vessels, with efficient energy consumption and low operating costs.

Unlike the case of liquefaction plants, and to a lesser extent regasification plants, the increase in the capacity of the vessels has meant that investment

prices have been contained, and consequently, in spite of the high demand, the investment per cubic metre has increased by less than 20%. The current cost of a tanker is around 1,500 - 1,600 dollars per cubic metre, and with a clear trend to decrease in coming years owing to the lower demand for new capacity.

Current average investment cost in the LNG chain

The scope of investment necessary for an LNG chain is very wide, depending on the variables affecting the costs, as discussed previously. As a guide, the investment necessary for a capacity of 5 Mtpa can range between 3000 million dollars if it is a new train in an existing liquefaction facility that does not invest in regasification and contracts tankers under a time charter, and over 12,000 million if it is a "grass roots" plant in a remote location including the investment made in regasification and purchase of tankers.

According to the estimates made by the International Energy Agency in their World Energy Outlook publication for 2015, the total costs of the natural gas chain, including the costs of gas at the inlet to the regasification plant and the operating costs, are typically itemised as follows:

- Cost of gas: 32%
- Liquefaction: 47%
- Transport: 13%
- Regasification: 7%

Natural Gas Prices

Background

Although the price of LNG has its own particular characteristics, it is obvious that LNG prices are closely linked to those of piped natural gas, with which it ultimately shares its final destination, and it is therefore relevant to analyse, in the first place, how the price of natural gas is formed.

Prices of natural gas are mainly determined by the basics of the offer and the demand, and as happens with other *commodities* this include current offer and demand and future forecasts of offer and demand. On the other hand, prices are correlated to the energy sources gas competes with, namely coal and oil, mainly the latter.

Bear in mind that the price of oil is established on the basis of indexes (Brent, WTI, etc.) and the price of each batch of oil bought and sold is referenced to one of those indexes, the price being adjusted by the quality of the crude oil, its geographical position and any other differentiating variable. Indexes in turn are also correlated, since the oil market is globalised and therefore when talking about the oil price suffice it to refer to one index only, the Brent being the most

widely used. In the case of gas, although we will see there are also indexes, the gas market is fundamentally regional, with large differences between countries. In 2014, 74% of natural gas produced in the world was consumed in the domestic market. From the 26% left for the international market (imports and exports), 14% was sent via pipeline connecting neighbouring countries and regions, and the remaining 9% was commercialized in the form of LNG, the latter being therefore the only correlation link between the different regional markets and the main force driving globalisation of natural gas.

Mechanisms for establishing gas prices

There are different mechanisms for establishing prices, with the most relevant being the following:

- Gas-on-Gas Competition or GOG: In this case the price of gas is referenced in a similar way to the price of oil, through indexes, the most important being the so-called Henry Hub which is used in most transactions in the United States and has been operating for decades, there being consequently many statistics for this index. Indexes have been introduced recently in other markets, namely the NBP (National Balanced Point) in Great Britain. These indexes are formed around transaction centres called Hubs, and can be either physical (as is the case of the Henry Hub) or virtual or notional (such as the NBP). As in the case of oil, these indexes can be used to operate in physical markets or futures markets. With this mechanism, the price is determined by crossing the offer and the demand on the gas market. In order to be efficient and representative it requires large contracting volumes, a multitude of buyers and sellers and therefore sufficient competition and market depth, and a sufficient number of transactions carried out on the spot market. Not all transactions are carried out on spot mode, in fact many are based on mid and long-term contracts, where the price is established on the basis of the reference index. These indexes are also used in the LNG spot market. Today, the only gas price index that is sufficiently representative, owing to the liquidity of the market, is the Henry Hub. The others, including the NBP, are much less representative of the markets, being more speculative and at the moment do not seem to have the potential to become generalised for mid and long-term contracts.

- Price referenced to other energies (Oil Price Escalation) or OPE. In this case, normally limited to mid and long-term contracts, the price is determined by means of a formula that is based on the price of oil and some of its derivatives, normally diesel or fuel oil, and sometimes coal. This mechanism for establishing prices is the most commonly used in LNG contracts and we will therefore analyse it in more detail in the section on LNG prices.

- Price referenced to the product price at the final destination of the gas (Net back from Final Product) or NET: In this case, also limited to mid and long-term contracts, the price is determined by means of a formula based on the final price of the product the gas buyer sells on the market. This mechanism is mainly used

for electricity production (using for example the price of electricity in the buyer country's electrical pool), but also in industries where natural gas is a raw material such as production of fertilisers or methanol, or industries that are very energy intensive, such as steel. For contracts of this kind to become generalised the products used in the calculation formulae need to have reliable, representative indexes and therefore provide sufficient guarantees for the gas seller. Sellers could be interested in this type of contract in order to diversify their earnings and not depend exclusively on gas or oil prices, but also in order to cover their positions in the futures markets providing that the product in question has a futures market and said market is sufficiently liquid.

- Regulated Price (RP): In this case a regulatory or administrative authority sets the gas prices. This mechanism is logically limited to the domestic markets, which we should remember, account for approximately three quarters of the world's gas market. To establish prices regulators logically take into account the production or purchase costs of gas and the return on investment, but there are sometimes other socio-political factors that could include tariff subsidies for certain consumers, large consumers of gas in sensitive industries or social tariffs for small consumers. In countries with large surpluses of gas, it is usually widely subsidised for industry and small consumers alike, and is sometimes distributed for free.

This mechanism has been of an almost universal use in the past, but today nearly all OECD countries have fully or partially liberalised their gas markets.

- Contracts between monopolies (Bilateral Monopoly) or BIM: The price in this case, for contracts with usually annual duration, is fixed between states or national companies.

How domestic prices are established by regions

- North America: Gas consumption on the North American continent accounted in 2014 for 27% of world consumption. Nearly all the gas was marketed via a Gas-on-Gas (GOG) competition mechanism.

- Europe: In 2014, 14% of the world's gas was consumed in Europe. The statistics for that year show a distribution where 61% was traded on Gas-on-Gas (GOG) competition, 32% was at a price referenced to other energies (OPE) and the rest through other mechanisms. The importance that GOG has acquired is a consequence of liberalisation of gas markets in the EU and is very recent, since until a short time ago the market was dominated by the OPE which in 2005 represented 78% of the market.

- Former Soviet Union countries: in 2014 these countries accounted for 18% of the world's gas consumption. In this region, regulated markets accounted for more than two thirds of the total.

- Middle East: In 2014 this region accounted for 13% of the world's gas consumption, way higher than its GDP share because of abundant production, to a large

extent a mere surplus of oil production, and the low prices of gas in the region, where the only possibility of obtaining better performing prices is through LNG production or producing methanol, fertilisers or other products. More than 80% of the market is regulated, highly subsidised and more than 15% of the market correspond to Bilateral Monopolies between states or via national companies.

- Asia: This region includes the big countries of continental Asia, China and India having a big weight, and excludes the coastal Pacific countries. As they are developing countries with low production, penetration of gas on their markets is still low. In 2014 they accounted for 8% of the world's consumption. Approximately half of the gas is marketed on regulated markets and for 45% of consumption the prices are established through competition formulae with other energies (OPE) given the weight of imports, a large part of which is in the form of LNG. The rest of the mechanisms used to establish prices are marginal.

- Asia Pacific: This region includes the islands in the Pacific, where Japan is the main consumer, the coastal countries and Australia. In 2014 they accounted for 12% of the world's consumption. There are countries in this region with large production capacity such as Indonesia and Australia, the latter having large reserves that make it today one of the main LNG exporters. On the contrary, the more industrialised countries such as Japan, Korea and Taiwan have very limited own resources and are therefore big energy importers. These countries have very highly developed gas infrastructures. LNG carries a large weight in their energy balance, it accounting for over 40% in the region as a whole. Consequently, 56% of the gas is priced in correlation to other energies (OPE); 17% is Gas-on-Gas (GOG) based, mainly in Australia, 18% is regulated and the remaining mechanisms for establishing prices are marginal.

- Latin America: In 2014 this region accounted for 5% of the world's consumption, there being countries in the region with high levels of gas penetration, such as Argentina, and countries with high production potential, such as Venezuela and Bolivia, but with scarce gas infrastructures, or Brazil with a huge potential for gas production, although still very incipient, importing most of the gas it consumes. Due to this diversity there is a more balanced distribution of mechanisms for establishing prices than in other regions: 41% of the gas is regulated, 26% is correlated to oil (OPE) and 21% is Gas-on-Gas (GOG) based. The relatively important weight of gas whose price is referenced to the price of the final product (NET) is rather striking.

- Africa: In spite of its production potential, and the weight it has traditionally had as an LNG exporter, the region is a fairly modest consumer of gas. In 2014 they accounted for 3% of the world's consumption. More than 85% of gas is regulated.

Gas prices compared to other energy sources

In comparison to the huge disparity in gas prices in the ultimate market, between regions and between countries in the same region, prices on the interna-

tional markets, although there are notable differences, have converged somewhat, largely because the dominant mechanism for establishing prices has been competition with other energies (OPE).

In the early days of development of the gas industry, when there were practically no environmental restrictions, natural gas had to displace coal and oil sourced manufactured gas. It should also be taken into account that over a long period of time, and even today in the big oil producing regions, gas was a by-product from oil extraction, and since it is not an easy product to store, it was necessary to sell it off at any price, the only other alternative being to burn it.

The major infrastructure investments necessary for development of the gas industry also required a lower gas price in order to make these investments profitable. Once these investments have been depreciated in developed countries, and the important advantages of natural gas have made it more competitive, its price has always been somewhere between the prices of coal and oil, in terms of energy equivalence.

Over time a consensus grew that in the mid-term, and despite its relatively high-er abundance, the difference in price between gas and oil would decrease, tend- ing towards what is known as “oil parity”.

A good way to compare the relative prices of gas and oil in the last thirty years is through the statistics that BP publishes annually in the BP Statistical Review of World Energy. The following table (Table 1) shows a comparison in terms of equivalent energy of oil prices (average import price for OECD countries) with prices of import/export gas from four developed countries where statistics are available, namely: Germany, Great Britain, Canada and Japan, and with the Henry Hub price.

Year	LNG		Natural gas				Crude oil OECD countries
	Japan \$/Bbl	Average German import price	UK \$/mm Bbl	US Henry Hub	Canada \$/Bbl		
1984	5.10	4.00	—	—	—	6.00	
1985	6.25	4.25	—	—	—	4.76	
1986	4.10	3.93	—	—	—	2.57	
1987	3.35	2.55	—	—	—	3.09	
1988	3.34	2.22	—	—	—	2.56	
1989	3.29	2.00	—	—	—	2.01	
1990	3.64	2.79	—	1.70	1.06	2.60	
1991	3.99	3.19	—	1.64	1.06	3.33	
1992	3.62	2.69	—	1.49	0.99	3.15	
1993	3.62	1.50	—	1.12	1.69	2.82	
1994	3.18	3.35	—	1.80	1.45	2.70	
1995	2.48	2.39	—	1.80	0.89	2.06	
1996	2.69	2.46	1.87	2.76	1.12	2.64	
1997	3.91	2.64	1.96	2.53	1.26	2.23	
1998	3.04	2.32	1.88	2.08	1.42	2.18	
1999	3.11	1.86	1.58	2.27	2.03	2.96	
2000	4.27	2.89	2.71	4.23	2.74	4.80	
2001	4.64	3.96	3.17	4.57	2.61	4.06	
2002	4.27	3.23	2.37	3.33	2.62	4.13	
2003	4.77	4.06	3.33	6.43	4.83	4.88	
2004	6.18	4.32	4.40	6.96	6.03	6.27	
2005	6.95	5.96	7.38	8.75	7.25	8.74	
2006	7.44	7.65	7.67	6.74	6.89	10.96	
2007	7.73	8.03	6.01	6.96	6.17	11.96	
2008	12.55	11.56	10.79	6.95	7.59	16.76	
2009	8.06	8.62	4.86	3.89	3.38	10.41	
2010	10.91	8.73	6.50	4.39	3.43	13.47	
2011	14.79	10.45	8.04	4.01	3.47	18.56	
2012	16.75	10.93	9.46	2.76	2.27	18.82	
2013	16.17	10.73	10.63	3.71	2.93	18.25	
2014	16.23	9.11	8.22	4.26	3.67	16.80	

Source: 1984-1992 German Federal Statistical Office, 1991-2011 German Federal Office of Economics and Export Control (GfE),
 Houston: KCS-Henry Energy Ltd.
 Toronto: Energy Intelligence Group, Natural Gas Week.
 Note: \$/Bbl = US\$/barrel; \$/mm Bbl = US\$/million barrels.

Table 1: Oil and natural gas prices in different markets.
 Source: BP Statistical Review of World Energy, 2015.

Geostrategy Of Liquefied Natural Gas (LNG)

The country with the lowest gas price in the track record is always Canada, a country with important gas surplus, which has only been able to export gas to the United States, having to compensate the higher transport costs through price, since to date Canada is not an LNG producer. It is followed by the United States, a major gas consumer but also a major producer, and neighbour of a large captive exporter. The United States is a paradigm today of cheap gas price, and of the competitiveness that this price confers to its economy. This has not always been the case. At the end of the last century, as a result in the decline of gas fields in the country, it was implied that domestic production would rapidly decrease, that this decrease could not be compensated by imports from Canada or Mexico, and that the only alternative was to import gas from other producing regions. The consensus in that by 2020 the United States would be the world's biggest LNG importer was unanimous. As a result of this market situation many American producers thought that they should not make further efforts to maintain production, since in a not too distant future the price marker would be established by LNG imports and that the future performance price of their gas would be substantially higher. The prices increased substantially, and in the table we can see how the Henry Hub price in the first years of this century exceeded European prices and positioned itself at an "Oil Parity" level. Infrastructures to import LNG were rapidly planned. Over forty regasification plants were planned of which more than twenty were actually built (as a consequence, incidentally, there are more regasification plants in the United States than in Europe). This trend did not last long however, and the unexpected, silent and rapid explosion of non-conventional gas production not only changed reality, but also future expectations, and the price of gas in the United States has fallen in recent years to half that of prices in Europe.

The USA is followed in the price range by the United Kingdom where, in the first years of the series, prices below the Henry Hub index were recorded as a country with a major gas surplus but without sufficient infrastructures at that time to export it. As gas production declined, and being forced to resort to importing gas from Europe and to import LNG, gas price has been increasing. The average price in the last five years more than doubles the Henry Hub index. When analysing this data, it should be considered that the referenced index, the NBP, is questionable in that it has a relatively short life, scarce volume of gas for its computation and is highly subject to seasonality, and therefore does not reliably reflect the average gas prices in the United Kingdom as much as the Henry Hub index does or the average import price in Germany.

Import prices in Germany are representative of the average price level in Central Europe, which is a region with its own production but largely dependent on imports. Gas imports from countries outside the EU are from Russia, Norway and Algeria, all via pipeline with very low capacity to import LNG in Central Europe. These exporting countries are in turn largely dependent on Europe to sell their gas production. With the exception of Algeria, which was one of the first countries in the world to export gas in LNG form, neither Russia nor Norway

became LNG exporters until only a short time ago and, as will be seen later, owing to technological reasons they will be in the future fairly uncompetitive LNG producers. This situation of mutual dependence, certainly unwanted, at least by the buyers, but with fairly balanced forces, has led to prices that would not be in practice so different had a situation of higher competitiveness arisen.

Japan, among all the considered countries, is the one who has had to pay a much higher price for its gas in the last thirty years, by a long way. Practically without any energy sources of its own, it has been forced to import all the gas it consumes in the form of LNG, being over all this time the world's biggest importer, by a long way. Because of its geographical situation, the LNG it needs has had to be imported from distant production regions, and Japan's preference to guarantee its gas supply has always been paramount to the price. The market of gas buyers in Japan has always been fragmented, and although individually they are major LNG buyers, they have never been able to enjoy the buying power they would, had they been able to concentrate their contracts.

Figure 1 shows in graphic form the evolution of gas prices in these same countries between 1997 and 2014.

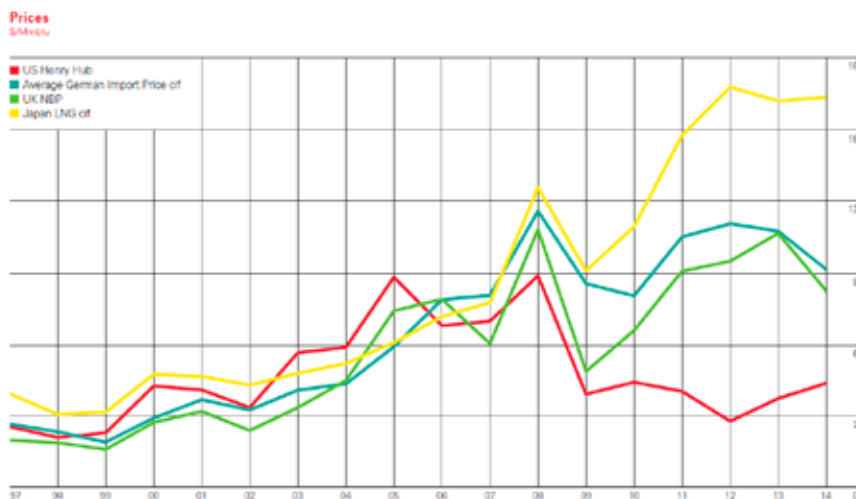


Figure 1. Evolution of international gas prices. Source: BP Statistical Review of World Energy, 2015.

The graph shows how the lines representing natural gas prices in the four analysed countries (United States, Germany, United Kingdom and Japan) remain grouped together, and how prices increase in line with the evolution of oil prices until 2008, when the highest peak on the curve of crude oil prices was produced.

From 2008 onwards the prices start to diverge. This divergence is more pronounced in 2011 in an extraordinary fashion as a result of the accident at the Fukushima nuclear power plant in Japan, when the tsunami caused serious

damage at two other plants. It was decided to thoroughly service all the nuclear power plants, forcing the country to stop using its nuclear power plants for an undefined period of time, and supplementing energy production with coal, oil and above all LNG. This over demand meant that the spot price of LNG tripled in just a few months, lasted over time and had a long-lasting effect however the shortage of gas, as explained in the section on LNG prices.

At the same time that this price increase took place, which, owing to Japan's weight as a consumer, affected the LNG market, there was a gradual fall in crude oil prices, and the price of other gases followed this trend, which in the case of the Henry Hub was made worse by the higher availability of non-conventional gas.

Figure 1 clearly shows how the range of prices by countries has expanded, what would paradoxically appear to point to an increasingly fragmented gas market.

When comparing the relative evolution of prices, it is worth remembering that gas is in "oil parity" when the price of oil, expressed as dollars per barrel, is approximately six times higher than the price of natural gas measured in dollars per million Btu's, the unit used to express figures in the Henry Hub index. The historical range of relative prices of the oil barrel and the Henry Hub, used to oscillate between five (expensive gas) and twelve times (cheap gas). In the last four years this range increased however to a level of between 23 and more than 40 times the ratio of prices between the oil barrel and the Henry Hub price. In 2015 the drastic fall in oil prices has moderated this trend, but, although the year has not yet ended, the ratio is not likely to fall much lower than twenty.

This increasing divergence between oil and gas prices, known as "Oil-Gas Decoupling" is limited to the United States and its area of regional influence, but it does provoke a major debate among the analysts about whether or not it is here to stay or is just here in passing, and whether or not it will spread to other regions.

Whichever the case, in the current scenario of low raw material prices and of energy price in particular, the recovery of gas prices is going to be slow, but it is obvious that the price difference between gas and oil is excessive, and will not be sustained for much longer owing to fundamentals; the substitution process with this price difference is inevitable, suffice it to think about the huge economic incentive driving penetration of gas in the transport sector. This penetration is already taking place, although, as in all these processes, at the beginning with strong inertia (in 2014 natural gas for transport in the USA was only 0.1% of total consumption), but, as has been seen in other countries, Argentina for example, over time these substitution process acquire critical mass and accelerate. The current price level of oil is working however against these processes. Although it is more profitable for an American consumer to replace a current diesel heating system for a natural gas system, he will not be very willing to do it if the fuel bill is half of the previous year.

With gas prices on the American market being so low (without dealing with prices in Japan, which are neither sustainable in time, gas price in Europe was more than double in 2014), there is a clear opportunity to export gas in the form of LNG. In a short time there have been many projects to transform regasification plants, currently unused, in liquefaction plants, of which five are currently under construction. It is expected for the first of them to start operating in early 2016, thus converting the United States in an LNG exporter, and the other four plants to start operations in 2018. LNG exports will contribute, further and faster than vehicle fuelling natural gas, to reduce the “decoupling” gap and the price difference among regions.

To end this section on gas price, a short discussion about the prices in Spain will be made. In view of the lack of comparable statistics, for indicative purposes only we have resorted to the scarce official information available and to the historical records of gas prices when it was regulated. In spite of the fact that in the first stages of gas development in Spain, all the gas was LNG, and this has been for a long time the most important part of the gas basket, it can be stated that gas import prices in Spain have been very similar to the rest of Europe, although slightly higher, and much lower than the prices in Japan or Korea. Contributing to this is the important diversification in the supply of LNG, the geographical proximity of some sources (Libya, Algeria, Egypt and even Trinidad and Tobago), and the competition with the little gas that came from Europe (contract with Norway) and subsequently from Algeria through the Maghreb pipeline first and the Medgas pipeline afterwards. Price levels are therefore comparable to the rest of Europe but with much greater diversification of the supply sources, and therefore higher security of supply.

LNG prices

Mechanisms for establishing prices

As could be no other way, the mechanism for establishing LNG prices cannot be independent from those applied to the rest of the gas, although there are some differentiating aspects, such as the higher weight and longer duration of long-term contracts. Right from the start of this industry, LNG prices have been set using this kind of contracts, with pre-established points of destination. Many of these contracts, with a view to giving gas price more stability, were set in relation to oil prices, but with a time lag of several months (six or nine months), and also with average prices of oil derivatives such as diesel and fuel oil in recent months. All contracts were protected by several confidentiality clauses, and the market was by no means transparent. The spot market was marginal, reduced to what the industry knows as “excess quantities”, i.e. LNG produced in excess of the quantities included in contracts at liquefaction plants, and seasonal situations (gas excesses in summer and demand peaks in winter). At the end of the last century a change in this trend began to be seen, which has accelerated over the last ten years, through the expiry of contracts liberating LNG, through the expansion of the market with an increasing number of producers and cus-

tomers, through the proliferation of regasification plants, through the existence of excess capacity of LNG carriers, and above all due to higher fragmentation of the gas market in the world and the wide price fork affording major arbitration possibilities and therefore a profitable market for agents who were able to place gas on the spot market. This trend has increased in the last decade, which has led to more diversity in contracting formulae.

In 2000 only 5% of the LNG was marketed on the spot or with contractual periods below two years. In 2012 this figure reached a peak of 27% and has stabilised over the last two years at slightly over 25%.

The last few years have seen a bonanza in the LNG market which has encouraged this contracting mode. The general opinion is that this stage has reached its end, and that the market in the coming years will be much more moderate. Several factors point in this direction: very low oil and other raw material prices and normalisation of the extraordinary demand in some countries, particularly Japan, but also Argentina and Brazil. Japan has recovered part of its nuclear generation capacity and has contracted additional gas through mid and long-term contracts. Argentina, which is now a country that structurally imports gas in winter, and no longer wants to exclusively depend on Bolivia, is buying LNG through mid-term contracts.

These, and other importing countries, in view of an energy market with very low prices, under huge uncertainty about the duration of this situation and the relative evolution of prices of the various energy sources, do not want long-term commitments, but do want to secure their energy supplies and not have to depend on a market as volatile as the spot market. These circumstances have brought about an increase in mid-term contracts (three to five years), although the contracted volumes under this modality are fairly low and only accounts for around 3% of the total LNG market. This trend of mid-term duration contracts is likely to continue, at least until the situation regarding the future of energy prices becomes more clear.

The reluctance of buyers to contract new quantities of gas on long-term basis has also been affected by the growing difference between oil and gas prices, the “decoupling”, particularly in the United States, which has only become more moderate in 2015 with the slump in oil prices. Bearing in mind that a long-term gas contract takes many months to mature, the mentioned effect has not materialised in recent LNG contracts. From the latest LNG contracts, as far as we are aware, the preference by buyers to take the American gas price as the reference can be deduced, i.e. the Henry Hub index, in the certainty that this reference index will lead to lower, more stable prices.

Evolution of LNG prices

The last ten years, and above all the last six, have been years of bonanza for the LNG industry at all levels and for most players, due to growth of the market and

evolution of prices. With the exception of structural buyers who, like Japan, have had to resort to big, unscheduled purchases on the spot market, all the rest have benefited from this situation. Producers have been able to sell non-contracted gas on an avid LNG market at prices much higher than contract prices. Buyers with free destination contracts or at least with a certain degree of flexibility have also been able to sell their gas at all times on the market at higher rates, which, in a fragmented market with huge regional price differences has reported extraordinary profits. Even the economic crises in developed countries, and the fall in the domestic demand in these countries has become an opportunity for producers and companies holding LNG contracts intended for those markets. It has been possible to redirect that gas surplus on the LNG spot market, and the price difference between the contract price and the spot price has been somewhat shared between the buyer and the seller.

Around the middle of 2014 the situation began to change, and since then, and throughout 2015 the situation has been deteriorating. Has the bonanza ended? Apparently yes, owing to several concurrent factors. Firstly, the world's weak demand for raw materials had to affect LNG as well. Lower demand for spot gas by Japan, a winter with abnormally mild temperatures, and the already felt deceleration of the Chinese economy, caused a crash in the spot market, leading to prices below 11 dollars per million Btus, practically half the price of previous years and for the first time in many years the spot price of LNG fell below contract prices. Secondly, the sharp fall in crude oil prices, which began back in September 2014 and that dragged them in January 2015 below 50 dollars, i.e. a slump of 50% in just four months.

This fall in prices has been damaging for nearly all players, except of course the structural LNG importers, whether buying on the spot market or through contracts. The new LNG producers, many of whom have preferred to direct part of their production to the spot market, now find themselves in a difficult position. For those whose gas contracts are linked to oil prices, the situation is not good either, although it was initially mitigated by the time shift of many contracts, it has worsened over the year. The least affected contracts are those linked to indexes such as the Henry Hub index, or to the electrical pool price, but contracts of this kind are a minority. The opportunity that LNG buyers used to have to redirect their gas to other destinations has also disappeared, at least temporarily, for their contracts are linked to oil, but with prices with a time lag of months meaning they were forced to pay high gas prices with few possibilities of redirecting it to the spot market, and with a loss of competitiveness of their gas in their domestic markets.

The largest beneficiaries from this situation, on the other hand as in the case of the rest of raw materials, are the end consumers and the economies of the importing countries.

The current situation, leaving aside the prices of oil, whose current level of over-offer and its consequences on price had not arisen for a long time, is noth-

ing more than a gradual return to normality, since what was outside this situation was in fact the LNG market. In the coming years we will see how this market changes from a clear over-demand to a probable situation of over-offer. From now until 2018, i.e. in the next three years, the LNG production capacity will increase by more than 60 Mtpa, i.e. 20% higher than the current production capacity, which the market will most likely not be able to easily absorb.

The evolution of the Asian economies, and the so-called Asia Pacific region will play a fundamental role in the evolution of LNG prices, since, as we will discuss later, these two regions are not only the highest consumers (together they account for consumption of over 75% of the world's LNG and their demand has grown in a similar proportion in recent years), but in the future more than 50% of the world's production is expected to be concentrated in these regions. The growth perspectives of other markets in the coming years are much lower, with a limited growth, if any at all, in

the developed countries, with a view to increasing the security of supply, and also with the entry in the LNG market, for the very same reason, of other countries such as Poland or Lithuania, who could take advantage of low prices on the spot market to partially substitute Russian gas. In these other countries, the incremental demand could arrive, in view of the perspectives of low LNG spot prices, from those who already have regasification infrastructures such as Argentina, Brazil or Chile, and also countries such as Egypt, traditionally an LNG exporter in which the growth of the internal market could force it to become an importer, without having to invest in infrastructures as it can use its liquefaction plants to import gas.

The end of the extraordinary boom the LNG industry has gone through in recent years does not mean it will no longer be an attractive industry, since, as we will see later, will continue to report strong growth. There is a lot of gas in the world where the best alternative to make it profitable is converting it in LNG. LNG projects that are truly competitive will materialise, and those that have been developed properly will become very profitable for their investors. It will not be as easy as in the recent past to develop one project, and the least competitive projects, or those that suffer cost overruns or delays through deficient execution or due to an erroneous assessment of their conditions, will result in a very deficient profitability. Basically, a return to normality.

LNG production. Where it is produced and future evolution

Distribution of gas reserves

There are abundant natural gas reserves in the world. According to the International Energy Agency the proven reserves today amount to 216 Tcm guaranteeing sixty years of production at current demand levels, but the technically and economically recoverable resources, 781 Tcm, would guarantee meeting current levels of demands for another two centuries. It is the study by the Agency itself

who indicates that the foregoing mentioned resources only include the non-conventional gas resources in regions where sufficiently accurate estimates have been made, but do not include regions such as the Middle East, which most probably have huge non-conventional gas reserves, and it could therefore be claimed that just with the current level of technology there are gas reserves for more than three hundred years. Although the biggest reserves are found in the Middle East, the rest is fairly well distributed, and if Russia is included in Europe, it could be said that all regions are capable of supplying their own natural gas for a long time, although logically gas is unevenly distributed among them.

Among the ten leading countries in the world in terms of proven reserves, only five: Russia, Qatar, Nigeria, Algeria and Australia have developed LNG production, and each one, within their possibilities, has a clear strategy to continue to grow in this business, although in the case of Russia this is still only marginal.

Among the other five, Iran, who is in contention with Russia for the country with the highest gas reserves in the world, has not been able to enter the LNG business due to political reasons, economic sanctions and technology limitations. The future opportunities of Iran will be discussed later on. Turkmenistan, the fourth country in terms of reserves, is not nor will be in the LNG market obviously because of its geographical position. The United States, the world's fifth country in terms of reserves, but the leading consumer of natural gas, until six or seven years ago was considered to be the biggest LNG importer in the future. With non-conventional gas coming into the equation, there has been a complete around in the situation, and the United States today has a promising future as an exporter. The two remaining countries, Saudi Arabia and Venezuela, sixth and seventh respectively in terms of proven reserves, are also major oil producers and since they do not have big natural gas consumers in their neighbouring areas, they could have resorted to LNG, but they have not done so. In the case of Saudi Arabia it is obvious that they have clearly opted to export oil, and use natural gas for domestic consumption, for the secondary recovery of oil and to industrialise the country, converting gas in fertilisers, methanol, etc., and this strategy is not likely to change in the future. As is only logical, Venezuela also gives priority to oil, and uses gas for domestic consumption. Although one LNG project was considered at a given time, there has not been much enthusiasm and the political situation has not helped either. Even though Venezuela may consider entering the LNG market in the future, it is not likely to become a relevant player.

Current LNG production in the world

The world's LNG production capacity at the end of 2014 was 301 Mtpa, with the Middle East accounting for 100 Mtpa as the leading producing region, Qatar being the world's leading producer with 77 Mtpa. Asia Pacific region is close behind, with over 95 Mtpa, Australia, Indonesia and Malaysia being the main producers. The third producing region is Africa, with Algeria and Nigeria as the

main producers, although there is also production in Egypt, Angola and Equatorial Guinea. However gas production in Egypt is declining, it has shown a strong growth in its domestic market and is becoming a marginal producer. In fact, in 2014 it only produced 0.2 Mtpa and that year it announced definite closure of its first liquefaction plant, Damietta. Libya, historically one of the world's leading LNG producers has also been several years without any production because of the situation it is going through, and does not look like it will start producing again in the mid-term. Latin America (including the Caribbean) produced around 19 Mtpa that year. Russia, at its plant on the Sajalin islands is still a marginal producer, as is Europe at the Snohvit plant in Norway. In total there are nineteen production countries in the world.

The utilization of the global LNG capacity is historically situated between 75% and 90%. In 2014 it reached 81%, an apparently low figure, but in which several factors affected it, including the shortage of gas at some plants, a shortage that in several cases (Indonesia, Egypt, Oman, Yemen) is now structural, and the fact that several units have been operating for only a short time, some with commissioning problems. Actually, the liquefaction plants that have not had this type of problems operated at practically full capacity.

New capacity under construction or design

Over thirty plants are currently under construction, many of them of a large capacity, which before 2020 will increase the production capacity by more than 125 Mtpa, accounting for an increase of more than 40% in production capacity.

Approximately half of this increase will materialise in Asia Pacific (Australia, Malaysia and Indonesia), with this region then clearly becoming the world leader in production, ahead of the Middle East. Australia, with seven big plants under construction will add 57.6 Mtpa by means of which it will overtake Qatar and become the world's leading producer.

The United States has joined the league of producing countries and, as could not be otherwise, does it in big way. The use of the large, unexploited capacity it has in regasification plants, therefore with pre-existing infrastructures and storage, means it has the opportunity to invest in liquefaction through brown roots projects, with the subsequent saving on investment. There are currently four plants already under construction, meaning that by 2020 production capacity will be 44 Mtpa, thus being positioned as the world's third producer in just five years. This is a record for a new player.

Russia, with its Yamal LNG project in the Arctic will increase its production by 16.5 Mtpa. Completion is scheduled for 2019, although the developers have announced that the first train will enter into service in 2017. This is a frontier project, entailing huge design, construction and subsequent operation challenges because of the extreme climatic conditions and remote location. Specially designed LNG carriers will be needed to transport the LNG in conjunction with

icebreakers. These difficulties have been made worse by the sanctions placed on Russia this year. The final result of this project, its possible cost overruns and delays, and the possible operating problems are crucial for the future development of LNG in Russia, who has enormous gas reserves in the Arctic, with the only viable outlet being LNG.

Future post 2020 investments

The driving force behind the LNG business in recent years has helped to maintain the logical interest in continued growth by the pre-existing players, but also by a multitude of new agents, starting with potential producing countries and oil companies who had previously not been involved in this industry; the buyers, both traditional buyers with the aim to integrate upstream and potential buyers to guarantee supplies under better conditions, and even investment banks who have wanted to participate as active investors in some of these projects. Consequently, a huge number of potential new projects have been announced, totalling approximately 800 Mtpa, nearly double the installed capacity in 2020. It is obvious that many of these projects will never materialise, and since projects of this kind take a long time to mature, only a small number of them will actually be started in the new future. Some of these projects have not even announced the scheduled dates to start operation, and can therefore be considered nothing more than a statement of intentions.

It is striking that the Middle East, currently the largest production region, is practically absent from these projects, and that most of those announced are in North America, which has historically been a marginal LNG exporter, Asia Pacific, in projects located in non-traditional production zones, on the east coast of Africa, where there is currently no production, and finally in the Arctic.

Most of the projects, of the announced fifty, are in North America, with an aggregate capacity of 615 Mtpa. Most of the projects in the United States are located in the Gulf of Mexico, but also in Alaska. In Canada most of the projects are on the west coast, but there are also some on its Atlantic coast. If these projects actually materialise, North America will be consolidated as the future third LNG exporting region. Even if only twenty percent of the projects announced in North America materialise, this region will become the world's leading exporter. In 1970 this region was a pioneer in the industry with construction of a plant in Alaska, Kenai LNG (this plant stopping production due to a lack of raw material this century), and is now ambitiously returning to the world of LNG.

The projects announced for Asia Pacific, with a total of 90 Mtpa, are in general still speculations, in very remote areas and with recent experiences of very high production costs.

On the African coast facing the Indian Ocean some large gas reserves have been discovered, where the intention is to capitalise on them through LNG pro-

jects. Projects totalling around 50 Mtpa in Mozambique and Tanzania have been announced.

Finally, in the Arctic region, in addition to the projects mentioned previously in Alaska (20 Mtpa), the projects announced in Russia include an extension of Sakhalin 2 on the Sajalin islands, which was initially announced for operation in 2018, but has been postponed, and other northerly projects still on the drawing board.

How many of this projects will actually materialise, and when? It is obvious that the "momentum" of many of these projects has passed. It is significant that the main traditional gas producers have not announced any plans, at least publicly, for short to mid-term growth, even though they are prepared to increase capacity with much more competitive projects than most of the projects that have been announced. It is obvious that the deterioration the industry is going to suffer in terms of profitability is making them reluctant to build plants in the short-term, but almost certainly increases in capacity in the Middle East will take place before many of the announced projects actually materialise.

Among the announced projects, those that entail the least uncertainty are the ones for the United States Atlantic Basin, which will be difficult for any other initiatives to compete with, particularly concerning those in the Gulf of Mexico. With infrastructures already being available, low, reliable construction costs, gas very close to the facility with proven, foreseeable regulation and low financing costs, the feasibility of each project is guaranteed. Some of the new projects are already in advanced stages of planning permission and exporting licenses, and will probably secure them in the short-term. But it is obvious that not all of them will be granted permission, since there is not enough gas production to assimilate up to 270 Mtpa of additional gas without increasing prices, and even less so in the current situation where investments in the oil and gas industries have fallen off drastically. Industries that consume gas, such as the petro-chemical industry are lobbying strongly for no more licenses to be granted, or at least to limit the quantity of exportable gas. The projects announced for Alaska will probably not be subject to this limitation but they are projects for which marine reserves will have to be developed and grass roots projects in remote areas, without infrastructures and with adverse climates, entailing very high investment costs. The feasibility of these projects at current gas and oil prices is a problem.

The projects planned in Canada entail more uncertainty than those in the Atlantic Basin off the United States, although they have similar regulatory conditions and probably more political support. Nearly all of them are grass roots projects and therefore with high investment costs at the liquefaction plant and stronger requirements for transport and port infrastructures.

The projects planned in the Asia Pacific area are also fairly uncertain at this moment. Most of them are offshore gas plants, which will have to be built in very remote areas with extremely high construction costs. Most of these pro-

jects require the use of floating liquefaction plants (FLNF), still a very incipient technology, with only one plant yet under construction, which is therefore still to prove its feasibility. These projects are therefore very speculative and seen as mid to long-term projects.

The projects planned for the Russian Arctic region have similar difficulties, if not more, than those in Alaska, worsened by the serious political and financing problems as a result of the sanctions currently in force.

As a conclusion regarding the announced projects, in the short term we are only likely to see the projects in the Gulf of Mexico actually materialise, and perhaps some in Canada, unless the oil and gas price forecasts change.

LNG Demand and MID-TERM Evolution

LNG regasification capacity in the world

The current regasification capacity in the world is 724 Mtpa, equivalent to 240% of the current liquefaction capacity. This excess is due to the fact that many regasification plants have been built as a back-up to ensure supply, to diversify energy sources, with these plants absorbing seasonal demand peaks, to take advantage of cheap LNG on the spot market and also because of the significant capacity installed in the United States (with regasification capacity of 132 MTPA, three times that of Spain, which in 2014 reported a utilisation factor of 1%).

There are thirty countries today capable of importing LNG. In addition to the traditional importers in Asia Pacific (Japan and Korea), and Europe (with Spain traditionally as the main European importer, with capacity for 43 Mtpa), other countries from all regions around the world have joined owing to the reasons explained above. Apart from Spain, there are seven countries with regasification plants in Europe: United Kingdom, France, Italy, Holland, Belgium, Portugal and Lithuania.

The regasification capacity will continue to increase in all regions around the world, with proportionally more modest growth in Asia Pacific and Europe, and more significant growth in Asia (China and India). The perspective for better LNG prices has driven renewed interest this year in the construction of new plants.

Major LNG importers

Japan is by far the world's main importer, as has been the case throughout the history of LNG, and the indicators suggest this will be the case for many years to come. In 2014 Japan imported 89 Mtpa. Although it is a country with a high level of gas infrastructures and economic growth perspectives, there is uncertainty about how long its nuclear power plants will remain in operation, and we are likely to see an increase in demand, driven by lower gas prices. In fact, a new regasification plant was commissioned that year.

Korea, which in 2014 imported 37 Mtpa is the world's second main importer, and, as in the case of Japan, this is an structural situation.

Spain, which in the same year imported 8.2 Mtpa net, traditionally being the third importer of LNG in the world, has fallen four places in the ranking, having been overtaken by China (19.9 Mtpa), India (14.5 Mtpa), Taiwan (13.6 Mtpa) and the United Kingdom (8.36 Mtpa).

These eight countries account for approximately 80% of world demand.

In the coming years LNG demand in Europe, which for its high prices had been displaced by Russian gas and by a more intense use of coal for electricity production, LNG having been redirected to other markets, is likely to increase, driven by a higher economic growth on the back of expected low prices in the spot market and by a much higher regasification capacity in the centre of Europe, meaning that market opportunities will be able to be exploited. For example, the Dunkirk LNG plant with due for commissioning at the end of 2015, with a capacity for 10 Mtpa, will be the biggest plant in Europe and one of the biggest in the world. Poland also has a plant under construction.

The demand for LNG is also likely to increase in Latin America, despite the difficult economic situation it is currently going through. Its LNG imports are partly linked to Henry Hub indexed contracts, or short-term duration contracts, and this region will therefore be able to buy LNG under more favourable conditions and have spot LNG at competitive prices.

The Asian continent will continue to report the highest rates of growth, mostly in continental Asia, driven mainly by China and India, but also by Pakistan.

The Future of LNG

The future of natural gas

There is consensus today about the promising future of natural gas in the 21st century. In its annual publication "World Energy Outlook" for 2015 (WEO2015), the International Energy Agency estimates the annual demand growth until 2040 at 1.4%, below the growth projection over recent years, in its "new policies" scenario, and therefore a reduction in greenhouse gas emissions. Even within such a context, by 2040, among all energy forms, natural gas would have a practically similar weight than the other two fossil fuels, namely oil and coal. By that year, gas will account for 24% of the energy mix. Also in agreement with the Agency's forecasts, 85% of the additional demand would come from non-OECD countries. Growth will take place practically all over the world, with the exception of Europe, Russia and also Japan. In the United States demand is expected to grow, but at a relatively low rate of 0.4%.

There is also consensus that later on in the century the gas quota will continue to grow, gradually displacing the rest of the fossil fuels. The effective reduc-

tion of emissions entails gradual electrification of transport, and an electricity generation mix with renewable energies, nuclear energy and combined cycles using natural gas. The leading role by Asia and Asia Pacific will continue in the foreseeable future.

Future weight of LNG in the energy balance

Although LNG has reported high rates of growth since it began, the trend has increased this century. Since 2000, demand for natural gas has grown by 2.7% every year in the world, whereas LNG demand has grown over 7%. Although this rate will be more moderate in the coming years, all the long-term forecasts expect LNG growth to carry on increasing its weight in the energy balance; in 2040 for example it would account for more than 20% of the total of natural gas compared to 10% today. This growth is due to the better opportunities offered to both the owners of gas reserves and the consumers.

The future of LNG production

In the recent past we have seen how the number of LNG producers has increased, with an array of newcomers, among whom Australia stands out, who in just a few years and starting from zero will become before 2020 the world's leading producer, while at the same time we will see the United States emerge as a major producer in an impending future. These last two cases, which nobody would have foreseen a few years ago, have arisen from the explosion of non-conventional gas, which not only significantly increases the quantity of recoverable resources, but also changes the geographical distribution of the potential production sources, since it is more widely distributed than conventional gas. This trend towards diversification in the production of LNG will continue. Of the two countries with the highest gas reserves, the first one, Russia, is still a marginal LNG producer, and the second one, Iran, does not currently produce it.

The possible future of Russia as a major LNG exporter depends on the future evolution and the duration of its current situation as a country subjected to economic sanctions by the United States and the European Union, and so on the evolution of technology permitting exploitation of the enormous reserves Russia has inside the Arctic polar circle. The current situation and the mid-term price forecasts for energy are not making Russia's position any easier.

Iran, in spite of its efforts, has not been able to pave its way into the LNG market because of its economic isolation and the limitations in terms of technology transfer. This situation has changed, but it will take several years to return to normal, and the uncertainty with regulations will remain present. On the other hand, it is likely that foreign investment, which in all scenarios is indispensable, will prefer to focus on oil, which requires a lower capital investment and shorter return on investment times, as well as an easier access to technology. This

preference to give priority to oil is also more likely to be upheld by the Iranian authorities for the same reasons, and in the end it is them who will make the decisions, and consequently today LNG is not likely to be a short-term option. In a longer term, the options Iran has to become a major LNG producer will remain present, owing to its huge gas reserves which, unlike the Russian reserves, can be developed and mobilised under unbeatable economic conditions.

Further to the impact for the future presence of Russia and Iran, and perhaps even more relevant, is the future development of "Floating LNG" or FLNG, i.e. floating liquefaction plants. This new technology, as discussed previously, is not currently operating anywhere, but it is expected for up to three plants to be commissioned this year and there are expected to be over a half a dozen in two or three years time. A sample of just how promising this could be is that a large part of the new liquefaction capacity proposed in the Asia Pacific area is based on this concept. The feasibility of the technology does not entail any major doubts, but it does remain to be seen however just how the investment costs evolve, and if they significantly decrease as the number of built units increases, and therefore obeys the classic experience curve, or, as in the case of the rest of the liquefaction plants, this trend is abnormally ignored. The fact that the location where plants are built can be chosen, brings the competition factor into play, and permits taking advantage of the lower construction costs of shipyards, while also reducing the risks, which leads us to believe that this technology is going to be a success.

There are many gas fields in the sea, which, because of their remote locations, far from coasts, or their size, do not justify the necessary investments to exploit them, and they are consequently not rated as gas reserves. These fields as a whole are referred to as "stranded gas". Many of them are located in shallow waters, and therefore the gas can be extracted through affordable investments. The development of the "Floating LNG" could make commercial exploitation of this gas possible, in the future, both on remote fields and on those fields with sizes that do not justify installation of a fixed plant. In the case of the latter, a floating plant could extract the gas over the few years required by the reserves, and then move on to another similar kind of field. Initiatives are current underway to invest in this type of plants by service companies who would rent out these plants to the owners of the gas fields enabling them to develop and exploit them without having to make the huge investments required by LNG technology. This opens up opportunities for many countries in the world with this kind of gas fields, and for medium and small oil and gas companies who are unable to breach the barriers preventing them from entering the LNG market today. The same concept could serve to develop gas reserves in remote areas on land, but located near to the coast. A good example of the opportunities afforded by "Floating LNG" is the Rubiales project in Colombia, to exploit the reserves off the coast of Colombia in the Caribbean. The project plans to use a 0.5 Mtpa floating plant, currently at an advanced stage of construction by a Chinese service company. Although the project has been postponed due to the current market situation, there can be no doubt that there will be more initiatives of this kind in the future.

The biggest challenge the LNG industry faces in its future of competing with other energy sources is the current level of the investment costs, mainly due to the inflation of the liquefaction costs. The fact that the technology for this process only lies in the hands of a few parties and the quasi monopoly in the supply of some specific equipment has been one of the factors leading to this escalation of prices. It is obvious that the current marketplace situation is going to require a major effort if costs are to be reduced, and it is imperative for the industry to take steps in that direction in order to successfully ensure a more competitive LNG in the future. Diversification of production agents would undoubtedly be welcome to help achieve this objective. Greater diversification and the foreseeable expansion of the spot market will have a weakening effect on the structure of the business chain, which in turn will reduce the perception of its risks, and will facilitate financing of new projects, and consequently new players entering the market.

The future of LNG demand

The relative weight of the major LNG consumers, Japan, Korea and Spain, will be much less in the future, since they will only contribute slightly to the demand growth, or not at all. They are developed countries, under strong pressure to reduce their CO₂ emissions, undoubtedly committed to this reduction, and with a limited potential for industrial growth. The main drive for new demand will be from the big emerging countries, China and India, but also from the rest of the emerging countries who need gas for their development. Gas production in Europe will decrease throughout the century, with production of gas in Holland, United Kingdom and Norway in decline, and without perspectives today of the barriers against non-conventional gas easing (whose resources in Europe are somewhat limited). The geopolitical difficulties that hinder consolidation of bringing gas from the Caspian Sea and from Central Asian republics via gas pipeline are not likely to disappear. If Europe does not want to increase its dependence on Russian gas, it will have to compensate at least part of its own production losses with LNG.

Traditional gas producing countries, including LNG producers of the past, will become LNG consumers as a result of the growth of their domestic markets and the decline of their own gas fields. The fact that countries such as Egypt, Bahrain, Dubai, Oman or Kuwait, or even some Indonesian islands are importers of gas today, or will in the immediate future be, and that they use their liquefaction plants to import gas, or have the intention to build regasification plants, is somewhat surprising.

LNG growth in segments and non-conventional markets

The LNG was not present until today in the final energy market, since it is used in its regasified form in the traditional gas using segments, but applications are

appearing for LNG today that use it directly with advantages meaning it can substitute other energy sources. The most important of these applications is the use of LNG as fuel for marine propulsion, mostly marine fuel oil on these days, for which in many regions around the world the poorest quality of fuel oil - highly pollutant therefore - is used. The demand to reduce emissions forces the use of marine Diesel instead, but this is unlikely to be able to compete with LNG either in price or emissions, and therefore the use of the latter is being already taken into account as the main fuel in the construction of new ships.

The use of gas for road transport is growing around the world, as a substitute for oil-based fuel because of the lower price of gas. This growth is higher where there are big price differences, and above all in emerging countries. It is estimated that there are twenty-three million vehicles in the world today that run on natural gas, and its use will continue to increase disregarding a possible more moderate scenario of lower prices.

For light vehicles, compressed gas is and will continue to be used. Nevertheless, for heavy transport, trucks and buses, the advantages of using LNG are becoming more obvious wherever it is available. The use of LNG in this segment will grow over time, although over a very small base and slowly in the early stages for the need to deploy distribution infrastructures, but it is a cheap alternative with a promising future to reduce emissions in locations where LNG is actually available. Its use is growing in highly polluted areas, such as in some parts of China, but also where there are stricter emission regulations, such as in California. The fact is remarkable that 7% of heavy vehicles sold in China in 2013 are ready to use LNG. In Europe there is a project driven by the European Commission to encourage consumption of LNG in heavy vehicles used for road transport. This project, called "Blue Corridors Project" does envisage investments in the distribution infrastructure and in truck fleets on the four main European transport corridors.

Another use of LNG, although marginal at present but which will expand in line with the incorporation of more liquefaction and regasification facilities in the world, is the so-called "Small Scale LNG" or SSLNG, which basically consists of small size storage and regasification plants that operate as satellites for conventional plants, receiving LNG through small size LNG carriers operating as shuttles or by road in the case of onshore plants. This concept is currently under full development all over the world, particularly in Asia, in order to take gas to islands, both in Japan and Indonesia (a similar concept is being used in the Caribbean), and in China to provide access to gas to remotely located industries.

LNG, a Global Industry in a Globalised World

LNG has only been in the world for around fifty years. Its quick development meant that countries such as Japan, Korea and Spain had access to natural gas as a key element of their economic development. For the producers (Algeria,

Trinidad) it soon became the keystone of their economies, and has also contributed to positioning Qatar in the position it is in the world today.

Already in this century, the growth in the volume of LNG and its geographical expansion has been even faster, and is now a fundamental component for many countries, consumers and producers alike. It guarantees 10% of the world's gas demand today, and 30% of the international gas market, production taking place on all continents. Nineteen countries currently produce LNG, who will soon be joined by the United States as a large scale producer, and thirty countries import it.

Natural gas is expected to continue its growth more than other fossil fuels, and in 2050 is expected to be the first energy source. LNG will grow even faster, and by the middle of the century it will account for 20% of the gas demand.

Just as important as its larger weight in the energy market, is its contribution to guaranteeing supply and to globalisation. The expansion of LNG and the increasingly important proportion of spot or short-term sales will have an ever time more mitigating effect on the big regional differences existing of the natural gas prices, and the so-called "decoupling" of gas and oil prices.

Chapter II

Geostrategic Overview of Energy Maritime Routes Spanish Energy Security in a Changing Scenario

Gonzalo Sirvent Zaragoza

Abstract

The new world economic order arising out of the Bretton Woods Agreements bases one of its fundamental pillars on maritime trade. For maritime trade to accomplish its purpose a powerful fleet of merchant vessels is needed with high cargo capacity, along with the freedom to sail unthreatened down the Sea Lines of Communications (SLOCs).¹ This need is even more critical in certain choke points, real bottlenecks where a high amount of oil tankers and gas carriers converge, whose free passage could be hindered or impeded by an armed conflict, by action from a certain State, terrorism or others. Should this traffic be interrupted, it would lead to severe delays in supplies and a major increase in prices on world markets, seriously affecting many countries, and entailing the risk of causing a general economic crisis.

Keywords

Crude oil, liquefied natural gas (LNG), maritime routes, critical points, free passage, maritime security.

¹ VOID

Introduction

This chapter initially describes the importance of free trade for economic development, something that has become an indispensable factor for the world's economy to function. It shall also be noted that trade exchange is essentially carried out by sea, on board large ships, true monsters in the economies of scale, whose performance permit the costs of freight transport be negligible. In the new economic model arising through the Bretton Woods Agreements, maritime trade benefits all, and particularly permits maritime transport of huge amounts of crude oil from countries with a surplus of this raw material to those that need buying it on the world markets, so that their economies are able to continue functioning. At the same time, natural gas transport in its liquid form at -161°C is being increasingly imposed, facilitating access by all countries to this developing market, more and more open and flexible each day.

Afterwards, the principal maritime routes that both cargoes follow shall be analysed, describing the most important flows, their entity, the points of origin and their final destination.

Likewise, the most widely used shipping courses will be analysed, particularly the traffic bottlenecks internationally known as "choke points", whilst their strategic importance and the main risks each of them entail is also analysed. This analysis will be as detailed as possible within the available space, and will include a description of the concepts and fundamental rights regulated by the United Nations Convention on the Law of the Sea, a true guarantee of freedom of navigation particularly the *right to passage in transit*, an indispensable right for the free sailing of these flows, from which all of us benefit.

Finally, the importance of Maritime Security will be discussed, based on coordination of all maritime stakeholders in countries and between countries, within the bounds of international cooperation programmes, placing special emphasis on the importance of warships and modern international aero-naval task forces as an element of cohesion and efficacy to ensure the free use of the sea, preventing and acting against all manner of risks and threats.

World Maritime Trade

Free trade

Free trade between nations entails many advantages. One of them is that it permits those resources that one country is short of to be acquired, some of which can be extremely valuable to maintain our way of life. This is the case of crude oil and natural gas. Moreover, trade is not a zero sum game in which some win and other lose, but both parties benefit from it, as proven by David Ricardo and other classic economists. Likewise, it acts as a growth multiplier, creating jobs, transmitting new ideas and stimulating innovation.

Other important induced effects are that it favours work specialisation, meaning that production becomes gradually cheaper as the learning curve advances, and economies of scale that appear when markets are extended. These economies are a consubstantial part with today's large vessels.

Finally, trade creates growing interdependence between countries, replenishing their needs, which in a free trade system represents an important source of stability and progress.

Background

Ever since early civilisations, ships were seen as the ideal mode of transport. At first they were used on rivers for trade, but mankind soon took to the seas to reach further away lands. Their large cargo carrying capacity and the use of sails meant that ships were a cheap mode of transport that permitted distances to be covered which on land would be at least excessively long, if indeed viable at all. Some other times the sea was the only possible way.

The Industrial Revolution applied steam engines to ship propulsion, whilst creating a strong demand for raw materials and all kinds of elaborated products, giving trade, shipping trade in particular, a spectacular boost. Construction of increasingly bigger ships contributed to shipping trade, the repercussion of transport costs in terms of unit price of the transported items being reduced. Likewise, shorter travelling times contributed to trade, as course and duration no longer depended on prevailing winds. Ships consequently became the *par excellence* mode of transport.

International trade continued to grow in a significant manner since then, with notable growth reported at the end of the 19th Century, when in just forty years it multiplied fourfold. The growing economies of scale in shipping performance, the increase in demand for all manner of goods and the opening of the Suez and Panama canals, which dramatically shortened shipping courses, contributed to this.

However, the existing economic model was based on protectionism and on each metropolis having its own areas of exchange, more or less closed off to the rest of the world, whilst there was strong rivalry among the main powers to secure raw materials. This situation of strongly conflicting economic interests was one of the causes that led to the two world wars, with dramatic consequences for all.

Fortunately, statesmen learnt their lesson and established the basis for free trade between equals, greater stability in the currency market and more cooperative relations between nations, which would include development aid for the least developed. Through the Bretton Woods Agreements of 1944 the GATT,² the

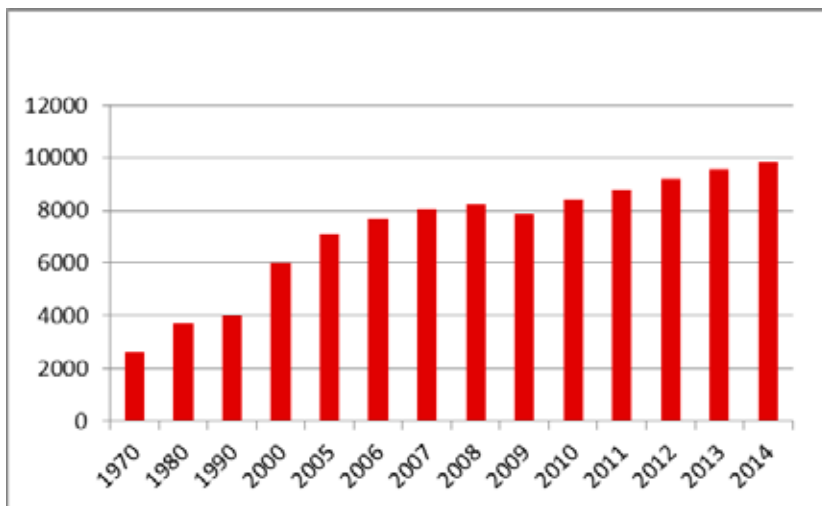
² Acronym of "General Agreement on Tariffs and Trade" as this organisation was known, that achieved unprecedented liberalisation in world trade. GATT became nowadays the "World Trade Organisation" (WTO).

International Monetary Fund and the World Bank were created, entrusted with the aforementioned tasks. Since then the world has enjoyed a long, prosperous period of growth that continues today.

Following graph shows the world maritime trade figures published by UNCTAD³ since 1970. These figures clearly show the spectacular evolution of trade, meaning the end of the 20th century seeing the tonnage of all kind of products in the last twenty-five years doubled again, in spite of the severe world recession caused by the two oil crises in the seventies.

Current situation

Around 10,000 million tonnes of products were transported by sea in the world in 2014, most of them vital for the functioning of the economic structure of the countries. From among the transported cargo, crude oil was the leading commodity in terms of quantity (26% of total tonnage) and importance, since it is the indispensable fuel for factories, transport and production of an endless amount of common products in everyday life. Coal tonnage also holds a significant place (12%), natural gas holding a more modest⁴ position (6% between natural gas, petroleum gases and other chemical products).⁵



World Maritime Transport (million tonnes).
Data. UNCTAD. Graphic: compiled by the author.

In recent years, once the recent economic recession has been overcome, international trade has recovered its pulse, and it is likely to double again by 2020

³ "United Nations Conference on Trade and Development".

⁴ In terms of transport by ship.

⁵ Source: UNCTAD, "Review of Maritime Transport 2015".

compared to the figures for year 2000. Moreover, growth in recent decades has been linked to an important development of nations, both in terms of GDP and improved living standards.

Furthermore, today's economic model has brought new heavyweight players into the ring, who have joined Europe, the United States and Japan, who until not long ago were the ones who played the starring roles. These new players are the emerging economies, who have reached high levels of development in just a few years, the most paradigmatic being China, which now has eight out of the ten world's principal ports.

This economic model depends however on maintaining the major maritime flows of cargo, particularly crude oil and natural gas,⁶ since many countries that lack these resources need the sea to receive their provision of primary energy, without which their production systems would collapse. The European Union (EU) is particularly noteworthy among these countries, whose dependence on crude oil is 88%, and 66% on natural gas. Of these quantities, Europe receives by sea 90% of the crude oil and 15% of the natural gas,⁷ the remaining 85% arriving through pipeline mainly from Russia.⁸

The World's Merchant Marine

General Overview

The world's merchant marine fleet on 1st January 2015 consisted of 56,636 ships,⁹ with a total cargo capacity of 1,665 million tonnes in terms of deadweight tonnage (DWT).¹⁰ This fleet includes 7,500 oil tankers representing 13.6% of the fleet in terms of number of vessels, and 22% in terms of tonnage. There are approximately 2,500 super tankers of different sizes engaged in transporting crude oil. Likewise, there are 1,700 LNG carriers, whose cargo capacity represents 5% of the fleet's total.

The principal merchant marine fleets are controlled by Greek, Japanese, Chinese, German and Korean shipping companies, in that order, the European Union as a whole being distinguished for controlling around 40% of the world's merchant marine fleet. The United States on the other hand, being much less dependent on sea trade and controlling a smaller percentage of the fleet, it is a nation however with a strong maritime vocation and with the most powerful

⁶ 61% of the world trade of crude oil is transported by sea. As for natural gas, the current proportion is 30%, maritime transport of gas being currently immersed in a strong expansion process.

⁷ Source: European Commission.

⁸ The case of Spain is different since it receives 55% of the gas it consumes from Algeria, which Europe could take advantage of to diversify its supplies.

⁹ Source: Lloyd's Register.

¹⁰ The deadweight tonnage gives an idea about the cargo capacity of a vessel. It technically includes the maximum weight of the cargo that it can transport, plus the crew and all consumables (fuel, water, supplies, etc.).

Navy in the world, its warships sailing all the seas, contributing to guarantee free sailing and maritime security, as defined in the US official doctrine.¹¹

Oil tanker fleet

Oil tankers are divided into two main types: those for transporting crude oil from the maritime terminal to a refinery (crude oil tankers) and those that transport derivatives such as kerosene, gasoline, gas-oil, etc. (product tankers). The latter are the smallest and are engaged in transport from refineries to other places not too far afield.

Crude oil tankers range in size from between 50,000 DWT to 500,000 DWT. The largest, around 600 vessels, are internationally known as Very Large Crude Oil Carriers (VLCC) and Ultra Large Crude Oil Carriers (ULCC). Large size tankers can carry around two million barrels of crude oil and only operate out of the world's major ports. Moreover, they exceed the maximum permitted dimensions to sail through certain canals. These ships have around 350 metres length, with a beam of¹² around 55 metres and a draft¹³ over 20 metres.

The most commonly used classification, for their tonnage and the restrictions associated with their dimensions, is as follows:

<u>Type</u>	<u>Size</u>
- Panamax	55,000 to 80.000 DWT
- Aframax ¹⁴	80,000 to 120,000 DWT
- Suezmax	120,000 to 200,000 DWT ¹⁵
- V.L.C.C.	200,000 to 320,000 DWT
- U.L.C.C.	Over 320,000 DWT

Europe controls a fleet of around 2,000 oil tankers, although many of them sail under convenience flags. Spain has 21 of these vessels, accounting for a total of 900,000 DWT.¹⁶

LNG Carrier Fleet

Ships used to transport natural gas are able to keep it very cold, at liquefaction temperature. Since methane is the principal component of natural gas, it needs

¹¹ Top level unclassified documents from the US Defence Department clearly state it is necessary to keep the world's shipping routes free to navigation, this being the only country in the world with sufficient naval capability to have advanced presence worldwide and to react against any kind of aggression.

¹² Maximum width of a ship.

¹³ Depth of the part underwater when fully loaded.

¹⁴ Technical denomination, although not related to the maximum measurements of any canal.

¹⁵ Vessels up to 300,000 DWT can currently pass the Suez Canal.

¹⁶ Data obtained from the report "Merchant Marine and Maritime Transport 2014/2015" by ANAVE (Asociación de Navieros Españoles).

to be cooled to -161°C its volume being reduced 600 times, making transport much more profitable.

Vessels that transport liquefied natural gas (LNG), also known as methane tankers, are sophisticated vessels that employ very advanced technology. Those currently in service have between 290 metres and 350 metres length and a loading capacity of between $150,000\text{m}^3$ and $266,000\text{m}^3$. There are around 400 large methane tankers in service today, along with a considerable list of orders.

The new methane tankers are part of an ongoing revolution, in which many countries are making major investments to provide themselves with the necessary infrastructures to receive LNG by sea. At the same time the producing countries are also investing in major facilities to export LNG by sea. This revolution will drastically change the gas market, which is excessively regionalised, in order to guarantee supplies and lead to a more flexible, competitive market. Spain has around fifteen such large methane tankers, capable of transporting 1,200,000 DWT, and six regasification plants, being one of Europe's most advanced countries in this field.

Maritime Energy Routes

Production, export and consumption of crude oil

The world consumes approximately 90 million barrels of crude oil per day.¹⁷ This means an annual consumption of around four thousand million tonnes of crude oil, most of which is transported by sea, as stated previously,¹⁸ along with large amounts of crude derivatives, all of them vital to keep our economies running.

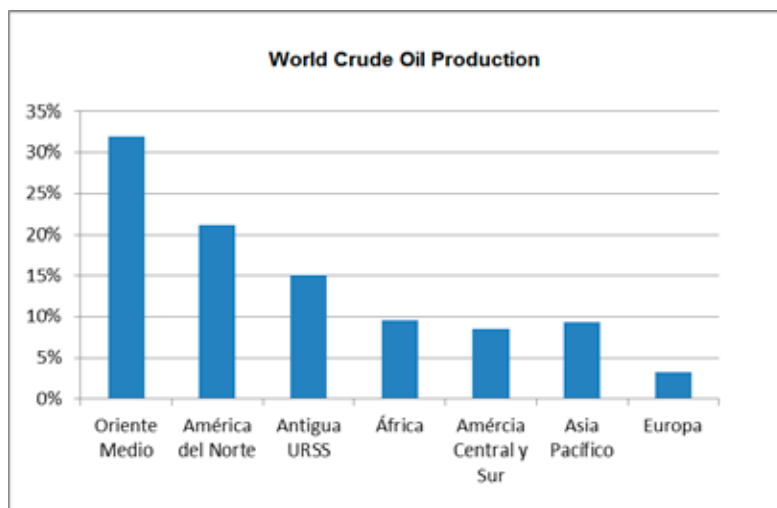
The main crude oil reserves are distributed in a rather erratic manner, usually away from the large consumers. The most important reserves are found in Saudi Arabia, Venezuela, Canada and Iran, who jointly account for 95% of the world's reserves, followed by Iraq, Kuwait, Arab Emirates and Russia. The main consumers are the United States, Europe, India and Asia Pacific countries. With the exception of the former, which in just a few years has become the world's leading oil producer thanks to the fracking technique, the majority of the others need to import the crude oil they consume, since they have none or very limited production.

By large areas the biggest conventional crude oil reserves are found in the Middle East, the former USSR, Africa (North Africa and the Gulf of Guinea) and South America (Venezuela, Brazil), in this order.

¹⁷ 92.57 million barrels per day in 2014 according to a report from CORES (Corporación de Reservas Estratégicas de Productos Petrolíferos).

¹⁸ 56.5 million barrels per day according to the Energy Information Agency (EIA) of the US Department of Energy.

In terms of today's oil production, the main producing region is the Middle East (32%),¹⁹ followed by North America (21.2%),²⁰ the former USSR countries (15.1%),²¹ Africa (9.6%) and Central and South America (8.6%). There is a certain amount of production in the Asia Pacific region (9.3%),²² but it is completely insufficient for the area. Finally, some European countries (headed up by Norway) produce around 3.4% of the world's crude, a very small quantity for the high energy requirements of the EU.²³



World Crude Oil Production
Source: CORES. Graph: compiled by the author.

Finally, it is necessary to outline the figures from the principal crude oil exporters, since they are the ones that truly reflect the origins of the world's flows. These figures can vary compared to the previous ones as a result of the amount of domestic consumption or the exploitation rate of the reserves in each country.

The main exporting zones in 2014 were²⁴: the Middle East (42%), Central America (11.5%), Russia (11.2%), Gulf of Guinea in Africa (10.5%), North America (6.5%), Europe (4.5%) and North Africa (2%). This data can be seen in the following graph, showing percentages and million barrels per day (mbd). This shows the enormous importance of the Middle East's oil, even at a time when Iran was hardly exporting any. The importance of the exports from America and Africa can also be seen.

¹⁹ The main producer is Saudi Arabia, accounting for 12.8% of the world total.

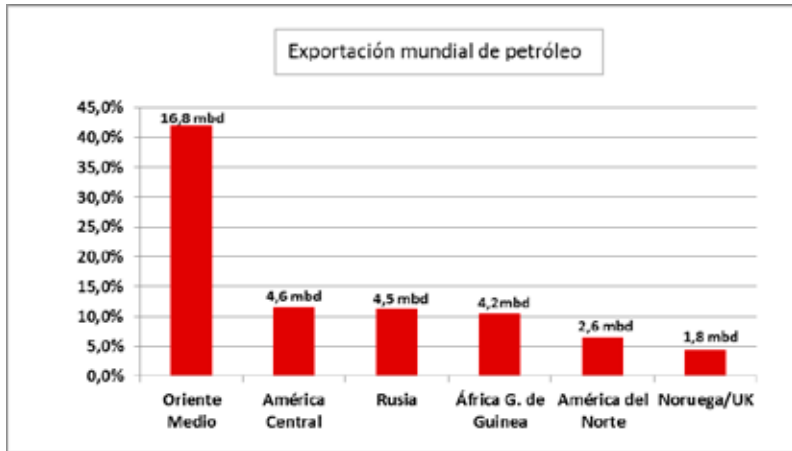
²⁰ The United States currently produces 13.3% of the world total.

²¹ Russia produces 12.2% and the region around the Caspian Sea, the remaining 2.9%.

²² The principal producer is China, with 4.7%.

²³ Data supplied by CORES for 2014.

²⁴ Source: OPEC. Annual Statistical Bulletin 2015.



Source: OPEC. Graph: compiled by the author.

These regions or countries represent the origins of the maritime flows of oil, the principal destinations being Europe, India and Asia Pacific.

Production, export and consumption of natural gas

According to OPEC natural gas production in the world is 3.5 trillion cubic meters per year. The countries that do not have enough of this resource need to import around one trillion cubic meters.

The world's main natural gas reserves are in Russia, Iran and Qatar, followed by the United States, Saudi Arabia and other of less relevant value, whereas the main consuming countries are the same as the already mentioned main oil consumers. By geographical zones, these reserves are mainly grouped in the former republics of the USSR, the Middle East and Africa, not disregarding the important natural deposits of non-conventional gas in the United States, under a rapid process of exploitation.

The region that produces most natural gas is North America (27.4%),²⁵ followed by the former USSR (21%),²⁶ Middle East (17.4%),²⁷ Asia Pacific (15.3%),²⁸ Europe (6.7%),²⁹ Africa (5.9%)³⁰ and Central and South America (5.1%).

²⁵ The United States produces 21% of the world's total, thanks to the use of new techniques that permit non-conventional extraction of gas (fracking).

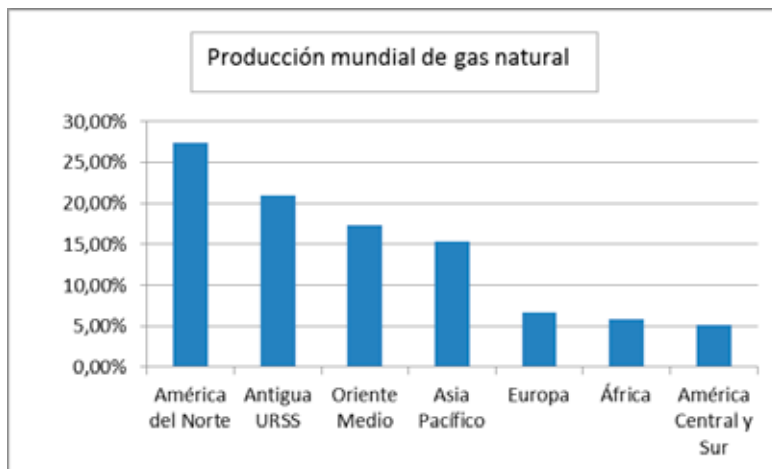
²⁶ Russia produces 16.7% of the world's total.

²⁷ Qatar is the main producer.

²⁸ China produces 3.9%, the rest of the production being very atomised.

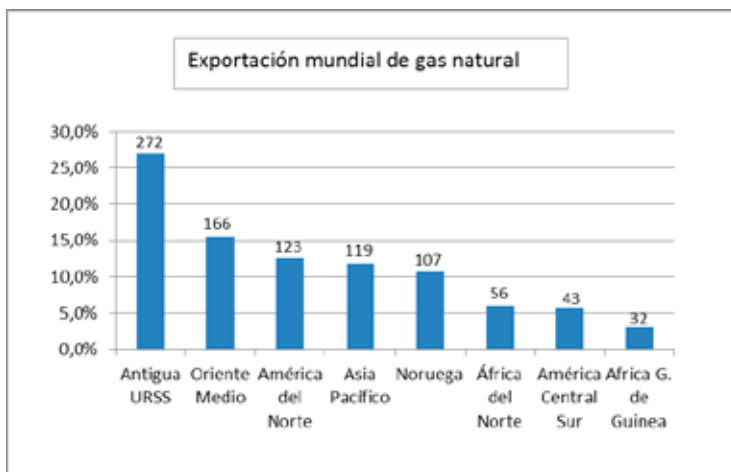
²⁹ European production, mainly concentrated in Norway, Holland and the United Kingdom, is far lower than the EU's requirements as a whole.

³⁰ North African countries produce 4.2% and Nigeria 1.1%.



Source: CORES. Graph: compiled by the author.

As for exports, the main suppliers in the world are as follows:³¹ the former USSR (272,000 million cubic metres or M cum),³² Middle East (166,000 M cum),³³ North America (123,000 M cum),³⁴ Asia Pacific (119,000 M cum),³⁵ Norway (107,000 M cum), North Africa (56,000 M cum), Central and South America (43,000 M cum) and finally the Gulf of Guinea in Africa (32,000 M cum).



Data: OPEC. Graph: compiled by the author.

³¹ Data for 2014, published by OPEC.

³² Russia is the main exporter of them all, at 195,000 M cum.

³³ Qatar is the main exporter, at 123,000 M cum.

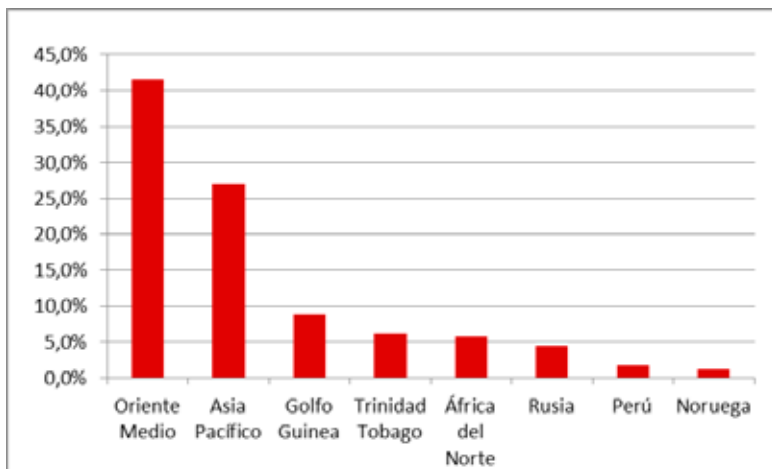
³⁴ Canada is the main exporter, at 79,000 M cum.

³⁵ Malaysia, Indonesia and Australia are the main exporters.

The following considerations should be taken into account with regard to these figures:

- The data refer to total exports, through pipeline or by ship.
- The former soviet republics in Central Asia are undergoing important growth, with their current production accounting for a third of Russia's, which continues to be the main exporter.
- The major importance of the Middle East, despite the sanctions on Iran.
- The growing importance of North America (Canada and the United States), and Africa (North coast and Gulf of Guinea).
- Exports from Asia Pacific countries are mainly carried to their own region, although quantities are far below the strong demand in this region.
- Exports from Norway are mainly intended for European consumption, being likewise far below the needs.
- The EU imports 40% of the gas it consumes from Russia.

Regardless of the foregoing, in order to define the maritime flows, it is first necessary to know which countries are the world's main LNG exporters, by sea, because they are the true source of maritime supply flows. These data have been obtained from the "World LNG Report 2015" by the International Gas Union and are summarised in the following graph:



World's Principal LNG Exporters. (30% of natural gas exports)
Data: International Gas Union. Graph: compiled by the author.

These exports, as previously explained, are mainly sent to Asia Pacific countries, European countries and India, in this order, Japan being the world's main consumer, far ahead of the other countries.

Principal maritime routes

The routes that crude oil and natural gas follow on board merchant ships, on the sea, will be described hereunder, regardless of the existing marine gas and oil pipelines, generally following the seabed at great depths, being very difficult to access and fairly safe therefore, which are not the subject of this paper.

The geographic location of the main exporting and importing countries determines the routes, summarised in the two attached figures, drawn up from export / import tables for each hydrocarbon.

In the first figure, prepared by the Energy Information Administration (EIA) of the US Department of Energy, the maritime flows of crude oil can be seen expressed in millions of barrels per day (mb/d) on the sea,³⁶ particularly at certain “choke points” of enormous strategic value, as they are true “bottlenecks” particularly vulnerable to specific risks or threats.

Note the enormous amount of oil, mostly crude oil, that exits the Persian Gulf (17 mb/d) mainly heading for the Asia Pacific region through the Strait of Malacca (12 mb/d). A flow of around 15.2 mb/d goes across this strait, adding the crude oil from the Persian Gulf and other minor flows that join it from the Suez Canal and the Cape routes. Note too that through the Mediterranean there is a flow of 4.5 mb/d from the Persian Gulf and another 2.9 mb/d from the Black Sea. An un-quantified flow not shown in the chart joins them from North Africa, with an approximate value of 1.5 mb/d. Furthermore, the flows shown on the chart directed to the United States (figures for 2013) are diminishing, due to the strong increase in their domestic production.



All estimates in million barrels per day. Includes crude oil and petroleum products. Based on 2013 data.

Maritime crude oil flows.
Source: US Energy Information Administration.

The following figure summarises the main LNG routes. Data refer to 2014 and have been obtained from the “World LNG Report 2015” by the International Gas Union.

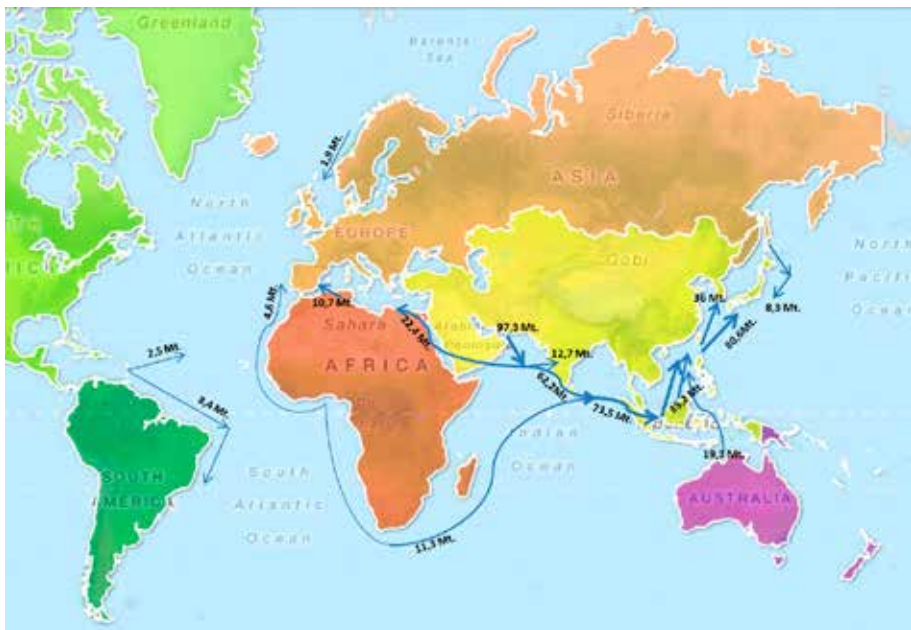
³⁶ Information for 2013. Data include traffic of crude oil and oil products.

Geostrategic Overview of Energy Maritime Routes

The most important flow is the one originating in the Persian Gulf with 97.3 million tonnes (Mt), mostly from Qatar. This flow follows three routes, the most important one towards the Asia Pacific countries (62.2 Mt), then the route towards Europe (22.4 Mt) and finally the one ending in India (12.7 Mt).

Another major flow is the one from the Gulf of Guinea towards Asia around the Cape, with 11.3 Mt, meaning that through the Strait of Malacca there is a flow of around 75 Mt to supply the economies of Japan (world's leading importer), Korea and China, whose total imports respectively amount 88.9 Mt, 38 Mt y 20 Mt. Malaysia, Australia and Indonesia, on the other hand, export another 63.3 Mt that are mostly delivered to the Asian markets.

Finally, flows from Russia towards Japan can be seen (8.7 Mt), from Algeria to Europe (10.7 Mt mainly to Spain and France), from Norway to Europe (1.9 Mt) and those flows from Trinidad and Tobago (10.9 Mt). The chart does not include other minor flows.



LNG maritime flows.
Data: IGU World LNG Report 2015. Figure: compiled by the author.

In global figures, it is worth pointing out that 65% of the world's LNG traffic travels through the China Sea.³⁷ All together, the Asia Pacific countries import an astounding annual total figure of 165.5 Mt.

³⁷ Also known as the South China Sea.

The European Union only imports 33 Mt of LNG by sea, approximately 15% of the total volume of its gas imports. In this case dependence on the sea is low, but there is a major dependence on the gas from Russia instead, which introduces an important vulnerability.

Trends

The foregoing flows are expected to undergo some changes over the coming years which are worth of mention. On the one hand, in the coming decades the principal growth in the world's oil demand will take place in India and the Asia Pacific countries, who will gather 72% of that growth, mainly China, India and Japan, to the extent that by 2040 the Asian countries will import two out of every three barrels of internationally marketed crude oil.³⁸ This means there will be a new increase in the number of large oil tankers that sail towards Asia Pacific, mainly through the Malacca Strait, and an increase too in the crude oil traffic in the China Sea.

The increase in demand in Asia will be accompanied by stagnation in consumption of crude oil in Europe and the United States, who will use more natural gas and renewable energy sources.

From the point of view of the offer, the United States as the main producer and consumer of crude oil in the world has already started to export it, and this trend is expected to continue in coming years. Likewise, major increases are expected in off-shore production at deep water sites in Brazil and the Gulf of Guinea. In addition to this, the United States is no longer consuming such large amounts of light crude oil from Africa (Algeria, Nigeria and Angola). This crude is now being shipped mainly to the Asia Pacific region. In order to achieve this, the oil from North Africa will use the eastbound route along the Suez Canal, the oil from the Gulf of Guinea will travel around the Cape and the oil from America will be able to use the extended Panama Canal, although only small tankers (up to 120,000 DWT) will be able to travel this route, while larger tankers will have to use other routes.

As far as Europe is concerned, diversification of its supply sources is very likely to take place, buying crude oil from the United States and from other countries of the Atlantic Basin, whilst reducing its dependence on Russia.

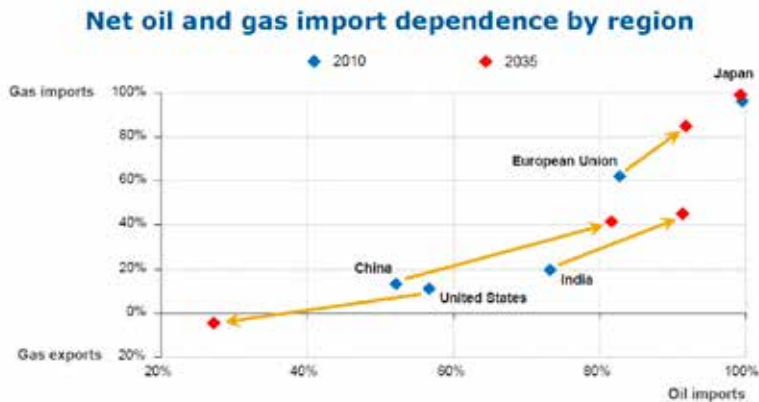
As for transport of liquefied natural gas by sea, a strong growth is expected to continue. By zones, the biggest increase in demand in coming years will also take place in Asia, mainly in China and India, whereas today's main producers, headed up by Qatar and Russia, will be joined by Australia and Nigeria, whose production will increase considerably. Non-conventional gas production will also acquire a higher key role, headed up by the United States who will start to export it, probably to Europe and also to Japan, in the latter's case via the extended

³⁸ Source: World Energy Outlook 2014.

Panama Canal. The most likely course of events concerning Asia is for the flow of LNG carriers through the Malacca Strait to keep increasing, which will depend to a large extent on the degree of exploitation of the Australian fields, which will grow significantly.

Hence, over the coming years, the Atlantic Basin will be more geostrategically important as a supplier of crude and natural gas, with flows mainly headed towards Europe and Asia Pacific. It is particularly important to note that Europe will be able to turn to new, important supplies from America and the Gulf of Guinea, which will help to reduce dependence on Russia. Moreover, new exploitations in the East Mediterranean will begin to operate, joining those already operating in Algeria and Libya, which will also help to reduce that dependence.

Finally a graph is attached showing the degree of energy dependence today concerning crude oil and natural gas by different countries and the situation envisaged for 2035. As can be seen, dependence by the United States by then will be practically zero, whereas in China and India it will increase significantly, mainly in the case of crude oil. With regard to EU dependence, it will increase even further for both hydrocarbons, and will approach the strong dependence by Japan.



Source: European Commission / EIA.

Principal Risks and Threats on Maritime Energy Routes

In documents concerning Security and Defence, both of national and international character (NATO, EU), differences are made between the *risks* that could materialise against our interests and the direct *threats* to these interests, where there is evident intention to damage them.

Both concepts could arise, and on occasions have actually arisen already, on the maritime energy routes, and can be grouped together as follows. Later on,

throughout this paper, the most worrying risks or threats at the principal critical points along these routes will be analysed, they being basically the following:

Serious international crisis or armed conflict

On the one hand, this situation could arise if a country decided not to respect free sailing across a particular pass or in a specific zone, for considering it its own waters or just to damage others, and tried to prevent that sailing, for example by laying mines. This would be a serious threat to the traffic if high-technology mines were to be used, or in case of a high-density mining. Fortunately, this hypothesis is not very likely owing to the enormous interdependence of economies today.

Nevertheless, this threat would be a real possibility in the case of an armed conflict between countries. Should this situation arise, a country or a coalition would have to use its naval forces to cancel out the threat and re-establish passage. In this sense, the already mentioned, strong commitment by the United States to maintain free navigation is noteworthy, as duly stated in the document "National Security Strategy" signed by President Obama in February 2015.³⁹ NATO on the other hand, although more oriented towards the scenario in the North Atlantic, has been since quiet a long time considering out of area operations if they were specifically authorised by the Atlantic Council. In this sense, NATO's doctrine on Maritime Security provides that its forces must be prepared to protect *free navigation* and contribute to *energy security* by protecting the lines of communication, all of it within the framework of operations authorised by the Atlantic Council.⁴⁰

Terrorist attacks aimed at closing a strategic passage

This could take different shapes. Within the irrationality that these groups have unfortunately demonstrated, it is not hard to image a chain of attacks against traffic, which would undoubtedly lead to a strong military response by the international community and would in the end fail. Secondly, an isolated attack on a large ship could occur with the intention of causing her serious damage or sinking it in a narrow, shallow passage. Laying sea mines more or less occasionally in this type of passage cannot be ruled out either. In both cases, if the attack is successfully carried out and the passage is blocked, the international community has sufficient technological and military means to re-establish normality in

³⁹ "The United States has an enduring interest in freedom of navigation and overflight, as well as in the safety and sustainability of the air and maritime environments. We will therefore maintain the capability to ensure the free flow of commerce": Section on "Air and Maritime Security", page 13.

⁴⁰ Document "Alliance Maritime Strategy", Section III (Maritime contribution to the Alliance Security).

a relatively short period of time. Even so, the current situation around the Sinai Peninsula is worrying, and close attention will have to be paid to the evolution of events in that area.

Piracy and armed robbery

This scenario would involve robbery and kidnapping including violence as is the unfortunate case of the large body of sea off the coast of Somalia, which has been practically eradicated thanks to the international effort carried out, or as it is still the case in the Malacca Strait and the Gulf of Guinea.

Serious accident blocking a strategic passage

This hypothesis could only prevent passage if it occurs in a very narrow, shallow strait, particularly in one of the artificial canals that the maritime energy routes cross. The Suez Canal seems to be the passage that is most vulnerable to this scenario.

Critical Points and Areas of Special Strategic Interest

It is more probable, and at the same time more alarming, that aggressions on freedom of navigation take place at choke points, where there is a major convergence of shipping traffic and where transit is a necessity due to geographical and economic conditioning factors, unless alternative routes are used, in general longer and more costly.

It is therefore necessary to protect international shipping routes used by thousands of oil tankers and LNG carriers, whose punctual arrival at port is extremely important. This is a top priority challenge for the world's naval forces, intrinsic to their very existence. Special attention needs to be paid to guarantee transit through the critical points used by these vessels, since closure of any of them would entail important delays in the supply of energy, with serious consequences for the importing countries and sharp price increases that would be rapidly transferred to the world marketplace, with the possibility of triggering a severe, global economic crisis.

These points and zones are as follows:

The Strait of Hormuz

a) Overview

This strait is formed between the coast lines of Iran on the north and Oman on the south. It is 21 miles wide (39 km)⁴¹ and is undoubtedly the most critical point

⁴¹ A nautical mile is equivalent to 1,852 metres.

in the world. 17 million barrels of crude oil travel through this strait every day, mainly heading to Asia (80%) where the world's biggest consumers are. Exports to Europe are also important, accounting for practically all of the remaining 20%. It is one of the few straits that permit passage by VLCC and ULCC super-tankers. The strait is crossed by around 14 tankers a day, which adds up to five thousand crossings by these vessels per year.



Oil tanker traffic in the Persian Gulf.
Source: www.marinetraffic.com.

Transport of LNG through this strait stands at 200 million cubic metres of LNG per year, on board large LNG carriers that mainly come from Qatar and that in most cases head for Asia Pacific countries, India and the European Union. This figure represents approximately 1,500 LNG tankers per year.

b) Transit Security

Among the causes that could cause closure of this strait, it is very hard to imagine a scenario, other than an armed conflict, that could achieve it even temporarily.

If international terrorism is to be considered, the strait's width and the depth of these waters (around 100 metres in the zone of passage) would easily withstand an attempt to block it by sinking a large vessel at the entrance or exit channels. Furthermore, it should also be born in mind that Western powers have been very forceful in recent years when dealing with the problem of piracy off the coast of Somalia and in the Gulf of Aden, and would be even more so if this case arose.

Another possibility that could be imagined, before the recent agreement with Iran, is a traffic hindering attitude by this country. Nevertheless, traffic could not be impeded unless a decision is made to blatantly breach the United Nations Convention of the Law of the Sea. This hypothetical attitude would never be allowed to prosper, since it would not be tolerated by the world's powers, particularly the United States, regardless of being detrimental to Iran itself, whose exports use this very same route.

Finally, in the event of a possible armed conflict, which can never be ruled out in this part of the world, there would be two potentially dangerous weapons: anti-ship missiles and naval mines. The former could be easily located and destroyed, whereas mining the strait, supposing this could be done without being detected, would not prevent traffic from being swiftly re-established by opening up an entrance and an exit channel. This task could be easily done by modern mine hunters, such as those in service in the Western navies.⁴²

c) Geostrategic considerations

Nearly half of the world's oil and natural gas reserves are found in the Persian Gulf.⁴³ This fact is evident from the impressive flow of oil that leaves the area through Hormuz, accounting for 42% of the world's supply. In the case of natural gas, 38% of the world's LNG market travels through the strait.⁴⁴ This strait is therefore of enormous strategic value.

Although there are some oil pipelines that permit the avoidance of transit through the strait, the amounts of crude oil that can be pumped are far lower than those transported daily by the supertankers. Moreover, some of the oil pipelines are in a poor state of repair. In other words, transporting crude oil by sea cannot be substituted by pipelines. The same could be said of the few gas pipelines being planned.

It is therefore indispensable to guarantee both flows through this strait. In this sense, the international community is lucky that the United States has its Navy permanently deployed in this area, nowadays maintaining the TF 152 joint task force in which different countries take part, namely Bahrain, Saudi Arabia, Qatar, Kuwait, Arab Emirates and the United Kingdom.

Even today, when the United States is practically self-sufficient in terms of energy, the North American commitment is very clear, as can be seen in the top level document "National Security Strategy", mentioned above.⁴⁵

This commitment is the consequence of the importance the resources in the Middle East have for world peace and stability. On the one hand, the region provides important resources for many NATO countries, and on the other hand, for the economies of Asia, particularly China, India and Japan, with high dependence on them. As a consequence, today's world economic model, strongly interdependent, would suffer a major shock in the hypothetical event of closure of this Strait.

⁴² Minesweeping and minehunting operations to clear a channel would be carried out in a short period of time, during which the strait may need to be closed.

⁴³ 47.7% in the case of oil and 42.7% respectively, according to the CORES report for 2014.

⁴⁴ According to the export figures recorded in the World LNG Report 2014, published by "International Gas Union".

⁴⁵ *"In the Middle East we will dismantle terrorist networks that threaten our people, confront external aggressions against our allies and partners and ensure the free flow of energy from the region to the world"*. Section on "Seek Stability and Peace in the Middle East and North Africa", page 26.

The Strait of Bab el-Mandeb

a) Overview

It is 16 miles wide, 60 miles long and 300 metres deep, flanked by Yemeni coasts on the north and Djibouti and Eritrea on the south. It gives natural access to the Red Sea / Suez Canal from the Persian Gulf and the Indian Ocean, and it gives also an exit towards the Indian Ocean for ships that cross the Suez Canal from the Mediterranean. Ships heading to Europe reach this strait through the Gulf of Aden, whose waters bathe the coasts of Yemen and Somalia along a stretch covering 1000 km. The Gulf of Aden, today under heavy surveillance, has frequently been used in the past for operations by Somali pirates.

The Bab el-Mandeb Strait is part of the sailing route used by oil tankers that supply crude oil to Europe, from the Persian Gulf, except for the largest tankers which are unable to navigate the Suez Canal because of their excessive draft. In 2013 crude oil and oil product traffic along this strait was 3.8 million barrels per day. The annual total in terms of number of merchant ships using this strait is around twenty thousand.



Graphic 11.

b) Transit Security

Transit through this strait, particularly the need to cross the huge Gulf of Aden (1000 km by 400 km) located between two conflictive countries the likes of Yemen and Somalia, will always entail the risk of being attacked by pirates or terrorist vessels.⁴⁶ The geostrategic and geopolitical objective must be to keep this risk to a bare minimum.

⁴⁶ The attack against the North American destroyer "USS Cole" in 2000, while she was moored in the port of Aden, should be remembered, with 17 members of the crew killed.

The first risk, very important several years ago, is currently very low thanks to the significant deployment of Western naval and air forces in the area, and the measures adopted by the international community against piracy. The risk of suffering a possible terrorist attack has increased however, given the complicated situation in Yemen, immersed in a civil war.

In order to carry out a terrorist attack against a ship during navigation, the most likely course of events would be for the authors to board her from smaller boats loaded with explosives in order to attempt to sink or seriously damage her. If this were to happen, exceptional security measures could always be employed, adapted to the threat, with the objective of making sure it is an isolated incident.

As for possible attempts to sink a large ship in the strait, due to the considerable width and water depth, this would not pose a problem at all for navigation.

Likewise, in the hypothetical case of laying naval mines, this would only pose serious problems for sailing through the strait itself. Nevertheless, to carry this mission out, highly-equipped and well-trained naval forces would be required, which are not readily available to terrorist groups. In addition, considering the fact that there is heavy air and naval surveillance in the region, and keeping in mind that due to the considerable width and water depth, a lot of mines would have to be laid to close the strait, this hypothesis has very little chance of success.

c) Geostrategic considerations

The strategic importance of this passage is closely linked to that of the Gulf of Aden, and of the Red Sea and the Suez Canal, since all of them are part of the same route, incidentally surrounded by unstable states. It is therefore a strongly overlapping strategic area, where any risk or threat that endangers navigating through these waters would have repercussions in the use of the whole "Persian Gulf - Mediterranean Sea" route.

More specifically, the outcome of the civil war in Yemen will strongly affect security in the area, since, if the insurgents win that war, they will take over control of the northern part of the Gulf and this could pose a serious threat to ship traffic. The perspective of Yemen ending up in chaos is not promising either, since Jihadist groups could easily operate from its shores with the intention of attacking Western interests, including oil and gas carriers sailing off their coast.

Fortunately the governmental troops, with the support of the Arab coalition, headed up by Saudi Arabia, have recently recovered the city of Aden, taken by the rebels in the month of March, with President Haidi being able to return to that city on 22nd September. These forces have also recovered Mayyun Island, from where traffic through the strait can be controlled, all of it representing a favourable about turn in the situation.

a) Overview

The Suez Canal joins the Mediterranean Sea and the Red Sea along 163 km through Egypt, from Port Said to Suez, thus permitting sailing between the Mediterranean and the Indian Ocean. Transit through the canal must be performed at very slow speeds since it is very narrow in some sections. Until August 2015 transit in both directions at the same time was not possible⁴⁷, the ships' draft being limited to 16.1 metres.

In 2013 it was travelled by 3,594 oil tankers transporting 3.2 million barrels of oil per day, including crude oil and refined products. In that year a total of 16,596 merchant vessels crossed the canal⁴⁸ in one or the other direction. It was also used by 649 gas carriers. Oil traffic mostly heads towards Europe. In addition to this crude oil, other significant amounts are transported along the SUMED pipeline from the Red Sea to the Mediterranean which is used by VLCC tankers that come from the Persian Gulf fully loaded, thus managing to reduce their draft and being able to pass through the canal. LNG traffic travels in both directions, from Algeria and Egypt to the Asian markets and from Qatar to Europe.

Ships sailing northbound, before reaching the canal have to cross the Red Sea. This sea covers a length of 2,200 km with a width of 300 km and an average depth of 500 metres, the maximum being of 2,100 metres. The coastal countries surrounding the Red Sea are Egypt (north and west coast), Israel and Jordan (north coast), Saudi Arabia and Yemen (east coast), Sudan and Eritrea (west coast) and Djibouti (south coast). This situation makes it very easy for uncontrolled vessels to operate from along these coasts.

b) Transit Security

Transiting the Red Sea lasts around three days. There is a risk of pirate or criminal attacks along the first section of this Sea, mainly pirates or outlaws coming from the coast of Yemen, which is an important risk given the unstable situation of that country. Terrorist attacks by any of the Islamic groups that are becoming more radicalised in the region, most likely operating out of Yemen or Sudan, cannot be ruled out either.

Navigation is then fairly peaceful through to the Gulf of Suez, where it passes near the Sinai Peninsula, narrowing along 300 km and making vessels more vulnerable. This is the most hazardous area for navigation because of the proximity to the coast and the shallow waters, meaning this area could be more effectively mined. The current proliferation of radical terrorist groups in Egypt

⁴⁷ Navigation along the canal lasts approximately one day and is in one direction only because of the small dimensions. Nevertheless, a new section was opened in 2015 covering 35 km parallel to the original canal, along with works for extension of the already existing canal. These works have meant that the capacity has been practically doubled.

⁴⁸ According to the information provided on the Suez Canal website (www.suezcanal.gov.eg)

adds to this problem, both along the western shores and particularly in the Sinai Peninsula. Two attacks by rocket propelled grenades against ships crossing the canal by the Al Furqan Brigade, on 29th July and 31st August 2013, are particularly noteworthy. Both attacks were filmed and uploaded to YouTube. Although the identity of the first ship was not revealed, the second attack was against the container ship Cosco Asia. Both attacks, fortunately without consequences, were perpetrated from the west banks between the city of Ismailia and Port Said.

Finally, a very significant risk involves the radicalization of some of the groups who operate on the Sinai Peninsula, linked to Daesh, or Islamic State, who have already perpetrated different attacks against oil pipelines and against the Egyptian armed forces, including a coast guard service vessel on 16th July last year, and the shooting down a military helicopter just a few months earlier. This is in addition to the bomb planted on a passenger airliner on 31st October which exploded during flight.

c) Geostrategic considerations

It is important to take the following strategic considerations into account regarding the "Persian Gulf - Suez Canal" maritime route.

- Europe's dependence on the crude oil from the Persian Gulf is not very significant in relative terms (12% of its supply). As for natural gas, dependence expressed as a percentage of the supplies it receives by sea is much higher (50% of imported LNG), although most of it is still received by gas pipeline from Russia.
- The Suez route permits saving nine thousand kilometres from the course connecting the main European ports with the Persian Gulf, which, it should not be forgotten, is where the world's main reserves are located. This is why it still has a major strategic value for the EU.
- The strategic interest in keeping these supplies is shared by the Gulf countries, as they make huge profits from their exports.
- The importance, not of the route itself, but of the Persian Gulf and the Indian Ocean for the crude oil and gas supplies required by the principal economies in Asia is huge. Nevertheless, the impressive traffic of container ships through the Gulf of Aden, the Red Sea and the Suez Canal to Europe, makes it crucial for the Asian economies, as 50% of the world's containers are transported through this canal.

These reasons, among others, justify the deployment by the United States in the Gulf of Aden, the Persian Gulf and the West Indian Ocean, of three multinational naval forces, the TF 150, TF 151 and TF 152, assigned on missions against terrorism, piracy and to guarantee security in the Persian Gulf respectively. These forces depend on US Central Command, based in Tampa (Florida), the command centre responsible for security in this part of the world, which joint staff in-

cludes representatives from 50 countries, a clear example of the strategic value of this area and that freedom of navigation is a shared objective.

The Straits of Bosphorus and Dardanelles

a) Overview

These straits connect the Black Sea and the Mediterranean through the Marmara Sea. They are very narrow passageways that cross Turkey and separate Europe from Asia. The first one of them divides the city of Istanbul.

The flow of crude oil from Russia and the Caspian Sea countries, particularly from Azerbaijan and Kazakhstan, travels through these straits. This flow mainly heads towards European countries and in 2013 accounted for 2.9 million barrels of crude oil per day.

The Bosphorus covers a length of eighteen miles and has an average width of 1,500 metres, although this is only 750 metres at the narrowest point. Its depth varies between 36 and 120 metres. In addition, it describes a naturally sinuous layout that forces constant changes of course. The Dardanelles Strait on the other hand is wider, covering a length of 40 miles and narrowing down to 1600 metres, with an average depth of 50 metres. Both straits feature strong marine currents, frequently exceeding four knots, which eventually can force their closure.

Around 50,000 ships sail through these straits every year, making them one of the most transited choke points in the world.⁴⁹ Consequently, it is necessary to be very cautious when travelling through them, since the transit is both difficult and risky. Likewise, the Turkish authorities have always been very sensitive to such high traffic travelling through the country's most highly populated city,⁵⁰ since this traffic includes a lot of oil tankers, gas carriers and other vessels carrying hazardous cargo. In 2013, these straits were used by 5,684 oil tankers, of which 1,777 were ships with lengths above 200 metres.⁵¹

The Straits are governed by the 1936 Montreux Convention, assigning Turkey their control and establishing free passageway by merchant vessels, with stricter regulations for war ships.

The principle of free passageway and navigation is contemplated in Articles 1 and 2 of the Convention. In particular, Article 2 establishes that "*in times of peace, merchant vessels shall enjoy complete freedom of transit and navigation through the Straits, by day and by night, under any flag and carrying any kind of cargo*".

⁴⁹ This is particularly true if it is compared to other choke points around the world, particularly the Suez and Panama canals, which both have less annual traffic (14,000 and 17,000 ships respectively). Nevertheless, there are wider straits with more traffic, for example the Gibraltar Strait, through which over 100,000 merchant vessels travel every year.

⁵⁰ 14 million inhabitants.

⁵¹ Official statistics at www.bosphorusstrait.com.

This Convention was agreed under great controversy, and it should be borne in mind that when it was signed only 15 ships passed the straits through a day, a lot smaller in size than the ships of today, whereas today the daily average is 130 large ships, including Aframax and Suezmax type tankers, which can carry 120,000 DWT and 160,000 DWT respectively, as well as large LNG carriers and chemical transport tankers. One of these controversies stems from the strict regulations for transit established by Turkey a few years ago. These rules enforce prior notice for passageway, sailing in one direction only if there is a large vessel passing, and only doing so during hours of daylight in the case of ships over 200 m length. This means that in practice there are queues to cross the strait.



Grapich 12.

b) Transit Security

This is a zone that is strongly controlled by Turkey, where the main risks are those derived from such a dangerous navigation in itself, as described, particularly the risk of collision between vessels given the narrow width of the two straits. Both in the event of a collision and in the case of a vessel colliding with the coast, spillages, fire and other damages⁵² could take place, with the added possibility of sinking, which could cause a major obstacle for transit, particularly in the Bosphorus where control and caution are logically greater. A terrorist attack with the same objective cannot be ruled out either.

⁵² In 1979 there was a collision between a Rumanian ship and a Greek tanker, causing the death of 43 people and spillage of 70,000 tonnes of crude oil. In 1994 there was another collision between a tanker and a cargo vessel.

Insofar as the possible use of naval mines by a terrorist group, although the shallow waters make these straits more vulnerable than other, the high level of control makes this hypothesis very unlikely, considering that if this should take place it would only be a one-off event with media impact, that would not seriously affect traffic. This hypothesis is also hard to imagine in the event of a serious international crisis, given the interests by all states in keeping this route open.

c) Geostrategic considerations

It is difficult to find a country in such a strategically important position as Turkey. Turkey is indeed not only located between Asia and Europe, but also between the Balkans, the Caucasus and the Middle East,⁵³ as well as between the Black Sea and the Mediterranean Sea. In fact, the Turkish straits are the only exit to the open seas for five of the Black Sea's coastal countries, and also for Armenia and Azerbaijan, not to forget the fact that it is a very important outlet to the sea for Russian oil.

Likewise, Turkey is located relatively close to the five former Soviet Republics of Central Asia, over which it exercises significant cultural influence, as well as being the natural outlet to the sea for petroleum from Kazakhstan, Turkmenistan and Uzbekistan (along with Azerbaijan), through oil pipelines. One of these oil pipelines in service is the Baku - Tbilisi - Ceyhan pipeline, which connects the capitals of Azerbaijan and Georgia with the Turkish city of Ceyhan, from where crude oil is sold on the world market. This is the only route that permits an outlet for crude oil from the Caspian to Europe without crossing Russia, conferring it major strategic importance. Its pumping capacity is one million barrels per day, to be added to the oil delivered through the straits.

As for natural gas, it should be stressed that there are considerable reserves in the Caspian Sea, a gas that at present is hardly reaching Europe. Nevertheless, it could do it perfectly well through Turkey, which would be the most advisable route and would not depend on Russia either. In this sense, the "Trans Anatolia" (TANSAP) gas pipeline project between Azerbaijan and Turkey, is receiving a new push following the recent crisis between Russia and Turkey, as result of Russia having stopped the project for construction of the gas pipeline which would carry the Russian gas to Europe across Turkey, known as "the Turkish Stream". Should the TANSAP works be successfully completed, its commissioning for service, planned for 2018, will represent an important change in the geopolitical situation of the natural gas market in Europe, as it would transport the Caspian Sea's gas from Azerbaijan to Turkey, crossing Turkey before continuing to Greece, Albania and Italy.

Whichever the case, the importance of the straits for the oil market is still very considerable, since nearly 3 million barrels travel through them every day and the existence of other routes that may contribute to their relief will always be good. In this regard, the fact that Russia is diverting part of its production to the Baltic ports, from where it can also access the world marketplace, will also be a help.

⁵³ Turkey has borders with Iraq, Iran and Syria.

a) Overview

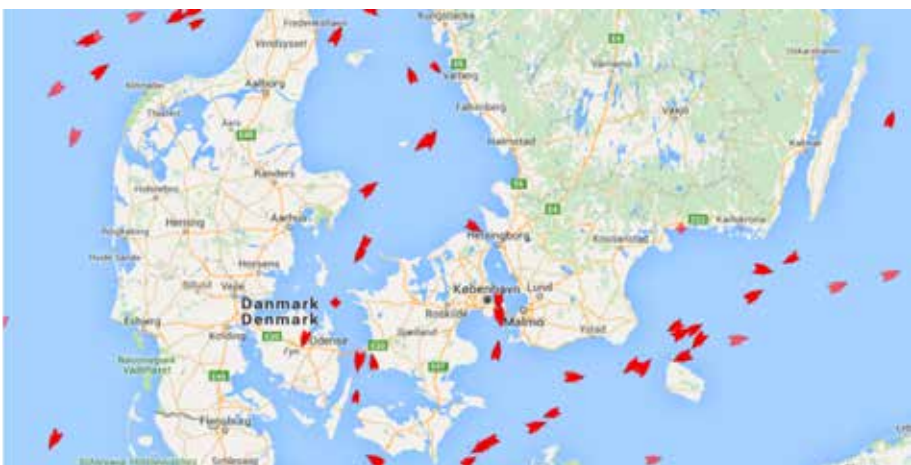
The Danish straits connect the Baltic Sea and the North Sea, and are the natural route joining ports in that sea with rest of the world. There are two principal routes. The shortest one passes through the Sund Canal, which runs along 225 miles between Copenhagen and the coast of Sweden (around 15 hours navigation time). The minimum width is 4 km. The shallow waters permit passageway of ships with up to 7.7 metres draft, and can therefore only be used by small vessels. It is also used by empty oil tankers heading to load at Russian Ports.

The second route uses the Great Belt Strait. This strait runs between Danish islands covering a length of 390 miles, having deeper waters allowing ships with drafts of up to 15 metres travel through it, which include Aframax tankers coming from Russian ports.

In 2013 a total of 3.3 mb/d of crude oil and refined products travelled through these straits. The traffic out of Russian ports accounts for approximately half, being also significant the traffic of tankers heading eastbound from Norway and the United Kingdom. In terms of annual merchant traffic, these routes are used by around 60,000 merchant ships, of which 20,000 are oil tankers.

The amount of Russian crude oil that leaves the Baltic ports⁵⁴ to the world's markets has been increasing over recent years, this trend being expected to continue.

Transit through the Danish straits is regulated under international agreements, the most important of which is the 1857 Copenhagen Treaty. Moreover, it is governed by different regulations enacted by Denmark and Sweden.



Oil tanker traffic in the Danish straits.
Source: www.marinetraffic.com.

⁵⁴ Primorsk, Vysotsk and Uss-Luga, near to St. Petersburg and Kaliningrad.

b) Transit Security

There are strong currents through the Danish straits, which, in conjunction with the bad weather and the presence of rocks and lows, make navigation perilous. It should be taken into account that although these straits are wider than the foregoing, the deep courses that large tankers have to follow take them sometimes through very narrow channels. Likewise, the traffic density is quite high, both day and night. This means that the principal risk is from accident by collision or stranding. The risk from piracy however is practically zero, and risk from a terrorist attack can also be considered low, although it can never be ruled out completely.

c) Geostrategic considerations

These straits are the only exit to the open sea for Poland, Finland, Lithuania, Latvia and Estonia, and are also an important outlet for Russia's economy. All these countries, and of course Sweden, Denmark, Germany and the European Union in general need these straits to import / export the raw materials and goods that they need for consumption or for shipment of their production. It should be noted that these straits connect very powerful economies.

The Baltic route for Russia in particular has major advantages over the Black Sea route. On the one hand, there is no collapse situation in the straits as in the latter case, which has led Russia to promote oil pipelines to terminals on Baltic ports. On the other hand, this route is closer to the major Atlantic ports of Europe, its main client. Finally, its proximity to the Arctic, where it has large crude oil and natural gas reserves, confers added value to this route, for its exports to be channelled to Europe.

The Panama Canal

a) Overview

This canal is 50 miles long. It is a complex feat of engineering that connects the Atlantic Ocean with the Pacific Ocean, enabling the difference in level between their tides and the water of Gatun Lake, located 26 metres higher up, to be compensated. This is achieved through two sets of entrance and exit locks at the lake, which lift and drop the vessels to and from that height. These two sets of locks are 33.5 metres wide at some narrow points, which until now has prevented the passage of vessels over 32.3 metres beam. The dimensions of the locks do not allow ships with drafts over 12 metres to pass through either, or those over 294 metres length (maximum permitted size), which is the reason for a lot of vessels to be unable to use the canal, including supertankers, container ships and the modern methane tankers.

In 2014, the canal was used by a total of around 12,000 ships.⁵⁵ The traffic of oil tankers was not very high though, with around 800,000 barrels of oil per

⁵⁵ 11,956 ships, according to the Canal authorities.

day, mostly in the form of refined products. Of this amount, only 125,000 bd corresponded to crude oil transport, mainly southbound from the Atlantic to the Pacific Ocean.

Nevertheless, the extension of the canal will open up a third lane, with the transit capability increasing considerably, both in terms of number of vessels and in size, as the new locks will allow ships with the following maximum dimensions to pass: length 366 m, beam 49 m and draft 15.2 m.

b) Transit Security

A possible terrorist attack on the canal is considered fairly unlikely, since it is a real mousetrap and can be easily avoided with strict security measures. It is possible perhaps to imagine a suicide commando boarding a ship and hiding until a lock is reached with the intention of sinking the ship and blocking the passage. Nevertheless, this hypothesis is not considered likely and is difficult to perpetrate. On the other hand, the existence of three lanes would always guarantee continued passage.

c) Geostrategic considerations

The canal is vital for ship transit, both war ships and merchant vessels, which need to cross between the two oceans, otherwise they would be forced to travel around Cape Horn, exceedingly much longer and exposed to storms. That is where its strategic value lies.

This value will increase once the extension works are completed, since the dimensions of the new locks will allow larger vessels to travel the canal, ships of these sizes that are frequent today in all sectors of maritime trade being so far unable to use it. In the case of gas carriers, the change will be substantial since most of them will be able to cross the canal (not the very largest though), and this will open up new market routes, particularly for LNG exports from the United States to Asia on a much shorter route, or from Trinidad and Tobago to Chile, or from Peru to Spain.

The change will also be important for the large container ships, many of which will be able to cross the canal, more specifically the sector that ranges from a capacity of 5,000 containers (the current limit in practice) to those carrying 13,000 containers, although larger vessels will still be unable to use the canal.⁵⁶

As for oil tankers, the change will be less significant, since the new locks will only permit passage of vessels up to 120,000 DWT, compared to the current 80,000 DWT, but larger tankers (VLCC and ULCC) will not be able to use the canal for the excess of both beam and draft.

Finally, it is worth mentioning that, for the United States, the new dimensions of the canal will help promote the strategic importance it has always had, by permitting rapid connection between its Atlantic and Pacific Coasts, not only for

⁵⁶ In particular, Triple E class container carriers, with capacity for 18,000 containers.

merchant traffic, but also for the Navy since the new locks will permit transit of its current aircraft carriers, so far unable to travel through it due to their dimensions.

The Malacca Strait

a) Overview

This strait runs between the Malaysia Peninsula and the Indonesian island of Sumatra. The Strait covers a length of 430 miles with a width ranging from 27 to 180 miles, although at the Singapore Strait the course is considerably reduced up to a width of only 1.7 miles (2.8 km) at the narrowest point. This route connects the Indian Ocean and the South China Sea, linking the economies of the South-east and East of Asia with the Persian Gulf. This strait also serves to channel a significant amount of maritime traffic from Asia to Europe, through the Suez Canal.

15.2 million barrels of oil a day are transported through the strait, of which 90% are crude oil supplies, accounting for one third of the world's oil traffic. The same can be said about general cargo maritime traffic, amounting to 70,000 vessels per year. The bottleneck at the Singapore Strait (Philips Channel) with an extremely high traffic density and only 2.8 km wide with day and night transit in both directions, is particularly noteworthy.

As for liquefied natural gas transportation, this route is also used by the large gas carriers from Qatar and other countries, which in 2013 transported around 80 million tonnes of LNG, mainly to Japan, Korea, China and Taiwan, in this order.

The minimum depth in the Singapore Strait is 25 metres, allowing the navigation of large VLCC tankers, with up to 300,000 DWT.

b) Transit Security

Acts of piracy and armed robbery⁵⁷ against ships are a constant threat in the waters near to Indonesia and Malaysia. In 2014, there were 100 cases in Indonesian waters and 24 cases in Malaysian waters, counting those actually perpetrated and failed attempts together. Overall, more than half of the recorded cases in the world took place in South-east Asia that year.⁵⁸ Concerning these data, it must be stated that over half the incidents were minor acts of pillage and assault without violence, and that in the Malacca Strait the number of cases per year is around 15, mostly on ships lying at anchor.

⁵⁷ According to the definitions in Article 101 of UNCLOS, and the International Maritime Organisation (IMO), piracy and armed robbery entails violent action against ships, against the people on board or against their properties. These acts are classed as *piracy* if they take place outside state territorial waters (twelve miles) or as *armed robbery* if they take place within those waters.

⁵⁸ Report by the ICC's International Maritime Bureau for the period between 1st January to 31st December 2014.

Whichever the case, insecurity in this region is traditionally of great concern and still represents a serious problem. Particularly worrying is the fact that most of the large vessels that are attacked are oil tankers. In fact, in 2015 at the time this report was written, there have been nine cases of boarding / attempted boarding and three cases of kidnapping / attempted kidnapping on vessels of this type (including vessels at anchor in Singapore).

These attacks usually exert violence, in most cases involving knives and firearms. Attacks on tankers pursue the objective of stealing fuel, which is transferred off to another vessel equipped for this.

There are no other risks worthy of mention in the Malacca Strait.

c) Geostrategic considerations

The level of congestion and the security problems on this route have led to different proposals to construct canals providing alternative routes that do not notably increase the travelling distance. This problem is inherent to the Lombok Strait route, which although safer is somewhat longer, and consequently if tankers were diverted through it, costs would be increased and this would subsequently be transferred to prices.

If the strategic importance of the Malacca Strait is enormous, that of the South China Sea is even bigger, and must therefore be discussed at this point. The oil and gas tankers that leave the Singapore Strait on their way to China, Japan and other countries in the region, and also those other tankers from Malaysia, Indonesia and Australia, all of them exporting countries of oil and LNG, continue their journeys through this Sea. This practically doubles the traffic through this Sea of crude oil, derivative products and LNG.

Furthermore, there are significant unexploited reserves, crude oil and gas, under this Sea, and considerable jurisdictional conflicts over its waters with traditionally jealous attitudes by the countries that claim sovereignty over them, particularly China. As if this were not enough in itself, nearly half of the world's merchant traffic sails through these waters, where eight of the world's biggest ports are found. This makes it a scenario of enormous strategic value.

It must be stated that China, being particularly conscious of its strategic dependence on oil, is strengthening its Navy and is building artificial islands in this Sea, meaning it will be able to operate out of them with aircraft and warships keeping therefore a strong air and naval presence. Moreover, this country follows a policy of major investments in energy exploitation facilities and port infrastructures all over the world. With these and other measures, it is earning a position to guarantee its supplies by sea, which are growing at an extremely strong rate, something that is particularly worrying if admitting that the energy resources will not be sufficient within a few years time.

The United States is voicing its concern about the situation in the Asia Pacific region in general, preparing specific security documents about it whilst deploying its Navy in an important effort to provide air and naval presence.⁵⁹

Other zones of interest

a) Somalia’s coast

Somalia’s coastline covers a length of approximately 3,000 km. In particular, the south coast of the Gulf of Aden covers a length of 1000 km, this gulf being the area where problems with piracy in the region originated, reaching very high levels since 2008 in terms of attacks and kidnapping. The problems later spread to a large area in the western part of the Indian Ocean, with pirates operating over a sea extent equivalent to the entire Mediterranean Sea.

As piracy escalated in an alarming fashion, this whole area became a high risk zone, particularly for the 20,000 ships that cross through the Red Sea and the Gulf of Aden every year. In response to this situation, and among other international efforts to tackle it, the reaction by the European Union upon request by Spain and France was notable, implementing the so called Operation Atalanta on 8th December 2008 with the mission of protecting maritime traffic. As a result thereof, a major naval and air force, consisting of some six warships and three maritime patrol aircraft, have been since patrolling the wide area between the Gulf of Aden and the Seychelles. Spain has dispatched a maritime surveillance aeroplane, based in Djibouti, and between one and two ships on a permanent basis, having been in command of the operation five times.

NATO has also supported this initiative with operation Ocean Shield. Both operations have been carried out in close cooperation with each other and with Task Force TF 151 headed up by the United States.

International efforts finally yielded their fruit as of 2012, when the number of attacks and kidnappings began to fall off drastically, and have all but disappeared today, as can be seen in the following table.

Somalia Coast. Annual number of attacks on traffic:

Place / Year	2009	2010	2011	2012	2013	2014
Gulf of Aden	117	53	37	13	6	4
Indian Ocean	80	139	160	49	7	3

⁵⁹ *“Asia-Pacific. Maritime Security Strategy”*. Department of Defence. 2015, a document establishing the following as the objectives for its naval presence: *“to safeguard the freedom of the seas, deter conflicts and coercion; and promote adherence to international law and standards”*.

Geostrategic Overview of Energy Maritime Routes

Source: ICC's International Maritime Bureau.

This serious problem also affected the traffic of oil tankers, either using the Suez Canal route or the Cape route, who suffered several attacks and kidnappings.



BAM [Maritime Action Ship] "Tornado" deployed in Somali waters.
Source: Spanish Navy

b) Gulf of Guinea

Geographically, the Gulf of Guinea describes a big entrance from the Atlantic Ocean facing the coast of twenty African states, from Guinea to Angola, although Senegal, Gambia and Guinea Bissau could also be included. This gulf lies on equatorial waters and covers a huge extension of sea, its coastline measuring around 7,000 km.

Major supplies of oil and natural gas leave the African continent through these countries, the main destinations being the European countries, China and Japan. Europe accounts for 44% of crude oil exports from this region, the rest being transported to Asia. European imports are mostly from Nigeria and Angola, the world's fifth and ninth exporters respectively. As for LNG exports, these mainly come from Nigeria, Angola and Equatorial Guinea, the principal markets being Japan (23%), South Korea (17%) and Spain (14%) in this order. This region is extremely important for Europe and Spain, who receive 12% and 25% of the oil they consume.⁶⁰ The supplies to China and Japan represent around 6% of their imports.

⁶⁰ Data for 2014, obtained from the European Commission and the aforementioned CORES report.

The problem of piracy in this region is increasing at an alarming rate, although technically it should be defined as armed robbery since most cases take place in the territorial waters of the coastal countries, which is only worsened by the fact that these countries have very small navies and limited naval resources to tackle piracy, except in the case of Nigeria.⁶¹ Consequently Europe, and Spain in particular, are implementing different cooperation programmes with the countries in this region.

At the very time of writing this report, the Spanish Navy's high seas patrol vessel "Centinela" is deployed in the Gulf of Guinea on a three-month mission, carrying out a comprehensive cooperation programme with the navies of Ghana, Gabon, Senegal and Cabo Verde. During this cooperation, liaison officers have been exchanged between the operation centres of these countries and the Spanish Navy's COVAM (Maritime Surveillance and Operations Centre), which keeps a permanent presence for traffic surveillance and control in this area, along with a voluntary cooperation programme with the national shipping companies.

c) Strait of Gibraltar

Although EIA does not consider the Gibraltar Strait as one of the choke points for energy, it is necessary to briefly discuss it. This important passageway, located between Spain and Morocco, separates Europe and Africa and also the Mediterranean Sea and the Atlantic Ocean. At the narrowest point it is 8 miles wide (14.5 km) with the depth varying between 300 m and 900 m. It is therefore found within the *territorial sea* of the two coastal states, which provide free exercising of the right to transit, in accordance with international legislation.

The importance of this maritime communication path is crucial as it connects by sea the countries in the south of Europe, the coastal countries on the Black Sea, Turkey, Syria, Lebanon, Israel and North African countries with the Atlantic Ocean, and therefore with America and most of the African continent. It also connects the shipping routes between Asia and Europe. This is evident from the annual traffic of around one hundred and ten thousand merchant vessels, including a high number of oil tankers as can be seen in the attached figure.

Security in this Strait is guaranteed by the coastal countries, by the EU and NATO, which would never allow the passageway to be threatened. In addition, on account of its width and depth, closing off the strait is an extremely unviable and improbable hypothesis, reasons why its use is considered safe and it is not normally included amongst the critical straits or *choke points* of the maritime energy routes.

⁶¹ 27 attacks on vessels were perpetrated in the Gulf of Guinea in 2014, of which 5 ended up as kidnappings. There were also 10 failed attempts. Most attacks take place at night with the objective of stealing fuel.



Oil tanker traffic in the Gibraltar Strait.
Source: www.marinetraffic.com.

Freedom of Navigation under the Law of the Sea

Ever since mankind started to sail the seas, he was aware of its enormity. As they were discovered, the sheer size and hostility of many of the seas made it clear that the idea of these enormous spaces could not have an owner, leading powers limiting themselves to claiming sovereignty over small stretches of sea in front of their coasts, known as *territorial sea*. These areas of water used to be three miles into the sea, compared to the twelve miles currently recognised. As most of the natural straits are wider than six miles, not many of the straits used for international shipping entirely fell in the *territorial seas* of the coastal states concerned.

Nevertheless, in the few cases where this was true, international agreements were signed to guarantee freedom of navigation, including the Montreux Convention of 1936 for the Turkish straits in the Bosphorus.

Today, evolution towards a system of free international trade for all nations has led to a strong belief that the sea, as a global space, can be used by all sailors.⁶² At the same time, the fact that different countries successively claimed extensions of the stretches forming their *territorial seas* and the appearance of new concepts, led the United Nations to call all States in order to prepare and sign a text whose draft was finished in 1982, after nine years of work, which is known

⁶² The seas were the first of the spaces of common use known as "*global commons*", over which no country can exercise sovereignty. This concept was later transferred to airspace, outer space and cyberspace.

as the United Nations Convention on the Law of the Sea (UNCLOS). This true Constitution of the Sea is undoubtedly one of the historical achievements by the United Nations Organisation.

UNCLOS came into force in November 1994, once it had been signed by the 60th state, and today is a fundamental piece of international law and of world's peace and stability.

The wording firstly defines the concept of *territorial sea* (Article 3), which can cover an area extending for a maximum of twelve miles from the coast,⁶³ over which the coastal country can exercise its sovereignty.⁶⁴ Although this strip of sea is considered a prolongation of the territory of the states, it must be emphasised that the country exercising sovereignty is obliged to permit *innocent passage* (Article 17 and following) by ships from any nation through its *territorial sea* when they are heading to call in one of its sheltered anchorage harbours or port facilities or when leaving them. Said passageway must be "fast and uninterrupted" and is subject to certain conditions that particularly affect warships.

UNCLOS also defines the concept of "*adjacent zone*" which can extend to a maximum of twelve miles from the territorial sea (twenty-four miles total) where the coastal state is entitled to exercise some limited rights, designed to prevent violation of its laws and its tax, immigration or health regulations (Article 33), as well as the "*exclusive economic zone*", which can cover an extension of up to two hundred miles from the coast. In this latter zone, the coastal state has its sovereignty limited to purposes of exploration, exploitation and preservation of natural resources, living and non-living, affecting their waters, the sea bed and the subsoil (Article 55 and following). Full freedom of navigation is recognised in both zones, providing the aforementioned rights are respected.

At a distance further away from the coast, the concept of "*high seas*" is applied, which encompasses most marine space (think about the two hundred miles of exclusive economic zone of Spain and the United States, compared to the five thousand miles separating the two countries). No state can claim the right to sovereignty over the high seas,⁶⁵ and all of them must ensure compliance with the provisions of UNCLOS, which guarantees full freedom of navigation for all effects.

Finally, the Convention of the Sea defines an extraordinarily interesting concept: the right to passage "*in transit*" through the straits used for international navigation between one part of the *high seas* or an *exclusive economic zone* and another one. This right cannot be hindered by coastal states, even when it crosses their *territorial sea* (Article 37 and following). Furthermore, this right can be exercised by any vessel wishing to use the strait, even if it is not sailing towards a port belonging to the coastal state. This transit must always be fast and uninterrupted,

⁶³ Computed on the basis of straight lines, joining the main headlands along the coastline.

⁶⁴ This sovereignty also extends to the air space, the sea bed and the subsoil.

⁶⁵ Except in the case of resources on the so-called "continental shelf", whose maximum extension cannot exceed 350 miles from the coast.

and can be regulated by those states, who will be able to define maritime routes and devices to separate traffic in accordance with international regulations, for the purpose of guaranteeing safe navigation.

Consequently, any natural, international strait that connects the *high seas* or *exclusive economic zone* with another analog zone must be considered open to all vessels. This is the case of most of the choke points discussed previously.

Before ending this brief discussion about the Convention of the Sea, two important remarks must be made. The first one refers to Article 35 c) which states that the Convention is not applicable to international straits *through which passage is fully or partially regulated by long-standing, international conventions that are still valid, specifically referring to those straits*. Such is the case of the Turkish straits, and the Danish straits.

Secondly, the case of artificial, man-made canals is very important. These canals are governed by their own specific regulations. Nevertheless, it is important to mention that these regulations tend to reflect the basic principles of international law to the maximum. In particular, the Constantinople Convention on the Suez Canal permits passage of all ships, both in peace and in war, and moreover, the treaties signed between the United States and Panama declared the Panama Canal a neutral passageway open to navigation by all countries, thus guaranteeing the right to passage in both cases.

“Maritime Security” on Energy Maritime Routes

The Concept of Maritime Security

It has been noted that the energy maritime routes are exposed to important risks and threats from state and non-state stakeholders, particularly from crime and terrorism. All of them could cause hazardous situations for merchant traffic in certain zones or points of passageway. The importance of maritime trade have also been noted, it being even more important in case of the supply of oil and natural gas by sea, on which many countries depend to a high degree, including most of the countries in the European Union and the Asia Pacific region. That is why it is of essence to guarantee free, safe use of these routes, which in turn is one of the fundamental objectives of what is internationally known as “*Maritime Security*”.

Maritime Security can be defined as the set of measures necessary to guarantee compliance with the law, whether international law or state law, avoiding any kind of crime at sea or in ports and avoiding the attempted use of the marine environment to perpetrate them.

Maritime Security in particular acknowledges among its main objectives, “*preserving the freedom of navigation, the right to passage in transit and the right to*

*innocent passage*⁶⁶ or “*maintaining freedom of navigation, maritime trade routes and energy flows*”.⁶⁷

Given the high number of stakeholders, either commercial or marine, police, military, etc., intervening in the maritime world in order to make Maritime Security more effective, close cooperation by all the maritime community is necessary, at national and international levels alike. This cooperation must be oriented, on the one hand to achieve deep “Maritime Situational Awareness” (MSA), and on the other hand to implement specific actions at sea.

Maritime Situational Awareness

Maritime Situational Awareness refers to the knowledge and monitoring of all activities that are carried out at sea. In order to achieve this it is necessary to know where ships are, their bearings, their speed, their scheduled port calls, their cargo and other similar data, in real time. All this information is automatically provided in electronic format by the AIS system.⁶⁸ Likewise, it is important to punctually know from reliable sources all the information about any kind of attacks or incidents concerning Maritime Security⁶⁹ that a vessel has suffered, or that information regarding the detection of any suspicious activity. The same applies about any collisions or serious accidents occurred that could endanger the physical safety⁷⁰ of vessels in the zone.

In order to obtain good information about maritime traffic in a specific zone, in addition to AIS, cooperation by shipping companies owners of the merchant vessels operating in those waters is also required. For this purpose NATO has established the voluntary cooperation system NCAGS.⁷¹ This information swapping system helps the Alliance’s command and control centres to have a clear, reliable idea in real time about vessels and incidents in any zone of interest. The aforementioned information is complemented by that from other sources, including information provided by ships at sea, police information and military intelligence.

Once all such information has been analysed and assessed, it becomes a powerful knowledge tool about the maritime situation in a given zone, helping take decisions effectively. The information can also be sent out to nearby warships,

⁶⁶ European Union Maritime Security Strategy. EU. 24th June 2014. Point IV (Maritime Security Interests).

⁶⁷ Allianz Maritime Strategy. NATO. 18th March 2011. Point II (The Maritime Security Environment).

⁶⁸ The international “Automatic Identification System” is compulsory for all merchant ships and other vessels over a certain size. This is something that is only done by vessels that operate within the bounds of current legality, and it is therefore necessary to pay special attention to the surveillance of vessels that do not emit any data.

⁶⁹ “Security” being understood as basically referring to crime.

⁷⁰ “Safety” being understood as basically referring to accidents.

⁷¹ Naval Cooperation and Guidance for Shipping.

and serve as advice for bearing changes and other preventive measures to merchant vessels sailing in the zone. All this massive amount of information is managed at suitable control centres through powerful IT tools.

The importance of naval forces

There are specialised organisations and agencies in many countries, dedicated to prevent and pursue crimes at sea, either grouped together in a coast-guard service or under different competences and with different missions, such as avoiding pollution or smuggling. These entities generally operate in waters close to the shore.

But the sea is also a very hostile environment that requires vessels to be large, highly autonomous permitting them to travel long distances and to remain at sea for a long time, fitted with powerful means of surveillance and control, as well as for actuating, including suitable weaponry capable of adapting to the severity of each situation. All this is best achieved by warships, which usually operate as part of combined air and naval forces, which, in addition to their extraordinary capability of exploring and controlling the sea, also have a high reaction capacity for situations where they are required, however distant or however conflictive they may be.

Very especially, naval forces are usually present in the areas of high strategic value as described previously, undertaking surveillance of the points where the threats and risks are highest, and operating uninterruptedly day and night.

Likewise, when warships from different countries are present in the same specific zone, they often work in coalition, as has been the case since 2009 in the waters off the coast of Somalia under EU command, in the Gulf of Aden under NATO command or forming other international coalitions such as those mentioned previously. Likewise, the trend towards greater cooperation is increasing between these coalitions and with warships or naval groups that are not included in them.

Comprehensive approach

The scope of naval cooperation is just another example of improved cooperation policies between countries. Thus, international policies aimed at achieving Maritime Security, act mainly within the field of diplomacy (establishing measures of trust and cooperation between countries, development aid programmes, etc.) and in many others, such as the maritime field (regulations for maritime companies or ports, coordination between agencies), the coordination at the police and judiciary level, and also at naval level as mentioned beforehand.

All of this is part of the so-called “comprehensive approach”, which tries to establish a wide framework of cooperation, and also to improve and take full ad-

vantage of the capability for action of coastal countries in the choke points and areas of highest interest along maritime routes.

In particular the efforts by NATO, the EU or the United States are of special importance, they being currently engaged in major international cooperation programmes aimed at achieving Maritime Security as a common objective, for guaranteeing free, safe use of the world's maritime routes.

Final Conclusions

If the foregoing pages had to be summarised in a few final conclusions, they would be as follows:

- The absolute dependence of modern economies on maritime trade, particularly those countries that need to import by sea the crude oil and natural gas that they require for their factories, means of transport and for their domestic economies to keep working.
- The vulnerability of sea lines of communication (SLOCs) at certain critical points, through which high amounts of oil and LNG travel near to the coasts. Blocking any of these points could have severe consequences for the world's economy.
- *Freedom of navigation* is an objective shared by most countries, which is perfectly defined by and regulated under UNCLOS. Moreover, it is a principal objective of Maritime Security, incorporated into the official doctrine by the European Union, the Atlantic Alliance and the United States.
- Countries must settle their jurisdictional conflicts in a pacific manner, respecting International Law, and closely cooperate to achieve effective Maritime Security, swapping information and coordinating action.
- Warships are the best prepared tools to effectively prevent, patrol and control this complex scenario, and to respond in the event of any kind of aggression on freedom of navigation. Their integration in multinational naval forces is the logical path to take, as it will permit synergies and will enhance security and international trust.
- The Atlantic Basin is going to achieve a very high degree of energy self-sufficiency. Europe should make the most of this situation to reduce its dependence on Russia, which is clearly excessive, both in terms of crude oil and natural gas.
- The countries in the Asia Pacific region are excessively dependent on crude oil and gas from the Middle East. This dependence should not only be worrying because of the concentration of their supply sources, but also because of the quantity consumed, in itself, and particularly because of the rate of growth that is not considered to be sustainable over time.

Chapter III

The Impact of Jihadism on the Energy Sector

Ignacio Fuente Cobo

Abstract

The dependence of modern societies on energy resources derived from hydrocarbons, has made the energy sector one of the priority objectives of the international terrorist organizations. This is particularly true as concerning the Salafist Jihadism whose two main exponents are Al Qaeda and, more recently, the so-called Islamic State or Daesh. In this document, the ability and the intention of terrorist groups to convert the energy sector in a preferred target of Jihadist action, will be analyzed, focusing on three key areas. On the one hand, the ideological foundation and strategic reasoning that drives terrorist groups to act against the energy sector. Moreover, the relationship between the political intention of these terrorist groups and their real capabilities to either significantly cripple this sector in the producing or destination states, or to control it in those areas where they have managed to impose their law. And finally, the main factors either discretionary or limiting, that make it difficult or impossible for these groups to launch and maintain in the long term a consistent and sustained campaign against the energy sector.

To achieve this we will focus on two different scenarios, represented by Syria and Iraq on the one hand and by Libya on the other, where Jihadist groups whose main manifestations are Al Qaeda and Daesh, hold very different strategies. The objective is, therefore, to study the ability of both groups to intervene within the energy sector through offensive actions aimed at the destruction of facilities, or at the simple occupation of them, so that we can then analyze the impact on energy markets and the possibilities for them to achieve their strategic objectives.

Keywords

Syria, Iraq, Libya, Jihadism, oil, gas.

The Ideological Foundations of the “Energy Jihad”

In the early days of modern jihadism terrorist groups were mainly based around the scope of Al Qaeda and were very reluctant to attack the oil and gas industries. The explanation behind this was that the Islamic Caliphate they were intending to establish would sooner or later have to depend on these resources, and it was therefore not logical to destroy them. Nevertheless, as time went by, this train of thought was modified as the ideological approaches of the Salafist Jihad also changed.

A major milestone was set by the publication in 2004 of the book “The Laws of Targeting Petroleum Related Interests and the revision of the Laws Pertaining to the Economic Jihad”.¹ The author of the book, the Saudi cleric Sheikh Abdullah bin Nasser al-Rashid called for a new doctrine of economic terrorism, and to do so he defined new rules of engagement for targeting oil infrastructures. According to these rules action against interests related to hydrocarbons represent a legitimate means to exercise the economic jihad, given the immediate effects on the increase of energy prices, the costs of protecting the infrastructures and the damage to the reputation of the producer and consumer countries, principally the United States.

Rashid describes four general types of interests related to petroleum: oil wells, oil pipelines, oil facilities (refineries and oil plants) and the personnel working in the petroleum industry, and he also calls to establish a number of considerations or rules in relation to the action that can be taken against each type of interest. For example, Rashid insists that attacking oil wells is not permitted whilst there are other, more realistic alternatives, for the negative consequences of this kind of action that usually exceed the intended benefits. Likewise, Rashid argues that although attacks on oil facilities can have a devastating effect on the economy, this kind of operation should not be carried out against facilities belonging to Muslims.

Rashid’s doctrine is based on the principle of proportionality that sets the obligation of establishing priorities, so that attacks do not damage the long-term oil production capacity but do, however, affect prices causing their increase. This logic of proportionality is particularly clear in Rashid’s preference to attack oil pipelines, which are easier and less costly to attack from an operational perspective. This preference is due to the fact that guarding oil pipelines is virtually impossible for the huge distances they cover. Therefore “attacking oil pipelines has huge benefits and is a severe blow against the enemy that cannot be achieved by other means”.²

Al Qaeda’s leaders subsequently developed this theory further, and at the end of 2004 they drew up their own strategy against the energy sector. In a video broadcast by Al-Jazeera in early November that year, Osama Bin Laden called for at-

¹ KOHLMANN, Evan, “Al-Qaeda in Saudi Arabia – excerpts from The Laws of Targeting Petroleum-Related Interests”, 01 March 2006, <http://www.globalterroralert.com/images/documents/pdf/0306/oiljihad0306.pdf>.

² Kohlmann, Evan, op. cit.

tacks on the oil industry as a part of the economic jihad against the United States. In his statement, Bin Laden highlighted how the conflict in Afghanistan in the nineties last century had made “the Russians bleed for ten years, until they were on the verge of bankruptcy and were forced to withdraw... we must continue with the same policy against the United States, so as to bleed them to bankruptcy”.³

This strategy of “bleeding to bankruptcy” has since been the doctrinal guideline of Al Qaeda in relation to the energy sector. In September 2005, the current leader of Al Qaeda, the Egyptian Ayman al-Zawahiri reinstated Bin Laden’s arguments in a video issued on the fourth anniversary of the 11th September 2001 attacks by claiming: “I call upon the Mujahideen to focus their attacks on the oil stolen from the Muslims. Most of its revenue goes to the enemies of Islam, and most of what they leave is plundered by the thieves who rule our countries. This is the greatest theft in the history of humanity. We must stop this theft any way we can, in order to save this resource for the sake of the Muslim nation”.⁴

Since then, little else we know of has been published by Al Qaeda or its followers that has any convincing strategic value, although attacks against the energy sector have been a recurring theme in Jihadist literature and its activity in the social networks. In February 2007 Abeer al-Bassam wrote an article in the *Sawt al-Jihad* magazine (“The Voice of the Jihad”) titled “Bin Laden and the Oil Weapon”,⁵ in which he emphasized the value of reconnaissance prior to attacking to ensure the success of tactical execution and recommended attacking the facilities before the personnel since the latter were indispensable to operate and maintain the infrastructure and energy facilities.⁶

Over the following years most of the proposals that appeared in the network showed less emphasis by Al Qaeda and related groups on attacking the energy sector, and therefore interest in this kind of activity was gradually transferred to the then “Islamic State of Iraq”, a new Jihadist group that would earn special relevance in Iraq and Syria before becoming today’s Daesh, also known as the Islamic State. The first sign of this apparent relief was in August 2009 when Iraqi members of the “al-Fal-lujah Forum” were discussing in the network that: “we have recently noticed a lack of interest by mujahidin’s to attack oil pipelines and refineries. We therefore ask the Islamic State of Iraq and other mujahidin’s to attack these pipelines that supply the occupation (North American). To date they are the principal source of their surviv-

³ “Al-Qaeda is bleeding the US to bankruptcy, Bin Laden claims”, The Guardian, 3 November 2004, <http://www.guardian.co.uk/world/2004/nov/03/usa.alQaeda>.

⁴ Extracts from the statement on video by Ayman al-Zawahiri were broadcast by Al-Jazeera in September 2005; however, the complete transcription of the interview only appeared on the Internet in early December 2005. “Newly-Released Video of Al-Qaeda’s Deputy Leader Ayman al-Zawahiri’s Interview with Al-Sahab TV”, The Middle East Media Research Institute, 8 December 2005, http://www.memri.org/report/en/0/0/0/0/0/1550.htm#_edn1.

⁵ “Al-Qaeda’s Oil War Falters”, Jane’s Terrorism and Security Monitor, 16 February 2008.

⁶ For example, he considered the attacks against the French flagged oil tanker MV Limburg on 6th October 2002 and against the oil processing plant in Abqaiq on 24th February 2006 as the only specific examples of Al Qaeda operations against the oil industry.

al”.⁷ In line with this call for action, through their occupation of a large extension of territory in northern Syria and Iraq, where major oil resources are found, as of 2014 Daesh made petroleum a fundamental item of its operational strategy.

In the case of Libya the profile of Jihadist terrorism since 2014 has been different from Iraq or Syria, as it has simply consisted on destroying oil fields and oil facilities. Daesh does not seek to control the energy sector to obtain resources to finance itself, but tries to create temporary bottlenecks to weaken its opponents and gain time to consolidate its position, even if this means destroying the sector mid-term.⁸

The explanation behind this different strategic approach can be found in the report written in December 2014 by members of the Al-Mourabitum Jihadist group after their attack on the gas plant in Tigantourine in the middle of the Algerian Sahara desert, in January 2013. The report - taken in by the Combating Terrorism Centre at West Point,⁹ explains in an After Action Report format how the target was selected, how the attack was planned and executed, and more importantly what went wrong and how to avoid it in the future. This report is a pragmatic analysis of a specific Jihadist action against the energy sector with a very clear purpose: inducing different terrorist groups to perpetrate similar action.

In this important document, the leader of the Mourabitum Jihadist group, associated with Al Qaeda in the Islamic Maghreb, the charismatic Mokhtar Belmokhtar, clearly shows his hostility towards the energy sector, stating that the attack was carried out in benefit of the Jihad and not to satisfy “social demands”. Tigantourine was chosen because of its “political, economic and strategic value”¹⁰ and the moment of the attack was due to the media impact offered through the incidental presence of a numerous group of foreign managers and experts on the site.

When justifying the attack, they also stated that the principal objective was to destroy the facility and among the lessons learned, they say the assailants should have used remote control detonators to compensate for the lack of human resources¹¹. Finally, the report warns other possible imitators of this kind of action that taking hostages is not enough to avoid a military assault, and therefore other additional measures should be taken. The report concludes with a phrase by the Jihadist ideologist Akram Hijazi which highlights the benefits of this action in that it provides terrorists with a “real” example of an operation that could be “replicated” in other scenarios or in other circumstances.¹²

⁷ Lando, Ben, “Prevention, attacks target oil”, Iraq Oil Report, 1 September 2009, <http://www.uslaboragainstawar.org/article.php?id=20247>.

⁸ Markey, Patrick and Elumami, Ahmed, “Islamic State risk for Libya’s troubled oil sector”, Reuter, Oct 28, 2015, <http://www.reuters.com/article/2015/10/28/us-libya-energy-idUSKCN0SM0HW20151028#bj-DeHlAHyGhqL8t.97>.

⁹ Porter, Geoff D. “Terrorist targeting of the Libyan oil and gas sector”, op.cit.

¹⁰ Ibidem.

¹¹ Ibidem.

¹² al-Samadi, Tamer. “Jordan’s Jihadists Divided Over Jihad in Syria,” al-Hayat, February 17, 2012.

Al Qaeda's Action Against The Energy Sector In The Arabian Peninsula

In spite of Al Qaeda's doctrine calling for proportional attacks on the energy sector, the analysis of its action over the last few years leads us to believe there is a clear disparity between the organization's intentions and its operational capacity. It is true that during the critical moments of Iraqi insurgency against North American occupation between 2004 and 2006, numerous facilities were attacked, mostly refineries and pipelines in Bayji, Dahuk, Kirkuk and Mosul,¹³ although most of these were carried out by militants who were not directly related to Al Qaeda. Nevertheless, outside the Iraqi theatre of operations, the campaign against the energy sector by Al Qaeda was very limited and practically reduced to a handful of incidents of certain relevance in Saudi Arabia and Yemen, with unequal strategic and tactical success.

The first of these incidents was on 6th October 2002 against the French flag tanker MV Limburg off the coast of Yemen. The attack consisted of an explosive attached to the side of the vessel which was detonated causing a fire and subsequent spillage into the Gulf of Aden of 90,000 barrels of crude oil (a quarter of the 397,000 barrels she was carrying). One of the members of the crew was killed in the explosion and 12 others were injured.¹⁴

The effects on the energy market were immediate, although somewhat limited. The price of crude oil increased by barely 1.3% (30 cents), but the insurance premiums for vessels operating in that area increased threefold. More important was the damage to the Yemeni economy where the cost of ship's demurrage rose by 150,000 dollars, causing a reduction of 30% in port activity and losses for the Yemeni treasury of 3.8 million dollars per month.¹⁵ For a country where 75% of its revenue depends on oil exports, this loss in port activity was a major blow to its economy.

The second attack took place on 24th February 2006 against the oil processing plant of Abqaiq in Saudi Arabia, with greater impact than the former because of the strategic importance of the target. Abqaiq is located next to an oil field with proven oil reserves of more than 17 million barrels, which in 2006 was producing around 4% of Saudi Arabia's total production, equivalent to 430,000

¹³ A complete list of the attacks on oil pipelines in Iraq since 2003 to the start of 2008 can be found at IAGS Energy Security, "Iraq Pipeline Watch", <http://www.iags.org/iraqpipelinewatch.htm>.

¹⁴ "Congressional Research Service Report for Congress, Maritime Security: Potential Terrorist Attacks and Protection Priorities", 14 May 2007, http://assets.opencrs.com/rpts/RL33787_20070514.pdf.

¹⁵ According to a report published on 8th November 2002 by the Office against Terrorism of the U.S. Department of State, "Yemen's Economy Suffering Due to October Terrorist Attack", November 8, 2002, <http://www.america.gov/st/washfile-english/2002/November/20021108162129skaufman@pd.state.gov0.4453089.html>.

barrels of crude.¹⁶ More concerning though, from a strategic point of view, was that two thirds of Saudi Arabia's production passes through the facility's pumping stations, the oil / gas separators and the oil pipelines before being exported through the terminals at Ras Tanura, Ras al-Juaymah and other export terminals in the Gulf. At the time of the attack in 2006 this entire oil complex accounted for 5 million barrels per day, i.e. a sixth of the world's crude oil production.

The operation failed mainly because of the wrong tactical approach, the lack of resources, poor execution and a certain over-estimate of the possibilities as such. The vehicles loaded with explosives were detonated at the outer security perimeter and the damage only affected pumping and processing facilities without affecting the main facility.¹⁷ The rapid response by the Saudi security forces was also a determining factor in the failure of the operation. Nevertheless, strategically this action had a higher impact since the effect on the price of crude oil was around two dollars. Through this daring attack it became obvious that the energy sector in Saudi Arabia and other states in the Gulf Cooperation Council had become a key target in Al Qaeda's terrorist strategy.

The third major attack took place on 15th September the same year (2006) against two oil terminals in Yemen. Badly designed, poorly planned and with even worse performance, both attacks were complete failures, as they combined an unsuitable selection of targets with a poor execution of the operation. Since they were terminals, and therefore non-critical facilities, protection was low and therefore tactical success would have been relatively easy (however hardly any damage was caused). But even if it had been successful, the strategic impact would have been very limited, as could be seen in oil prices which did not change at all after the attack.

Although the security situation in Yemen has been deteriorating for several years now, there is no sufficient evidence to prove direct participation by Al Qaeda in the execution of this attack. It would seem that the operations were carried out by a small group of Yemeni Islamists who were trying to copy the tactics of their Jihadist peers in Saudi Arabia and Iraq.

These attacks brought to light the fact that, in spite of the ideological discourse on the legitimacy of attacking and sabotaging oil infrastructures, the terrorist groups had serious difficulties to actually achieve any degree of success. The first reason

¹⁶ Production in Abqaiq has been reduced since then (partly due to natural exhaustion). According to IHS Cambridge Energy Research Associates (IHS CERA), production in Abqaiq in 2009 reached 375,000 barrels per day. IHS CERA, "World's Largest Oil Fields and Top Oil Producing Nations", 18 August 2009,

<https://www.cera.com/asp/cda/public1/news/articles/newsArticleDetails.aspx?CID=10534>. See also Energy Information Administration, "Country Analysis Briefs – Saudi Arabia", November 2009, http://www.eia.doe.gov/cabs/Saudi_Arabia/Full.html.

¹⁷ Al-Rohan, Khalid R. "The Impact of the Abqaiq Attack on Saudi Energy Security", Center for Strategic and International Studies, 27 February 2006, http://csis.org/files/media/isis/pubs/060227_abqaiqattack.pdf.

for this is due to the strong security measures that are dominant in this specially protected sector. For example, in 2006 the Saudi government spent more than one and a half billion dollars on security, which included deploying over 25,000 soldiers, in addition to helicopters and F-15 fighter planes, 24 hours a day.¹⁸ In Iraq, a similar situation was true on those dates. With the help of North American logistics, the Iraqi government established a number of Pipeline Exclusion Zones (PEZ) surrounded by barbed wire, fences and security pits, and trenches at critical points which were protected by guards and patrols armed with rocket launchers and other types of heavy weapons. Through action of this kind, as an example, in the 12 months between July 2007 and July 2008 after completion of the Kirkuk to Baiji PEZ in northern Iraq, crude oil exports through this pipeline were multiplied by ten, with hardly any interruptions of relevance.¹⁹

Another factor that also helps to explain this failure by Al Qaeda is the disconnection between the energy sector as a strategic target and the real operational capacity of the Jihadist group to act against it. At the same time, its failure to establish an Islamic Emirate which was its principal objective, entailed a gradual loss of credibility amid the Islam world in the Middle East, North Africa and South-east Asia, to the extent that many active or potential Jihadists came to question the organization's leadership.

But nowhere else was this questioned more strongly than in Iraq where the "Sunni Awakening" (the curious process of military alliances between North American forces and Sunni tribes from the Northern provinces) rejected the view of a Pan-Islamic State as claimed by Al Qaeda.²⁰ The Islamists harboring this idea quickly reduced in number before the proliferation of new players with different views about what the Islamic movement should be. The most radical factions were cornered over those years by the more conciliating parties who believed in the possibility of a single Iraqi state as a political solution to the war situation the country was embroiled in. They would have to wait until the so-called revolutionary Arab Spring movements began in 2011, with transforming consequences, before the hydrocarbon sector became an essential item in strategy of the Jihadist movements.

¹⁸ Cordesman, Anthony H, and Obaid, Nawaf, "Saudi Petroleum Security: Challenges and Responses", Center for Strategic and International Studies, 30 November 2004, http://csis.org/files/media/isis/pubs/saudi_petroleumsecurity041129.pdf.

¹⁹ Blanchard, Christopher M., "Iraq: Oil and Gas Legislation, Revenue Sharing, and U.S. Policy", Congressional Research Service, 3 November 2009, <http://www.fas.org/sgp/crs/mideast/RL34064.pdf>; Lando, Ben, "Iraqi forces step up oil protection", Iraqi Oil Report, 24 September 2009, <http://www.iraqoilreport.com/security/iraqi-forces-step-up-oil-protection-2248/>. Energy Information Administration, "Country Analysis Briefs – Iraq", June 2009, <http://www.eia.doe.gov/emeu/cabs/Iraq/pdf.pdf>, and "Safer pipeline lets Iraq oil exports flow: report", Reuters, 26 July 2008, <http://www.reuters.com/article/idUSN2641627720080726>.

²⁰ Burke, Jason, "Perceptions of leaders: Examining extremist views of Al-Qaeda", in Al-Qaeda's Senior Leadership – A Jane's Strategic Advisory Services Supplement, IHS Jane's, November 2009, pages 2-6.

During the years prior to these movements, the anti-terrorist pressure exercised by the United States and its allies in regions bordering Afghanistan and Pakistan, where Al Qaeda's leadership was hiding, led this organization to become a network of strongly decentralized associated groups. Operational authority gradually moved away from the centre, responsibility lying more and more with the regional franchises that had their own interests and objectives, not always in line with those of the central organization. Consequently, Al Qaeda Headquarters was practically relegated to a type of reference structure, responsible for the doctrinal guidance of the franchises and defining the organization's general agenda, i.e. it evolved from a "terrorist group that featured in the media, to a celebrity organization that acted in the field of terrorism".²¹

Another operational limitation that should also be taken into account refers to the internal power struggles within Al Qaeda that took place over the last decade, fundamentally between Egyptian Jihadists and those from other places. These struggles in the central structure of Al Qaeda not only undermined the organisation's long-term strategic success, but also reduced its operational and tactical capacity. Egyptian over-representation in Al Qaeda Headquarters became the main cause of friction for non-Egyptian Jihadists who were unable to reconcile the discrepancy existing between the ideals of a supranational community of believers and the reality of the Egyptian predominance in Al Qaeda's leadership.²²

The death of many of Al Qaeda's Headquarters principal leaders, of Egyptian origin, by North American drones²³ only served to complicate matters, marking the decline of Egyptian influence at senior leadership level compared to the second level of leadership dominated by Arab Jihadists.²⁴ For many of these Jihadists who showed an exacerbated religious jealousy, but who also sought targets with high impact in the media to reach notoriety, the operations targeting the oil industry and mainly targeting oil pipelines, very easy to repair, lacked the necessary interest to satisfy their ambitions, and they therefore became second class targets.²⁵

²¹ Brachmann, Jarret, "Retaining Relevance – Assessing Al-Qaeda's Generational Evolution", in *Al-Qaeda's Senior Leadership – A Jane's Strategic Advisory Services Supplement*, IHS Jane's, November 2009, pages 26-30.

²² Steinberg, Guido, "Towards Collective Leadership – The Role of Egyptians in Al-Qaeda", in *Al-Qaeda's Senior Leadership – A Jane's Strategic Advisory Services Supplement*, IHS Jane's, November 2009, pages 7-11.

²³ Among them Mustaffa Abu al-Yazid, an Egyptian citizen also known as Sheikh Saeed al-Masri, who was number three in Al Qaeda's chain of command, whose death was confirmed by the Jihadist organisation on 1st June 2010. "U.S. Welcomes Death of Al-Qaida Leader in Pakistan", *Voice of America*, 1 June 2010, <http://www1.voanews.com/english/news/usa/Pakistani-Based-High-Ranking-al-Qaida-Leader-Killed-95292139.html>.

²⁴ The Libyan Yahya al-Libi has become one of the highest ranking ideologists and religious authority in Al Qaeda since he escaped from Bagram air base in 2005, frequently appearing in video and audio releases. See Steinberg, Guido, op. Cit.

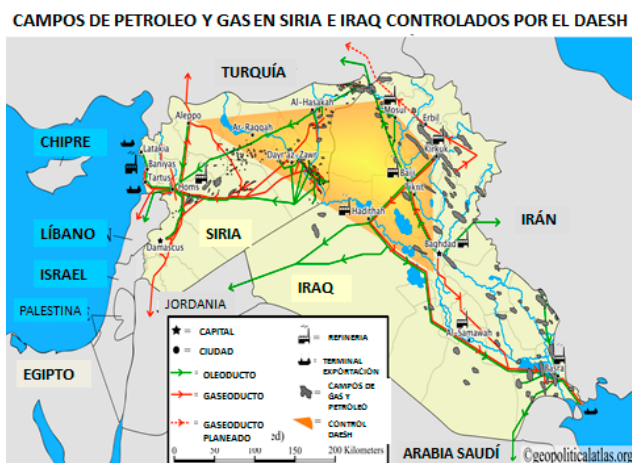
²⁵ Pippard, Tim, op.cit. pag. 11.

All these factors mean that although Al Qaeda kept its intention of organizing and carrying out direct attacks against all manner of energy targets, the organization now had to face a wide range of new challenges that limited its capacity to keep up its campaign against this type of targets. These challenges were both from external sources due to pressure by North American forces in Afghanistan, Iraq and Yemen or the constant pursuit by the crude oil powers in the Gulf, and also from internal sources concerning ideological divisions, power struggles and difficulties in recruitment.

The difficulties to tackle such external pressures and to overcome its own internal contradictions, prevented Al Qaeda since then from attacking any critical energy facilities in places like Iraq or the Arabian Peninsula, where its leadership is questioned through the emergence - with Arab revolutions - of much more radical organizations in terms of their approaches and strategies, and also much more effective as is the case of Daesh or the Islamic State as of 2013.

Action by Jihadist Groups Against the Syrian Energy Sector

In comparison with the Iraqi oil reserves, Syria's production of 380,000 barrels of crude oil per day is not a very tempting offer, nor is it an excuse to take the centre of gravity of a war with strong geopolitical connotations to the production regions. Oil nevertheless, has been playing a fundamental role in the development of the war, more particularly in the east of Syria where most of the country's production is found.



DAESH controlled oil and gas fields in Syria and Iraq
Graphic 1.

In the east, around the city of Deis ez-Zor and from there onwards towards the Iraqi border, there are several oil fields that were discovered by Shell and Total in the middle of the eighties, last century. Production at these sites reached a maximum of 400,000 barrels one decade later and gradually diminished to reach 125,000 barrels a day at the end of 2010, some weeks before insurrection began against the Syrian government²⁶.

The second major crude oil production area is in the northeast of the country, mainly northeast of the city of Al-Hasakah and west of the city of Qamishli, in an area that is almost completely controlled by Kurds, and more specifically by the military arm of the Democratic Union Party, the Syrian branch of the Kurdistan Workers' Party (PKK) based in Turkey. The fields in this region which have been exploited since the sixties by the Syrian Petroleum Company, Syria's public company, and the Karatchok field as well, are characterized by supplying a very heavy crude oil, production being around 250,000 barrels on the eve of the uprising. Opening up exploration zones as of 2004 to foreign companies meant that different independent companies invested in crude oil production, including Chinese companies but also mixed companies such as Gulfsands, a British company in a partnership with Rami Maklouf, one of the richest men in Syria and a cousin to President Assad.

The appearance of Jihadist groups in the Syrian theatre in 2013 accounted for a change in the energy strategy of the insurgents fighting against President Bashar al-Assad. Right from the outset of their operations in Syria and Iraq, the Jihadists saw crude oil as a fundamental part for the construction of an Islamic State, as it would be able to finance insurgency and above all to create a Caliphate. Whereas Al Qaeda was mostly financed by donations, Daesh's finances were based on crude oil production.

It could be said that war has affected the crude oil sector in different ways. The embargo imposed by the international community in autumn 2011, particularly by the European companies buying 90% of Syrian crude oil, meant that exports were suspended, with the subsequent reduction in production, the revenue in currency of the public treasury likewise falling by 90%. At the same time the sanctions forced western companies to withdraw from the country leaving the oil sector practically closed to the Alawi regime.

Still more important was the east of the country falling under the control of the rebels, in spring 2013, which on the one hand deprived the Syrian government of access to its oil fields forcing it into the hands of its Iranian ally to finance crude imports and thus creating a strategic dependence between Damascus and Tehran. On the other hand, it represented a kick-off for a free-for-all between the different Jihadist groups for the control over these energy resources in an attempt to finance their war efforts. This fight for the oil fields reached

²⁶ Yazigi, Jihad. «Le pétrole syrien finance la guerre», The Syria Report, July 2014. <http://www.lecommercedulevant.com/regional/reperes/syrie-liban/le-petrole-syrien-finance-la-guerre/23679>.

a particularly high level of violence in the region of Deir ez-Zor where Jihadists, different Arab tribes and the West-supported fighters from the Free Syrian Army, all converged.

Initially the European Union sanctioned to a certain extent the legality of plundering Syrian oil through the decision in April 2013 authorizing the "Interim Government" of Ahmad Tu'mah a member of the so-called National Coalition for Syria, to finance itself through the sale of part of the crude subject to international sanctions by Europe and North America.²⁷ This was not about the Western states trying to recover an oil that, owing to the relatively small quantity, they did not need, but more about feeding the war machine opposing the al-Assad regime from the revenue obtained through illegal exports.

Nevertheless, the National Coalition was not capable of selling a single barrel of Syrian crude oil and the Ministry of Energy, depending on the Coalition, located in the Turkish city of Gaziantep was incapable of controlling the crude oil that was being sold through the Syrian border town of Tal Abyad, to where it was transported by the different insurgent groups for refining before being sold on to Turkish companies.

The principal beneficiaries of crude oil contraband in the early days of insurgency were the local warlords associated with Jabhat Al Nusra, the local version of Al Qaeda. For this purpose, they bought the small Turkish refineries near the border, financing them with the sale of Syrian cotton gin machines that were found in Aleppo and in the Ras-al-Ayn silos. This way, in 2014, the Al Nusra front was extracting around 10,000 barrels a day from the al-Omar oil field which it controlled directly, selling it off at 40 dollars a barrel, reporting an income of around 400,000 dollars a day.

At the same time this was going on, the rival group of Al Nusra, the self-proclaimed Islamic State or Daesh, was gradually expanding through Syria redirecting its main efforts towards the oil-rich east, where it had created a bridgehead in 2013, and began to abandon the north-west region which, although strategically important, did not have any oil. As their rivals at Jabhat al-Nusra did, they tried to unite the different tribes under the Jihad flag and the wells they controlled. This reunification is one of the principal aspects of the fight for regional supremacy between the two groups born from the regional Jihad branch of Al Qaeda: the "Jariyies" of the Islamic State of Abu Bakr Al Bagdadi and the "Apostates" of Jabhat Al Nusra led by Abu Muhammad al-Golani.

In June 2014 Daesh took control of the important Al-Taim oil field located next to the Deir ez-Zor military base, the object of fierce fighting. It also took control of the Al-Jafra oil field which it wrested from the legislative council of the Mufti of Jabhat al-Nusra, Omar al-Hadawi. After the middle of 2014 Daesh established its capital in the northern city of Raqqa and, as its military situation became

²⁷ As-Safir, "Who controls Syria's oil?" Al Monitor, 6 July 2014, <http://www.al-monitor.com/pulse/security/2014/07/syria-conflict-control-oil-fields-ambiguity.html>.

more consolidated, its control over the oil fields extended further to gain complete dominance. In September 2015 the last oil field still in the hands of the Syrian government fell under its control: Yezl, to the northeast of Palmyra and close to a region containing the principal gas fields in the country, Daesh now controlling seven oil fields in Syria.

With its tremendously aggressive strategy, Daesh became financially self-sufficient in Syria through the sale of crude oil, increased further still by wheat and water and taxing the local population.²⁸ Since then, Daesh's military leader in Syria, Omar al-Shishani committed to reinforcing control over the Syrian oil fields and to unify the contraband networks, whilst protecting the communication channels and means of transport from Deir ez-Zor to Raqqa in the north, and from there to the Turkish border.

Hence, for example, according to the Financial Times, in the al-Jibssa oil field in Hassakeh province, in the northeast of Syria, which produces 2,500-3,000 barrels a day, between 30 to 40 large tanker trucks of 75 barrels capacity each were being loaded every day in October 2015.²⁹ Even more important, at the huge oil field of al-Omar controlled by Daesh as are all the fields in Syria, there were queues of trucks up to six kilometers long, it taking several days for each truck to wait until reaching the filling point. Once loaded, the trucks headed for local refineries, or the oil was sold at different intermediate points where it was transhipped to smaller vehicles for subsequent transport to cities such as Aleppo or Idlib. Selling the oil off locally in these places or cities was a simple affair, since the demand for a product that is necessary for almost everything was very high.

As for the local tribes al-Bakir, al-Bakara, al-Koran, Albu Dakr, etc., who initially operated almost independently, they gradually joined forces with Islamic organizations, mostly with Daesh. When it seized the Al-Jafra oil field, Daesh granted concession of exploitation of 30 wells to several tribes in the Deir ez-Zor region, in exchange for their loyalty and commitment to exploit and protect the wells. Other wells were jointly exploited through alliances between local tribes and the commanders of the Daesh units operating in the area³⁰, managing to produce around 40,000 barrels a day from several dozen oil fields spread out around the region.

²⁸ Pizzi, Michael and Shabaan, Nuha, "ISIS Builds Power Base Unchecked, Takes Over a-Raqqa", Syria: Direct, August 2013, <http://syriadirect.org/news/isis-builds-power-base-unchecked-takes-over-a-raqqa>.

²⁹ Solomon, Erika, Chazan, Guy & Jones, Sam, "Isis Inc: how oil fuels the jihadi terrorists", Financial Times, October 14, 2015, <http://www.ft.com/intl/cms/s/2/b8234932-719b-11e5-ad6d-f4ed76f0900a.html#axzz3t3gPtIWx>.

³⁰ For example, the Tink Oil oil field, which is one of the biggest in the region was divided up between an alliance consisting of Ahrar al-Sham, the Jaafar Tayyar Brigade, Ibn al-Moukim and Ahl al-Asar on one side and a group of tribes and families from the region on the other. Ver As-Safir, op.cit.

In the other major Syrian oil region, located around Hassakah and Qamishli, the military situation was not as complex as it was in Deir ez-Zor since the main oil fields were controlled by the Kurdish forces of the Democratic Union of Kurdistan party, who avoided fierce battles for control taking place there. The estimated production of around 10,000 barrels per day was sufficient to supply oil products refined in a rudimentary fashion - for example by boiling the crude oil anywhere, in small puddles in the yards of private houses-, to all the northeast region of Syria.³¹

Ever since the start of insurrection, a black market was created for the sale and distribution of crude oil for legal consumption and export. The first place for transactions of this illegal traffic was the city of Manjib to the east of Aleppo where buyers and sellers met to negotiate the sale of crude oil and refined products. This was initially carried out to meet local demands, but soon started to be exported to Turkey. The paradox of the matter is that since Islamic groups took control of the fields in 2013, the principal client happened to be the Syrian State, who initially negotiated with the al-Nusra front.³² Nevertheless, this business quickly fizzled out, mainly due to the difficulty of transporting the crude oil between areas under different control. Likewise, the al-Nusra front benefited from the exactions it obtained by permitting transit of crude oil through zones it controlled, to refineries in Homs and Baniyas under government control. This role was later taken over by Daesh as it seized power over the oil fields.

The central role of petroleum is also evident in the importance that is being given to the decentralized structure of power of Daesh in the territories under its control. This is mostly based on regional "*walis*" (Governors) who administer the territories in accordance with the precepts established by the central *Shura*. Nevertheless, crude oil, along with Daesh's military and security operations and its sophisticated production of means of communication, is directly controlled, the central *Shura* being responsible for everything in connection with this prosperous business.

Supervision of oil wells is closely controlled by the *Amniyat*, Daesh's secret police, who ensures that the revenues are directed towards the organization's objectives, and applies brutal punishment if this is not the case. The pumping stations are guarded by heavily armed guards and surrounded by protected sand banks.

Crude oil is considered a business in which no potential partners are ruled out. The Syrian regime has been a key economic partner for the Jihadist group, which has been selling crude from its wells in Syria at low prices. Since summer 2015 this activity has largely been reduced due to the increase in surveillance by Turkey of the activities on its borders with Syria, although the Syrian regime is

³¹ Ibidem.

³² Ibidem.

still a fundamental customer.³³ The Islamic State has also been selling oil to the Free Syrian Army (FSA) and to Jabhat al-Nusra, who in turn has benefited from oil sales on the Turkish black market.

Crude oil production has been fluctuating in 2014 and 2015, consistent with the security conditions on wells and pipelines, although the changes between 2013 and 2014 were relatively small in comparison with the global reduction in the sector since the start of the war.³⁴ In the first quarter of 2014 it was reduced to 14,200 barrels a day compared to 60,500 barrels in the same quarter in 2013. The second quarter in 2014 saw an increase in production of crude oil to 20,700 barrels a day, accounting for an increase of 10.8 percent over the same quarter the previous year. Nevertheless, average production is estimated at 17,700 barrels a day in the third quarter, accounting for a reduction of 14.4% compared to the previous quarter, but an improvement of 7.7% compared to the same quarter in 2013. Finally, in the fourth quarter 2014 production was estimated at 17,500 barrels per day, an increase of 36.5% compared to 2013.

As far as gas is concerned, unlike crude oil it is extracted from fields in the west of the country, mainly in the area around the city of Palmyra, which is mostly under the government's control. Nevertheless, around the middle of 2014 Daesh forces took control of the CONICO gas refinery, wresting it from its rivals Jabhat al-Nusra, whilst cancelling agreements between the latter and the local Khachman tribes, in exchange for guaranteeing these tribes a third of the gas production. This way Daesh became the owner of the refinery supplying gas to the electrical plant in the important city of Homs.³⁵ One year later, during the offensive push to the west in May 2015 Daesh captured Palmyra, a city near to a region where the principal gas extraction fields in the country are found, thus threatening the supply to the area controlled by the Syrian government.

In 2010 natural gas production was approximately 24 million cubic metres, figures that were gradually reduced to reach 15.6 million cubic metres per day in the first quarter of 2015.³⁶ To date, the gas fields that have fallen into the hands of Jihadist organizations are relatively of a minor size. The biggest one, developed in the last decade by international companies such as Suncor Energy and Canadian INA, Croata Petroleum, is under threat, but still remains in the hands of governmental forces.

³³ Vinograd, Cassandra and Cheikh Omar, Ammar, "Syria, ISIS Have Been 'Ignoring' Each Other on Battlefield, Data Suggests," NBC News, December 11, 2014, www.nbcnews.com/storyline/isis-terror/syria-isis-have-been-ignoring-each-other-battlefield-data-suggests-n264551.

³⁴ Bensemra, Zohra. "Syria, Alienation and Violence, Impact of Syria Crisis Report 2014", UNDP, REUTERS, 2015 Syrian Centre for Policy Research (SCPR), Damascus, March 2015. http://www.unrwa.org/sites/default/files/alienation_and_violence_impact_of_the_syria_crisis_in_2014_eng.pdf.

³⁵ As-Safir, op.cit.

³⁶ «La lutte s'intensifie pour le contrôle des ressources naturelles syriennes», Jihad Yazigi, July 1 2015, <http://jihadyazigi.com/tag/petrole/>.

The biggest gas plant in Syria, CONOCO's, in the province of Deir ez-Zor was held by the al-Nusra front until the end of 2013 when it was taken over by Daesh. This station provided gas to the Jandar power station in the proximity of Homs in a region controlled by the regime, and also to the stockage centers controlled by Jihadists. Daesh was selling gas extracted in limited quantities from this very same field as bottled gas at a price of 3 dollars per bottle. 1000 bottles were thus obtained providing additional revenue of 3000 dollars, a meagre amount compared to the revenue earned from the sale of crude oil. Nevertheless, the simultaneous sale of gas to the different fighters brings to light the specific features of the Syrian conflict, with the development of dynamics proper of civil wars, in which declared enemies continue to do business, in spite of everything, in mutual benefit, without this being a reason to stop fighting. The fact that gas is a product that is harder to market and distribute than oil, and Daesh's only potential customer is the government that needs gas and in turn controls the fields, explains why the shortage of electricity in Damascus and other urban areas has been limited until now.

Consequently, gas production in 2014 has been relatively moderate, with a decrease of 9.6% due to insecurity and limited destruction of infrastructures. This reduction is largely related to military operations around the Al-Shaer gas field where a fierce battle took place in the middle of July 2014 when radical Daesh's Jihad warriors attacked and captured the field, wresting it from government forces, an action that was followed by a counter-attack by the Army. It was one of the bloodiest battles to date in the war between this group's fighters and the Syrian army.³⁷

It could be said that Islamic groups, mainly Daesh, and the government of Bashar al-Assad have held relations largely based on pragmatism. At the same time as they fight for territorial possession of large areas in the north and centre of the country, and for control of energy resources, the Syrian regime has been an energy customer and has facilitated its military activities, whilst the terrorist group have helped to validate Damascus government's narrative that it was fighting Islamic extremists, which is a strategy that has served to discredit Syrian opposition. Daesh has been useful for Assad as a tool to fight the regime's enemies, including both the Free Syrian Army (FSA) - a group of moderate fighters and rebels - and Jabhat al-Nusra, the local affiliate of al-Qaeda. It is therefore not surprising that by November 2014 only 6% of the regime's attacks that year had targeted Daesh objectives.³⁸

³⁷ Mroue, Bassem, "Reports: At least 115 Syrian troops, workers killed in Islamic militants' seizure of gas field", Guelph Mercury, July 18 2014, <http://www.guelphmercury.com/news-story/4640736-reports-at-least-115-syrian-troops-workers-killed-in-islamic-militants-seizure-of-gas-field/>.

³⁸ Khatib, Lina, "The Islamic State's Strategy: Lasting and Expanding", Carnegie Middle East Center, June 29 2015, <http://carnegie-mec.org/2015/06/29/islamic-state-s-strategy-lasting-and-expanding/ib5x>.

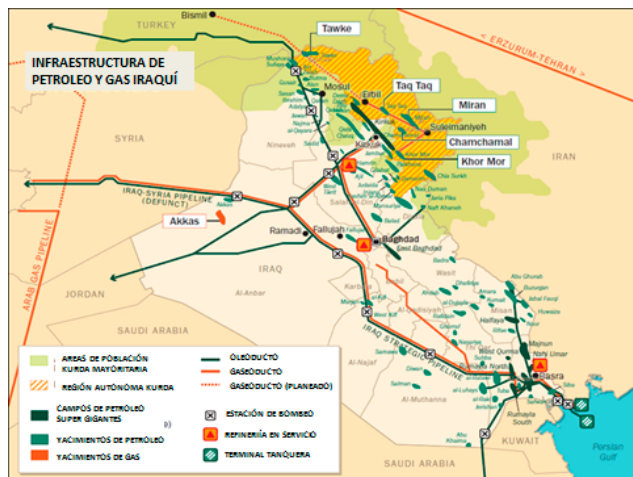
The pragmatic relations between Daesh and the regime have continued even during the bombings of Raqqa at the end of 2014, being reflected not only in coordinating the provision of services such as electricity with the militant group that controls a number of dams on the border between Iraq and Syria, but also in the fact that the regime is still paying most of the salaries of State employees who reside in areas controlled by the Islamic State.³⁹

This pragmatic and dynamic behavior between Daesh and the Syrian regime is a sign that the latter is still not considering launching a serious attack on the Jihadist group, since it understands that if this group eliminates other Islamic factions and the major players remaining in Syria are Assad's regime and Daesh only, the regime could then appeal to the international community for support against the Jihadists. Daesh, on the other hand, appears to base its calculations on being able to ultimately defeat the regime on its own.

Daesh's Energy Strategy in Iraq

The religious conflict in Iraq, reawaken by Daesh's Jihadist insurgency, features a strong energy component. In a country that earns nine tenths of its national wealth through its crude oil reserves, the outcome of the war necessarily involves control of wells and pipelines. Iraq is one of the world's main petroleum powers.

With reserves estimated at over 144 thousand million barrels, compared to the 265 thousand millions of Saudi Arabia and 157 thousand millions of Iran, Iraq is, according to the statistics published by the OPEC.⁴⁰ one of the richest countries in the Middle East. Iraq's production, severely diminished due to the conflict with Iran, the first Gulf War in Kuwait, the UN sanctions



Graphic 2.

³⁹ "Islamic State and Assad 'Ignoring' Each Other on the Battlefield, Says IHS Jane's Terrorism and Insurgency Centre," IHS press release, December 12, 2014, <http://press.ihc.com/press-release/aerospace-defense-terrorism/islamic-state-and-assad-ignoring-each-other-battlefield-sa>.

⁴⁰ "Petroleum: An Engine for Global Development", OPEC Annual Statistical Bulletin, Organization of the Petroleum Exporting Countries, Vienna, 3-4 June 2015, http://www.opec.org/opec_web/static_files_project/media/downloads/publications/ASB2014.pdf.

and the invasion by the United States, has recovered in early 2014 to levels in line with its former records.

With reserves estimated to last for 158 years, at the start of 2014 oil production in Iraq was around 3 million barrels per day, this being expected to reach 9 million by 2020.⁴¹ This amount is higher than the production figures in Iraq for 2006 when it stood at 2 million barrels per day and even higher than the 2.6 million barrels the country was producing before the coalition invasion in 2003.⁴² The country had not pumped out so much oil since 1979 when Saddam Hussein came to power.⁴³

In a country destabilized by decades of war and occupation, the country's wealth in oil made it a tinderbox when, for ethnic and religious reasons, part of the population began to monopolize the resource, in detriment of the rest. In the case of Iraq, Shia power antagonized the Sunni population, located mainly in the centre of the country, but also the Kurds located in the north, owing to the fact that the Shia population in the south occupied the most strategic region for the oil industry. There, in the area surrounding Basra, the biggest oil reserves and production sites are located, accounting for 90% of the total in the country. The largest oil terminal in the country is also located there, through which 80% of Iraq's exports flow, and logically where the pipeline network is densest.

With the rise of Shia power in Baghdad after the former Sunni president Saddam Hussein was toppled, the United States permitted the victims to carry out acts of revenge against their former Sunni tyrants, granting them control of the oil wealth, particularly in the south of the country.

In the north the situation was different. Although Kurdistan is a region significantly poorer in oil reserves - this autonomous region only produces 10% of the total of the fields in Iraqi subsoil around Kirkuk, and to a lesser extent around Mosul - the more than five thousand million barrels of crude oil resting in the fields of Khor Mor, Chamchamal, Miran, Taq Taq and Tawke are a strategic asset for the Kurdish government established in the city of Erbil. Control of these oil fields is fundamental for survival as a possible independent state.

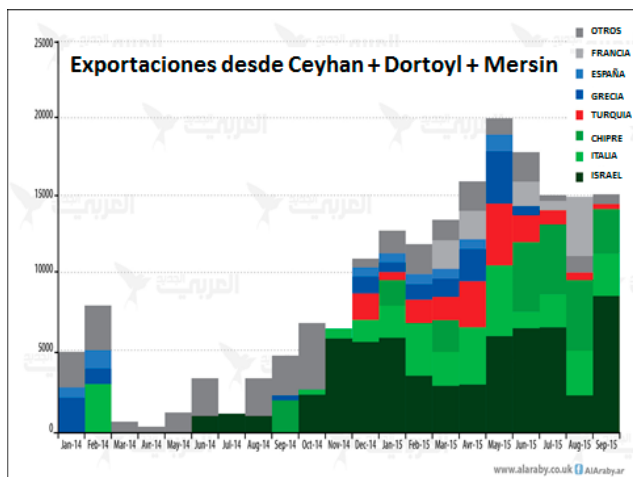
Therefore, when the Daesh Jihadists launched their offensive in early 2014, the Kurdish Peshmergas fighters became the front line to stop their advance and prevent occupation of the oil fields in the north. This way, following the political reasoning by the Kurd governors, the confrontation should give them a certain degree of legitimacy when the time comes for them to demand recognition of their national rights. With authorization by Turkey and released from the author-

⁴¹ Luft, Gal, "How Much Oil Does Iraq Have?" Brookings, May 12, 2003, <http://www.brookings.edu/research/papers/2003/05/12globalenvironment-luft>.

⁴² "Iraq Oil". Country Analysis Briefs, US Energy Information Administration, 2007. <http://www.eia.gov/emeu/cabs/Iraq/Oil.html>.

⁴³ Kent, Sarah, "Iraq's Oil Output Surges to Highest Level in Over 30 Years" The Wall Street Journal, March 14, 2014, <http://www.wsj.com/news/articles/SB10001424052702304914904579438860227481506>.

ity of Baghdad, Kurdistan began to directly export oil. The Kurds opened up a new oil pipeline at the end of 2013 through their territory, in order to export through the Turkish ports of Ceyhan, Mersin and Dortoyl in the Mediterranean, where it is pumped onto oil tankers lying at anchor in the Mediterranean.⁴⁴ This was a blatant defiance of the Shia authorities in Baghdad, who believed that only the central government had the power to organize exports through the public company *State Oil-Marketing Organization* (Somo).⁴⁵ The inability by the Iraqi State to react to this position of almost complete independence was proof of its weakness to enforce this rule.



Graphic 3. (Source: Al-Araby)

To justify their “disobedience” of Baghdad, the Kurds upheld a convincing argument that basically said that since they were unable to pump their oil through the historical pipeline because of constant sabotage, they had no other option than to transport it from the north using their “own” pipeline that crosses the Tawke oil field before continuing onwards to Turkey. Through this pipeline Iraqi Kurdistan would export 560,000 barrels of crude oil to the port of Ceyhan, plus another 20,000 barrels that are clandestinely transported every day across the Turkish border in hundreds of tanker trucks. It is through this contraband in trucks how the crude bought from Daesh is being distributed, without this meaning the existence of structural trade directed by the major state companies.⁴⁶

⁴⁴ Haquet, Charles. « Irak: les Kurdes font main basse sur l’or noir », L’Express, 27/07/2014, http://www.lexpress.fr/actualite/monde/proche-moyen-orient/irak-les-kurdes-font-main-basse-sur-l-or-noir_1561371.html#USF1zbzMDjKimPwS.99.

⁴⁵ Collected by the Federal State, revenue should be distributed among the different provinces. Thus, for example, the autonomous region of Kurdistan would receive 17% of the oil wealth.

⁴⁶ MOURANZA, Andrés, op.cit.

This was not the first time that Kurds defied the central Iraqi government. For years, convoys of Kurdish trucks have been transporting contraband crude oil to Turkey without anybody being unaware of the situation. Ankara even published an official decree that stipulated the custom duties on this traffic. The Iraqi authorities, on the other hand, were fully aware of this action, although they turned a blind eye, since the amounts of diverted crude oil were insignificant.⁴⁷

On the background of the Iraqi oil map, this complex situation permits better understanding of the main reasons explaining the increase in the number of Sunni Jihadists and the speed of their progress in the centre of the country, where they account for the majority of the population. By being kept out of the oil bonanza and any control of the strategic installations such as oil fields and terminals, most of Iraq's Sunni population had few reasons to oppose the advance by Daesh Islamists, a group of opportunists who took advantage of their frustration.

Consequently, in January 2014 Iraq was once again immersed in a wave of violence when Sunni insurrection in the north of the country enabled Daesh terrorists to take control of large extensions of territory in the areas around Ramadi and Fallujah, the two main Sunni cities in the province of Anbar. Daesh was able to capitalize on the Sunni ill feeling in Iraq due to the systematic exclusion of this religious minority from politics and the economy by Prime Minister Nouri al-Maliki, causing these regions, mostly populated by Sunni tribes, rose in arms against the central government. Daesh took advantage of this tension to show itself as a vindication tool for the Sunni.

Daesh's advance towards Mosul and occupation of this important city in June 2014, the capital of the north of Iraq, represented a huge military success by the terrorist group which was now strongly positioned in the centre of the oil region in the north of the country. By applying pressure in the north of Iraq, Jihadists managed to take over the major oil fields of Ajil and Allas in the northeast province of Kirkuk, ensuring the operational structure of oil transport to the domestic and Turkish market right from the first day of occupation.

The terrorists intended to take the fight to the Kurd front line before they had enough time to rearm and take over the oil wealth, as a previous step to the region's independence. This was therefore a first stage before deploying their offensive towards Baghdad and the rich oil producing region in the south⁴⁸. Daesh also took control of the oil pipeline linking central and southern Iraq with the port of Ceyhan in Turkey. Although the Jihadists sabotaged this historical pipeline in the north, they also proved that they were not interested in systematically

⁴⁷ HAQUET, Charles, *op.cit.*

⁴⁸ Rovira Torres, Florencia, « Les djihadistes de l'Etat islamique en Irak et au Levant (EIL) se rapprochent de la capitale Bagdad », La carte de l'avancée des djihadistes en Irak, Les Echos 12/06/14, http://www.lesechos.fr/12/06/2014/lesechos.fr/0203560223487_la-carte-de-l-avancee-des-djihadistes-en-irak.htm#8jqG2cS1vjMDQc5Z.99.

destroying the oil facilities on which they would eventually base their financial autonomy in a hypothetical sovereign Islamic State.

It is hardly surprising therefore that right from the start the Daesh Islamists started to export fuel bringing-in hundreds of trucks from Kirkuk and Mosul, a daily average of 150 trucks amounting to an approximate value of 10,000 dollars of fuel each. Although these fields were lost in the fighting of April 2015, during the ten month period they were under Daesh's control the terrorist group earned approximately 450 million dollars.⁴⁹

As was the case in Syria, Daesh Jihadists had no qualms about doing business with their enemies here either. In fact, business is done through Kurdish intermediaries who buy the oil at half the international market price, paying 1,500 dollars for each truckload of fuel passing through the Peshmerga checkpoints in the areas of Kirkuk, Makhmour, Daquq and Tuz Khormato. The city of Zakho to the north of Mosul, controlled by the Kurds and close to the Syrian and Turkish borders, plays a determining role in this business, since it is here that most of the truck traffic is channeled travelling from Iraqi oil fields towards Turkey. Convoys of between 70 and 100 trucks fully loaded with crude oil reach this city and this is where it is sold on to Turkish and Iranian buyers⁵⁰. Once sales have been secured, the loaded trucks are replaced by empty ones that return to the zones under Daesh control to start the wheel turning again. Each truck driver obtains an estimated profit of between 120 and 150 dollars per trip, whereas Daesh obtains a profit of 15 to 18 dollars per barrel, in other words, around 19 million dollars per month.⁵¹ In Turkey the contraband petroleum cannot be told apart from the petroleum sold by the Regional Government of Kurdistan, since both are sold as "of unknown source", "illegal" or "unlicensed" oil.

Right from the start the impact of Daesh's actions on the Iraqi energy sector were felt in the prices that on 13th July 2014 reached a maximum over 9 months of 106 dollars, as a result of Daesh taking control of the oil city of Kirkuk, near which the country's second largest crude oil reserves are found. Within the sectarian fight the country was embroiled in, on 14th July this led to the forces of the Regional Government of Kurdistan taking control of the Bai Hassan and Kirkuk oil fields in the north, seizing them from Baghdad's control despite threats of "serious consequences" if the fields were not returned.⁵²

⁴⁹ SOLOMON, Erika, CHAZAN, Guy and JONES, Sam, op.cit.

⁵⁰ Myers Jaffe, Amy. "Commentary: ISIS victories and oil", Fuelfix (ARAMCO) May 25, 2015, <http://fuelix.com/blog/2015/05/25/isis-victories-and-oil/>.

⁵¹ "Raqqa's Rockefellerers: How Islamic State oil flows to Israel", Al-Araby al-Jadeed, 26 November, 2015, <http://www.alaraby.co.uk/english/features/2015/11/26/raqqas-rockefellerers-how-islamic-state-oil-flows-to-israel#sthash.wtvcLHkJ.dpuf>.

⁵² Hauslohner, Abigail, "Tensions mount between Baghdad and Kurdish region as Kurds seize oil fields". Washington Post, July 11, 2014,

https://www.washingtonpost.com/world/middle_east/tensions-mount-between-baghdad-and-iraqs-kurds/2014/07/11/7baeea5e-2bfe-4d07-942b-1653af3d60a3_story.html.

Having said that, Kurdish success was very relative. The fields located around Kirkuk are very old, have a low economic value and are in decline since they contain heavy products. Without really knowing how to make them profitable, the Iraqis systematically re-injected them in the wells, contaminating them therefore. Even today nobody knows in what state the oil fields are, which would require some very expensive drilling work. That is why occupation of Kirkuk by the Kurds in July 2014 is explained more through politics than economics, allowing them to stake claim to a region that they have historically considered to be theirs.

The fact that on 18th June 2014 Daesh attacked the Baiji oil refinery the biggest and most important in the country, with mortars and machine guns, capturing 75% of the facilities, only helped the situation to deteriorate further. This refinery has a strategic value since it supplies a large part of Iraq owing to its production capacity of 300,000 barrels of crude oil per day before it was taken over by the Jihadists and, moreover, it is located halfway along the oil pipeline from Kirkuk eastbound towards Turkey.⁵³ Built in the 1980's the site has a long history of violence. Bombed by the Tehran air force during the Iran / Iraq war, it was likewise severely damaged in 1991 during the intervention by the United States against Saddam Hussein, and was repaired afterwards.

If the facility were to be destroyed or occupied by the rebels, the Iraqi government would lose an important asset, since Baghdad would be left with just two refineries: Dora, a small site near the capital, and Basra in the south, insufficient to meet the needs of the army and the population. The loss of Baiji would force Baghdad to import huge amounts of gasoline and diesel, which would in turn require enormous financial resources and infrastructures, which the Iraqi government does not have.

In order to avoid this unfavorable situation, on 19th June, i.e. the day after occupation by Daesh, governmental forces launched a counter offensive in which, after fierce fighting killing 100 militants,⁵⁴ they claimed to have recovered control of the whole refinery. The truth of the matter is that Daesh flags were still flying over the watchtowers and checkpoints around the facility, despite claims to the contrary by the government.⁵⁵

After a few months of uncertainty, during which the refinery changed hands several times, on 23rd December 2014 the Iraqi forces in conjunction with Shia militia launched an assault on the city of Baiji, which would later be called the Battle of Baiji. This battle lasted from the end of December 2014 until the end

⁵³ «Irak : la guerre du pétrole contre l'Etat islamique», Europa 1, 02 June 2015, <http://www.europe1.fr/international/irak-la-guerre-du-petrole-contre-letat-islamique-1349628>.

⁵⁴ "Iraq Forces 'Retake' Oil Refinery From ISIS". Sky News. 19 June 2014. <http://news.sky.com/story/1285416/iraq-forces-retake-oil-refinery-from-isis>.

⁵⁵ "ISIS Militants' Black Banners Hang at Beiji Refinery: AP Witness". NBC News, 19 June 2014. <http://www.nbcnews.com/storyline/iraq-turmoil/isis-militants-black-banners-hang-beiji-refinery-ap-witness-n135306>.

of October 2015⁵⁶ with the Iraqi troops eventually gaining complete control of the refinery⁵⁷ and the road from Baghdad to Baiji, meaning that the Iraqi armed forces could use Baiji as a base for launching a future assault on Mosul.⁵⁸ Nevertheless, the Daesh forces that had controlled a large part of the facility from April to May set fire to the facility as they were leaving, rendering the refinery practically inoperable.⁵⁹

Whichever the case, it would appear reasonable to state that it was the attention shown by all parties in affairs related to the petroleum industry and the interests of each party to keep the facilities in operating conditions, which was one of the principal factors serving to explain why, in spite of the ferocious combats, the facilities have not yet been destroyed, and therefore oil prices have hardly been affected.⁶⁰ Nevertheless, it is not difficult to imagine that if Daesh Jihadists were pushed into a corner, they would probably decide to attack and destroy the oil facilities, both at production terminals and export terminals.

Jihad Action Against the Energy Sector in North Africa

In a place such as the north of Africa where Al Qaeda was capable of keeping its predominance within the Jihad mist, its local franchise Al Qaeda in the Islamic Maghreb (AQIM) was capable of perpetrating some daring actions against the energy sector, taking advantage of the power vacuum in countries such as Libya after the fall of Gaddafi.

The most spectacular attack was the one performed against the Tigantourine gas facility, located in Amenas in the Algerian desert and operated by the Algerian national company Sonatrach in conjunction with BP and the Norwegian company Statoil. This field supplied 10% of Algeria's natural gas production.⁶¹

⁵⁶ Iraq Weekly Security Report 23 December 2014. The InsideTrack.

<http://edinburghint.com/insidetrack/iraq-weekly-security-report-23-december-2014-2-2-2/>.

⁵⁷ "Iraqi forces retake the Baiji oil refinery from the Islamic State". ABC news, 19/04/2015. <http://www.abc.net.au/news/2015-04-19/iraqi-forces-retake-baiji-oil-refinery-from-islamic-state/6403640>.

⁵⁸ RUSSELL, Jill S, "How important is the battle for Iraq's Baiji oil refinery?" BBC News, 12 May 2015, <http://www.bbc.com/news/world-middle-east-32663262>.

⁵⁹ In this battle, along with the regular Iraqi army, Shia groups also took part such as Asaib al Haqq (League of the Righteous), the Hezbollah Brigades, Kataib Imam Ali, Kataib Sayyed al Shuhada, Harakat Nujaba, the Peace Brigades, etc. Roggio, Bill and Weiss, Caleb, "Islamic State assaults Baiji oil refinery", The Long War Journal, April 13, 2015. <http://www.longwarjournal.org/archives/2015/04/islamic-state-assaults-baiji-oil-refinery.php>.

⁶⁰ « Cours du baril de pétrole en euro dollar », Prix du baril - Le cours officiel du baril de pétrole. <http://prixdubaril.com/>.

⁶¹ Chrisafis, Angelique; Borger, Julian; McCurry, Justin; MacAlister, Terry. "In Amenas: timeline of four-day siege in Algeria". The Guardian, 25 January 2013.

<http://www.theguardian.com/world/2013/jan/25/in-amenas-timeline-siege-algeria>.

The Impact of Jihadism on the Energy Sector

On 16th January 2013 terrorists affiliated to a brigade directed by Mokhtar Belmokhtar⁶² attacked the facility taking numerous hostages.⁶³ The attack was directed by Abdul al Nigeri, one of the highest ranking commanders of Belmokhtar, who was killed during the course of events. After four days Algerian Special Forces assaulted the facility in an attempt to free the hostages, leading to the murder of at least 39 foreign hostages and one Algerian security guard, and also 29 militants.⁶⁴ A total of 685 Algerian workers and 107 foreigners were freed and 3 militants captured. The final result was that production was not recovered until September 2014, more than a year after the attack.

The truth of the matter is that the efficiency of the Algerian security forces, however questionable their methods, is the main reason leading us to understand why Jihadist groups, mainly the Maghreb faction of Al-Qaeda, and more recently Daesh, have been so unsuccessful acting against the energy sector in the country with the largest resources in North Africa.

The situation in Libya is completely different though, a country that is deeply divided since the revolution in 2011 ending Gaddafi's reign and that has since fell into complete chaos. Revenue from hydrocarbons in Libya account for 80% of the GDP, for 95% of revenue from exports and for 99% of the government's revenue.⁶⁵ Petroleum pays Libya's cereal imports which account for 90% of consumption in the country⁶⁶ and the salaries of public employees, who account for over 80% of the workforce.⁶⁷ Without petroleum there is no work, no salaries, no food. Moreover, without petroleum, Libya potentially fails to exist.

Libya has the highest quantity of petroleum reserves in Africa, the fourth highest gas reserves on the continent and is also one of the world's main suppliers of light and sweet (low Sulphur content) oils, mostly exported to Europe.⁶⁸ There-

⁶² Belmokhtar, a veteran of the Algerian civil war and of the soviet war in Afghanistan, dubbed "The Uncatchable" by French intelligence, was a high ranking commander in the local Al Qaeda branch before deciding to form his own armed Islamic group at the end of 2012, apparently after falling out with other terrorist leaders. In spite of the separation, his fighters were still loyal to Al-Qaeda, a fact which was mentioned in his communication to the media after the initial assault.

⁶³ "Amenas Hostage Crisis: Oil Workers 'Killed' in Algeria Air Strikes". Rigzone. 17 January 2013, http://www.rigzone.com/news/oil_gas/a/123516/Amenas_Hostage_Crisis_Oil_Workers_Killed_in_Algeria_Air_Strikes.

⁶⁴ "Thirty hostages reported killed in Algeria assault". Reuters. 17 January 2013 <http://www.reuters.com/article/2013/01/21/us-sahara-crisis-idUSBRE90F1JJ20130121>.

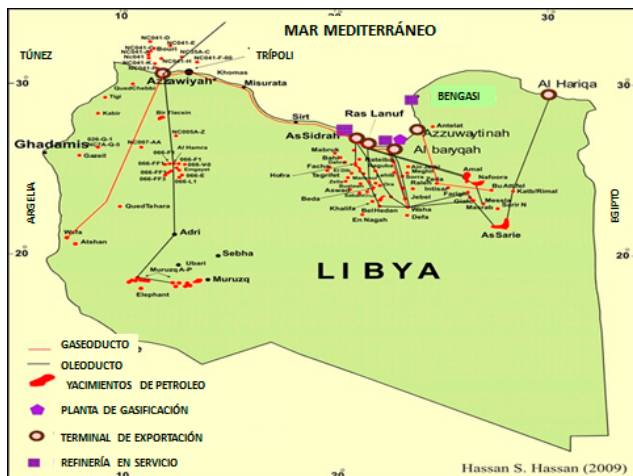
⁶⁵ "2015 Index of Economic Freedom", The Heritage Foundation, January 2015. <http://www.heritage.org/index/>.

⁶⁶ "Libya Country Brief", Food and Agriculture Organization of the United Nations, January 26, 2015.

⁶⁷ "MENA Quarterly Economic Brief", The World Bank, January 2014, p.18.

⁶⁸ Libya has proved to have crude oil reserves amounting to 48 million barrels since January 2013, the largest quantity in Africa accounting for 38% of the continent's total, and the ninth

fore it is hardly surprising that control of energy resources is one of the main objects of the fight for power that has been taking place in Libya since 2011.⁶⁹



Graphic 4.

Before the revolution Libya was planning to increase production to 1.7 million barrels per day in a first stage, and afterwards, in the second stage, increasing this amount to 2 million. The lifting in 2004 of international sanctions for the Lockerbie attack of 1984 had permitted oil companies to return, and the investment program to be continued. This development program which started in 2009 included the opening of 23 new oil fields adding 775,000 barrels per day to current production.⁷⁰

Nevertheless, deterioration of security upset these ambitious plans. Since the 2011 revolution, production and export of hydrocarbons has been seriously affected as a result of the political instability scourging the country. During the civil war exports practically came to a halt and production was reduced to exclusively meet domestic demands, leading to an almost complete economic collapse and a fall in the annual gross domestic product of 62%.⁷¹ However, since 2012, production gradually began to recover, although it never reached the lev-

largest reserve in the world. Approximately 80% of Libya's reserves are located in the Gulf of Sidra.

⁶⁹ STEPHEN, Chris. "Partition of Libya looms as fight for oil sparks vicious new divide". The Observer, Sunday 16 March 2014. <http://www.theguardian.com/world/2014/mar/16/libya-partition-looms-fight-oil-tanker>.

⁷⁰ As-Shafir. "Libyan Militias Control the Oil Industry". Al-Monitor. February 14, 2014.

<http://www.al-monitor.com/pulse/security/2014/02/libya-oil-industry-control-militias.html>.

⁷¹ "IMF Country Report No. 13/151, Libya", International Monetary Fund. May 2013. <https://www.imf.org/external/pubs/ft/scr/2013/cr13151.pdf>.

els it was before the civil war, being sporadically interrupted by the strikes that took place in different oil fields and port facilities.⁷²

In 2013 these protests mainly carried out by workers and guards of the different militia contracted to provide security to the facilities, escalated to the extent that in the month of August there was an almost complete stoppage at the two main outlet ports of Sidra and Ras Lanuf and Tobruk (*Harika Port*) in the central and eastern regions from where 60% of the Libyan crude oil is exported. On the western side the militia at Zintan cut off in August and September the two main oil pipelines that connected the *El Sharara* and *El Feel* ("Elephant") fields with the export terminals of Zawillah and Mellitah respectively, causing the stoppage of production.⁷³

Since then the economic situation continue to worsen as political affairs gained more importance over labor affairs. As a result of the protests in some fields and at the loading ports, crude oil production fell from one million barrels per day in July to 600,000 barrels per day in August, reaching a minimum of 200,000 barrels per day in the middle of September 2013.⁷⁴

Crude oil exports plummeted during the 2011 civil war, falling below 400,000 barrels per day. These figures recovered somewhat in 2012 reaching approximately 1.25 million barrels per day in the first six months of 2013. But when production interruptions became more intense that year, exports of crude oil fell to 830,000 barrels per day in July and 445,000 barrels per day in August.⁷⁵

As for gas, the trend followed was similar to that of crude oil. With reserves estimated at 1.549 trillion cubic meters (2014)⁷⁶, Libya's production and exports of gas had been developing since 2003, when the so-called Western Libya Gas Project began, which entailed construction of the 370 mile *Greenstream* gas pipeline operated by the national Italian company ENI in conjunction with the Libyan

⁷² En 2012, Libya produced 1.37 million barrels per day of crude oil, above the average of 500,000 in 2011. Before the start of hostilities in 2011, Libya had been producing approximately 1.65 million barrels of high quality, sweet crude oil per day. Production in Libya had been increasing over most of the previous decade, from 1.4 million barrels per day in 2000 to 1.74 million barrels per day in 2008, but production remained below the maximum levels of 3 million barrels per day reached at the end of the 1960's. Crude oil production in Libya in the 1970's through to the years 2000 had been affected by the partial nationalization of the industry and by the sanctions imposed by the United States and the United Nations, preventing the necessary investments to keep crude oil production at its highest levels.

⁷³ "Libya Overview". IEA. US Information Administration. 10 October 2013. <http://www.eia.gov/countries/cab.cfm?fips=ly>.

⁷⁴ Most of Libya's crude oil is sold to European countries. In 2012 approximately 71% of Libya's exports were sent to Europe, the principal customers being Italy, Germany, China, France and Spain. The United States started importing crude oil from Libya again in 2004, after the sanctions were lifted, importing 56,000 barrels per day of Libyan crude in 2012, which was approximately 0.6% of the total US imports that year.

⁷⁵ Commercial figures from the Global Commercial Atlas and APICE Petroleum Data.

⁷⁶ "NATURAL GAS-PROVED RESERVES(CUM)", The World Factbook, Central Intelligence Agency, 2015, <https://www.cia.gov/library/publications/the-world-factbook/fields/2253.html>.

national company NOC, which began operating in the direction of Italy in October 2004. The gas flow was interrupted during the war for a period of eight months, with recovery commencing in 2012, although it has never reached the levels it was at before hostilities began.

A similar scenario has developed for Liquefied Natural Gas (LNG), where Libya was a pioneer along with Algeria and the United States (Alaska) in exporting to foreign markets, mainly Spain. Nevertheless, during the revolution the only LNG plant in the town of Marsa-Al-Brega, belonging to NOC and operated by the Sirte Petroleum Company, was seriously damaged in early 2011, exports being therefore interrupted. In any case, production has never exceeded a third of the maximum capacity, mainly due to technological limitations.⁷⁷

The importance of hydrocarbons as a political tool was clearly understood by the different militias, who in summer 2013 kept a blockade on the four principal petroleum export terminals. The main demand was centered on claims for greater financial resources from hydrocarbons to be invested in their regions, Cyrenaica being the region where these claims were strongest, through the self-proclaimed *Cyrenaica Political Bureau* orchestrating and leading them.

Aware of the weakness of the central authorities, their action was taken further still with attempts to directly sell hydrocarbons in the international marketplace. The capture of the tanker *Morning Glory* in March 2014 in Es Sider port in Cyrenaica by a local militia called the Barqa Army with 16,000 armed men, led by the charismatic Ibrahim al-Jadran, leader of the Cyrenaic Political Bureau, represented a significant milestone in this escalating process defying the central government for the control of energy resources by the regional militia.⁷⁸

The dangers that aroused for the control of energy sources in the eastern region of the country falling into the hands of local militias, drove the opposition led by the Muslim Brotherhood to dismiss the elected Prime Minister Zeidan, accusing him of weakness in his attempt to resolve the crisis and of corruption, replacing him by the former Defense Minister Abdullah al Thani.⁷⁹ The attempt by the Congress to recover the vessel with the support of the Libyan Shield forces in Misrata, considered to be the most reliable and powerful in the country, was a dismal failure. The fighting in Sirte in the eastern region only inflamed the population's disgust and led to a circumstantial alliance between rebel militia of the Cyrenaica Political Bureau, and units from the regular army deployed in *Wadi al*

⁷⁷ The plant does not have the technology to separate out some liquid gases from the liquefied (LNG) gas, which limits the number of receiver terminals capable of processing the latter.

⁷⁸ Ibrahim Jadran became popular during the revolution as a guerilla leader defending Benghazi.

⁷⁹ CHRIS, Stephen. "Partition for Libya looms as fight for oil sparks vicious new divide". The Guardian/The Observer. 16 March 2014.

Hammar (Red Valley), blocking the approach to Cyrenaica's ports and preventing recovery of the blockaded ports by the central authorities.⁸⁰

In the end all attempts by the separatist leader Ibrahim al-Jahdran to sell crude oil by himself failed, as did his political demands. When he realized the situation would not change, he gave up his occupation of the area.⁸¹

In the west, in the mountains near the border with Tunisia, the Zintan militia, whose numbers were slightly less than those of the rival militia of Misrata, but greater than the tiny regular Libyan army, has formed different alliances occasionally with the Berbers in the north and with the black race *Tobou* tribe inhabiting the south of the country, to cut off oil pipelines and occupy the oil fields. In general terms it could be said that the object of attacks against oil facilities during this first post-revolution stage was not actually to seize the revenue from the facilities or damage them, but rather to deprive the government from them, and therefore force it to accept the demands from the attacking group. Cases where groups making social or economic claims block or occupy oil and gas facilities have been many since 2012 through to 2014, including the protests in the *Arabian Gulf Oil Company* (AGOCO) in Benghazi, the *Mellitah Oil & Gas*, the *Zawiya Petroleum Refining Company*, in the Sharara oil field, and in the el-Feel (the Elephant) oil field.

Control of the Hydrocarbon Sector after the 2014 elections in Libya

The elections in June 2014 gave a new lease of life to the political situation of the Libyan hydrocarbon sector. The forming of two different governments, one being the General National Congress (GNC) in Tripoli and the other being the Chamber of Deputies (HoR) in Tobruk, at the end of 2014, created an unsustainable situation. Since both governments depended for survival on revenue from hydrocarbons indistinctly channeled through the Central Bank of Libya, the fight between them was reinvigorated in successive attempts to deprive each other of income from this exclusive source of finance.

With both governments entrenched in antagonistic political standpoints, military confrontation for control of the revenue from petroleum was inevitable, although the risk was mitigated somewhat towards the end of 2014 by militia fighters being paid state salaries regardless of their religious affiliation or political loyalty. The neutrality of the National Oil Company (NOC) and the Central Bank of Libya was upheld by both governments, avoiding the politicization of the energy sector.

⁸⁰ AL-WARFALLI, Ayman, "Libyan Army in Heavy Fighting with Oil Ports Rebels", The Daily Star, Lebanon. 22 March 2014. <http://www.dailystar.com.lb/News/Middle-East/2014/Mar-22/251050-libyan-army-in-heavy-fighting-with-oil-port-rebels.ashx>.

⁸¹ PORTER, Geoff D., "Stopping a Civil War in Libya" Politico Magazine, March 19, 2014, http://www.politico.com/magazine/story/2014/03/remember-libya-104782_Page2.html.

Hence, while al-Hassi's government in Tripoli controlled civil administration as result of physically possessing governmental buildings and their corresponding staff, al-Thinni's government in Tobruk was supported by international recognition by most governments. The balance was held providing neither government had access to the marketing processes of petroleum, or to the currency reserves, which were deposited abroad in the Libyan Foreign Bank.⁸²

In the meantime the Central Bank of Libya, holding nearly 90 thousand million dollars in currency reserves and receiving the revenue from the National Oil Company (NOC) tried to remain neutral continuing to pay salaries and subsidies to consumers in the territories controlled by both rival governments.⁸³

Nevertheless, both governments would soon start to try and bring the hydrocarbon industry under their own management. The HoR in Tobruk dissolved the Ministry of Oil and Gas and gave control of the entire sector to the National Oil Company (NOC), appointing the President thereof in Tobruk. The revived GNC in Tripoli on the other hand, maintained its own Oil and Gas Ministry.

This new situation however did not completely displace the former tactic of exploiting the oil and gas industry to settle grievances. In February 2015 demonstrators closed Marsa Hariga, one of the few export terminals still operating in Libya, since the Minister of the Interior in Tobruk had proposed an agreement with GNC. The demonstrators demanded resignation by the Minister of the Interior, which finally happened. And as soon as it did, the port began operating normally again. The objective nevertheless, was not simply to hold the facilities hostage to force the government to act in a specific way, but rather on the contrary, to occupy the facilities in order to control their revenue and use it to support one government or the other.

The difficulty of finding a solution to this kind of situations illustrates the complexity of the relations between the opposing forces who control ports, oil fields and pipelines. For example, in the case of the *Al-Ryayna* oil pipeline leading out of the *El Sharara* oil fields to the ports in the Gulf of Sidra, blockaded since the end of 2014, Tripoli's government claimed to be negotiating with the tribal elders to lift the blockade through a region controlled by forces from the city of Zintan, who oppose the authorities in Tripoli. But the forces in Zintan, on the other hand, refuse any kind of negotiations with Tripoli's government for considering it illegitimate, justifying this refusal by saying that the fields were closed by the petroleum guards belonging to their own militia as a precautionary measure after the recent Islamic attacks in the southern fields.

⁸² "Libya's political rivals compete for oil revenues", Jane's Intelligence Review, 02 December 2014.

⁸³ Kirkpatrick, David D., "One of Libya's Rival Governments Moves to Control Oil Revenue", The New York Times, April 5, 2015, <http://www.nytimes.com/2015/04/06/world/middleeast/one-of-libyas-rival-governments-moves-to-control-oil-revenue.html>.

Since the end of 2014, polarization of Libya's governability has led to an increase in physical threats to oil infrastructures, when both governments and their allied forces started to fight for control over the oil fields, including an assault on the Sidra and Ras Lanuf facilities in December. A month earlier, on the sixth of November the Chief of Staff of al-Hassi's government in Tripoli, Abdussalam Jadallah Obeid urged his militias to "free the oil fields" from the eastern forces which he qualified as "terrorists".⁸⁴ Consequently, the Misrata militia forces belonging to the "Libyan Dawn" loyal to Tripoli, took control of the large oil fields of *Sharara* and *El-Feel* near to Obarii in the south, ousting the rival Zintan militias who had held control since 2011. The latter reacted by blocking and sabotaging the pipelines from the fields controlled by the "Libyan Dawn" militias to the west coast of Tripolitania.

In the Cyrenaica region, in the east, where two thirds of oil production take place, the battles were centered on control of the major terminals in the Gulf of Sidra located in As Sidr, Ras Lanuf, Zueitina and Brega, in the hands of the militia loyal to the Tobruk government. These facilities, critical to define victory in favor of one contender or the other, became a strategic objective for the rival government of Tripoli, although the latter was in an operational disadvantage owing to the distance they are found from the capital and the hostility of the tribes defending them. All attempts to occupy the facilities by the GNC have been in vain so far, as was the case in the period between August 2013 and June 2014 when Tripoli's government attempted to recover control and was detained in Wadi al-Ahmar, a natural bottleneck that became a line of defense around 80 kilometers to the west of Sirte.⁸⁵

It could be said that the fight for control of the oil resources is one of the fundamental factors to understand the rapid process of political disintegration of the country, which will drive, if a solution is not found in the short term, to an almost inevitable partition. The military trends by both governments are prevailing for the political perspective in both jurisdictions, and this reduces any incentive to reach a political compromise. In the east, the Tobruk government will be very reluctant to cede control of the facilities it controls in the strategic Gulf of Sidra, unless an agreement is reached about the legitimacy of its mandate, born of the June 2014 elections. The population of Cyrenaica is also unlikely to accept a solution that does not guarantee a high degree of autonomy, including management of its energy resources which the region of Tripolitania, with the most numerous population, will find very hard to swallow as is used to governing the country.

On reciprocal terms, in the west, the Islamic militias comprising the core of "Operation Dawn" are not likely to accept a final solution while the military campaign known as "Operation Dignity", fostered by the government of Tobruk, continues. The consequence is that both sides continue fighting for control of the oil facil-

⁸⁴ Ibidem.

⁸⁵ "Libya's political rivals compete for oil revenues", op.cit.

ities and state institutions, without the conversations about a final agreement harbored by the United Nations in the Moroccan city of Skhirat having reached so far any satisfactory outcome. This political and military deadlock is likely to lead to a division of the energy sector, with the subsequent withdrawal of foreign oil companies and constant interruptions of oil production. It is also very likely for tribal protests to escalate regarding their role in the security of the facilities and the lack of economic perspectives. These protests can only escalate further as access to state funds dries up, which to date have been used to finance all the parties and to calm the general discontent.

Jihadist Violence and the Destruction of the Energy Sector

If the situation in the energy sector was already sufficiently serious as a result of the low-scale war between the governments of Tobruk and Tripoli, a new Jihadist threat has arisen with extreme violence since the outset of 2015 which has only served to make matters worse. In February this year, a group claiming loyalty to Daesh attacked the Mabruk oil field operated by a Joint Venture between the national company NOC and TOTAL.⁸⁶ Twelve workers were killed during the assault and seven others were taken prisoner while the facility was deliberately seriously damaged, which had not happened until then.

Ten days later the facilities were attacked again at the same time as the Bahi oil field operated by another Joint Venture between NOC and Oasis,⁸⁷ and the following day the oil pipeline connecting the Sarir field operated by AGOCO with the Marsa Hariga terminal was bombed causing an explosion that forced closure. This attack was a copy of the operational tactics used the previous month of January by the Jihadist group *Ansar Bayt al-Maqdis* loyal to Daesh on the Sinai Peninsula, where it attacked an Egyptian gas pipeline in the area. All these incidents accounted for a change in strategy by Jihadist groups compared to the one used until then by the different militia groups to apply pressure to the hydrocarbon sector in order to force their political claims. None of these attacks sought to capture or control the oil or gas facilities. Their objective was to destroy them.

The appearance of Jihad violence in the oil and gas sector in Libya is partly a reflection of the appearance of Jihad violence in Libya in general, where violent Islamic groups have taken advantage of the civil war to entrench themselves, above all in the eastern city of Derna from where they swore loyalty to Daesh in October 2014. With the governments of Tobruk and Tripoli at loggerheads in their fight against each other, since February 2015 Jihadist groups have

⁸⁶ PORTER, Geoff D. "Terrorist targeting of the Libyan oil and gas sector", Combatting Terrorism Center at West point, February 27,2015, <https://www.ctc.usma.edu/posts/terrorist-targeting-of-the-libyan-oil-and-gas-sector>.

⁸⁷ Oasis is a consortium comprising the North American companies Hess, Marathon, and ConocoPhillips.

been taking advantage of this circumstance to spread with increased impunity through the Gulf of Sidra.

Jihad's obsession with the oil sector could also be due to the arrival in Libya of activist groups with greater operational experience. In particular, the attack on Mabrouk was allegedly perpetrated by the Tarek Ibn Ziyad Brigade, a terrorist unit founded in 2007 as part of Al Qaeda in Islamic Maghreb which is very active in the Sahara, in the region between Niger and Mali.⁸⁸ The pressure by French military operations in Mali (*Operation Serval and Operation Barkhane*) was probably the reason why the Brigade was forced to seek calmer waters in Libya, a country out of control. This group moreover, has a long history of attacks on extraction facilities, including the attack in 2010 on a uranium mine of Areva in Niger, where seven hostages were taken.⁸⁹

Within this new Jihadist strategy, in March 2015 Daesh attacked and caused damage to several oil fields in the region of al-Ghani, forcing the Tobruk government to stop production at eleven oil fields in the Sidra's central basin. Eleven guards were murdered, several of whom were beheaded. Nevertheless, there was no attempt to hold the fields and secure their revenue, as had been the case by Daesh in Iraq and Syria. The objective was simply to destroy the oil fields. This shows that the profile of Jihadist terrorism in Libya is different from Iraq: here Daesh seeks to create temporary bottlenecks in order to weaken their opponents and gain time to consolidate their position.⁹⁰

Future Implications of Jihadist Activity in the Energy Sector

Petroleum, mainly in Syria and to a lesser extent in Iraq, is the basis of Daesh's operation as an alleged Islamic State and a guarantee of its mid and long-term survival. Petroleum also fuels the war efforts, provides electricity and provides the Jihad fanatics with the means to finance their political and social structure, essential to face their rivals. Unlike Al Qaeda, who depends on external donations for its finances, Daesh does so by taking advantage of its monopolist position as producer of an essential raw material for operation of production activities and for life in general in the huge area under its control.

⁸⁸ FAUCON, Benoît and BRADLEY, Matt, "Islamic State Gained Strength in Libya by Co-Opting Local Jihadists" The Wall Street Journal, February 17, 2015. <http://www.wsj.com/articles/islamic-state-gained-strength-in-libya-by-co-opting-local-jihadists-1424217492>.

⁸⁹ PORTER, Geoff D., "AQIM's Objectives in North Africa," CTC Sentinel 4:2, 1 February 2011. <https://www.ctc.usma.edu/posts/aqim's-objectives-in-north-africa>.

⁹⁰ MARKEY, Patrick and ELUMAMI, Ahmed, "Islamic State risk for Libya's troubled oil sector", Reuter, Oct 28, 2015, <http://www.reuters.com/article/2015/10/28/us-libya-energy-idUSKCN0SM0HW20151028#bj-DeHIAhyGhqcl8t.97>.

We could talk about Daesh, having spread over a large area in the north of Iraq and north and east of Syria, as operating more like a state oil company that has grown in size and experience over time, benefiting from local tension and hardly being affected by international attempts to eradicate it. Therefore, even if it was possible to prevent oil exports, Daesh would still be able to benefit from the huge captive market it has in Iraq and Syria.

In Syria, Daesh painstakingly manages the oil business, whose oil fields have been completely under its control since September 2015, hiring qualified workers including engineers and experts. Under this scenario, production in "its" territory reached an estimated volume of 34-40,000 barrels per day in October 2015. The oil is sold at source at an estimated price of between 20 and 45 dollars per barrel, providing the terrorist group with an estimated revenue of approximately 1.5 million dollars per day.⁹¹ Oil has been sold to any bidder, including the forces fighting against Daesh, who, on the other hand, have normally no other option than to buy it from this Jihadist group.

In Iraq, where Daesh controls the Sunni region, it has acted in an even more professional way, hiring experts who are able to keep operating all oil extraction and storage processes. Right from the start it began exporting fuel by using hundreds of trucks from Kirkuk and Mosul, at a rate of 150 trucks a day, each one with a fuel load valued at approximately 10,000 dollars. Although these fields were lost in the fighting of April 2015, in the ten month period they were under Daesh's control the terrorist group earned approximately 450 million dollars.⁹²

If we bear in mind that "breaking down borders" between Syria and Iraq is part of their narrative,⁹³ short of any reliable statistics, the estimates for both scenarios jointly are many and varied. Some of the more optimistic estimates place production by the terrorist organization at between 1.5 and 2 million barrels a day, a huge amount that would position the organization ninth on the Organization of Petroleum Exporting Countries' (OPEC) ranking.⁹⁴

Nevertheless, these data seem clearly excessive. More realistic sources claim much more modest figures. Valérie Marcel, an analyst specializing in petroleum at Chatham House, believes that even with the more modest data of 100,000 barrels of oil per day, through which Daesh would earn profits of three million

⁹¹ "Isis Inc: how oil fuels the jihadi terrorist", op.cit.

⁹² SOLOMON, Erika, Chazan, Guy & Jones, Sam, "Isis Inc: how oil fuels the jihadi terrorists", Financial Times, October 14, 2015, <http://www.ft.com/intl/cms/s/2/b8234932-719b-11e5-ad6d-f4ed76f0900a.html#axzz3t3gPtIWx>.

⁹³ Daesh has created a new "Euphrates Province" reaching through the eastern province of Deir ez-Zor and the western province of Anbar, including the districts of Albukamal in Syria and al-Qaim, Rawa and Aná in Iraq.

⁹⁴ BLANCO MORO, Víctor, "ISIS would be among the top 9 biggest oil producers in OPEC", El Economista.es, 16 November 2015, <http://www.economista.es/mercados-cotizaciones/noticias/7152020/11/15/El-ISIS-estaria-entre-los-9-productores-de-petroleo-mas-grandes-de-la-OPEP.html>.

dollars a day, it results “exaggerated”.⁹⁵ Production is unlikely to be over 40,000 barrels per day. Other institutions, such as the International Energy Agency, reduce this figure by half, which in conjunction with the sharp fall in international prices of crude oil over the last year and a half, mean the jihadist group’s annual profits would probably not reach 100-200 million dollars, which is a significant amount but a far cry from the figures of thousands of millions that are usually speculated about.⁹⁶

Supporting these much lower figures are the documents that have been filtered by the Syrian Aymenn Jawad al Tamimi, one of the few investigators who has had access to Daesh’s financial documents in recent times, and has published the figures for the new “Euphrates” province, the richest in oil and under complete control of the terrorist group since July 2014, reaching from the Syrian province of Deir ez-Zor to the Iraqi province of Anbar, including the districts of Albukamal in Syria and al-Qaim, Rawa and Ana in Iraq. According to the known data, the revenue from crude oil would be around a few million dollars a month, and not dozens, or even hundreds of millions as sometimes reported in the international media. These means that the average yield from the wells in this province would stand at around 66,433 dollars per day per well,⁹⁷ which would account for a total in the “Euphrates” province of 150,000 to 300,000 dollars a day, a far cry from the figure of 3 million dollars a day often talked about.⁹⁸

Nevertheless, up until the Paris attacks in November 2015 - and the subsequent international reaction-, it is doubtful that the organization has lost any significant part of its production through destruction of oil fields, since there were no major attacks until that date by military forces on the Syrian and Iraqi facilities, and those by the Syrian and Iraqi forces have been fairly insignificant. Having said that, this advantageous situation of Daesh cannot last much longer. The Jihadist group has seen that it will be unable to sustain oil production at current levels indefinitely not only for it lacks the required technical knowledge, but also because its fighters are incapable of avoiding attacks they suffer to recover key facilities. Few people with adequate technical training have remained behind in the territory controlled by Daesh, and the efforts by the group to coerce qualified staff into staying in their jobs by threatening the lives of their families or confiscating their estate, has proved to be fairly ineffective. Consequently, any ma-

⁹⁵ MOURANZA, Andrés, “How does ISIS oil contraband really work?”, El País, 07 December 2015, http://internacional.elpais.com/internacional/2015/12/05/actualidad/1449332363_449457.html.

⁹⁶ Ibidem.

⁹⁷ JAWAD AL-TAMIMI, Aymenn, “The Archivist: Unseen Islamic State Financial Accounts for Deir ez-Zor Province”, October 5, 2015, C:\Users\ifuecob\Documents\IEEE 2015\GRUPOS DE TRABAJO\GT ENERGIA\The Archivist Unseen Islamic State Financial Accounts for Deir ez-Zor Province Aymenn Jawad Al-Tamimi.mht.

⁹⁸ “Experts: ISIS makes up to \$3 million daily in oil sales”, Al Arabiya News, 28 August 2014, <http://english.alarabiya.net/en/perspective/analysis/2014/08/28/Experts-ISIS-makes-up-to-3-million-daily-in-oil-sales.html>.

ior repairs requiring complex procedures, such as injecting water into mature production fields in Syria is proving to be an insurmountable feat for the limited technical capabilities of Daesh.⁹⁹

This is heightened even more by the effects of air strikes by the coalition, along with Russian intervention in the Syrian theatre and the fall of prices in the international marketplace, a combination of factors that could completely alter the currently existing energy equation. Although it was Daesh itself who was up to some months ago controlling the entire production chain, from production through to refining and transport to the border, the air strikes have made this a much more dangerous business now, meaning that it has had to be subcontracted with the subsequent cost increase.¹⁰⁰

We could therefore conclude that even if the different players acting against Daesh were to respect the energy facilities, which is not the case, the Syrian oil fields are practically exhausted, whereas the Iraqi ones are seriously damaged. Both sets of facilities are in serious need of major technological investments by international investors to ensure continuation of operations, something that Daesh is incapable of bringing in. Under these circumstances, the forecast in the most favorable case will be a decrease in production resulting from obsolescence and damage to the infrastructure, and in the worst case scenario, the destruction of facilities as a result of attacks. In both cases the outcome will be similar and will lead to a major depletion in production. Summarizing, in any of the above scenarios, as long as Daesh needs oil for its own operations, it will have less to sell in the marketplace.

In the case of Libya the situation is different, and even more concerning. The consequences of the combined effect of the power struggle for the control of the energy sector between the two governments, and the Jihadist attacks on the facilities with the aim of destroying them, is threatening to convert Libya in not only a political and military disaster, but also an economic and humanitarian one. The main cause for this, as explained in this paper, is the damage caused to the energy infrastructure in a country that is completely dependent on hydrocarbons. This damage, which has been especially important since December 2014, when fighting between both government forces started for the Ras Lanuf and Sidra refineries in the Gulf of Sidra, their export capacity of 500,000 barrels a day being interrupted since then.¹⁰¹ The party that has most benefited from this is Daesh, an opportunistic group which has realized that the most important factions are more interested in fighting each other than fighting it, which means it has been able to expand through the centre of Libya finding very little resistance.

⁹⁹ MYERS JAFFE, Amy. "Commentary: ISIS victories and oil", Fuelfix (ARAMCO) May 25, 2015, <http://fuelfix.com/blog/2015/05/25/isis-victories-and-oil/>.

¹⁰⁰ MOURANZA, Andrés, op.cit.

¹⁰¹ MYERS JAFFE, Amy, op.cit.

With production having fallen to less than 300,000 barrels a day, a drastic fall if we compare it to the 1.6 million barrels that were being produced at the end of 2010,¹⁰² the country is in serious risk of going into bankruptcy. This means that since February 2015 production by the national company NOC has fallen by 80% and it is very likely for it to stop completely should fighting continue.

If we add to this the heavy slump in oil prices in the international marketplace, the result is that revenue from hydrocarbons barely reaches 10% of the estimated forecasts for 2015.¹⁰³ The major question mark Libya has to deal with is how to cover the State's basic costs, in a country where 80% of the population are public employees. With income having been reduced to 14,000 million dollars compared to 68,500 million dollars in 2012, Libya drastically needs over 30,000 million dollars every year to cover its basic imports, 80% of which is food in a country where food production is in tremendous shortage.¹⁰⁴ The rest is used to pay public employees, including over 200 militias currently existing in the country which is an additional cost of 35,000 million dollars.

Libya's problem is that it lacks nowadays any other source of wealth that could supplement the fall in production and price of oil, and its only alternative is therefore to resort to the currency reserves to cover its huge deficit. Until 2015 the depleting reserves were still following an acceptable trend having fallen from 110,000 million dollars in 2011 to 93,000 million dollars in 2014, even with an occasional increase in 2012 when fighting was less intense.¹⁰⁵ But since 2014 the fall is being much greater, and therefore with the current rhythm in which most of the imports and state functions are financed by reserves, it is very likely that in less than a year Libya will have no reserves left.

Still more concerning is the fact that, should Libya manage to suitably settle its political differences and end the threat by Jihadist groups, the damage to the infrastructures has been done and it will be difficult to repair it in the short-term. The estimates for reconstruction of these infrastructures are in the range of 200,000 to 480,000 million dollars over a 10-year period.¹⁰⁶ This is an amount that Libya will find very hard to secure unless there is a huge external finance effort. But even in the event of this taking place, the escalating violence will have to end first, which again will be very difficult in the short-term. The truth of the matter is that overconfidence in hydrocarbons as the basis for the national economy has made Libya extremely vulnerable to any political alterations. In this sense, action by the Jihadist groups together with internal political antago-

¹⁰² GAUB, Florence and Luengo-Cabrera, José: "Libya: crude implosion", European Union Institute for Security Studies, February 2015, http://www.iss.europa.eu/uploads/media/Alert_14_Libya_oil.pdf.

¹⁰³ *Ibidem*.

¹⁰⁴ *Ibidem*.

¹⁰⁵ "Total reserves (including gold, \$US at current prices)", World Bank, 2015, <http://datos.bancomundial.org/indicador/FI.RES.TOTL.CD>.

¹⁰⁶ GAUB, Florence y LUENGO-CABRERA, José, *op.cit*.

nism have meant that petroleum today instead of being a blessing on the country, could be its downfall.

As a general conclusion it could be said that Daesh's experience in managing oil shows an increasingly concerning perspective for the energy infrastructure and for the sector as a whole in Syria, Iraq and Libya. Daesh's oil strategy is a serious threat, not only for the impact of the military action on facilities, but also because of the technical ineptitude that the terrorist organization has proven in the places where it has taken control of the resources.

The biggest danger is that in the end Daesh will reach the conclusion that controlling energy resources will not provide the economic advantage they expected, which appears to be happening in Libya, and then realizing that it will be more to their advantage to attack and destroy the oil facilities in order to deny access to revenue from hydrocarbons by their enemies. Consequently, unless this jihadist group is finally stopped, more oil facilities will be damaged, reducing the amount of hydrocarbons that can be produced in all the Middle East and North Africa. If this happens an even higher economic cost will be added to the worst human tragedy this group of extremists has already caused. It is hard to believe that at a time when no country appears to be prepared to "get its soldiers boots on the ground", destruction of energy resources in an entire geo.

Chapter IV

Oil Prices and World Geopolitics

Raúl Cardoso Maycotte

Abstract

Throughout its already long history, the oil market has always been an influential factor on World Geopolitics. The importance of this product as a catalyst for the development of countries has been a benchmark for changes in the dynamics of political decisions of producers and consumers alike. Its use in the transportation and in industry sectors has established its historically starting point. But let us take a look at more recent history and analyze its impact.

OPEC was created over 50 years ago in response to a Geopolitical issue by some oil producing countries, against the irrational and controlling position exerted by the companies known as the “Seven Sisters”.

If we go back to those historical dates, we would have to make reference to the initiative of certain producing countries such as Venezuela, Iran, Iraq and Saudi Arabia who decided to join forces to counteract on the dominant and imbalanced policies exerted by the oil companies in their countries.

From that moment on, OPEC has played a major role, not only in balancing the offer in the oil market, but also in the struggle for power, mainly between the countries in the Middle East area.

The countries outside the axis of the Middle East and Africa have been far away from the relevant decisions by the Organization (Indonesia, Venezuela and Ecuador) and only in specific cases have they managed to agree and fight for their own interest and regional policies.

OPEC has undergone several significant political episodes throughout its history. For example OPEC's reaction as an organization during the Yom Kippur War, when it decided to block oil exports to the allies of Israel, i.e. the United States and the Netherlands, leading neutral countries such as Norway and Mexico to provide their support to Israel and causing the most spectacular increase of oil prices and the first Oil Crisis, of 1973, whose effects on the world's economy were felt through to the early eighties. Another moment of high impact was the kidnapping and slaughter of some Algerian Ministers in 1975, by the infamous Venezuelan terrorist "Jackal".

During the long war between two OPEC members, Iran and Iraq, the Organization also played a determining role. The war led the countries to establish the quota policy based on their production capacities. This system, which is still valid today but not enforced, has been progressively adjusted in accordance with the evolution of prices and political or capacity problems of its members. This policy was abandoned by the members last year, but it could be reinstated in a more flexible manner.

The war itself provoked that countries such as Saudi Arabia and its traditional allies in the Gulf supported the policy by dictator Hussein, financing the war against Iran over many years. This strategy was abandoned when Saddam Hussein began his expansion process in the region, rejecting Saudi guidance.

Nevertheless, it was after the price crisis of the eighties when OPEC sought dialogue and fostering of other independent producers such as Russia, Norway, Oman and Mexico. But this fostering strategy has only worked relatively well in very specific moments. Today, nearly members today reject the idea of reaching a common agreement because of the dissimilar agendas and strategies they each pursue.

Negotiations by the United States and its European partners concerning Iran could lead to sanctions being lifted and the possibilities of growth where the offer would be relative to the level of investment; but it is a country that has important oil reserves that will affect the balance within OPEC and therefore force its members to once again negotiate the necessary space so that countries with capacity can return to the market. We have to remember that before the war Iran was producing 4 million barrels per day, whereas its capacity today is only 2.3 million, i.e. almost half of what it was.

Saudi Arabia is the country which has undoubtedly benefited the most from the lack of control and disappearance of several countries from the region such as Iraq, Iran, Libya, Nigeria, etc., leading to enormous profits for the main producer within the Organization.

The Saudi Kingdom's current strategy of volume for price has been delayed by the appearance of Russia's offer, other capital-intensive projects and fracking by USA. Nevertheless, Saudi Arabia does not want to take up its role as a swing producer again, to the benefit of its hardly compliant partners and remaining non-OPEC producers.

Keywords

Oil prices, OPEC, geoeconomics.

The 2014-2015 fall in the Oil Prices

The present decrease of the international oil quotations is primarily a result of Saudi Arabia's strategy, consisting in putting downward pressure on oil prices with an aim to reduce the high cost production. This means: Saudi Arabia and OPEC have concluded that it is necessary to apply cuts to the international crude oil production, but this time the sacrifice will have to be carried out by the non-OPEC countries.

Analysis of the current international oil market

This is not the first time that the oil industry faces relatively low crude oil prices. Nor is it the first time that one of the main causes of price slumps is caused by a surplus in the offer. But it is the first time that the reduction of international oil prices, although not entirely caused, it has undoubtedly been emphasized, maintained and imposed deliberately and consciously by the Organisation of Petroleum Exporting Countries, the famous OPEC. The fact that the guardian cartel of international oil prices self-inflicts such a punishment of this nature upon itself sounds rather contradictory. But with a proven reserve ratio for production for over sixty years, Saudi Arabia, the member that calls the tune in OPEC, is implementing a medium to long-term conservation strategy at the expense of the immediate term.

In the mid-eighties the OPEC agreed to cut down on production. Saudi Arabia did so from a total hydrocarbon production of more than 10 million barrels per day (mbd) in 1981 to 3.6 kbd in 1985. The other OPEC members did not follow the Saudi example. Failing to comply with the agreements led Saudi Arabia to decide to flood the market increasing its total production to over 5 mbd, with the subsequent chaos in international oil prices in 1986. Today the situation is different. At the official meeting in November 2014, OPEC agreed to maintain its current level of production to discourage non-conventional high-cost production, whilst at the same time being successful in sustaining or increasing the market share by the organisation's members and in turn supporting demand with relatively low prices. Extra officially, a Saudi conspiracy plan was argued to affect Iran, and via knock-on effect Russia too, both allies of al-Assad, but this hypothesis was catalogued as a simple conspiracy theory.

It is true that higher production by non-OPEC countries has been taking some of the organisation's market share away. The clearest example of this is the high-cost conventional and non-conventional production. The latter has particularly increased in the USA. This new production method has caused a major and constant reduction in exports of crude oil from some OPEC member countries. Crude oil imports in the United States have dropped by 30% compared to 2005, when the highest level in history was reported at over ten million barrels per day. During the same period, the reduction in imports from OPEC was of nearly 40%, with some of its members such as Algeria, Libya and Nigeria having prac-

tically stopped exporting their raw material to the USA. The elimination of 3 mbd in imports has caused a fierce price war to open up or secure places in the alternative markets: Europe and Asia.

Having applied a production reduction policy to boost prices, would have simply postponed the principal problem for OPEC. On the one hand, higher prices produce greater competition from high-cost production, and on the other, it affects world demand. In this scenario, and in spite of the fall in price levels, in November 2014 OPEC decided not to change its production level. OPEC correctly concluded on the excess offer on the market and the need to balance it out. Nevertheless, on this occasion the conventional response of reducing production to re-establish market balance was not considered to be suitable, particularly by Saudi Arabia, and as a result OPEC is now in a phase of price discovery. Without reducing the offer in the equation, the organisation is allowing equilibrium to be re-established at a balanced price level that will restore stability to the international marketplace; however it may take longer than the members of OPEC wish for.

The diagnosis elaborated by Saudi Arabia is correct. This cycle of offer surplus is different from the ones which occurring in the eighties and nineties. On this occasion the macro-economic expansion policies, particularly in the United States and Europe, to help the economies recover from the 2008-2009 recession, by means among other measures, of keeping interest rates very low for prolonged periods, have meant cheaper financing for many new companies in the hydrocarbon industry, which, under other circumstances, would not have been created. This is the case of many exploration and production companies in the United States that not only secured cheap financing for incorporation and start-up of costly operations, particularly in non-conventional wells such as shale, levered by the illusion of high oil prices, but rather prolonged their agony and eventual closure. According to data published by Standard & Poor's, around 16 oil production companies in the USA have been unable to repay their debts. The group of US shale producers in the United States is very diverse, since in spite of slumps in oil prices, they are still able to operate within good margins. There are producers who manage to produce and reinvest to replace reserves at only 20 usd/bl, while others require prices in excess of 70 usd/bl, with an average of 50 usd/bl, meaning that at the current international price level, over half of the producers in this kind of oil fields are losing money.

Regardless of the accurate, cautious outlook by Saudi Arabia, high dependence of income from oil exports means that not all the orchestra is in tune with the conductor. The group of so-called OPEC "hawks", namely Venezuela, Iran and Algeria, are usually more aggressive with their price objectives, and consequently seek agreements within the organisation to reduce production. The "hawks" request prices over 100 dollars per barrel (usd/bl) in order to balance their budgets.

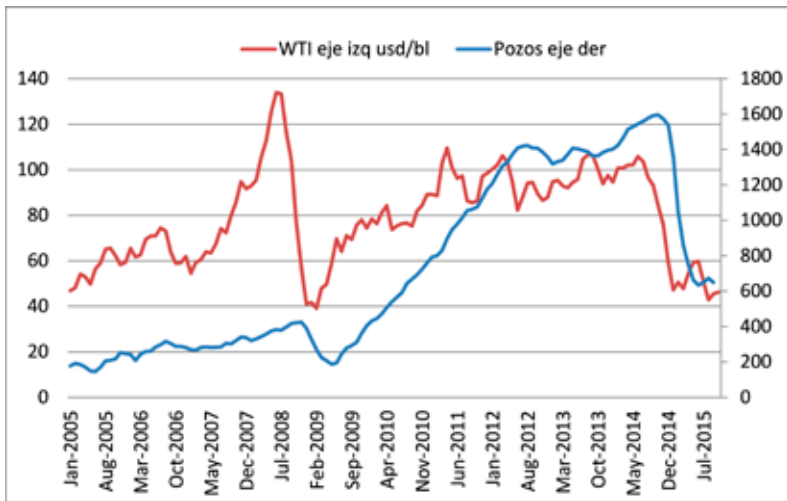
The most recent data suggest that OPEC crude oil production is higher than the levels recorded for 2008 when in that summer the Brent international market price reached an all time high of almost 150 usd/bl. From then on, prices plummeted to less than 40 usd/bl in January 2009. With such slump in prices at that time, OPEC decided to reduce production, lowering it for 2009 by slightly over 2 mbd compared to the previous year's level. From 2014 to date, OPEC production has not only been maintained, but has increased to around 32 mbd. In other words, today's production is at around 700 thousand barrels per day (kbd) above the high level recorded for 2008 that brought about the free-fall in prices and approximately 2 mbd above the OPEC demand, or what is considered the international demand for crude oil produced by members of the organisation. As a result the marketplace is flooded with oil. The world's crude oil and derivatives inventories are practically at total capacity and the prices of this raw material, with some peaks and troughs, remain at around 60 usd/bl below the levels reached in summer 2014.

One year after the decision in November was made, though slower than initially estimated, the sacrifice has barely started to show figures that could indicate that the most ambitious objective by Saudi Arabia is being achieved, namely discouraging high-cost production, such as non-conventional production of shale oil, particularly in the United States.

Recent data published by the US Department of Energy (DOE) show the first signs of reductions in production in North Dakota, where shale crude oil production is located in the Bakken fields, and in Texas where shale oil is also produced in the Eagle Ford fields. Stemming from major increases in productivity, just in April 2015 the United States managed to produce over 9.6 kbd of crude oil, the highest level achieved since the seventies. Data by the DOE for August indicate a 3% reduction in production compared to April. The North Dakota producers have moderately reduced production compared to the high of last November with 1.23 kbd, and the fields in Texas have reduced production by 5% compared to the all time maximum in March 2015 of 3.6 kbd. Although the DOE data is too recent to indicate that there is a permanent fall in production, the reduction in the number of oil wells in the country is an indicator of the downward trend of shale oil production in North America, but thanks to the benefits in efficiency, knowledge about the fields and technology, the reduction is and will be less than what the OPEC wishes.

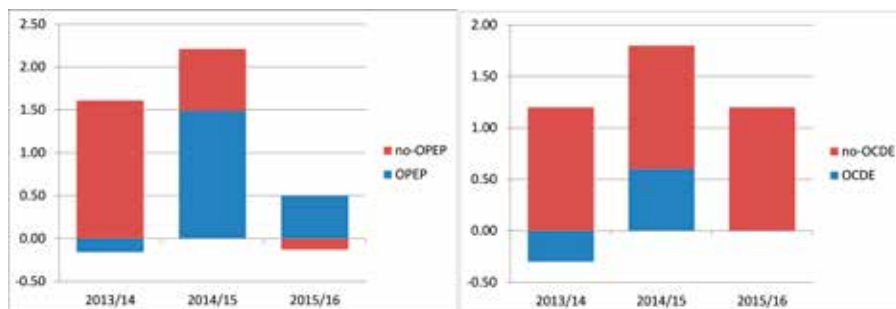
The DOE reported an abrupt reduction in the number of crude oil wells in the United States, from an all time record of 1,596 wells in October 2014 to only 650 in September 2015, approximately the same number of wells there were in 2010. Production levels have not dropped at the same rate as the number of wells, mainly because both the technological and economic resources have been concentrated on the so-called *Sweet Spots*, or the wells with easiest production, and also through improved efficiency of wells that are producing an increasing amount of crude oil. In spite of the higher efficiency achieved per well and the rate of decline of the Eagle Ford, Niobrara and Bakken wells went from

70% to 50% in the first two years. This means that IN ORDER to maintain the growing production trend, operators must drill new wells to set off the rapid, abrupt decline. By drilling fewer wells, stopping this decline is increasingly more difficult and costly. The data published by the DOE appear to indicate that the US's non-conventional production is effectively beginning to be reduced, more slowly though than Saudi Arabia and the other members of the organisation expected. Graph 1 shows the effect of the most recent reduction in crude oil price marker West Texas Intermediate (WTI) in the number of oil wells operating in the United States.



Graph 1: WTI Prices and Number of Oil Wells Operating in the USA. Source: EIA DoE.

The efforts by the world's biggest crude oil exporter to discourage non-conventional or high-cost production is achieving its goal. For 2015 the DOE estimates total crude oil production of 9.29 kbd and 8.77 kbd for 2016. Major conventional projects such as in Canada or Brazil have been suspended or postponed, as have some exploration plans in the North Sea and in the Arctic. OPEC data reveals that non-OPEC production has changed from growing at a rate of over 1.5 kbd between 2013 and 2014 to being reduced in 2016 (Graph 2, left). Hence, OPEC's market share is expected to increase from 34.7 percent of the total offer, to over 36% in 2016. OPEC's strategy, whilst achieving a reduction in the costly non-OPEC offer, is also stimulating the growth for demand. According to the figures released by the International Energy Agency, it will grow by 1.8 kbd in 2015, the highest increase in five years, and even the OECD demand increased after nearly ten years of stagnation. For 2016 the Agency estimates an additional increase in demand of 1.2 kbd (Graph 2, right).



Graph 2: Annual growth of the OPEC World Crude Oil Offer and Non-OPEC (left) and Annual World Demand Growth for OECD and non-OECD Oil. Data expressed on million barrels per day. (GRAPH 2) Source: OPEC for offer data and EIA for demand data.

But while the reduction in more costly non-OPEC production is consolidated, the price OPEC is paying for it is absolutely staggering. At the low international crude oil prices, with OPEC's basket standing at less than 45 usd/bl in August, not one single member country of the OPEC is able to cover its budget requirements without biting into its international reserves. In spite of exports having increased by approximately 2 mbd, OPEC is receiving less than one thousand million dollars for oil exports, the lowest level since 2010, and nearly two thousand million dollars less than last year. Thanks to its increase in exports, Saudi Arabia has managed to reduce losses and positions itself as the member with the best revenue, whereas countries like Iran, because of export restrictions due to international sanctions, are receiving less revenue than in 2005.

Despite holding the best position within the Organisation, it is estimated that Saudi Arabia's budget deficit could fall to 20% GDP, which would be the first time it has a deficit in over a decade. The reserves of its central bank have been reduced by 10%, equivalent to 70 thousand million dollars compared to last year. Devaluation of the Riyal or the rest of the currencies of the OPEC member states cannot be ruled out. Saudi Arabia's GDP has multiplied fivefold since the 1998 crisis, with a heavy load of profits being generated in the years of bonanza which are very expensive to maintain. Subsidised gasoline, water and electricity, and no income tax payments, added to excessive salaries, high bonuses, among many other expensive privileges. The Saudi government, the most important provider of employment in the country, cannot maintain this level of costs if low oil export prices are maintained much longer. The work on infrastructures and public spending have helped maintain the country's economic growth in recent years, but it is not certain that Saudi Arabia will be able to keep up this level of spending after nearly a year of falling prices, especially with the increased social costs brought on by the Arab Spring. Consequently, tax pressure is on the increase, with an estimated tax deficit of over 14% the GDP in 2015.

Nevertheless, and in comparison to what can be seen in the Euro zone, we cannot confirm That Saudi Arabia is in a crisis situation, or that there will be a recession in the short-term. For the moment, Saudi Arabia has reported nearly

650 thousand million dollars in net foreign assets, and very low government debt, below 2% of the country's GDP. Although it is difficult to cut subsidies, Saudi Arabia has plenty of areas where it can cut costs. One litre of gasoline in Saudi Arabia costs 15 USD cents, whereas light oil is sold at double the price on the international market.

The cost that seems the hardest to touch at this time is the military cost, which has tripled since 2005, amounting to \$81 thousand million in 2014. Attacks to Shiite rebels in Yemen are led by Saudi Arabia and no radical change to the strategy is expected. Moreover, Saudi's finances support greater use of the long-term stock market. In spite of Fitch reducing Saudi Arabia's rating from stable to negative, the country is still rated AA- by Standard & Poor's.

Saudi Arabia is still in a good macro-economic situation. We should not lose sight of the fact that Saudi Arabia has 16% of the world's proven oil reserves, contributes 13% to world production and nearly 15% of total oil exports at global level. Saudi Arabia has a margin for manoeuvring, to adjust public spending amounting to a quarter of its GDP, for example the privatisation of a number of ports and airports would help to reduce the pressure. Saudi Arabia also has a very low level of debt, and has sovereign funds, reserves and sufficient credit rating. In 2015 the Central Saudi Bank will place bonds to raise around \$25 thousand million. Not many countries in the world today can boast such a good position in the international capital marketplace, as Saudi Arabia can, but under the current level of oil prices and at the forecasts for coming years, these reserves are rapidly depleting. The Monetary Fund drew attention to the fact that by covering its current expenses the Kingdom would exhaust its funds in less than five years.

The economic and financial situation of Algeria, Iraq, Libya, Nigeria and Venezuela are a far cry from that of Saudi Arabia. The recent reduction in the oil prices has worsened Venezuela's problems. The shortage of basic products resulting from the fall of imports started in 2013. Barclays Capital highlighted that only an international price of oil over 40 dollars per barrel, establishing a macro-economic adjustment plan and counting with Chinese financing, would save Venezuela from imminent default. However, if the barrel price is below that figure, the bank estimates default on foreign debt payment by around the middle of 2016. Eurasia Group modified its forecast on Venezuela to a 60% probability of default on debt payment by the second half of 2016. Between August and December, when the parliamentary elections are held in 2015, payment matured on debt amounting to 6,300 million dollars, and in 2016 Venezuela will have to pay \$12.500 plus an additional \$ 5,000 million to China for loan repayment. The resulting amounts are unaffordable with the current price of Venezuelan oil barrel having fallen below 40 dollars, in a nation whose oil exports account for 96% of the total income from exports.

The government of Muhammad Buhari, the newly elected President of Nigeria, main oil producer in Africa, is facing 8% devaluation of the Naira, and over 9%

inflation. It is estimated that Nigeria could devalue its currency by 20% as oil reserves run out. Libya and Algeria have reported deficits in their current accounts since 2014, which will continue through this year and next year. Moreover, both countries are on the verge of political chaos. In Libya a quarter of the country's population is on the public payroll, and salaries have increased by 250% since the revolution in 2011. Oil production in Libya now stands at a fifth of what it was before the crisis (1.6 kbd). In the light of falling prices, if an increase in oil production is not visible on the horizon, the Government will find itself in a very tight situation to meet its obligations. The rival parliament, with headquarters in Tripoli, announced that it was considering lifting subsidies on fuel, which amount to 20% of the GDP, a measure that would help to close some of the increasing gaps between public costs and income.

Algeria has called the twelve members of the organisation to hold an extraordinary meeting before the meeting scheduled for December. Venezuela and Ecuador have joined the initiative by Algeria, whose income from oil exports account for over 60% of the total. Amid the decline in international prices, Venezuela and Algeria are pressing OPEC to take action. Venezuela is in close talks with Russia, the biggest exporter of oil outside the Organisation, seeking initiatives to stabilise the market and its oil and gas dependent economy. The International Monetary Fund estimates that Russia's GDP will shrink 3.8% in 2015.

Nevertheless, in September 2015 Russia openly stated that it would not be putting its shoulder behind OPEC. To quote the words of Igor Sechin, CEO of Rosneft and close ally of Vladimir Putin, he said that the "golden years" of OPEC were a thing of the past and that the "Organisation cannot even manage its internal quotas, and if they could, then the market would be balanced". In this sense, Sechin also stated that the petroleum industry in Russia is largely private owned, which does not permit hydrocarbon administration in the same way as in countries belonging to OPEC. If this were not enough, Mexico joined the negative to cooperating with OPEC as it did in 1998-1999. On this occasion, freeing up the Mexican energy sector and falling production were the principal reasons why Mexico refused to join a possible joint effort between OPEC and non-OPEC.

Analysis of the Principal Geopolitical Problems in the middle east and their influence of the behaviour of Oil Prices

The aggressive opening of Iran's industry, attempting to stimulate the return of the major European oil companies, represents, under a low price scenario, an excellent opportunity for firms that seek to optimize their resources in areas of lower costs and higher productivity. Both the production companies and the European refineries, particularly those located in the Mediterranean, are quite familiar with Iran's geology and oil type. The sanctions however have been lifted in a very sensitive moment for the Middle East power balance. To the ancestral rivalry between shiites and sunnies, we must add Israel's serious concern for

the United States and Iran rapprochement and for the appearance of brutal terrorist groups such as ISIS.

After 20 months of negotiations an historical Agreement was reached to bring a halt to Iran's nuclear programme. The United Nations Security Council (UNSC) endorsed the Agreement reached between Iran and the world's main powers about its nuclear programme. This gave started the process to lift the sanctions that were in place. In a unanimous resolution, the organisation composed of 15 members approved the Agreement and requested full compliance with the deadline established therein. It is expected that the Agreement, known as Joint Comprehensive Plan of Action (JCPOA), signed on 14th July 2015 by Iran and P5+1 comprising the United Kingdom, China, France, Russia and the United States plus Germany, will lead to the elimination of sanctions against Iran. The resolution states that the UNSC will suspend its sanctions against Iran after receiving a report by the International Atomic Energy Agency verifying compliance with the nuclear commitments established in the JCPOA.

It is thought that Iran is likely to comply with the Agreement as it has too many reasons to do so. It is calculated that the sanctions have cost the country nearly 20% of its GDP since 2010. Once the sanctions have been lifted, it is believed that Tehran will inject between 500 kbd and 1 mbd of oil during the following 6 to 12 months in a market where there is already an offer surplus. In 1974, before the Revolution, the Persian nation reached a production level of 6 mbd. Bearing in mind that Iran has the fourth biggest oil reserve in the world, 158,000 million barrels, and the biggest reserves of natural gas on the planet with 34 trillion cubic metres, its potential as an energy supplier is huge. However, the hydrocarbon infrastructure in Iran is technologically behind and requires major investments to revitalise it and improve current production, standing at around 3.6 kbd of liquid products. Even if the investment is driven by major multinationals, it will perhaps take decades to construct the necessary infrastructure to cope with the country's energy supply potential.

The Gulf countries will swing between the two heavyweights in the region, to take positions in order to exploit Iran's economic reopening to the maximum. The Emirates will be able to especially benefit from Iran's return to the world economy. There are companies in Dubai that have for some time been doing business with Tehran and will be the ones in the best position to respond to the growing demand for goods and services by the Iranians. The fact that there has been a lot of ethnic migration to the UAE from Iran will also help. Turkey is in a similar situation, and it will also capitalise on Iran's return to the geopolitical game board.

European energy ministers and industry leaders have opened up a dialogue with Iran intended to re-establish the trade and the investments after the sanctions are lifted. Iran's Minister of Petroleum, Bija Zanganeh, has received government envoys from Austria, Germany, Italy, United Kingdom, France and Spain, and from major private corporations such as Shell, ENI and Total. The Spanish del-

egation consisted of the Foreign Affairs Minister, Jose Manuel García-Margallo, the Public Works Minister, Ana Pastor and the Energy and Tourism Minister, Jose Manuel Soria. In the presence of Iran's Vice-President, H.E. Soltanifar, Margallo said "The best is yet to come. We have proved we are trustworthy, and we are looking forward to working together".

The first proof of this political and business closeness was the announcement made by the Spanish Minister of Public Works. Even though in the wording of the Nuclear Agreement the sanctions would remain in force until December, Spain and Iran are negotiating an agreement to establish direct flights for passengers and goods between Tehran, Madrid and Barcelona, on a basis of two flights per week. "We have agreed to pave the way to signing a new transport agreement. We are going to sign the agreement within the shortest possible timeframe", said the Minister.

With regard to hydrocarbons, the meetings centred on re-establishing exports, a key issue for Repsol and Cepsa who in 2010 imported more than 150 kbd of Iranian crude oil, or 15% of the total imported that year, but as a result of the sanctions, imports were suspended as of June 2012. Zanganeh said that Spain is not only interested in reactivating crude oil imports, but also in taking part in the development of oil and gas fields, refining and petro-chemicals. Although Iran is still behind in its Liquefied Natural Gas (LNG) projects, a future supply from Iran to Spain was discussed. With regard to gas projects, it must be remembered that Repsol was a partner in the Joint Venture with Shell and National Iranian Oil Co. for production of 14 million tonnes of LNG per year from South Pars. This project is almost certainly on the long list of activities to be rekindled between both nations, as is tourism, transport and energy.

In addition to supporting al-Assad in Syria, Hezbollah in Lebanon and the revolution in Yemen, fought militarily by Saudi Arabia since March 2015, Iran will continue to finance the Shiite militias who are currently fighting against the Islamic State (IS). On several occasions Washington has stated that beating that group is a priority objective in the region, but while the United States refuses to send troops to fight in another conflict of dubious duration in the region, it will have to take advantage of Iran's support, even if Saudi Arabia does not like it.

Iran has historically defended Shiite communities in the Middle East, unlike the great Sunni kingdoms driven by the Gulf countries and headed up by Saudi Arabia. Moreover, the Saudi Arabian government accused Iran of promoting and financing Shiite dissidence within its own territory. The Persian country also supports objectors in Bahrain who oppose the Sunni dynasty in power, supported by Saudi Arabia, and the Palestinian Islamic groups Hamas and Islamic Jihad.

Rivalry between Persians and Arabs is historic. And since the Islamic Revolution of 1979, the United States has been on the side of the Saudis. But after the nuclear agreements, the balance is no longer so heavily in favour of the Saudis. Saudi Arabia, as the principal oil producer in the region, will be directly affected if Iran reaches business agreements with the West, and will not take it well if

its principal ally in the West “befriends” its enemy to take potential investments away from them.

Saudi Arabia is not Iran’s only historical enemy in the region. Nor is it the United States’ only ally. Israel has clearly stated that it is not in favour of international understanding with Iran. The Israeli Prime Minister, Benjamin Netanyahu has voiced his deep concern over this agreement that he labelled as an “historical error”.

Impact of Iran’s return to the market and geopolitical implications: USA, Israel, Saudi Arabia, Syria and Iraq

Consequential to the financial pressure suffered by their highly oil-dependent economies and after one full year of low prices, OPEC’s meeting of December 4th, 2015, went by in an environment of animosity among its members, the imminent return of Iran’s production to the already oversaturated oil market not being a good omen for the 2016 quotations.

Animosity aside, business is business. Sooner or later Saudi Arabia and Iran will have to sit down to negotiate. At the end of the day it will be a political decision, but it carries enormous economical weight. To a greater or lesser extent, economic contraction is applying pressure to all OPEC countries. Part of the equation for the slump in international oil prices is the low growth in demand, particularly in China, the second oil consumer in the world with over 11 mbd forecast by the DOE for this year, but which was recently reporting reductions in its crude oil imports (11% in one year), to 5.5 kbd, the lowest level since February 2014 and after an all time high of 7.4 kbd in April. The concern about stock falls in China is that reduced economic growth in the country could cause a domino effect in the rest of the Asian markets and eventually reach the still fragile European and US economies.

Despite all the above, the likelihood that the demand by the World’s second consumer of crude oil will plummet is low, since domestic production is expected to be around 4.65 kbd in the coming years, which will require its import levels, even though they could grow more slowly, to remain fairly stable to supply the domestic market. According to the DOE, in spite of the reduction in economic growth, China will continue to be the biggest growth driver for the world demand, with expected growing of 1.3 kbd in 2016, of which around 300 kbd will be sourced in China.

OPEC can only indirectly influence demand. But OPEC can exercise direct influence on the other side of the equation. The surplus in the world’s offer of hydrocarbons will raise, once Iran rejoins the market in 2016. According to statements by Iran’s Minister of Petroleum, Bijan Zanganeh, the country could increase its offer by 500 kbd as soon as the sanctions are lifted, and increase it by a further 500 kbd just a few months later. Philip Hammond, the UK’s Foreign Affairs Min-

ister, estimates that the restrictions on oil exports imposed on Iran in 2012 could be lifted during the second quarter of 2016.

Saudi Arabia must assess how to fit in the additional barrels from Iran in a market that already has an offer surplus and a demand that is not growing excessively. The oil price forecasts for next year are not at all promising. The days of bonanza with prices over 80 usd/bl are on a distant horizon, at least two years away. The problem of the offer surplus would not be eradicated just by reducing high-cost, non-OPEC production. Although Libya is very unstable at the moment, it will be able to increase production rapidly by up to an additional 300 kbd. Iraq is currently producing levels that have not been seen since the Iranian Revolution, with around 4 mbd, and could increase its capacity in 2016 by another 300 kbd. Owing to its war situation, Iraq has been exempt from cutting production or keeping to a production quota within the OPEC. With a demand for OPEC's crude oil, estimated by the Organisation itself and by the International Energy Agency (IEA) of around 30 mbd, today there is an excess in the offer of almost two million barrels a day which is being stockpiled at onshore terminals, and also in tankers used as floating stores, estimated at around 60 mbbls, according to statements by the Iranian Minister of Petroleum, Bijan Namdar Zanganeh.

If the oil barrels from Iran, and some also from Libya and Iraq, actually materialised, the offer surplus in 2016 could add an extra million barrels per day. Consequently, the offer surplus would accumulate nearly three million barrels per day, despite the fact that the demand for OPEC oil estimated by the IEA for that year could grow by around one million barrels per day. The international trade storage capacity is currently calculated to be 80% full. Next year the trade storage capacity could be strongly compromised, which would leave oil cargoes floating around with an urgent need to place them in order to avoid excessive freight costs. Refineries will know how to make the most of these opportunities to buy their raw material at the cheapest possible price.

At this point some possible scenarios can be drawn up in an attempt to foresee what decisions Saudi Arabia will possibly take. On the one hand, the Saudis may not agree on cuts to accommodate the eventual higher production by Iran and company. Consequently the prices are almost certain to remain below 50 usd/bl for the first half of next year. Low price levels would entail some demand gains, as can be seen on the US highways where there is an increasing number of large vehicles adding to the demand for gasoline. It is also true that some exploration and production projects will no longer be profitable, particularly those in ultra-deep waters, the Arctic and oil sands; but it is no less true that improved efficiency by shale oil producers has managed to keep production levels high, given the number of wells that have been closed or projects that have been cancelled.

If, on the other hand, Saudi Arabia decides to make room for the other members of the organisation and reduce production by around one million barrels per day, to 9.5 kbd, but with the expectation of prices recovering to say 70 usd/bl, then

the Organisation's earnings would increase. Saudi Arabia would simply earn an additional \$250 million per day producing 9.5 kbd at 70 usd/bl than by producing 10.5 kbd at 40 usd/bl.

As has been done in the past with satisfactory success, although temporarily, in order to give a certain amount of consistency to the market, in terms of objectivity and automaticity, OPEC could decide to implement a flexible quota system whereby production increases if the price exceeds a certain ceiling for more than a given period of time, for example 80 usd/bl, and vice versa if the price falls below say 50 usd/bl. An automatic quota system is difficult to verify in real time, but a signal is sent to the market that, in spite of political differences, the organisation is acting in good synchrony, cooperating with the aim of discouraging non-OPEC high-cost projects, whilst supporting the demand for hydrocarbons at a reasonable price for producers.

Regardless of the scenarios we have put forward here, Saudi Arabia will be the key player in the events that will take place in the international oil market. From its total exports of around 8 mbd, the Kingdom exports an average of 4.4 kbd of crude oil to its seven main trade partners in Asia, whose imports amount to 19 mbd. Saudi Arabia supplies 16% of China's imports, 33% of Japan's, South Korea's and Taiwan's, 20% of India's and nearly 20% of Thailand and Singapore's. Asia is the natural market for Saudi Arabia, and it will strive to protect it from the bigger offer by Russia, and eventually the offer by Iran, perhaps at the cost of permitting prices to continue their downward trend for some years. The fight to maintain or open markets is so intense that Saudi Arabia has recently managed to export oil to Poland, which is almost 100% Russian territory.

Unfortunately, the extremely complex problems in the Middle East will not ultimately lead to high oil prices. Unlike what happens within the OPEC, where Saudi Arabia is the clear leader, in the conflictive Middle East there is no longer a dominating regional power. A very dangerous power vacuum has come about in the Middle East.

Although the United States is not going to fully withdraw its Armed Forces, it is no longer so willing to indiscriminately increase its military presence in the region. More so after the terrible background of years of military and economic intervention in Iraq and in Afghanistan. Apart from some well-calculated military action, coordinated with other countries like the strategic air strikes against the Islamic State in Iraq and Syria, the United States will seek to exhaust diplomatic channels to resolve, or at least contain, a fundamental strategic threat, as is the case of the nuclear threat in Iran and in spite of the fact that back home, the Republican wing fully disapproved the agreement.

Iran and Saudi Arabia are the first countries on the list to fill in the power vacuum. The armed conflicts in Lebanon, Iraq, Syria and Yemen are a true geopolitical reflection of the struggle for regional supremacy. It is very difficult to imagine an atmosphere of open dialogue and understanding within OPEC, the strong differences between Shiite and Sunni Muslims is the irreconcilable basis

of their fierce rivalry that has continued through wars and unsuccessful international intervention. The international threat of terrorism by extremist groups that both countries support has become a crucial strategy on the international agenda.

Iran, without nuclear weapons, is less assertive in the fight for regional supremacy. In this sense, international diplomacy has helped a giant step forward to be taken in placating geopolitics in the region. But a more economically solid Iran is not to the liking of Saudi Arabia or Israel.

Immediately after the historical nuclear agreement with Iran, signed on 14th July 2015, the US Defence Secretary, Ashton Carter, held a meeting in Jeddah with King Salman and his son, Prince Mohammed bin Salman, who is also the Defence Minister and second in line to the throne, to assure them of the United States support and to guarantee them that the US would not tolerate any "interference" by Iran in the affairs of its Arab neighbours. Carter sought to mollify his allies in the Middle East with visits to Israel and Jordan too. Carter offered Saudi Arabia enhanced military cooperation with tuition and training of security forces, IT and defence. In Jerusalem he met with Prime Minister, Benjamin Netanyahu, who refuses to accept the agreement reached between the world's powers and Iran.

Further to Carter's tour, King Salman had a meeting with President Obama in the White House, which was his first official visit to the United States after ascending to the throne in January 2015. The visit took place in early September, a few days before the US Congress assembled to vote on backing or rejecting the agreement with Iran, lobbying to halt the agreement.

Oil accounts for nearly 80% of all income from exports, and between 50% and 60% of the State's income. Iran's economy could grow substantially with the lifting of the sanctions. It would only be logical to assume that an Iran with higher economic resources would alter the balance of power in the region. What Iran has achieved in hard times, will now mean, that with greater liquidity, it will commit additional resources to al-Assad and will provide support to all its allies in the area. Consequently, Saudi Arabia can only be expected to have to defend its own geopolitical plans, exacerbating the situation of uncertainty in the Middle East.

As we mentioned previously, regardless of all the geopolitical pressure, Iran and Saudi Arabia will have to sit down and negotiate. OPEC is an excellent forum to ensure understanding between both countries. Not only their own economic future depends on this understanding and cooperation, but also that of the rest of the members. Gregory Gause, III, in the article published by Brookings Doha Center, "Sultans of Swing? The Geopolitics of Falling Oil Prices", concludes very optimistically that negotiations inside OPEC between Iran and Saudi Arabia could set the base for building a bridge of negotiation and diplomacy for geopolitical conflicts. Gause even suggests that the agreements could contribute to reducing sectarian conflicts in the Middle East, since as they would be under

economic pressure, they could seek reducing their armed conflicts. This alternative which he calls “creative diplomacy” could even be taken advantage of by the United States, since it has shown diplomatic willingness through the nuclear agreement with Iran, and by Russia that also requires higher oil prices for its economy.

Gause’s proposal, more desirable than actually plausible, will be difficult to see materialise. The conflicts between Iran and Saudi Arabia, and in the Middle East, go back centuries before OPEC. Ever since it was founded some 50 years ago, its dissimilar members have managed to reach agreements with varying degrees of cohesion and cooperation. They have maintained communication, discussion and have forged an institution that has become sufficiently solid to survive changes of governments, falls of regimes, wars, volatile prices and ethnic and religious differences. Nevertheless, conflicts in the Middle East, and also between Iran and Saudi Arabia are still present, and are reaching a particularly delicate level.

As mentioned previously, through its existence, agreements within OPEC have proven independence from the reality outside the organisation. Regimes have been born and died; armed conflicts have started and finished, regardless of the existence of OPEC and the price level of oil barrels. However, the world has become increasingly better interconnected. The havoc being reaped by the Islamic State is being felt beyond the Middle East, with young adepts from Europe leaving their homes to join them, whereas London and Paris are in constant status of alert against terrorist attacks. The recent migrant crisis of refugees from Syria, Iraq and Afghanistan to Europe is a consequence of the pitiful state the Middle East is in at the moment, and the immediate consequences for Europe. Obviously the level of oil prices, either very low or very high, has international repercussions. Gause is right when he says that a reconciliation between Iran and Saudi Arabia within OPEC sets the basis for diplomacy at another level, at a level on which USA and Russia, along with other powers could discuss the geopolitics of the Middle East, since it is not only in the interests of Saudi Arabia and Iran and the region in general to reduce this escalation of conflict, but also the rest of the world’s.

Relevance of Saudi Arabia as a Crude Oil Supplier

Saudi Arabia and the adventure into renewable energies

The mission of Saudi Arabia continues being to perform as the most competitive oil supplier in the world. Its growing population however demands the implementation of measures to diversify its economy, adventurous as they may seem, whilst reducing its growing appetite for the use of fossil fuels at the same time.

The now legendary Minister of Petroleum of Saudi Arabia, Ali al-Naimi, said his country could decide to eliminate the use of fossil fuels by the middle of this

century. "In Saudi Arabia we know, that in the end, sooner or later, fossil fuels will not be needed; perhaps in 2040, 2050 or later", said Ali al-Naimi. So much so is the case that the Saudi Kingdom has embarked on a programme to develop renewable energies and intends to become a "world authority in solar and wind power". In fact, according to the Minister, they could start to export electricity instead of oil in the near future.

This statement by the Saudi Minister for Petroleum could sound somewhat shocking. It costs Saudi Arabia less than 10 dollars to produce one barrel of oil, which even today can be sold at around 35 to 40 dollars on the market. Nevertheless, the rapid increase in the use of energy, the needs for economic diversification and job creation for the country's growing, young population, converts the renewable discourse in a possible alternative for the Saudis. Moreover, the costs of solar panel technology have been reduced and efficiency has improved. Owing to its geography, energy requirements and economic diversification, it is obvious that Saudi Arabia is seeking to take advantage of renewable energies, particularly solar energy.

Saudi Arabia is the main consumer of hydrocarbons in the Middle East, and has the highest per capita income in the world. More than 25% of its total oil production, which is around 11 million barrels per day, is consumed domestically, other refined products being also imported. According to a report by Citigroup and Chatham House, if the demand for oil in the Kingdom continued to grow at the current rate, the country will change from oil exporter to net importer in 2030.

The new energy plan by Saudi Arabia will develop the installation of 41 GW of solar, photovoltaic and thermo-solar energy by 2032. Its geographical location means it has a high radiation potential, which in conjunction with its economic resources, could make the country one of the biggest photovoltaic solar energy markets in the world. Its new energy development programme envisages an investment of dozens of millions of dollars "to catapult Saudi Arabia to join the group of world leaders in developing renewable energy". But not only photovoltaic solar energy, wind power too, geothermal energy, waste conversion and nuclear power plants in order to have more energy diversity in the future.

The principal objectives of the programme are to reduce the use of hydrocarbons to produce electricity, and to establish a local solar power industry with creation of jobs.

In the last report by the European Photovoltaic Industry Association (EPIA) "Perspectives of the world market for photovoltaic energy until 2016", the association confirmed that Saudi Arabia is a "promising" solar market, because of the growing awareness and interest by the politicians.

Adam Sieminski, director of the US Energy Information Administration believes that the fall of oil prices will not affect expansion of solar and wind power. Governments are in favour of renewable energies and their action will be vital for the energy transition. Bill McKibben, one of the strongest defenders of renew-

able energy in the United States explains that “the Saudis are trying to prolong the oil era... But the improvement in efficiency and fall in costs of renewable energies will mean the cycle will continue on the road towards cleaner energy generation”. More than a few hypotheses have been put forward to explain the new normality of “low” oil prices: the fight against fracking by the USA, an internal “war” in the Muslim world, a way of containing expansion of renewables, etc.

It is also said that the current oil prices are part of Saudi Arabia’s plan to prolong the crude oil era over the encroaching cleaner rivals (renewable energies) and to oust the producers of fracking, in order to win a bigger market share. A plan orchestrated by the Saudi Arabian authorities and led by the Minister for Petroleum, Al Naimi, as explained by Bloomberg. Daniel Yergin, a historian of the oil industry explains that the passivity by OPEC before the slump in crude oil prices “is something historic, the cartel sent out a message that allowed reading between the lines that OPEC would no longer be the market administrator. The market will be the new manager of the market itself... When this type of surprise moves take place, prices can reach the levels that we have seen”.

Whilst prices were plummeting and it was being proclaimed that Saudi Arabia’s strategy was to fight against fracking, Naimi was pushing prices lower, above all to slow down the progress of renewable energy as a substitute for oil. Cheaper crude oil is more attractive for producing energy, thus trying to delay solar, wind power, etc., from being present in the energy mix of countries, for as long as possible. On the other hand, the policy also served to eliminate many competitors, such as crude oil producers through fracking in the United States, who incur higher costs to produce a barrel of crude oil.

Although oil after its price decrease is more attractive, in Saudi Arabia they are conscious that sooner or later the day will come when the demand for crude oil will start to fall. The Petroleum Minister, Al Naimi pointed out that “the peak in demand will arrive before the peak in the offer”, demand will start to fall before the offer does. As Daniel Lacalle explained, an economist and expert in raw materials, “the last barrel of oil produced will not cost millions, it will be worth zero”, because crude oil will no longer be used to produce energy, and will consequently have lost all its value.

In view of this situation, Saudi universities are making enormous efforts to diversify the training of their human capital. But the longer time they have available to get the country ready for the new energy era, the better the results will be. The objective is to “draw out” as much as possible the era of oil in the world, centring the strategy above all on emerging powers, who are the ones recording highest economic growth but who have not yet reached the level of commitment to the environment that some countries such as Germany or the Scandinavian countries have.

Saudi Arabia intends to move in a determined manner in relation to renewable energy, installing over 50 GigaWatt in the next 20 years. Saudi Arabia has started a project with the US Department of Energy’s National Renewable Energy

Laboratory (NREL) to evaluate the capacity of its territory for solar energy production. The objective is to understand just what the risks and real potential of photovoltaic technology are in this area, being exposed to extreme phenomena such as sand storms. NREL will back the installation of over 50 control stations in the Middle East to measure solar irradiation and assess the best sites to install the power plants.

This will be the first step in developing Saudi Arabia's energy plan, which expects to install more than 50 GigaWatt of renewable energy in the country, satisfying at least 30% of its energy requirements before 2032.

Saudi Arabia is determined to diversify its energy sources and reduce its dependence on hydrocarbons. In 2012, King Abdullah clearly stated that the Kingdom will make moves to extend its energy mix. There is no coal or natural gas in Saudi Arabia and an enormous amount of energy is required to desalinate water, and heat turbines to take energy to homes and companies. Electricity is in high demand, particularly in summer when temperatures exceed 45°C and air conditioners alleviate the effects of the scorching heat. Growth of the renewable energy share could also release barrels of oil from internal use for exports, thus contributing to the Kingdom's treasury.

China, the Great Allied of the Energy Demand

China has been characterised in the last ten years as the growth driver of Asia, and more recently of the world. China has required increasing amounts of fuel and raw materials to feed its economic performance. The effect of lower growth than expected in China entails lower demand for raw materials, but this effect is not proportional for all materials. Metals, particularly copper and aluminium tend to suffer more from this reduction than oil.

More than causing greater havoc in petroleum prices, the news of a lower growth in China and its exchange policy, just added more wood to the fire caused by the higher offer that has been building since 2014. China consumes around 40% of the world's copper, but no more than 15% of the world's oil. The figures published by the International Energy Agency (IEA) suggest an increase in oil consumption in China from 4.6 kbd to 11 mbd in fifteen years. During the same period, the world's demand has grown by more than 17 kbd to currently stand at 94.4 kbd with growth forecasts indicating around 1.4 kbd in 2016 and 1.2 kbd in 2017.

There is an excessive impression that China is the hope of growth in the demand for oil, particularly if we bear in mind that per capita consumption is only 13% of the consumption in the United States and that if it was increased to a quarter, the demand would reach 10 mbd, but the truth of the matter is that China has reached 1 mbd in just one year over the last fifteen years, with a yearly growing average of only around 400 kbd in terms of growth. The IEA estimates that by 2016 China's demand will stand at 11.51 kbd, a growth rate of 320 kbd com-

pared to 2015. The figures are still significant however, as China's contribution to growth in the world's demand has been 40% in the last ten years, but growth is also spread around several other countries as well.

In years with low oil prices, such as 2014 and 2015, China has taken advantage to increase its strategic and commercial reserves, owing to which growth in demand between 2014 and 2015 was over 550 kbd. There are no official figures about the total reserves in China, but it is believed they could have a capacity for 650 kb or 90 days of imports. Once that capacity is full however, it is only natural for demand to fall, as forecast by the IEA.

China will still be a strong magnet for oil, although at a lower scale. The governmental agreements with Ecuador, Venezuela and Russia will continue to be an incentive for this flow. Russia is the world's second exporter behind Saudi Arabia, with both countries competing for market share in China. Russia has announced that it will topple Saudi Arabia as the leading oil exporter to China, and is contemplating the possibility of increasing its exports to the Asian market from the current figure of 25% of its exports to 30% by 2020 and 40% by 2030. This threat is credible since the average production cost in Russia is 20 usd/bl and it already has the logistics and facilities ready to send crude oil from Siberia to the Asian market.

Some Conclusions

Oil prices will not recover in the next two years, and if peaks of 60 or 70 usd/bl are seen, they will be just that, peaks, since any stable recovery will entail higher production costs, whether this is conventional or non-conventional given the irreversible leaps forward in terms of efficiency.

In view of the forecasts for offer and demand, no considerable leaps or volatility are expected, although geopolitics could cause some vertigo. Economic desperation is added indeed to the military tension in the Middle East, a consequence of the lower oil export prices that particularly affect to a different degree all OPEC countries.

Fatih Birol, Director of the IEA, announced that the CAPEX in upstream projects fell 20% in 2015, around \$550 thousand million dollars in cuts are expected for 2016, particularly centred in the United States, Canada and Brazil, which represents two consecutive years of investments never seen in the last ten years. The non-OPEC producers will wait for higher prices and a more stable horizon before restarting high-cost projects, but those where there is already installed capacity will speed up, demonstrating that the oil offer within a certain range and in certain projects is more flexible than initially thought.

In addition to the financial pressure in OPEC and some non-OPEC countries, there is a complex armed conflict in the Middle East with deplorable human consequences. International coalitions against ISIS's terrorism still have not coordinated their strategy. There is also social and political instability inside some

of the world's main oil exporters, as is the case of Venezuela, Libya, Iraq and the world's biggest exporter, Saudi Arabia. Less than a year after King Salman came to power there is already talk of discontent within the Saudi royalty who are sceptical about his ability to lead with the pressure of the growing, young population of the country, in an atmosphere of low oil prices that are gnawing away at the country's finances, with Iran ever closer to returning to the market with additional volumes, with an armed conflict on its southern border and growing geopolitical instability as a result of the fight against ISIS.

Discontent against the current king in the royal family could spread to the population. It should not be forgotten that 46% of Saudi Arabia's nearly 30 million inhabitants are between 25 and 54 years old, with the average age being 27, which is a focus of pressure on the government to create jobs in an economy that is still largely concentrated on oil and which will start to cut on benefits and budget. In spite of the efforts to diversify its economy, 90% of its export revenues and 80% of the Saudi government's income come from hydrocarbons.

In November 2015 the OPEC basket price fell below 40 usd/bl for the first time since 2009, which partly reflects the significant cost of the strategy applied to discourage high-cost production, whilst recovering its market share. OPEC's annual income could close 2015 at around half the average of the previous five years, estimated at more than one thousand million dollars.

Despite the pressure suffered by Saudi Arabia and the other members of the Organisation, OPEC's Secretary General, Abdalla El-bradi, stated that the world market is on the right track to becoming balanced in 2016. Without counting on Iran's return to the market, the forecast by the Secretary General would be correct. There is currently an offer surplus of around 1.5 kbd and for 2016 this excess could be around 400 kbd but Iran's return to the marketplace is nearly a fact. It is estimated that around 500 kbd will enter the market during the second quarter of 2016, but another 500 kbd, as anticipated by Iran's government, is fairly unlikely, although 200-300 kbd would indeed be feasible. Assuming that the demand estimates do not increase, and that non-OPEC production is not reduced, we will find ourselves before an accumulation of stock at similar levels to those of this year. The big problem is that by the third quarter 2015 stock is already at very high levels, with over 4,500 million barrels stored in OECD countries, which is 300 million more than in 2009.

2015 has been a very hard year for OPEC and 2016 will almost certainly be another one. Although through a lot of suffering and slower than initially forecast, OPEC's strategy is working. There is less non-OPEC production, leaving more room for low-cost production, and demand has partly recovered. A change in the strategy could hardly be expected when the objective has not yet been achieved. Unfortunately, the geopolitical events will also continue to be present in the coming years, and the process of short-term price opening will play an important role, as will the future strategy of oil producing countries.

Chapter V

The water, energy, food nexus

Mariano Cabellos Velasco and Lucila Izquierdo

Abstract

Poverty is a primary issue affecting a high percentage of the world population, has and this implies a major geopolitical component. Poor people wanting to get out of poverty try and find solutions to the problems they suffer: violation of human rights, armed conflicts, disasters, epidemics and pandemics, famine... Population growth suggests that migration is likely to stay on top of the global agenda for all countries.

Poverty manifests through people's inability to access specific key basic services. Food, water and energy are goods and services to which everybody have access rights, although access to energy has not yet been recognised as a human right.

This chapter assesses the achievement of the Millennium Development Goals and the implications of the Sustainable Development Goals regarding eradication of poverty and hunger, human right to water and sanitation and the universal access to suitable, sustainable and modern energy services.

Achieving universal access to water, energy and food requires a comprehensive analysis, assessing their global interconnections, since different policies in each one of these sectors have impact on the two others.

Furthermore, different practical situations showing the existing interlinkage between water, energy and food are described.

Keywords

Poverty, migration, water, energy, food, isolated rural areas, universal access.

Introduction

Poverty in the world

Poverty is a phenomenon that affects a large percentage of the world's population and is the cause, and sometimes the justification, of many of the problems Humanity has to face. Poor people wanting to get out of poverty try and find solutions to the problems they suffer. These problems range from violated human rights, war conflicts, catastrophes, epidemics and pandemics, famine, etc. This all leads in turn to new problems of migration, religious conflicts, fights over land, fights for water and energy, which all creates socio-economic instability and insecurity.

Poverty is not something new; it has been around ever since man first set foot on earth. There have always been wealth and poor people! as the popular saying goes. While the poor keep quiet, there are not usually any problems, but globalisation and new technologies have opened windows up in the world allowing others to instantly see what is going on elsewhere, and consequently stimulating people to imitate or to want to be or have what others are or have in different parts of the world. Those who do not have water, energy, food and see surpluses in other places want access to these goods and services, so as to improve their standard of living.

Poverty is not synonymous of developing countries, and since poverty is sometimes the result of social inequality, it is also present in developed countries with high standards of living for most citizens, where there are minorities submerged in sometimes very extreme poverty. Social policies can resolve the basic needs of these minorities, but not always, and this is not the case in all countries.

The relatively new phenomenon of climate change is another factor that needs to be considered when analysing poverty in the world, as it is the underprivileged who will suffer the harshest consequences of climate change.

Moreover, there are other aspects worthy of mention that affect, or are caused by poverty, but these aspects should be addressed by specialist institutions who are better qualified to deal with them in more detail than in this paper.

In the year 2000 the 189 member countries of the United Nations established the Millennium Development Goals (MDG). Eight goals were set for 2015. The first was to eradicate extreme poverty and hunger. Nevertheless, the fight against poverty has been a concern for a much longer time. More specifically, since 17th October 1987 when more than one hundred thousand people assembled in Paris to pay homage to victims of extreme poverty, violence and hunger. The Heads of State met in Trocadero Square in Paris, where the Universal Declaration of Human Rights was declared in 1948 and it was there that poverty was first talked about as a violation of human rights.

Among the eight goals, the first referred to reducing by half the proportion of people with income less than 1.25 dollars per day between 1990 and 2015, i.e. reducing extreme poverty by half.

The UN has regularly published reports about the progress of the MDGs. The 2015 report, published in July, was a final report,¹¹ indicating the degrees of accomplishment of the MDGs. This report shows that goal 1.A, consisting of reducing extreme poverty by half (between 1990 and 2015) has been accomplished. But: a) How is extreme poverty measured?¹ b) Was the goal too easily attainable?

As can be seen in the following table “Extreme poverty rates in developing regions, 2002 and 2011”, both the poverty rates measured and the people who live on less than 1.25 dollars a day or those who live on less than 2 dollars a day, have improved in the period between 2002 and 2011 for all regions in the world. Nevertheless, more than 46% of people in Sub-Saharan Africa still live on less than 1.25 dollars per day and more than 78% on less than 2 dollars per day. In south-east Asia these figures were 24%\$ and 32%.

Region	Extreme poverty rate US\$ 1.25 per day			Extreme poverty rate US\$ 2.5 per day		
	2002	2011	Variati on (%)	2002	2011	Variati on (%)
	Sub-Saharan Africa	57.1	46.8	18	84.2	78.0
Southern Asia	44.1	24.5	44.4	86.7	74.5	14.0
East Asia and Pacific	27.3	7.9	71.0	62.4	31.9	48.8
Latin America and the Caribbean	10.2	4.6	54.7	27.1	13.3	51.0
Middle East and North Africa	3.8	1.7	55.9	31.9	22.1	30.7
Europe and Central Asia.	2.1	0.5	77.0	11.6	3.8	67.2

Table 1: Extreme poverty rate, in developing regions, 2002 and 2011
Source: World Bank calculations based on the PovcalNet (a tool for on-line analysis), World Bank Washington DC, <http://iresearch.worldbank.org/PovcalNet/>. Note: The data on poverty in Latin America and the Caribbean differ slightly from those published by SEDLAC due to variations in the methodology used to calculate the poverty rate.

¹ In 2000 this was defined as having income of less than 1 US Dollar per person per day (measured on a par with purchasing power). It was then raised to 1.25 US dollars per day to account for inflation. Increasing the figure to 1.90 US dollars per day is currently being considered.

Climate change is another factor that affects poverty. In this sense according to the World Bank (WB),² around 100 million people could reach poverty levels between now and 2030 if measures are not taken to tackle climate change, mostly because of its effects on agriculture.

Population growth leads everyone to believe that the phenomenon of migration will continue to play a fundamental role in the search for places to live in a dignified manner for many people who are born in poor countries with an uncertain future. Poverty moves from country to country!

According to the UN³ in 2013 the number of migrants in the world reached the figure of 231.5 million people, more than half of them setting in developed countries, Europe and Asia being the continents with the most number of migrants, followed by the United States.

Poverty is one of the reasons why people decide to risk their lives by travelling, sometimes thousands of kilometres, to reach an uncertain destination with the hope of improving their standard of living and that of their families.

Hunger, lack of resources, lack of prospects, war, catastrophes, in short poverty in the world means that every day the Human Rights of millions of people are contravened. Article 25 of the Declaration of Human Rights by the United Nations in 1948 established that *"Everyone has the right to a standard of living adequate for the health and well-being of himself and his family, including food, clothing, housing, health care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control"*.

The availability of modern energy, water and sanitation services, given the nexus between these services and food, will make it possible to achieve the current Sustainable Development Goals and be able to think, in a not too distant future, about "Zero Poverty" in the world.

The Water, Energy, Food Nexus. A global vision of the challenge

Since the initial conception at the Bonn Conference on "The nexus between water, energy and food safety", organised by the German government in 2011, the ultimate objective of the Nexus Water Energy Food has become more consolidated as the meeting point to suitably deal with the relations between these three essential resources that permit optimum management of each one in relation to the others.

Water, energy and food are essential for human welfare and for sustainable development. Making water, food and energy available to all the planet's inhabitants is a challenge that is not exempt of risks. The importance of

² "Shock Waves: managing the impacts of climate change on poverty, World Bank".

³ "Trends in international migrant stock, the 2013 revision, UN".

these three elements for people's welfare is obvious, but so is the amount of relationships and interferences between them, since each one of them is necessary for the other two, production and consumption of all of them being largely dependent on ecosystems and having a strong impact on the environment.

By 2050 the world's energy demands are expected to have doubled compared to today's figure, whereas the demand for water and food will have increased by over 50%. This is mainly due to the increase in the world's population, which will rise from 6,800 million to 8.300 million people, to the rapid economic growth of emerging economies and consequently of their middle classes, which are expected to double, and likewise to the efforts to improve the existence of 1,200 million people who barely have access to electricity, 783 million people without drinking water and 842 million people with severe nutritional deficiencies.⁴

In order to simultaneously deal with the expected growing demand for energy, water and food, the "nexus" between them will have to be taken seriously into account: Extraction and processing of fossil fuels and electricity production requires water consumption that globally accounts for 15% of the available fresh water. Therefore, energy security depends on the availability and accessibility of fresh water supplies. On the other hand, alterations in the energy supply, which is vital to treat, manage and distribute water, directly affect the security of latter's supply. When water and energy supplies are at risk, so is food safety, which is affected by droughts and the price of energy, which in turn directly affect availability, price and access to food throughout time. The food supply chain currently consumes 30% of the world's energy and 70% of the available fresh water.⁵

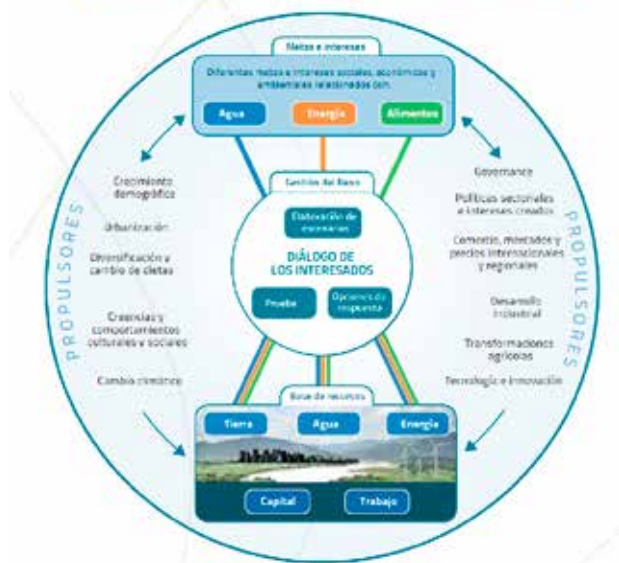
In view of these interconnections, governments and the private sector, academia and other international players must search for comprehensive solutions that reduce the pressure on these limited resources, and to design formulae for development based on their sustainability and efficiency of their use.

The Nexus Water-Energy-Food has been the subject of deep reflection by FAO, and a comprehensive vision has been established on sustainability while at the same time a balance between the different goals and interests and the needs of people and the environment. It specifically considers the complex interrelations and feedback between natural and human systems, as can be seen in the following figure:

⁴ Source: IRENA, International Renewable Energy Agency.

⁵ NEXUS Water, Energy, Food, FAO 2013.

Figure 2: El enfoque de la FAO sobre el Nexo Agua-Energía-Alimentos



The FAO approach to the Water - Energy - Food Nexus Illustration 1.

The basis of these resources consists of natural and socio-economic resources, which are interdependent for achieving social, environmental and economic goals in terms of water, energy and food. The interrelations of the nexus are related to the way the resource systems are used and administered, describing their interdependence (the way each of them depends on the others), the difficulties (imposing conditions or compromising solutions) and the synergies (the way certain benefits are strengthened or shared).

Other organisations have elaborated different visions and analyses of the problem, either considering the elements two by two or all three together.

What value does a joint approach to water-energy-food add?⁶

- An inter-sector, dynamic perspective
- It helps to better identify the complex, dynamic relations between water, energy and food so that the scarce resources can be used and administered sustainably.

⁶ Outlook FAO 2013.

- This approach means that the repercussions a certain decision has in one sector must be taken into account not only in that sector, but also in the other two.
- By forecasting potential solutions for compromise and synergy, response options that are viable in different sectors can be designed, valued and prioritised.

The global approach for the three sectors provides information for the decision-making process and guides the development of policies related to all three, and at the same time provides a basis for the people responsible for making decisions to consider compensation and benefits of a possible intervention in the different sectors.

As will be seen in Section 5, there are different methodologies for estimating and assessing these relationships. FAO in the report "Walking the Nexus Talk: Assessing the Water-Energy-Food Nexus in the Context of the Sustainable Energy for All Initiative"⁷ proposes one of them in order to jointly analyse the three sectors and their interrelations.

Current Situation of the Water, Energy and Food Sectors in Development

Achievements and failures of the MDGs

The eight Millennium Development Goals mentioned previously⁸ referred to poverty, education, health (3), gender, the environment and international cooperation. They were developed in 21 targets, through which subjects such as food - under the "Poverty" goal - or water - under the "Environment" goal - were included. The horizon was 2015.

The MDGs had a lot of weaknesses: they were drafted hastily, the choice of goals, targets and indicators was a little arbitrary and they responded to a rather limited, fragmented vision of development: *poverty and needs are in poor countries which have to develop, meet the goals: the role of rich countries is to provide help / cooperation and serve as a model*; a view that is now being questioned, but they contributed to raising awareness in the public opinion, to mobilising and giving more visibility and priority to development and cooperation.

Have the MDGs been achieved?

According to the 2015 progress report,⁹ the answer is very modulated. At global level some targets have been achieved while others have not. By countries and

⁷ <http://www.fao.org/3/a-i3959e.pdf>.

⁸ <http://www.un.org/es/millenniumgoals/>.

⁹ United Nations: Millennium Development Goals - 2015 Report: http://www.un.org/es/millenniumgoals/pdf/2015/mdg-report-2015_spanish.pdf.

regions, the result is dissimilar; in Asia many have been met, in Sub-Saharan Africa, very few. But the analysis does allow for some relevant reflections. In Section 1 reference was made to the situation in terms of poverty, but we could put forward others: why have some or other MDG targets been achieved - or not - or the goals as a whole? How can we define how much of this is due to economic growth in the world, how much to government policies, how much to development cooperation, how much to the spectacular growth of China? Perhaps some targets were too easy and others not very realistic?

We shall now examine the situation regarding: a) Water and sanitation, b) Energy, and c) Food and food safety.

The human right to water: situation and principal challenges

The human right to water and sanitation was recognised as such by the United Nations in 2010¹⁰. This culminated a long process¹¹ which took a decisive step forward in November 2002 when the UN's Social, Economic and Cultural Rights Committee adopted its "General Observation No. 15".

The human right to water and sanitation is encompassed in the economic, social and cultural rights. It is not established as a generic right for all uses, but is limited to certain uses and in certain amounts: access, under equal conditions and without discrimination, to a sufficient amount of drinking water for personal and domestic use (between 50 and 100 litres per person per day), including consumption, washing, preparing food and personal and domestic hygiene for livelihood and health. It also defines the characteristics the water should have: be safe -from a hygienic and technical point of view-, be acceptable - particularly important for sanitation-, be affordable - the costs related to water and sanitation should not exceed 3% of the household's income- and be physically accessible - the water source should be less than 1,000 m away from the home and the time required to collect it should not exceed 30 minutes. Some general criteria are also established: participation, access to information, transparency and accountability and sustainability. The resolution acknowledges that this needs to be executed gradually.

The Millennium Development Goals (MDG) were therefore established before the human right to water was acknowledged. Although there is no specific MDG concerning this matter, water and sanitation were included in several of the targets for Goal No. 7 "Guaranteeing sustainability of the environment". Therefore the 2015 United Nations Report on the MDGs, mentioned previously, provides up to date, proven data concerning several fundamental aspects related to water. Three of them can be considered:

¹⁰ Resolution 64/292 of the United Nations General Assembly, July 2010.
http://www.un.org/spanish/waterforlifedecade/human_right_to_water.shtml.

¹¹ UN Conference on Water in Mar del Plata, Argentina, 1977.

Water resources

Approximately 12% of the fresh water used around the world is for municipal / domestic use, 19% for industry and 69% for agricultural use.

The hydrological stress indicator most commonly used is the proportion of water resources that are extracted, which is affected by the availability of water and the national policies; scarcity can be physical, economic or institutional. Extracting more than 25% of the resources is considered a hydrological stress situation; more than 60% is a shortage of water, and more than 75% is a severe water shortage.

At world level only 9% of the renewable fresh water resources are extracted to cover all uses, but there are major differences between countries and regions. In 2011, 41 countries were in a situation of hydrological stress, when in 1998 there were only 30. Of these, 10 of them (in the Arabian Peninsula, North Africa and Central Asia) extracted more than 100% of their renewable water resources and were forced to resort to fossil water or non-conventional sources (desalination or reused water).

Water shortage affects more than 40% of people in the world, and this figure is expected to increase. This confers a strategic value to water resources: it jeopardises the sustainability of natural resources, it hinders economic and social development and can also affect other areas, including security.

Access to water

In 1990, only 76% of the world's population had access to an improved source of drinking water.¹² This figure currently stands at 91%. This shows that the target has been achieved: reducing the number of people who do not have access to water by half. But the highest level of service (tap drinking water in the home) is only available to 58%; today there are still 159 million people who use surface water, even if this does meet the "improved source" criteria.

There are therefore 663 million people in the world who use not improved sources of drinking water, consequently entailing many risks. Nearly half of these people live in Sub-Saharan Africa (where the relevant MDG has not been achieved) and 20% live in southern Asia.

Access to sanitation

With regard to sanitation, the situation is even worse. In 1990, only 54% of the world's population used improved sanitation facilities.¹³ A target was set in the

¹² An improved drinking water source is a source which, owing to its construction, suitably protects water from external contamination, particularly from faecal matter. (WHO: http://www.who.int/water_sanitation_health/monitoring/jmp2012/fast_facts/es/.)

¹³ An improved sanitation system is one that hygienically prevents contact by human beings with human excreta (WHO: http://www.who.int/water_sanitation_health/monitoring/jmp2012/fast_facts/es/).

MDGs to reduce the percentage of people who did not use them by half. Today, they are used by 68% of the population. Consequently, although the situation has improved (since 1990, 2,100 million people have gained access to improved sanitation facilities), the target has not been achieved. 2,400 million people use non-improved sanitation facilities, which includes 946 million people who still defecate in the open air. The regions where this situation is worse are Sub-Saharan Africa, Oceania and Southern Asia, where the percentage of people who use improved sanitation facilities is 30%, 35% and 47% respectively. In India, with all the progress and growth it has undergone, this is one of the indicators where least progress has been made.

Apart from the geographical differences, there are other disparities: rural - urban and by social groups. In urban areas 82% of the world's population uses improved sanitation facilities and only 2% defecate in the open air. In rural areas however, these figures are 51% and 25% respectively.

Gradually eliminating the inequality in access and improving service levels is still a major challenge for mankind.

Access to energy: situation and principal challenges

Energy was not among the objectives of the Millennium Development Goals (MDG). In spite of that, in Goal 7 (Environment), in the target "Including principles of sustainable development in national policies and programmes and reducing the loss of environmental resources" one of the indicators referred to greenhouse gas emissions, particularly CO₂. And the energy production sector is the one that produces most CO₂.

The International Energy Agency (IEA)¹⁴ has consolidated its analysis capability and has extended its scope of activities, both in terms of encompassed subjects: economic development, the environment, energy - poverty, biomass, water-energy nexus, and in terms of geographical scope - non-member countries, global vision-. The World Energy Outlook, published every year, is a reference publication in the sector.¹⁵

The initiative "Sustainable Energy for All" (SE4All) was launched in 2011, driven by the UN's Secretary-General. It established three goals: 1) To provide universal access to modern energy services, 2) To double the global energy efficiency rate, and 3) To double the part of the global energy "mix" from renewable energies. SE4All has mobilised players, conducting and stimulating analysis, driving financing, providing mechanisms so that each country designs its plans to meet

¹⁴ IEA: <http://www.iea.org/> Created in 1974 after the first oil crisis, to guarantee the energy supply (initially for its member countries, the developed countries).

¹⁵ The 2015 report is a special report on "Energy and Climate Change". <https://www.iea.org/publications/freepublications/publication/weo-2015-special-report-energy-climate-change.html>.

the objectives and has implemented a tracking mechanism, namely the “Global Tracking Framework”. It is interesting to note that objectives 2 “energy efficiency” and 3 “renewable energies” in the initiative are quantified, whereas the first one “universal access” is not. This reveals a difficulty in exactly what we understand by “access” and by “modern energy services”.

As for pure access, it is relatively easy to measure the number of homes / people connected to the electricity grid; as said earlier, it is estimated that at world level 1,200 million people are not, which is why most of the available data refers to this indicator. But: a) “being connected” does not necessarily mean suitably using available electricity since there are problems of affordability, b) there are sources of energy for lighting or for heating other than the electricity grid, and c) energy is not only required in homes, it is also required for community services, production, transport, etc. And access: Under what conditions of quality and reliability, in what amount and at what cost?

The term “energy poverty” is usually defined as a situation in which there is not access to “sufficient” energy at a cost below a certain percentage of income. Even with limitations and inaccuracies, it can be reasonable for developed countries (where it was coined), but not for developing countries, underprivileged groups or isolated geographical situations.

The IEA and SE4All have developed the tier concept for access to energy. SE4All establishes five tiers depending on the power and the time it is available: “tier 1” means 1w for 4 h/day (1.5 Kwh/year); “tier 5”, the highest level, 2,000w for 22 h/day (16,000 Kwh/year). The IEA defines “initial access” as consumption of 250 Kwh/year for rural homes and 500 Kwh/year for urban homes (it is expected to increase this figure to 800 Kwh/year by 2030).¹⁶

There are no reliable data or estimates, or at least they are not readily accessible, about how many people in the world are in each of these tiers, whether defined by SE4All or by the IEA.

On the other hand, defining access tiers by power brings about doubts regarding the methodology employed. It is useful for the supplier, but not for users: their power needs depend on the electrical appliances they use (light bulbs, cell phones, etc.) and the evolution technology pursuant to energy efficiency means that appliances require increasingly less power. It would seem logical to establish the level of access from the point of view of users’ needs. The Universal Access to Energy Panel¹⁷ has followed this line. An “acceptable level” of access to electricity is proposed. This should permit each household to have: a) 300 lux

¹⁶ I. Pérez Arriaga, 2015.

¹⁷ “Mesa para el Acceso Universal a la Energía”, established in 2014 by six organisations: Instituto de Investigación Tecnológica del ICAI at Comillas University; ONGAWA, Ingeniería para el Desarrollo Humano; Fundación de Ingenieros del ICAI para el Desarrollo; Fundación Energía sin Fronteras; Centro de Investigación Tecnológica para el Desarrollo Humano at Madrid Polytechnic University and Fundación Acciona Microenergía.

lighting for at least 4 hours during the night; b) radio, television, computer and cell phone; c) a system permitting preservation of food. Moreover, the electricity supply should be reliable, of quality, according to the needs and capacities of users, affordable and sustainable.

In addition to electricity, energy is also required for heat (cooking and warming up). It is estimated that 2,700 million people do not have access to modern cooking sources,¹⁸ instead they use traditional biomass, wood, with inefficient combustion. This has a lot of negative impact in terms of: a) health 4.3 million deaths / year¹⁹ due to poor air quality-, burns, back problems, eye problems; b) environment -greenhouse gases, deforestation-, c) gender -it is usually women who collect wood and cook- and d) economy -cost, missed opportunities-.

Insofar as access to clean cooking methods is concerned, the Universal Access to Energy Panel considers the "adequate level" to be the use of stoves which, although using solid fuel, have smoke extraction to the outside of the home and the obtainment of fuel taking less than 30 minutes a day.

Two final considerations: 1) Apart from access to energy for homes - household systems-, the community requires energy for common services (schools, health centres, street lighting, water pumps) and for production (agriculture, workshops, shops...) 2) Statistics cast a lot of doubt about the reliability and comparability of the data.

Food security: situation and principal challenges

The first of the Millennium Development Goals included, as target 1C: "Reducing by half, between 1990 and 2015, the number of people who suffer from hunger". The above mentioned 2015 UN Report about the MDGs,²⁰ shows the situation and progress since 1990 through two indicators.

a. The number and proportion of people with insufficient nutrition.²¹

In 1991, 18.5% of people were in this situation worldwide, which has been reduced to 10.9%. Only considering developing regions, the reduction was from 23.3% (991 million people) to 12.9%; which being close to the target still is a lot of people: 780 million. Several factors have hindered the process: volatile prices of basic products, prices of food and energy, higher unemployment, economic recessions (the one at the end of the 90s and that between 2008 - 2010), extreme meteorological

¹⁸ World Energy Outlook 2014, IEA (2012 values):
<http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/#d.en.8609>.

¹⁹ WHO: <http://www.who.int/mediacentre/factsheets/fs292/en/> (most recent methodology.)

²⁰ United Nations: Millennium Development Goals - 2015 Report:
http://www.un.org/es/millenniumgoals/pdf/2015/mdg-report-2015_spanish.pdf.

²¹ This is measured by the energy content of the diet.

incidents, political instability, natural disasters and humanitarian crises. These factors have affected different countries in different ways.

The situation of, and the reduction in hunger is very different between regions and between countries. Two thirds of the reduction in the number of people with insufficient nutrition correspond to China. In Latin America and North Africa, the proportion of people with insufficient nutrition is less than 5%. Sub-Saharan Africa started with a hunger rate of 33%, which has been reduced to 23%, but, due to the population increase, the total number of people suffering from hunger has actually grown by 44 million and varies greatly by sub-regions, the worst being Central Africa. In Southern Asia the proportion of people with insufficient nutrition has been reduced from 24% to 16%, but it is the region where there are most people (281 million) in this situation. It is also relevant to emphasise the case of Western Asia (the Middle East), where in 1990 there were only 6% of people with insufficient nutrition, and this has increased to 8% today - in spite of the major progress made in several countries - due to wars, social unrest and the number of refugees.

- b. The proportion of children under 6 years old whose weight is moderately or very below normal.²²

14% of children in the world weight notably less than normal, which increases the risk, frequency and severity of common infections and is linked to a deterioration in cognitive capacity and poorer schooling and labour expectations. Half of the children in this situation are found in Southern Asia, and one third in Sub-Saharan Africa. There are significant differences between the rural and urban populations: in developing regions in rural environments 32% of children weigh notably less than normal, whereas in urban environments this figure is 17%. And, as can only be expected, there are clear differences depending on the level of household income; always focusing to developing regions, children with lower weights in the lowest of the five income tiers account for 38%, whereas 14% are in the highest fifth of income tier.

Sight should not be lost of the fact that the fundamental problem of hunger, nutrition and food security at world scale, does not rest on the total amount of food produced, but is more related to the fact that many people do not have access to it. And the access problem is not necessarily a question of physical access, but rather affordability.

At this point it would appear relevant to reflect on two questions analysed by Martín Caparrós in his recent book.²³ The first is the volatility of food prices, which has already been mentioned. The *Chicago Board of Trade*, which has existed since the 19th century, became more sophisticated by introducing future transactions, with the idea of reducing the risks associated with climatic vari-

²² This is estimated according to the standards established by the World Health Organisation for children's growth. The WHO and UNICEF are conciliating the anthropometric data used.

²³ "El hambre", Martín Caparrós. Published by: Anagrama, January 2015.

ations. From 1991, Goldman Sachs prepared a “*GS Commodity Index*”, in which the prices of up to 18 staple food products were considered, each with its own weight, and launched a product on the financial market related to the evolution of this index, an initiative that was followed by other banks. Investments in these products brought about a generalised increase in the price of food²⁴ making access to it more difficult by the part of the population with fewer resources. In the meantime, many capitals took shelter in financial products linked to raw materials. As with other financial products, a large part of the management is carried out through highly sophisticated negotiation tools known as “*high frequency trading*”. This means that food products became the subject of speculation.

The second question is “*land grabbing*” (the appropriation of land). Without agreement by the inhabitants, rural land is occupied by international investors for commercial use, using modern agricultural technology. Local governments usually render licences for use over long periods of time at very low rents and commit to deliver the land free of occupants (the inhabitants often have no ownership titles). This causes displacement of the local population. The people who do not manage to make a new livelihood for themselves in those lands tend to end up in the slums outside cities. In general, this is a not labour-intensive production and the workers need to be specialised, not local, while production is not for the local market either, but is exported to the countries of origin of the companies or to the world market. It is estimated that from the land that has been subject to “*landgrabbing*” in the world, once third is used for food production, another third for biofuel and the rest for different uses (exploitation - often unsustainable - of forests, flower crops, producing carbon credits, rendering them unproductive...).

The post-2015 development agenda. Universal access to water, energy and food in the SDGs

At the end of September 2015 at the Special Sustainable Development Summit, the UN General Assembly adopted the post-2015 development agenda (“Agenda 2030”).²⁵ The core of this document consists of 17 Sustainable Development Goals (SDG). A road lasting several years thus ended, indeed very participative (a multitude of queries to the different players) and in which two processes merged. On the one hand, since the MDGs had the horizon of 2015, it was necessary to establish a new development agenda. On the other hand, the Environment Summit held in Rio de Janeiro in 2012²⁶ agreed to establish some “sustainable development goals” to set the world’s commitments with regard to the environment.

²⁴ “The food bubble: How Wall Street starved millions and got away with it”, Frederick Kaufman, Harper magazine, 2010.

²⁵ Resolution A/RES/70/1: “Transforming our world: the 2030 Agenda for Sustainable Development”.

²⁶ Rio Declaration on Environment and Development, <http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm>.

The 17 SDGs, broken down into 169 targets, cover many more subjects (human rights, security...) than the previous MDGs and emphasise more the interrelations between them. A fundamental novelty is their universality. It is not a plan for “developing countries” but rather for all countries. Consequently, they establish that each country - the principal party responsible for its own economic and social development, in the words of the Resolution - will set its own national targets, guided by the general goal, but taking into account the circumstances of each one and including them in national plans, policies and strategies. It recognizes the results of the Addis Ababa Conference on financing development,²⁷ where the different sources of finance for development, beyond “Official Development Aid” (ODA) were set: national resources (public and private), migrant consignments, foreign investment... It also clarifies that development is not just the responsibility of governments, but everyone’s: the private sector’s, civil society’s and individuals’. It also states the importance of strengthening capabilities and institutions as well as technology transference.

The following are some of the goals and targets identified on the Agenda:

Goal #2: “End hunger, achieve food security and improved nutrition and promote sustainable agriculture”. This is specified in eight precise targets:

- Access by all people to healthy, nutritional and sufficient diets.
- Eradicating malnutrition - it re-establishes goals already set for children - and covering the nutritional needs of adolescents, pregnant women and older people.
- Income of small scale food producers.
- Sustainability of food production systems.
- Genetic resources: genetic diversity of seeds, plants and animals.
- Investments and technology in the rural environment.
- Commercial restrictions and distortions in agricultural and livestock markets.
- Basic food product markets: operation, access, information.

Goal #6: “Guaranteeing availability and sustainable management of water and sanitation for all”. This is specified in seven targets covering:

- Universal and fair access to drinking water at affordable prices.
- Access by all to adequate, fair sanitation and hygiene. End open defecation.
- Improve water quality (contamination, untreated waste water); recycling and reusing.
- More efficient use of water (to tackle shortages).

²⁷ Addis Ababa Action Agenda, July 2015:
<http://www.un.org/esa/ffd/ffd3/press-release/countries-reach-historic-agreement.html>.

- Comprehensive management of hydrological resources.
- Water-related ecosystems: protect and restore them.
- Support for developing countries to strengthen their water and sanitation capabilities, efficient use, treatment, recycling and technology.
- Greater participation by local communities in water and sanitation management.

Goal #7: "Guaranteeing access to affordable, reliable, sustainable, modern energy for all". This goal has five targets:

- Universal access to affordable, reliable, modern energy services.
- "Considerably" increase the share of renewable energy in the global energy "mix".
- Doubling the rate of improvement in energy efficiency
- More cooperation to facilitate access to research and technology in clean energy.
- More infrastructures and technological progress for developing countries.

As can be seen, the first three goals are taken directly from the "Sustainable Energy for All" (SE4All) initiative, which was referred to earlier on.

It is important to point out that although the 2030 Agenda comes into force on 1st January 2016, at the time this paper was written²⁸ there was still no agreement about the indicators that will be used to measure the targets and progress made. It is expected for an agreement to be reached around April 2016.

Components of the Water, Energy, Food Nexus

The water, energy, food nexus can be analysed from several perspectives: focusing on just one of the three elements, widening the perspective of the analysis regarding conventional methodologies; studying the interaction between two of them, or analysing the complete system, perhaps still a too complex task given the multitude of variables in play. Most of these initiatives approach the nexus as bilateral relationships between two sectors, there being hardly any studies or initiatives that deal with the triple nexus.

The Water - Energy Binomial

The "Water - Energy" binomial or nexus is defined as the coincidence of these two elements in a number of common situations, related to their obtaining, generation and distribution, where said concurrence provides opportunities for exploitation of possible synergies and mutual strengthening, both in optimisation

²⁸ November 2015.

of services and reduction of risks and possible impacts produced. In this sense, the relationship between water and energy is two way: energy supply requires water - “water footprint” on energy - and the complete water cycle is not feasible without energy - “energy footprint on water”.

Water is vital for the extraction, transformation and use of energy; it is utilized as a production factor for hydroelectric power and as a cooling agent in all thermal generation processes. Moreover, biomass for heat and electricity production consume water, and biofuel require intensive use of this resource. Finally, water and electricity are raw materials in hydrogen production. In short, extraction and processing of fossil fuels and electric power generation require a consumption of water that globally accounts for 15% of available fresh water. After agriculture, the electricity sector is the main user of water in advanced economies.

PRODUCT	EXTRACTION	TRANSFORMATION	DISTRIBUTION
PETROLEUM		25-65	Minimum
Traditional	3-7		
Enhanced oil recovery	50-9,000		
Oil sands	70-1,800		
BIOFUELS		Ethanol 47-50	Minimum
Maize	9,000-100,000	Biodiesel 14	
Soya	50,000-270,000		
COAL	5-70	Liquefied coal 140-220	Minimum
GAS			Minimum
Traditional	Minimum	Processing	
Shale gas	36-54	of natural gas 7	

Water Consumption in litres per Gigajoule
 Table 2: Source: World Economic Forum with Cambridge Energy Research Associates and own production.

Therefore, energy security depends on the availability and access to the sources of fresh water.

Energy, on the other hand, is indispensable in the hydrological system: water management has growing needs for energy: for pumping, transport and distribution, in desalination processes, for treatment and cleaning and for ultimate domestic, agricultural and industrial use.

In spite of the attempt to develop other energy sources, 75% of the increase in electricity demand forecast for 2030 is expected to be produced through fossil

fuels,²⁹ particularly coal. This situation could be counteracted with the development of low carbon power generation technologies. The problem is that these technologies with low carbon emissions are in most cases water consumption intensive.

Some examples of this are the carbon capture and storage technology or liquid coal technology, as alternatives to oil derivatives, among others.

PRODUCT	EXTRACTION	TRANSFORMATION	DISTRIBUTION
Surface water	0-2,400	Treatment: variable depending on water quality	Depends on the distance and elevation: 290
Underground water	At 40 metres: 150 At 120 metres: 520	High quality: 26 Healthy water: 300-1,400 Desalination of sea water: 3,600-4,500	
Recycled water		660	

Energy Consumption in KWh per 1000 m3 of water
 3. Source: World Economic Forum with Cambridge Energy Research Associates and own production.

Likewise, the development of hydroelectric plants that on average currently consume 17 m3 of water per MWh produced, owing to evaporation, also represents a problem. Even so, the International Energy Agency estimates that there is an aggregate of 170 GW currently under construction in the world, of which 77% are located in Asia.³⁰

Another technology currently under development, to fight against climate change, is concentrated solar power - also known as CSP - using relatively large amounts of water to produce the steam that drives the turbines, which has led to its implementation in some places already being restricted for the low availability of water.

The water / energy relationship is also present in the drinking water supply in cities and in sanitation and filtering systems, since energy is an important component of these systems. In this sense it is important to value recycled water because of the significant energy cost it involves, and the need to improve some processes such as obtaining energy from waste water treatment, particularly through anaerobic digestion of filter sludge with high carbon contents.

²⁹ Thinking about water differently: Managing the water–food–energy nexus. Asian Development Bank. 2013.

³⁰ Thinking about water differently: Managing the water–food–energy nexus. Asian Development Bank. 2013.

The United States Department of Energy has prepared a report about the water, energy nexus called “The Water-Energy Nexus: Challenges and Opportunities” in which six strategic pillars are identified to tackle the nexus between water and energy:

1. To optimise the efficiency of drinking water in energy production, power generation and end use systems.
2. To optimise the energy efficiency of water management, treatment, distribution and end use systems.
3. To improve the reliability and energy recovery capacity of water systems.
4. To increase the safe, productive use of non-traditional water sources.
5. To promote responsible energy operations regarding the quality of water, ecosystems and seismic impact.
6. To take advantage of production synergies between water and energy systems.

Water and Food Safety

Closely linked to the tensions described in the previous section is the interrelationship between water and food. It is obvious that water is intrinsically linked to food production because of its high consumption throughout the food chain.

With data from the United Nations, 70% of the water that is consumed in the world is used in agriculture, 20% in industrial processes and 10% in direct human consumption. A person drinks between 2 and 4 litres of water a day and additionally consumes between 2,000 and 5,000 litres of water incorporated into the food he/she eats. As examples of this, an apple has 70 litres of water, a beef steak more than 2,000 litres and 100g of vegetables, 20 litres of water.³¹

This means that “*ending hunger, achieving food security and improving nutrition and promoting sustainable agriculture*”, as proposed in the second of the Sustainable Development Goals (SDG) means substantially increasing the need for drinking water.

Extreme poverty is characterised by a serious deficit in food, with a high rate of malnutrition in the infant population of underdeveloped countries. But in turn, the lack of water plays a decisive role in obtaining food, both vegetables and livestock. The fight for water and the international conflicts related to its availability are essentially caused by people’s needs in the involved countries for access to water for their crops.

³¹ UN WATER. World Water Day 2013 International Year of water cooperation.

If we add to this the foreseeable demographic growth - the world's population is expected to grow from 7,000 million people today to over 9,000 million people by 2050 -, the result will be not only an increase in the need for food but a similar increase in the need for drinking water. In fact, it is expected for water extraction to grow by 50% by 2050. The increase in the middle classes needs to be added to the population growth, with their higher demands for water as a result of changes in lifestyle.

The following chart shows the evolution of the percentage of undernourished people, and their distribution by regions.

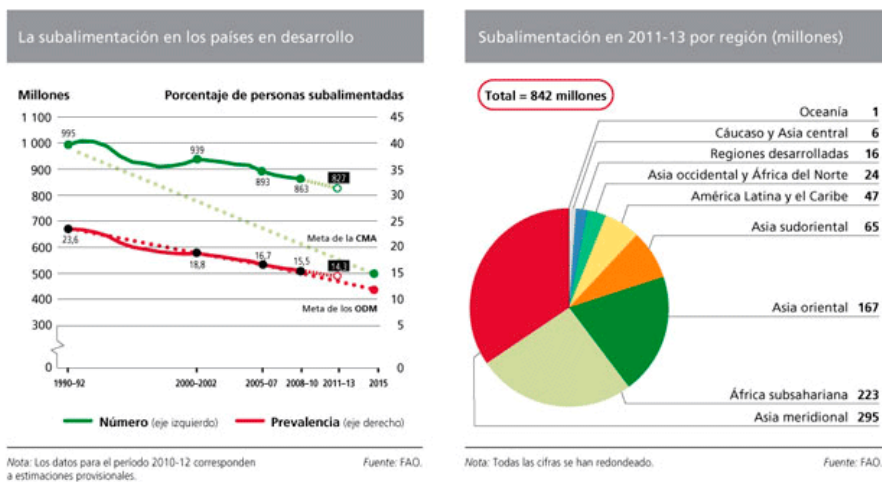


Illustration 2: Undernourishment in developing countries and by region.

Such a challenge endangers the welfare of the world's population and the environmental balance, in the same way as it can also be threatened by climate change.

In relation to the latter, the FAO has identified certain areas, particularly in southern Asia that could be affected by these changes, such as:

- Irrigated land with water supplies from glaciers and thawing.
- Deltas that will be covered by water flows.
- Underground water levels that will be affected by the variability in rainfall.
- Humid tropics where droughts will increase and rainfall will be heavier.

The search for food security when pursued through the provision of water without considering anything but the need to satisfy crop requirements, could lead to situations of conflict, which in turn translates as a risk of exhausting hydrological resources due to over-exploitation. It could also lead to exacerbated com-

petition between the use of water for agriculture, and other uses, domestic and also industrial.

An example of this is the use of water for agro-fuel crops in direct competition with food production. Another is the construction of dams in order to produce hydroelectric power, when the use of water for this purpose poses a risk to production systems of villages downstream the dam.

Having said that, as the United Nations recognises *“there is enough water available for the world’s future needs, but this scenario hides some enormous areas of absolute water shortage that affects thousands of millions of people, many of whom are poor and underprivileged. Some fundamental changes are required in management and policies throughout the entire agricultural production chain to guarantee the best possible use of water resources and thus respond to the growing demand for food and other agricultural products”*.

A new approach becomes necessary where policies for efficient land use, less wasteful irrigation techniques of the little water available, reusing waste water or sludge for fertilisation, coincide and mutually strengthen. There are initiatives of this kind such as the use of active carbon obtained from biomass waste to fertilise the land and to improve yield, whilst at the same time reducing the need for water.

There are different levels of action, globally, tackling for example the impact of the EU’s agro-fuel policy on food security in Africa or Latin America, and at regional level to improve coordination between countries and sectors in the transnational hydrographical basins, or at national level, improving planning processes.

Some projects are being put into practice today that considers the water - food security nexus. These are projects in which the variables related to the components of the nexus are considered in parallel to each other, and in which optimum policies for the whole of the variables are integrated, which will always lead to a more balanced, beneficial result than if attempts are made to maximise the results for just one of the variables.

Some lessons can be learned from these considerations and experiences that can be used as recommendations for projects focussing on food safety.

- Food security projects, are usually centred on increasing agricultural production, should not only include water availability, but should also try to preserve this resource.
- In order to do so, priority should be given to crops suited to the local rainfall level, avoiding others that would lead to over-exploitation of resources.
- Agro-forestry aspects should also be considered in terms of their impact on hydrological resources, eucalyptus management for example.

- Water-saving irrigation methods should be implemented, avoiding sprinkler irrigation with the subsequent loss of water through evaporation.
- Research and implementation of soil improvement techniques should continue with the inclusion of carbon to achieve higher yields with a lesser provision of water.³²

In general terms, during the project design phase, it is necessary to compile information about the status of natural resources, ecosystems and their uses, and other items that could affect, or be affected, by intervention in water, food and energy.

Energy - Food

As in the case of the binomial analysed previously, the relationship between energy and food is bidirectional, most agricultural practices - the principal source of food production - and the different stages of the food chain, intrinsically carry the consumption of large amounts of energy in aspects such as irrigation, transport, food distribution or preservation in cold stores.

Back in 2000 the FAO brought the attention to the lack of rural energy policies focussing on agriculture, particularly taking into account the role of agriculture in food safety, and the crucial role it plays in supporting rural livelihoods and avoiding migration to urban areas. Back then, the FAO denounced, *"in general, very little modern energy is available for agriculture, in spite of the fact that the needs for energy are high: as mentioned previously, agriculture requires energy, directly for fuel for tractors and machinery, and for pumping water, irrigation and drying of crops; and indirectly for fertilisers and pesticides"*.

In relation to the preceding statement, it is necessary to bear in mind that an important, additional element in the energy - food nexus stems from the promotion of intensive farming and the use of synthetic nitrogen fertilisers which are nearly all produced using natural gas, which in turn affects atmospheric CO₂ emissions.

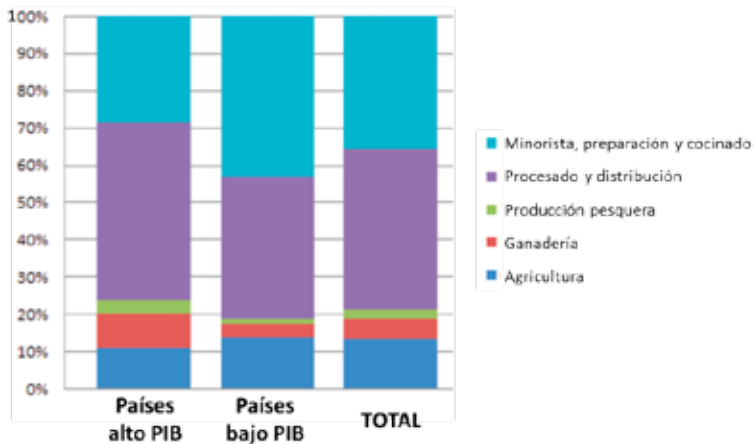
The food sector consumes approximately 30% of the world's primary energy demands. Of this total, approximately 14% is used in farming, i.e. slightly over 4% of the total. Nevertheless, whereas in developed countries the percentage for agriculture, of the total for the food sector, accounts for slightly over 10%, this percentage is still around 14% in less developed countries.³³ In the latter countries, most agriculture is based on human and animal energy, and on traditional fuels. Experience suggests that the possible gains in agricultural productivity through developing modern energy services is a long way from being achieved

³² The water, energy, food nexus in the context of the 2030 ONGAWA Agenda, Nov. 2014.

³³ "ENERGY-SMART" FOOD FOR PEOPLE AND CLIMATE. FAO 2011.

in these countries, which reduces the quantity of food produced and the quality of this food.

Even though agriculture represents around 30% of the GDP in developing countries, the energy requirements for agriculture are not featured in most of the national energy policies. Having said that, important steps have been made in recent years, although more action is required.



Fuente: "ENERGY-SMART" FOOD FOR PEOPLE AND CLIMATE. FAO 2011

Illustration 3: Percentages indicating final consumption of energy in food production

The large demand for energy by agriculture means the cost that this input can have on the efficacy and economic sustainability of local farming systems needs to be taken into close account. For example, attention is called to the warning issued by the Asian Development Bank regarding this matter which describes the positive impact that the cost and availability of electricity has had in some countries in the Asia Pacific region, enabling millions of people to break away from poverty and hunger. The expansion of the rural electricity grid, subsidies for electricity, the availability of cheap pumps and the local drilling techniques have brought about a boom in the use of pipelines for irrigation. For example, the volume of underground water extracted in India increased from 10-20 cubic kilometres before 1950 to 240-260 cubic kilometres in 2000. However, the Bank also warns that this supply is not sustainable in all areas.³⁴

Another important link between energy and food is related to the production of biofuels, i.e. to agriculture as a supplier of energy. Providing local bio-energy sources can help to consolidate and improve rural life, and in the opinion of the FAO, it should be fostered, but always under strict surveillance in order to avoid adverse effects. Among others, these adverse effects are related to competition

³⁴ Thinking about Water. Differently Managing the Water-Food-Energy Nexus. Asian Development Bank. 2013.

for land use, reductions in the quality and fertility of soils caused by modifications to the carbon reserves, the impact on biodiversity and water sources, not to mention other negative economic and social effects. It should not be overlooked the fact that the large fostering of biofuels to ensure sustainable transport has often led to a reduction in the availability of water for food. Likewise, the policy for promoting biofuels has also been seen by many people as the cause of volatility in the maize and soya prices which brought about the food crises of 2007/2008 and 2010/2011, since, with some exceptions, all these raw materials are also used as food produce, causing great alarm. In short, this is a controversial subject.

In order to prevent as far as possible these possible impacts, the use of waste products is being promoted (used fat and oil), and the so-called "second generation biofuels" is being implemented, directly extracted from cellulose or lignine through more advanced technologies that permit the use of non-foodstuff raw materials, consequently reducing the demand for resources that could be used for human consumption. Likewise, through different directives, the European Union has included the so-called Sustainability Criteria that all liquid biofuels must comply with, when they are marketed in the European Union.

Management of the Water, Energy, Food Nexus

There are many approaches to the water, energy, food nexus, although the first is to decide what the main elements to consider are (the three elements jointly, or just focussing on one of them), to identify the variables that are to be included in the analysis, and the geographical scope of action - global, regional, national or local.

There are also different issues to be analysed in the approach to managing the nexus. Some researchers strive to design models of the complex, dynamic systems in the nexus and parameterise each of the intervening variables in order to be able to estimate the consequences of a specific action on one of them, on the remaining elements. Others, with more practical objectives, prefer to find new technologies to exploit the existing synergies between the technical interactions and find immediate solutions to urgent problems. Managers and politicians try to analyse the conflicts that arise in practice so that lessons can be learnt from them and adequate formulae can be found to treat them and prevent them from happening again in the future. The ultimate goal is always to help the people responsible for making decisions, informing them about how to deal with issues by taking into account the different, multiple impacts that the responses could have in different sectors and over time.

Whichever the case, "suitable management of the water, energy, food nexus" requires quantitative and qualitative knowledge, as far as possible, about the intricate relations and interdependence of the different uses of resources, considered as dynamic systems, not only related to each other, but also related to

the wide, complex conjunct of natural and human systems. As the FAO reminded, interrelations keep a close relationship to the general way in which resource systems are used and administered.

Analysis models and methodologies

The different analysis methodologies try to find a point of common comprehension in the mutual relations between water, energy and food and the underlying factors that drive them. The methodologies require available data, drawing up scenarios and designing analysis models in order to be able to inform the interested parties about the interrelations between the considered elements, highlighting compromise solutions and synergies between the different use of resources. The data must be accurate, reliable, relevant and appropriate. The scenarios must describe likewise a conjunct of plausible future facts in an intrinsically random world, so that they can be used to explore strategic issues, review policies or investment decisions. This information is important to find alternative answers - such as planning and application of new policies, investments, regulations and incentives, or developing technical capacities and action - as well as informing about the process for assessing and comparing the repercussions of the different action.

In addition, apart from the information that these models can provide, dialogue between the interested parties is indispensable, as it will contribute to bringing out the true objectives, interests and uses by the different players and will provide an opportunity for settling any differences.³⁵

There are different calculation tools to enable these analyses. The following figure shows the quantitative tools with increasing complexity from left to right. To the left an isolated approach for energy policy is shown in which inputs relevant to the energy sector policy only are entered, as part of an energy model which produce descriptive outputs from the sector, i.e. an energy balance without considering the impacts that such policy could have on water, land and food.

The centre of the figure shows a more inclusive approach through a basic water, energy, food nexus analysis tool, which receives inputs about the energy policy and relevant data from the energy sector, but it also includes basic water and land/food inputs, and produces results about the basic resources (water and land) that said energy policy actually requires.

Finally, the right side of the figure refers to a comprehensive analysis tool that accepts detailed inputs from the three sectors and supplies information about the necessary resources (e.g. total land), complemented by qualitative aspects (e.g. type of land) and other indirect factors, such as equality in distribution, governance, etc.

³⁵ The water, energy, food nexus. A new approach to supporting food security and sustainable agriculture. FAO, Rome 2014.

In some cases, represented by broken arrows, the outputs of an analysis can serve as inputs for other more comprehensive ones, although the figure does not intend to describe a sequential process³⁶.

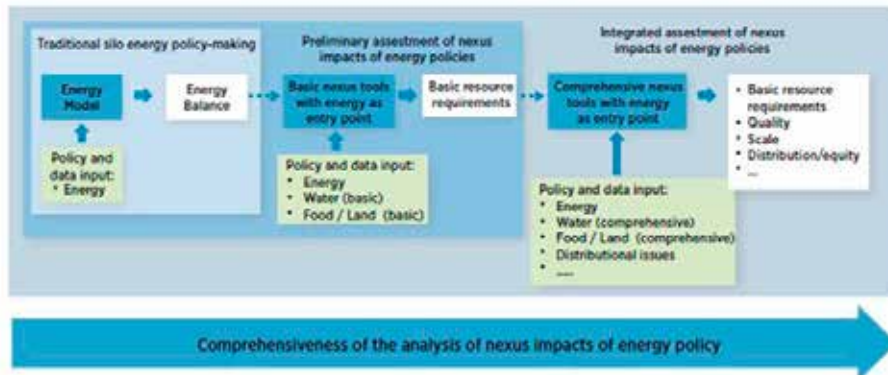


Illustration 4: Different levels in the analysis of energy policies

IRENA have also carried out a comparative analysis of eight calculation tools that have the factor of being easily accessible in common, taking into consideration at least two of the three sectors and which permit analysis of policies at country level.³⁷ An important conclusion from this analysis is that the principal obstacle all tools find is obtaining reliable, complete data for each sector and their interactions, it requiring a lot of time and resources because in many cases they are simply not available. This has led IRENA to conceptually propose a tool that permits quick, preliminary assessment of the nexus, with a limited amount of data, which does not substitute more complete analyses but rather precedes them, producing early inputs for the decision-making process and serving as a basis for those subsequent analyses.

When this tool is applied to a specific country, it would take different decision conjuncts as inputs that configure a specific energy balance, and would then produce outputs in the form of necessary land and water estimates, emissions and costs associated with each scenario. The outputs from this analysis could comprise the first level of a more complete analysis of the impact of renewable energies on the water, energy, food nexus in different aspects and scenarios.

The FAO has also³⁸ developed a methodology to jointly analyse the three sectors and their interrelationships, which is described in the report "Walking the Nexus Talk: Assessing the Water-Energy-Food Nexus in the Context of the Sustainable Energy for All Initiative". The aim is to understand the interrelations between the

³⁶ Renewable Energy in the water, energy, & food Nexus. IRENA April 2015.

³⁷ Renewable Energy in the water, energy, & food Nexus. IRENA April 2015.

³⁸ <http://www.fao.org/3/a-i3959e.pdf>.

water, energy and food systems in a given context and to assess the results of technical and political interventions within that context. The ultimate target is to inform about the related responses, in terms of strategies, political measures, plans, institutional configurations or interventions.

The first part of the assessment focuses on the analysis of the context, supplying information about the status of the water, energy and food nexus in the context:

- Current status and pressure on the natural and human resource systems.
- Demand expectations, driving trends of the resource systems.
- Interactions between water, energy and food systems.
- Different sectorial targets, policies and strategies concerning water, energy and food; this includes an analysis of the degree of coordination and consistency in the policies, including the scope of regulation of uses.
- Planned investments, acquisitions, reforms and large scale infrastructures.

The key players are the decision makers and the user groups.

After analysing the context, a number of tools are suggested for more in-depth specific problems, in order to perform the quantitative analysis of the impacts from different uses of resources and for developing strategic scenarios and outlooks.

The next part of the assessment looks specifically at the performance of intervention techniques and policies in terms of efficient use of resources and productivity. Through this it is possible to compare different interventions, based on the efficacy of the use of water, energy, food production land, employment and finance capital. A number of basic indicators are also proposed.

Regardless of the analysis afforded by the tool, the FAO believes that the final decision should be taken by consulting all interested parties.

The players must be actively committed in the assessment process in order to reach a consensus concerning strategic issues and decide how to respond to these matters. The decision model must be considered as a methodology in permanent evolution, learning from the lessons learned through experience.

It is also worth highlighting the Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism (MuSIASEM), a framework developed by researchers at the Autonomous University of Barcelona, which permits analysing the physical relationships and interconnections that exist between resources such as water, land and energy in comprehensive socio-economic systems. The system permits integrating data from national accounting systems and from other databases from different organisations such as the FAO, with those from Geographical Information Systems (GIS) and can be used for diagnostic and simulation purposes.³⁹

³⁹ <http://www.nexus-assessment.info/>.

The methodology has been applied to the water, energy, food nexus in three specific cases: production of biofuels from sugar cane in the Republic of Mauritania, production of grain in the Indian state of Punjab, and comparison of two electricity production alternatives in the Republic of South Africa.

Possible conflicts. Conflicts over water, as an example

There can be no doubt that the demand for scarce, essential resources for different uses and from different sectors with diverse social, economic and environmental interests and objectives, leads to conflicts of all kinds. To get an idea about some of the conflicts frequently arising from competition between water, energy and food services we have chosen water as the axis that generates conflicts, since most conflicts that arise usually end up being caused by demands or intentions related to hydrological resources that cannot be satisfied simultaneously.

Conflicts over water have increased in recent years in many regions around the world, with the increasing scarcity and competition for use between different sectors such as the energy sector, agriculture or land being the main causes, but also the growing mobilisation by civil society and unfair distribution of wealth are also common causes.

Water, as an essential resource, has certain characteristics that make it susceptible to producing conflicts. The first of them is the mobility inherent to the hydrological cycle, which does not take political, administrative or legal limits into account, and therefore makes determining rights over use somewhat difficult, leading to uncertainty. The second is the array of uses of water, which can lead to rivalry in exploitation. The third is interdependence, in general by uses; users downstream of a basin are largely dependent on the uses made by users upstream, who are in a privileged situation. Water quality is another source of conflict, since poor quality makes other essential uses of water unviable.

From all these characteristics conflicts can arise *between uses, between users, with non-user players, or conflicts between generations, jurisdictions or institutions.*⁴⁰

A typical example of a conflict *between uses* is that caused by the use of water in a reservoir intended for hydro-electric production when the agricultural activity in the area also depends on the stored water, either because of the water taken away that is necessary for producing electricity, or because of the time lag between agricultural and electricity usage. Another typical example is about water diversion: water which was originally planned for, assigned to and forecast for domestic use, being diverted for production use in growing urban agriculture.

⁴⁰ Ideas taken from the document L. Martin, JB Justo. Analysis, prevention and resolution of conflicts over water in Latin America and the Caribbean. CEPAL No. 171 April 2015.

Competition between agricultural, industrial and domestic use is one of the main factors leading to conflicts between rural and urban environments. On occasions, prevailing urban growth trends in the last century have led to exhausting the hydrological resources near major metropolis, which then have to resort to more costly sources located further away, often affecting the needs of the neighbouring rural areas. The other side of the same coin is how urban consumption is affected by over-exploitation of underground hydrological resources for agricultural purposes.

Conflicts can also arise between current and future uses, whenever the benefits of the current use can pose risks for new development opportunities in areas that do not currently benefit from the use of the same water source. There are also conflicts when the benefits are enjoyed by users who live a long way from the area in question, the impacts however being local and immediate, such as the case of hydroelectric power generation.

Sometimes this type of conflict over water use does not arise through competition in the use of the water, but rather because of the interests of certain *users*. This is usually the case of transferring water between basins. Conflicts between users are commonplace in the mining industry with the latter usually being assigned the exploitation rights over hydrological resources that were previously controlled and used, very often less intensively, by local communities. In this context the scarce protection of consuetudinary uses gains particular relevance, like all the problems associated with the rights of indigenous peoples to territories and natural resources.

Conflicts do not always arise between the parties who share the same hydrological resources, but also in front of *third parties*. This is the case of certain policies in sectors other than water, such as the energy or agriculture sectors, which either do not pay due attention to protecting hydrological resources, or jeopardise their sustainability.

Conflicts between *generations* arise when there is tension between the needs and preferences of today's generations and preserving the rights of future generations. It is true that the way water is used today can affect the future, although this effect can be temporary or permanent. Problems arise however when the impact exceeds the natural environment's ability to recover, and the damage is or at least can become irreversible, especially when the way the consequences are managed, compensated or mitigated are not seen to be correct.

Conflicts between *jurisdictions* reflect tensions between competence of different political / administrative divisions due to a lack of agreement over the physical or territorial boundaries of basins and the problems of fragmentation and lack of coordination this usually entails. This type of conflict are particularly serious when the water sources affect several countries, worsened by the lack of international legislation over these affairs, either due to an absence of instruments establishing the essential rules to avoid these conflicts, or because of the difficulty of enforcing compliance with the decisions that are made.

All these conflicts can become highly complex and have serious effects on economies, social stability, political relations and the environment. The core for the majority of these conflicts lies in exploitation, management and protection of hydrological resources, but most of the time they are worsened by deficient governability of the systems to access, distribution and exploitation of water, both nationally and cross-border. In general diverse other factors also play a role, including factors of an economic, political, social, cultural or environmental nature, which heightens the complexity since it means that multiple interests competing for a scarce asset have to be satisfied. Conflicts involving local communities or indigenous peoples with limited resources are particularly sensitive, as these people need the water to drink or to guarantee their subsistence economy and are sometimes faced with major projects that require high water consumption and are driven by powerful entities.

The difficulty in preventing these conflicts and also in managing them, often stems from deficient governability of the hydrological resources in many countries. This governance deficiency often arises through:

- Insufficient legislative frameworks: unsuitable approaches to rights; lack of environmental or social considerations; overlapping of regulations; lack of attention to consuetudinary rights, etc.; and also a lack of capability to apply them, either due to institutional weakness or inefficacy of the frameworks themselves.
- Excessive fragmentation of decision power, both territorial and sectorial. Lack of participation in decision-making; only the users are usually consulted without considering other affected parties, and more often than not consultations are only informative and do not condition the decision,⁴¹ considering other affected parties, and more often than not consultations are only informative and do not condition the decision.⁴²

The declaration of human access to quality water and sanitation as a Human Right by the UN in summer 2012 can help to reduce the number and complexity of these conflicts since it represents a change in the approach to management of water resources, which is expected to be gradually included in legislation and procedures concerning hydrological resources, particularly considering *integrating, cooperative and participative perspectives*. Nevertheless, there are still some situations that this Right, as it is currently formulated, does not allow the conflict to be resolved, including failing to consider all the uses of water. Similar arguments can be made for each of the policies and real situations that affect energy and food.

⁴¹ Ideas taken from the document by L. Martin, JB Justo, Analysis, prevention and resolution of conflicts over water in Latin America and the Caribbean. CEPAL No. 171 April 2015.

⁴² Ideas taken from the document by L. Martin, JB Justo, Analysis, prevention and resolution of conflicts over water in Latin America and the Caribbean. CEPAL No. 171 April 2015.

A major challenge for today's society

Today's society is faced with a spectacular challenge from which an endless number of global problems stem; namely social (poverty), economic (inequality in resources and consumption), and environmental (climate change, desertification, impact on biodiversity), whose solution will only be possible with participation by all. Thus, most international organisations state the need to tackle international cooperation strategies that help to find adequate solutions.

All these strategies entail:

- Finding possible, sufficient financing mechanisms.
- Providing technologies that are safe, environmentally sustainable, attainable and affordable for all, and
- Training and increasing the awareness among the different social agents so that they are conscious of the problems, what the most appropriate solutions may be and to what extent they are to participate in them.

Today's technology permits finding solutions to most of the problems, but technology is only a part of the solution to the problem, the main difficulties are of a social, economic or political nature. Comprehensive and at least consisting action and policies are required, to ensure the welfare of the population and sustainability of the environment.

Responsibilities in the management of the water, energy, food nexus are shared:

Governments must acknowledge their responsibility in considering interrelations between these essential resources in their sectorial policies and in ensuring that the public administration departments and private agents also take them into account. Financing institutions should be sensitive to the financing difficulties in poor regions, and in some cases reduce the demands for credit eligibility. Imaginative solutions are needed for the poorest. Universities have an opportunity to strengthen their role in society, not only by developing technology or knowledge, but also inducing collaboration proposals among the players, by providing neutral terrain to debate the different solutions to the problem and their implications be them of a technical, economic, social or environmental nature. The solution to the problems will not be possible without concurrence by the business world, which will also benefit directly in its own management and indirectly through development and improvement of living conditions by people within its scope of action. Companies should be aware that this is a part of their social responsibility. NGOs are conscious of the role energy and water play in the fight against poverty, but they should also be aware of the role they can play as catalysts to prevent and resolve problems by improving coordination of their activities and working complementarily with the activities covered by the rest of the social players.⁴³

⁴³ Project REGEZRA Final Report - Energía sin Fronteras and collaborators. 2009.

International cooperation has no doubt an essential role to play, particularly in problems that are more closely related to reducing poverty, as that is precisely where the greatest challenge for cooperation actually lies and where imaginative alternatives will need to be found, that permit optimising the efforts by all society in order to find more effective solutions.

It is well worth pointing out the initiatives by the German government and the GIZ⁴⁴ cooperation agency, who are carrying out an active programme in the water - energy - food nexus, promoting regional dialogue in the Economic Commission for Latin America and the Caribbean (CEPAL), the Arab League and the African Union and performing other more local actions with very encouraging results.⁴⁵

The Specific Problem of Isolated Rural Communities

One of the geographic levels that requires attention in the management of the water, energy, food nexus is the local level, since this is where most of the effects of mismanagement take place, its inhabitants often not having the opportunity of taking part in the decisions that caused it. In view of this situation specific, self-sufficient solutions are often sought, or at least solutions that pragmatically consider and take into account the real situation.

At local level, the situation that requires the most urgent solutions is that of the most isolated rural communities (IRC). It is in these communities where there is most poverty, and more specifically a lack of access to water and energy services, essential not only to overcome poverty but also to be able to guarantee adequate food and dignified health care. Geographic isolation, lack of attention by public authorities and the scarce interest by major corporations in these areas only increase the difficulty of providing this access under sustainable conditions. As discussed previously, the number of people in the world today without access to electricity is estimated to be 1,200 million, and over 2,700 million do not have access to efficient combustion systems for cooking, 783 million do not have access to water suitable for drinking, while 842 million suffer severe nutritional deficiencies.⁴⁶ Most of these people concentrate in isolated rural areas.

The most general situation for these communities, in many countries, is the lack of a State-wise outlook on the problem, with a complete lack of national development plans specifically designed for these areas, which because of their difficult access are left out of the general plans for extending national supply networks. This also includes a lack of public financing and the absence of spe-

⁴⁴ Acronym of "Deutsche Gesellschaft für Internationale Zusammenarbeit":

<https://www.giz.de/de/html/index.html>.

⁴⁵ A Guijarro, E Sánchez El nexo agua-alimentación-energía en el marco de la Agenda post 2015.ONGAWA November 2014.

⁴⁶ Source: IRENA, International Renewable Energy Agency.

cific regulations for decentralised solutions, often making it harder for these services to be provided under suitable conditions.

Isolated rural communities

Within the concept of isolated rural communities, a wide array of communities can be considered, with different ways of life and consequently presenting different problems with regard to development.

In principle, isolation can be identified by the following two essential characteristics: very low level of development, connectivity with infrastructures and provision of services, and an obvious political and administrative isolation.

Isolated rural communities are characterised by having:

- A high geographical dispersion, being located far from the most populated centres, with poor transport and communication infrastructures, generally located in areas of difficult orography and sometimes in highly valued environmental zones.
- A low consumption density and a low level of income, with poor growth perspectives. In general terms for these areas, the cost of basic services, should they be available, would be above the affordability of the citizens.

Access to energy and water services in IRCs is a complex and difficult matter, since, for them to be sustainable, not only do the technical and economical aspects need to be taken into account, but also the different issues related to organisation, culture, basic education and capacities of the communities concerned. On the other hand, different players converge in this process, each with different objectives and incentives.

The main problem is undoubtedly the need to cover the difference between the cost of the supplies and the paying ability of the users, which means subsidies or other kind of financial help are indispensable, not only for the construction of the initial infrastructures, generally very costly, but also to cover the cost of management and maintenance of the services. In all cases it is necessary to ensure that the tariffs to be paid by the users for the received services are affordable on a basis of equity and fairness, and that they are never higher than what other citizens pay for the same service when supplied by the main distribution networks.⁴⁷

Another fundamental problem is the management and maintenance necessary to guarantee the quality of the provided services. The technical difficulty for performing this management in remote regions is added to the low consumption and paying ability by the users, making the business not very attractive for the traditional distribution companies of these supplies. In most cases it must be

⁴⁷ Technologies for human development in isolated rural communities. Chapter 2. Royal Engineering Academy of Spain 2011.

the communities themselves in one way or another who take on all or at least some of this management. In most cases also it will be necessary to identify a local management model that is suitable for each of the communities. For this to be possible, these communities must be provided the relevant education and training. This will require a special local awareness and training campaign and a permanent monitoring by external organisations, over a period of time that will vary greatly depending on each case. It will be also indispensable to provide the communities with the necessary education to make appropriate use of the offered services. It must be remembered that the technologies provided are completely new and unknown to them.

Community management

Experience, technological progress and the persisting lack of interest by conventional distribution companies to act in these regions has led to a *community management* model, which has been improved over recent decades, intended for both the water and sanitation and the energy services. The model is based on the need to guarantee a leading role by the communities not only during the implementation stage of the systems, but also during their management, and particularly during operation and preventive maintenance. The model acknowledges the need to pay for services in order to recover the management, operation, maintenance and equipment replacement costs.

Community management however is a model that cannot be easily replicated. It is a complicated affair that goes beyond purely technological aspects and is also essentially related to social, political, cultural, financial and economic issues, not always taken into account in a consistent manner and full extent. It is not about building infrastructures that can permit access to something, but is more about providing continuous, desired services with the necessary quality. For this to take place, some essential considerations need to be taken into account:

- The service provided must meet a real need, identified and claimed by the community, and should be able to satisfy the expectations generated during the project stage.
- The technology offered must be appropriate for the area where it is to be implemented, and should not require materials or equipment that are hard to find in the local surrounding areas.
- The communities must take part actively in the design and execution of the project, and in the relevant decisions, including women as appropriate.
- Some sort of organisation must be established, to be in charge of all aspects related to the general management and the operation, maintenance and exploitation of the facilities, to the extent that the community must take on these responsibilities, providing it with the necessary training for this purpose.

- The operation and maintenance cost of the facilities must be estimated correctly for their entire life cycle, in all technical and managerial aspects.
- The necessary financial conditions must be foreseen so that tariffs payable by the users to cover these costs are in line with their paying ability.
- Procedures must be arranged to guarantee support for community management, particularly for any aspects that cannot be covered by the communities themselves.
- Continued support for maintenance of the systems is especially necessary as is support for implementation of the administrative and financing systems, compliance with current legislation, resolution of conflicts, planning, etc. Public authorities at state level bear obviously the main responsibility for this support, and they must define an institutional model that takes the singularities of these areas and these types of decentralised supplies into account, whilst also preparing specific plans and regulations to permit the start-up of the necessary services in a fair, universal manner. The local administrations will have to be trained to exercise the competences they have been conferred, since their role in the monitoring of the service quality is essential.

Civil society institutions, universities, NGOs and other project sponsors must provide support to local communities for the time necessary to ensure that the capabilities acquired during the project are going to be maintained.⁴⁸

Joint management of water and energy services

In spite of the reluctance there has been for some time, technological evolution, particularly the important progress made in renewable energies and their implementation thereof through decentralised systems in the rural sector, means that today people are convinced that water services will require an increasing supply of energy and vice versa, and that, in order to make both services sustainable, a joint outlook and treatment will be indispensable. In the case of the most isolated communities, dealing with water and energy services jointly confers some rather interesting synergies. The possible synergies are found in energy projects to which a water supplement can be added - the excess energy produced is used to obtain water - and in water projects where the water itself that is captured can be used to produce energy. The energy source applied to obtaining water can also provide surplus energy that can be used for other purposes. Experience in this field, has allowed the identification of a number of characteristics that are common to most water and energy projects in isolated communities, and the drafting of a series of recommendations intended to optimise the efficiency of undertaken projects, to ensure mid and long-term

⁴⁸ Technologies for human development in isolated rural communities. Chapter 5. Royal Engineering Academy of Spain 2011.

sustainability and to appropriately satisfy the needs and wishes of communities, their quality of life and their necessary development.

Solar or photovoltaic technology is one of today's best answers to this challenge, due to the significant fall in costs over recent years. Micro-hydroelectric and wind power technologies, depending on local conditions, can also be case-by-case appropriate solutions. The essential matter however is to conduct a proper survey of the region, assess the natural resources (particularly wind and water), the conditions for supply of materials and other resources, and the culture and capabilities of the communities themselves. The technologies employed must be the most suitable for each specific area.

The specific case of micro-hydroelectric technology deserves some technical comments; its implementation would be optimum in villages where there is already a forced pipeline to bring water via gravity to a tank with or without a silting basin, where the fall is broken before distributing water around the village. In this case, a turbo generator can be fitted at the inlet to the tank / basin, parallel to the main pipeline, to take advantage of the existing excess pressure, which is otherwise dissipated at the entrance to the tank or silting basin. Even if water is not brought to the site, channelling part of a river is also a viable solution to take it through a forced pipeline, and from there onwards to a turbine. By this means, the energy needs of the population is met with cheap, 100% clean energy, free from contaminating emissions, prolonging the useful life of the items subject to breakage such as regulation valves and reducers, silting basins and even the tank itself.

On the whole, renewable energy technologies are the only ones that combine the ability to offset local energy shortcomings without compromising the quality of the environment or creating economic dependence on fossil fuels. Through these solutions, the use of generating sets is avoided, thus doing away with their dependence on fuel and with the emission of contaminating gas implicit to the combustion of that fuel.

The governments in the countries concerned recognise this opportunity and are showing interest in promoting implementation of systems based on renewable energies, for electricity and water supply alike. Until now, when attempting to do so, a lack of interest was found from the traditional electricity companies operating in their territory, whose models - essentially based on centralised generation and on distribution through long-distance networks - do not fit in with the distributed generation philosophy. Fortunately today many of these companies are incorporating to their business the new distributed generation models, better suited to the distinct characteristics of isolated areas.

In projects designed to meet any other basic service for IRCs, be it health, education or any other, once the interdependence of water and energy and the need for both as necessary transversal resources to drive any development project has been established, it has been deemed convenient to include these supplies within the scope of those projects and to tackle them at the very design stage,

instead of dealing with them as a secondary element to be added or even ignoring the need for them. A determining aspect that justifies the convenience of extending the scope of a project to include an additional element, whether water or energy or both, depending on local conditions, is the exploitation of the resources mobilised around a project: logistics of project preparation, search for finance, and the human and technical resources deployed on the ground. Preparing a project and executing it entails mobilisation of significant resources, human, technical and economic, and for a period of time that can sometimes be lengthy.

This logic is also consistent with a programmed approach to projects, according to which the impact is multiplied when they merge in a joint action over the same area, i.e. in a programme: projects tend to mutually strengthen each other because the benefits of one part positively affect the other, and vice versa, activating synergies and increasing the impact. Before any development project, the fact of tackling the problem of water and energy in an isolated manner, sometimes simply as a mitigating action for a shortcoming, often leads to higher costs, and tends to produce poorer results than if the two supplies had been catered for in the same project right from the start. The lack of preparation and experience by organisations, particularly concerning energy, tends to result in a lack of optimisation of resources and a limited operational performance. Water and energy are not ancillary resources, but are essential ones that deserve priority being given to them by the designers of any development project.

The synergies deployed go beyond the technical aspect, as they also include the economic dimension owing to optimisation of resources: the same financial, human and organisational base is used to achieve a wider scope of targets in a project, and therefore the extension of its impacts. For example, if the same photovoltaic generation facility is used to extract water via pumping, and additionally for lighting an institution, the impact will have been doubled with only a slightly higher investment than the one required for pumping water, and taking full advantage of the whole project infrastructure (study, design, subsidies, logistics, etc.).

Other examples are:

- Taking advantage of the kinetic energy from water taken from height (hydroelectric).
- Adding a lighting supply component to a water extraction facility through photovoltaic power supplied pumping.
- Adding the supply of electricity to a water pumping wind farm station.
- Increasing the power of a hydroelectric turbine beyond the specific planned uses to include operation of water pumps for irrigation.
- Operating low water column irrigation pumps from power produced at mobile solar stations.

The last example shows the direct connection between the availability of water and energy with food safety.

Practical Cases of Managing the Nexus Resources

The examples described as follows are just some examples of managing the resources of the water, energy, food nexus, in which their sustainability has been sought whilst respecting the environment.

KENYA: The bio-friendly village of Nyumbani⁴⁹

170 km east of Nairobi is the Bio-friendly village of Nyumbani, an institution managed by the NGOD "Amigos de Nyumbani. Children of God Relief Institute", which takes in abandoned, orphaned children who lost their parents as a result of the AIDS pandemic that decimated their generation, and 100 elderly ladies who were likewise in a situation of vulnerability through the loss of their children, as heads of family and carers.

The infant population, that includes from newborn babies to adults, is structured around "families" of 10 children under the tutorship of a grandmother, who exercises the role of mother for them, housed in detached houses. 100 houses have been built and are lived in, surrounded by family vegetable gardens and small farms for breeding hens and rabbits.

The Bio-friendly village provides its inhabitants with food, medical and health care and psychological care, and also education from the infants' school to professional training, with different workshops and sewing and hairdressing schools, so that when they leave the village they can become productive members of society.

One of the ideas behind the foundation of the Bio-friendly village was for it to be self-managed and sustainable, without any external economic support, and also for it to be completely respectful towards the surrounding environment.

The economic sustainability, which has not yet been achieved, is based on four fundamental pillars: Energy self-sufficiency, balanced management of hydrological resources, production of sufficient quantity and variety of food produce and generation of complementary earnings from its business activity.

Fundación Energía sin Fronteras (EsF) has contributed decisively to energy self-sufficiency, with the help of SunPower, Hidroeléctrica del Cantábrico, Iberdrola and other donors, completing in 2014 the installation of a photovoltaic solar farm with nominal power 44.3 KW, which supplies electricity to the polytechnic institute workshops, with annual savings of € 30,000 in fossil fuels. The

⁴⁹ Sources: ONGD "Amigos de Nyumbani. Children of God Relief Institute" and Energía sin Fronteras.

surplus solar energy from the solar farm is used to pump water from the wells and dams in their territory, which is used in agricultural projects. The houses, which still did not have electricity, are being fitted out with photovoltaic panels. For cooking, they have cheap cookers running on biomass from renewable plantations within the complex.

Owing to the semi-arid nature of the land, water resources are limited and conditioned by the seasons. This situation is tackled through all manner of saving and recycling measures, such as collection of rainwater and recycling of sewage water for subsequent use in drip-feed irrigation systems for the family vegetable gardens. The community irrigation land uses pumped water, likewise via drip-feed irrigation systems. The Bio-friendly village has built sand dams to collect water, filtering it into the subsoil during the rainy season. This water is pumped to storage tanks in the village.

The family and community agriculture, from which all manner of vegetable produce is grown, contributes to the self-sufficiency in food. The protein content and the dairy products are obtained by breeding cows, goats, hens, rabbits and tilapia, a fish native to Kenya.

Care for the environment is performed through implementation of measures such as forbidding any material that could produce non-degradable waste in the Bio-friendly village, and the exclusive use of natural fertilisers obtained from animal and human excrement. Urine is effectively used to fight against termites.

The principal production project in the village, in order to generate income, is called "Trees 4 Children", supported by North-American cooperation and other international donors. This project consists of reforestation of the land in the complex with *Melia Volkensii* trees, which grow quickly and have high value for wood, at a rate of 12,000 trees per year over 10 years. In 2018 the planned 120,000 trees will have been planted, and commercial exploitation will begin. Craft products made by the grandmothers are also sold, as well as metal structures and furniture made in its workshops.

SRI-LANKA and MALAWI. Agroforestry for rural electrification⁵⁰

Agroforestry applies a number of techniques to improve the fertility of the soil and to increase crop yields, thus improving food security and income for farmers. One of these tools is called *intercropping*, or complementary crops, which consists of sowing or planting certain tree species and annual food-producing crops on the same land, with the trees providing nitrogen to dramatically improve the yield of the crops through this association without the need for mineral fertilisers. In Malawi, by uniformly distributing *Gliricidia Sepium*, a leguminous, fast-growing tree, in maize plantations, an average crop yield of 3.7 tonnes per hectare is achieved, compared to 0.5 to 1 tonne per hectare without the *Gliricidia*

⁵⁰ Source: IRENA (2015) Renewable Energy in the Water, Energy & Food Nexus.

or mineral fertilisers. In Sri-Lanka *Gliricidia* is effectively associated with coconut crops.

A more sophisticated application of intercropping now commercially available consists of using biofuel produced from trees to generate electricity in an energy - food programme. A 1 to 10 MW thermoelectric power plant is located in the area around maize crops - which may belong to several small scale farmers, where *Gliricidias* have been planted following a pre-established uniform layout. Regular pruning of these trees produces leaves with high protein content that can be used as forage for livestock, or as a fertiliser, and branches that can be used as biofuel at the power plant, covering the area's energy requirements. *Gliricidia* plantations next to villages can also provide wood for cooking, meaning that women and children do not have to carry heavy loads from public land, and preventing deforestation of the environment that the latter entails.

JAPAN: Simultaneous production of electricity and crops⁵¹

The concept of co-production of energy and food, known as Solar Sharing, was introduced in Japan in 2004. The idea behind this is that, beyond a certain level of sunshine, plants do not increase their photosynthesis, and therefore the "surplus" sunshine can be used to produce energy.

Several projects have been developed in Japan, where there are photovoltaic panels raised over crops, arranged at intervals that permit movement of machinery and also sufficient sunlight reaching the plants for photosynthesis to take place. In one of these projects in the prefecture of Chiba, 348 PV panels have been fitted 3 metres above ground level on a 750 m² farm where peanuts, sweet potatoes, cucumbers, aubergines, tomatoes and pumpkins are produced, reaching an annual electricity production of 35,000 kWh without being detrimental to agricultural production.

INDIA: Solar energy over channels⁵²

A 1 MW photovoltaic solar plant has been built in India, covering a length of 750 metres of irrigation channel with solar panels which, in addition to not occupying useful cultivation land, significantly reduce water losses through evaporation. The plant produces 1.53 GWh of electricity per year, and saves 9,000 cubic metres of water per day from losses through evaporation. This experiment represents interesting opportunities for water-saving and cultivation land saving around the channel network in India, which covers a total of 19,000 km. If 10% of the channels were covered with solar panels, there would be a preservation

⁵¹ Source: IRENA (2015) Renewable Energy in the Water, Energy & Food Nexus.

⁵² Source: IRENA (2015) Renewable Energy in the Water, Energy & Food Nexus.

of 4,400 hectares of land and a saving of approximately 20 million cubic metres of water per year.

Another initiative to save energy in food production in India is the plan they have announced to replace 26 million underground water extraction pumps for irrigation for solar pumps. The savings in resources that this change will represent is enormous. For example, replacing 5 million pumps driven by diesel generators for solar pumps would save 18.7 equivalent Gigawatts (GW) of installed power, 23.3 terawatts x hour of electricity, 10 million cubic metres of diesel fuel, and 26 million tonnes of carbon dioxide emissions.

WEST AFRICAN CAPITALS. Urban and suburban agriculture⁵³

The African continent has been undergoing a continued urbanisation process, ever since independence of the countries, which has brought a large number of poor peasants to the outskirts of cities in search of better living conditions. This has led to urban and suburban agriculture and to a lesser extent to dairy livestock and poultry farming, activities that have a beneficial social impact due to job creation and the contribution provided to food safety.

The main difficulties encountered by suburban agriculture lay on the access to arable land, for which every one competes although it legally belongs to no one, and also the access to healthy water at affordable costs.

Access to water, a pressing problem throughout all West Africa, is worse in poor districts because of the lack of supply points, losses in the network or insufficient earnings to pay for the service. This has led to alternative sources of easily accessible water being sought, of which the cheapest and most abundant is residual water from industry or domestic sources, usually channelled away, without any kind of prior treatment, to the sea, rivers or directly into the public paths.

Waste water is rich in NPK (nitrogen, phosphorous and potassium) and other nutrients that drinking water or surface water are short in. Consequently, using this water reduces the necessary provision of organic or mineral fertilisers.

Nevertheless, the use of this water for irrigation entails a major health risk due to the toxicity of the pollutants it contains. Waste water from industrial sources usually contains heavy metals that can cause lead poisoning (*saturnism*). Waste water from domestic sources can contain high levels of faecal micro-organisms, easily as dangerous as the latter, which in some cases exceed the recommendations by the WHO for irrigation water, by more than 100 times. The most frequent impact of these practices is diarrhoea and other parasite infections among the farmers and their families, but they can also cause other diseases such as cholera and gastroenteritis, among the population who eat the contaminated vegetables without previously washing them.

⁵³ Extract from: "Agriculteurs dans les villes africaines", Éditions Karthala, IAGU, Crepos, 2009.

Although this health situation cannot be accepted (in fact irrigating with faecal water is forbidden in most countries), formulae should be researched to make urban agriculture compatible with enforceable health safety, since this practice has a positive socio-economic impact and contributes to the food security of many families.

A possible solution would be to apply waste water a previous treatment, to a level that is sufficient for irrigation use, using extensive techniques such as macrophyte plant lakes to digest pathogenic germs. These facilities, whose costs are 50% lower than the intensive techniques used in the North, which cost could in addition be subsidised by governments, work with solar energy and do not require specialised labour to operate them. This gives them added value in the water, energy and food Nexus, and would permit saving drinking water for domestic use, cooking and hygiene use.

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