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Introduction

Definition

Geostrategy and geopolitics are fields of analysis with imprecise profiles and that partly overlap. Clearly, the same thing happens when referring to the energy sphere. One way of differentiating the meaning of both terms is to have regard to the specific content of the studies published with each denomination[1]. Another way is to make use of the express definitions, being aware that any of these that are the chosen ones may be disputed.

In any event it may be useful, at least as a point of reference, to attempt to characterise both concepts. J. Black[2] defines the concept of geopolitics as the "relationship between political, principally the composition and use of power, and geographical factors, especially space, location and distance". He adds that "geopolitics calls attention to the context in which national

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

[2] J. BLACK (2009). "Geopolitics". The Social Affairs Unit

security decisions are made and issues of war and peace are decided, and, more particulary, the relationship between strategy and geography". Conversely, L. Freedman[3] defines the concept of strategy as that referring "about mantainign a balance between ends, ways, and means; about identifying objectives; and about the resources and methods available for meeting such objectives". Freedman moreover, states that "strategy comes into play where there is actual or potential conflict, when interests collide and forms of resolution are required. This is why a strategy is much more than a plan". It is sufficient to add the geographical factor to this definition, so as to obtain a characterisation of the concept of geostrategy. As Freedman points out, on the other hand, his definition of strategy is applicable to both the military sphere, and the political or business one.

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

"Energy geostrategy", like all strategic studies in general, can effectively use the conceptual framework that is offered to it by techniques that are fundamentally developed in economic theory, such as cooperative or non-cooperative gaming theory, or the theory of real options[4]. However, there is a *trade-off* between the analytical rigour of these disciplines in decision-making modelling and the realism and practical relevance of the conclusions in very complex environments. States, coalitions of states or companies that interact in the global energy resources map must, in addition to sophisticated formal decision models and geographical factors (space, location and distance), take account of other extremely relevant factors such as technology, geology, institutions, history and particular ethnic features. "Energy geostrategy" hence requires an inter-disciplinary approach and a balance between the using of quantitative techniques and knowledge that is hard to quantify.

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

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

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

The influence of the Middle East geopolitical scenario on the oil market is surely the one of the most studied of the causal relationships mentioned (impact of geopolitics on the energy environment). One example of causality in the opposite direction is offered by the development of hydrocarbons is offered by the development of unconventional hydrocarbons in the USA which will lead to this country becoming self-sufficient in gas supplies in the medium term, and also practically in oil in the long run[5]. Perhaps, therefore, there will be a possible review of the designing of its Middle East diplomacy and security and defence policy, bringing about possible variations in geopolitical equilibriums in that geographical area. China's new international role provides another example of this two-way causality. The change in its political scenario, brought about by Deng Tsiao Ping's leadership, has led China to strong and sustained economic growth in the last two decades. This will be foreseeably extended to the medium and long-term, albeit with a more modest profile. Given the scale of this country (with a few short five-years spells, its G.D.P. will exceed that of the USA, in absolute terms), a shifting of the weight in energy demand towards Asia is now taking place that will become more acute in the medium and long-terms (with the additional pressing of India). This entails a profound modification in the international movements of fuel and a re-orientation of the transport infrastructures and investments. Conversely, China's energy security challenge is inducing significant changes in the global economic scenario, leading to that country's increasing international penetration, by targeting the guaranteeing of covering its huge energy needs in a stable manner. Up to now, this penetration has preferably been developed by means of a commercial and investing strategy. However, in the long run, it will inevitably take the form of greater political pressure[6].

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

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

[5] World Energy Outlook. 2013. I.E.A.

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

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

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

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

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

The decades in which the European Union has been functioning, with its common institutions and its progress in the configuring of a common citizenship have made it possible to dispense with the barriers, mentioned above, which constitute the political antagonisms, so as to undertake a common energy strategy. The 20/20/20 targets (Saving and efficiency, penetration of renewable energies and abatement in CO_2.emissions) for 2020 and the regulations orientated towards building an internal market for gas and electricity are the form that is taken for a European energy policy that is aimed at moving forward in the threefold target stated above (competitiveness, security, sustainability) in the horizon 2020. There is also the added intention (already specified in the deliberation and discussion processes) of continuing in that direction with longer-term horizons (2030 and 2050). This cooperative process on energy matters between states –without parallel in any other regional area- nonetheless presents limitations and inconsistencies that illustrate the difficulties in achieving international agreements in the energy field, even though these targets are shared. Firstly, in the European Union, in spite of the high degree of political, economic and institutional homogeneity of the member coun-

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

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

The restrictions imposed by the community targets of a quantitative nature, the specific regulations concerning energy and the European Union's competition policy leave extensive room for discretion by the member countries on energy policy. The regulatory competences in the electrical and gas sectors essentially pertain to the national authorities in the same way as the decision-making capacity to make investments in essential infrastructures and, even more clearly, the energy security policy[8]. This fragmenting of competences, together with the asymmetries in the energy supply policy as a result of the difficulties in geographical localisation and trade history impedes making use of economies of scale that should facilitate a foreign energy security policy for the Union. In the same way, the construction of the energy interconnection infrastructures map in Europe has clearly followed a less than optimum path, both from the perspective of building an interior energy market and the European energy security challenges.

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

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

community action with respect to the shareholding of the State as a corporate control of exchange rate barrier[9].

The difficulties that are put forward in the European Union policy concerning managing *trade-offs* between competitiveness, security and sustainability are unrelated (other than in a specific case such as the policy on coal) to reconciling the interest of the different member states. This problem is also broached, albeit with different profiles in each case, in the energy policy of non-European countries, and it is probably the hardest one to solve. In the European case, the security (increase in energy self-supply) and sustainability (environmental protection) challenges justify the restrictions imposed by means of the penetration targets of a 20% reduction in CO_2.emissions by 2020 (as well as the even more restrictive ones that are still being discussed for 2030, of 30% for renewable and 40% for CO_2.emissions). Progress in meeting these targets, as well as being hard to make compatible with the standard design of the interior energy market (as far as this concerns the electrical sector) that the particular community institutions are pressing for, is provoking an increase in energy costs. This is hard for public opinion to take on board (it is not well-enough informed about the security and sustainability restrictions that entail an excess cost) and furthermore, it is creating a growing breach in competitiveness with other geographical areas (specifically with the USA).

The explanation for the competitiveness gap with the USA that could induce the differential in energy costs (gas and electricity) lies in both regulatory and technological factors. The US has not approved any mechanism at the federal level that leads to setting a price for the CO_2.released (neither cap and trade or tax), something that does occur in Europe (with the current cap and trade mechanism). For European consumers, this represents an excess cost that will be reflected in both the gas price and in that for electricity (as the gas and coal is used as a fuel in generation). On the other hand, the excess cost of the growing penetration of renewable energies that energy consumers almost fully bear in the European Union is covered to a significant degree in the US by its federal budget (the federal incentives to introducing renewable energies is fundamentally implemented through tax credits). Recently, moreover, the mass extraction of unconventional gas (accompanied by keeping the prices of liquid hydrocarbons high) has made it possible to attain natural gas prices in the US market that are around a third of those currently applying in Europe. A medium and long-term extrapolation of the current situation would lead to a general loss of competitiveness of the European economy

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

and growing offshoring (towards the US) of energy-intensive European countries. The regulatory standards relating to the price of CO_2.in the US, and the system of providing federal incentives for renewable energies will probably be maintained in the long-term. Natural gas prices, however, will tend to become aligned with the average costs of extracting unconventional gas in the medium-term (not including the effect of the remuneration from liquid products). Therefore, the differential with European prices will be reduced (although this will be kept at a relevant sum)[10]. In the long-term, there is plenty of uncertainty, owing to the effects of the second round provoked in the international gas market by the self-sufficiency of the US and the impact of the gradual replacement of contracts in Europe that are very long-term and indexed to the price of oil or oil products and the progressive development of the organised gas markets (hubs) in European territory.

The global dimension of the greenhouse gas abatement policy

The most decisive and urgent international agreement in the sphere of global energy policy is that which should lead to a global decarbonation strategy. This corrects the potentially devastating long-term effects of climate change that would be caused by the current trend in CO_2.emissions continuing. The decarbonation policy is the main vector of one of the three goals of energy policy (sustainability), but unlike the other two (competitiveness and security), it only makes sense if it is tackled in a global sense since the climate change phenomenon is global. However, since the negotiations about the Kyoto protocol where (essentially for industrialised countries apart from the US that did not ratify the Protocol) quantitative targets for reducing greenhouse gases by 2012 were set, there has only been one quantified international commitment: the 2009 Copenhagen agreement (adopted by statute in Cancun the following year). This limited the increase in the planet's temperature to less than 2ºC at the end of the century, which would require the developed countries to reduce their greenhouse gases by about 80-95% by 2050[11]. Of course, as has already been stated, the European Union has set the target of reducing carbon emissions with the horizon 2020, by means of a cap and trade mechanism and the operation of an emission rights market, initiated in 2005 and that entered its third phase in 2013. The European effort doubtless has an exemplary effect, but its global quantitative impact is insufficient (European greenhouse gases represent 12.5% of total number of green-

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

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

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

On the other hand, focusing on the 2ºC heating limit as the basis for a possible international agreement is perhaps not the right methodology. The M.I.T. professor, R. S. Pindyck[13] does a radical critique of the reliability of the most commonly-used products integrated assessment models in order to estimate the social cost of CO_2.emissions. This is used as the basis for an assessment of alternative greenhouse gas abatements policies. *"*These models have crucial flaws that make them close to useless as tools for policy analysis: certain inputs (e.g., the discount rate) are arbitrary, but have huge effects on the social cost of carbon estimates the models produce; the models' descriptions of the impact of climate change are completely ad hoc, with no theoretical or empirical foundation; and the models can tell us nothing about the most important driver of the social cost of carbon, the possibility of a catastrophic climate outcome. Integrated Assessment Models based analyses of climate policy create a perception of knowledge and precision, but that perception is illusory and misleading*".*

Pindyck's scepticism as regards the usefulness of the most-commonly used models for evaluating the social cost of CO_2. emissions does not mean that he considers this cost to be irrelevant. On the contrary, he is of the opinion that the effects of heating could be catastrophic. But, in demonstrating the low degree of reliability of both "climate sensitivity" models (that associates CO_2.concentrations in the atmosphere with temperature increase) and the "damage function" (that associates temperature increase with reductions in G.D.P., consumption, etc.), Pindyck invalidates *fine-tuning* methodology so as to evaluate the different alternatives of climate policies that are presumably guided by the non-existing precision of sophisticated models. Conversely, he proposes a simpler alternative methodology consisting of "come up with rough subjective estimates of the probability of a climate change sufficiently large to have a catastrophic impact, and then some distribution for the size of that impact (in terms, say, of a reduction in GDP or the effective capital stock)". On these bases, Pindyck conceives of a greenhouse gases abatement policy "as a form of insurance: society would be paying for a guarantee that a low-probability catastrophe will not occur (or is less likely)". The conceiving of the greenhouse gas abatement policy as an insurance policy against low-probability events (e.g. 7 - 8º C increases in the temperature by the end of this century), but one with potential catastrophic effects,

[12] European Commission (2013): "E.U. Energy in figures"

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

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

There are to be considerable multiple obstacles to an effective international agreement on tackling climate change. Generally speaking, the costs of the greenhouse gases abatement policy are perceived of in the short-term, while the effects of failing to adopt these (potentially catastrophic) will take place in the very long term. This tends to induce public opinion to be reticent when faced with short-term severe measures (if an inter-generational lack of solidarity predominates and discount rates are high, a cost-benefit analysis would rationally justify this position). The impact of this phenomenon, common to all countries, has nonetheless had a very different political translation between them. It is enough to compare the climate change policies in the European Union and the US. It is possible that this relative insensitivity of the public opinions is being corrected insofar as a reasonably-reliable correlation can be established between the global warming that has already taken place and the extreme weather phenomena that we are experiencing, even though this raising of consciousness will foreseeably be gradual. On the other hand, the social cost of CO_2.emissions reflects negative externality, which provides incentives for the trend of states they behave like free-riders. Also, in this case, we can highlight the European counterexample, although pronouncements against a strict greenhouse gas emissions policy are increasingly extending in the European Union, which are not accompanied by an analogous strategy of other large polluters. The resistance of some countries towards signing an agreement also reflects the influence of economic interests (business or state) that are associated with consumption or the production of fossil fuels. Furthermore, in amongst the challenge of sustainability such as the greenhouse gases abatement policy and the security and competitiveness targets, there is a measure associated with the trade-offs that differs between different countries. Bordoff and others[14] point to coal as an example of this trade-off. This offers a lower security risk than oil or gas, in spite of being a greater CO_2.emitter, or the development of "coal-to-liquid" technology that would improve the security standard (above all, in countries with considerable coal resources) by reducing oil consumption. Then again, it would have a more negative impact on climate change. In general, those countries whose self-supply is based upon fuels with high levels of CO_2.emission (coal above all) will undermine their energy security (or, at least, made costlier by a sustained control of emissions). It is true that the commercial exploitation of decarbonated technologies (above all, CO_2.capture or confinement) would radically alter this scenario, but that threshold has

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

not yet been exceeded. The differences between countries as regards the trade-off between climate policy and competitiveness are also significant, but the competitiveness differential between countries (or regional areas as the European Union), which undertake ambitious greenhouse gas abatement policies and countries that do not do this (thus avoiding the excess energy cost associated with this policy) is fundamentally recorded. Lastly, it is understandable that developing countries, which are not responsible for CO_2.concentration (and that of other greenhouse gases) in the atmosphere caused by the economic development of industrialised countries over the course of the last two centuries, are pursuing a differentiated form of treatment in a possible international agreement so that it does not significantly put the brakes on their economic development programmes.

Every international agreement on CO_2.emissions abatement policy implies the acceptance of an excess energy cost. Pindiyck[13] mentions the broad variability in the estimated social cost values of CO_2.emissions (from $ 12 per Tn of CO_2.in an estimate by W. Nordhaus to $200, which would be the figure that N. Stern considers to be in line with the necessary abatement of greenhouse gases), and he suggests the proposal (updated) made by the US Interagency Working Group of $33/Tn as an approximate acceptable value. This would be used as a basis for setting a tax or a cap on greenhouse gases, consisting of a shadow of this amount. The choice of the mechanism used is not a matter of indifference. Although a cap and trade model provides greater security when it comes to meeting the quantitative targets of reducing greenhouse gases and this represents, at least in theory, a more efficient allocation of emission rights, the experience of the functioning in the first two phases of the European emission rights market (in which prices have recorded wide fluctuations that has made them invalid as an indication for investments with lives longer than thirty years) would make the balance tip towards utilising taxes. An intermediate model could be inspired by the British electrical system reform proposal that sets a floor for CO_2.prices. It is rather unlikely that there will end up being one single worldwide model (whether a universally applicable tax or a global cap and trade mechanism with an international emission rights market and one sole price) but the different mechanisms that are established should imply a similar excess cost for the group of industrialised countries. It should also include instruments (e.g. by means of assistance for technology transfer) that reduce the excess energy cost for developing countries.

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

tinue to assume, ambitious greenhouse gas abatement policies. China, although it has officially declared itself to be in favour of establishing a greenhouse gases control policy, is facing up to the problem of replacing a coal-focused energy system (almost 80% of electrical generation uses coal as a fuel, and the proportion of this in total energy consumption is greater than 60%). In a country with strong growth in expected energy demand, a drastic change in the CO_2.emissions profile would not therefore take place because of the penetration of nuclear energy and renewable energies, but rather because of coal being replaced by natural gas in electrical generation, if the current estimates of recoverable resources of shale gas (with 1.115 trillion cubic feet in 2013, the highest in the market)[15] are translated into extraction projects that are viable from the economic, locational (water availability), environmental and institutional viewpoints. There is no doubt that the US is amongst the greatest polluting countries and it is the one that displays the greatest political division. It did not ratify the Kyoto Protocol and neither did it complete the congressional approval of the Waxman-Markey legislation in 2009-2010, which envisaged the setting-up of a cap and trade system and a target of reducing greenhouse gases by 17% by 2020, as compared to 200511. In 2013, President Obama presented his Climate Action Plan with a set of initiatives for the Federal Administration, but without Congress's support. As D. Robinson[16] states, although the proposed measures are heading in the right direction (in fact, there are in line with the regulations that were ultimately not passed in 2009-2010), the lack of legislative approval reduces their effectiveness and, above all, it undermines the political weight of the USA in its negotiations on the U.N.F.C.C. (United Nations Framework Convention on Climate Change), which should have led to an agreement before the end of 2015. Domestic political difficulties in reaching a consensus on a greenhouse gas reduction programme that obtains Congress's approval are as paradoxical as the target of a 17% reduction by 2020 (which appears in the Waxman-Markey regulation, in the targets assumed in Copenhagen in 2009 and that is repeated in Obama's 2013 Climate Action Plan) being easily attainable (largely due to the intense replacement of coal by natural gas associated with the exploitation of unconventional gas in the US).

The CO_2.reduction policy, as the main vector of the sustainability target of a global energy policy, will foreseeable open the way up, in the form of a global agreement sponsored by the U.N.F.C.C.C., in spite of the countless differences set out above. This is not the case with the other two components of the triple energy policy targets. Nothing similar to an international agreement that shapes what the global targets would be on the

[15] L. HORNBY and E. CROOKS (2.014). "A new frontier". Financial Times (8 January)

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

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

Energy security

The energy security objective[17] is traditionally defined as a guarantee of continuity in energy supply (probability of interruption below an economically and politically acceptable level) at certain stable and reasonable prices (stability and reasonableness are also defined in terms of their political and economic acceptability). So, energy security is a crucially-important strategic variable in the agenda of both the diplomatic action of states and in their security and defence policies. This is the reason why some states resist assigning responsibilities in that field to multinational institutions, even when these have attained a certain degree of political integration (such as in the European Union). Energy security policy is also, consequently, a risk management policy that entails both physical assuring of the supply and the coverage of price risks. The strategy of minimising the risk of the energy supply being interrupted obviously moreover depends on the policies of a domestic nature aimed at promoting the reliability of the national energy system (infrastructures planning, the diversification of the fuels and technologies mix and a suitable regulatory framework) regarding the extent of self-supply, the geographical diversification of the supplies, the political stability of the suppliers and the solidity of the diplomatic relationships with these.

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

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

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

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

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

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

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

Energy factors: global energy and competitiveness

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

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

The energy policy initiatives targeted at promoting energy security and sustainability (e.g. the CO_2.reduction policy) usually implies an excess cost for energy supply and consequently, they negatively affect competitiveness. Inasmuch as that excess cost reflects negative externalities, energy security and sustainability policies are economically rational, but the differences between states in assessing these externalities or in the instruments used to internalise them, lead to results that are different in terms of competitiveness. For example, different estimates of the social cost of CO_2.emissions would take the form of different amounts (relating to the t. of CO_2.emitted) if the imposing of these is the mechanism chosen to reduce emissions, or in differentiated required quantitative targets of the reduction mechanism is of the cap and trade type. The excess costs of the different alternatives would be different and the same would happen with the impacts concerning competitiveness. A second example, which has already been mentioned, is that offered by the differential effects in competitiveness of the use of different instruments to provide incentives for the use of renewable energies (an essential vector of the security and sustainability policies). The utilisation of a framework of incentives, as predominantly occurs in the member states of the European Union, in which the excess cost of the penetration of renewable energies falls on consumers as compared to the use of instruments such as tax credits that are used by the US federal government is conducive to a penalty relating to the competiveness of the European countries as compared to the US. In Europe, the companies will bear an excess cost that is imposed on taxpayers in the US.

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

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

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

Competition and cooperation

In the preceding pages, it has been stated that the respective role of competition and cooperation between states in order to attain the energy targets (competitiveness, security, sustainability) on a global scale is different for each target. International cooperation is a necessary condition to attain the CO_2.emissions reduction targets that are compatible with an effective climate change policy. Global warming is a worldwide phenomenon and therefore, a policy of minimising the potentially catastrophic risks of excessive warming can only be effectively tackled with policy covering the plant that results from an international agreement. In the case of energy security, the result of a worldwide cooperative effort between states would doubtless be more advantageous for everyone. But

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

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

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

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

The articles contained in this publication

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

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

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

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

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

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

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

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

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

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

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

The article then goes on to present an estimate the resources at the global level, at the same time as evaluating their potential production costs. Once the abundance of these and the economic viability of extracting them (without internalising the costs associated with the CO_2.emissions generated) has been confirmed, the article goes on to focus on the geographical distribution of the unconventional oil and gas resources. The aim is to find out whether their geographical location may represent a counterbalance to the current concentration of the conventional resources in certain regions of the planet. Subsequently, he moves on to analyse the prospects for production during the next two decades, identifying the potential leading players and evaluating the possibility of unconventional resources, which constitute a real and long-lasting alternative to the current hegemony of OPEC and the Middle East, in the case of oil, and of this latter region and Russia in the case of gas. An assessment is made of the change that producing unconventional hydrocarbons could introduce in the current exporter-importer balance sheet of the different countries and regions. In this way, he seeks to recognise changes in the direction of the commercial movement of oil and natural gas, as well as the possible trends of re-organising the current map of world trade and the possible implications that such a reorganisation could have on the security of global supply routes. The author of the article states that the methodology used to cover the objectives of his studies basically consisted of the detailed study and a summary of the data and conclusions presented in several recently-published reports of the International Energy Agency. The article concludes with an extensive presentation of conclusions relating to both unconventional oil and unconventional gas and it features a final reflection on unconventional hydrocarbons and energy dependency, applied to examining the different paths that the US and Europe will foreseeably follow in the medium and long-term.

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

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

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

I. García Sánchez's article moreover carries out an extensive study of China's energy resources in coal, natural gas and oil (including an examination of its potential exploitation of conventional hydrocarbons), of the demands for the supply of those fuels, of the possible routes and the necessary transport infrastructures. It also examines technological factors of special strategic value for China (such as, for example, the possible development of CO_2.capture and confinement technology, which would enable clean exploitation of Chinese coal resources) and the new post-Fukushima nuclear security scenario that has a bearing one of the vectors of its decarbotation policy and boosts the integrating trend of the energy structure in the Asia-Pacific region.

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

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

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

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

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