EUROPEAN SECURITY – A EUROPEAN PERSPECTIVE

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Abstract. In spite of its critical role, energy security lacks a universally agreed definition, which given its complexity may well just be unrealistic. The concept is still used in a wide range of reports and documents, often without discussion of its dimensions and their significance. As a consequence, the literature is characterized by an almost overwhelming focus on securing supplies of primary energy sources and geopolitics. Clearly, views on energy security also differ widely between nations. The European Union's approach towards energy security is presented in this paper; it can be derived from several policy legislations and proposals that followed the European Commission's 2000 Green Paper "Towards a European Strategy for the Security of Energy Supply".

Introduction

The horrors of two world wars and a long history of violent conflict between European powers prompted a desire to bridge the divisions between European nations and move towards more integration. On May 9, 1950, the French Foreign minister Robert Schuman proposed to place the French and German production of coal and steel, essential military resources, under a common High Authority, "open to the participation of the other countries of Europe". By inextricably linking economies, so the hope was, the creation of a European Steel and Coal Community would make war "not only unthinkable but materially impossible". Today, European economies and specifically the energy systems are closely interlinked and cooperation is essential for securing our energy supply.

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Energy is indispensable to our economies and our way of life. Since production and consumption for most energy carriers are separated by long distances and since energy cannot be easily substituted or stored, energy security is an essential concern for industrialized nations. It should not be forgotten, however, that energy poverty still afflicts over a third of the world's population, which lives without access to electricity.

The major challenge for both policymakers and policy-oriented research is to select economically rational strategies for energy security, i.e. strategies based on a careful consideration of their costs and benefits and the possible interactions between policies. This will require a robust, rigorous and transparent approach to assess future energy security challenges. The aim of this chapter is to present the key elements of such an assessment, and to highlight some of the main challenges for securing Europe's energy.

The Concept of Energy Security

In spite of its critical role, energy security lacks a universally agreed definition, which given its complexity may well just be unrealistic (Chester 2010). The concept is still used in a wide range of reports and documents, often without discussion of its dimensions and their significance. As a consequence, the literature is characterized by an almost overwhelming focus on securing supplies of primary energy sources and geopolitics. Clearly, views on energy security also differ widely between nations (Yergin 2006).

Any consistent assessment of energy security issues requires an explicit discussion of the concept and measures of energy insecurity. This vagueness of energy security lends itself to justify various policies or actions, and be "exploited in various ways by different interest groups" (Loeschel, Moslener et al. 2010). Depending on how the problem of energy security is framed (for example how many sectors are considered), the same energy system can be considered either secure or insecure (Winzer 2010). Starting from the general definition of security as "the condition of being protected from or not exposed to danger" (according to the Oxford English Dictionary) and from a review of several definitions, Winzer reduces energy security to the "absence of or protection of a system against energy supply related threats". There are two key elements in these definitions, one general and one specific: First, the condition of "not being exposed" to danger, or the "absence" of threats requires an assessment of the probability that critical events can occur, as well as their potential magnitude and impact. Second, the condition of being "protected" from threats, or of not being vulnerable to possible adverse events, can be synthesized to the concept of energy system resilience, i.e. the "capacity of an energy system to tolerate disturbance and to continue to deliver affordable energy services to consumers".

A corollary of this concept of energy security is the need to extend the restrictive concept of security of supply towards the more systemic concept of "energy services security" of the energy system as a whole (Tosato 2007, DBERR 2007, Jansen 2009). A system approach aims at including all significant elements of the system under study, emphasising the relations and synergies between them and the integral nature of the system. Energy systems include the complex, interrelated chains of commodities and processes linking the extraction of primary energy to the satisfaction of the demand for energy services. The extended concept of energy services security has much wider implications than securing the smooth behaviour of the global crude or natural gas markets. It encompasses all energy sectors and all steps in the energy chain, from the oil reservoir or coal mine to the passenger kilometres or the warm water demanded by the end user (Tosato 2009).

In the short term, the options for an economy to substitute energy for capital or labour are limited, which means that, for industrialized countries, energy possesses the role of a limiting factor for production as well as consumption. Problems due to energy supply disruptions can therefore rapidly and extensively affect the welfare of a country. The impact of possible adverse events on energy security is determined by the economic system, as well as by the timing of incidents. This is due to the wide variety of factors determining the capacity of the system to cope with those events, i.e. what is generally known as 'energy system resilience' (Lovins 1982).

In summary, even if many policies focus on a specific supply chain, a comprehensive assessment of energy security needs to take a systemic approach. A robust measure of energy security "should focus on what society cares about, i.e. the well-being of its members" [DBERR, 2007].

Quantitative Approaches to Energy Security

A key question for policy oriented research in energy security is how different policy options shape an energy system that is resilient enough to disruptive events to satisfy society's needs for energy services? This requires an assessment of the impacts of a policy on the energy system and an understanding of what is resilient 'enough'. All energy systems deliver some level of security for consumers (NERA 2002) and any increase in resilience comes at a price. Beyond a certain point, the costs of increased resilience exceed the expected benefits.

If the need for a policy intervention has been accepted, then both the nature and the extent of that intervention have to be carefully assessed, as any policy may have a considerable influence on the energy system. There is also a risk that market interventions are being justified by the need to increase energy security without proper assessment, in fact furthering different objectives. Policies on climate change and economic competitiveness, directed towards goals other than energy security, will have a strong impact on the structural characteristics of the energy system. Despite the synergies between those policies, it needs to be examined how they impact energy system resilience.

Two broad approaches to the quantitative assessment of energy security can be distinguished: The first is based on energy security indicators, sometimes combined with energy scenario analyses. Indicators are useful policy instruments because they enable a certain level of standardization. Composite indicators of high complexity lose the advantage of being transparent, while simple indicators can be too numerous or too narrow to be applicable in real situations. A more structural limit of this approach is that even the most sophisticated indicators are not measures of the resilience of the entire energy system. The second approach encompasses efforts to estimate costs and benefits of energy security. Some of these estimations are simply derived through ad hoc assessments. In other cases they are based on more complex macroeconomic, econometric or energy system models. An advantage of this approach is the possibility to carry out comprehensive, quantitative assessments of energy security and to assess mitigation strategies (Gallaghar, 2009).

European Energy Policy and Energy Security Implications

The European Union’s approach towards energy security can be derived from several policy legislations and proposals that followed the European Commission’s 2000 Green Paper “Towards a European Strategy for the Security of Energy Supply”. This stated that “The EU’s long-term strategy for energy supply security must be geared to ensuring […] the uninterrupted physical availability of energy products on the markets, at a price which is affordable for all consumers, while respecting environmental concerns and looking towards sustainable development”. In 2006, a second Green Paper titled “A European Strategy for Sustainable, Competitive and Secure Energy” of 2006 (COM(2006)105) defined security of supply as one of the three pillars of European energy policy, alongside competitiveness and sustainability.

A central element of the European energy policy is the will to fundamentally change its energy system to a low carbon economy, with the explicit goal of breaking “the cycle of increasing energy consumption, increasing imports, and increasing outflow of wealth created in the EU to pay energy producers” (COM(2008)781). Also, Member States agreed to drastically cut greenhouse gas (GHG) emissions until 2050 (Second Strategic Energy Review 2008). This requires a shift towards new technologies laid out in the Strategic Energy Technology Plan (SET Plan), including renewable electricity, second-generation biofuels, smart grids, electricity storage, transport sector electrification, and carbon capture and storage among others. Clearly, time frames in the lead up to 2020 are too short for fundamental infrastructure changes, but many of the foundations need to be laid, including financial and market structures. The IEA estimates that 2 trillion EUR are needed in energy infrastructure investment by 2030 (IEA 2009), which could be financed by returns from the Emission Trading Scheme or other support mechanisms.

In January 2008 the Commission launched the so called “20-20-20” Energy and Climate package (agreed by the European Council in March 2007), which requires the EU to reduce its GHG emissions by 20%, to increase the share of renewables in energy consumption to 20% and to save 20% of total primary energy consumption compared to baseline (‘business as usual’, i.e. no major changes), all by 2020. It is remarkable that all 27 Member States have committed themselves to a legally binding target of introducing 20% of renewable into their energy system by 2020, requiring national action plans that establish pathways for the development of renewable energy sources and creating cooperation mechanisms to help achieve the targets cost effectively (Directive 2009/28/EC). In the medium-long-term, the EU's 20-20-20 strategy calls for "an energy system with a diversity of non-fossil fuel supplies, flexible infrastructures and capacities for demand management [that] will be very different in energy security terms than today's system." In the short to medium term, effective provisions for preventing and dealing with supply crises must be made, in order to diminish the vulnerability to energy supply shocks (Figure 1).

Figure 1. Target for the share of renewables in energy consumption in 2020.

Key elements to reach the three underlying objectives of EU's new energy and environment policy are the idea of energy security as an issue of common EU concern and further integration of energy markets. "Solidarity between Member States is a basic feature of EU membership, and strategies to share and spread risk, and to make the best use of the combined weight of the EU in world affairs can be more effective than dispersed national actions" (Second Strategic Energy Review, COM(2008)781 final). While the energy mix is still the responsibility of the Member States, the Lisbon Treaty has established the role of the European Union, reflecting the increasing interdependence of national energy systems and the benefits of a more coordinated external energy policy. Notwithstanding the trust in market mechanisms and market integration as the most effective ways for increasing energy security, the explicit goal of reducing energy imports, expressed in the EU Energy Security and Solidarity Action Plan, still reflects a preventive attitude with “energy supply autonomy” as a useful strategy to reduce the exposure of the economy to international energy crises (Gnansounou 2008).

Yet striving for energy independence alone would be too narrow a view of energy security. In a global economy, to seek independence would be an exception to the wider free trade Western policy and could on balance be negative for consumers. The EU has thus developed advanced dialogues with important energy producers, transit and consumer countries, including Early Warning Mechanisms to deal with energy supply disruptions. Energy security is thus embedded in a context of international organizations, institutions or mechanisms, such as the Energy Community, the Energy Charter Treaty, the IAEA, IEA, UNECE, and the EU-Russian Federation Partnership.

Energy Security Challenges for Europe

To identify the main European energy security challenges, it is useful to briefly consider some current trends. World demand for energy is set to increase by around 40% between 2007 and 2030 (IEA 2009). China is now the second biggest economy, and non-OECD countries already account for more than half the world energy consumption. The EU’s gross inland energy consumption reached 1806 Mtoe in 2007, corresponding to about 15% of the world’s consumption. Europe’s primary energy demand is projected to grow by just 0.2% per year by 2030 (IEA 2009). At the same time, Europe’s indigenous hydrocarbons resources are shrinking as well as its overall energy production. As a result, the European Union imports more than half of its energy, a trend that is expected to continue through 2030. Russia is still the EU27 main energy partner, providing about 33% of imported oil, 42% of imported gas and 26% of imported coal. The EU is becoming increasingly exposed to the effects of price volatility and price rises on international energy markets. Energy security concerns in European Member States differ widely as a result of different energy national consumption patterns. Transnational energy transport is increasing and European infrastructure is highly interdependent. Some Member States depend fully on imports. For example, after the decommissioning of its nuclear reactor, Lithuania lost 80% of its electricity production capacity, which was largely replaced by (nuclear) electricity imports from Russia. Therefore, initiatives like the Baltic Energy Interconnection Plan and Mediterranean Energy Ring promote regional integration.

As a result of these trends, on the world stage Europe is still an important consumer, but increasingly sharing this role with other emerging players. Europe is and will continue in the medium term to be highly dependent on import from a small number of producer countries and long reaching transport corridors. If prices could adjust freely, security of supply could in principle be guaranteed (Helm

2002). But if market failures occur, a pure market approach does not produce a desirable outcome for society. To the extent that access to energy is a public good, public intervention (through subsidies, taxes or carbon pricing for example) can be justified.

Making energy production more sustainable through the introduction of renewable generation also presents energy security challenges. A reduction of hydrocarbon energy consumption will decrease imports, but also implies fundamental changes to the European electricity and wider energy system. In order to comply with the energy and climate change policy targets of the EU by 2020, the grids must be capable to host 'Renewable Energy Sources for Electricity' (RES-E) covering at least 30–35% of the EU electricity consumption compared with a 16% share recorded in 2006. To meet this objective, it is necessary to change the electricity infrastructure, primarily in order to cope with large amounts of variable generation from renewable energy sources such as wind and solar power generation. Adjectives such as 'super' and 'smart' are therefore more and more adopted when analysing future electricity grids to reflect features such as improved adequacy, flexibility, reliability and controllability (SET-Plan technology map (JRC 2009).

Flexible, coordinated and adequate electricity networks designed according to new architectural arrangements and embedding innovative technological solutions, are essential to address the risks of deterioration of reliability and security of supply. Information and Communication Technology (ICT) can contribute to increase the adequacy and robustness of the system, thus reducing the need for building new infrastructures, as well as augmenting its monitoring and governing.

While there is much debate on how Europe's ambitious targets can be reached, it is clear that one of the most important ways is to increase energy efficiency. Consumer behaviour does not yet support these ambitious goals, although average energy savings benefits for a household per year can be up to 1,000 EUR (COM (2008)772). Energy consumption is about 20% higher than for economic reasons necessary.

One important step to reduce energy consumption is to curb oil utilization, which remains the most important energy carrier. Transport in Europe is still almost exclusively dependant on oil, making demand highly inelastic. Consequently, replacing oil as a transport fuel is a focus of development and research. The capacity of EU policymakers to put in place efficient policies on transportation will play a key role. In the meantime, however, the classic energy security concerns associated with oil still apply and oil price volatility remains a major concern.

Specific European Challenges and Initiatives

In the following we highlight, by way of example, three specific challenges for energy security in Europe, and describe key policy initiatives designed to tackle them: the role of natural gas as a bridge energy carrier, the need for a remodelling of the European electricity grids and the problem of cybersecurity. The common characteristic of all these challenges is in their "network nature", implying that dealing with them relies on the reduction of the vulnerability of energy networks and increased resilience.

SECURITY OF GAS SUPPLY

Natural gas is likely to play an important role in the medium term as a bridge energy carrier on the road to a 'low carbon energy system'. It has considerably lower emissions than oil and coal and global gas supply is abundant, projected at 150 times current annual consumption levels (MIT 2010). However, for the European Union, in particular its Eastern Member States, securing natural gas supply is a key energy security concern.

Gas is a network bound energy carrier and for the whole of Europe, supply routes are quite evenly distributed: roughly one quarter comes from North Africa, the North Sea, the Middle East and Russia respectively (Figure 2). Yet, many Eastern European countries receive supplies almost exclusively from Russian gas fields and 80% of Russian supplies are transported via Ukraine. There are wide discrepancies in the role of natural gas in Member States' primary energy mix and in their ability to substitute it with other energy carriers. Since the Member States' ability to store gas also differs widely partly due to geological differences, trans-national pipelines are used to their maximum capacities during cold peak winter periods (Winter Outlook by Gas Infrastructure Europe). Problems became evident when in January 2009 a trade dispute between Russia and the Ukraine led to a 2 weeks interruption of 20% of Europe's gas supply, equivalent to 30% of imports. While gas transmission operators were able to restore supplies, the incident showed that at the core of the difficulties were inadequacies in channelling gas flows through pipelines along new routes, like reverse flow capabilities, but also some organizational weaknesses, for example different emergency measures called by Member States without sufficient coordination.

The European Commission identified two market failures in relation to security of gas supply (SEC/2009/0980 final): the insufficient integration (of physical networks and network management) and transparency of the internal gas market, and the issue of security of supply as a public good. As a consequence, the European Council and the European Parliament have called for a revision of the existing Directive (2004/67/EC) concerning measures to safeguard security of natural gas supply. Important elements of the new regulation are an improved information exchange, an assessment by individual Member States of risks to their security of gas supply and the development of national emergency plans.

A big unknown is the role of unconventional gas in Europe. For long, gas was extracted from permeable geologic formations. The development of advanced drilling and reservoirs stimulation methods have increased the production rate of the unconventional gas resources and made the production of shale gas economically viable. Shale gas extraction is seen as a potential game changer in both regional and, in longer term, world gas markets. Potential large shale gas resources exist in the United States, China and also in Europe. The long term global recoverable gas resources represent more than 850 tcm (trillion cubic meters), of which 45% are unconventional. In Europe, countries with large potential shale gas resources are Austria, France, Germany, Hungary, Poland and the UK. The first interdisciplinary shale gas initiative in Europe (GASH) was launched in 2009, focusing primarily on Denmark and Germany. According to estimates of Polish Ministry of Environment, Polish shale gas reserves alone could amount to 1.4–3 tcm, however no shale gas field has been documented yet. Despite its prospects, shale gas extraction has raised concerns about environmentally sound drilling and the protection of groundwater and surface water. Also, the land leasing regulations in Europe, as opposed to those in the United States, seem to be less favourable for shale gas development.

Figure 2. Existing gas network in Europe and Trans-European gas projects.

THE EUROPEAN ELECTRICITY GRID AND RENEWABLE ENERGY INTEGRATION

The European power system, one of the largest and most complex machines in the world, is aging, experiencing increasing congestion and undergoing challenging market liberalisation and renewable integration processes. Developing, and to a certain extent remodelling the European electricity grids will be a crucial step in the pursuit of the EU's competitiveness, sustainability and security of energy supply objectives for 2020 and beyond.

In order to better understand why and how this redesign will take place, European grids can be distinguished into transmission and distribution networks. These differ in terms of their function, structure, planning and operation philosophies. The pan-European transmission network hosts large-scale power plants, which constitutes the lion's share of generation in Europe (some 70–80% of installed capacity) and carries power over relatively long distances. It features higher voltages and a multi-terminal, so-called meshed, interconnected structure (composed of a few hundred thousand kilometers of wiring). The regional distribution networks embed lesser quantities of small-scale generation (roughly 20–30% of the installed capacity) and transfer power passively from the upstream transmission system to the final customers. They feature lower voltages and generally simpler radial structures (i.e. point-to-point connections, including several million km of lines).

Moving Europe to a low carbon, resource efficient and climate resilient economy also entails increasing our reliance upon renewable energy and what are known as 'Distributed Energy Resources'. These include small-sized power plants, such as certain renewable generation units (e.g. photovoltaic panels), as well as storage technologies and electric vehicles. The share of renewable electricity consumed in Europe (30–35% by 2020 according to EU targets) will increase further after 2020 and impact both transmission and distribution grids (with the integration of onshore/offshore wind and solar power playing a key role).

Both the European electricity system transmission and distribution grid will have to adapt, which is described as becoming 'super' (for the transmission grid) and 'smarter' (distribution grid):

The Super transmission grid: The best locations for the generation of renewable electricity are not uniformly distributed across the continent, and are often in places where connections to the electricity network are weak. To fully utilise these resources, the power grid must be enhanced to allow electricity to be transported to the main centres of demand and storage. A super grid can be defined as an electricity transmission system designed to transport large amounts of electricity from remote areas to consumption centres. A super grid could well be a high transfer capacity layer superimposed to the traditional transmission system.

Smart distribution grids: Due to the rising deployment of distributed energy resources, distribution networks will have to change their control properties and become more similar to the transmission network we have today: that is, they will need more 'active' control features. Distributed units will be fully integrated into the management of the electricity system, and collectively serve a role comparable to large conventional power stations. The electricity grid will enable this by becoming 'smarter' and more interconnected. This so-called smart grid requires hardware, software and data networks capable of delivering and responding to information quickly: the installation of smart meters could reduce energy consumption and make both generation and consumer demand more responsive and flexible.

The move towards renewed and redesigned power grids should be carefully monitored and studied system-wise and technology-wise. A number of large-scale power disruptions highlighted the risks attached to lack of coordination and foresight in the electricity systems operation and development. Modernized electric power systems can be increasingly vulnerable to different threats affecting security of energy supply and fundamental societal functions (Figure 3).

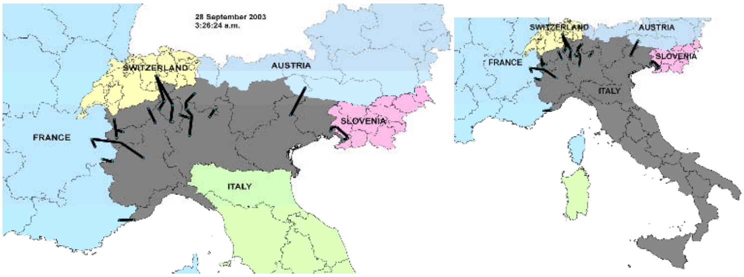

Figure 3. The electricity blackout in Italy on Sept 28, 2003.

The 2008 International Energy Agency Reference Scenario for Europe quotes investments in excess of EUR 1.5 trillion in the period from 2007 to 2030 in order to revamp the electrical system from generation (two thirds of the investment) to transmission and distribution (one third). In turn, distribution needs account for 75%, against 25% for transmission of the expected investment in electricity grids according to the SET Plan technology map (JRC 2009). These structural changes are expected to be enabled by a pervasive deployment of Information and Communication Technology (ICT) for upgraded monitoring, control, and protection functionalities. Improving monitoring and control of the networks through the deployment of metering, telecommunication and remote control technologies is also conducive to a more secure and reliable grid operation with an increased share of distributed energy resources. As an example, even if a large penetration of electric vehicles can strongly affect the distribution grids architecture and operation, it can also help in optimising power system management. Installation of smart meters coupled with demand side energy management measures may rationalise energy consumptions and make the load more responsive and flexible. The development and improvement of cost-effective and coordinated high-power energy storage systems will also play a vital role.

THE ROLE OF ICT IN THE NEW ENERGY SYSTEM AND CYBERSECURITY

Energy networks make extensive use of ICT means: their control, protection, measurement, management etc. at the company level are all ICT based. Not least, links with the customers are mediated by cyber means for the metering and billing of consumption. Moreover, the operation of the energy infrastructure requires the exchange of data over wide-area networks among operators and with authorities. The evolution of the energy networks in Europe will require more ICT inter-connections, crossing national borders and jurisdictions. The lack of common accepted cyber security standards and criteria, does not contribute to the confidence on the existence of proper protection of the ICT systems.

This cybersecurity risk was negligible until a decade ago, but it has had to be taken into consideration with the connection of energy systems to open communications networks like the Internet. The security of industrial ICT is so impending because most technologies have not been designed with cybersecurity in mind. Control protocols are old and vulnerable to attacks. Security countermeasures derived from the general purpose ICT field (such as firewalls and anti-viruses) are only partially applicable in energy systems. Those solutions rarely considered the real-time and other particular requirements of industrial ICT.

On the one hand, the security of those ICT functions is crucial for the efficient management of the installations, but increasingly it is the security of energy supply that is at stake. Malicious actions affecting the availability of the data or their integrity could have direct impact on the operations of the energy systems. One can easily imagine how the failure of a control system might cause the impairment of a technical installation, and possibly bringing it to a halt. A key aspect to consider is the use of similar technologies in many different installations. This might be the cause of common failures – for instance in case of some malware affecting that technology. In addition, ICT components age rapidly, much faster than the electrical and mechanical components of the energy infrastructure. This requires appropriate responses, which at times should be coordinated across systems (e.g. for solving problems of interoperability). In Europe there is still no common agreed approach to tackling these issues.

In the last years, some initiatives have tried to discuss the cybersecurity problems in energy infrastructures in Europe, most notably the expert group on energy supply within the working group organised by the European Committee for Standardization (CEN) on the "Protection and Security of the Citizen" (formally called CEN BT/WG 161).

PROTECTION OF EUROPEAN CRITICAL ENERGY INFRASTRUCTURE

The previous brief discussion on some key challenges regarding the European energy networks demonstrates how energy systems extensively deployed over EU territory are exposed to security threats. In particular, LNG terminals and pipelines, the power grid and substations, are soft targets. So far, energy infrastructures in Europe have not been subject to major attacks by terrorist groups, which may be due to terrorist targeting rather than lack of opportunity (Toft, Duero et al. 2010). Beyond the EU borders, attacks were more frequent, for example in 2008, when the BTC gas pipeline was attacked in Turkey. While so far, the only substantial interruptions to energy supplies have been accidental (e.g. the 2003 blackout affecting Italy) or the result of trade disputes (2006 and 2009 for gas supplies from Russia), an increasing complexity makes these networks vulnerable to malicious attacks with more severe impacts.

The Council Directive 2008/114/EC on the identification and designation of European critical infrastructures was designed to ascertain the vulnerabilities of

European relevance in the energy system (i.e. with incidents possibly affecting two or more Member States) and improve their protection. In synergy with this, the European Programme for Critical Infrastructure Protection (COM(2006)786) emphasized the need for Member States to manage their national critical infrastructures. It is based on an all hazards approach, not confined to terrorism, but also including criminal activities, natural hazards and other causes of accidents.

Concluding Remarks

Given the challenges to European energy security, a comprehensive and coherent approach to energy policy is essential. A major task, both for policymakers and policy-oriented research, is to select economically rational strategies for energy security and to assess the interactions of different energy strategies. This will require adopting a rigorous, robust and transparent approach to assess the future energy security challenges, not only to verify that the implementation of EU policies is not self-defeating, but also to identify new opportunities for synergy between policy domains.

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