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SECURITY OF SUPPLY IN THE RUN-UP TO THE POST-2020 PERIOD

STUDY FOR THE MINISTRY OF ECONOMIC AFFAIRS, THE NETHERLANDS

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EDITOR
Deborah Sherwood

DESIGN
Studio Maartje de Sonnaville

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Clingendael International Energy Programme (CIEP)

ADDRESS
Clingendael 7, 2597 VH The Hague, The Netherlands
P.O. Box 93080, 2509 AB The Hague, The Netherlands

TELEPHONE
+31 70 374 66 16

TELEFAX
+31 70 374 66 88

EMAIL
ciep@clingendaelenergy.com

WEBSITE
www.clingendaelenergy.com

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EXECUTIVE SUMMARY

GENERAL:

- Security of supply includes both long-term and short-term issues in supply and capacity. Due to the introduction of new, intermittent energy in the mix, the short-term Security of Supply (SoS) issues will gain in importance, while the traditional longer-term issues also continue to be important in energy policy-making. International efforts to further security of supply, e.g. through access to resources, trade and investment, should be combined with domestic and European efforts.
- The Netherlands has an open economy with regard to energy and, due to its location and natural gas sector, has developed a strong position in both liquid and gaseous fuels, while also the electricity sector has developed substantial regional connections. Competitiveness of the economy matters, also in the energy-industrial cluster.
- The introduction of new fuels to the energy mix of the Netherlands and the specific energy economy requires integrated attention to the functioning of the energy system because often the output of one part of the energy sector is an important input elsewhere in the system. This is particularly true for the liquid/natural gas/chemical cluster in the Netherlands, where both international developments and developments in neighbouring countries could impact the balance of energy production and feedstock within the cluster.
- The impact of the policy choices of neighbouring countries on the evolving energy markets can both limit and widen the possibilities for the energy and energy-related sectors in the Netherlands, if understood properly.
- The growing importance of electricity is clear. Nevertheless, other solutions or development paths should not be discounted, particularly as long as storage of electricity remains problematic and when taking cost efficiency into account.
- Dutch participation in international organizations is important to furthering the country's energy sector interests. In many international organizations, the Dutch government has seen its relative importance decline (for instance in the IMF and the Group of 20), while in energy the Dutch government can rely on a strong and trusted position, built up over the past 5 decades in both the IEA and IEF (and the EU). The strong international position in energy relations also serves other international interests of the Netherlands.

ENERGY HUB:

- The Netherlands is an important hub in NW European energy markets. It is a traditional natural gas exporter to neighbouring countries, while both in Rotterdam and Amsterdam energy trade flows are important activities for the incomes of those harbours. These trade flows also underpin the energy and petrochemical complexes of the Dutch and neighbouring countries' economies since the 1950s.
- The Netherlands has substantial interconnections with pipelines (oil, oil products and natural gas) and power lines with neighbouring countries (the UK, Germany, Belgium, France, Norway and Denmark). In addition to these connections, the harbours (Rotterdam, Amsterdam, Eemshaven and Vlissingen) and rivers connect the Netherlands and its European hinterland to the international energy markets. This has also resulted in clustering of these energy and energy-related industries.

OIL/LIQUIDS:

- Due to the shale gas and tight oil 'revolution' in North America, liquid trade flows are changing rapidly and are impacting the business models of the European downstream energy and petrochemical industries. The discussion about the competitiveness of these industries features in a wider discussion on the competiveness of European industry as a result of the varying energy strategies among major economies around the world.
- The balance in Atlantic oil product trade, exports of gasoline to the US and diesel to Europe is changing. The US is now exporting gasoline to traditionally 'European' export markets and is importing less gasoline from Europe, while European diesel imports have not declined. This is impacting the European energy trade balance. The decline in competitiveness in refining has already resulted in a substantial decline in refining capacity in Europe. However, more closures are expected, also due to the start-up of new export refining centres in the Middle East and India and an upgrade of Russian capacities.
- If refining capacity continues to decline in the future, Europe and the Netherlands could face increasing oil product imports, while crude imports will decline. The income models of our harbours, which are still mainly based on crude flows, in particular to Rotterdam, would have to be reviewed if crude flows decline and product flows change.
- As a result of these developments:
  - It is important to consider how the Amsterdam-Rotterdam-Antwerp (ARA) position can be strengthened as compared to other European clusters in order to maintain the activity. The logistical consequences of having to service a larger hinterland in oil products should also be taken into account.

– Something else to consider are the consequences for strategic reserves (both crude and products).

NATURAL GAS:

- The maturity of the Dutch gas sector requires different SoS management than in previous decades. The gas hub policy has connected the Dutch gas system with the European and even global gas system. Pipelines connecting with Russia, the UK and an LNG terminal in Rotterdam have created the capacity to import gas from elsewhere, in addition to Dutch gas production.
- Policies to enhance domestic production (those regarding new generation of small fields to stimulate the production of offshore gas, tight gas, shale gas, green gas and gasification technologies) could help to manage production from the mature fields, including Groningen.
- The quality of Dutch Groningen gas is different from North Sea gas and imported natural gas. Sufficient conversion capacity and preparing the adaptation of the Dutch market to higher calorie gas are already on the post-2020 agenda. Without adaptation of the gas quality to international gas supplies or sufficient conversion capacities, the security of supply of Groningen quality gas to the Dutch market will require additional supply and demand management measures.
- The recent changes to the production plan for the Groningen field and the on-going study on how to guarantee above-ground safety might require the gas quality agenda and other issues relating to the security of gas supply, such as conversion and storage capacity, to be brought forward on the policy agenda. The next three years, covering the period of the current production plan, should be used to develop an integrated plan for the gas sector to manage this new stage in the Groningen field's lifetime.

ELECTRICITY:

- The introduction of new energy sources into the energy system of the NW European energy market (initially mainly in electricity generation) and the intermittency of supply of some of these energy sources requires a new look at security of supply at the level of the energy system. In particular, the next few years must show how the new supply sources can be economically made to collaborate in balancing demand and supply, and which business models can underpin this newly evolving energy system, where intermittent supply and conventional back-up capacities need to be available in the system. Currently, many conventional generation plants are not 'in the money', leading to closures and the mothballing of predominantly gas-fired generation capacity.

- In the future the energy system will include an increasing number of de-centralized energy production units, which will demand changes in the organization of the market and regulation.
- De-carbonization of the power sector does not imply that all solutions should be electric. Instead they should be integrated with solutions for liquids and gas, as this could offer efficient transportation and storage potential, while they can also continue to service the heating/cooling and mobility markets. Consideration should be given to how to combine 'smart and efficient' in decarbonization policies for various types of consumers and types of energy consumption.
- The dimensions of various energy markets (heating, cooling, mobility, power and feedstock) are often misunderstood among stakeholders and can confuse discussions on policy options. These discussions tend to focus on a fuel-by-fuel approach rather than an energy system approach. Some wind parks could produce hydrogen, if it were economically efficient to do so. Hydrogen can be integrated in the gas system, while in the residential sector solar power could perhaps be more efficiently stored in heated water instead of being delivering to the grid. The technical and economic properties of energy, both new and old, can easily become under-utilized when approached on a fuel-by-fuel basis, while transportation systems could become wrongly sized. Here the long amortization period could also play a role when considering the various options.
- Average demand and supply and installed capacity are poor indicators for the speed of change; a relatively small share of solar and wind have structurally changed the business models of conventional power plants.

ORGANIZATION/ POLICY-MAKING:

- De-centralized energy production (geothermal, solar, green gas, etc.) might need a partner in organizing that supply. Distribution network companies and producers of power and gas may vie for this function, because it could fit within the new business logic of both these types of companies. Currently, legislation has separated network and production functions in the market, which could become illogical in the post-2020 period market circumstances and prevent certain innovations from being embraced. The innovative possibilities should not be impeded by regulation. The tension between the European market approach and local developments could imply a need for further adjustment of the market model.
- The current developments in both new energy technologies, the function of conventional power generation in the market, the development of 'prosumers' and other local producers could lead to a re-thinking on ownership unbundling.

- In the post-2020 energy market (particularly in the Netherlands), a new definition of what is and what is not infrastructure might be needed when looking at the organization of the sector, allowing for innovative models to emerge. For example: is a gasification plant for biomass different than the Gate LNG terminal? Is a solar panel on a residential roof part of infrastructure or not? Is it only transportation hardware or also the software of balancing energy supplies that is important?
- In the shorter term, there must be a plan for what to do when a utility that is relatively large in relation to the service area and which is important for system stability, active on the Dutch power market, collapses (too big to fail?) while the asset market (for nuclear and gas) is non-functioning. Under the current legislation the providers of last resort are TSOs of TenneT and Gasunie. However, their mandate to provide last-resort services is of relatively short duration.
- With regard to cyber security in a more electronic-intensive energy world, it might be a good idea for the government to discuss with the sector the possibility of creating a closed communication system or at least having back-up frequencies for energy system communications in order to guard against cybercrime, as part of a critical infrastructure policy (either local or of a broader scale).

1 INTRODUCTION

In the past four decades, the three priorities of Western energy policy-making – a relatively low price, security of supply (SoS) and the environment – have competed for pre-eminence on the policy agenda. Based on the development of policies by the International Energy Agency (IEA), energy security or security of supply can be defined as the availability of energy at all times in various forms, in sufficient quantities and at reasonable and/or affordable prices.[1] The eminence of SoS on the policy agenda depends on the level of structural import dependency, the distribution of reserves and investments, the flexibility of the energy system, economic and geopolitical risk assessments, the organization or structure of supply and demand, and, increasingly, the available carbon space. The three priorities of energy policy cannot easily be pursued simultaneously because a relatively low price for coal or oil may, for instance, compromise the carbon space needed for economic growth. At the same time, a preference for domestically produced fuels could both jeopardize affordability and the environment. Also, markets do not produce security of supply unless forced to do so by government policies. The geographic concentration of fossil fuel reserves and access to these resources can present a government with a dilemma regarding how best to balance the energy mix. The three priorities of energy policy-making often present governments with a trilemma of how to best balance their policy priorities.

The dimensions of security of supply can be approached on three levels: operational, strategic and long-term (See Figure 1), and include both capacities and supply. Security of supply (SoS) covers a wide range of issues with a corresponding wide range of policy measures. To structure any research in SoS, three criteria can be distinguished, each with its own characteristics and issues, its own sets of remedies and its own policy focus:

- **'operational' adequacy**. To this category belong not only issues like whether a market will have sufficient gas to see it through a severe winter, but also the current multi-fuel concern that the electricity market may not have sufficient capacity (or back-up) to meet demand when renewable energy supply is low: issues which we will address in this paper. Remedies could include capacity markets and demand management. This category has a predominantly national and regional policy dimension.

1 Richard Scott, IEA: The First 20 Years, Major Policies and Actions, volume II, pp. 37-52.

- **'strategic' robustness.** This addresses the vulnerability and/or resilience of any energy system to sudden interruptions of supply, be it (geo-)political, technical or otherwise, domestic or external. This is probably the category with the highest complexity, leading to policy measures affecting fuel diversification, investments in infrastructure, storage of fuels, crisis management and international cooperation. We will discuss various issues of this category in this paper.
- **'long-term' availability.** In this category we find issues surrounding the implementation of long-term policy objectives, e.g. 20-20-20 and 2050, but also those surrounding the security of fossil fuel availability in the longer term, and hence issues like geo-political relations and investment climate, timely investments in infrastructure, in new international supplies and contractual arrangements.

In all cases the issues may focus on infrastructure or on the fuel itself or on both, particularly in a market where ownership is separated. Using this distinction between these categories helps to structure and discuss the wide range of policy matters, as each has its own set of issues and potential remedies.

FIGURE 1. SECURITY OF ENERGY SUPPLY DIMENSIONS

Security of Energy Supply Dimensions

	Operational	Strategic	Long-term
capacity	Capacity to process (or import) and transport energy to meet defined peak daily demand	Processing (or import) and network supply capacity sufficient to meet peak firm demand in the event of defined loss of infrastructure	Processing and network expansion designed to meet the anticipated demand growth
supply	Supply available to meet both the defined daily peak demand and to supply during a severe period/ winter	Ability to meet firm demand in the event of a severe disruption to the principal supply source	Supply available to cover the future projected demand

SOURCE: D. DE JONG, LECTURER ON SOS, EDI, 2012.

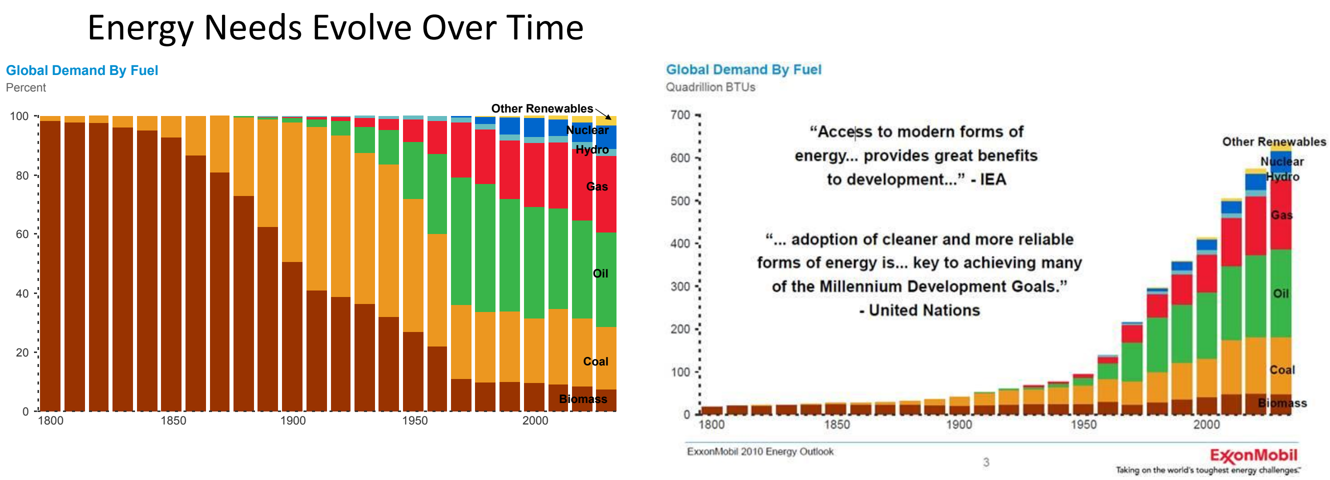
In international energy relations, the point is often raised of the distribution of risks and benefits through the energy value chain, relating to the differences in market organization in the world. Regulatory differences and ownership issues regarding resources, transportation, sales and processing all impact the flow of energy between countries, while a certain organizational model of the energy industry can impact the demand for imported energy or the supply of exported energy. In terms of investments, access to resources and access to markets is another issue often raised in international energy relations. Recently, national energy subsidies have also drawn attention regarding their impact on demand and supply. Apart from a wide range of international energy security of supply issues, domestic security of supply is also important. In the EU, these issues relate to both the EU-level and to the national level. Although the EU shares competency over many energy policy issues, notably the environment and competition, the energy mix of a member state is its own competency. Within the EU policy framework this allows the member states freedom over the choice of policy instruments regarding the energy mix. Their choices have an impact on the flow of energy in the EU internal market and on the security of supply of other member states. Recently, the EU Commission has attempted to both address the internal and the external energy competition issues with communications on public intervention and competition, while also publishing its proposals for the period 2020-2030.[2]

Throughout time certain fuels dominate the energy mix. With the advance of technology and transportation, and with increased access to and applications for capital goods and other goods, new fuels entered the fuel mix, adding to diversity and optionality with regard to sources (see Figures 2 and 3). Coal was replaced with oil in the transportation and light industries but remained in the energy mix for power generation, depending on cost and the access to resources. Natural gas entered the energy mix later, mainly in industry, power generation and household applications (heating and cooking). More recently, biofuels, biodiesels and natural gas entered the market for transportation fuels, which had long been dominated by crude oil and oil products. The fuel mix to generate power has always been diverse, including coal, hydro, nuclear, oil (though this is now in decline), and recently also biomass, wind and solar, depending on local supply and the country's level of economic development.

2 With its 'guidance to Member States on state intervention in electricity markets', the Commission acknowledges that: "In some cases, state intervention in energy markets may be necessary in order to ensure security of supply and to achieve climate objectives. To avoid adding extra costs for consumers and distorting the functioning of the internal electricity market, public intervention has to be designed with great care." Com (2013) 7243 final, 5 November 2013; Com (2014) 21 final, 22 January 2014, on energy prices and costs; Com (2014) 15, A Policy Framework for Climate and Energy in the Period 2020 to 2030, 22 January 2014.

The diversification of the energy mix in the world is growing. Yet this growth is unevenly distributed among countries depending on domestic resources, regional trade, ability to import and capacity to transport energy resources. The energy mix per country is the combined result of economic development, energy market developments and government policy.

FIGURES 2 AND 3. GLOBAL FUEL MIX (IN SHARE AND VOLUMES)

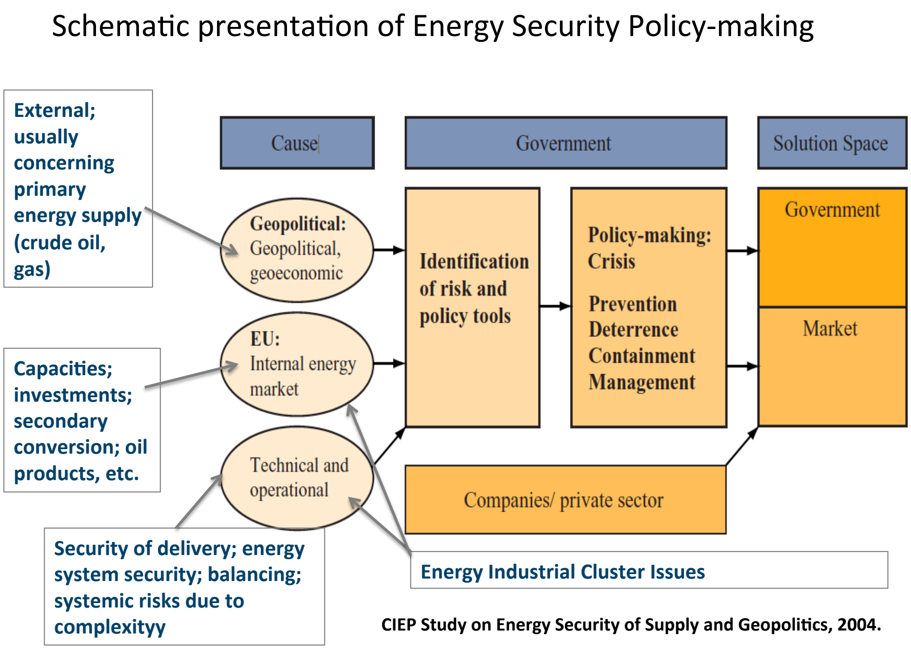


SOURCE: EXXONMOBIL, THE OUTLOOK TO 2040, 2013 AND 2012.

In terms of security of supply, both governments and markets are part of solution space, but government policies force the market and the market participants to deliver on SoS measures. These measures cover mainly adequacy and strategic issues, while most long-term measures are covered by government policies (see Figure 4).

Due to the constrained carbon space, but also the availability of competing fuels, the energy mix is changing. The organization of energy markets also varies in intensity and geographic reach. Crude oil and, increasingly, oil products are the most internationally organized energy markets, while coal and natural gas are also traded internationally. Natural gas is traded by pipeline, mainly servicing regional markets, while LNG is traded internationally (with a traditional emphasis on Asia where the LNG market first developed). Some renewables are also traded, such as biomass, biofuel and biodiesels. Electricity trade is limited to local/regional markets. Technology can change the tradability of energy sources in terms of geographic reach and marketability and can change the availability of supply on international markets.

FIGURE 4. SCHEMATIC PRESENTATION OF ENERGY SECURITY POLICY-MAKING



SOURCE: CIEP STUDY ON ENERGY SECURITY OF SUPPLY AND GEOPOLITICS 2004.

In this study on security of supply in the post-2020 period, the underlying assumption is that the energy mix of the Netherlands and other countries which are part of the NW European energy market will meet the targets set under the 20-20-20 energy policy of the EU. It is yet unclear how the policy framework will look in the post-2020 period. Some interest groups press for setting higher renewable targets, while others prefer to strengthen the EU ETS. The European Commission's proposal attempts to strengthen the CO_2 emission reduction policy by setting new binding national emission reduction targets, while renewables will be subject to a EU-wide target.[3] Among other things, discussions about the costs for consumers and producers of certain renewable support schemes (for instance in Germany), the impact on the competitive position of the economy and the effectiveness of the EU ETS as a way to price carbon emissions, and the differing interests of the member states could change the policy approach such that the pace of investment in renewables alters. Yet, as we will discuss in this report, relatively small shares of renewables already have had a sweeping impact on the business models underlying conventional power

3 COM (2014) 15 final, 22 January 2014, p.21.

generation plants in the NW European market.[4] The combination of developments in international energy markets (i.e., the production of shale gas on a large scale in the US and the subsequent flows of US coal to other markets), government decisions and the impact of the economic crisis on demand certainly play a role, too, but it is clear that the economic constraints for the conventional generation sector to adapt have turned out to be larger than the expected technical constraints. Expectations about the role of gas as the natural provider of flexibility have so far not materialized, in part because of the fuel cost differences (a combination of low CO_2 prices and lower coal prices). Apart from electricity markets in the EU, also the international natural gas, crude oil and oil product markets are undergoing rapid changes, partly because new supplies and processing plants have entered the market and partly because demand is changing.

In assessing the type of security of supply issues in the post-2020 period, we therefore have to assume that certain current trends will continue. Also, as a result of energy system complexities and the presence of a large energy-industrial complex in the Netherlands, there is great sensitivity to EU and international changes in markets and in the policies of other governments. We do not claim to be complete, but rather attempt here to sketch the impact of certain trends on the future security of supply of the Netherlands and the NW European market.

4 Although the impact of renewables on conventional power generation is evident, also in the US power market; EIA, Energy Today, 30 September 2013.

2 RECENT ENERGY POLICY DEVELOPMENTS

ENERGY POLICY-MAKING IN AN INTERNAL MARKET SETTING

In the EU, the emphasis in the 1990s was mainly on liberalizing intra-EU energy markets, while EU environmental policies, especially with regard to managing the carbon space, gained traction.[5] The relatively low oil and natural gas prices in the 1990s had pushed security of supply issues back in the policy merit order. This changed radically just after the turn of the century when rapid demand growth in emerging markets, combined with production problems in certain key countries such as Iraq, reduced the spare or swing capacity in international oil markets.[6] Exports of crude oil originated in only a few countries. Natural gas markets were still mainly regional, resulting in fairly concentrated natural gas (pipeline) flows with little ability to diversify to other supplier countries.[7] At the same time, the domestic gas supply in the EU was in decline.[8] As part of the environmental policies, non-fossil energy resources were stimulated in order to give them a larger share in the EU energy mix under the 20-20-20 policy.[9] Although the ambition to increase the share of biofuels in transportation was strong, the strain this effort put on food supplies created a backlash against this first generation option in the EU,[10] while corn-based fuels in the US kept growing.[11] The introduction of solar and wind in the power sector was more successful, although the variation among the EU member states in terms of installed capacity is substantial.[12]

While energy policies leading towards a lower carbon economy were implemented, relatively little thinking went into the impact on SoS policies or the internal market, perhaps with the idea that the relatively small shares of renewables and other CO_2 reduction measures would have a small impact. To be sure, renewables offered the member states diversification in their energy mixes and often the prospect of a reduction of imported fossil fuels. At the onset of the 20-20-20 policies, the lower

5 The EU Climate and Energy Package, http://ec.europa.eu/clima/policies/package/index_en.htm
6 EIA, Energy Today, 24 May 2013.
7 Algemene Energieraad, *Gas voor Morgen*, 2005: http://www.energieraad.nl/Include/ElectosFileStreaming.asp?FileId=86; accessed on 1 May 2013.
8 Annex 3, Slide 15.
9 Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources.
10 European Parliament, 11 July 2013, Environment Committee Advocates Promoting Advanced Biofuels.
11 EIA, US Energy Information Administration, July 2013, Monthly Biodiesel Production Report.
12 EPIA, 2013, Global Market Outlook, see also Figures 15 and 16.

carbon economy was seen as one of the remedies for the increasing structural import dependency, particularly when domestic renewables were promoted.

With the process of transition only a few years underway, both at the level of system adequacy and the strategic level, new SoS issues have emerged, such as guaranteeing sufficient back-up capacity for intermittent energy sources and transportation and storage capacity to match supply and demand. The EU has addressed some of these issues with its infrastructure policy and gas security of supply directive, but local bottlenecks remain. Long permitting procedures and pressure on tariffs by local regulators can be at loggerheads with investments in new transportation capacities servicing future supply and demand. Here the issue is the 'noise' between the national and the EU level in the coordination of various parts of the energy value chains, the market framework[13] and the ability to accommodate rapid changes taking place in the economic logic in energy value chains.[14] At the same time, the 'brief' of regulatory authorities often does not sufficiently take (strategic) security of supply into account due to the (mandatory) short-term focus on competition.[15]

The effectiveness of coordinating energy policy at the EU and member state levels is far from ideal, leaving many issues that need addressing, including security of supply issues at the operational and strategic levels. In the longer term, the EU and the member states should also be concerned about its attractiveness for foreign suppliers to export their energy to the EU market. With the political attention on internal market competition and renewables, competition with other countries for energy flows has not received sufficient attention. Furthermore, the implementation of the 20-20-20-policy has stimulated national policy approaches to become more prominent. EU energy policy and member state energy policies still struggle with achieving more policy consistency.

PRICES

In the period 2003-2008, security of supply in crude oil and gas quickly ascended on the political agenda, when prices kept rising and energy trade imbalances growing.[16] The financial and subsequent economic crisis in the US and EU alleviated some of the pressure in energy markets, with OECD demand dropping, causing prices to decline

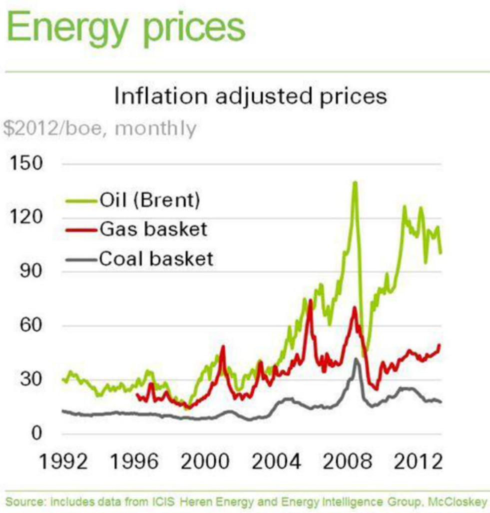
13 *CIEP Vision on the Gas Target Model*, CIEP, August 2011.

14 Nora Meray and Leonie Meulman, *Capacity Mechanisms in Northwest Europe,* CIEP, November 2012.

15 *CIEP Vision on the Gas Target Model,* CIEP, August 2011. http://www.clingendaelenergy.com/inc/upload/files/Gas_Target_Model.pdf

16 BPSR 2012.

Figure 5. *Inflation adjusted primary energy prices*



and spare capacities to increase. In 2011 and 2012, oil prices had recovered, in part because of the production policy of OPEC, but also because demand in China and other Asian countries continued to grow. Demand growth was so strong prior to 2008 that international oil, gas and coal prices were all increasing. After the financial and economic crisis, prices collapsed. The recovery of prices was different for each fuel, depending on the particular supply and demand situation. Natural gas prices in the US declined as a result of rapidly increasing supply from shale plays, but prices in Asia were high when demand for gas increased after the Fukushima disaster. OPEC managed to restore oil prices to a level acceptable for oil income-dependent producers within a few months of the steep decline by reducing production, while keeping deep offshore and tar sand production in the money.

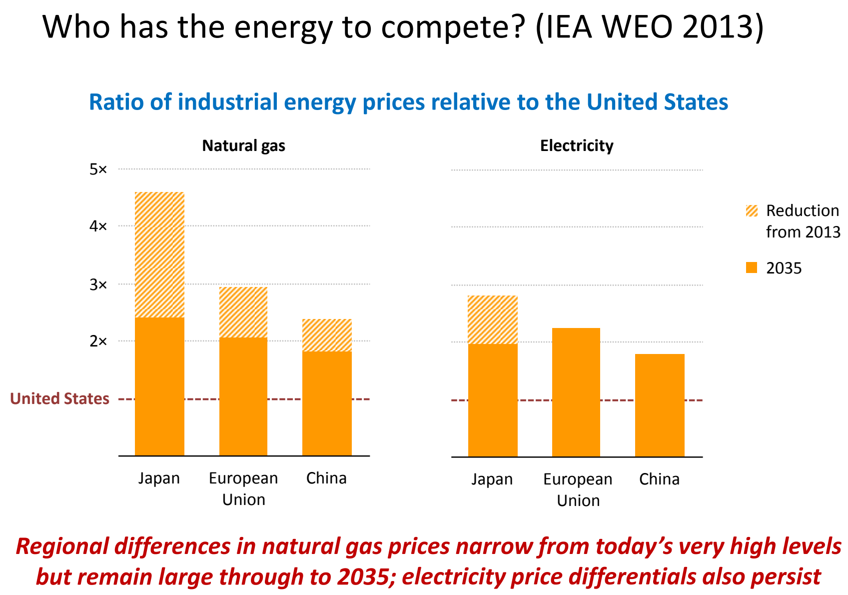
The 'demand shock' in the period 2003-2008 also led to discussions in the G-20 group of countries about the impact of subsidies on prices. This issue was first raised in the Jeddah conference in July 2008. They decided to aim for an end to fossil fuel subsidies by 2020 as part of demand management and climate change policy efforts.[17] In general, fossil fuel consumption in OECD countries is taxed, while emerging and developing countries often offer subsidies. Another issue that concerned many governments was the impact of paper traders on oil pricing, and studies into speculation were initiated.

Another remarkable development in the past two years was the widening spread between WTI and Brent, with the revival of North American oil production and the infrastructure inadequacies to evacuate the flows to the market. Also the energy trade balance of North America is predicted to improve substantially, while the energy trade imbalance of other major markets is increasing. The net cost of the negative energy trade balance was in part compensated for by exports to producing countries, although the success of the US, EU and China in this varied. The on-going changes in the flow of oil and oil products to and from Europe and the economic crisis could

17 G-20 meeting in Pittsburg, US, in 2009, see: http://www.g20.utoronto.ca/2009/2009communique0925.html#energy

impact the ability to balance trade. The revival of American oil and gas production was also noticeable in the widening spread between natural gas prices in the US, Europe and Asia.[18] Demand for natural gas in Asia has been strong, in part because of the closure of Japan's nuclear plants and in part because of gas demand in China and elsewhere in Asia. The combination of strong demand in Asia and the prevalence of oil-indexed LNG prices in the region resulted in a disappointing availability of cheaper LNG supplies for Europe, while competitiveness of the economy also became an issue.

FIGURE 6. ENERGY PRICES AND COMPETITION



SOURCE: IEA WEO 2013

High prices and price volatility can be a risk for the economy, particularly when energy costs cannot easily be translated into higher prices of export products or compensated by other exports, while high prices also impact inflation. The recent divergence of energy prices in various markets is also a concern, changing their international competitive positions, particularly those of energy and energy-intensive sectors.

18 Presentation CIEP, Uncertainty Reigns, April 2013; at: http://www.clingendaelenergy.com/files.cfm?event=files.download&ui=64E729B4-2200-0A20-1F60ACAAC4A2461C

GOVERNANCE

The International Energy Agency (IEA) is the main organization through which OECD countries manage their security of supply policies in oil. Under the IEA, International Energy Programme (IEP) member states of the organization agreed in 1974 to henceforth coordinate their SoS policies and responses to any oil supply crisis.[19] This was the start of international cooperation with regard to strategic issues in security of oil supply. At the same time, NATO operates oil product pipelines to ensure supply in case of a conflict involving NATO member states. The IEA policy coordination evolved to include peer reviews on national energy policies of the member states. Over time they have broadened the terrain of the IEA to include other fuels, although no crisis management system is in place, nor does the IEA have policy competencies for supply emergencies in natural gas, coal or renewables. The EU developed similar policies to include non-IEA EU member states.

In the 1960s oil-producing countries had established their own organization (Organization of Petroleum Exporting Countries; OPEC) to further their interests against the influence on their economies of private international oil companies. In the 1970s, National Oil Companies in many oil-producing and -consuming countries became important vehicles of developing the energy sector. While a process of privatization in some consumer countries prevailed in the 1990s, NOCs are still/again important agents for government interests in energy.[20]

OPEC and IEA have been at loggerheads for nearly two decades. In the early 1990s, a producer-consumer dialogue finally started, later resulting in the International Energy Forum (IEF), where a wider range of issues is discussed among more producer and consumer countries than IEA and OPEC member states alone. Particularly the participation of countries such as Brazil, India and China in IEF holds the potential for an important role in international energy governance, despite the lack of competencies and the informal setting of the meetings.[21] Increasingly, also G-8 and G-20 meetings deal with energy issues, in part due to the large balance-of-payment impact and the trade diversion propensities of energy taxes and subsidies.

Particularly the emergence of India and China, as large energy-importing countries, has changed the international SoS debate. The impact on price formation in international markets of net-oil importer China has drawn much attention, and the environmental

19 Bassam Fattouh and Coby van der Linde, *Twenty Years of Producer-Consumer Dialogue,* IEF, 2011.

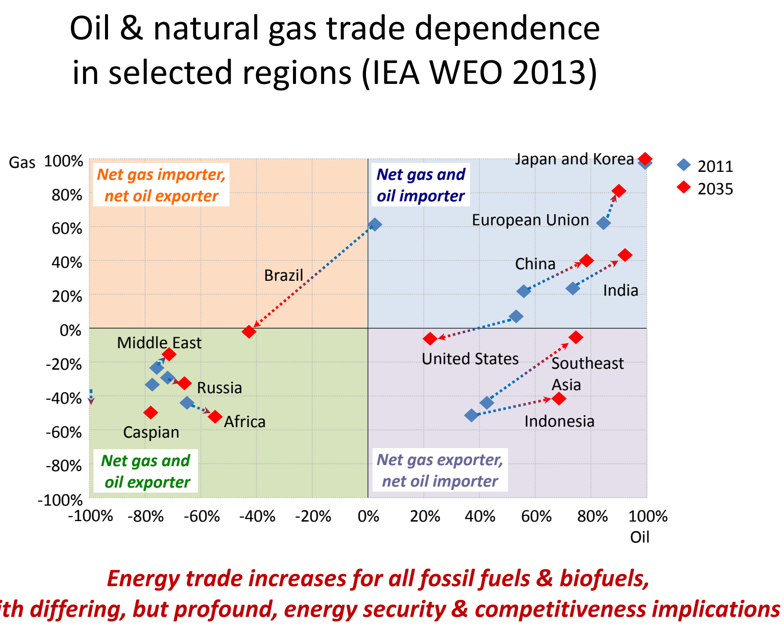
20 David G. Victor, David R. Hults, Mark Thruber, *Oil and Governance, State-Owned Enterprises and the World Energy Supply*, Cambridge University Press, Cambridge, 2012.

21 Fattouh and Van der Linde (2011).

burden of its coal consumption has become a main issue. At the same time, the relative decline of OECD countries as consumers of traded energy is changing the role these countries play in international energy governance. In the 1970s they consumed more than 75% of all traded energy, while this share is now less than 50%. This declining share also translates into the relevance of these countries in the geopolitics and geo-economics of energy relations.

Recently, the emergence of Canada and Australia as important energy exporters and the re-emergence of the US as a producer, reducing its import dependency, are again impacting the energy relations in the world (see Figure 7). All three countries offer access to their resources to private and public investors, attracting large investment flows. The fact that the US, based on 1970s policies, is currently not automatically an exporter of natural gas or crude oil, raises questions about how exactly the US energy market will be integrated in world markets. The level and type of integration of the US in world markets will be very important in the coming years. Exports from the US can offer net-importing countries with alternative supplies, helping diversification, offering investment opportunities and, more importantly, managing geopolitical and geo-economic energy relations.

FIGURE 7. CHANGING INTERNATIONAL ENERGY RELATIONS



SOURCE: IEA WEO 2013

For Europe, the diversity of imports becomes important in the face of declining domestic production. The types of measures described in the Fuel Quality Directive currently being discussed can seriously hamper such diversity of supply, making imports from the 'safe' fellow OECD countries more expensive if designed incorrectly. Moreover, the aim of negotiating a free trade arrangement between the US (and NAFTA) and the EU (transatlantic free trade area) should also include the energy trade in the arrangement. Discriminating among types of oil (and gas) could seriously hamper the negotiations.

Fossil fuel and renewable energy developments take place in varying degrees everywhere, changing the domestic energy preferences of countries and energy relations around the world. Furthermore, energy efficiency has gained renewed attention from policy-makers. The drivers changing the energy mix of countries around the world can be found in the voiced economic, strategic and environmental concerns of various consuming countries. The IEA is in the process of adapting to the new realities of energy relations, while the process of broadening the security of supply thinking to other fuels and demand is underway in various organizations. The IEF is evolving as well with the changing energy relations, but the organization suffers to some extent from a lack of competence in policy-making and is forced to invest mainly in building trust among its members.

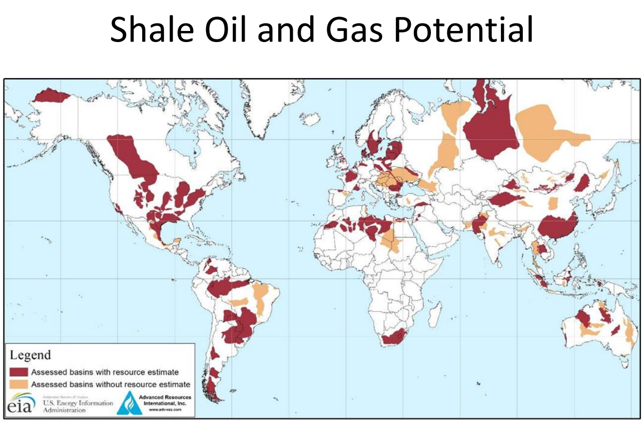
Governance in energy is a patchwork quilt of different organizations. Interests of governments, private and public companies are brought together in these organizations, often with the result that little power resides with the organizations themselves. Their main function is to keep open information channels. Only the IEA, through the IEP, has oil crisis management tools at its disposal for a group of countries larger than the EU (i.e., OECD countries). Europe is no longer a main player in energy relations, like in the past, but at the same time also not an insignificant one, due to its large market and import dependency. The pace of change and size of its call on imported energy does matter for other countries and companies.

Addressing economic, environmental and strategic security

Over time, the emphasis on economic, strategic and environmental security is subject to change, depending on the price, volume and geographical issues of certain or all fuels. In the short term, most economic issues concern the price or price volatility of specific primary energy sources and the impact on certain sectors, economic growth and inflation. Volatility can arise from sudden changes in demand and supply, geopolitical uncertainties or financial market movements. In the longer term, the economic concerns are more focussed on investments in production capacity, processing, and distribution. Another concern is the free flow of energy in the market, particularly for those consuming countries that depend on substantial imported volumes and the ability to diversify these flows. Restrictions on the free flow of energy and a decline in energy market integration would seriously undermine some countries' long-term security of supply. In the IEP of the IEA, as mentioned, oil security policy focuses on both the supply and demand issues in case of a sudden change in supply.

Comparable policy instruments for fuels other than oil have not been developed at the international level. The geographic distribution of coal reserves and the proportion of domestic coal reserves in relation to imports have not raised real security of supply concerns among OECD countries. This is in part because coal-exporting countries were not organized like the oil-exporting countries and partly also due to the availability of some domestic supplies. Until recently, the natural gas market was regional in structure. The development of LNG has alleviated both enhanced international market integration and diversity of supply, although the integration of the market slowed markedly with the outbreak of the crisis in the Euro-countries, the expansion of shale gas production in the US and the Fukushima nuclear disaster in 2011. LNG is mostly traded in the Asian market, while the US and EU saw real and potential demand for imported LNG drop. It is still unclear if and when shale gas outside the US can make it into the supply mix, due to environmental, economic and political challenges. Nevertheless, the reserve potential is bound to increase when confidence in applying the new techniques to produce this natural gas grows (see Figure 8).

FIGURE 8. SHALE OIL AND GAS POTENTIAL



SOURCE: EIA, INTERNATIONAL ENERGY OUTLOOK 2013.

A new 'old' concern is the growing dependence on and the access to rare earth materials (needed for batteries and solar panels) in the generation of renewable energy, complicating the energy security debate.[22] For countries that cannot access these resources other than through trade (of the resource of their final product application) or foreign direct investment, there is a vested interest in an open international economy. Apart from trade in rare earth raw materials or their import in the form of finished products, these materials can potentially also be harvested from old appliances, helping to reduce supply security concerns. At the moment, the cost of recycling many resources is still higher on international markets than the price of the raw materials, but when costs of recycling come down or prices of the resources go up, the economics could change quickly.[23]

Long-term energy security issues are more difficult to pinpoint, but they involve, among other things, the development of the international economic order and the risk of a major geopolitical conflict. Although the integration of the world economy, known as globalization, has been impressive, there is no guarantee that this development will continue in the future or that it will be without conflict over resources. Past experience shows that conflicts can also arise between countries involved in intense economic relations.[24] The challenge of the US and its allies by China in the next decades is one of the uncertainties playing a role here, but also the US-EU relations and the EU-Russia relations play a role, while uncertainties about the EU itself are also mounting. The impact of changing strategic relations on energy trade and economics cannot be under estimated, also when proxy wars elsewhere are fought. In the latter case, the Middle East, Africa and Central Asia are vulnerable to conflicting interests of major powers, on top of home-grown unrest in these regions.

For Europe, both of these types of strategic security of supply issues will continue to be important because, despite its efforts to reduce the share of oil, gas, and coal in the energy mix and expand the share of renewables, strategic dependencies on imported resources remain. What could change is the instrumentation of risk management when risks are dispersed over more resources and countries of origin.

22 See results of the Polinares project, 2010-2012: http://www.polinares.eu/docs/policy/polinares_policy_brief_no4.pdf

23 Louis A. Tercero Espinoza, *The Contribution of Recycling to the Supply of Metals and Minerals*, Polinares work package 2: http://www.polinares.eu/docs/d2-1/polinares_wp2_chapter8.pdf

24 Michael Levi, *The Power Surge, Energy, Opportunity, and the Battle for America's Future,* Oxford University Press, Oxford, 2013, p.183-186.

The 'shale revolution' in the US rapidly increased domestic oil and natural gas supply in a few years, changing the supply and demand landscape at home and abroad. Fuel diversification can also help to make the transportation sector less structurally dependent on oil (whether domestic or imported) and open it to including domestic biofuels, natural gas, and electricity. For EU member states, the import dependency will only decline as a result of diversification of fuels and their geographic sources. However, electrification of transportation, when generated with domestic renewable fuels (wind and solar, with enough storage capacity and/or smart to distribution systems) can in future also contribute to reduced import dependency. At the same time, the fact that solar and wind require a lot of space, which is also limited, only increases the need to improve energy efficiency. Demand management should therefore be an integral part of security of supply policies.

Energy security standards

Several efforts on trying to model energy security risks have been undertaken in an effort to objectify the review and assessment of supply security for the EU and its member states. Ideally, operational, strategic and long-term issues would be captured in one standard, but that has proven to be very difficult. The efforts of both the ECN/CIEP and the IEA illustrate that it is difficult to capture the unique characteristics of a country's energy system and that it is very hard to make generalizations.

One effort to develop a standard was inspired by a study on security of supply and geopolitics for the EU Commission,[25] where the integrated approach to energy security was promoted instead of the fuel- or sector-based approach that had prevailed up to then. In this study, both the government and the market players had important roles in remedying disruptions, while fuel-switching capabilities also mattered. In the ECN/CIEP study *EU Standard for Energy Security of Supply* (April 2007), both a supply/demand index and a flexibility index was developed in an attempt to capture the vulnerability of the EU member states' energy systems to disruption. The supply/demand standard in this study includes energy system thinking: "The S/D index covers final energy demand, energy conversion and transport and primary energy sources (PES) supply. (…) The supply security of end users also depends on the capacity and reliability of energy conversion installations (e.g. power stations, refineries, etc.) and energy transmission and distribution networks."[26] With the crisis capability index,

25 CIEP, *Study on Energy Supply Security and Geopolitics*, for DGTREN contract number TREN/C1-06-2002, 2004, The Hague, The Netherlands. See also: www.clingendaelenergy.com/publications/2004

26 Jacques de Jong, Hans Maters, Martin Scheepers, Ad Seebregts, *EU Standards for Energy Security of Supply, Updates on the Crisis Capability Index and the Supply/Demand Index Quantification for EU-27*, ECN/CIEP, April 2007, pp. 8 and 29. See also: www.clingendaelenergy.com/publications/2007

which refers to the ability of a country to respond to and mitigate a sudden supply disruption, the researchers tried to capture the flexibility of the energy system. The idea was that the method could help member states to review each other's vulnerabilities. Nevertheless, a standard has limitations because it is difficult to capture the specificities of individual country's energy system and to capture SoS at all three levels.

In 2011 the IEA developed the IEA Model of Short-term Energy Security (MOSES),[27] including many of the ideas also found in the ECN/CIEP study, and attempted to bring the approach further. The fact that the IEA member states already had an established peer review method among them and the fact that strategic energy security is an important part of their mission potentially made this analytic tool a basis for discussion about the specificities of their energy system and the individual solutions and potential solutions. Looking at the results of the study so far, it is clear that the level of analysis does not yet properly capture the security of supply vulnerabilities of the IEA member states. For instance, the vulnerability stemming from energy industry clustering in countries and/or the cascading effect of a disturbance to the hinterland could not be fully covered in the approach.

Importantly, a standard always says something about past vulnerabilities, while it still has limited say about future vulnerabilities, particularly not in a period of substantial change.

Cyber security

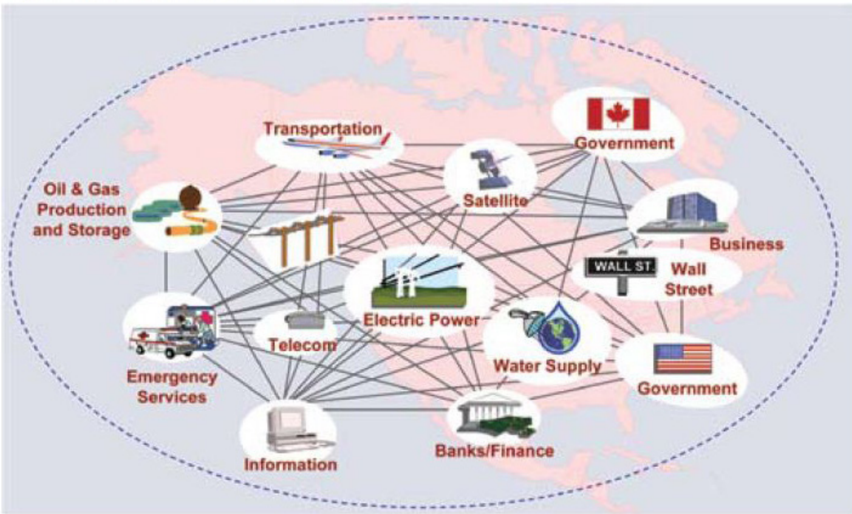
A new issue in security of supply is cyber security. Many countries and companies are concerned about the greater use of electronic components, software, communication devices and people monitoring these in our energy networks and processing, but also how this development interconnects larger and larger parts of our economy. With the growing interconnection of national grids and other energy delivery systems and the clustering of energy industries, the cyber risks are increasing in the entire value chain. With the greater use of electronics in all parts of the economy, electricity supply becomes crucial in making sure the systems work. The integrity of the energy delivery systems is therefore vital for the economy, health and security. This integrity can be disturbed as a result of system malfunctioning (complexity), human error, software problems and/or intentional disturbances, such as politically and economically motivated attacks on systems. It is crucial that we understand the risks of system interdependencies, including those in energy systems.

27 Jessica Jewel, *The IEA Model of Short-term Energy Security (MOSES), Primary Energy Sources and Secondary Fuels,* working paper, IEA, 2011. See at http://www.iea.org/media/freepublications/2011/moses_paper.pdf

Electronics are used to monitor traffic in energy delivery systems, to measure this traffic, to link customers, etcetera. Increasingly, companies also use electronic systems and devices to manage their maintenance schedules and reduce downtime in case of a disruption. They depend economically on the electronic systems to deliver accurate and timely information. This implies the involvement of many electronic systems, devices, and domains across companies and governments to make the systems work. Companies and governments may, for instance, use the cloud to store data or use mobile phone network to communicate data. The security of the systems depends on the security protocols of all the players in the system, and it is becoming increasingly important to make the users more security conscious and systems more robust.

FIGURE 9. GROWING INTERDEPENDENCIES DUE TO USE OF ELECTRONICS AND THE IMPORTANCE OF ENERGY

Interdependencies Across the Economy



SOURCE: HOMELAND SECURITY, ENERGY-SECTOR SPECIFIC PLAN, 2010; HTTP://WWW.DHS.GOV/XLIBRARY/ASSETS/NIPP-SSP-ENERGY-2010.PDF

Sharing information on the type of security breaches that occur is also important. Other sectors depend on similar electronic systems and the energy system to run them. The economy is becoming more and more interconnected, with greater reliance on electronic devices. The integrity of electronic systems is becoming an increasingly vital part of wider security as well. Also energy systems can fall prey to forces that may want to cause a disruption in energy delivery. Errors in one system provide important information for other systems to continue learning and securing. Very often the software can learn from errors and dynamically adapt.

In the US, the Department of Homeland Security has the task of coordinating the security of all vital infrastructures. Under the programme for the energy sector, together with the Energy Department, a roadmap to enhance cyber security for the energy delivery systems was developed.[28] Work of the various coordinating groups is published online, providing insights in the type of work in which the various committees engage. In the EU, a directive on cyber security was adopted on 7 February 2013, in which collaboration on energy system security is included. Member states are asked to report on their progress. In the Netherlands, public-private and EU/international collaboration on cyber security has been carried out at the National Cybercrime Security Centre since 2012. This was preceded by a number of other initiatives, most recently under the aegis of TNO. Collaboration on process security and the energy sector in the Netherlands dates back to the middle of the last decade.

Before the computerization of systems, certain vital sectors developed back-up systems in close cooperation with government agencies, while governments also developed policies for securing scarce energy for vital sectors. For instance, hospitals are required to have diesel-powered aggregates for the event of a power failure, while switchable consumers can also be taken off the system. Mechanical back-up for electronic systems could be important in case of a large power failure (as was shown in the aftermath of the storm Sandy), as could the ability to switch to a stand-alone operation, for instance in the case of solar panels for households and other rooftop producers. Major incidents such as storms Katrina and Sandy and the storm at Fukushima hold many lessons for the energy system, also with regard to sensitivity to electronic disruption. In the case of a natural disaster, the source of the disruption is known, but in case of a cyber-disruption it could be unclear where the disruption is coming from and whether it is safe to bring systems back on line.

More and more countries are developing policies to deal with cyber security and critical infrastructure. While they develop plans to manage cyber security, they should also think about the consequences of linking larger and larger networks to each other, making the number of players very large. The system's security is as strong as the weakest link. The introduction of smaller scale renewables, such as solar,

28 See report http://energy.gov/sites/prod/files/Energy%20Delivery%20Systems%20Cybersecurity%20Roadmap_finalweb.pdf

could bring the benefit that, at least during day-time hours, some electricity can be produced for domestic use in an integrated network and, when the option is created, it can mechanically stand alone when the grid is down. A smart combination of centralized and de-centralized power systems can help to manage the impact at the household level or even town level.

Critical energy systems and the greater use of electronics should be included and become an integral part of energy security policy. Energy policy-makers and companies should also be actively included in managing the risks, as they are in the US. The system is as strong as the weakest link in the system, and by creating larger and larger interconnected grids, a disturbance can ripple through the system, affecting many people and businesses. While creating a stronger defence against cyber vulnerabilities, energy systems should also be made more resilient by thinking about clever combinations of central and de-centralized systems and having mechanical back-ups; failure of parts of the system should not lead to a failure of the entire system. Electrification of the economy can make the economy more vulnerable unless alternatives – either in energy or off-grid – is offered as a security. With a roof full of solar panels on a sunny day, the power should not have to be out.

3 DEVELOPMENTS PER ENERGY SECTOR

ELECTRICITY SECTOR

In the EU, the introduction of non-fossil fuels in the energy mix was seen as an effective way to serve both the security of supply and the environmental policy priorities. The fact that solar and wind are produced in the domestic economy was seen as an added advantage, although the organization of the value chain of both these resources increasingly implies importing wind turbines and solar panels.[29]

Five years into the economic crisis, the introduction of non-fossil fuels into the electricity sector is raising a new set of security of supply issues to the policy agenda. Solar and wind as variable sources are not always available to match demand.[30] Typically, as long as the ability to store electricity is limited, these intermittent resources require 80% of their capacity to be backed up by other electricity generation capacities.[31] Yet the relatively small share of these sources (compared to future projections) has already changed the economics of a traditional power plant such that they are rendered uneconomical in the current markets for electricity.[32] This is happening much earlier than anticipated in studies on transition. This is partly due to the preferential treatment of wind and solar being able to enter the system first, the concentrated installation of wind and solar, the quick up and down times that require other plants further down the merit order to stay 'warm', and the over-production of electricity at the most lucrative hours. Already the number of hours per year that a traditional plant runs is becoming less.[33] Together with the low coal import prices partly resulting from the shale gas revolution in the US, even the most efficient gas plants are being rendered less economical.[34]

29 In order to protect domestic producers of solar panels, the EU was contemplating raising import tariffs on solar panels on the grounds of unfair competitive practices, as has been done in the US. Financial Times, 10 May 2013 and FT, July 23, 2013: EU and China Settle Trade Fight Over Solar Panels, http://www.ft.com/cms/s/0/4e468c26-f6ab-11e2-8620-00144feabdc0.html#axzz2c2l8oK6k

30 Nora Meray, *Wind and Natural Gas: Back up or back out?*, CIEP 2011. www.clingendaelenergy.com/publications

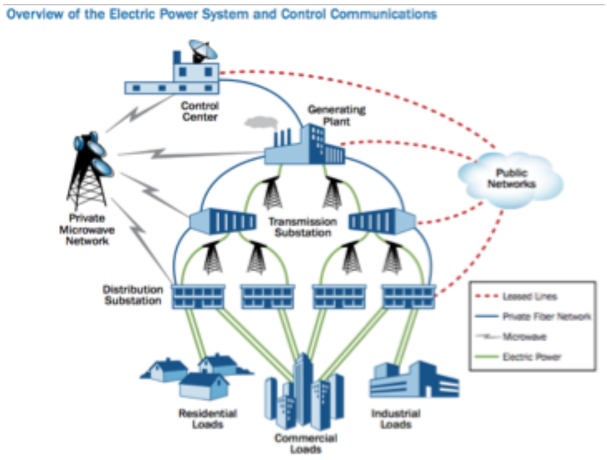
31 'ibid.'

32 The Wall Street Journal, 9 May 2013, *Shale Boom Is a Bust for EU Gas Plants.*

33 Fraunhofer, 2013, *Electricity Production from Solar and Wind in Germany in 2013.*

34 Koen Groot, 2013, *European Power Utilities Under Pressure*, CIEP, 2013; and also see press releases E.ON and RWE on half year results 2013.

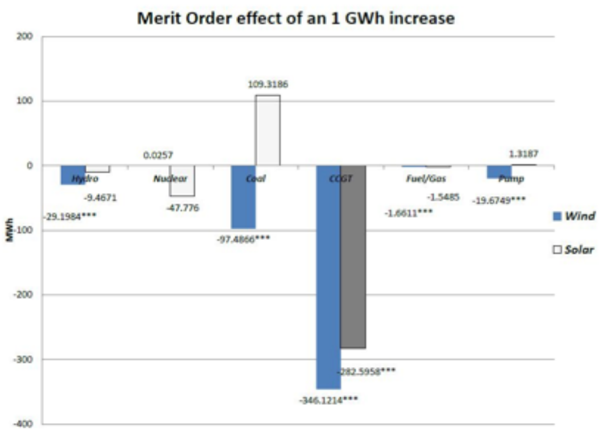
FIGURE 10. THE ELECTRICITY SYSTEM



SOURCE: ENERGY-SPECIFIC PLAN, HOMELAND SECURITY/DOE, US, 2010

The incompleteness of the carbon market presents another dilemma. Prices for CO_2 emission rights have steadily declined, failing to push carbon-rich resources back in the electricity merit order. Instead, natural gas has been relegated to a marginal position in the merit order, even though its CO_2 emission profile is a better fit with the carbon space objectives. The flexibility of natural gas-fired plants was predicted to be a perfect fit with the intermittency of wind and solar, while the carbon prices were supposed to benefit natural gas compared to coal-fired plants. This is, however, not the reality in the current markets (see Figure 11).

FIGURE 11. MERIT ORDER EFFECT OF RENEWABLES[35]

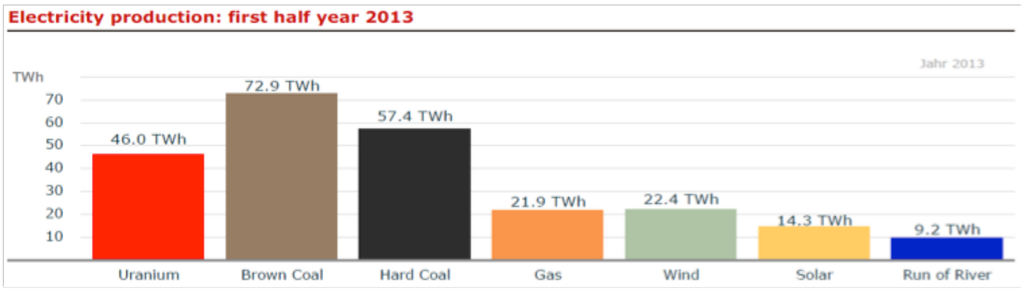


SOURCE: BOCKERS, GIESSING, ROSCH,THE GREEN GAME CHNAGER, 2013.

35 Source: Veit Böckers, Leonie Giessing, Jürgen Rösch, The Green Game Changer: An Empirical Assessment of the Effect of Wind and Solar Power on the Merit Order, Düsseldorf Institut für Wettbewerbsökonomie, no. 104, August 2013.

Here, the economic crisis and the resultant decline in demand for electricity and lower coal price (due to the shale gas revolution in the US) play their part. The rapid increase in solar and wind supply in a declining market led to a reduction of uptime for conventional plants. Another issue is that relatively old coal and gas fired generation plants were still in the system. Some of these older coal plants will retire in the years 2015/2016 due to the Large Plant Combustion Directive and other more local agreements, creating some space in the market for the more efficient and flexible plants. The supply of cheap coal, at the same time, has created a serious competitive gap between coal and natural gas-fired plants. According to the Fraunhofer institute (2013) the first half-year of electricity production in Germany showed the dominance of coal in the power mix.

FIGURE 12. ELECTRICITY PRODUCTION JAN-JUNE 2013



SOURCE: FRAUENHOFER, 2013

Another issue in electricity markets is that the coordination between the various parts of the value chain is less than optimal. While capacities in renewables expanded rapidly in some parts of the NW European market, the transmission (transportation and distribution capacity) of electricity had a hard time keeping up with the changing pattern of demand and supply. Although ENTSO-E is trying hard to remedy the coordination deficiencies with their 10-year capacity plans, the ability of certain transmission companies to invest in new capacities and adapt existing capacity to new demand is strained in the post-2008 capital markets. Here the regulated rate of return could be not stimulating enough (or offer certainty enough) for certain transmission investment projects to materialize. Also the long lead-time for obtaining permission to build has become an issue in adapting the infrastructure to the new realities of demand and supply.

The openness of the Netherlands to investments in large power plants (including coal) prior to 2008 was based on the logic of the continuation of market integration. The location on the coast, offering cooling water and cheap primary energy supply lines and having a well-developed electricity network were thought to position these plants well for the NW European power market. The power production capacity in the Netherlands was developed as part of the NW European market.

The ramping up of renewable capacity in the past 5 years as part of the EU 20-20-20 policy (and embraced with varying gusto by member states, such as Germany) and the turnaround with regard to nuclear energy by Germany has changed the large incumbent companies' CO_2 profile, their base-load capacities and their locational strategies, with little time or ability to remedy the situation.[36] Instead, wind and solar capacity had to be accommodated on a network not outfitted to carry such amount of power in a North-South direction. Loop flows in the grid were the result, as well as negative prices due to overproduction of electricity in the German market area as a whole. Market conditions have consequently changed, and it is increasingly questioned whether the energy-only market will provide for sufficient backup capacity for renewables in the system.[37] Most of the subsequent proposals with regard to capacity markets address back-up capacity for national systems, rather than for relevant markets. This could leave the Netherlands with serious overcapacity in its system, depending on the type of measures.[38] Efforts to combine such initiatives in the NW European market could prevent another uneven playing field from coming about and could win in effectiveness when other policies, such as the renewable capacity, would be more aligned, too.

Fuel mix changes, intermittency and SoS

Operational security of electricity supply relates to the ability of the electricity system to be balanced in time. Since electricity storage does not play a significant role in the system, production and use must be balanced at every moment. In order to do so, a balanced mix of generation facilities and transport infrastructure is vital. Load-following generation facilities have traditionally played a key role in this regard.

The strategic and long-term dimension of security of electricity supply refers largely to the availability of inputs into the (Northwest European) electricity system and the adequacy of infrastructure. Relevant inputs include most notably coal, natural gas,

36 Koen Groot, 2013, *European Power Utilities Under Pressure,* CIEP, May 2013.

37 Leonie Meulman en Nora Meray, *Capacity Market Mechanisms,* CIEP December 2012.

38 Nora Meray, *Wind and Natural Gas: Back up or back out?*, CIEP, 2011.

uranium and – to a lesser extent – biomass. Natural gas supplies will be discussed elsewhere.

- Coal reserves and resources are relatively abundant, and coal is supplied through a relatively mature global market. Although changes in exports from countries presently supplying Europe (e.g. the US) can have consequences for global prices, supplies are relatively diversified and flows can adapt relatively easily to changing regional supply/demand balances, which decreases the risk of supply issues.
- The global uranium supply/demand outlook looks balanced. Moreover, the market for assembled fuel for Light Water Reactors (the dominant type in Europe) has become increasingly competitive in recent years; there are competing suppliers. A factor further enhancing security of electricity supplies from nuclear sources follows from the fact that nuclear fuel can be stocked relatively easy.
- Biomass presently has a limited role in the European electricity system. This could change in the post-2020 period if a substantial amount of electricity were to be generated from biomass. Growing concerns regarding the desirability of using biomass for energy may have altered the outlook (including post-2020) regarding the role of biomass in electricity generation, as well as the manner in which the security of biomass supplies should be assessed. Concerns include the carbon footprint of the supply chain and land use issues, as well as competition between biomass use for energy on the one hand and for alternative uses (food, biochemicals, etc.) on the other.

From the ENTSO-E analysis it follows that no issues regarding generation adequacy should be expected for the years up to 2020. Some countries, including Germany, may be import-dependent for their security of electricity supply, but the European system is balanced.

After 2020, the most prominent complicating factor regarding the operational dimension of electricity supply will relate to the decarbonization of the electricity sector, as envisioned in various policy roadmaps, of which the EC Roadmap 2050 is the most prominent.

Specifically, the potential introduction of a substantial amount of intermittent electricity generation in the electricity mix may have major consequences. Different than load-following generation, intermittent generation from solar and wind does not follow end-use patterns but rather patterns of nature.

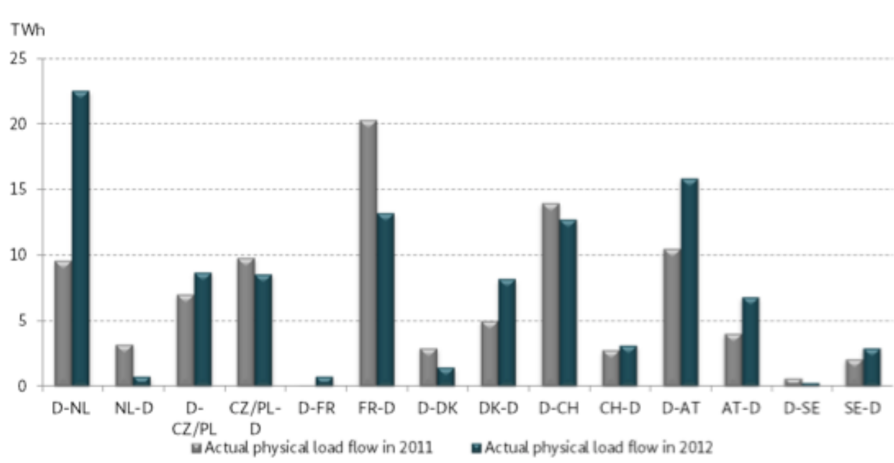
In recent years, the substantial growth of intermittent capacity, particularly in Germany, turned out to affect particularly the North-western European power markets more significantly than had been foreseen by many. In Germany alone, a further increase from 60 GW of intermittent capacity (solar plus wind) in 2012 to some 115 GW in 2022 is realistic, while peak demand in Germany is around 80 GW and most hours of the year (significantly) lower. Substantial volumes of electricity from this intermittent capacity already flows into neighbouring countries including the Netherlands (see Figure 13).

At the same time, other countries in North-western Europe seek to increase the shares of intermittent generation capacity in the mix as well. Since weather conditions are related across the region, this generation from solar and wind capacity is not necessarily levelled out.

Without breakthroughs in electricity storage technologies, flexible load-following generation as well as demand responses are key in accommodating the increasing amounts of intermittent generation in the post-2020 period. In the internal EU energy market, the market has to deliver in this respect. It will only do so if the investment climate is attractive for technologies that are required.

FIGURE 13. PHYSICAL CROSS-BORDER LOAD FLOWS[39]

Figure 5: Physical cross-border load flows (Source: ENTSO E – European Network of Transmission System Operators for Electricity)



SOURCE: BUNDESNETAGENTUR BUNDESKARTELLAMT, MONITORING REPORT 2013.

39 Source: Bundesnetagentur Bundeskartellamt, Monitoring report 2013 at http://www.bundesnetzagentur.de/SharedDocs/Downloads/EN/BNetzA/PressSection/ReportsPublications/2013/MonitoringReport2013.pdf;jsessionid=EB2FB0C2FFEE9124FE43BEF6300D27CF?__blob=publicationFile&v=9

Due to the financial and economic crisis, falling demand for electricity and continued government-induced (renewable intermittent) capacity expansions, power markets may stay depressed (low prices) in the coming years.

Renewable support schemes differ widely in nature from one member state to another. Apart from the question of whether this is suitable in a single European energy market, it can also hamper investments and particularly could lead to investment in generation capacity in the places where it is not most effective.

The European carbon market (EU ETS) is presently oversupplied, leading to emission allowance prices being much lower than anticipated by many relevant public and private actors. This undermines the climate change policy goal because the coal-gas merit order remained untouched while CCS technology development has stalled.

While some countries have an energy-only market, capacity mechanisms either already exist in other member states or the introduction is being considered. It is dubious whether national approaches to capacity mechanisms are an effective way to address concerns regarding security of future electricity supplies.

The Netherlands should take a hard look at the current developments in the power market. All in all, it is debatable as to whether the present state of the internal EU energy market, with the carbon market, the variety in renewable support schemes and the increasing variety in capacity mechanisms, provides for an investment climate that attracts investments in those technologies that are needed in a post-2020 electricity system with increasing amounts of intermittent generation, as envisioned in many policy roadmaps and scenarios. Instead, a more strategic approach to energy efficiency and carbon abatement could be developed and assess the role and size the power sector should be to fully function in the role of energy hub that the Netherlands might aspire to maintain.

OIL AND LIQUIDS

Recent developments in the liquid fuels/energy-industrial cluster warrant attention. In the 1980s, the refining and petrochemical industry was experiencing large overcapacities. These were also due to multiple of factors, including new capacity additions that came on-stream after the oil price increases of the 1970s while demand declined.[40] At the same time, new plants were built in the Middle East to benefit from

40 Coby van der Linde, Dynamic International Oil Markets, Kluwer, 1991.

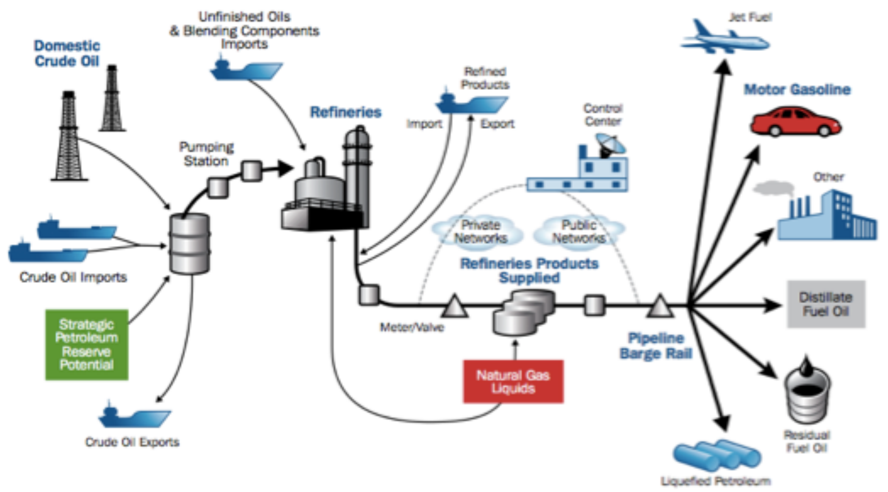
lower energy costs. In the end, some plants were scrapped, some capacities improved to include complex refining, some were refurbished to specialize on certain special products, and other capacities swapped among companies to improve economies of scale. In addition, demand in the 1990s recovered, while North Sea production was at its peak. Moreover, trade barriers to help them compete on the domestic EU market protected the petrochemical industry. Nevertheless, the restructuring of the downstream oil industry implied disinvestments by some market players but also the introduction on new ones. Pure refiners or other non-vertically integrated market players purchased smaller refineries, often inland and not part of an energy-industrial complex. The relatively low prices of crude oil helped demand to recover, and margins improved.

In the 1990s, oil products were actively traded to satisfy demand for certain products. Europe was importing diesel to feed demand for this transportation fuel, while gasoline was exported to the US (see Figure 14). In the US, the downstream industry had also undergone a transformation, in part due to the Clean Air Act of 1991, and in part to accommodate the new supply realities. New large refineries were built along the Gulf coast, close to the booming offshore production centres, while small inland simple refineries were closed because, among other things, they could not carry the cost imposed by the Clean Air Act.

The 1990s were a period of globalization, also for the already very international oil industry. Import dependencies were high. This time the downstream industry became much more focussed on international trade rather than on the domestic market as before. Markets were supplied from various sources of crude, including the important North Sea oil, and sourced other markets with certain products. Infrastructure did not always follow these industry structure changes, also because vertical integration as a model for the oil industry declined somewhat in the OECD consumer markets, allowing single segment players to gain market share. In Europe the commercial exploitation of the NATO oil product pipeline system helped to connect the various European oil product markets, but a connection between the NATO system and the old COMECON pipeline system did not materialize.[41] Rail and river barge transportation became even more important, while road transportation also increased.

41 NPS, NATO Pipeline System at: http://www.nato.int/cps/en/natolive/topics_56600.htm, accessed on 10 May 2013.

FIGURE 14. OIL SYSTEM



SOURCE: ENERGY-SPECIFIC PLANS, HOMELAND SECURITY/DOE

The demise of the Soviet Union in the early 1990s and the subsequent deep economic crisis in that region had freed up flows of crude oil and products despite declining crude production.[42] The European market absorbed much of these supplies, also because both crude and product supplies from Iraq and Kuwait were down. The increase in demand for oil in Asia then exerted a logical pull on the capacities in the Middle East and Asia, while Russia became an important supplier to Europe. The legacy of its export infrastructure became an important vehicle in supplying European markets.[43] However, these capacities had to compete with alternative supply routes, making oil pipeline imports less problematic than natural gas ones.

In the early 2000s the structure of the oil industry, after a long period of consolidation, began to change again. Large international oil companies invested mainly in large complex upstream developments and less in the downstream part of the value chain. Crude oil price increases depressed reefing margins, while traders in crude and oil products had become a much more diverse group of market players. The mid- and downstream parts of the value chain were no longer the domain of the large international oil companies alone.[44] Countries such as India and China became increasingly interested in building their own refining and petrochemical capacities, sometimes also for export markets. The growth in demand for crude and oil products was buoyant, however, and largely hid the underlying structural problems.

42 Thane Gustafson, *Wheel of Fortune, The Battle for Oil and Power in Russia*, The Belknap Press of Harvard University Press, Cambridge MA., 2012, p.10.

43 Ibid., pp. 9-13.

44 Jochem Meijknecht, Aad Correljé and Bart van Holk, *A Cinderella Story?: Restructuring of the European Refining Sector*, CIEP, April 2012: www.clingendaelenergy.com/publications

This changed with the financial and economic crisis. Demand for crude oil and oil products declined in the US and Europe, while growth elsewhere continued. At the same time, shale gas in the US took flight, impacting Henry Hub natural gas prices so much that soon the industry began to focus on tight oil plays.[45] The new demand and supply dynamics in the US[46] changed the market for the European refineries dramatically. They are now challenged in their traditional gasoline export markets in the US, Caribbean, Africa and Latin America, unbalancing trade in oil products. A consolidation of the refining sector in Europe is eminent, also because in the Middle East and Asia new export refinery capacities are being developed, while Russia is also in the process of upgrading its industry. The outlook for various crude oil transportation fuels in Europe is stagnation at best, but decline is more likely in the longer term. Without export markets or other alternative markets, the refining sector in Europe will have to adjust and/or shrink. At the Oil&Money conference traders declared in a discussion of the market developments: “Europe faces a new wave of refinery closures due to rising competitiveness of US plants which can run on cheap gas and a continued fall in European demand.(…) In the next two years we will see probably five, six plants, 500,000-700,000 barrels per day being closed”.[47] If this restructuring process takes place based on the competitive position of refineries, the complex refineries, which are also part of a larger energy industry complex, are better positioned to survive than the more isolated simple refineries. However, government intervention could interfere with the logic of restructuring if the resultant new oil product flows lead to new import dependencies in Central and East Europe that are politically unwanted.

The refinery sector is under pressure to change. Developments in the internal market and on international markets are making an end to the traded balance in supply and demand. This is bound to impact SoS of crude oil and of oil products in certain parts of the EU market. EU governments, with the exception of France, have shown very little interest in the fate of their refining industries, mostly because the refineries are part of the IOCs' activities in a worldwide portfolio, but also because they are focussed on moving demand away from fossil fuels. However, the timing of the changes is going to be critical for security of supply because there is a distinct danger that the refining sector will adjust to international competitive pressure long before low carbon alternatives are available on the scale needed.

45 EIA, 21 May 2013, Outlook for Shale Gas and Tight Oil Development in the U.S.: http://www.eia.gov/pressroom/presentations/sieminski_05212013.pdf

46 Sammy Six, *US Refining Dynamics: Why the European Refining Sector Should More Closely Observe the Ongoing Tight Oil Boom In The US,* CIEP, January 2013 at www.clingendaelenergy.com/publications

47 DownstreamToday, 1 October, 2013 at: http://www.downstreamtoday.com/news/article.aspx?a_id=40895

From upstream to more mid- and downstream risks

EU domestic oil production is declining. Output from key producers Norway and UK is declining and is currently only about 3 mb/d. In ten years' time, output from these two countries will have halved. Unlike gas, the consumption of oil in Europe is not expected to grow. To the contrary, it will probably decline by about 1 mb/d by 2020 and almost 3 mb/d by 2035.

Europe imports two-thirds of its oil demand, and that share is destined to grow. Nevertheless, the volumetric structural import exposure remains fairly balanced because of lower demand. In terms of diversification of imports, Europe is doing relatively well. It imports about one-third from OPEC countries, one-third from Russia, and one-third from other countries (especially Norway and Kazakhstan). Ural crude imports from Russia are expected to increase, but the growing Chinese market might compete for the same flows.[48]

Crude oil markets are well supplied, although production increases in Iraq are behind schedule and some countries in (North) Africa suffered from supply disruptions. OPEC has significant reserves, and non-OPEC production – mainly that resulting from unconventional production in North America – is on the rise. Europe, however, is planning to make it difficult to import these new sources of supply (FQD), which can cause security of supply issues. The importance of oil import diversification does not get the same political attention as gas in the EU.

The majority of crude is imported via tankers (85%), implying that Europe has a large stake in safeguarding vital shipping routes. These include the Turkish Straits (Bosporus and Dardanelles), Suez, Bab-el-Mandab and the Danish straits. The shale revolution in the US has sparked a debate about whether the US will continue the same commitment to safeguarding the free flow of oil or that more active participation is demanded from other countries (especially consuming countries).

The plateau in demand and uncertain future outlook for oil and oil products has led to an overcapacity in refining. In recent years the European refining sector has been going through a period of intense restructuring. Between 2008 and 2012 around 30% of total European refining capacity changed hands, was mothballed or converted. This restructuring has led to somewhat healthier refining margins. However, the European refining industry faces major challenges that it will probably not be able to overcome: high crude feedstock prices, high energy costs (gas), skewed production towards gasoline and not diesel, dependency on diesel imports from FSU and dependency on

48 Financial Times, July 2013: Russian Oil Shipments to Europe at 10-year Low.

gasoline exports to US, West-Africa and Latin-America (and Europe is quickly losing these markets as a consequence of US refining dynamics), strict environmental and other legislation and competition from new-builds in the Middle East and Asia.

The shale revolution is having adverse effects on the overall industrial competitiveness of Europe (e.g. petrochemical sector), although cheap product flows (such as Naphtha) could also come Europe's way when the market in the US is saturated or unbalanced, further pressing the European refining sector to adapt or restructure. The FQD and other policies do not enhance the confidence of the refining and petrochemical industries in Europe. Disinvestment could be the result, rather than more indirect and direct investments, making Europe more dependent on all sorts of oil product imports.

The Netherlands should, together with the other energy and energy-industrial complex stakeholders, consider how best to maintain its role and potential for the future in these sectors.

The energy-industrial complex

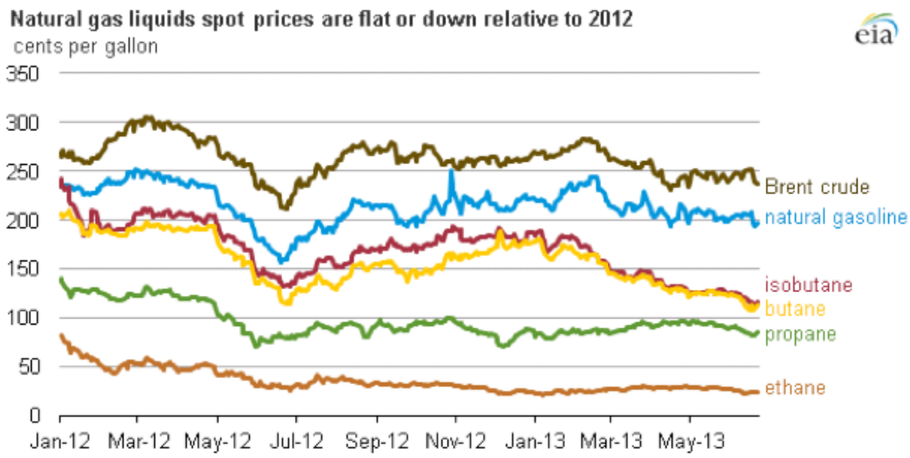
The refining industry in Europe is at the core of the energy-industrial complex, also in the Netherlands. The refining industry is not only crucial for the transportation markets but is also a prominent supplier for the petrochemical industry. Although the chemical industry (particularly the bulk segment) can source from international product markets, the infrastructure to do so may not be easily available. More often than not, it is part of an industrial complex where various parts of the petrochemical and refining are clustered in one location. In Europe and Asia, the petrochemical industry is naphtha (crude oil) based, while the US and the Middle East the petrochemical industry is ethane (natural gas) based. Ethane prices have been declining in the US, and in July 2013 the first contract to export liquefied ethane to Europe materialized[49], perhaps allowing the European chemical industry to benefit from the developments in the US market.

The recent widening difference in oil and gas prices, particularly in the US, has an impact on the competitive position of the European chemical industry. Despite the clear difference in the US and European natural gas price, the exact impact on the

49 A European petrochemical producer has entered into a 15-year agreement to ship Marcellus Shale ethane to Norway from a Sunoco Logistics terminal in Marcus Hook.; http://articles.philly.com/2013-01-25/business/36529244_1_ship-ethane-mariner-east-sunoco-logistics

competitive position of the European chemical industry should include an assessment of the development of the feedstock prices (ethane and naphtha) in both markets. The shale gas and tight oil production increases have caused all sorts of processing capacities to be tested in their adaptability to the new supply slate, and the oil product market has changed dramatically as a result.[50] Some of these changes have also caused costs to decline for European industries.

FIGURE 15. NATURAL GAS / LIQUIDS PRICE DEVELOPMENT

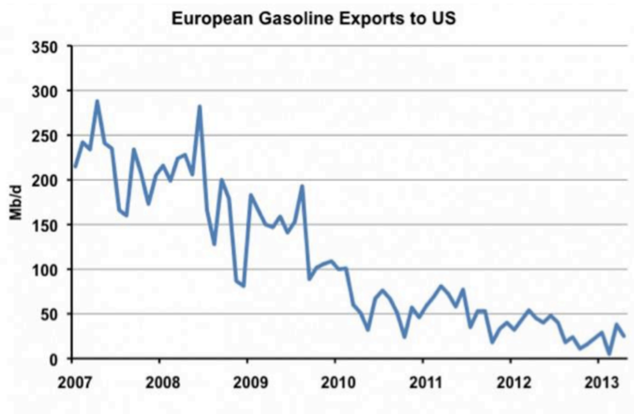


SOURCE: EIA, JULY 2013 TODAY IN ENERGY.

The change from oil-indexed natural gas prices to hub-based pricing only offers a partial remedy because natural gas prices will continue to be higher in Europe than in the US (See also Figure 6). Closing important resource cycles through recycling products is one remedy, while developing bio-based chemicals is another way to develop competing strategies. Yet the pressure to improve resource efficiency and reduce emissions influences the balance between the refinery and its outputs and the industries downstream.

50 EIA, Short-Term Energy Outlook, Petroleum section, July 9 2013.

FIGURE 16. US GASOLINE IMPORTS FROM EUROPE DECLINING



(IEA, 2013)

In the 1950s these petrochemical /industrial clusters were built based on the emergence of market refineries, which provided them with cheaper feedstock than before. The refinery would import the crude oil and process the crude into both industrial feedstock and transportation fuels. The refinery slate depended on the type of crude oil and the refining technology, while demand depended on a combination of transportation fuel demand and industrial demand. When the supply of crude oil on world oil markets became heavier, new processing technologies managed to restore the balance between supply and demand and to some extent allow arbitration among crude inputs. In simple refineries, the output is more determined by the crude input, while in complex refineries, processing methods can offer further balancing between the various submarkets for oil products.

Since the 1980s, government policies, particular the fiscal treatment of certain transportation fuels, biased the European passenger and small trucks transport fuel market to favour diesel over gasoline, when the fuel price was a larger part of the marginal cost of the vehicles. This policy was so successful that Europe became a large importer of diesel and a large exporter of gasoline. As long as trade could balance the refining and petrochemical supply and demand, the industry remained in good shape. But the recent surge in oil and natural gas production in the US is now upsetting this balance. US refiners are competing for export markets with the European refiners in the Caribbean, Latin America and Africa, while gasoline imports into the North-eastern US are declining at the same time. Some of the drive to export gasoline on the part of US refiners has to do with the shortage of ethanol RINs,[51] driving up their price, and providing part of the industry with a stimulus to

51 Renewable Identification Numbers (RINs), which began in 2005 and was revised in 2007 as part of the Energy Independence and Security Act of 2007 (EISA). Beginning in 2009, US ethanol production began to grow beyond the targets set by the RFS, leading to an increasing supply of banked RINs through 2012: http://www.eia.gov/todayinenergy/detail.cfm?id=11551 and EIA, 5 June 2013, US ethanol production and the Renewable Fuel Standard RIN Bank.

export rather than sell the proscribed gasoline blends in the domestic market.[52] Here, the efforts of the American government to improve the share of renewables in the transportation sector and blend larger shares of corn ethanol in the gasoline had serious trade consequences in other markets. The fact that the government intervened in an open market – in various parts of the oil, gas and coal value chain to further increase the share of renewables – implies that the impact is often as much domestic as international. Also the European Clean Fuel Directive may have international impacts, when certain crude oils are given different weights. The impact on trade and on the competitive position of various governments' environmental and renewable energy policies in open (international) energy markets is bound to become an important issue in trade negotiations. Although it makes energy products available to some countries, it also negatively influences the competitive position of others, making environmental policies an increasingly important trade policy tool.

Although the refining and chemical industry has weathered structural changes before, the current developments combine a change in the international competitive position of energy-intensive industries with policy-induced restructuring and a severe economic downturn. The irony is that the refining and chemical industries are also part of the transition strategy, as innovators and investors, but that the ability to transform may be seriously hampered by the short- to medium-term challenges posed by the shale gas and tight oil revolution and the shift of growth, on which these industries depend, to Asia. After decades of international or globalized positions of the industry, the European refining and bulk chemical industry could be forced to take a more modest regional view. This could have serious implications for the capacities necessary for such an approach and could lead to a different energy trade profile.

NATURAL GAS

The natural gas sector has been the success story of the post-1973 European economy. The Netherlands, the United Kingdom and Norway formed the bedrock of European gas market expansion, while Russia and Algeria were important external suppliers. In the 1990s, sufficient supplies helped to liberalize the internal gas market. The rise of LNG allowed more EU countries to import gas and diversify supplies.[53] With European

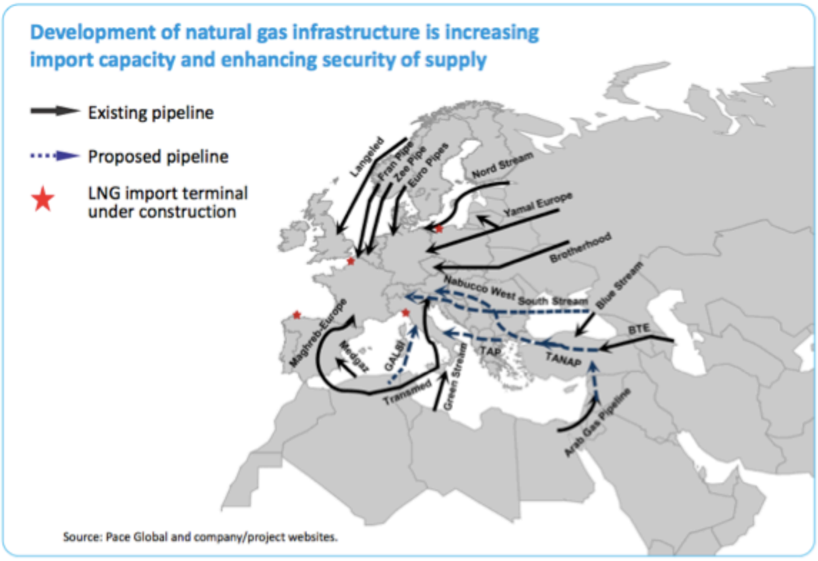
52 See also: http://www.eia.gov/todayinenergy/detail.cfm?id=11671; EIA, 13 June 2013, What Caused the Run-up in Ethanol Prices During Early 2013?

53 Presentation CIEP, Uncertainty Reigns, April 2013.

supplies declining, the import dependence of the EU is bound to increase.[54] The legacy of the development in the gas infrastructure is still visible in today's structure (see Figure 17). The Netherlands first developed its pipeline gas infrastructure in its own market and to neighbouring countries. In the 1970s and 1980s, pipelines from Norway, Russia and North Africa allowed for the further expansion of the gas market in Europe, while LNG terminals also connected European markets with external suppliers.

In the period before 2004, Western Europe's security of supply was fairly balanced between domestic supplies and Norway, Algeria and Russia, although the dependence on Russian gas supplies was always seen as problematic by the US. The dissolution of the Soviet Union and the attempt to open up the market for investments in energy in the former Soviet Union through the Energy Charter was supposed to remedy this. The regional concentration of North African supplies in Southern Europe was a concern to those countries in which cross-border gas pipeline infrastructure was insufficient to import gas from other markets and make up for interruptions in supply. Spain, for example, introduced legislation limiting gas supplies from a single source. The countries around the North Sea were well supplied, while France used gas essentially for residential and industrial purposes.[55] France and Italy also have strategic gas stocks.

FIGURE 17. EUROPEAN NATURAL GAS IMPORT INFRASTRUCTURE



SOURCE: EGAF, THE FUTURE ROLE OF NATURAL GAS, 2013.

54 See Figure 7.
55 EC Market Observatory for Energy. Key Figures. June 2011: http://ec.europa.eu/energy/observatory/countries/doc/key_figures.pdf

The SoS situation (and perception at the EU level) changed drastically when the Eastern European countries joined the EU. The import dependence in Eastern European countries was close to 100%, and they were supplied only by Russia. The political and economic legacy of the relations between the former Soviet Union and the Central European states made the energy relations much more political. The Eastern European countries expected the entry into the EU to reduce their exposure to SoS risks but instead found that overall EU energy trade with Russia was intensifying. In addition, the 2020 policy of the EU potentially required that these countries force a reduction in coal-firing plants. The gas conflicts in 2006 and 2009, caused by contractual conflicts between Russia and the Ukraine, created problems deep into the European market.[56] The lack of reverse flow capability on many of the East-West pipelines left Eastern Europe without much ability to source elsewhere in the market. Again the legacy of the old gas supply system aggravated the SoS problems in Europe. While Western European markets have constructed LNG terminals and benefit from the potential to source from the growing LNG exporting countries, Eastern Europe remains exposed to only one pipeline supplier.

FIGURE 18. NATURAL GAS SYSTEM

SOURCE: SECTOR-SPECIFIC PLANS, HOMELAND SECURITY/DOE, 2010.

56 Edward Chow and Jonathan Elkind, *Where East Meets West: European Gas and Ukrainian Reality*, The Washington Quarterly, volume 32, issue 1, 2009, pp. 77-92..

Efforts to develop alternative pipeline supplies from Central Asia were fraught with difficulties of both an economic and geopolitical nature.[57] Competition from China and uncertainties about volumes available for Europe delayed investments. At the same time, Russia tried to position its own gas supplies in the EU market by developing alternative pipeline routes (Nord and South Stream) and improving the security of transit for its gas. Although Nord Stream has been realized and work on South Stream continues, the EU gas market is no longer as certain a bet as before for external suppliers. The impact of wind and solar energy and the availability of cheap coal (from the US) on the economics of gas power plants are disturbing the future role of gas in electricity generation. The current inability to price the lower CO_2 content in natural gas is complicating its competitive position, crimping the prospect of a larger role for natural gas in the transition to a lower-carbon economy. Such a development is in part counter- intuitive, also because the green revolution in other regions, Asia and North America is blue (the colour associated with natural gas).

The natural gas sector has developed to a situation where more natural gas imports from outside the EU supply the market. Policy makers in the EU take the view that market liberalization is incomplete without liberalization of the external supply sources, which has led to tension in the relationship with Russia. The structural import dependence of some EU countries on one or two suppliers and the structure of supply (monopoly on exports/NOC) and the expectation of substantial growth of the LNG market of market players have stimulated efforts to diversify supply sources by building more LNG terminals. These are nearly all located at the Atlantic/North Sea and Mediterranean coast, and the lack of West-East pipeline capacity and the cost of transportation (compared to traditional supplies from the east) prevent most of these new supplies from reaching the Eastern parts of the EU. The arbitration line stretches over Western Europe, also depending on Asian prices. Gas was expected to be an important primary energy source for the power industry and provide back-up capacity for wind and solar power. Instead, coal is currently taking up this latter role, squeezing gas out of the market. The question remains as to whether the gradual transition to short-term spot price transactions will jeopardize the longer-term security of gas supply.

57 Christof van Agt, *Caspian Oil and Gas: New Perspectives beyond Projects and Pipelines*, CIEP, 2014-01 at www.clingendaelenergy.com/publications.

Changing EU Demand and Supply

Domestic EU natural gas production is declining, and the demand outlook is uncertain. Demand recovery depends on the duration of the financial crisis, which is difficult to predict, but also on the future role of gas in Europe's energy mix. Keeping these uncertainties in mind, most scenarios suggest that gas demand in Europe will probably grow by 2020 and that the gas import dependency rate is set to increase.

Europe will need to import more gas. The availability of external supplies should not be a problem. First of all, there are margins to increase imports through pipelines that are currently underutilized. New pipelines are also being planned (GALSI from Algeria, the Southern Corridor from Azerbaijan and South Stream from Russia). Second, the global LNG market is also well supplied. Moreover, new supply capacity will be added to the current capacity by the end of this decade. LNG projects in Angola and Algeria (Skikda, Gassi Touil) are the next to come on stream, and a new wave of LNG supplies is expected after 2015. However, delays and cost overruns in some regions (notably Australia) have prompted some analysts to object to this mainstream view. They warn against the risk of a tight gas market in the years to come. In this case, the pressure would be mainly felt in Europe, since North America is self-sufficient and Asia is attracting most of the additional supply capacity by paying a premium (oil-indexed price) for security of supply. Arctic LNG (Russia, Norway) could be developed, but gas prices will influence the timing of the development.

While the availability of physical supplies is not the main matter of concern, it remains to be seen whether these sources will prove to be affordable for cash-constrained European buyers. The current market conditions, which could last for several years, are placing a lot of pressure on the gas business in Europe. Europe is experiencing a momentous transition in its gas business model in the midst of a deep financial/fiscal crisis. Demand weakness in Europe could play an important role in investment decisions in projects that would logically be developed to feed the European market.

- Gas consumption fell by 11% in 2011 and by 6% in the first ten months of 2012 relative to that same period in 2011. In the short term, this intuitively improves security of supply.
- Europe's major utilities have postponed investment plans (especially Southern Europe's Enel, Iberdrola and Gas Natural-Union Fenosa but also Germany's E.ON). Investment in interconnectors and reverse flow capacity has been sluggish. The financial crisis adds uncertainty to the investment climate (investors are reluctant to invest in new projects, given the discouraging outlook for demand). Both banks and governments are less liquid in providing the sector with capital. For

example, the European Commission estimates that €1tn is needed in order to complete the integration of Europe's internal energy market. Investment requirements in storage, interconnectors and LNG facilities are very high, and it will be difficult to meet them in the current market environment. The gas industry would need higher gas prices to allocate investment. However, higher gas prices also mean a risk that the role of gas in Europe's energy mix will be reduced, and they are not practicable in the new business model where end-users can buy cheaper gas on spot markets or where other fuels are very competitive.

The financial crisis has shelved urgent debates on the scarcity of minerals and energy in Europe, whereas these debates are still relevant in major developing countries (notably China and India), resulting in strategically oriented institutional and investment support for these sectors, including natural gas.

In Europe, the financial crisis is coinciding in time with the shift from long-term oil-indexed contracts to short-term hub-based transactions. There are diverging interpretations about the contribution of this shift to security of supply.

Some fear that this shift endangers Europe's security of supply: a) Hub indexation will give more market power to the producers (they would be more able to play value-over-volumes strategies, as Norway seems to be already doing, i.e., increasing prices by reducing production or even by buying gas on the market, which Gazprom is able to do after having established trading units in London). In the worst case scenario (for Europe), producers could even coordinate and collude (the possibility of a Russian-Qatari axis cannot be ruled out); b) Buyers, in turn, could also lower prices through dumping strategies. Combined with greater room for opportunity for manipulation by the producers, this could result in quite an adversarial relationship between buyers and sellers, which is perilous for strategic and long-term security of supply; c) The risk of volatility inherent to the shift to hub indexation has been shown by the US, where a grab-and-investment rush took place. The very low, unsustainable Henry Hub prices caused a fall in investments and a subsequent fall in upstream activity. Exports of LNG will improve price levels to some extent, while day-to-day volatility will remain; d) Volatility could increase also due to the larger role of financial/paper trade, which is a consequence of the larger role of hubs. This would also create a wedge between prices and market fundamentals; e) One of the most powerful arguments against hub indexation and a short-term-oriented market is that it could jeopardize large upfront investments in new supplies if these need to be backed by long-term, oil-indexed contracts; f) Many proponents of the shift argue that it would increase the availability of cheap gas. However, Asian prices and the different development of demand and supply of oil explain why hub prices have been lower than oil-indexed prices (in a tight market, gas hub prices could be higher than oil-indexed prices); g) The outcome of this shift may be good, but the transition has its own risks (more volatile environment, risk of default of some players), especially if it takes place in the midst of a financial crisis; h) The risk of a two-speed Europe (Northwest Europe moving faster than the rest, Eastern Europe, i.e. the most dependent region, lagging behind).

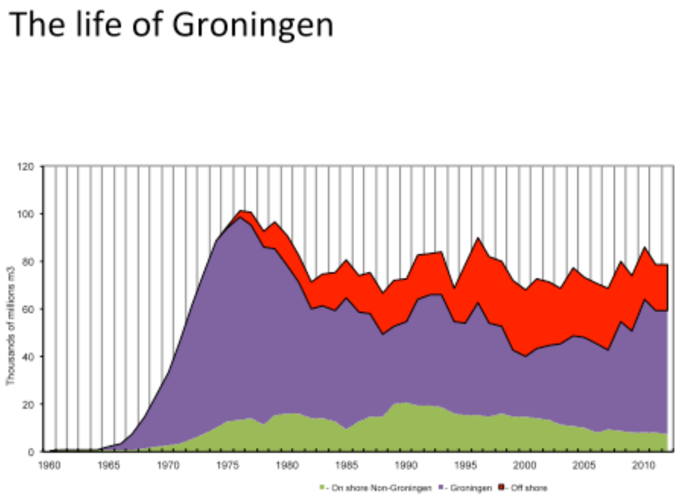
The proponents of the shift claim its positive effects on security of supply:

a) Deregulation was seen by the Commission as a way to boost security of supply, by reducing concentration and increasing the number of players in the various segments of the gas market;
b) Virtual hubs balance supply and demand and make sure that gas flows where it is needed. Price signals are replacing vertical integration as an instrument to balance the network;
c) The process enjoys strong political support in Brussels, and the Commission is working to bring it to full maturity (by building a framework that facilitates traders, aware that the new arrangement works only if the market is deep and liquid);
d) Investments are being allocated more rationally, being grounded on real market conditions and not on centralized decisions by incumbents. Price signals guide investments. Jonathan Stern, for instance, underlines that the lack of committed quantities did not inhibit substantial investments (examples: receiving Qatari LNG terminals, Gate, Ormen Lange, pipelines in North America).

In addition to the changing European gas market, the Netherlands is also experiencing some profound changes in its gas sector. It is clear that with the decline in small field gas production and the greater reliance on Groningen production, Dutch gas production had entered a new phase (see Figure 19). The maturity of Dutch gas production has resulted in developing the gas roundabout, preparing the market for more imports. Developing pipeline connections with the UK and with Germany and Russia (Nordstream) and the Gate LNG terminal evidence the change in Dutch gas policy.

The recent intensified incidence of gas-related earthquakes in the Netherlands resulted in the production plan for Groningen being changed in January 2014, effective for the next three years. This plan was based on a set of 14 studies, issued by the Ministry of Economic Affairs, covering a wide range of matters related to gas production from the Groningen field.[58] Uncertainties with regard to above-ground safety led to a revision of the production plan, capping production at 42.5 bcm – 40 bcm for a three-year period, rather than allowing production to average over a ten-year period. The change in the Groningen production policy signals a re-thinking on the future management of the large Groningen field and could have ramifications for security of supply. In the coming three years, more studies will need to shed light on the production level within above-ground safety parameters. This could impact the management of flexibility, the use of and the need for storage capacity, the need for conversion capacity and – perhaps earlier than foreseen – the shift to a new gas quality standard for appliances. The deep penetration of gas in the industrial, residential and power markets could mean a complex process of adjustment.

FIGURE 19. DUTCH GAS PRODUCTION



SOURCE: PRESENTATION AAD CORRELJE, CIEP GAS GROUP 6 FEBRUARY 2014.

For the Netherlands, the changing structure of the natural gas sector is particular relevant because natural gas forms the backbone of the energy system in the country. Not only industry and the power sector, but also the deep penetration of natural gas in the household sector makes the long-term supply of natural gas a relevant issue. Consumers in the Netherlands rely on Groningen gas quality, which is different from imported gas. In a declining Dutch supply situation either appliances have to be adapted to burn H-gas instead of L-gas (Groningen) or

58 See: http://www.rijksoverheid.nl/onderwerpen/aardbevingen-in-groningen/besluit-rijksoverheid-over-aardgaswinning-groningen

sufficient conversion capacity must be available. In the next three years, while the recently adopted production plan is running, the specific security of supply issues emerging from the above ground safety issues must be considered in the new production strategy for the Groningen field. In terms of storage capacity and import/export infrastructure, the natural gas energy complex has a future beyond the Groningen resources. Storage of electricity in the gas system is an option that should be actively explored, in particular because Germany is 'going electric' and will require a more flexible neighbour. How this will work in the current internal market framework is uncertain. The current short-term focus of the market will make the longer-term strategic investments very difficult. A redesigned market for energy is likely, and the Netherlands should make sure it is well prepared to further the Dutch interests in the outcome.

4 MOVING TO SECURITY OF SUPPLY IN THE POST-2020 ERA

The energy security definition of the International Energy Agency (IEA) is broad compared to the Dutch one.[59] In the Netherlands (and in Dutch), we make a linguistic and conceptual distinction between security of supply and security of delivery. With this distinction, we separate the long and the short-term issues, but also internal/domestic and international supply issues. Nevertheless, the realization of the EU internal electricity and gas market complicates this distinction, although the EU is coordinating the capacity adequacy plans. The internal or domestic level might not be where security of supply issues materialize. More often, as a result of improved interconnectivity and market liquidity, these security issues present themselves at the regional level, while policy-making resides at the national and EU level and only marginally at the regional level.[60]

Security of supply in the 1970s and later years focussed on the supply of foreign-produced primary energy and the risks to the international energy trade flows. Structural import dependency could be managed by diversification of fuels (coal, oil, gas, nuclear) and sources (stimulating diversification away from OPEC). At that time, strategic reserves were designed to counter any temporary disruptions in oil trade, while demand management measures were designed to lengthen the time that a market could function during a supply disruption (complete or partial), albeit at a lower level of consumption. All these policies are still in place and are managed in the IEA International Energy programme (IEP, 1974). The Netherlands is a founding member of this organization.

The EU, too, has developed security of supply policies. Diversification of the energy mix was stimulated early on. EU security of supply policy has incorporated the IEA oil SoS policies and has developed regulations for natural gas. Gas security of supply regulation no. 994/2010 aims to create solidarity among member states in case of short-term supply disruptions, while the European Energy Infrastructure Package aims to improve connectivity through investments and the serving of common interests.[61] Despite progress at the EU level, policy surrounding the security of natural gas supply

59 See footnote 1.

60 Van der Linde et al., 2012, *Harvesting Transition? Energy Policy Cooperation or Competition Around the North Sea,* CIEP, January 2012.

61 Jean-Michel Glachant, Manfred Hafner, Jacques de Jong, Nicole Ahner, Simone Tagliapietra, *A New Architecture for EU Gas Security of Supply*, European Energy Studies, Claes & Casteels Pub., 2012, pp. 160/161.

is less sophisticated than the measures for oil, because the measures taken under the IEP do not lend themselves easily to natural gas security. The cost of imposing strategic reserves is a major hurdle, while taking account of dual-firing capacities and other demand management policies is difficult given the different security of supply issues among the member states. These do not lend themselves to general measures but rather require more tailor-made approaches. The EU energy efficiency goal in the 2020 policy can also be seen as part of a demand management effort, but it has been difficult to instrumentalize in policy-making.

With the EU acceptance of the existence of a limited carbon space in the world, and the subsequent policy measures to limit CO_2 emissions, new dimensions have been added to security of supply since the 1970s as it developed. The introduction of more renewable generation capacity often adds to the domestic production capacity, and when available, it reduces the demand for imported fuels for electricity generation. But it is exactly in the 'when available' or the variability that a new generation of security of supply issues lies. Although sun and wind are often producing, they are not always available.[62] Moreover, variable energy sources require back-up capacity as long as storage technologies are insufficient to balance the system at all times, also when solar and wind are not producing. These back-up capacities require conventional fuels, which are often (and increasingly) imported. Although these back-up capacities are currently available, the business models underlying these capacities are changing as a result of competition from renewables. The amount of up time is diminishing on a yearly basis, while the costs of providing back-up (keeping the power station 'warm') are not covered. If capacities are mothballed or old capacities not replaced, security of supply (as in delivery) can become an issue in the short and in the long term.[63] The latter is the case when 'back-up' generation capacity cannot contract their fuels on the terms that they need, either because other markets provide better terms or because investments do not materialize in various parts of the value chain. In this case a lack of sufficient security of demand could create security of supply problems. Also, infrastructure to ship energy from one part of the market to another is an issue.

62 Germany is planning to oversize its solar capacity to the extent that production on even not so sunny days will grow, while during peak hours on sunny days it will develop a large over/export capacity compared to demand (see also Figure 13). If all NW EU countries would follow this strategy and storage capacity would not yet be available or sufficiently large, it could have a large impact on price formation in the market and on the business models of other power generators (including wind). EWI, 2013, Trendstudie Strom 2022 - Belastungstest für die Energiewende, p. 9.

63 Leonie Meulman and Nora Meray, *Capacity Mechanisms in Northwest Europe: Between a rock and a hard place?*, CIEP, December 2012.

Security of supply has become a much more complicated issue than before when either prices or volumes of imported oil, natural gas and coal were at stake (mainly strategically). Providing security of demand is an important prerequisite for investments to materialize in the upstream parts of the fossil fuel value chains, while the open energy markets allow government interventions in the energy mix to quickly ripple through regional and international markets. For an industry with long lead times, such circumstances create serious uncertainties with regard to supply and demand for certain fuels and energy products. At the same time, the long life of energy infrastructure, production and processing capacities provide certainties about supply in the shorter term. Yet these sometimes fail to signal changes in demand on time, which is important for new investments. The variability of new energy production and the changing business models for conventional power plants could, if not addressed, impact SoS at the operational level as well as on the strategic and long-term levels.

INVESTMENTS AND SOS

The impact of a variety of climate change policies on SoS is substantial. Attempts to develop an international strategy to manage CO_2 emissions have failed, and instead countries are developing their own regional or national policy preferences. Also, in some countries the focus is moving away from CO_2 abatement to the replacement of fossil fuels with renewables, leading to completely different energy mix outcomes, not all of them equally 'CO_2-emission-reduction-or-food-and-water-security-friendly'. Because energy is traded internationally, and yet not truly left to market forces, it results to some extent in government policies competing with each other, not in effectiveness of reducing CO_2 emissions (the professed policy goal) or energy efficiency, but in strategically managing energy and other resource flows, industrial policies and the balance of payments. Climate change policies are thus as much part and parcel to the strategic interests of states – and therefore geopolitics – as energy policies were before.

How, then, does the position of Europe fit within these international developments, and what policy tools does it have when slowly emerging from a deep economic crisis? How attractive is the European market for investments? From an investor perspective, the European market for oil, natural gas and coal from a 'safe' but somewhat stagnant market (as opposed to the fast-growing but less certain markets in emerging Asia) to a highly uncertain market. A safe but stagnant market can play an important part in spreading demand risk for energy suppliers (in a portfolio approach to risk). But an uncertain market in decline does not offer such remedy to suppliers but rather adds risk, not only in terms of volumes but also in prices realized. Although the US has become just as much of a risk to the demand security of its external fossil fuel suppliers, investments flock into the upstream US energy industry to understand the new technologies and production methods for application elsewhere. That results in a different investor appetite. In Europe these investments are not materializing because there is a fairly widespread public reluctance to embrace new fossil fuel production technologies. At the same time, the wind and solar industry are part of a different knowledge and industrial base than the traditional energy industries. Moreover, the power industry in the world is still very nationally or regionally organized, while the production of capital goods (turbines, nuclear, etc.) is much more internationally oriented. Often, the national or regional power markets are strictly regulated.

Furthermore, the economic rents on the new European energies are no comparison to the economic rents in the new fossil energies in the US and in the deep offshore industry.[64] The question is often raised as to why the large international oil companies are not investing more in renewables, at least not in the politically preferred wind and solar sectors, because they do invest in biofuels and diesels. The economic rent issue, the fact that solar and wind still need consumer or taxpayer subsidies, and the fact that wind and solar do not (yet) call on any of the skills typical for an international oil company are good reasons to believe that such investments by IOCs on a large scale will not come about anytime soon.

Power companies, with large traditional or nuclear portfolios are investing in renewables in Europe but are struggling with the sudden decline in the business case for their existing plants as a source of finance for the new business.[65] Also for them the solar and wind technology requires a new skill base in the company, which requires time to develop. Project finance is possible and available, but the bank crisis plays a role here, too. At the same time, the ability of governments to finance certain technologies through the 'valley of death' has also declined.[66] As a result, financing the new energies in Europe is somewhat more problematic because the capital intense capacity build-up is not attractive for investors to be involved in, unless governments or consumers are partly covering the up-front risks. This could slow down the expansion of large offshore wind parks, while solar, with the right incentives (price, cost, and the ability to use it as a personalized back-up system, stand-alone or small-scale storage in batteries), can possibly continue to grow.

64 However, the rents decrease when the unconventional oil and gas cannot be evacuated to international markets.

65 Energeia, August 2013.

66 See: How Many Bridges Does it Take to Cross the Valley of Death? More Than You Might Think, 21 March 2011, https://financere.nrel.gov/finance/content/commercialization-valley-death

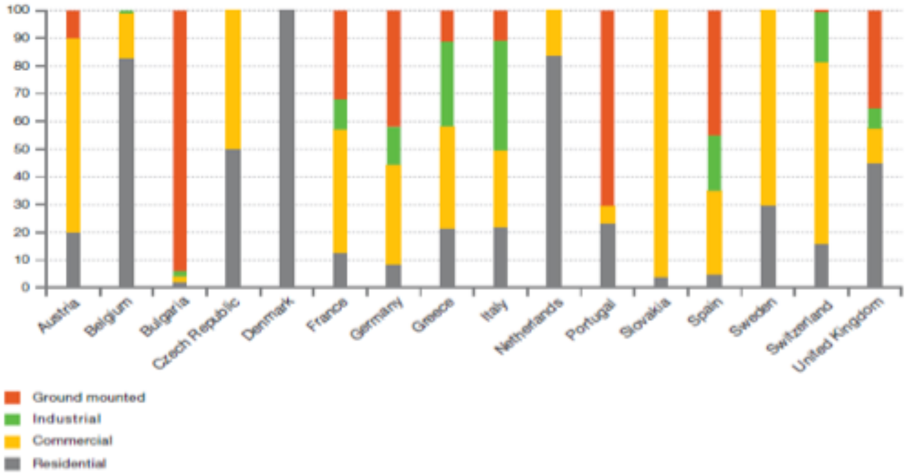
The growth of solar can become attractive for anyone with a roof and could, in combination with energy efficiency measures (insulation, lights, heating systems), generate sufficient growth despite the economic crisis. Here the incentive package is critical, because it implies dealing with a large set of small investors, also in existing buildings.

The problem here is that a centralized power system has been developed in the past decades. In anticipation of the completion of liberalization and, in some EU member states, ownership unbundling, allowing power production companies to be privatized, consolidation of the power generation sector took place. These large firms produce power in several EU member states. The size of these large European companies, apart from member state legislation and permits, is difficult to combine with the small-scale investments implied by certain renewables. One could debate whether a solar panel is part of the power infrastructure, therefore more befitting in the logic of the (distribution) network companies, part of the production part of the value chain or both.

The growth of solar in Europe sheds some interesting light on how the different sectors of the economy – households, commercial, industrial, etc. – have been stimulated to develop solar capacities. Striking is that in the Netherlands (and Denmark), solar growth has so far mainly been due to the household sector, while in other member states the commercial and industrial sectors have also played a role. It is clear that differences in incentives (apart from the advantage of Southern countries' greater efficiency) play an important role, as evidenced by the German and other member states' solar capacity diversity over sectors (see Figure 20).

Large power companies often seek investments in large, nearly industrial-sized, renewable projects, while the smaller investments might also be interesting from the point of view of creating new (albeit variable) production capacities.

FIGURE 20. EUROPEAN SOLAR PV CAPACITY BY TYPE



SOURCE: EPIA, 2013, GLOBAL MARKET OUTLOOK FOR PHOTOVOLTAICS 2013-2017, P. 23

The growth of solar and perhaps other small-scale production impacts the organization of the market. More small producers are entering the market, and decentralized systems may gain importance. The current centralized organization of the market could become challenged when small producers demand new services on their investment or demand to use the option to produce stand alone during a network failure. SoS has traditionally been approached in a centralized manner, looking at both the operational and strategic levels for the country. In the future, with more production in houses and neighbourhoods and a greater importance of electricity systems dependency (for example due to more health at home care and an aging population), these smaller units of organization could insist that there be options to function in a localized stand-alone mode. SoS policy-making should include these new developments to increase the SoS options of small consumers.

INTERNATIONAL SOS RISKS

The international market depends heavily on vast flows of oil and natural gas from the Middle East and other regions. The Arab Spring and the subsequent regime change in some countries have impacted the level of integration of these countries in the international economy. The importance of unhindered exports from Iran, Iraq, Kuwait, the United Arab Emirates, Saudi Arabia and Qatar is crucial. Regime changes, which interfere with a country's position in international energy markets and export reductions to benefit domestic consumers are important risks for consuming countries. Increasingly, more assertive middle classes in emerging economies (Turkey, Brazil, and the Arab countries) are questioning the merits of the international monetization strategies of their governments, demanding more investment in the domestic energy economy. Argentina is an example of a country where the country's potential cannot be realized due to socio-political constraints on the energy industry, while also Bolivia could produce more. The monetization strategy of oil and gas resources could become more intensely scrutinized in the future, which could impact the export capacity to international markets.

The importance of access to major energy-shipping routes remains crucial. The current unrest in the Middle East and the security of main shipping routes is reason for concern. The availability of buffer production capacity in both oil and gas is important to compensate for disrupted production elsewhere. However, redundancy in the system is costly. In oil, OPEC, and in particular Saudi Arabia, has carried the cost of providing the world market with buffer capacity. Strategic reserves of consuming countries also provide the market with flexibility in times of disruption. In natural gas, the flexibility of the LNG market has improved the SoS situation, but LNG, too, depends on the availability of shipping routes.

Depletion levels of large but now mature oil and gas fields in major exporting economies, such as Russia and Saudi Arabia, require substantial future investments to maintain exports while also satisfying rising domestic demand. Although the unconventional revolution can potentially bring more commercial oil and natural gas production to the market, much will depend on the ability of countries to ramp up their production capacities and service industries to realize the potential. In many ways, the situation in the US is unique. Countries such as China, India, Japan, Korea and the European countries will depend on the oil-producing countries to supply them with crude oil and oil products as long as they are unable to switch to other fuels. In transportation, natural gas, through GtL or LNG/CNG can provide some diversification in addition to biofuels.

The recent interest in Arctic developments and the important progress in governing Arctic developments[67] could contribute to risk management from the perspective of oil companies and consuming countries alike. The growing dependency of Asian energy-importing countries on Middle Eastern oil and gas should also be a concern to Europe. The changing call of the US on Middle Eastern energy resources could

67 Scott G. Borgerson, The Coming Arctic Boom: As the Ice Melts, the Region Heats Up, in: Foreign Affairs, July/August 2013.

imply a subtle change in its willingness to manage the free flow of energy to world markets,[68] while China's growing dependence on this region raises the stake it has in securing the flows. Europe has long relied on the US to secure the free flow of energy and has invested mainly in soft policies to secure its share of the flows. With European longer-term demand for natural gas and crude oil increasingly uncertain as a result of its energy transition strategy, the ability to secure these fossil fuel flows with soft policies could be weakening.

The varied dependence among the EU member states on fuels and on certain producing countries does not bode well for the development of a robust SoS policy. Russia, the Caspian Sea region, and North Africa each have their own EU clientele, and each requires a different approach, which mostly originates in the capitals of the member states. Being a member of a range of different international institutions (IEA, IEF, NATO) in which the member states feel more comfortable discussing foreign policy and security issues will continue to compete with the internal logic of deeper European integration. As long as this 'battle' of preferences, competences and sovereignty continues, external energy security (as part of foreign and security policies) will be incomplete. Some European countries ultimately feel more comfortable in an Atlantic alliance than in a continental European one and will continue to try to avoid a choice.

International security of supply will remain as important as in the past, but Europe's position in being able to demand policy changes in producing countries is declining, in part because of its changing energy mix and in part because of the reduction of its relative share in world demand. Europe will increasingly change into a 'rule follower' with regard to shaping international energy governance in oil, natural gas and coal markets. With declining economic weight comes the increasing importance of energy diplomacy to further the security of supply interests of the EU and the Netherlands. Particularly the Netherlands, with its open market approach, can offer access to markets, albeit a stagnant one. This can still offer attractive opportunities to producing countries to balance their supply portfolio. In an open international market, SoS will be easier to obtain than in a strategically-oriented world. In a strategic world, long-term contracts could help realize long-term SoS.

68 Michael Lewis, The Power Surge: Energy, Opportunity, and the Battle for America's Future, Oxford, 2013, pp. 183-194.

THE NETHERLANDS, EUROPE AND THE WORLD

The Netherlands has been very active in international organizations, underpinning the international focus in SoS policy-making; it initiated the Energy Charter and is an active member in the IEA and IEF. These international activities reflect the importance of the Netherlands as a long-time net exporter of natural gas and host to a large energy-industrial complex in the Rotterdam area. Recently, the development of the Eemshaven complex has expanded the hub function for electricity and liquid fuels (oil storage and bio-refining), while the importance of the Groningen field is clear. These developments were inspired by the liberalization of the European energy market and the function the Netherlands expected to fulfil in such a market, in which the logic of location is different than in a collection of national markets. The investments in infrastructure in natural gas and electricity by the Dutch state infrastructure companies to secure a stronger connection to the hinterland were a logical element in this strategy. Despite the implementation of the Third Package, the national orientation of the climate change policies proved detrimental to the expected division of labour in energy markets. New barriers between member states appeared and policy competition in renewables became an issue, leaving the Netherlands with ample capacity. The current situation of overcapacity offers both opportunities and drawbacks; inefficient old generating plants can more easily be forced to close, but a lack of demand for new generation capacity will hinder the swift expansion of renewable capacities, particularly the industrial rollout of offshore wind.

Strategic plays

In the post-2020 period it is clear that all segments of the energy-industry complex will undergo changes that could also impact the SoS (in the wider IEA explanation) of the Netherlands and the EU. Many of the policy initiatives that trigger the changes are part of EU policies (among others on climate change), member states policies or are due to international developments. They do not per se offer the best option for the Netherlands. Nevertheless, the Netherlands with its open energy economy and regional hub function will have to adapt to these changes, which originate both in the internal EU market and in the international markets.

In the Polinares project[69] four futures were developed with distinctly different world economic order regimes. This is relevant for the thinking about SoS in the post-2020 period because Europe tends to have a Kantian view of the world,[70] while the rest of the world is said to have a more Machiavellian view. In the latter, strategic behaviour

69 www.polinares.eu, WP 3, part II.

70 Albert Bressand, *The Changed Geopolitics of Energy and Climate*, CIEP, December 2012. Presentation, 4 April 2013, meeting on SoS, The Hague.

and economic blocks are more likely to occur and the survival of the open economy is less obvious than generally assumed in Europe. As a net importer of energy, Europe relies on access to energy resources produced elsewhere, and on well-functioning markets to access the free flow of energies. In a more strategic world, Europe and the Netherlands might encounter more difficulties accessing energy flows, depending on the coalition to which they belong, either because these flows are smaller, strategically competed for or earmarked for certain groups of countries. Strategic coalitions around energy supply could emerge and impact the strategic energy options of the EU. In a much more strategic world, EU energy relations could be strongly guided by its interests in securing supplies than is the case today. European policy could change to one in which strategic flows of energy are attracted to the European market due to the economics or in which Europe becomes part of a relatively energy-rich trading bloc to ensure access, either transatlantic or with Russia.

Since 1973 Europe has been successful in exporting goods to energy-exporting countries, while the US has been less successful. Also China, so far, has been able to remedy to some extent its import bill with exports to energy-exporting countries. There is, however, no guarantee that the current ability to finance imports of energy with exports of processed goods will continue at the same level. The competitive position of industry is important in this.

Economic recovery

The current economic recession is changing the energy supply and demand outlook of the Netherlands and Europe substantially. Energy demand is stagnating or in decline, creating overcapacities in the energy system. At the same time, the transition policy is requiring substantial investments to meet the 2020 targets, exacerbating the overcapacities in the fossil fuel part of the energy system and changing the economics of maintaining these systems. A return to healthier economic growth rates could alleviate some of the current pain in the European energy industry but is predicted to be some time away. In the meantime, some capacities could become mothballed or scrapped because they are uneconomical to operate, changing the energy system before alternatives are in place. Although some of the energy-intensive economic sectors may not be able to survive given the changing energy landscape in Europe and elsewhere, it would be advisable to at least be aware of the consequences.

Both North America and the Middle East are currently better positioned to expand their energy-intensive industries in the coming years, such as petrochemicals and refining, while relatively cheap coal is helping energy-intensive heavy industries in emerging markets, where demand for steel and cement is relatively high. Only more specialized energy-intensive production can survive in Europe due to this global shift, while the economies of scale for base petrochemicals are moving to other more energy-competitive economies. A similar change took place in the 1980s, in the wake of the oil price increases of the 1970s, when the European refining and petrochemical industry was restructured. Then, the restructuring of the petrochemical industry was accompanied by trade policies to protect domestic markets. The EU and the Gulf Cooperation Countries (GCC) have negotiated for two decades to lower these trade tariffs to allow more products from the Middle East to enter the EU market. With the new dynamics in international energy markets and the prevailing national approaches to climate policies, the trade policy tool could emerge as an option with which to manage the impact on certain strategic industries. In his book *The Carbon Crunch*, Dieter Helm suggests that trade policies could be considered for the management of the variation in climate change policies and the impact on carbon consumption. Such a trade policy could be based on the CO_2 content of imported products, enforcing a level playing field on the domestic market and tackling Europe's CO_2 consumption.[71] Given the recent political response to the energy-intensive industries' complaint about deteriorating competitiveness, the likelihood of a trade policy targeting carbon consumption viz. protecting current petrochemical industry interests is not very high when considering the differing interests on competitiveness among the EU member states.

Markets and renewables

The emphasis on electricity production will change the balance in the energy industrial complex, requiring smaller and different flows, and perhaps more specified fossil fuel flows than currently flow in the European market.

The current emphasis of national policies with regard to renewable capacities is an important trend for the Netherlands, with implications for the call on the import-export capacities. The Netherlands can develop into a flexible supplier of all sorts of energy flows to help balance the energy system of itself and its neighbouring countries by providing services and capacities in the liquid, gaseous and electricity clusters, but it is also possible that the neighbouring countries will develop these services themselves. For a country to succeed in being a regional balancer, the reward for such a role must be high enough. It is likely that in time, solar and wind producers or their consumers must contribute to paying for the integrity of the required back-up system and thus to security of supply. Completion of the internal market, including coordination or unification of renewable support schemes and capacity markets is then a prerequisite.

71 Dieter Helm, *The Carbon Crunch, How We're Getting Climate Change Wrong- and How to Fix it*, Yale University Press, 2012.

The dynamics of future energy markets create a lot more uncertainty about the energy mix, the technologies that will break through and the market designs that will be needed to facilitate these changes. In the aftermath of the 1970s oil price crisis, security of supply policies were developed to deal with international oil supply dependencies and organization structures. More than the ownership/ sovereignty issues that prevailed in the 1970s, the current changes are driven by a combination of politics, economics (supply and demand), climate and technological developments in various fuels and resources. As a result, a much wider part of the policy toolbox (regarding energy in particular) is impacted when dealing with security of supply issues, not only including foreign and security policies, but also industrial and trade policies, in addition to energy and climate policies.

INCREASING COMPLEXITY, SIZE, SQUEEZES AND OPTIONALITY

The lesson from the past few decades is that deeper economic integration, incomplete policy-making and implementation, and dramatic changes in international energy markets are challenging the traditional remedies for Security of Supply. The growing complexity of the energy system and the fact that the interdependencies within the energy system and in the economy have increased, require us to think about the consequences of these complex systems for energy security policy-making.

Energy is a basic need and an important input in the economy. Widespread failure of the energy system (beyond the local) can create serious social, economic and health problems. Many measures are already in place, often originating in the 1970s, after the oil crisis and based on the collaboration in the EU and IEA. Already hospitals and other institutions are required to have back-up systems in case electricity supply fails, and other large energy consumers organize their own back-up systems. In the next two decades the energy system will change further from a fossil fuel-based system into a more hybrid system. Some of these changes are taking place at the large-scale electricity generation end, such as the on and offshore wind parks, others at the consumer end with the installation of solar panels and energy-saving technologies. Optionality, at both the national and the individual household level, may become more important.

These changes in the energy mix also include the transportation sector, where new fuels, such as compressed natural gas, LNG and electricity are gaining ground. Currently, biofuels and biodiesels are also making inroads into traditional oil product markets, and their share can increase until they hit the blend wall. Also demand is changing. Changes in lifestyle, the organization of office work, car technology, mobility changes in big cities (including parking costs) and public transportation are impacting demand for transportation fuels. These developments are expected to continue and will make the post-2020 energy landscape much more varied that before. From a security of supply perspective, the greater optionality will improve security of supply. Switching between options should be as smooth as possible and transparently available. These options can stay available in a carbon-constrained economy if emission permits are properly priced. In the transportation fuel market, substantial energy efficiencies of vehicles powered by fossil fuels or hybrids are still possible, while the performance of electric vehicles is also improving.

At the same time, chemical industries will also improve their optionality by developing feedstock optionality to include oil-, gas- and bio-based materials. As a consequence, the oil-processing industry is facing stagnant and declining markets at home and competition from other fuels and commodities. The size and type of the oil-processing industry servicing a certain market will change over time. Some refineries will aim at international markets, while others will specialize in servicing specific markets. For Rotterdam, Amsterdam and Antwerp, this will also have consequences. Either the energy-related industries will develop a deeper hinterland to service the more specialized demand and at the same time develop international markets, or they will have to re-size to fit the new market realities. Much will depend on the networks (road, rail, barge, pipeline) to service these markets and for new business models and an optimized plant size to emerge. More inter-fuel competition is expected to develop, offering cost-competitive choices to industry and small consumers, unless certain options are favoured or disfavoured by governments through taxes, subsidies, permitting, etc. For the Netherlands, developing greater optionality in fuels and products can enhance security of supply.

In the electricity generation sector a similar development with regard to demand can be expected. Demand is expected to grow less quickly than before (based on modest economic growth),[72] while supply is diversifying, not only in terms of primary energy, but also in terms of type of suppliers. After a long period of consolidation in the power generation sector, which created ever-larger companies, new entrants are gaining ground. These entrants are both small companies and individual households with their solar panels and/or geothermal facilities. The market and organization model needs to adapt to include these new players, while the reliability of the system must not be compromised.

72 TenneT TSO b.v., Rapport Monitoring Leveringszekerheid 2012-2028, p. 27

Also in the electricity sector new technologies at the consumer, producer and network ends are changing the relationships between the players. Households could be offered more options for becoming mini-suppliers, but this option cannot be exercised in cases of power failure; their solar panels are also switched off. For security of supply at the household level, offering both stand alone and connected to the network type of services should at least be considered. Houses are no longer built with fuel switching abilities (such as open fire hearths for heating, etc.) and sometimes only have an electricity connection, instead of an electricity and gas connection.

Back-up capacities to supply neighbourhoods, regions or small companies are limited. They are not sufficient when more consumers in a larger area are affected by a power failure. Storms Katrina and Sandy showed the vulnerability of urban centres to a failure in energy production, transport and distribution. Moreover, some failures cascade through the energy system, one system affecting the other. With the energy system undergoing rapid changes, it is important to think through the systemic consequences of these changes and the ability of the government and energy sector to manage and remedy the costs of failure. Security of supply is important at the micro-,[73] meso- and macro level and involves a lot more than merely overseeing tariff structures and licensing energy and network companies to invest adequately[74].

The interests of the various players (both public and private) also play an important role with their rent-seeking behaviour, and more often than not it has contributed to a certain opaqueness of the energy industries. At the same time, private players engage in all sorts of behaviour that impacts competition (among others between fuels) and allows them to redistribute some of the costs to the public sector or consumers. Perhaps the 'too big to fail' problem also applies to certain energy industries in some countries, including EU member states. Such problems, in addition to energy

73 The development, for instance, in the health sector to keep patients only for a minimum time span in the hospital and instead to send them home to recover, exposes patients to more risks because they are no longer covered by the hospital's back-up facilities. Also with health technology improving, more treatments can be done at home, for instance kidney dialysis, increasing the necessity to provide households with security of supply at the micro level. Also the policy to help older people to live in their own homes creates new vulnerabilities. Just like in a heat wave, older people are more vulnerable in a cold snap. They rely, just like patients, much more on the energy system working. For relatively short interruptions, batteries can provide for back-up, but for interruptions of a few days or weeks, these will not suffice. Other small back-up systems, such as diesel generators, played an important role in the aftermath of storm Sandy.

74 TenneT TSO b.v., *Rapport Monitoring Leveringszekerheid 2012-2028, leveringszekerheid tijdens extreme situaties*, p. 7; based on a wider diversity of the electricity fuel mix (coal in addition to gas) to the conclusion that security of supply will improve, but does not take the larger share of variable sources into account, nor cyber security.

system complexity,[75] should be more thoroughly investigated, based on the lessons learned in the 2007-2008 financial crisis. These lessons include issues of regulatory oversight on the systemic risk of interconnected players, moral hazard issues and the exposure to large firms that outgrow the problem-solving capacity of their home or host government.[76] In security of energy supply issues, the 'too big to fail' risk has not been studied sufficiently, relying on other producers or network companies to take over the assets of the company going into liquidation. In the case of small companies such a scenario might be realistic, but the failure of a large company might be more difficult to resolve and force the government (or a proxy) to step in.[77] Apart from

75 Complex systems, which also include modern energy systems, are rife with interdependencies and non-linear responses: "Man-made complex systems tend to develop cascades and runaway chains of reactions that decrease, even eliminate, predictability and cause outsized events. So the modern world may be increasing in technological knowledge, but, paradoxically, it is making things a lot more unpredictable. (…) and the loss in robustness owing to complications in the design of everything, the role of Black Swans is increasing." In short, according to Taleb, the risks of large and high impact events are increasing due to complexities. Nassim Nicholas Taleb, *Antifragile: Things That Gain from Disorder,* Random House, New York, 2012, p. 7

76 See statement of Ben Bernanke on 'too big to fail' and other systemic risk issues in The Financial Crisis of 2007/2008: http://www.federalreserve.gov/newsevents/testimony/bernanke20100902a.htm

"A broader failing was that, for historical reasons, regulation and supervision were focused on the safety and soundness (or the practices) of individual financial institutions or markets. However, in the United States and most other advanced economies, no governmental entity had sufficient authority – now often called macroprudential authority – to take actions to limit systemic risks." (…) "But many small vehicles, and a few big ones, that were spread across a lot of banks added up to a systemic vulnerability." (…) On 'Too Big to Fail': "Many of the vulnerabilities that amplified the crisis are linked with the problem of so-called 'too big to fail' firms. A 'too big to fail' firm is one whose size, complexity, interconnectedness, and critical functions are such that, should the firm go unexpectedly into liquidation, the rest of the financial system and the economy would face severe adverse consequences. Governments provide support to 'too big to fail' firms in a crisis not out of favoritism or particular concern for the management, owners, or creditors of the firm, but because they recognize that the consequences for the broader economy of allowing a disorderly failure greatly outweigh the costs of avoiding the failure in some way." (…) "In the midst of the crisis, providing support to a 'too big to fail' firm usually represents the best of bad alternatives; without such support there could be substantial damage to the economy. However, the existence of 'too big to fail' firms creates several problems in the long run."

77 See statement of Ben Bernanke on 'too big to fail' and other systemic risk issues in The Financial Crisis of 2007/2008: http://www.federalreserve.gov/newsevents/testimony/bernanke20100902a.htm "First, 'too big to fail' generates a severe moral hazard. If creditors believe that an institution will not be allowed to fail, they will not demand as much compensation for risks as they otherwise would, thus weakening market discipline; nor will they invest as many resources in monitoring the firm's risk-taking. As a result, 'too big to fail' firms will tend to take more risk than desirable, in the expectation that they will receive assistance if their bets go bad. Where they have the necessary authority, regulators will try to limit that risk-taking, but without the help of market discipline they will find it difficult to do so, even if authorities are nominally sufficient. (…)

A second cost of 'too big to fail' is that it creates an uneven playing field between big and small firms. This unfair competition, together with the incentive to grow that 'too big to fail' provides, increases risk and artificially raises the market share of 'too big to fail' firms, to the detriment of economic efficiency as well as financial stability.

Third, as we saw in 2008 and 2009, 'too big to fail' firms can themselves become major risks to overall financial stability, particularly in the absence of adequate resolution tools.' (…) 'If the crisis has a single lesson, it is that the 'too big to fail' problem must be solved. Simple declarations that the government will not assist firms in the future, or restrictions that make providing assistance more difficult, will not be credible on their own. Few governments will accept devastating economic costs if a rescue can be conducted at a lesser cost; even if one Administration refrained from rescuing a large, complex firm, market participants would believe that others might not refrain in the future. Thus, a promise not to intervene in and of itself will not solve the problem."

the capability of the government to step in, the ripple effects on the entire energy sector, both domestic and in neighbouring countries, will be large. For a government seeking to manage the risk of supply security, it is important to focus on both the compounded small risks to the system and the large systemic risks.[78]

It is also clear that policy-making does not always contribute to better working markets or more optimal regulation of externalities.[79] Both security of supply and climate change are externalities to the energy markets. Subsidies and taxes are only a part of the types of interventions that governments engage in and which can change the inter-fuel competition. This is the case in producing countries, transit countries and in consuming countries alike. Demand and supply are therefore greatly influenced by these interventions. Already in 2009 the G-20 appealed to end fossil fuel subsidies by 2020 and improve transparency of markets by improving data collection on international oil and natural gas.[80] If this G-20 appeal is successful, the next issue on the agenda will be other interventions in markets, as evidenced by the dispute between the US and EU with China over the dumping of solar panels.[81] The ramp-up of subsidies and other support for renewable energies, understandable from a climate change perspective, could nevertheless interfere with industrial and trade policies of countries and invoke new interventions. Climate change policies, already widely discussed in WTO circles for years, do have the propensity to hamper free trade. Proposals such as the carbon border tax[82] and the use of trade policy tools illustrate the potential international debates to come.

Managing Energy System Complexity Post-2020

Given the integration of markets, the increasing clustering of energy complexes, the larger size of companies and mixtures of fuels in transportation, heat, cooling and electricity, it is important to approach and understand SoS in an integrated manner.

78 Nassim Nicholas Taleb, *Fooled by Randomness: The Hidden Role of Chance in Life and in the Markets*, Random House, New York, 2001/2005; *The Black Swan: The Impact of the Highly Improbable*, Random House, New York, 2007; *Antifragile: Things That Gain from Disorder,* Random House, New York, 2012.

79 Nassim Nicolas Taleb, (2012), p. 11. Policy-makers and/or other economic agents insist on implementing policies to make the unpredictable more predictable or manageable. "A complex system, contrary to what people believe, does not require complicated systems and regulations and intricate policies. Complications lead to multiplicative chains of unanticipated effects. Because of opacity, an intervention leads to unforeseen consequences, followed by apologies about the 'unforeseen' aspect of the consequences, than to another intervention to correct the secondary effects, leading to an explosive series of branching 'unforeseen' responses, each one worse than the preceding one." An example here could be the introduction of the feed-in tariffs on the business models of other power producers, the proposed remedies (capacity markets) and the fact that increased production of solar and wind energy backed up by coal produces more CO2 emissions rather than less. Both climate change and security of supply involve market interventions, which could easily create other unforeseen responses.

80 See: http://www.g20.utoronto.ca/2009/2009communique0925.html#energy

81 See: http://europa.eu/rapid/press-release_IP-13-501_en.htm

82 Financial Times, 14 October 2009.

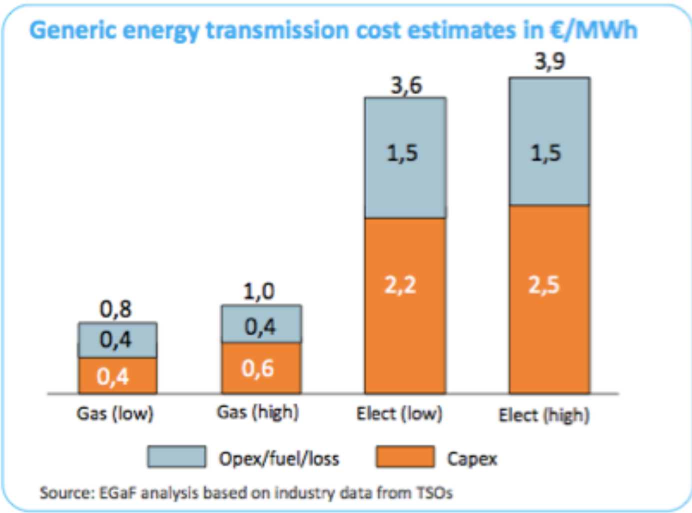
Policy instruments can be aimed at particular parts of the energy market or value chain as long as they are understood to function as part of a larger whole. The ability to store or transport one energy product in the form of another (for instance power-to-gas; see Figure 21) or the ability to switch fuels, means that the traditional fuel-by-fuel approach does not always do justice to the agility of energy markets to respond to a disruption in the system. The cost of various methods to store and transport energy should become an integral part of SoS policy-making and the coordination of energy policy implementation. Our integrated knowledge of the energy markets is limited, however, in part because of the size, in part because of the interconnections of the system, and also due to the unknown ripple effects a disruption in one part has on another. Nevertheless, and perhaps as a result of our limited understanding of the interplay on complex international markets and within and between the various parts of the value chain, the unpredictability invites governments to intervene in the hope of gaining some control. That said, some of the unpredictable outcomes were the result of compounding policy interventions (at various policy levels), as we have seen in the previous sections.

That is why it is important here to include thinking on complex systems and how and when to manage or not manage risks, including security of supply risks, the subject of this study. Securing supply and combating climate change are aimed at preventing energy and climate 'Black Swans'.[83] But Black Swans are unpredictable. Most of our past efforts have been in trying to manage the known or past risks rather than the unknown future ones.

Also in the EU, the efforts with regard to managing natural gas SoS issues have been more a response to past disruptions than a way to deal with future ones. This is also due to the widely differing interests and risk exposures of the member states, the incomplete internal gas market and political differences about relations with main suppliers.

83 It can be argued, however, that the 1973 oil crisis and change in sovereignty over oil reserves and production was not a Black Swan but was instead quite predictable based on developments in the previous decade.

FIGURE 21. GAS AND ELECTRICITY TRANSPORTATION COSTS COMPARED



SOURCE: EGAF, THE FUTURE ROLE OF NATURAL GAS, APRIL 2013.[84]

The reason why Security of Supply is important to policy-makers (at all levels) is because a shock in demand or supply (disregarding the cause) or a squeeze in supplies (also the ones due to bottlenecks) can radically change the economic viability of large companies and small consumers alike (requiring a larger share of household income) and affect the stability of the economy (and the socio-economic and political make-up), impacting the competitive position of countries and/or companies but also weakening their strategic position in the world. The quest for predictability (geopolitical, geo-economic, domestic) drives many security of supply policies and is often the reason why governments, despite the cost, also prefer a certain balance between domestically produced energy and imports but then increasingly rely on somewhat vulnerable electronic systems to manage the same energy systems. However, the cost of security of supply is not always easy to socialize in the economy. Governments might for SoS reasons prefer some redundancy in the system, allowing for 'rainy days', while the regulatory authorities are usually keen to remove them in order to protect consumers from consistently overpaying for inefficiencies. The problem here is non-linearity and the acceleration of exposure to harm, creating a larger vulnerability to big events.[85]

84 http://europeangasforum.files.wordpress.com/2013/04/egaf-natural-gas-brochure-03-april-2013.pdf

85 "Layers of redundancy are the central risk management property of natural system", Taleb, (2012), p. 44 ; (…) fragility stems directly from non-linearity and convexity effects, and convexity is measurable (…) "The technique – detecting acceleration of harm – applies to anything that entails decision making under uncertainty and risk management", Taleb, (2012), p. 292 and p. 298 for a technical explanation.

Smoothing the curve or…?

In energy, and particularly in Security of Supply studies and policy-making, we tend to look mostly at what can go wrong and concentrate less on what went right. The 1973 energy crisis, again, is a case in point. The international oil companies successfully collaborated in keeping the OECD countries supplied, even in the face of the oil embargo. The success of the policy response in the IEA is that this success was included in the crisis management approach. Does this, however, guarantee future success? The answer is no, because the organization of the oil value chain has since changed dramatically. The international oil companies do not control sufficient crude or processed capacities to remedy future larger disruptions of oil or gas supply. Instead, such a function would be better left to the state oil companies that control the bulk of these flows today. Yet state oil companies vary greatly in terms of governance and ability to play such a role. For SoS, this is also where the problem becomes more complicated. Which state oil companies will be able and willing to play such a role, and which ones are part of the problem? The changed structure of the crude oil market and increasingly also the oil product market implies that, apart from the depth of the international integration of these markets, the traditional players can no longer be solely relied on to provide crisis management for the OECD countries.

Security of supply policy (or demand) thus tries to remedy the fragility[86] of the energy system with regard to large volume or price shocks or other failures. However, it is far easier to "figure out if something is fragile than to predict the occurrence of an event that may harm it. Fragility can be measured; risk is not measurable".[87] We can say with some certainty that our energy system becomes more vulnerable to international supply shocks when import dependency increases and the number of external suppliers is limited, while we cannot assess the risk of a regime change in, for instance, Russia or Saudi Arabia, and the impact on their oil export levels. Energy markets are dynamic, and small errors and other imperfections occur every day. These errors and imperfections, if small enough, can make the energy system stronger rather than weaker, because the system is allowed to 'learn' from the small shocks.[88] For example, the strategic oil reserves developed under the IEA were intended to be able to compensate for large disruptions of supply. When, after 1979, supply shocks were rare, the IEA began to fine-tune the requirements, including for smaller events,

86 Taleb has defined antifragility as such: "Fragility and antifragility can be detected by a simple test of asymmetry: anything that has more upside than downside from random events (or certain shocks) is antifragile; the reverse is fragile", Taleb, (2012), p.5.

87 Ibid., p. 4.

88 Ibid., p.3, "Some things benefit from shocks; they thrive and grow when exposed to volatility, randomness, disorder, and stressors and love adventure, risk and uncertainty."

as a reason to call on strategic reserves, thus attempting to smooth out the supply variations. Such practise, if used often, would deny the market the information of price signals.

In another example, the quality of the strategic reserves of the United States declined dramatically in the 1980s, to the point that strategic reserve releases could do little to remedy squeezes in US oil product markets because the quality of crude in the reserves did not match the quality of crude needed in US refineries. As a result, the strategic oil reserves lost SoS effectiveness until this problem was addressed after the First Gulf war in 1990-1991. Taleb contends: "Crucially, if antifragile is the property of all those natural (and complex) systems that have survived, depriving these systems of volatility, randomness, and stressors will harm them."[89] This is important because very often government policies try very hard to smooth out the curves, i.e., to prevent volatility and other swings in markets from occurring. In doing so, the system cannot respond to small changes and errors and cannot learn. Instead, it becomes more fragile.[90] So a very effective SoS policy in the shorter run could merely hide the underlying fragility of that part of the energy system and make it more vulnerable to large shocks in the longer run.

Apart from energy system complexity, size also plays a role. The recent consolidation of the European electricity sector has left the power sector with a couple of large incumbents. These companies have proven to be vulnerable to the introduction of wind and solar in the power market. The concentration of centralized power generation capacity in these companies makes them 'too big to fail' from the perspective of SoS, while their fragility is in part caused by the government's policy to stimulate renewables in the market on a fixed time scale. The demand for new capacity in this deep recession, where demand for power was stagnant at best, and the inability of these large companies to invest in wind and solar, created a mismatch between policy-making and market developments. For a long time wind and solar lacked the industrial scale that makes large companies want to invest, in addition to the fact that the willingness to subsidize large companies is low in most countries. In the EU, several member states are now being challenged by large companies to

89 Ibid., p. 5.

90 Ibid, p. 105: "To summarize, the problem with artificially suppressed volatility is not just that the system tends to become extremely fragile; it is that, at the same time, it exhibits no visible risks. Also remember that volatility is information. In fact these systems tend to be too calm and exhibit minimal variability as silent risks accumulate beneath the surface. Although the stated intention of political leaders and economic policy makers is to stabilize the system by inhibiting fluctuations, the result tends to be the opposite. These artificially constrained systems become prone to Black Swans. Such environments eventually experience massive blowups, of the type seen in Figure 3, catching everyone off guard and undoing years of stability or, in almost all cases, ending up far worse than they were in their initial volatile state. Indeed, the longer it takes for the blowup to occur, the worse the resulting harm to both economic and political systems."

introduce capacity markets.[91] The remedy of investing in renewables and increasing their optionality still draws the large power companies to large industrial scale renewables, further centralizing production. They represent a more top-down model of development, more in line with large wind parks (on and offshore), while solar is most often developing from the bottom-up.

The current situation in the sector is that large traditional generation plants are in jeopardy. In the UK, this has already led to a reversal of the energy market and the reintroduction of widespread government intervention. In other member states, the push for more centralization and conglomeration is countered by a growing preference (particularly by lower governments) for smaller or more decentralized systems. Also in the recently published Shell scenarios,[92] a centralized and top-down future energy system is confronted with a more bottom-up, decentralized energy system. In the latter, solar eventually becomes the backbone of the energy system in the world. The large gas-fired and other industrial-scale energy production and transportation systems require a lot more government intervention and regulation to provide investors with sufficient comfort to invest in the capital-intense activities. Arguing in the vein of Taleb's analysis, the second system, the bottom-up system, should be preferred for its larger antifragility and thus its resilience to security of supply types of shocks, while the previous top-down one should not.[93]

If we return to the operational, strategic and long-term issues in SoS, it is clear that some of these issues can be addressed more easily at a higher level of organization than others. Also the development of the energy mix requires a re-think on what organizational level SoS issues can best be addressed. The leverage in international political and economic issues, which includes many of the long-term SoS issues, is larger when countries cooperate, while some operational and strategic issues benefit from cooperation at the relevant organization level. In the EU, the gaps between the local, the national and the EU levels are sometimes too large, particularly when it comes to instrumentation. Efforts to collaborate at a regional level among various authorities are an attempt to remedy this.

91 Meulman and Meray, 2011.
92 See: http://www.shell.com/global/future-energy/scenarios/new-lens-scenarios.html
93 Taleb, (2012), pp. 278-283.

5 CONCLUSIONS

Netherlands

The current Dutch energy economy is shaped by the substantial natural gas production (onshore and offshore), consumption and trade, the large energy-industrial complex in Rotterdam and Amsterdam (and to smaller extent in Eemshaven and Vlissingen), part of the ARA complex, servicing large parts of the NW European market in crude oil, oil products, petrochemical products and the energy transportation networks (gas pipelines, power lines, crude and oil products pipelines, river and rail connections). The Netherlands energy economy is open and connected to world markets (coal, oil, pipeline gas, LNG, biomass, oil products, biofuels) and European markets (electricity). The Netherlands is an important energy hub, and the status of 'hub' is economically important for the Netherlands. Its continued role as a hub depends on the Dutch economic and energy strategies and on the (economic and energy) strategies of neighbouring countries. The Netherlands (government and stakeholders in the hub) should evaluate if and how this hub function needs to be strengthened in the context of a post-2020 lower-carbon hinterland economy.

State-owned companies (Gasunie and TenneT) operate the transportation of electricity and natural gas (*splitsingswet*), while companies owned by cities and provinces carry out the distribution of electricity and natural gas. The public-private company Gasterra sells gas from the Slochteren or Groningen field, while non-Slochteren gas is sold by the producers (often to Gasterra). Gas-fired power plants hold a large share in power production, although the share is relatively declining due to an increase in coal-fired and renewable electricity generation. The production of power is a private sector affair. Power production in the Netherlands is dominated by large European power companies (Vattenfall, E.oN, RWE, GDF), and is complemented by production of the smaller public companies Eneco and Delta and renewable energy entrants. Current market circumstances are difficult for the gas-fired power stations and also impact the production of heat. New applications for gas, such as in transportation, are on the horizon, but are currently too small to offer an alternative for the declining share of gas in the power market. Other innovations include power-to-gas, where gas and its infrastructure might be used as a transportation vehicle for power (exploiting the lower cost of gas transportation compared to the transportation of electricity), indicating that the natural gas sector is adapting to new market circumstances. With a traditionally strong domestic gas sector and the development of the gas roundabout, the position (and system function) of gas in a future energy mix is important for the Netherlands. Despite the uncertainty about the post-2020 energy policy, it is clear that in the NW European energy market renewables will have an important place, while the position of natural gas in the power generation merit order will depend to a large extent on post-2020 carbon policy.

Increasingly, modern energy networks rely on commercial communication infrastructure (GPS, etc.). Apart from cyber security, a re-think about what part of communication infrastructure is a public interest (and thus part of energy system security) and what part is commercial, is important. This is also relevant for other critical sectors such as water.

Governance

The Netherlands is a member of the EU, and both the electricity market and the natural gas market are part of the EU internal energy market. Energy is a shared responsibility between the EU and the member states, while the energy mix is a member state competency. The carbon space is governed by EU policies, which is currently the 20-20-20 policy. The implementation of EU energy policies leaves a lot of room for national policy instruments. This is understandable because the energy economy of the member states is still very different. One size does not always fit all. Nevertheless, the impact of national policy measures on a neighbouring member state's energy market can be large, requiring coordination. Regional and bilateral initiatives at various levels of policy-making, policy implementation and regulation, as well as information sharing, have grown as a result of the EU 2020 policies. SoS policies, particularly at the operational and to some extent strategic level should be included in these collaborations.

Although policy-making has been transferred for a large part to the EU level, policy implementation has remained a member state affair. It is in the lack of coordination in implementation that additional operational and strategic SoS risks can appear. The variety of implementation tools and methods among member states (in energy and climate) have become the main channel through which these new (internal market) risks are being transferred, creating beggar-thy-neighbour type of problems. Current governance systems are not kitted out to deal with these new generation type of problems: not in the EU, where member states remain competent in domestic fuel mix issues, but also not in the member states themselves, where risks are obscured by border issues and a regulatory focus on short-term efficiency and not on energy system security. A review of the EU energy market model is often suggested as a remedy for the new problems related to variable sources. For SoS at the operational and strategic level, it is also important to consider the role and function of the regulatory authorities with regard to energy system security. Markets do not automatically produce SoS, and governments have an important role to play.

One could argue that the remedy for the EU competency problem depends on the confidence in the continued existence of the EU and its ability, in time, to overcome the policy competency failures. In the 2007-2008 financial crises and the Euro-crisis aftermath, politicians have (so far) taken the stance that the EU is 'too big to fail'. However, it is still unclear how the EU will evolve in the post-2020 era, with more powers or with more subsidiarity. A conclusion could be that more effort should be invested in coordinating both policy-making and the policy implementation, at the same time making sure that the national/regional SoS position/options remain strong, too.

In any case, large EU member states have always determined their own energy policies and will continue to do so, despite the EU policy-making efforts. Given the importance for Dutch energy sector developments of the energy policy and market developments in the neighbouring countries, further developing the functions of the energy hub should match developments in the hinterland. The speed with which Germany, for instance, wishes to expand its renewable energy share in the mix, redefines the speed of transition of the other parts of the (integrated) energy system. This should be recognized both in the Netherlands and in the neighbouring countries. The recent initiatives towards discussions with Germany are a good start and should be followed through, particularly with a view on the integrated energy system stability.

Regional efforts,[94] such as those of the Pentalateral Group, the North Sea Group, and/or bilateral initiatives, could remove or soften the impact of some of the operational risks and help to develop policy frameworks and implementation guidelines at the EU level – or at the regional level in case the EU does not deliver. For security of supply, the work on critical infrastructures (including their vulnerabilities to cyber attacks/manipulation), insights into demand and supply optionality in various sectors of the economy and their remedies, critical industry clusters and the existence of redundancies (and how they are financed) could be shared and analysed in a peer review process to improve the performance of the member states and/or regional markets. At the same time, we must conclude that the policy process in each member state is based on its own internal logic. Accepting this reality and instead seeing regional cooperation as a better, bottom-up approach to coordinating the

94 Jacques de Jong en Koen Groot, *A Regional EU Energy Policy?*, CIEP 06, August 2013.

implementation of policies and managing policy competition could be a logical outcome. The EU could then focus on the more general framework in which these regional groups of countries collaborate and make sure that consistency prevails.

With regard to international SoS issues, channelling efforts through the EU, IEA and IEF is logical. It is important that the IEA and EU continue to work closely together. The Netherlands is an active member of the IEA and also gains from the insights and policies developed in the framework of the IEA. Continuation of the country's active participation is crucial, also considering the importance of crude oil and oil products for the Dutch economy.

Liquid/chemical cluster

The importance of the ARA energy-industrial complex reaches beyond the energy and economic interests of the Netherlands (and Belgium), also in a lower-carbon economy. Yet these two countries may increasingly become the main windows (hubs) on the oil market for NW Europe, when the smaller (inland) energy-industrial complexes face restructuring due to the shrinking size of the traditional market.

The number of entry points for crude oil and oil products could, in the face of the rapidly changing international oil and natural gas markets, decline in the EU. The importance of ARA energy and petrochemical products for a larger hinterland could grow. This should be reflected in policy-making. It is important to not only understand the working of the ARA energy-industrial complex and the challenges it faces in remaining a competitive coherent whole (or at least an interrelationship of cluster economics), but also that all stakeholders recognize it.

Power sector

The *Energiewende*, combined with the growing solar and wind capacities due to feed-in tariffs and the economic difficulties of the past five years, along with the disappointing performance of the EU-ETS and low coal prices, have reduced the performance of newer gas-fired power stations. Some of the capacities now being mothballed are very recent additions to the power generation park, while others are older (gas, nuclear and coal). Some coal plants in the EU will soon be retired due to the Large Combustion Plant directive (LCPD, 2001/80/EC), others for economic reasons. EoN,[95] RWE[96] and others have recently announced the retirement of both

95 http://www.eon.com/content/dam/eon-com/Investoren/130813_First_Half_Results_2013_Charts.pdf, slide 14 shows that 6.5 GW of the announced 11 GW has already been shut or mothballed.

96 http://www.rwe.com/web/cms/mediablob/en/649048/data/114404/54/rwe/investor-relations/factbook/RWE-company-presentation-3-Steps-to-long-term-value-2013-06.pdf

coal and gas-fired plants but also the mothballing of newer natural gas burning plants due to negative earnings. The reduction of conventional power generation capacity due to the changing business conditions can be problematic when capacity falls below the level needed to satisfy demand (including peak times). In addition, the larger the wind and solar capacity, the greater the need for flexibility. Retiring or mothballing plants for economic reasons can create security of supply difficulties, particularly when new additions to capacity are mainly in variable sources, which require flexible back-up.

The economic crisis is rapidly removing the redundancy from the system, while this redundancy is, , important for the robustness of the energy system. The Netherlands is vulnerable to a continued depressed position of its gas-fired capacities. The attempt of large power companies to manage their portfolios in a profitable manner could be at loggerheads with SoS if plant retirements and mothballing continues without consideration for SoS issues.

The predicament of the power sector could also imply 'too big to fail' issues when one of the large companies in a certain market collapses. The security of supply assumption was that TSOs are responsible for calling on capacities to deliver power and that assets, in case of a company collapse, would be fairly quickly taken over by other companies. However, the current market for gas-fired power generation capacity must be considered temporarily dysfunctional, and it could be that no company is interested in the short-term in taking over loss-making assets. If we look at the portfolios of the large power companies, they all more or less face the same problems in their coal and gas portfolios. Without a functioning market for conventional capacities, governments could be confronted with a 'too big to fail' type of problem (like the nuclear sector in the UK in 2002) and could be forced (at least temporarily) to step in.

Natural gas

With the current decline in gas demand, SoS does not pose a problem at the operational level. In the longer term, insecurity of demand could increase SoS concerns if investments towards supplying the European market fail to materialize.

In the post-2020 period, the Netherlands is bound to experience a decline in domestic natural gas production, while demand for gas remains uncertain. Import (LNG and pipelines) and storage facilities have been developed, improving the connection with international gas markets and neighbouring countries. The recent additions to international gas reserves indicate that long-term supply issues should not be an issue, although timely investments to supply world markets remain a concern. Diversification of fuels has also improved. Nevertheless, the production potential in the Netherlands should not be overlooked. Small offshore gas fields, tight and shale gas, hydrogen, biogas and biomass gasification could potentially reduce the rate of decline in domestic production. The small field policy has been very successful in extending the lifetime of the Groningen field. A more sober version of the small field policy was introduced with the liberalization of the gas market and the reorganization of the *gasgebouw*, making exploitation of these resources less attractive. New technologies in exploration (both offshore and with regard to tight gas and shale) and in the production of biogas and the gasification of biomass could enhance the production potential of Dutch gas. The government should contemplate improving the investment climate for new marginal gas production.

6 RECOMMENDATIONS

The position of the energy-industrial clusters, their role in the national and international energy economy and their contribution to security of supply for the NW European energy market should be better understood. Their importance, also in a lower-carbon economy, should be prioritized on the Dutch and the European international policy agendas.

Natural gas is the backbone of the Dutch energy system. The importance of gas for the energy system of the NW European energy market is undervalued. The potential contribution of gas in the transportation and storage of renewable power is substantial. The function of gas within the energy system should be promoted through policy-making. At the same time, the gas industry could, together with policymakers, further contribute to de-carbonizing the energy system by advancing the use of gas in the transportation sector.

The Dutch government should underpin the system function of gas in the future by stimulating new gas supply. This can be done through building on the success of the 'small field' policy by including and extending the policy to include all new gas (onshore/offshore, bio-gas, tight, shale, hydrogen and biomass gasification).

Cyber security will become a crucial issue in security of supply. The government should contemplate developing a secure communication system for critical infrastructure communication and data traffic in an effort to protect the integrity of the energy system against cyber crime.

We recommend that the speed and timing of introducing renewable capacities be studied for its impact on security of supply in the short- and longer term (ideally together with neighbouring countries) and that if the market for conventional capacities stays depressed much longer, that governments and/or their proxies (TSOs) in relevant markets develop criteria (beyond the technical ones) regarding which parts of the power system are crucial for operational and strategic SoS.

The government should think about the current arrangements in place for dealing with potential failures of large utilities active on the Dutch market and should consider the ability of the market to absorb such an event in the context of security of supply.

The role of the Netherlands in international energy organizations will remain crucial in the future.

CLINGENDAEL INTERNATIONAL ENERGY PROGRAMME | CIEP

VISITING ADDRESS
Clingendael 12
2597 VH The Hague
The Netherlands

POSTAL ADDRESS
P.O. Box 93080
2509 AB The Hague
The Netherlands

TEL +31 (0)70-374 66 16
www.clingendaelenergy.com
ciep@clingendaelenergy.com