Market-based Options for Security of Energy Supply

Christian Egenhofer, Kyriakos Gialoglou,
Giacomo Luciani, Maroeska Boots,
Martin Scheepers, Valeria Costantini,
Francesco Gracceva, Anil Markandya
and Giorgio Vicini

NOTA DI LAVORO 117.2004

SEPTEMBER 2004

IEM – International Energy Markets

Christian Egenhofer, Kyriakos Gialoglou and Giacomo Luciani, *CEPS*
Maroeska Boots and Martin Scheepers, *ECN*
Valeria Costantini, Francesco Gracceva, Anil Markandya and Giorgio Vicini, *FEEM*

Market-based Options for Security of Energy Supply

Summary

Energy market liberalization and international economic interdependence have affected governments' ability to react to security of supply challenges. On the other side, whereas in the past security of supply was largely seen as a national responsibility, the frame of reference has increasingly become the EU in which liberation increases security of supply mainly by increasing the number of markets participants and improving the flexibility of energy systems. In this logic, security of supply becomes a risk management strategy with a strong inclination towards cost effectiveness, involving both the supply and the demand side. Security of supply has two major components that interrelate: cost and risk. This paper focus the attention on costs in the attempt to develop a market compatible approach geared towards security of supply.

Keywords: Energy supply, Market-based options

JEL Classification: Q41, Q43

This paper was prepared in connection with the INDES Project (Insuring against Disruption of Energy Supply), a one-year project financed by the European Commission – DG TREN (Contract Number NNE5/2002/91).

Address for correspondence:

Giorgio Vicini
Fondazione Eni Enrico Mattei
Corso Magenta, 63
20123 Italy
Phone: +390252036955
Fax: +3952036946
E-mail: giorgio.vicini@feem.it

I. Security of supply in open markets

Energy market liberalisation and growing international economic interdependence have affected governments' ability to react to security-of-supply challenges. The EU internal market has changed the policy instruments available to governments as well as altered the reference framework for policy and market participants alike. Whereas in the past security of supply was largely seen – with some exceptions – as a national responsibility, the frame of reference has increasingly become the EU and the European Economic Area (EEA). What constitutes the 'European dimension' of security of supply and what are the 'new' ingredients of such a policy are important questions

In general, liberalisation increases security of supply by increasing the number of market participants and improving the flexibility of energy systems. Liberalisation may also pose new risks, such as those associated with reserve capacity or consistency with environmental or economic objectives. Moreover, governments may need to re-assess the level of security of supply they seek to achieve. Markets make the costs of security of supply more transparent, which in turn can lead to a situation where consumers are prepared to pay a premium for increased security of supply or to accept a reduced level of security in exchange for lower prices. The main effect of liberalisation, however, is that it has shifted the prime responsibility for achieving security of supply from governments towards the inclusion of market participants. Fully competitive markets significantly reduce the scope for intervention by governments. Over the long term, measures that rub against the grain of the market are not only unrealistic and ineffective, but may also impede European competitiveness. Markets can actually serve as very effective and efficient tools in achieving policy goals: governments establish the objectives and set the rules that enable firms to achieve those objectives. As a result, security of supply has become a common responsibility shared among firms, governments, and whenever applicable, individual consumers.

II. Scope of project and research approach

In this logic, security of supply becomes a risk-management strategy with a strong inclination towards cost-effectiveness, involving both the supply and the demand side. Security of supply has two major components that interrelate: risk and cost. This project has mainly concerned costs and attempted to develop a 'market-compatible approach', geared towards securing supply. To follow a market-compatible approach is to identify risks and costs, deal with them by focusing on cost-effectiveness and utilise a broad 'arsenal' of policy instruments. The latter forms the 'insurance' component of this project.

In considering costs, it is crucial to analyse the costs of energy disruptions, which fall under two categories: private and social costs. There is a growing – although still small – body of literature on private costs, both theoretical/methodological and empirical. This literature, still inconclusive, is reviewed at the end in section 5.

This Working Paper is organised as follows:

1. The approach is presented in section 1, in the Introduction;
2. Section 2 provides guidance as to how to make security of supply operational by introducing an exemplary eight-step decision tree;
3. An extensive section 3 presents the main conclusions and recommendations on natural gas import-dependency [3.1], natural gas infrastructure and investments [3.2], oil with special reference to transport [3.3] and electricity adequacy [3.4];
4. Section 4 provides a synthesis of geopolitics for oil and natural gas, which serves as background for the preceding analysis in section 3; and
5. Section 5 adds a review of the literature on private and social costs.

The INDES project has set out to ‘reduce’ complexity and aims at making security of supply operational. By following a rigorous, market-compatible approach it has attempted to introduce a variety of instruments wherever these could provide optimal solutions in the short and long term. Again, the guiding principles are market compatibility and cost-effectiveness.

III. Conclusions and recommendations

This section summarises the essential conclusions and recommendations of the INDES Working Papers. More detailed analysis and conclusions are presented in later sections of this paper, to which we refer in brackets. These are organised in line with the research objectives laid out in section 1: a descriptive map of security risks, security responses in the supply chain and a review of research on private and social costs.

Security risks

Oil

1. A comparative analysis of energy scenarios points to the following main long-term risks: i) collusion among exporters owing to the growing dependence of industrialised countries and insufficient diversification; and ii) demand/supply imbalance, with consequent instability for exporting regions because of insufficient demand and lack of infrastructure.

Gas

2. The analysis of scenarios shows that a reduction of dependency on gas through an increase of domestic production or through energy saving is not credible [4.1].
3. Europe’s position in the world market depends on the growth of African/Middle Eastern exports but most importantly on growth of liquefied natural gas (LNG) volumes. LNG growth (especially in a spot market) is the key factor for improving Europe’s position in the gas market, as it increases market flexibility [3.1, 3.2 and 4.1].
4. The critical factor for LNG growth in Europe is infrastructure investment [3.1, 3.2 and 4.1].
5. There is no problem of scarcity even in the long term and conventional reserves should be sufficient at least until 2035–40. This implies that the risk of an increase in prices, or at

least those owing to the need for unconventional reserves, is small [4.1]. There are other factors, however, that create uncertainty regarding price developments [3.2].

Electricity

6. Sufficient investment in electricity capacity in unregulated markets does not take place continuously, but has a cyclical character. At present, there is no scientific consensus on whether markets are expected to continuously produce adequate capacity levels. Practical experience is too limited and the available cases involve complex and disputed data that can further blur the picture [3.4].
7. Most European electricity systems do not have any specific provisions to ensure adequacy of capacity. They rely on the electricity market to provide the incentive for investment. Price (expected) is the only driver of investment incentives [3.4].
8. While in theory spot pricing can deliver optimal results with regard to securing supply in the long *and* the short term, real markets do not seem able to verify theory and therefore raise questions over their ability to secure supply [3.4].
9. The provision of electricity is characterised by a strongly asymmetric loss-of-welfare curve. The loss of welfare relating to under-investment by a certain amount should be expected to be many times higher than the loss of welfare owing to over-investment by the same amount. But no reliable figures exist [3.4, 5].

Security responses

A. Global level

Oil

10. Different reserve/production ratios provide different capabilities for expanding supply, reducing the risk of collusion among exporting countries [4.1].
11. According to scenarios by the International Institute for Applied Systems Analysis (IIASA), there could be a reduction of dependence through energy efficiency, without negative consequences for exporting countries, i.e. maintaining sustained oil-export revenues for the Middle East [4.1].
12. Diversification of suppliers and transport routes, through cooperation and international investment in infrastructures, could reduce the dependence and vulnerability of OECD Europe, even if Western countries face reduced market power [4.1].
13. Investments in the Middle East – in terms of increasing production capacity and political stability – will play a key role for energy security [4.1].
14. Given present consumption patterns, energy conservation in the US – which is possible even in high economic-growth scenarios – would be useful to help reduce the pressure on the Middle East [4.1].
15. A critical factor that could affect security of supply is the extension of world trade liberalisation to energy. *Positive* consequences of this would be more competition among producers (and thus a reduction of cartel power), a wider technological (and know-how) exchange and higher direct investments. Yet there is a *danger* that an increase in conflicts among regional economic blocs to achieve market shares and technological supremacy could bring forward new geopolitical frameworks that are not favourable to Western countries. Another negative impact of trade liberalisation could be a rise in conflicts over ‘environmental scarcity’ (negative effects in terms of over-depletion of water, forests, land, fisheries, etc.) [4.2].

16. Increasing oil consumption by developing countries could improve cooperation among importing areas to ensure supply security, but at the same time there could be an increase in world oil consumption and prices, with possible conflicts or aggressive policies to obtain access to resources [4.2].
17. Cooperation with exporting countries to enhance investments in production capacity, and with developing countries in order to reinforce the negotiation position of oil-importing countries, seem to be the most effective policies at the international level [4.2].

B. Responses at the EU or member-state level

All sources

18. Increasing energy saving and efficiency through modified consumption behaviour and technological innovation have been recognised as the best EU and national policies [4.2].
19. Market-compatible approaches must identify the specific security event for which responses need to be designed. Blanket security concerns such as import dependency are too general to allow for a transparent security framework of standards and obligations for market participants. Risk identification is a political responsibility, best done at the EU level [2, 3.1]. At present, the only significant security of supply threat in gas may arise from Europe's single most important foreign supplier of gas – Russia.

Oil

20. The strategic stockpiles system run by the International Energy Agency (IEA) has been tested several times and it has so far been able to help avert crises. Nevertheless, incremental improvements can be made [4.2].
21. The IEA emergency system should be extended to non-OECD countries (notably developing Asia), which neither hold strategic stocks nor participate in emergency-sharing mechanisms. This has the potential to be a great source of instability if disruptions occur [4.2].
22. At the EU level, Community measures are characterised by a lack of solidarity among member states. There is no Community decision-making power to dispose of oil stocks on the market: in the event of a crisis, the European Commission may set a target in terms of a reduction in consumption, but the Commission has no powers to order stock disposal [4.2].
23. Owing to the lack of even an ad hoc monitoring system and stockholding by national agencies, there is mix, at industry-level, of strategic and operational stocks – which prevents full transparency. This should be addressed urgently [4.2].
24. Irrespective of this, in the long term it may be wise to aim at reducing the price inelasticity of oil. For many industrial economies, the option of increasing the ability to divert oil used within the domestic economy towards transport has largely been exhausted. While energy-source diversity characterises the electricity and low-grade heating sectors of the economy, surface transport and aviation remain persistently committed to only one fuel technology. Reducing price inelasticity is not necessarily the same as reducing total demand [3.3].
25. A more proactive policy on transport price-elasticity could see three mutually compatible tracks. The *first* is the capability of bringing increased supplies of non-Middle Eastern oil on stream. The *second* is to free oil from other uses by fuel substitution. The *third* is to

open up a new transport-fuel supply grid, using sources such as biofuels, hydrogen and electricity. Among these three suggestions, the third has possibly the best political prospect – at least in the longer term – although such a strategy raises major cost issues. This is another way of looking at a possible security premium. The EU may be ready to pay a security premium for transport-fuel diversification, which has an additional environmental benefit [3.3]. There is a strong link to the cost section in this report [5].

Gas

26. Import dependence per se does not necessarily entail greater insecurity. In any case, EU independence from energy imports including gas imports is not an option [3.1].
27. Importers should be encouraged to diversify their sources and promote demand flexibility. Supply flexibility, which is a function of diversification, mode of transmission (pipeline versus LNG) and redundancy in import infrastructure, is very important for both security of supply and competition, but it is very expensive. This calls for a well-calibrated policy regarding the regulations applied to construction and access to infrastructure facilities (LNG terminals and pipelines) to avoid hampering their development. This suggests the establishment of systematic and formal market-surveillance mechanisms, which could be coordinated by the European Commission together with national regulators, possibly within the Council of European Energy Regulators (CEER) or by an agency as described in item 32 below [3.1, 3.2].
28. Policymakers should put forward measures that welcome the introduction of geographical diversification of gas imports (such as exemptions from competition rules and financial instruments), while increasing imports from an established source should be avoided. Although such policy measures are best formulated at the member-state level, they should be based on systematic and formal market-surveillance mechanisms (see item 27 above) [3.1].
29. Not all consumers have the same needs. A differentiation among priority ('firm' or non-interruptible) and interruptible customers must be made. Suppliers should be required to protect their priority customers. As long as their exposure to the possible negative event (percentage shortfall in supplies) is lower than the share of priority over total customers, they may not need to worry about security of supplies [3.1].
30. As a result, an increase of natural gas in power generation will improve the ratio between non-interruptible and interruptible consumers and therefore increase security of supply for gas. Yet to some extent this increases the risks for power generators, who would eventually need to invest in dual-fired generation and incur an increase in costs [3.1].
31. In an interconnected competitive market, well-diversified companies enjoying a small protected-customer base could be permitted to sell emergency supply rights to other companies that possess less diversified supply or customer bases (or both), or those companies that are more oriented towards priority customers [3.1].
32. An agency should be in charge of the general oversight of the security of the system, including the surveillance of interconnection capacity and ensuring a supplier of last resort. The agency could be organised as either an EU or member-state body, such as an EU agency or a system of national agencies, possibly placed within the national regulators. It could be funded partly by taxpayers and partly by a levy on emergency supply rights for importers to meet their minimum security obligations [3.1].

33. Costs may be socialised to some extent because the diversification of sources, redundancy of import infrastructure and a provider of last resort are also tools to encourage competition. Who will be called upon to finance this activity is an open question that needs to be decided by policy. Cost implications for the power sector should be included in cost estimations [3.1].

Electricity

34. There are several suitable, cost-effective mechanisms that could address the issue of long-term adequacy: mothball reserves, capacity payments, capacity requirements, reliability contracts and capacity subscriptions. They all have different merits and shortcomings. We could not identify 'the' instrument. The baseline should be that the demand for reserve capacity should be made explicit, i.e. the solutions should be market-based. Capacity markets, reliability contracts and capacity subscriptions satisfy this condition. Since reliability contracts and capacity markets are the most market-based, they also produce the fewest legal issues at the EU level in terms of state-aid rules, public service obligations and cross-border issues [3.4].

35. The analysis has shown that in order to be cost-efficient, the instrument finally chosen should apply to the entire market, which could be the EU as a whole or 'regional markets', should this concept be implemented as the European Commission has suggested. The existing reality in the EU is that it is the national governments or their regulators that are responsible for adequacy [3.4].

Review of research on social and private costs

36. Oil disruptions can have a direct and an indirect impact, which can be seen at both global and local levels. The effects of oil disruptions extend across a short- and a medium-term horizon. Electricity shortages also have direct and indirect effects but their impact becomes evident in a shorter period of time than oil. INDES research demonstrates a general correlation between higher oil prices and lower GDP growth rates with a one- to two-year time lag [5.1].

37. A review of social cost methodology and data on supply disruptions confirms that the current approaches to methodologies of cost estimations are inadequate [5].

38. In the area of social costs, the main reason the data are unreliable is that existing methodologies operate with so many variables that projected results are easily distorted [5.1].

39. With regard to private costs, the main challenge is the weighting of the real costs of a supply disruption among and within different customer categories, based on the time the disruption occurs. There are only a few studies, which use a variety of approaches and consequently reach very different conclusions [5.2].

40. Far more work on methodological and empirical issues for assessing private and social costs is needed before the findings become policy-relevant.

Introduction

The point of departure of this project is that the rapidly changing economic environment in which the energy sector operates requires new concepts and policies to deal with security of supply. Liberalisation of energy markets, the completion of the EU's internal market, growing global economic interdependency, competitive pressures stemming from globalisation and the emerging international climate, and environmental regimes increasingly call into question the utility of traditional approaches. Approaches relying on national responses, driven by governments and the focus on the physical availability of energy supplies are gradually being replaced by market-compatible, economic risk-management strategies, in which responsibility is shared among member states, the EU, energy companies and customers.

1. A changing concept of security of supply and the new research agenda

Ensuring a reliable supply of energy in the EU and elsewhere has traditionally been regarded as primarily the responsibility of governments. In the past, governments not only intervened to manage risks to supply interruption, they also did so with little regard to cost. These measures ranged from subsidies for national sources – coal and nuclear – and stocks of imported fuel, to backing national champions abroad, government-to-government contracts and even military intervention. Many of these approaches are no longer feasible, given that European energy companies operate in a free market. The EU is currently assessing how security of supply can be achieved under conditions of energy market liberalisation and privatisation. The 'guiding philosophy' appears to be that the key security-relevant results of liberalisation are thought to be 1) diversification, both in a geographical sense and with regard to fuels, including endogenous fuels; and 2) flexibility, through open networks and demand-side measures that seek to improve energy efficiency and conservation.

The success of this 'guiding philosophy' in a competitive market is based on two implicit assumptions. The *first* is that private operators in the supply chain will each pay an 'insurance premium', i.e. they will assume (at least part of) the economic costs in their contractual and investment decisions associated with avoiding supply disruptions. These may include fuel stocks, redundancies in supply networks (shipping, pipelines, and electricity links), mixing secure high-cost sources with cheap open-market supplies, investing in generators' dual-use

[*] Centre for European Policy Studies (CEPS)

[**] Energy research Centre Netherlands (ECN)

[***] Fondazione Eni Enrico Mattei (FEEM)

capabilities, etc. A *second* assumption is that the sum of these micro-economic investments in security (the metaphorical 'premium') needs to be equal to a macro-economic (not to mention a political/strategic) optimal premium, or put differently, private costs need to be equal to social costs to achieve security. If there is a micro-macro gap – which we would expect – the question arises as to how to identify it, and by extension, how should governments react.

The answer to both questions (in qualitative and if possible in quantitative terms) is relevant not only to define the need and the scope of government action in security of supply – addressing market failure – but also for the development of innovative energy solutions in the European Union. Such solutions, whether they involve energy saving or alternative sources of supply, usually have two *qualities*: initial costs are higher than current market costs; and they have an in-built 'autarchy' premium. They are also invariably oriented towards the longer term and include security considerations such as climate change, which is not concerned with interruptions *to* supply but dangers *from* (certain) supplies. Governments are therefore willing to intervene in narrowing the gap between short-term market prices and the initial high costs of alternative energy. The discovery of a security deficit could add a further socio-economic rationale for the support of research and the introduction of innovative energy solutions, including energy efficiency and conservation, as well as renewables or hydrogen.

This project aimed at scrutinising these assumptions by reviewing recent research and by discussing the early results with relevant stakeholders, before synthesising the findings in this Working Paper.[1] The project has set out to 'reduce complexity' rather than add another 'interdependent' aspect to the overall picture of security of supply. The core questions addressed are:

- Is there (and if yes, what constitutes) a micro-macro gap (private versus social costs)?
- What are the appropriate policy responses?

To answer these questions, a number of more specific questions required attention first:

- A review of research (data and methodologies) on private versus social costs was undertaken to develop a methodological framework for systematically analysing the scope of the gap and thereby energy security needs (section 5).
- The project developed an initial descriptive map of security risks and possible responses in the supply and consumption chain, at both global and EU levels (sections 3 and 4).
- Given the institutional complexity of the EU, we attempted to provide an indication of possible policy responses, attributed to the layer of government to which the response is best suited (what the EU and what member states should do). This analysis was undertaken on a case-by-case basis.
- Finally, the project identified research required to build the foundations for such responses, which is referred to in the text.

2. Making security of supply operational

A discussion of security of supply requires a common understanding of the definition of the concept. A number of different approaches and definitions of security of supply have been put forward to accommodate the new economic and commercial environment. (For an overview see Box 1.) Definitions share a number of common features. The *first* – and possibly most striking – is that they all avoid the term 'policy'. This reflects the growing conviction that security of supply is a shared responsibility among governments, firms and customers that

[1] For a further elaboration of the project's methodology see 'About INDES' at the end of this paper.

goes beyond 'command and control' and towards the allocation of tasks among stakeholders. Because the allocation mechanism is typically the market, approaches need to be market-compatible. A *second* feature is that security of supply is perceived as some sort of cost/risk judgement, defining security of supply in terms of a risk-management strategy. The *final* commonality is that security of supply has two equally important constituent parts: physical availability and price. Given that energy prices crucially affect economic growth, wealth and the competitiveness of industries, price and physical availability are inextricably linked.[2]

This link also prevails for domestic customers, although in a different way and on a different scale. It is low-income groups in particular that are the hardest hit by high energy prices, whether these are a result of an overly expensive security-of-supply policy or a supply shortage that leads to price increases. As a result, the 'cost' of insurance, i.e. security of supply measures taken by firms or by governments is an important part of the definition of security of supply.

Box 1. Definitions of security of supply

European Commission: "Energy supply security must be geared to ensuring…the proper functioning of the economy, the uninterrupted physical availability…at a price which is affordable…while respecting environmental concerns…Security of supply does not seek to maximise energy self-sufficiency or to minimise dependence, but aims to reduce the risks linked to such dependence" (European Commission, 2000, p. 2).

International Energy Agency: "Technological developments will affect the choice and cost of future energy systems but the pace and direction of change is highly uncertain. Governments will…have an important role to play in reducing the risk of supply disruptions. Regulatory and market reforms…will also affect supply. Increased competition between different fuels and between different suppliers of the same fuel will tend to narrow the gap between production cost and market prices, reducing monopoly rents, encouraging greater efficiency and lowering the cost of supply" (International Energy Agency, 2001).

European Parliament: "Being dependent on imports is neither necessarily a bad thing nor economically inefficient provided the sources are diverse, no one supplier is dominant and we can produce sufficient goods and services to pay for them…We cannot alter the fact of where the oil comes from, but we can do a number of things on the demand side, in particular in the transport sector" (European Parliament, 2001).

CEPS, in the context of a task force has used the following definition: security of supply consists of a variety of approaches aimed at insuring against supply risks. Security of supply becomes a cost-effective risk-management strategy of governments, firms and consumers (Egenhofer & Legge, 2001).

Source: Egenhofer & Legge (2001 revised).

This common ground has been translated into an operational definition by Stern (2002), related to the gas sector. The argument goes that as a consequence of market liberalisation, European governments need to make cost and risk judgements, and create a transparent security framework of standards and obligations, which clearly set out:

- the specific security events for which responses need to be designed in order to prevent disruption of supply to firm, and specifically residential, customers;

[2] Since all major OECD countries including the US, Japan and the EU are price-takers (of world market prices), the distortions to competition owing to different border prices should not be excessive, as long as world markets function. Energy price differentials are usually a result of different tax levels or a lack of competition in energy markets.

- the obligations that should be placed on different market participants to enable them to maintain the required minimum level of supply and capacity in the case of such events; and
- the costs associated with obligations and how these should be allocated.

The literature traditionally distinguishes between two different kinds of risks: short-term and long-term risks (see for example IEA, 1995 and Stern, 2002).[3] Short-term risks are generally associated with supply shortages because of accidents, terrorist attacks, extreme weather conditions or technical failure of the grid. This is sometimes described as 'operational security' or 'systems security'. Long-term security is associated with the long-term adequacy of supply, the infrastructure for delivering this supply to markets and a framework to create strategic security against major risks (such as non-delivery for political, economic, *force majeure* or other reasons). In this paper we concentrate on the long-term security or adequacy element, however, we include issues of 'operational' or 'systems' security as long as they are 'systemic', meaning how systems can be designed to function properly and give the proper investment incentives. For example, this is the case with reserve capacity in the power sector or the security of the grid.

Continuing to follow the approach of Stern (2002), we identified the eight steps that regulators and policymakers could take into account when addressing security of supply questions, i.e. a descriptive map of how the risks and costs of energy disruptions can be identified, measured and, if possible, insured against or mitigated.

2.1 Eight steps towards the discovery and estimation of risks and costs

Step 1: Identification of risks (What is the risk?)

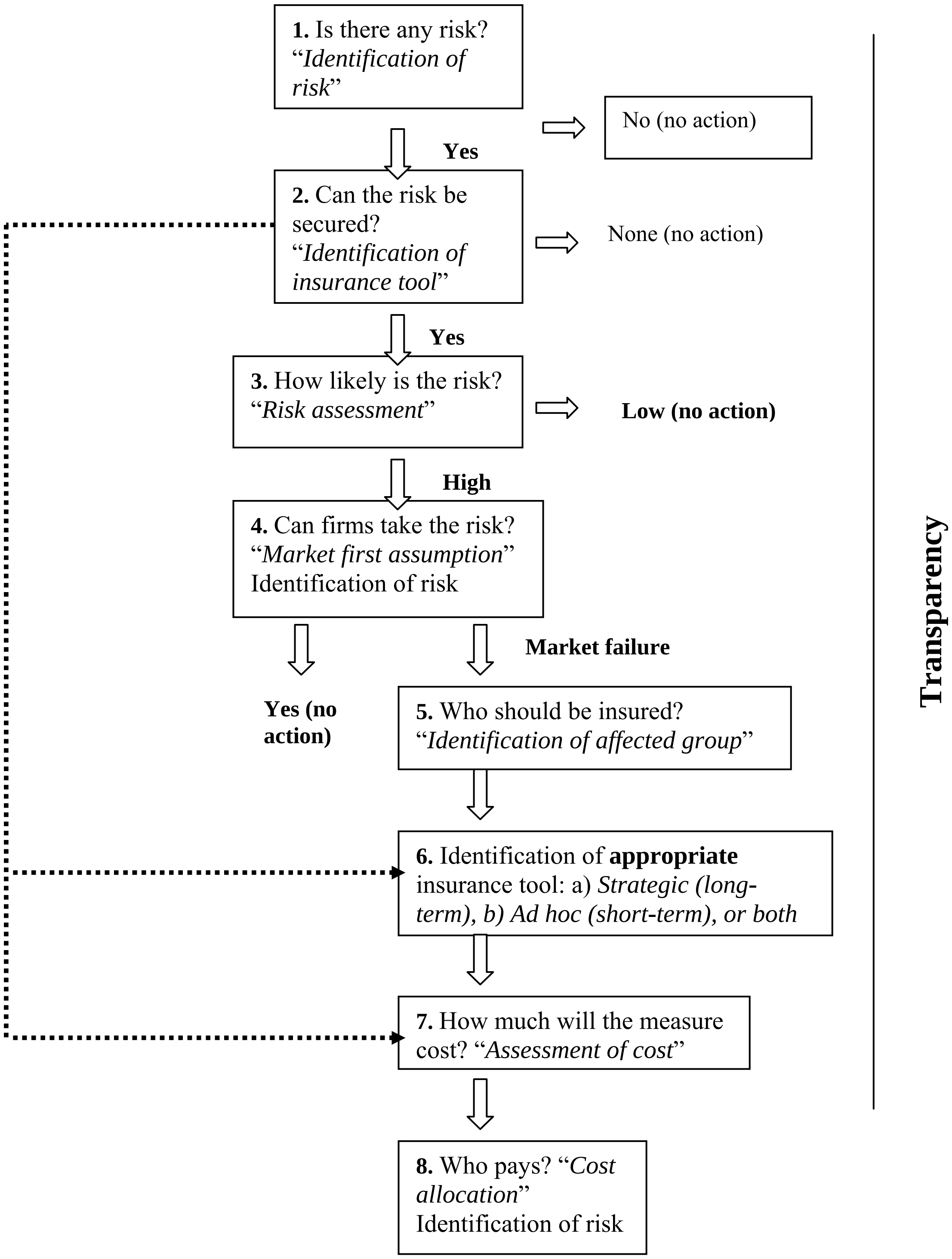
The first step identifies the concrete risks (i.e. *definition*) to security of supply. This necessitates that generic risks such as 'import dependence' or 'dependence on unstable countries' are broken down into the sub-topics that are associated with the risk. Generic categories of such risks are too broad to identify a targeted response. For example, in the case of natural gas, the risks stemming from import dependence can be associated with source dependence, transit dependence or facility dependence. In all three cases the response is different. This issue is dealt with in all the INDES Working Papers. A detailed study is provided by Luciani in Working Paper No. 2.

Step 2: Insurability (Can the risks be insured?)

Insurance only makes sense if there are tools (used with reasonable effort) to hedge risk. Some risks could deliberately go uninsured because they are 'uninsurable', at least in the short term (e.g. terrorist attacks or the failure of all major gas suppliers to deliver). This point is explored with regard to gas in Working Paper No. 2 by Luciani.

[3] There is no agreement on terminology. Different terms are used for the same concepts.

Figure 1. Eight-step decision tree



Step 3: Assessment of risk (How likely is the risk of disruptions?)

The next step concerns the likelihood of disruption. Some disruptions may be extremely unlikely (such as a meteorite falling on a major installation). Conclusions on the likelihood of disruption need to be closely related to potential consequences. This will guide policymakers to decide whether the risk is big enough to consider insurance against it. It may be reasonable not to insure against a highly unlikely, limited risk. This point is where the issue of cost assessment comes into play for the first time. Both Boots and Constantini & Gracceva critically assess risk-estimation methodologies (for Boots, see chapter 4 of the draft report presented at the Stakeholders Workshop,[4] for Constantini & Gracceva, see Working Paper No. 6, which looks into energy disruptions and social costs).

Step 4: Market functioning/failure (Can the market ensure the risk?)

Companies, or more generally, the market may be prepared to accommodate risk if the market allows for price differentiation to make it commercially attractive. Examples include the price differential between long-term supply contracts and spot markets both in oil and power. Another example is 'interruptible contracts'. The fundamental question is how to optimise pricing tools and market instruments (term markets, short-term markets, hedging tools, long-term contracts, involvement of the financial sector, etc.) to achieve a maximum degree of security. Working Paper No. 5 by de Vries & Hakvoort considers reserve capacity in electricity. Cayrade undertakes a similar analysis in Working Paper No. 3 with a focus on gas infrastructure.

Step 5: If the market fails, identification of the affected groups (Who should be insured?)

A particular risk may not have the same consequences for all members of the society. While a major gas supply interruption for a company with dual-fuel capacity may not constitute a fundamental problem, it may be very serious for a domestic customer during winter in Finland. Therefore, there is a need for a clear distinction about how different sectors are affected. Luciani develops this analysis in Working Paper No. 2, by distinguishing between different customer groups, notably *priority* and *interruptible* customers.

Step 6: Identification of an appropriate insurance tool (in conjunction with step 2)

Mitigating policies can have a long-term 'strategic' character (e.g. investing in technological innovation and alternative fuels or in the democratisation and political stability of fuel-exporting states) and a short-term component (e.g. holding emergency stockpiles of oil and possibly natural gas or taxing fuel to reduce private car use while providing incentives for using public transport). The two approaches are mutually reinforcing. It is thus necessary to decide, based on the issue at stake, what tool should be given preference, but only in combination with step 7 below. In Working Paper No. 4 Fisk discusses this issue with regard to the inelastic character of energy demand in transport.

Step 7: Cost assessment of the measures (How much will the measure cost?)

If policymakers and regulators have identified a risk that needs to be insured against, as well as a target group, there is a need to assess the cost of the measure. Estimation of costs

[4] Chapter 4 can be downloaded from the project's ad hoc Stakeholders Workshop website (http://www.ceps.be/Article.php?article_id=235&).

pervades the entirety of the INDES project, with the focus mainly on the methodology of cost assessment. There is a review of social cost methodology and data related to supply disruptions in Working Paper No. 6 by Constantini & Gracceva. A somewhat different focus is provided in Working Paper No. 3 by Cayrade, who concentrates on costs for gas infrastructures, which should be seen as security-relevant expenditure.

Step 8: Allocation of costs (Who should pay the costs?)

Once the measure is implemented, there is still the question of who pays. It does not always have to be the customers. For example, the low-income groups are often those who are most affected by supply disruptions. At the same time, these groups may not be able to pay for expensive measures. Certain costs may as well be allocated at the member-state level (and thus burden citizens within one country only) or concern the entire EU (through taxation). They can also be shared among all customers in the Union through the imposition of a levy or by other means. Luciani, in Working Paper No. 2 explores the possibility of a European fund (based on contributions from market participants) that will underwrite investment in gas infrastructure. Fisk analyses the potential synergies between 'eco-charges' in Working Paper No. 4, using the example of the City of London where 'green vehicles' are exempt from the London Congestion Charge.

Answers to questions in steps 1–8 will differ in relation to the various sectors (i.e. oil, gas, coal, power) as well as to individual countries, reflecting for example differences in fuel mixes or vulnerabilities. Nevertheless, there appear to be a number of sensible *EU* responses while respecting the principle of subsidiarity. The policy synthesis in the framework of INDES does not make the case for a 'one-size-fits-all' security of supply policy. Rather it provides policymakers and regulators with a framework to shape decisions on the risks to be insured. (See Figure 1 for an illustration of the above eight-step approach.)

3. Main messages from the INDES Working Papers

The following section summarises the key findings of the analysis undertaken. The findings are presented in the form of bullet points. Complete analyses and background research are provided in the related Working Papers.

3.1 Security of supply and natural gas

This section presents some of the key findings from the two workshops and Working Paper No. 2 by Luciani on S*ecurity of Supply for Natural Gas Markets*. The findings focus on the design of a cost-effective, market-compatible strategy to deal with the possible risks of import dependency in natural gas.

Diplomacy and diversification

- The starting point is that security of supply is best obtained by diplomacy and stable international relations. Nevertheless, good diplomatic relations and stable external affairs can not reduce risks to zero. There is always a risk associated with import dependency.
- Importers should be encouraged to diversify their sources and promote demand flexibility. Policymakers should put forward measures (e.g. exemptions from competition law, financial instruments) that welcome the introduction of geographical diversification of gas imports, while increasing imports from an established source should be avoided. Although such policy measures are best formulated at the member-state level, they should be based on a systematic and formal *market-surveillance mechanism*, coordinated by the

European Commission together with national regulators – possibly within the Council of European Energy Regulators or another agency.

- The case for the EU to develop a set of policies to promote diversification and redundancy of import capacity is strengthened by the fact that it would not only improve security, but also and indeed primarily because it would support competition in gas markets.

The proposal to deal with import-dependency risks

- The first step is to identify a relevant risk. This is a political responsibility that should be addressed at the EU level, although in close consultation with member states and stakeholders. This effort is greatly helped by a Community solidarity mechanism, taking into account the technical, economic and infrastructural situation. At present, the only significant threat[5] could arise from Europe's single most important foreign supply country, Russia. The already dominant role that Russia plays as a supplier is exacerbated by the importance that it has in new member states.
- Not all consumers have the same needs. A differentiation among *priority* (firm or non-interruptible) and *interruptible* customers should be made. Suppliers should be required to protect their priority customers. As long as their exposure to the possible negative event (percentage shortfall in supplies) is lower than the share of priority over total customers, they may not need to worry about security of supplies. This idea suggests that the security of supply standard could be defined as the guarantee that all the gas volumes demanded by non-interruptible (firm or protected) customers, are available at a reasonable price. Such a standard is best established at the EU level.
- As a result, an increase of natural gas in power generation will improve the non-interruptible and interruptible consumer ratio and therefore increase security of supply for gas. Nevertheless, to some extent this increases the risks for power generators, who would eventually need to invest in dual-fired generation, which is likely to increase their costs.
- Interruptible customers need to be offered lower prices since they do not require protection in the event of a crisis (they may opt to withdraw from the market or maintain their own alternative fuel capacity).
- The distinction among various kinds of customers can be contractual, in which case the law or regulatory system should guarantee the meaning of contractual obligations. Thus suppliers' claims of *force majeure* as an impeding factor to the delivery of gas are limited. Details would need to be agreed at the member-state level.
- In an interconnected, competitive market, well-diversified companies enjoying a small protected-customer base could be permitted to sell *emergency supply rights* to other companies that possess less diversified supplies or customer bases (or both), or that are more oriented towards priority customers.
- An agency should be in charge of general oversight of the security of the system, including the surveillance of interconnection capacity and ensuring a supplier of last resort. The agency could be organised as either an EU or member-state body, such as an EU agency or a system of national agencies, possibly placed within the national

[5] Such a threat means that if gas of such a significant proportion is not delivered, it can cause physical interruptions over a period of time but not indefinitely.

regulators. The agency could be funded partly by taxpayers and partly by a levy on emergency supply rights for importers to meet their minimum security obligations.

- A company's gas procurement portfolio and the composition of its customer base should determine storage obligations.
- Costs could be socialised to some extent, because diversification of sources and redundancy of import infrastructure or a provider of last resort are also tools to encourage competition. As such, they may be assumed to be a systemic priority. Who will be called upon to finance this activity is an open question that will need to be decided by policy. Cost implications for the power sector should be included in estimations.

3.2 Infrastructure and investment

Supply flexibility, which is a function of diversification, the mode of transmission – pipeline versus liquefied natural gas (LNG) – and redundancy in import infrastructure, is very important for both security of supply and competition. On the other hand it is very expensive. Working Paper No. 3 by Cayrade presents an analysis of cost implications and possible policy responses. The following conclusions and recommendations are derived from discussions in both workshops.

- Overall, the enlarged EU faces the challenge of major investment in natural gas and LNG capacity to secure import capacities of up to 525 Bcm. In reality the figure may be higher, depending on the degree to which the current and future commitments from the Kyoto Protocol are fulfilled. Investment in expanding current gas pipeline links and LNG receiving facilities along with new infrastructure over the next 20 years translates into a total cost estimate of between $150 and 200 billion.
- The development of LNG markets is expected to ease some concerns about security of supply, because of its advantages of flexibility and diversification.
- Sustained uncertainty about future gas prices may have an adverse impact on raising appropriate financing. Gas prices will be influenced by new infrastructure investment, production in more difficult conditions and longer transportation routes. The EU emissions trading scheme – itself another gas 'driver' – creates additional uncertainty about prices, although it is generally expected that it will push prices up. For example, McKinsey (in Lekander, 2003) assumes that CO_2 regulation increases demand growth from 2.7% to 3.8% p.a., translating into an increase of gas border price by 15% in 2014.
- The good news is that technological progress is expected to reduce both capital investment and unit transport costs, thereby opening up new supply opportunities for pipelines and LNG.
- This calls for a well-calibrated policy regarding the regulations applied to construction and access to infrastructure facilities (LNG terminals and pipelines), to avoid hampering their development. We point to the suggestion put forward in the previous section to establish a systematic and formalised market-surveillance mechanism, coordinated by the European Commission together with national regulators, possibly within the CEER or an EU agency.

3.3 Oil and transport

The system to ensure security of supply for oil and oil products revolving around the IEA has been tested many times. It has proven to be resilient. Nevertheless, there appears to be no need for immediate action in this field. There has been a long-term trend in the late 20th

century towards the increasing inelasticity of demand for oil-based products in the transport sector in the EU and other economies, reflecting the strategic dominance of transport within economies. Some of the associated challenges are highlighted in Working Paper No. 4 on *Transport Energy Security – the Unseen Risk?* by Fisk, which were discussed in the two workshops.

- Although strategic stockpiles system run under the IEA has been tested several times and it has so far been able to help avert crises, it may be wise in the long term to aim at reducing the price inelasticity of oil. Reducing price inelasticity is not necessarily the same as reducing total demand.
- For many industrial economies the option to increase the ability to divert oil used within the domestic economy towards transport has largely been exhausted. While the diversity of energy sources characterises the electricity and low-grade heating sectors of the economy, surface transport and aviation remain persistently committed to only one fuel technology.
- A more proactive policy on transport price elasticity could be envisaged along three parallel tracks. The *first* is the capability of bringing increased supplies of non-Middle Eastern oil on stream. The *second* is to free oil from other uses by fuel substitution. The *third* is to open up a new transport-fuel supply grid, which may include biofuels, hydrogen or electricity. Among these three suggestions, the third has possibly the best political prospect – at least in the longer term – although such a strategy has major cost implications.
- This point raises one of the central issues that the project addresses. How much is the EU prepared to pay as a security premium, which has an additional environmental benefit? Unfortunately, there are no reliable cost estimates at the moment to allow an informed choice based on data. (Some of the methodological issues are addressed in section 4 of this paper.)

3.4 Electricity adequacy in liberalised electricity markets

In general, liberalisation increases security of supply by increasing the number of market participants and improving the flexibility of the energy systems. Liberalisation may also pose new risks. Reserve capacity is one of them. In the monopolised market structure, capacity shortages were never a problem. The system inherently produced excess capacity in the knowledge that costs could easily be passed on to consumers. In competitive markets the situation has reversed. Investment decisions for generation capacity are based on calculations of profitability. Particularly if peak demand only rarely occurs, which by definition is the case for the marginal kWh, incentives to build reserve capacity are low. Theoretically, shortages of generation capacity could be offset by trade but interconnection capacity is not sufficient. Working Paper No. 5 by de Vries & Hakvoort analyses possible solutions based on *market-based* compensation schemes.

- Sufficient investment in electricity capacity in unregulated markets does not take place continuously, but rather has a cyclical character. At present, there is no scientific consensus on whether markets are expected to produce adequate capacity levels *continuously*. Practical experience is too limited and available cases involve complex and disputed data.
- The specificities of electricity (non-storability) make wholesale prices highly volatile, making it vulnerable to supply interruptions.

- Most European electricity systems do not have any specific provisions to ensure adequacy of capacity. They rely on the electricity market to provide the incentive for investment. Price (expected) is the only driver of investment incentives.
- While in theory spot pricing can deliver optimal results with regard to securing supply in the long *and* the short term, real markets seem not to be able to verify theory and therefore raise questions over their ability to secure supply.
- There are a number of factors that instigate market failure in the setting of optimal investment signs (based on price) to invest in generation adequacy. These include price restrictions, imperfect information (about consumer willingness to pay or future supply and demand), regulatory uncertainty and/or restrictions relating to investment regulation and risk-averse behaviour by investors.
- Regulatory intervention towards the maintenance of reserve capacity is desirable because of the public good character of it. The more reserve capacity exists, the higher the reliability of the supply system and the service. At the same time, consumers having the certainty of existence of reserve capacity will opt for understating their willingness to pay, and attempt to free-ride on the demonstrated willingness of others (as demonstrated by the premiums they would be willing to pay) and thus distort the market to their benefit.
- Long-term contracts are not optimal investments where these concern peaking units, as they allow for free-riding by consumers (prices are received from competing retail companies that buy from generators at probably higher prices and then have to compete); further, such contracts do not have a long enough duration to dampen the business cycle.
- The provision of electricity is characterised by a strongly asymmetric loss-of-welfare curve. The loss of welfare because of under-investment by a certain amount is many times higher than the loss of welfare as a result of over-investment by the same amount.
- Two strategies are proposed to reduce the risk of under-investment. The *first* is to continuously over-invest in the electricity system. This strategy, however, is flawed by a welfare loss with regard to the social optimum, but at the same time it insures against the much greater risk of under-investment. The *second* strategy is to 'flatten' the investment optimum by changing the dynamics of the system. By making demand more responsive to price, random rationing and extreme prices could be avoided. The least valuable loads would reduce their demand and thereby the overall social cost of a disruption would be reduced from the average value of lost load to the value of lost load of the least valuable customers.
- There are a number of suitable cost-effective mechanisms that could address the issue: mothball reserves, capacity payments, capacity requirements, reliability contracts and capacity subscriptions. These all have different merits and shortcomings. An evaluation is provided in Annex 1. This paper does not identify *the* instrument. Nevertheless, the baseline should be that the demand for reserve capacity should be made explicit, i.e. that the solutions should be market-based. Capacity markets, reliability contracts and capacity subscriptions satisfy this condition. Reliability contracts and capacity markets are the most market-based and they also pose the fewest legal issues at the EU level in terms of state-aid rules, public service obligations and cross-border problems.
- The analysis has shown that in order to be effective in a cost-efficient way, the instrument finally chosen should be applied to the entirety of the market, which could be the EU as a whole or 'regional markets', should this concept be implemented as the European

Commission has suggested. The existing reality in the European Union is that it is the national governments or their regulators that are responsible for ensuring adequacy.

4. Synthesis of background analysis

Sections 4 and 5 provide a concise summary of the backdrop against which the sector-specific analysis has been undertaken.[6] The analysis notably includes a review of different scenarios and projections of energy dependence and possible supply risks. Risk assessment is always at the centre of any security of supply approach.

4.1 Geopolitics of oil and gas

A comparison of the different results of a set of six scenarios produced by international energy experts (IEA, IIASA/World Energy Council, US Department of Energy/EIA, European Commission/WETO), forms the basis of our critical review of existing energy-security policies, suggesting alternative or complementary future actions to reduce European dependence and vulnerability. The pessimistic outlook on the increase of the EU's external energy dependence are not confirmed by all the energy scenarios, as there are substantial differences on both production and imports by different regions.

Oil

Considering the supply-side, projections for the growth of reserves and undiscovered deposits show an increasing role for Latin America and the former Soviet Union within oil producing countries. In absolute terms, though, there could be a bipolar situation, with the Middle East on one side and America on the other, mainly based on estimates of non-conventional oil reserves in Canada and Venezuela. In any case, within 12 long-term scenarios, the total *resource-base* can fulfil cumulative consumption until 2100 but *conventional* reserves can only last until 2030, with the need for *unconventional* reserves ***increasing***. Looking at production projections, on average there will be a small increase in market share for Africa/Middle East and the FSU, reduced OECD production (from 29% to 18% by 2020), higher growth of Latin American oil production (8% to 15%) and a reduction of non-conventional oil production compared to reserves potentiality, because of an insufficient transport infrastructure for moving supplies to the market. There is no agreement among the scenarios on the role of the Middle East or the FSU, with a high variation regarding an *increase* in oil production for Africa/Middle East. This is attributed to uncertainties and the possible lack of investment by the FSU, owing to investment for transport routes in the Caspian Region.

Looking at the demand-side, oil generally remains the most important fuel source for transport, especially for developing countries. In the world oil market, on average the market power of OECD countries will be reduced (Europe -6%, North America -7%, and the Pacific by -5%), while market power in Developing Asia will increase to a 26% share of world oil consumption by 2020. Thus Developing Asia could play a decisive role in the market according to the European Commission WETO, but its role is less significant in IIASA scenarios. Finally, looking at intra-area trade flows, both Europe and Developing Asia will depend more and more on the Middle East, with possible conflicts in the world market.

---

[6] The detailed analysis can be found in Working Paper No. 6 by Constantini & Gracceva, dealing with energy disruptions and social costs; see also chapter 4 of the initial report presented to the Stakeholders Workshop (retrievable from http://www.ceps.be/Article.php?article_id=235&) and Working Paper No. 7 by Constantini & Gracceva, entitled *Oil Security, Short- and Long-Term Policies*.

Dependence on oil imports by OECD Europe in physical terms could be substantially different according to the analysed scenarios, with a range of between 290 and 662 Mtoe. Differences in economic terms are explained by divergent assumptions in oil price forecasts and different values of oil imports. Demand-side vulnerability measures present the same range of variation, with a more optimistic view according to IIASA projections and a more pessimistic one from the other scenarios.

Gas

The current situation concerning physical availability shows a great role for the FSU and the strategic role of Iran. The historical trend of reserves distribution shows that total discoveries in the last three decades have doubled gas reserves and projections are equally optimistic.

Gas production is concentrated within three main areas: North America, North Africa and the Middle East (mostly Algeria, Saudi Arabia and Iran) and the FSU. Western Europe provides 10.7% of world supply, concentrated in the Netherlands, Norway and the UK. From a historical perspective, during the period 1970-2002 OECD countries faced a consistent reduction in supply share, falling from 74.4% to 43.2% of world gas production by the end of 2002, mainly as a result of reductions in the US market share. The Middle East and Africa increased their production share from 2% to 17%, while FSU production increased by around 10%, reaching a market share of 27% at the end of 2002. Other areas such as Western Europe and Asia Pacific saw a slow but positive growth rate in gas production.

Concerning gas availability, the global cumulative consumption in a set of long-term energy scenarios shows that the *resource base* is sufficient to meet demand until 2100 in almost all scenarios (without the need of additional quantities or large transformations of resources into reserves). Moreover, the need for unconventional reserves is more moderate than for oil, because conventional gas reserves should be sufficient at least until 2035–40, so that the upward pressures on gas price will probably occur later than for oil.

With regard to supply/demand projections, gas consumption is projected to expand in all regions: even in the slowest growing scenario it increases by 50% and on average it is projected to almost double between 2000 and 2020 (from about 2 Gtep to 3.5 Gtep). In the longer term gas is gaining greater prominence as the fossil fuel with the best prospects, mainly because of the diffusion of highly efficient and economically attractive conversion technologies. The range of projections is much more limited than those regarding change in regional oil consumption, indicating that uncertainty about the evolution of the gas market is much more modest (uncertainty concerns mainly two regions, North America and Eastern Europe/FSU) and the possibility of affecting the trend is probably reduced as well. A consequence is that the distribution of gas demand will probably not change radically in next 20 or 30 years: it is quite certain that the gas system will continue to be characterised by the presence of two main areas of consumption, North America and the FSU. Western Europe will remain the third area, while the use of gas in Developing Asia, notwithstanding sharper increases vis-à-vis other regions, will continue to account for a smaller share of the market.

Gas production is expected to increase in all regions, except in the EU, where production could slightly decrease. Here too the difference among the scenarios' projections is much smaller than that for oil, because of the rigidity and the regionalisation of the gas market: "the projected trends reflect to a large extent the proximity of reserves to the major markets" (Constantini & Gracceva). Nevertheless, in absolute values the major increases in production will probably occur in Eastern Europe/FSU and in Africa/Middle East (where production in 2020 could be more than three times the 2000 level). The huge increase of production in

Eastern Europe/FSU allude to the fact that natural gas will become even more dominant in Russia's energy mix, and the role of Russia will become even more central in the gas system, reflecting its prominent role in the world's proven gas reserves. Regarding the Middle East, since nearly all natural gas exports are in the form of LNG, a key factor determining the actual increase of gas production will be the effective realisation of a number of pipeline options or a significant growth of LNG trade flows (or both), which are both necessary to increase export capacity. Western Europe is the only region for which declining gas production is considered likely, and the possibility of a (moderate) increase in production is directly linked to the development of other new sources.

The growing demand for gas in all regions, combined with the regional disparities in gas reserves and production costs, will obviously lead to the development of an inter-regional gas trade, thus increasing the linkages among regional markets. At the global level, in 2020 inter-regional gas trade (at present a marginal share of total world gas consumption) is indeed projected to reach levels two to four times larger than in 2000. This will inevitably imply new investments in long-distance pipelines from producing to consuming regions and significantly increase LNG trade and investments in LNG infrastructure. Two quite different outlooks seem possible, depending on how the main issue in the world gas market after 2020 is resolved, i.e. the transportation of gas from the two main regions that have the possibility of a large increase in production (the FSU and the Middle East), towards the two regions which will probably have greater needs for imports (Europe and Developing Asia).

- *Outlook 1*: An international market is characterised by two main importing regions with about the same level of gas import, i.e. Western Europe and Developing Asia. Each one is served by a main production area and another less important area: FSU is the main exporter for Europe and Africa/Middle East is the main exporter for Asia. This market structure leads to the key question of how the available gas will be allocated among the consumption areas to meet world demand and to what extent the rapid growth in gas demand in developing regions will affect the long-term EU gas-supply pattern.
- *Outlook 2*: An international market is characterised by a single main importing region, served by two main exporting areas, one of which (the Middle East) is by far the key player in the market, exporting significant amounts of gas towards almost every other region with about the same level of export. Western Europe is by far the main importing region and is served by the FSU and the Middle East, each with a share not far from 50%. In this case, the structure of the gas market seems more favourable for Europe in geopolitical terms, giving it the possibility to enjoy a position somewhat similar to a monopsony with respect to any of the potential sources.

Focusing on Europe, the share of gas within the total primary energy supply (TPES) will increase up to 30%, principally at the expense of coal and fuel-oil use in electricity, so that dependence will grow substantially according to all the scenarios. This means that import capacity expansion is needed well beyond current plans and proposals: the minimum projected increase of gas import is 311 Bcm, while projected capacity is 280 Bcm. Increasing imported volumes should be accompanied by diversification of gas imports, as a strong increase of imports from the Middle East could help Europe to diversify its supply routes or terminals. Diversification of imports will help Europe to avoid becoming secondary in the world gas market or developing a monopsony situation, as projected by these scenarios.

Conclusions of section 4.1

According to a comparative analysis of energy scenarios, the main risks and negative effects for *oil* in the long term could be:

- an increasing risk of collusion among exporters, owing to a growing dependence of industrialised countries and insufficient diversification; and
- a risk of demand/supply imbalance, with consequent instability for exporting regions because insufficient demand and lack of infrastructure resulting in insufficient supply.

Policies implemented by industrialised countries and other factors could mitigate such risks. Different reserve/production ratios provide varying capabilities for expanding supply, reducing the risk of collusion among exporting countries. Further, according to IIASA scenarios there could be a reduction of dependence through energy efficiency, without negative consequences for exporting countries, i.e. maintaining sustained oil export revenues for the Middle East. Diversification of suppliers and transport routes, through cooperation and international investment in infrastructure, could reduce the dependence and vulnerability of OECD Europe, even if Western countries face reduced market power. Finally, as all scenarios show that the Middle East will provide the bulk of incremental oil supply, investments in this area – both in terms of increasing production capacity and political stability – will play a key role for energy security. Given present consumption patterns, energy conservation in US (which is possible even in high economic-growth scenarios), could be useful to help reduce the pressure on the Middle East.

The analysis of scenarios shows that a reduction of dependency on ***gas*** through an increase of domestic production or through energy saving is not credible. The situation is different with regard to diversification of the sources of energy. Europe’s position in the world market could be more favourable depending on whether African/Middle Eastern exports grow substantially, backed by significant volumes of LNG. The latter’s growth (especially in a spot market) seems to be a key factor for improving Europe’s position in the gas market, as it increases market flexibility.

Another critical factor is transportation capacity towards Europe, as it seems very likely that expected demand is higher than the projected infrastructure; this obviously implies the need to gain access to gas reserves, to open up producing areas to international investments and to give due attention to the stability of ‘transit countries’.

Finally, regarding the risk of depleting gas reserves, there is no problem of scarcity even in the long term and conventional reserves should be sufficient at least until 2035–40, so that the risk of price increases (owing to the need for unconventional reserves) is also small.

4.2 Oil security

4.2.1 International policy measures in response to emergencies: short-term measures

A primary mission of the IEA was the creation of a mechanism to mitigate the negative effects of oil disruptions. The mechanism of emergency response was adopted with the International Energy Programme (IEP). The emergency programme is supposed to become active when international disruptions occur that result in a 7% loss of world supply. For all IEA member countries, the emergency response system has been built on four main elements: stockdraw, demand restraint, spare production capacity and fuel-switching capacity. Stockdraw and demand-restraint policies are the most feasible and effective measures in the

International Energy Agency context, because of high oil stock capacity, great dependence on oil (high demand), the reduced spare capacity and the reduced fuel-switching capacity.

There are three different categories of stocks, depending on the holder: *primary* stocks are held by production, transport and refining facilities and by large distribution terminals; *secondary* stocks are held by small distribution stations, wholesalers and retailers; *tertiary* stocks are held by consumers. An alternative classification refers to the nature of the oil stock: *strategic* stocks are oil reserves held for critical events that occur at the international level; *operational* or *industrial* stocks are the oil reserves necessary for the production process for the energy industry. Two factors affect oil stock policies: the actual availability of some stocks and the controversy in stocking crude oil or oil products.

In mid-2000, global primary oil stocks were estimated to be around 5.9 billion barrels (about 90 days of world consumption), of which 1.3 billion barrels were strategic stocks and 4.6 billion barrels were commercial stocks. IEA stocks seem adequate for a medium-scale disruption of short- to medium-term duration, while for larger disruptions the instrument is sufficient only for short periods of time.

Demand restraint as a policy approach refers to the short-term oil savings that can be achieved during a period of crisis. The measures to achieve demand restraint fall into three main categories: persuasion and public information, administrative and compulsory measures, and allocation and rationing schemes. Demand-restraint programmes reflect local demand patterns and economic structures, legislation and emergency-response policies.

In general, IEA countries must have a ready programme of demand-restraint measures equal to 7% of oil consumption if supplies are cut by 7% (approximately equivalent to 3.2 mb/d), and 10% of oil consumption (approximately equivalent to 4.6 mb/d) if supplies are cut by more than 12%. Some measures that can be adapted to changing market conditions include: reduced speed limits, carpooling, odd and even car registration plates, car-free days, restrictions on residential and commercial energy consumption related to heating and lighting, and free urban public transport. Restraint measures are designed mainly for the road transport sector, which is the biggest oil-consuming sector in OECD countries (>50%), but price elasticity of the sector remains very low in the short term and is decreasing. The ability to switch from oil to other fuel has been significantly reduced since the 1970s. This decrease is mainly a result of the growth of natural gas use, which has reduced the scope for fuel-switching in power generation. Oil-fired electricity generation in IEA countries now accounts for less than 7% of total electricity compared with one quarter in the mid-1970s.

The aggregated capacity of IEA countries to increase oil production is small, but some oil-producing countries have such spare capacity. For Europe, spare production capacity could not be maintained for a very long time, owing to current high production rate in the North Sea Basin and the projected reduction in domestic production after 2020.

Conclusions and recommendations of section 4.2.1

The IEA mechanism of emergency response is partially under review. Our attention is mainly focused on three issues: the relatively high costs of stock management for private industries, use of strategic reserves to smooth out prices when significant disruptions have not taken place (few IEA countries have adopted national mechanisms to use strategic reserves) and the extension of the IEA emergency system to non-OECD countries. It is notable that Developing Asia neither holds strategic stocks nor participates in emergency-sharing mechanisms. If disruptions were to take place, this factor could be a great source of instability.

At the EU level, Community measures are characterised by a lack of solidarity among member states, which is not compatible with the objectives of an internal energy market. Moreover, there is no Community decision-making power to dispose of oil stocks on the market. In the event of a crisis, the European Commission may set a target in terms of a reduction in consumption, but the Commission has no powers to order stock disposal. A second problem is the mix – at industry level – of strategic and operational stocks, owing to the lack of an ad hoc monitoring system and stockholding by national agencies.

4.2.2 Long-term measures

Long-term measures for enhancing oil supply security could be envisaged on the demand-side and the supply-side. The main demand-side policies involve:

- stimulating energy saving and efficiency, reducing oil intensity, investing in research and technology, such as energy certification of buildings, energy audits, direct funding for research and development, setting industry standards, changing relative prices through subsidies and taxes, transferring risk over a larger pool of projects and reducing barriers to market entry for smaller firms. The main critiques of these policies come from a possible low-demand scenario and thus low prices for producers, with a higher proportion of supply coming from the low-cost supplies of the Middle East. Further, higher fuel-efficiency standards for vehicles, buildings and industry could produce higher costs for energy supplies, consequently reducing domestic competitiveness compared with regions such as the developing Asian countries, where energy costs are lower.
- reforming tax on energy products and state aid to steer demand towards better-controlled consumption, which is more respectful of the environment. In this case there is a risk of reduced competitiveness for domestic industries in the global market.
- reducing oil price inelasticity, especially for the transport sector, encouraging the use of fuel substitutes (biofuels, hydrogen), rationalising the use of conventional private cars in the cities, implementing measures to make alternative transport modes (i.e. rail) more competitive compared with road transport (through infrastructure investments, market liberalisation and improving public services).

The key supply-side policies could be summarised as cooperation and institutional promotion of diversification of suppliers and routes, as in, for example the Energy Charter Treaty and the Euro-Mediterranean Energy Partnership. To protect foreign direct investment and promote the flow of Western investment and technology into the energy sector of the Eastern transition economies, a long-term framework for investment and trade in energy among the participating countries should be provided. As a consequent risk, excessive diversification policies using high-cost oil (Russian versus the Middle Eastern oil) could reduce domestic competitiveness.

Conclusions of section 4.2.2

The main factors that could affect long-term policies are the liberalisation of international trade (even extended to the energy sector) and the increasing role of oil demand from developing countries. Increasing liberalisation could improve competition among producers with a consequent reduction of cartel power (and a reduced oil price), a wider technological and know-how exchange and greater direct investment.

At the same time, increasing conflicts between regional economic blocs to achieve market share and technological supremacy could bring forward new geopolitical frameworks that are not favourable to Western countries. Another negative impact of trade liberalisation could be a rise in conflicts relating to 'environmental scarcity' (negative effects in terms of over-depletion of water, forests, land, fisheries, etc.).

Increases in oil consumption by developing countries could improve cooperation among importing areas to ensure security of supply, but at the same time there could be an increase in world oil consumption and prices, with possible conflicts or aggressive policies to obtain access to resources.

Cooperation with exporting countries to enhance investments in production capacity and with developing countries in order to reinforce the negotiation stance of oil-importing countries seem to be the most effective policies at the international level. Increasing energy savings and efficiency through modified consumption behaviour and technological innovation has been recognised as the best national policies.

5. Private and social costs of energy supply disruptions

Informed policy choices depend on an accurate assessment of not only risks but also costs. The costs that matter relate to both supply disruptions and proposed measures. While estimations of costs for proposed measures follow the standard impact-assessment procedures applied in the EU and elsewhere, assessing the costs of supply disruptions poses difficult methodological and empirical issues. Working Paper No. 6 by Costantini & Gracceva has reviewed the growing body of literature on social costs. The main findings and key conclusions are reproduced below. For details on methodological, empirical and quantitative aspects, we refer to Working Paper No. 6.

5.1 Social costs

There is general agreement within the literature that the nature of the costs of supply disruptions go well beyond the economic measure of national accounts. Energy use pervades daily life in such a constant and ubiquitous way that it is very difficult to distinguish all real negative effects in the short and long term. Social costs of supply disruptions can be classified under the category of economic externalities. Social costs of security are those that accrue to others in the economy, generating a need for governments to step in and take protective measures.

According to different kinds of risks, such as a physical shortage of oil or a prolonged interruption in electric power (quantity risk), or a sudden rise in oil price (price risk), the social costs of energy disruptions can be analysed under various headings. Usually **oil** disruptions have both direct and indirect effects, with a short- and medium-term horizon. The economic effects of power-generating shortages are also both direct and indirect, but the temporal lag is shorter than for oil disruptions. In any case, a perfect distinction between internal and external costs (i.e. private and social costs) is a difficult task.

The security problem therefore has a long-term and a short-term component: a long-term rise of prices for oil imports has a different implication for an economy than sudden price hikes or price volatility. Reviewing past experience, after the major oil crises OECD countries and the world were stricken by high inflation, trade and payments imbalances, high unemployment and weak business and consumer confidence. The magnitude of the economic costs of an oil price increase depends on many factors: the level and the duration of the price increase; the response of the oil markets; the weight of energy costs on GDP and the flexibility of the energy sector. Nevertheless, it is important to recognise that *the duration of the macroeconomic impact of oil shocks is generally limited to two years after the price change*.

Generally speaking, an increase in the world oil price leads to an increase in the OECD import prices, with three major kinds of effects: *a direct effect* through more spending allocated to energy costs, *a financial effect* through the rise of inflation and interest rates, and *a trade effect* through the increase in the oil import bill, which worsens the trade balance.

Other indirect effects at the macroeconomic level could be a fall in tax revenues and, as a result of rigidities in government expenditure, an increase in the budget deficit, driving interest rates up. Furthermore, because of resistance to real declines in wages, an oil price increase typically leads to upward pressure on nominal wage levels. Wage pressures together with reduced demand tend to lead to higher unemployment. These effects are greater the more sudden the price increase is and the more the market labour is inflexible, and are magnified by the impact of higher oil prices on consumer and business confidence.

Looking at the GDP growth rate, a general correlation between higher oil price and lower GDP growth rate with a one- or two-year time lag is quite clear. A general assessment of magnitude of GDP loss could be constructed analysing the GDP growth rate variation after the three main oil crises. After any crisis a negative impact on GDP growth seems evident. As a matter of fact, *during last 40 years the European Union GDP growth rate was negative only twice: in 1975 and in 1993*. In both cases, it happened with a one- or two-year time lag after an oil price shock.

Other negative effects on the economic performance, with more a direct impact in terms of social costs could be based on trends in the inflation rate and unemployment. These two factors directly affect governments and citizens through higher public expenditures for welfare measures, such as increasing subsidies for unemployment and reduced market power for consumers. Looking at real data, different effects emerge in terms of inflation and unemployment. The inflation rate has a sudden response to an oil price increase, owing to the direct market-transmission mechanism. An increase in the unemployment rate is the result of an indirect mechanism, because of the rigidity of the EU's nominal wages in labour markets, with possible lags (of one or two years) after the oil shock: wage pressure and a diminishing GDP growth rate tend to lead to higher unemployment only in successive periods. In any case, such negative effects in terms of increasing unemployment should take into account a typical, medium-term economic cycle and other structural factors.

The social costs of energy disruptions relating to electricity shortages are easier to distinguish because of their immediate negative impact, and relatively small indirect and successive effects. The social costs of an electricity disruption depend on the existence and quality of various factors, such as the extension of the disruption, the duration, the availability of advance warning and information. Many sectors are affected by black-outs, including public health and education, public transport and administrative offices.

5.2 Private-cost estimation: Value of Lost Load (VOLL)[7]

The costs of supply interruptions for customers are usually calculated by multiplying the energy not served by a factor called the Value of Lost Load (VOLL). VOLL is estimated on the basis of different types of methods including econometric models and case studies of interruptions. Nevertheless, customer surveys are the most prominent. There are a number of

[7] This section largely draws upon chapter 4 of the draft INDES report that was presented to the participants of the Brussels Stakeholders Workshop (retrievable from http://www.ceps.be/Article.php?article_id=235&).

case studies available on the economic impact of specific outages. For example, the 1977 New York City black-out is well documented and studied. The advantages of such case studies are that actual customer experiences are taken into account instead of hypothetical scenarios and that the indirect cost to society can be quantified. Still, there are only a limited number of cases and usually only large incidents are studied in this way, while most outages are much smaller. But more importantly, it is difficult to generalise the results of specific cases.

The official value of VOLL used by the Pool in England and Wales was until recently based on a Finnish survey from 1977, converted into UK pounds sterling and adjusted for inflation. The Finnish study derived a function relating VOLL to the duration of an outage, averaged across different kinds of customers. The overall load-weighted VOLL ranged from $3.8/kWh (in 1999 US$) for a one-hour outage to $1.8/kWh for an outage of longer than 24 hours.

A more recent and extensive survey was conducted in 1994 in the UK as part of a study by the University of Manchester Institute of Science and Technology (UMIST) (Kariuki and Allan 1996, referenced in Rios, et al., 1999), which analysed the sensitivity of the cost of interruptions to variations in time of day, time of week and season. The costs of interruptions of varying length were weighted by peak demand.

Alternative model for VOLL

The definition of VOLL as a standard value suggests that the value attached to a supply interruption depends on the *amount* of energy not supplied. Nevertheless, 'worth of supply' and 'energy not supplied' are not directly related, rather the cost per disconnection instead of per kWh should be stressed. After all, the circumstances around a certain disconnection do matter, such as the activities affected by the outage, the time of day, the mix of customers, the number of interruptions, the duration of interruptions, the availability of advanced warnings, the time of year and weather conditions, and the availability of alternative energy sources.

For example, the value of being unable to watch a live transmission of an international football match may be considerably higher than that of being unable to use a washing machine. Though the energy consumed by the latter is much higher, watching the live game is time-critical. Therefore, VOLL does not correctly reflect the value that consumers place on their supply of energy.

In order to get around some of the drawbacks of a single VOLL value, an alternative method to estimate the cost of energy supply interruptions was developed. This approach recognises that the VOLL should reflect the factors that influence the cost of outages (such as duration of interruption and differences among sectors) as much as possible. It comprises three steps. In step one, the VOLL for a specific sector and a specified duration (and nature) of the interruption is defined. Step two derives a weighted sum of these values that gives an average VOLL for a specified duration of interruption. It should be noted that weighting based on energy makes more sense than weighting based on the number of consumers, since the latter creates a bias of the value towards the VOLL for residential consumers. In the final step, an overall VOLL is derived by weighting the values for a specific duration based on the probability of an outage for that duration. The approach described here leaves room for choice, depending on which VOLL is desired. Moreover, it requires a cost model, a load model and a probability-of-outage model, which are not always easily available. The conclusion of this short review is that given the range of options that can be used to estimate and calculate the costs of energy supply disruptions, many outcomes relating to the level of these costs can be found.

References

Cayrade, P. (2004), *Investments in Gas Pipelines and Liquefied Natural Gas Infrastructure: What is the Impact on the Security of Supply?,* INDES Working Paper No. 3, CEPS, Brussels, March.

Costantini, V. and F. Gracceva (2004), *Social Costs of Energy Disruptions,* INDES Working Paper No. 6, CEPS, Brussels, March.

Costantini, V. and F. Gracceva (2004), *Oil Security: Short- and Long-Term Policies,* INDES Working Paper No. 7, CEPS, Brussels, March.

Egenhofer, C. and T. Legge (2001), *Security of Energy Supply: A Question for Policy or the Markets?*, report by a CEPS Working Party, CEPS, Brussels, November.

European Commission (2000), *Towards a European Strategy for the Security of Energy Supply*, Green Paper, COM(2000) 769 final (http://www.europa.eu.int/comm/energy_transport/en/lpi_lv_enl.html).

European Parliament (2001), *Report on the Commission Green Paper towards a European strategy for the security of energy supply* COM(2000) 769 final – C5-0145/2001/2071(COS)), Committee on Industry, External Trade, Research and Energy, 17 October, Rapporteur: Giles Chichester.

Fisk, D. (2004), *Transport Energy Security: The Unseen Risk?,* INDES Working Paper No. 4, CEPS, Brussels, March.

International Energy Agency (1995), *Natural Gas Security Study*, IEA/OECD, Paris.

International Energy Agency (2001), *World Energy Outlook Insights 2001*, IEA/OECD, Paris.

Lekander, P. (2003), "Impact of ETS on power prices", presentation at CEPS Task Force meeting on "The Business Consequences of the Emerging EU Emissions Trading Scheme", 16 December.

Luciani, G. (2004), *Security of Supply for Natural Gas Markets: What is it and what is it not?,* INDES Working Paper No. 2, CEPS, Brussels, March.

Rios, M. et al. (1999) *Computation of the value of security*, University of Manchester Institute of Science and Technology (UMIST), October.

Stern, J. (2002), "Security of natural gas supplies", *Journal of the Royal Institute of International Affairs*, London, July.

de Vries, L.J. and R.A. Hakvoort (2004), *The Question of Generation Adequacy in Liberalised Electricity Markets*, INDES Working Paper No. 5, CEPS, Brussels, March.

Annex 1

Approaches to Guaranteeing Adequacy of Electricity Supply

a. Capacity payments

Generators, under this system, are given a payment based on their available generation capacity, independent of whether electricity is actually provided or not. Capacity payments provide more stable and, in some instances, higher revenues for generating units. This results in incentives for investment in generation assets since the risk premium and the costs of capital are reduced. Besides capacity payments, the generator receives the normal wholesale price for the electricity actually produced. The capacity payments are collected from customers through a mark-up generally implemented in the transmission charge.

Although capacity payments provide a more stable signal to generators there are some important drawbacks. They do not explicitly identify reserve capacity as a marketable/commercial product, they may introduce distortions in the short-term wholesale market and they add complexity towards in determining the proper allocation and level of payments to generators.

b. Purchases of peaking units by the system operator

As previously explained, peaking plants could be pushed out of the market because of the existence of overcapacity, uncertainty about income and lack of revenue by (virtual) price caps in the wholesale markets. In order to prevent peaking plants from being decommissioned (or mothballed), the system operator purchases a determined number of these plants as strategic reserves. The Transmission System Operator (TSO) may also commit to purchase (or tender for) new peaking units. The extra costs incurred are collected through a mark-up on, for example, the transmission charge.

The interventionist character of this system is a disadvantage. The fact that the system operator owns production capacity could increase the uncertainty in the market and discourage new investors, as the future price curve could largely depend on the decision of the TSO. Another issue is the removal of operating capacity from the market. As the system operator purchases peaking plants it reduces the available capacity, thus potentially increasing its power in the market.

c. Competitive bidding prompted by regulations

When concerns about under-investment in generation capacity arise, the regulator may initiate a tender (or any equivalent) procedure for the addition of the required extra generation. Article 7 of the new Electricity Directive (Directive 2003/54/EC) explicitly regulates this option as an exceptional measure for reasons of security of supply. Again this option intervenes in the market and purchasing decisions that are dictated by the regulator may influence market prices (and strategic behaviour).

d. Capacity markets (capacity requirements)

The basic principle of a capacity market is the obligation of consumers of electricity (or retailers for them) to purchase a pre-determined amount of capacity to cover their expected annual peak-load consumption levels plus a regulated margin. This margin is calculated by the system operator on behalf of the regulator, for example 15% more of capacity than the average peak-load consumption, and would have to be delivered by the generators on demand. Generators are encouraged to deliver the stipulated capacity by the threat of heavy fines. The advantage of this system is that it is market-based and identifies the generation adequacy product. Nevertheless some disadvantages exist, notably the fact that customers remain fully exposed to the potential of high prices in the electricity market and the problems associated in determining the hydro capacities.

e. Reliability contracts

The basic principle of this system is the existence of a number of contracts, considered as ‘call’ or ‘put’ options, which would introduce a price cap in the wholesale electricity market. The system operator would buy these contracts on behalf of the end-consumers.

The reliability contracts have a strike price, which allows consumers to buy electricity at that price whenever they intend to do so. Therefore, when the wholesale price of electricity surpasses the strike price, consumers are able to hedge themselves by exercising the contracts. Generators receive a fixed payment as a compensation for the sale of these reliability contracts. This fixed payment compensates for the investment costs of the reserve plants. Further, the existence of hefty fines would discourage generators from failing to provide enough electricity when the contracts are exercised.

The auctions for reliability contracts can be organised either annually or once every few years. The disadvantages of the first option are that it may increase the volatility of the premium paid to generators and it would not be long enough to attract many bidders. Other disadvantages of this system are the possible abuse of market power and that the system does not promote the demand-side response when prices surpass the strike price of the contracts.

f. Capacity subscription

This futuristic approach of capacity subscription allows customers to choose their level of generation adequacy. Each customer has to buy an electronic fuse, which limits the individual’s electricity use to his/her subscribed peak capacity. During periods of scarcity, the fuses can be activated by the TSO. The market for fuses thus indicates the demand for generation capacity, providing generators with fixed income to cover their investments. However elegant this approach may be, it may not yet be technically feasible on a large scale.

NOTE DI LAVORO DELLA FONDAZIONE ENI ENRICO MATTEI

Fondazione Eni Enrico Mattei Working Paper Series

Our Note di Lavoro are available on the Internet at the following addresses:

http://www.feem.it/Feem/Pub/Publications/WPapers/default.html

http://www.ssrn.com/link/feem.html

NOTE DI LAVORO PUBLISHED IN 2003

PRIV	1.2003	*Gabriella CHIESA and Giovanna NICODANO*: Privatization and Financial Market Development: Theoretical Issues
PRIV	2.2003	*Ibolya SCHINDELE*: Theory of Privatization in Eastern Europe: Literature Review
PRIV	3.2003	*Wietze LISE, Claudia KEMFERT and Richard S.J. TOL*: Strategic Action in the Liberalised German Electricity Market
CLIM	4.2003	*Laura MARSILIANI and Thomas I. RENSTRÖM*: Environmental Policy and Capital Movements: The Role of Government Commitment
KNOW	5.2003	*Reyer GERLAGH*: Induced Technological Change under Technological Competition
ETA	6.2003	*Efrem CASTELNUOVO*: Squeezing the Interest Rate Smoothing Weight with a Hybrid Expectations Model
SIEV	7.2003	*Anna ALBERINI, Alberto LONGO, Stefania TONIN, Francesco TROMBETTA and Margherita TURVANI:* The Role of Liability, Regulation and Economic Incentives in Brownfield Remediation and Redevelopment: Evidence from Surveys of Developers
NRM	8.2003	*Elissaios PAPYRAKIS and Reyer GERLAGH*: Natural Resources: A Blessing or a Curse?
CLIM	9.2003	*A. CAPARRÓS, J.-C. PEREAU and T. TAZDAÏT*: North-South Climate Change Negotiations: a Sequential Game with Asymmetric Information
KNOW	10.2003	*Giorgio BRUNELLO and Daniele CHECCHI*: School Quality and Family Background in Italy
CLIM	11.2003	*Efrem CASTELNUOVO and Marzio GALEOTTI*: Learning By Doing vs Learning By Researching in a Model of Climate Change Policy Analysis
KNOW	12.2003	*Carole MAIGNAN, Gianmarco OTTAVIANO and Dino PINELLI (eds.)*: Economic Growth, Innovation, Cultural Diversity: What are we all talking about? A critical survey of the state-of-the-art
KNOW	13.2003	*Carole MAIGNAN, Gianmarco OTTAVIANO, Dino PINELLI and Francesco RULLANI* (lix): Bio-Ecological Diversity vs. Socio-Economic Diversity. A Comparison of Existing Measures
KNOW	14.2003	*Maddy JANSSENS and Chris STEYAERT* (lix): Theories of Diversity within Organisation Studies: Debates and Future Trajectories
KNOW	15.2003	*Tuzin BAYCAN LEVENT, Enno MASUREL and Peter NIJKAMP* (lix): Diversity in Entrepreneurship: Ethnic and Female Roles in Urban Economic Life
KNOW	16.2003	*Alexandra BITUSIKOVA* (lix): Post-Communist City on its Way from Grey to Colourful: The Case Study from Slovakia
KNOW	17.2003	*Billy E. VAUGHN and Katarina MLEKOV* (lix): A Stage Model of Developing an Inclusive Community
KNOW	18.2003	*Selma van LONDEN and Arie de RUIJTER* (lix): Managing Diversity in a Glocalizing World
Coalition Theory Network	19.2003	*Sergio CURRARINI:* On the Stability of Hierarchies in Games with Externalities
PRIV	20.2003	*Giacomo CALZOLARI and Alessandro PAVAN* (lx): Monopoly with Resale
PRIV	21.2003	*Claudio MEZZETTI* (lx): Auction Design with Interdependent Valuations: The Generalized Revelation Principle, Efficiency, Full Surplus Extraction and Information Acquisition
PRIV	22.2003	*Marco LiCalzi and Alessandro PAVAN* (lx): Tilting the Supply Schedule to Enhance Competition in Uniform-Price Auctions
PRIV	23.2003	*David ETTINGER* (lx): Bidding among Friends and Enemies
PRIV	24.2003	*Hannu VARTIAINEN* (lx): Auction Design without Commitment
PRIV	25.2003	*Matti KELOHARJU, Kjell G. NYBORG and Kristian RYDQVIST* (lx): Strategic Behavior and Underpricing in Uniform Price Auctions: Evidence from Finnish Treasury Auctions
PRIV	26.2003	*Christine A. PARLOUR and Uday RAJAN* (lx): Rationing in IPOs
PRIV	27.2003	*Kjell G. NYBORG and Ilya A. STREBULAEV* (lx): Multiple Unit Auctions and Short Squeezes
PRIV	28.2003	*Anders LUNANDER and Jan-Eric NILSSON* (lx): Taking the Lab to the Field: Experimental Tests of Alternative Mechanisms to Procure Multiple Contracts
PRIV	29.2003	*TangaMcDANIEL and Karsten NEUHOFF* (lx): Use of Long-term Auctions for Network Investment
PRIV	30.2003	*Emiel MAASLAND and Sander ONDERSTAL* (lx): Auctions with Financial Externalities
ETA	31.2003	*Michael FINUS and Bianca RUNDSHAGEN:* A Non-cooperative Foundation of Core-Stability in Positive Externality NTU-Coalition Games
KNOW	32.2003	*Michele MORETTO*: Competition and Irreversible Investments under Uncertainty
PRIV	33.2003	*Philippe QUIRION:* Relative Quotas: Correct Answer to Uncertainty or Case of Regulatory Capture?
KNOW	34.2003	*Giuseppe MEDA, Claudio PIGA and Donald SIEGEL*: On the Relationship between R&D and Productivity: A Treatment Effect Analysis
ETA	35.2003	*Alessandra DEL BOCA, Marzio GALEOTTI and Paola ROTA:* Non-convexities in the Adjustment of Different Capital Inputs: A Firm-level Investigation

GG	36.2003	*Matthieu GLACHANT*: Voluntary Agreements under Endogenous Legislative Threats
PRIV	37.2003	*Narjess BOUBAKRI, Jean-Claude COSSET and Omrane GUEDHAMI*: Postprivatization Corporate Governance: the Role of Ownership Structure and Investor Protection
CLIM	38.2003	*Rolf GOLOMBEK and Michael HOEL*: Climate Policy under Technology Spillovers
KNOW	39.2003	*Slim BEN YOUSSEF*: Transboundary Pollution, R&D Spillovers and International Trade
CTN	40.2003	*Carlo CARRARO and Carmen MARCHIORI*: Endogenous Strategic Issue Linkage in International Negotiations
KNOW	41.2003	*Sonia OREFFICE*: Abortion and Female Power in the Household: Evidence from Labor Supply
KNOW	42.2003	*Timo GOESCHL and Timothy SWANSON*: On Biology and Technology: The Economics of Managing Biotechnologies
ETA	43.2003	*Giorgio BUSETTI and Matteo MANERA*: STAR-GARCH Models for Stock Market Interactions in the Pacific Basin Region, Japan and US
CLIM	44.2003	*Katrin MILLOCK and Céline NAUGES*: The French Tax on Air Pollution: Some Preliminary Results on its Effectiveness
PRIV	45.2003	*Bernardo BORTOLOTTI and Paolo PINOTTI*: The Political Economy of Privatization
SIEV	46.2003	*Elbert DIJKGRAAF and Herman R.J. VOLLEBERGH*: Burn or Bury? A Social Cost Comparison of Final Waste Disposal Methods
ETA	47.2003	*Jens HORBACH*: Employment and Innovations in the Environmental Sector: Determinants and Econometrical Results for Germany
CLIM	48.2003	*Lori SNYDER, Nolan MILLER and Robert STAVINS:* The Effects of Environmental Regulation on Technology Diffusion: The Case of Chlorine Manufacturing
CLIM	49.2003	*Lori SNYDER, Robert STAVINS and Alexander F. WAGNER*: Private Options to Use Public Goods. Exploiting Revealed Preferences to Estimate Environmental Benefits
CTN	50.2003	*László Á. KÓCZY and Luc LAUWERS* (lxi): The Minimal Dominant Set is a Non-Empty Core-Extension
CTN	51.2003	*Matthew O. JACKSON* (lxi)*:*Allocation Rules for Network Games
CTN	52.2003	*Ana MAULEON and Vincent VANNETELBOSCH* (lxi): Farsightedness and Cautiousness in Coalition Formation
CTN	53.2003	*Fernando VEGA-REDONDO* (lxi): Building Up Social Capital in a Changing World: a network approach
CTN	54.2003	*Matthew HAAG and Roger LAGUNOFF* (lxi): On the Size and Structure of Group Cooperation
CTN	55.2003	*Taiji FURUSAWA and Hideo KONISHI* (lxi): Free Trade Networks
CTN	56.2003	*Halis Murat YILDIZ* (lxi): National Versus International Mergers and Trade Liberalization
CTN	57.2003	*Santiago RUBIO and Alistair ULPH* (lxi): An Infinite-Horizon Model of Dynamic Membership of International Environmental Agreements
KNOW	58.2003	*Carole MAIGNAN, Dino PINELLI and Gianmarco I.P. OTTAVIANO*: ICT, Clusters and Regional Cohesion: A Summary of Theoretical and Empirical Research
KNOW	59.2003	*Giorgio BELLETTINI and Gianmarco I.P. OTTAVIANO:* Special Interests and Technological Change
ETA	60.2003	*Ronnie SCHÖB:* The Double Dividend Hypothesis of Environmental Taxes: A Survey
CLIM	61.2003	*Michael FINUS, Ekko van IERLAND and Robert DELLINK*: Stability of Climate Coalitions in a Cartel Formation Game
GG	62.2003	*Michael FINUS and Bianca RUNDSHAGEN*: How the Rules of Coalition Formation Affect Stability of International Environmental Agreements
SIEV	63.2003	*Alberto PETRUCCI:* Taxing Land Rent in an Open Economy
CLIM	64.2003	*Joseph E. ALDY, Scott BARRETT and Robert N. STAVINS*: Thirteen Plus One: A Comparison of Global Climate Policy Architectures
SIEV	65.2003	*Edi DEFRANCESCO*: The Beginning of Organic Fish Farming in Italy
SIEV	66.2003	*Klaus CONRAD*: Price Competition and Product Differentiation when Consumers Care for the Environment
SIEV	67.2003	*Paulo A.L.D. NUNES, Luca ROSSETTO, Arianne DE BLAEIJ*: Monetary Value Assessment of Clam Fishing Management Practices in the Venice Lagoon: Results from a Stated Choice Exercise
CLIM	68.2003	*ZhongXiang ZHANG:* Open Trade with the U.S. Without Compromising Canada's Ability to Comply with its Kyoto Target
KNOW	69.2003	*David FRANTZ* (lix): Lorenzo Market between Diversity and Mutation
KNOW	70.2003	*Ercole SORI* (lix): Mapping Diversity in Social History
KNOW	71.2003	*Ljiljana DERU SIMIC* (lxii): What is Specific about Art/Cultural Projects?
KNOW	72.2003	*Natalya V. TARANOVA* (lxii):The Role of the City in Fostering Intergroup Communication in a Multicultural Environment: Saint-Petersburg's Case
KNOW	73.2003	*Kristine CRANE* (lxii)*:* The City as an Arena for the Expression of Multiple Identities in the Age of Globalisation and Migration
KNOW	74.2003	*Kazuma MATOBA* (lxii): Glocal Dialogue- Transformation through Transcultural Communication
KNOW	75.2003	*Catarina REIS OLIVEIRA* (lxii): Immigrants' Entrepreneurial Opportunities: The Case of the Chinese in Portugal
KNOW	76.2003	*Sandra WALLMAN* (lxii): The Diversity of Diversity - towards a typology of urban systems
KNOW	77.2003	*Richard PEARCE* (lxii): A Biologist's View of Individual Cultural Identity for the Study of Cities
KNOW	78.2003	*Vincent MERK* (lxii): Communication Across Cultures: from Cultural Awareness to Reconciliation of the Dilemmas
KNOW	79.2003	*Giorgio BELLETTINI, Carlotta BERTI CERONI and Gianmarco I.P.OTTAVIANO*: Child Labor and Resistance to Change
ETA	80.2003	*Michele MORETTO, Paolo M. PANTEGHINI and Carlo SCARPA*: Investment Size and Firm's Value under Profit Sharing Regulation

IEM	81.2003	*Alessandro LANZA, Matteo MANERA and Massimo GIOVANNINI:* Oil and Product Dynamics in International Petroleum Markets
CLIM	82.2003	*Y. Hossein FARZIN and Jinhua ZHAO*: Pollution Abatement Investment When Firms Lobby Against Environmental Regulation
CLIM	83.2003	*Giuseppe DI VITA*: Is the Discount Rate Relevant in Explaining the Environmental Kuznets Curve?
CLIM	84.2003	*Reyer GERLAGH and Wietze LISE*: Induced Technological Change Under Carbon Taxes
NRM	85.2003	*Rinaldo BRAU, Alessandro LANZA and Francesco PIGLIARU*: How Fast are the Tourism Countries Growing? The cross-country evidence
KNOW	86.2003	*Elena BELLINI, Gianmarco I.P. OTTAVIANO and Dino PINELLI:* The ICT Revolution: opportunities and risks for the Mezzogiorno
SIEV	87.2003	*Lucas BRETSCGHER and Sjak SMULDERS:* Sustainability and Substitution of Exhaustible Natural Resources. How resource prices affect long-term R&D investments
CLIM	88.2003	*Johan EYCKMANS and Michael FINUS:* New Roads to International Environmental Agreements: The Case of Global Warming
CLIM	89.2003	*Marzio GALEOTTI:* Economic Development and Environmental Protection
CLIM	90.2003	*Marzio GALEOTTI*: Environment and Economic Growth: Is Technical Change the Key to Decoupling?
CLIM	91.2003	*Marzio GALEOTTI and Barbara BUCHNER*: Climate Policy and Economic Growth in Developing Countries
IEM	92.2003	*A. MARKANDYA, A. GOLUB and E. STRUKOVA*: The Influence of Climate Change Considerations on Energy Policy: The Case of Russia
ETA	93.2003	*Andrea BELTRATTI*: Socially Responsible Investment in General Equilibrium
CTN	94.2003	*Parkash CHANDER*: The γ-Core and Coalition Formation
IEM	95.2003	*Matteo MANERA and Angelo MARZULLO*: Modelling the Load Curve of Aggregate Electricity Consumption Using Principal Components
IEM	96.2003	*Alessandro LANZA, Matteo MANERA, Margherita GRASSO and Massimo GIOVANNINI:* Long-run Models of Oil Stock Prices
CTN	97.2003	*Steven J. BRAMS, Michael A. JONES, and D. Marc KILGOUR:* Forming Stable Coalitions: The Process Matters
KNOW	98.2003	*John CROWLEY, Marie-Cecile NAVES* (lxiii): Anti-Racist Policies in France. From Ideological and Historical Schemes to Socio-Political Realities
KNOW	99.2003	*Richard THOMPSON FORD* (lxiii*)*: Cultural Rights and Civic Virtue
KNOW	100.2003	*Alaknanda PATEL* (lxiii): Cultural Diversity and Conflict in Multicultural Cities
KNOW	101.2003	*David MAY* (lxiii): The Struggle of Becoming Established in a Deprived Inner-City Neighbourhood
KNOW	102.2003	*Sébastien ARCAND, Danielle JUTEAU, Sirma BILGE, and Francine LEMIRE* (lxiii) : Municipal Reform on the Island of Montreal: Tensions Between Two Majority Groups in a Multicultural City
CLIM	103.2003	*Barbara BUCHNER and Carlo CARRARO:* China and the Evolution of the Present Climate Regime
CLIM	104.2003	*Barbara BUCHNER and Carlo CARRARO*: Emissions Trading Regimes and Incentives to Participate in International Climate Agreements
CLIM	105.2003	*Anil MARKANDYA and Dirk T.G. RÜBBELKE:* Ancillary Benefits of Climate Policy
NRM	106.2003	*Anne Sophie CRÉPIN (*lxiv)*:* Management Challenges for Multiple-Species Boreal Forests
NRM	107.2003	*Anne Sophie CRÉPIN* (lxiv)*:* Threshold Effects in Coral Reef Fisheries
SIEV	108.2003	*Sara ANIYAR (* lxiv): Estimating the Value of Oil Capital in a Small Open Economy: The Venezuela's Example
SIEV	109.2003	*Kenneth ARROW, Partha DASGUPTA and Karl-Göran MÄLER(*lxiv)*:* Evaluating Projects and Assessing Sustainable Development in Imperfect Economies
NRM	110.2003	*Anastasios XEPAPADEAS and Catarina ROSETA-PALMA(*lxiv)*:* Instabilities and Robust Control in Fisheries
NRM	111.2003	*Charles PERRINGS and Brian WALKER* (lxiv): Conservation and Optimal Use of Rangelands
ETA	112.2003	*Jack GOODY* (lxiv): Globalisation, Population and Ecology
CTN	113.2003	*Carlo CARRARO, Carmen MARCHIORI and Sonia OREFFICE*: Endogenous Minimum Participation in International Environmental Treaties
CTN	114.2003	*Guillaume HAERINGER and Myrna WOODERS*: Decentralized Job Matching
CTN	115.2003	*Hideo KONISHI and M. Utku UNVER*: Credible Group Stability in Multi-Partner Matching Problems
CTN	116.2003	*Somdeb LAHIRI*: Stable Matchings for the Room-Mates Problem
CTN	117.2003	*Somdeb LAHIRI*: Stable Matchings for a Generalized Marriage Problem
CTN	118.2003	*Marita LAUKKANEN*: Transboundary Fisheries Management under Implementation Uncertainty
CTN	119.2003	*Edward CARTWRIGHT and Myrna WOODERS*: Social Conformity and Bounded Rationality in Arbitrary Games with Incomplete Information: Some First Results
CTN	120.2003	*Gianluigi VERNASCA*: Dynamic Price Competition with Price Adjustment Costs and Product Differentiation
CTN	121.2003	*Myrna WOODERS, Edward CARTWRIGHT and Reinhard SELTEN*: Social Conformity in Games with Many Players
CTN	122.2003	*Edward CARTWRIGHT and Myrna WOODERS*: On Equilibrium in Pure Strategies in Games with Many Players
CTN	123.2003	*Edward CARTWRIGHT and Myrna WOODERS*: Conformity and Bounded Rationality in Games with Many Players
	1000	**Carlo CARRARO, Alessandro LANZA and Valeria PAPPONETTI: One Thousand Working Papers**

NOTE DI LAVORO PUBLISHED IN 2004

IEM	1.2004	*Anil MARKANDYA, Suzette PEDROSO and Alexander GOLUB*: Empirical Analysis of National Income and So2 Emissions in Selected European Countries
ETA	2.2004	*Masahisa FUJITA and Shlomo WEBER:* Strategic Immigration Policies and Welfare in Heterogeneous Countries
PRA	3.2004	*Adolfo DI CARLUCCIO, Giovanni FERRI, Cecilia FRALE and Ottavio RICCHI:* Do Privatizations Boost Household Shareholding? Evidence from Italy
ETA	4.2004	*Victor GINSBURGH and Shlomo WEBER:* Languages Disenfranchisement in the European Union
ETA	5.2004	*Romano PIRAS:* Growth, Congestion of Public Goods, and Second-Best Optimal Policy
CCMP	6.2004	*Herman R.J. VOLLEBERGH:* Lessons from the Polder: Is Dutch CO2-Taxation Optimal
PRA	7.2004	*Sandro BRUSCO, Giuseppe LOPOMO and S. VISWANATHAN* (lxv): Merger Mechanisms
PRA	8.2004	*Wolfgang AUSSENEGG, Pegaret PICHLER and Alex STOMPER* (lxv): IPO Pricing with Bookbuilding, and a When-Issued Market
PRA	9.2004	*Pegaret PICHLER and Alex STOMPER* (lxv): Primary Market Design: Direct Mechanisms and Markets
PRA	10.2004	*Florian ENGLMAIER, Pablo GUILLEN, Loreto LLORENTE, Sander ONDERSTAL and Rupert SAUSGRUBER* (lxv): The Chopstick Auction: A Study of the Exposure Problem in Multi-Unit Auctions
PRA	11.2004	*Bjarne BRENDSTRUP and Harry J. PAARSCH* (lxv): Nonparametric Identification and Estimation of Multi-Unit, Sequential, Oral, Ascending-Price Auctions With Asymmetric Bidders
PRA	12.2004	*Ohad KADAN* (lxv): Equilibrium in the Two Player, k-Double Auction with Affiliated Private Values
PRA	13.2004	*Maarten C.W. JANSSEN* (lxv): Auctions as Coordination Devices
PRA	14.2004	*Gadi FIBICH, Arieh GAVIOUS and Aner SELA* (lxv): All-Pay Auctions with Weakly Risk-Averse Buyers
PRA	15.2004	*Orly SADE, Charles SCHNITZLEIN and Jaime F. ZENDER* (lxv): Competition and Cooperation in Divisible Good Auctions: An Experimental Examination
PRA	16.2004	*Marta STRYSZOWSKA* (lxv): Late and Multiple Bidding in Competing Second Price Internet Auctions
CCMP	17.2004	*Slim Ben YOUSSEF:* R&D in Cleaner Technology and International Trade
NRM	18.2004	*Angelo ANTOCI, Simone BORGHESI and Paolo RUSSU* (lxvi): Biodiversity and Economic Growth: Stabilization Versus Preservation of the Ecological Dynamics
SIEV	19.2004	*Anna ALBERINI, Paolo ROSATO, Alberto LONGO and Valentina ZANATTA:* Information and Willingness to Pay in a Contingent Valuation Study: The Value of S. Erasmo in the Lagoon of Venice
NRM	20.2004	*Guido CANDELA and Roberto CELLINI* (lxvii): Investment in Tourism Market: A Dynamic Model of Differentiated Oligopoly
NRM	21.2004	*Jacqueline M. HAMILTON* (lxvii): Climate and the Destination Choice of German Tourists
NRM	22.2004	*Javier Rey-MAQUIEIRA PALMER, Javier LOZANO IBÁÑEZ and Carlos Mario GÓMEZ GÓMEZ* (lxvii): Land, Environmental Externalities and Tourism Development
NRM	23.2004	*Pius ODUNGA and Henk FOLMER* (lxvii): Profiling Tourists for Balanced Utilization of Tourism-Based Resources in Kenya
NRM	24.2004	*Jean-Jacques NOWAK, Mondher SAHLI and Pasquale M. SGRO* (lxvii):Tourism, Trade and Domestic Welfare
NRM	25.2004	*Riaz SHAREEF* (lxvii): Country Risk Ratings of Small Island Tourism Economies
NRM	26.2004	*Juan Luis EUGENIO-MARTÍN, Noelia MARTÍN MORALES and Riccardo SCARPA* (lxvii): Tourism and Economic Growth in Latin American Countries: A Panel Data Approach
NRM	27.2004	*Raúl Hernández MARTÍN* (lxvii): Impact of Tourism Consumption on GDP. The Role of Imports
CSRM	28.2004	*Nicoletta FERRO:* Cross-Country Ethical Dilemmas in Business: A Descriptive Framework
NRM	29.2004	*Marian WEBER* (lxvi): Assessing the Effectiveness of Tradable Landuse Rights for Biodiversity Conservation: an Application to Canada's Boreal Mixedwood Forest
NRM	30.2004	*Trond BJORNDAL, Phoebe KOUNDOURI and Sean PASCOE* (lxvi): Output Substitution in Multi-Species Trawl Fisheries: Implications for Quota Setting
CCMP	31.2004	*Marzio GALEOTTI, Alessandra GORIA, Paolo MOMBRINI and Evi SPANTIDAKI:* Weather Impacts on Natural, Social and Economic Systems (WISE) Part I: Sectoral Analysis of Climate Impacts in Italy
CCMP	32.2004	*Marzio GALEOTTI, Alessandra GORIA ,Paolo MOMBRINI and Evi SPANTIDAKI:* Weather Impacts on Natural, Social and Economic Systems (WISE) Part II: Individual Perception of Climate Extremes in Italy
CTN	33.2004	*Wilson PEREZ:* Divide and Conquer: Noisy Communication in Networks, Power, and Wealth Distribution
KTHC	34.2004	*Gianmarco I.P. OTTAVIANO and Giovanni PERI* (lxviii): The Economic Value of Cultural Diversity: Evidence from US Cities
KTHC	35.2004	*Linda CHAIB* (lxviii): Immigration and Local Urban Participatory Democracy: A Boston-Paris Comparison
KTHC	36.2004	*Franca ECKERT COEN and Claudio ROSSI* (lxviii): Foreigners, Immigrants, Host Cities: The Policies of Multi-Ethnicity in Rome. Reading Governance in a Local Context
KTHC	37.2004	*Kristine CRANE* (lxviii): Governing Migration: Immigrant Groups' Strategies in Three Italian Cities – Rome, Naples and Bari
KTHC	38.2004	*Kiflemariam HAMDE* (lxviii): Mind in Africa, Body in Europe: The Struggle for Maintaining and Transforming Cultural Identity - A Note from the Experience of Eritrean Immigrants in Stockholm
ETA	39.2004	*Alberto CAVALIERE:* Price Competition with Information Disparities in a Vertically Differentiated Duopoly
PRA	40.2004	*Andrea BIGANO and Stef PROOST:* The Opening of the European Electricity Market and Environmental Policy: Does the Degree of Competition Matter?
CCMP	41.2004	*Micheal FINUS* (lxix): International Cooperation to Resolve International Pollution Problems

KTHC	42.2004	*Francesco CRESPI:* Notes on the Determinants of Innovation: A Multi-Perspective Analysis
CTN	43.2004	*Sergio CURRARINI and Marco MARINI:* Coalition Formation in Games without Synergies
CTN	44.2004	*Marc ESCRIHUELA-VILLAR:* Cartel Sustainability and Cartel Stability
NRM	45.2004	*Sebastian BERVOETS and Nicolas GRAVEL* (lxvi): Appraising Diversity with an Ordinal Notion of Similarity: An Axiomatic Approach
NRM	46.2004	*Signe ANTHON and Bo JELLESMARK THORSEN* (lxvi): Optimal Afforestation Contracts with Asymmetric Information on Private Environmental Benefits
NRM	47.2004	*John MBURU* (lxvi)*:* Wildlife Conservation and Management in Kenya: Towards a Co-management Approach
NRM	48.2004	*Ekin BIROL, Ágnes GYOVAI and Melinda SMALE* (lxvi)*:* Using a Choice Experiment to Value Agricultural Biodiversity on Hungarian Small Farms: Agri-Environmental Policies in a Transition al Economy
CCMP	49.2004	*Gernot KLEPPER and Sonja PETERSON:* The EU Emissions Trading Scheme. Allowance Prices, Trade Flows, Competitiveness Effects
GG	50.2004	*Scott BARRETT and Michael HOEL:* Optimal Disease Eradication
CTN	51.2004	*Dinko DIMITROV, Peter BORM, Ruud HENDRICKX and Shao CHIN SUNG:* Simple Priorities and Core Stability in Hedonic Games
SIEV	52.2004	*Francesco RICCI*: Channels of Transmission of Environmental Policy to Economic Growth: A Survey of the Theory
SIEV	53.2004	*Anna ALBERINI, Maureen CROPPER, Alan KRUPNICK and Nathalie B. SIMON:* Willingness to Pay for Mortality Risk Reductions: Does Latency Matter?
NRM	54.2004	*Ingo BRÄUER and Rainer MARGGRAF* (lxvi): Valuation of Ecosystem Services Provided by Biodiversity Conservation: An Integrated Hydrological and Economic Model to Value the Enhanced Nitrogen Retention in Renaturated Streams
NRM	55.2004	*Timo GOESCHL and Tun LIN* (lxvi): Biodiversity Conservation on Private Lands: Information Problems and Regulatory Choices
NRM	56.2004	*Tom DEDEURWAERDERE* (lxvi): Bioprospection: From the Economics of Contracts to Reflexive Governance
CCMP	57.2004	*Katrin REHDANZ and David MADDISON:* The Amenity Value of Climate to German Households
CCMP	58.2004	*Koen SMEKENS and Bob VAN DER ZWAAN:* Environmental Externalities of Geological Carbon Sequestration Effects on Energy Scenarios
NRM	59.2004	*Valentina BOSETTI, Mariaester CASSINELLI and Alessandro LANZA* (lxvii): Using Data Envelopment Analysis to Evaluate Environmentally Conscious Tourism Management
NRM	60.2004	*Timo GOESCHL and Danilo CAMARGO IGLIORI* (lxvi):Property Rights Conservation and Development: An Analysis of Extractive Reserves in the Brazilian Amazon
CCMP	61.2004	*Barbara BUCHNER and Carlo CARRARO*: Economic and Environmental Effectiveness of a Technology-based Climate Protocol
NRM	62.2004	*Elissaios PAPYRAKIS and Reyer GERLAGH*: Resource-Abundance and Economic Growth in the U.S.
NRM	63.2004	*Györgyi BELA, György PATAKI, Melinda SMALE and Mariann HAJDÚ* (lxvi): Conserving Crop Genetic Resources on Smallholder Farms in Hungary: Institutional Analysis
NRM	64.2004	*E.C.M. RUIJGROK and E.E.M. NILLESEN* (lxvi): The Socio-Economic Value of Natural Riverbanks in the Netherlands
NRM	65.2004	*E.C.M. RUIJGROK* (lxvi): Reducing Acidification: The Benefits of Increased Nature Quality. Investigating the Possibilities of the Contingent Valuation Method
ETA	66.2004	*Giannis VARDAS and Anastasios XEPAPADEAS*: Uncertainty Aversion, Robust Control and Asset Holdings
GG	67.2004	*Anastasios XEPAPADEAS and Constadina PASSA*: Participation in and Compliance with Public Voluntary Environmental Programs: An Evolutionary Approach
GG	68.2004	*Michael FINUS*: Modesty Pays: Sometimes!
NRM	69.2004	*Trond BJØRNDAL and Ana BRASÃO*: The Northern Atlantic Bluefin Tuna Fisheries: Management and Policy Implications
CTN	70.2004	*Alejandro CAPARRÓS, Abdelhakim HAMMOUDI and Tarik TAZDAÏT*: On Coalition Formation with Heterogeneous Agents
IEM	71.2004	*Massimo GIOVANNINI, Margherita GRASSO, Alessandro LANZA and Matteo MANERA*: Conditional Correlations in the Returns on Oil Companies Stock Prices and Their Determinants
IEM	72.2004	*Alessandro LANZA, Matteo MANERA and Michael MCALEER*: Modelling Dynamic Conditional Correlations in WTI Oil Forward and Futures Returns
SIEV	73.2004	*Margarita GENIUS and Elisabetta STRAZZERA*: The Copula Approach to Sample Selection Modelling: An Application to the Recreational Value of Forests
CCMP	74.2004	*Rob DELLINK and Ekko van IERLAND*: Pollution Abatement in the Netherlands: A Dynamic Applied General Equilibrium Assessment
ETA	75.2004	*Rosella LEVAGGI and Michele MORETTO*: Investment in Hospital Care Technology under Different Purchasing Rules: A Real Option Approach
CTN	76.2004	*Salvador BARBERÀ and Matthew O. JACKSON* (lxx): On the Weights of Nations: Assigning Voting Weights in a Heterogeneous Union
CTN	77.2004	*Àlex ARENAS, Antonio CABRALES, Albert DÍAZ-GUILERA, Roger GUIMERÀ and Fernando VEGA-REDONDO* (lxx): Optimal Information Transmission in Organizations: Search and Congestion
CTN	78.2004	*Francis BLOCH and Armando GOMES* (lxx): Contracting with Externalities and Outside Options

CTN	79.2004	*Rabah AMIR, Effrosyni DIAMANTOUDI and Licun XUE* (lxx): Merger Performance under Uncertain Efficiency Gains
CTN	80.2004	*Francis BLOCH and Matthew O. JACKSON* (lxx): The Formation of Networks with Transfers among Players
CTN	81.2004	*Daniel DIERMEIER, Hülya ERASLAN and Antonio MERLO* (lxx): Bicameralism and Government Formation
CTN	82.2004	*Rod GARRATT, James E. PARCO, Cheng-ZHONG QIN and Amnon RAPOPORT* (lxx): Potential Maximization and Coalition Government Formation
CTN	83.2004	*Kfir ELIAZ, Debraj RAY and Ronny RAZIN* (lxx): Group Decision-Making in the Shadow of Disagreement
CTN	84.2004	*Sanjeev GOYAL, Marco van der LEIJ and José Luis MORAGA-GONZÁLEZ* (lxx): Economics: An Emerging Small World?
CTN	85.2004	*Edward CARTWRIGHT* (lxx): Learning to Play Approximate Nash Equilibria in Games with Many Players
IEM	86.2004	*Finn R. FØRSUND and Michael HOEL*: Properties of a Non-Competitive Electricity Market Dominated by Hydroelectric Power
KTHC	87.2004	*Elissaios PAPYRAKIS and Reyer GERLAGH*: Natural Resources, Investment and Long-Term Income
CCMP	88.2004	*Marzio GALEOTTI and Claudia KEMFERT*: Interactions between Climate and Trade Policies: A Survey
IEM	89.2004	*A. MARKANDYA, S. PEDROSO and D. STREIMIKIENE*: Energy Efficiency in Transition Economies: Is There Convergence Towards the EU Average?
GG	90.2004	*Rolf GOLOMBEK and Michael HOEL* : Climate Agreements and Technology Policy
PRA	91.2004	*Sergei IZMALKOV* (lxv): Multi-Unit Open Ascending Price Efficient Auction
KTHC	92.2004	*Gianmarco I.P. OTTAVIANO and Giovanni PERI*: Cities and Cultures
KTHC	93.2004	*Massimo DEL GATTO*: Agglomeration, Integration, and Territorial Authority Scale in a System of Trading Cities. Centralisation versus devolution
CCMP	94.2004	*Pierre-André JOUVET, Philippe MICHEL and Gilles ROTILLON*: Equilibrium with a Market of Permits
CCMP	95.2004	*Bob van der ZWAAN and Reyer GERLAGH*: Climate Uncertainty and the Necessity to Transform Global Energy Supply
CCMP	96.2004	*Francesco BOSELLO, Marco LAZZARIN, Roberto ROSON and Richard S.J. TOL*: Economy-Wide Estimates of the Implications of Climate Change: Sea Level Rise
CTN	97.2004	*Gustavo BERGANTIÑOS and Juan J. VIDAL-PUGA*: Defining Rules in Cost Spanning Tree Problems Through the Canonical Form
CTN	98.2004	*Siddhartha BANDYOPADHYAY and Mandar OAK*: Party Formation and Coalitional Bargaining in a Model of Proportional Representation
GG	99.2004	*Hans-Peter WEIKARD, Michael FINUS and Juan-Carlos ALTAMIRANO-CABRERA*: The Impact of Surplus Sharing on the Stability of International Climate Agreements
SIEV	100.2004	*Chiara M. TRAVISI and Peter NIJKAMP*: Willingness to Pay for Agricultural Environmental Safety: Evidence from a Survey of Milan, Italy, Residents
SIEV	101.2004	*Chiara M. TRAVISI, Raymond J. G. M. FLORAX and Peter NIJKAMP*: A Meta-Analysis of the Willingness to Pay for Reductions in Pesticide Risk Exposure
NRM	102.2004	*Valentina BOSETTI and David TOMBERLIN:* Real Options Analysis of Fishing Fleet Dynamics: A Test
CCMP	103.2004	*Alessandra GORIA e Gretel GAMBARELLI:* Economic Evaluation of Climate Change Impacts and Adaptability in Italy
PRA	104.2004	*Massimo FLORIO and Mara GRASSENI*: The Missing Shock: The Macroeconomic Impact of British Privatisation
PRA	105.2004	*John BENNETT, Saul ESTRIN, James MAW and Giovanni URGA*: Privatisation Methods and Economic Growth in Transition Economies
PRA	106.2004	*Kira BÖRNER*: The Political Economy of Privatization: Why Do Governments Want Reforms?
PRA	107.2004	*Pehr-Johan NORBÄCK and Lars PERSSON*: Privatization and Restructuring in Concentrated Markets
SIEV	108.2004	*Angela GRANZOTTO, Fabio PRANOVI, Simone LIBRALATO, Patrizia TORRICELLI and Danilo MAINARDI*: Comparison between Artisanal Fishery and Manila Clam Harvesting in the Venice Lagoon by Using Ecosystem Indicators: An Ecological Economics Perspective
CTN	109.2004	*Somdeb LAHIRI*: The Cooperative Theory of Two Sided Matching Problems: A Re-examination of Some Results
NRM	110.2004	*Giuseppe DI VITA*: Natural Resources Dynamics: Another Look
SIEV	111.2004	*Anna ALBERINI, Alistair HUNT and Anil MARKANDYA*: Willingness to Pay to Reduce Mortality Risks: Evidence from a Three-Country Contingent Valuation Study
KTHC	112.2004	*Valeria PAPPONETTI and Dino PINELLI*: Scientific Advice to Public Policy-Making
SIEV	113.2004	*Paulo A.L.D. NUNES and Laura ONOFRI*: The Profile of a "Warm-Glower": A Note on Consumer's Behavior and Public Policy Implications
IEM	114.2004	*Patrick CAYRADE*: Investments in Gas Pipelines and Liquefied Natural Gas Infrastructure What is the Impact on the Security of Supply?
IEM	115.2004	*Valeria COSTANTINI and Francesco GRACCEVA:* Oil Security Short- and Long-Term Policies
IEM	116.2004	*Valeria COSTANTINI and Francesco GRACCEVA:* Social Costs of Energy Disruptions
IEM	117.2004	*Christian EGENHOFER, Kyriakos GIALOGLOU, Giacomo LUCIANI, Maroeska BOOTS, Martin SCHEEPERS, Valeria COSTANTINI, Francesco GRACCEVA, Anil MARKANDYA and Giorgio VICINI*: Market-Based Options for Security of Energy Supply

(lix) This paper was presented at the ENGIME Workshop on “Mapping Diversity”, Leuven, May 16-17, 2002

(lx) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications”, organised by the Fondazione Eni Enrico Mattei, Milan, September 26-28, 2002

(lxi) This paper was presented at the Eighth Meeting of the Coalition Theory Network organised by the GREQAM, Aix-en-Provence, France, January 24-25, 2003

(lxii) This paper was presented at the ENGIME Workshop on “Communication across Cultures in Multicultural Cities”, The Hague, November 7-8, 2002

(lxiii) This paper was presented at the ENGIME Workshop on “Social dynamics and conflicts in multicultural cities”, Milan, March 20-21, 2003

(lxiv) This paper was presented at the International Conference on “Theoretical Topics in Ecological Economics”, organised by the Abdus Salam International Centre for Theoretical Physics - ICTP, the Beijer International Institute of Ecological Economics, and Fondazione Eni Enrico Mattei – FEEM Trieste, February 10-21, 2003

(lxv) This paper was presented at the EuroConference on “Auctions and Market Design: Theory, Evidence and Applications” organised by Fondazione Eni Enrico Mattei and sponsored by the EU, Milan, September 25-27, 2003

(lxvi) This paper has been presented at the 4th BioEcon Workshop on “Economic Analysis of Policies for Biodiversity Conservation” organised on behalf of the BIOECON Network by Fondazione Eni Enrico Mattei, Venice International University (VIU) and University College London (UCL) , Venice, August 28-29, 2003

(lxvii) This paper has been presented at the international conference on “Tourism and Sustainable Economic Development – Macro and Micro Economic Issues” jointly organised by CRENoS (Università di Cagliari e Sassari, Italy) and Fondazione Eni Enrico Mattei, and supported by the World Bank, Sardinia, September 19-20, 2003

(lxviii) This paper was presented at the ENGIME Workshop on “Governance and Policies in Multicultural Cities”, Rome, June 5-6, 2003

(lxix) This paper was presented at the Fourth EEP Plenary Workshop and EEP Conference “The Future of Climate Policy”, Cagliari, Italy, 27-28 March 2003

(lxx) This paper was presented at the 9th Coalition Theory Workshop on "Collective Decisions and Institutional Design" organised by the Universitat Autònoma de Barcelona and held in Barcelona, Spain, January 30-31, 2004

2003 SERIES	
CLIM	*Climate Change Modelling and Policy* (Editor: Marzio Galeotti)
GG	*Global Governance* (Editor: Carlo Carraro)
SIEV	*Sustainability Indicators and Environmental Valuation* (Editor: Anna Alberini)
NRM	*Natural Resources Management* (Editor: Carlo Giupponi)
KNOW	*Knowledge, Technology, Human Capital* (Editor: Gianmarco Ottaviano)
IEM	*International Energy Markets* (Editor: Anil Markandya)
CSRM	*Corporate Social Responsibility and Management* (Editor: Sabina Ratti)
PRIV	*Privatisation, Regulation, Antitrust* (Editor: Bernardo Bortolotti)
ETA	*Economic Theory and Applications* (Editor: Carlo Carraro)
CTN	*Coalition Theory Network*

2004 SERIES	
CCMP	*Climate Change Modelling and Policy* (Editor: Marzio Galeotti)
GG	*Global Governance* (Editor: Carlo Carraro)
SIEV	*Sustainability Indicators and Environmental Valuation* (Editor: Anna Alberini)
NRM	*Natural Resources Management* (Editor: Carlo Giupponi)
KTHC	*Knowledge, Technology, Human Capital* (Editor: Gianmarco Ottaviano)
IEM	*International Energy Markets* (Editor: Anil Markandya)
CSRM	*Corporate Social Responsibility and Management* (Editor: Sabina Ratti)
PRA	*Privatisation, Regulation, Antitrust* (Editor: Bernardo Bortolotti)
ETA	*Economic Theory and Applications* (Editor: Carlo Carraro)
CTN	*Coalition Theory Network*