

ENERGY SECURITY RISKS AND RISK MITIGATION: AN OVERVIEW

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INTRODUCTION

The issue of energy security has been in the forefront of the preoccupation of UNECE member States at least since early 2000. Over the last six years various factors have heightened concerns and added to anxieties regarding energy availability and security of energy supplies including: rapid economic growth; increasing dependence on external energy supplies; Middle East political tensions; sabotage and terrorist attacks; the 2003 electric power blackouts in North America and Europe; the interruption of natural gas and oil supplies in early 2006 and 2007 respectively in Europe; the forced re-negotiation of oil revenue sharing arrangements between Governments and the private sector in some oil producing countries; and conflicts in a number of crude oil and natural gas producing regions.

Despite the growing public concern and efforts by countries to develop a common understanding of energy security risks and risk mitigation strategies, there continues to be wide differences among UNECE member States on key aspects of energy security, including their causes and appropriate policy responses. The inability of countries to forge a common approach on energy security is due to the significant divergence in the energy mix, industry structure, and availability of domestic energy resources, particularly of crude oil and natural gas, among countries; differences in access to alternative energy imports, geopolitical influence and energy policy orientations; and the differences in capacity, disposition and willingness of countries to deal with international issues on a bilateral and multilateral basis.

DEFINING SECURITY OF ENERGY SUPPLY

Although energy security is currently one of the most debated issues in the UNECE region, a generally accepted definition is still lacking. Therefore, the term “energy security” or “security of energy supplies” is used in various contexts, for different purposes, often having very dissimilar meanings. While energy security is not easy to define because it is a multifaceted concept, there are four dimensions of particular relevance: (a) physical disruption of supplies resulting from infrastructure breakdown, natural disasters, social unrest, political action or acts of terrorism; (b) long-term physical availability of energy supplies to meet growing demand in the future; (c) deleterious effects on economic activity and peoples due to energy shortages, widely fluctuating prices or price shocks; and (d) collateral damage from acts of terrorism resulting in human casualties, serious health consequences or extensive property damage. All four dimensions are relevant in the current environment.

Taking into consideration these four dimensions, energy security could be defined as “the availability of usable energy supplies, at the point of final consumption, at economic price levels and in sufficient quantities and timeliness so that, given due regard to encouraging energy efficiency, the economic and social development of a country is not materially constrained”. Clearly, this is but one of a number of possible definitions that could be put forward, however it does have the merit of capturing the multidimensional nature of energy security.

Due to the complexity of the issue and its multidimensional nature, this note focuses primarily on one element of energy security, that is, the long-term physical availability of energy supply to meet the growing future demand for energy. The dimensions examined in this note include the future availability of energy resources, the reliability of energy supplies, the deliverability through infrastructure development and the affordability of energy by consumers. The other dimensions of energy security are not examined here. For example, the macroeconomic consequences of energy disruptions or price shocks, the vulnerability of energy infrastructure to terrorism and so on are not discussed.

THE ROLE OF MARKETS

It is commonly accepted that economic efficiency is best promoted through decentralized and liberalized energy markets, with freely determined market prices. Over the last ten to fifteen years, technological, institutional and societal changes have tended to favour the implementation of measures to open up and liberalize energy markets. However, there continues to be a wide diversity of views among countries on the role of free markets and market forces in promoting societal objectives, such as energy security.



Due to geopolitical, economic and historic considerations, the belief in free markets and the power of free markets to deliver on social objectives is strongest in North America. The view in Western and Central Europe is more varied. Some countries have a predilection or predisposition to market solutions while others favour a more cautious approach with strong government oversight and intervention whenever needed. For example, despite the efforts and the vigorous measures taken by the European Commission to open up and liberalize electricity and natural gas markets in the European Union (EU) region, a number of EU Governments continue to be attached to their national state enterprises, to favour national champions and to closely oversee the functioning of energy markets.

The belief or commitment to free markets is much less pronounced in countries of Eastern Europe and Central Asia for a variety of reasons, though here again there is no unique view. For example, the free interplay of market forces in the Russian Federation is somewhat constrained by government measures favouring the creation of large state owned or controlled enterprises in the oil and gas sector, state control of oil and gas pipeline facilities, particularly export pipelines, and the imposition of limits on the foreign ownership/control of energy assets while, at the same time, accepting some private-sector ownership of energy assets. Kazakhstan, on the other hand, has been more open to the development of energy resources by the private sector. Nonetheless, it is probably fair to conclude that the commitment to free markets in energy is less pronounced in Eastern Europe and Central Asia than in Western Europe and North America.

Consequently, national aspirations and the diversity of views on the role of the market and of government, including the different market practices and institutional arrangements in countries, complicate discussion of and agreement on collective efforts to improve energy security. In addition, the private sector, while recognizing the role of government in establishing investment conditions that are fair and conducive to facilitating inward investment flows, is on the whole much less predisposed to direct intervention in energy markets.

Large oil and natural gas companies, private as well as state-owned, have had a significant influence and played a major role in the development of the world's hydrocarbon industry in the past. However, there are now concerns that in a period of heightened instability and with the rapid growth in energy demand in developing countries, the private sector as well as state companies may not be able, by themselves, to ensure sufficient energy supplies to meet the growing demand for energy in the future and to prevent disproportional energy price increases that could send shock waves through national economies. The sharp increases in crude oil, natural gas and electricity prices worldwide since 2002 are seen as a sign or motivator for more government involvement and intervention in energy markets to ensure access to and the development and deliverability of energy resources, notably hydrocarbons, at economic price levels.

However, not everyone shares this opinion. There are those that believe that the massive investment of about US\$ 20 trillion in energy infrastructure worldwide that will be required over the next three decades, according to the International Energy Agency, can only be raised through the efficient and unhindered functioning of markets. This is predicated on the view that the current growing energy security concerns are at least partially the consequences of long-standing market inefficiencies, the lack of suitable, transparent and favourable investment frameworks and excessive state intervention in many energy producing and transit countries.

However, irrespective of one's views on the role of the market and of government, it would seem that a strengthened dialogue on energy security, its principles and policy alternatives, among countries within the UNECE region would be worthwhile. Many UNECE countries are alarmed by the expected increase in their crude oil and natural gas import dependency.

While this increasing and high dependency itself does not necessarily reflect a deterioration in energy security, importing countries nonetheless are uncomfortable with the thought of being reliant on a few suppliers for their energy needs. This is particularly the case for hydrocarbons where the major suppliers are the Russian Federation, the Organization of the Petroleum Exporting Countries (OPEC) and countries from the Caspian Sea region and Africa. Despite the relatively good historical reliability of crude oil and natural gas deliveries from those regions, the lack of substantial domestic crude oil and natural gas reserves, intensified competition with emerging economies, such as China and India, and persistent high energy prices, have created an uneasy feeling about energy security in many UNECE countries.

This greater sense of energy security vulnerability is leading countries to search for ways and means to enhance their security of energy supplies. On the other hand, producing countries, such as the Russian Federation, Norway, the Caspian Sea producers and others are seeking greater security of demand. Developers are called upon to make large upfront capital commitments in the hope that demand and prices remain reasonable over the life span of projects that are usually in the order of 30 to 40 years. This mutuality of interests suggest that a regional dialogue or compact among UNECE countries on the subject could be meaningful and could lead to policy measures that would benefit both consuming and producing countries.

HYDROCARBON RESOURCES

The re-emergence of concern over high oil and natural gas prices and apprehension over security of oil and natural gas supplies has rekindled the fear that the world could soon run out of natural resources, notably hydrocarbons (oil and natural gas). Once again, stark warnings, similar to those heard in the 1970s, can be heard about the sharp draw down of conventional hydrocarbon resources.

Within the current range of energy prices and with the present technology, it is estimated that conventional reserves of crude oil and natural gas are expected to be capable of meeting cumulative world demand for the next forty or more years. The current worldwide reserve to production ratios of 40 to 70 for crude oil and 70 to 100 for natural gas provide a comforting picture in that respect. In addition, there are large non-conventional hydrocarbon resources that could be developed, if necessary, to meet growing demand, notably for oil. Hence, resource depletion per se is not of major concern at this time. However, what is of vital concern is whether the existing and potential new reserves will be financed and developed in an efficient and timely manner. This is the unanswered question that currently hangs over oil and natural gas markets, adding to uncertainty, risks and anxieties.

While global fossil fuel reserves, including those of hydrocarbons, are sufficient to meet energy demand growth for many decades to come, their unequal geographic distribution and high concentration in several vulnerable and unstable regions of the world is generating concern about whether those hydrocarbons will be accessible, developed and delivered when needed. By 2030, the Middle East is expected to supply around 40 per cent of all the oil consumed in the world, compared to about 30 per cent now. OPEC is likely to supply about 50 per cent by 2030, which is close to the 54 per cent share it supplied in 1973 during the first oil crises, as compared to the today's 40 per cent share. Moreover, approximately two-thirds of the world's established reserves of crude oil are in the Middle East. While gas reserves are not as highly concentrated geographically as oil reserves, nonetheless two countries, the Russian Federation and the Islamic Republic of Iran, have about 40 per cent of the world's reserves.

In addition, with the high geographic concentration of hydrocarbon reserves, direct access by large international oil and gas companies to those reserves and to hydrocarbon resources is increasingly being restricted. Currently, more than 75 per cent of the world's hydrocarbon reserves lie outside their reach. And therefore, lacking investment opportunities in upstream projects, more and more of those companies are redirecting their considerable earnings away from exploration and upstream development to repurchasing their own shares and/or increasing dividends to shareholders.

According to the International Energy Agency, about US\$ 8 trillion of investment will be needed globally over the next three decades to maintain and expand energy supply systems in the oil and natural gas sectors and, most notably, in upstream oil and gas projects. The problem though is that most of the remaining undeveloped hydrocarbon reserves and resources are concentrated in developing countries. Many of these countries are not private sector investment friendly and, moreover, as mentioned earlier are in economically vulnerable and unstable regions of the world.

In sum, it can be concluded that hydrocarbon reserves and resources are sufficient to meet the growing demand for energy over the foreseeable future. Likewise, financing is available. However, the environment for developing these reserves is not sufficiently investment friendly at the current time. Ensuring the security of hydrocarbon supplies will require access to and development of these reserves; availability, access to and reliability of transportation infrastructure; appropriate legal, regulatory, fiscal and policy frameworks conducive to investment; technology transfer to enhance the efficiency and recovery of energy resources; and acceptable methods of addressing environmental issues. For this to happen, UNECE countries, both individually and collectively, will need to engage hydrocarbon producing countries to tackle domestic problems and remove existing barriers to investment while, at the same time, taking active measures to mitigate against the potential risks of inadequate future hydrocarbon supplies.

While long discussed and feared, the pressure exerted on world energy markets and particularly on the hydrocarbon markets by the fast-growing emerging economies, such as China, India and Brazil, has now materialized. Over the last three to four decades, hydrocarbon market disturbances have tended to originate on the supply side, but this time demand pressures have also contributed to the current disturbances and the tight market conditions. Furthermore, the increased demand for crude oil and natural gas by emerging economies has intensified the direct competition with UNECE countries for securing energy supplies with obvious consequences for prices.

The challenge to meet the expected increased demand for crude oil and natural gas by new emerging economies is indeed daunting. For example, while today the United States of America consumes about 21 million barrels per day (b/d) of crude oil, China on the other hand consumes only between seven and eight million b/d. However, Chinese demand is expected to exceed 15 million b/d by 2015. This additional amount of crude oil is higher than the total current annual production of Saudi Arabia or the combined annual output of the United States of America and Canada. And this is only the increased demand by China. There are many more emerging economies that will need additional supplies of hydrocarbons.

Notwithstanding this, the emergence of new promising markets is good news for hydrocarbon producers and exporters that are likely to benefit from this increased demand. Among the UNECE countries, it is the Russian Federation, Kazakhstan, Azerbaijan and Turkmenistan, which are adjacent or nearby to the growing markets of Asia, that are likely to be the chief direct beneficiaries of this development. However, since the market for oil is global in nature and increasingly so for natural gas, other UNECE energy exporters, such as Norway, the Netherlands and Canada, are also likely to benefit from the increased demand of the emerging economies.

The importance of pipelines, ships and the liquefied natural gas (LNG) supply chain in delivering oil and natural gas to markets in an efficient and timely fashion cannot be underestimated in an ever more competitive world economy and society which demands high flexibility at reasonable cost. Moving hydrocarbons in a timely fashion and processing them to market specifications will continue to be a major challenge both for private and state-owned enterprises and for policymakers. The current technological progress and cost reductions being achieved in the LNG supply chain will increasingly contribute to the globalization of the natural gas market as well as enhancing gas deliveries to, and energy security for, both Western Europe and the United States of America.

CRUDE OIL PRICES

Broadly speaking, crude oil prices are a function of supply-demand fundamentals, available surplus or spare oil production capacity, and geopolitical and energy security risks. The rapid growth in oil demand in recent years, particularly in Asia but also elsewhere, has meant that the growth in demand has outstripped additions to global oil production capacity. Today, demand and supply are very finely balanced. The slower expansion in production capacity in comparison to the growth in oil demand has also meant that spare production capacity has been greatly reduced. In the past, Saudi Arabia maintained significant spare oil production capacity that could be brought on stream quickly, if needed, to moderate price increases. This is not the case any more, or at least not for the time being, because Saudi Arabian spare oil production capacity is also quite constrained.

With supply and demand finely balanced and no real appreciable spare oil production capacity available, geopolitical and energy security risks have taken on added significance. Crude oil prices are constantly reacting to negative political events and energy security developments. It is estimated that 20 to 30 per cent of the price of crude oil, when prices were about US\$ 70 per barrel in 2006, was attributable to geopolitical and security concerns. That translates to about US\$ 15-20 per barrel. However, even if the premium due to geopolitical and security concerns was stripped out, the crude oil price would still have been above US\$ 50 per barrel – this is a reflection of tight global supply and demand conditions.

It would seem that the underlying long-run energy fundamentals that prevailed in the 1970s and early 1980s have reappeared or were never really transformed. Needless to say, energy markets today are different from those that existed in the 1970s, but there are many unrelenting trends that are of concern.

COAL, NUCLEAR AND RENEWABLE ENERGY

The renewed preoccupation with energy security is refocusing the debate on the future role of coal, nuclear power and renewable energy in meeting the energy needs of UNECE countries. These energy sources are perceived to be more secure than for oil and natural gas.

Indeed, these are very interesting times for coal. Not long ago coal was viewed as having little or no future. The situation has changed dramatically in just a few years. Energy demand is increasing at a rapid rate, especially in developing countries. With high natural gas prices and supplies of coal plentiful in many countries, coal is re-emerging as a reliable and cost-effective option. Coal has the advantage that world coal reserves are large; sources of supplies are diversified; ample supplies are available from politically stable regions; world infrastructure is well developed; new supplies can be easily brought on stream; and coal can be stored.



However, coal faces many challenges, not the least of which is its environmental footprint throughout the supply chain. The greening of the coal-energy chain is vital. Existing, commercially viable clean coal technologies offer opportunities to mitigate the environmental impact of coal use at all stages of the coal cycle. Moreover, emerging new technologies (carbon capture and storage, gasification and liquefaction) could offer the potential of using coal for power generation with low or no emissions in the future and, in the longer-term, ultimately for transport. But, while the expected progress in clean coal technologies will certainly increase coal's environmental appeal, it will add both to capital and operating costs.

Since 1973, nuclear power has significantly contributed to meeting rising electricity demand in the UNECE region. However, since the early 1980s, far fewer orders for nuclear power plants have been placed, stemming in part from public concern and political debate on the possibility and consequences of accidents, on the lack of adequate methods for disposal of nuclear wastes, and over the costs of nuclear power plants themselves, including their decommissioning costs.

There are signs of a revival of interest in nuclear power, as evidenced by the decision of Finland to move forward with the construction of a new nuclear power reactor, the decision of the United Kingdom to potentially resume the construction of new nuclear power plants, the continuing work on the completion of nuclear facilities in Eastern Europe (Romania, the Russian Federation and Ukraine), the rise in the resale value of existing nuclear power plants in the United States of America and ongoing work on the construction of about 27 reactors worldwide, mainly in developing countries but also in Japan. On the other hand, it should be noted that some UNECE countries, such as Sweden and Germany, continue to opt against the construction of new nuclear power plants and for the phase out of current plants.

While the revival signs are there, the future prospects for nuclear power are still uncertain. Concerns about nuclear safety and the disposal of nuclear waste continue to plague the industry. But perhaps as important are financial and economic considerations. The high upfront capital costs required and the uncertainties about the potential future liabilities associated with the nuclear fuel cycle continue to act as a major hindrance to nuclear energy investments.

Renewable sources of energy are perceived to be the most environmentally benign sources of energy and are seen as the way forward for solving many energy-related health and environmental problems. Indeed, government programmes and targets for renewables continue to be very ambitious; new initiatives, both at the regional and national levels, are being launched; direct and indirect support is being provided; and the means for financing projects are multiplying. In particular, wind and solar technologies are being rapidly developed and the installed capacity is expanding quickly.

There is no doubt that renewables will increase their market share of total energy consumption over the coming years, but they are not likely to displace, in a significant way, the use of fossil fuels over the foreseeable future. This is because of their much higher supply costs and their requirements for vast tracts of land and water surfaces. For example, between 1990 and 2004, the contribution of renewables in meeting the total primary energy requirements of EU countries rose from 4.5 per cent to 6.5 per cent, from 12.0 per cent to 14.5 per cent for electricity generation, including hydro, and from 0.8 per cent to 5.0 per cent for electricity generation, excluding hydro. The corresponding numbers for North America are from 6.5 per cent to 5.9 per cent for total primary energy, 18.6 per cent to 15.3 per cent for electricity generation, including hydro, and from 3.0 per cent to 2.4 per cent for electricity generation, excluding hydro.

Thus, despite their rapid development and commercialization, the contribution of renewables in meeting the growing energy demand of the UNECE region has not appreciably risen over time and is unlikely to do so for the foreseeable future. Even the potential of hydroelectric power to contribute to increasing electricity demand is limited. The region as a whole is characterized by a state of maturing (or limits) when it comes to the development of hydroelectric power. Suitable sites are increasingly difficult to locate for hydrological reasons, competition with alternative land and water uses, and public resistance to the impact of hydro schemes on the natural environment. The Russian Federation still possesses substantial untapped resources, but these are in Eastern Siberia and are unlikely to be developed very quickly because of their remoteness and low population density. Likewise, there is still considerable potential in a number of countries in Central Asia, but their development is hampered by the same constraints as those that apply to the development of oil and gas projects.

Currently, natural gas is the fuel of choice for power generation for cost and environmental reasons. But large-scale combined lignite mining and power generating facilities remain cost competitive. The same is true for conventional coal-fired power plants where low-priced coal is readily available. However, these facilities contribute to much higher levels of environmental pollution. On the other hand, nuclear and renewables, except in special circumstances, tend to be higher cost options for power generation.



The wider the variety and types of energy sources used to generate electricity, the greater the security of electricity supplies. Over-reliance on one type or form of energy, particularly imported energy, can increase a country's vulnerability to unforeseen mishaps. A well-balanced fuel mix for generating power is the safest way for countries to ensure energy peace of mind. The choice of fuel mix for future power plant capacity can have a long-lasting and profound impact on energy import dependency, and thus on energy security considerations. Over the longer-term, nuclear power and renewable energy remain potential alternatives for electricity generation. While nuclear power may not necessarily be a desirable option for each and every country, removal of that option for all countries, as a group, would remove an important element of flexibility and diversity in energy supply and, thereby, undermine energy security for all countries.

TECHNOLOGY AND INVESTMENT

It is difficult to predict whether there will be a significant technological breakthrough related to traditional and renewable energies in the near term. There are many barriers to energy innovation at each stage from the laboratory, through demonstration and early deployment, to widespread dissemination. However, considerable efforts are currently being expended and funds deployed by governments and the private sector to promote the development and commercialization of more advanced coal combustion and nuclear technologies, renewable energy technologies, transportation bio fuels, hybrid systems, hydrogen-based processes and carbon capture and storage technologies, that are more environmentally and publicly acceptable than many of the technologies and processes currently in use. The more new technologies are developed and commercialized, the greater will be the range of energy options available to individual consumers and countries, and the healthier will be the situation with respect to energy security.

Very large energy investments will be needed all along the energy supply chain if the expected energy demand in the UNECE and other regions of the world is to be met. Given the long lead times, the long-term nature and international character of the world energy sector particularly for hydrocarbons, as well as the relatively unstable political and economic situation in a number of hydrocarbon producing and transit countries, it is important that this investment challenge be addressed sooner rather than later.

Energy production, transport and distribution infrastructure, including pipelines, electricity grid systems, LNG terminals and ships as well as refineries, are very costly, with long payback periods, requiring huge investments. The total capital costs of Europe's first export facility for the liquefaction and shipment of natural gas, currently under construction by Statoil at Hammerfest in the Norwegian Arctic Region, is estimated at about US\$ 8 billion, including the costs of the offshore natural gas production facilities. The world's first large-scale coal-fired power plant (450 megawatts (MW)) with integrated coal gasification and carbon dioxide (CO₂) capture and storage, currently under consideration by the RWE Group in Germany, is expected to cost in the order of one billion euros. To be profitable, such investments with high upfront capital costs will require relatively robust international energy prices in the future.

CONCLUSIONS

Global energy security risks have increased sharply because of steeply rising oil import demand in developed and more importantly developing countries; the narrowing margin between oil supply and demand which has driven up prices; the volatility of oil prices arising from international tensions, terrorism and the potential for supply disruptions; the concentration of known hydrocarbon reserves and resources in a limited number of the world's subregions; the restricted access to oil and gas companies for developing hydrocarbon reserves in some countries; the rising cost of developing incremental sources of energy supplies; the lengthening supply routes; and the lack of adequate investment along the energy supply chain, including the electricity sector.

Governments in producing and consuming countries can mitigate these risks by promoting investment in the energy sector through the provision of the legal frameworks, regulatory environments, tax incentives together with fair and transparent processes to foster the public-private partnerships needed to promote and protect investments in existing and new oil and natural gas supplies; by removing barriers to trade and investment for both private sector and public energy companies; by encouraging the mutual self-interest of energy producers and consumers to secure long-term and committed demand for hydrocarbons; and by seeking the convergence of norms, standards and practices as well as new forms of cooperation to facilitate the financing of resource developments.



Additionally, government measures are needed to promote energy security that complement, flank and facilitate the functioning of markets. Energy security risks and rising import dependence can be mitigated by a range of additional policy options aimed at furthering the diversification and flexibility of energy systems, including multiple supply routes; increasing indigenous (domestic) energy supplies; improving energy conservation and efficiency; expanding the fuel mix available to consumers; diversifying energy sources of supply; building-up and maintaining strategic and commercial stocks where warranted; encouraging research and development in greening the fossil fuel energy supply chain; developing and commercializing new and renewable sources of energy; improving the protection and safety of energy infrastructure against possible acts of terrorism; and strengthening international cooperation.

The strengthening of policy measures and the mitigation of energy security risks would benefit to a significant degree from a strengthened and more coordinated multilateral producer-consumer dialogue between governments, industry, the financial community and relevant international organizations on the following issues: (a) data and information sharing and increased transparency, (b) infrastructure investment and financing, (c) legal, regulatory and policy framework, (d) harmonization of standards and practices, (e) research, development and deployment of new technologies, and (f) investment/transit safeguards and burden sharing.

There is already considerable work underway in many of the areas identified above, not only at the UNECE but also in other international organizations, such as the International Energy Agency, the International Energy Forum, the Energy Charter and the Organization of the Petroleum Exporting Countries. Nonetheless, these ongoing activities could benefit from stronger multilateral cooperation and political endorsement.

Many of the elements of the UNECE programme of work in energy are of direct or indirect relevance to the issues raised above. In addition, the UNECE Committee on Energy and some of its subsidiary bodies have directly addressed energy security issues periodically over many years. The Committee continues to be well placed for a pan-UNECE dialogue on energy security issues and related aspects, including the relationship between financial markets and energy security.