




THINK

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# THINK half-way and beyond

Think Tank advising the European Commission on mid- and long-term energy policy

mid-term BOOKLET
June 2010 - January 2012

SEVENTH FRAMEWORK PROGRAMME

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THINK is a project funded by the 7th Framework Programme. It provides knowledge support to policy making by the European Commission in the context of the Strategic Energy Technology Plan. The project is organized around a multidisciplinary group of 23 experts from 14 countries covering five dimensions of energy policy: science and technology, market and network economics, regulation, law, and policy implementation. Each semester, the permanent research team based in Florence works on two reports, going through the quality process of the THINK Tank. This includes an Expert Hearing to test the robustness of the work, a discussion meeting with the Scientific Council of the THINK Tank, and a Public Consultation to test the public acceptance of different policy options by involving the broader community.

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# Foreword

## Christof Schoser

Acting Head of Unit
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It must have been during one of the rare moments of thoughtful reflection in a usually hectic work environment that the idea to contract a think tank to systematically analyse key issues of today's EU energy policy was born. Even though the energy sector is in many ways characterised by a long-term horizon due to long investment cycles, policy makers sometimes struggle to take due account of such long-term considerations. It may therefore be of no coincidence that the idea of the THINK project emerged in the field of energy research, an area very much used to looking beyond daily business to envisage what the future may and should bring.

THINK combines a rigorous scientific approach to analysing key energy issues with systematic reality checks through expert panels. It is this combination of analytical rigour and stakeholder consultation that has led to final reports being both scientifically sound and relevant to policy makers.

After one and a half years, THINK has produced a collection of six reports addressing a number of key questions about today's EU energy policy. Most of the questions are forward-looking, trying in one way or another to analyse how Europe can achieve its ambitious energy and climate policy targets. In this respect, financial and regulatory questions are predominant in most of the reports. However, as is commonly the case in EU policy, the reports usually also address - at least implicitly - the institutional question of who should act: the EU, Member States, regulators, companies or, in the case of Smart Cities, local authorities.

Altogether, the six reports constitute an interesting and up-to-date reader of some of the most pressing issues of EU energy policy. It is fortunate that these reports are now published in one volume and, even more so, that the work of the THINK project will continue for another 18 months. Colleagues in the Commission and hopefully also outside should take these reports as an inspiration to THINK…

# Preface

**Ignacio Pérez-Arriaga** (Comillas, MIT)
In charge of the THINK Project Dissemination, and Member of its Steering Board

During the last few years the EU has made important commitments in energy policy, with a special emphasis on achieving a low carbon economy, and establishing specific targets for 2020 and defining roadmaps to 2050. The role of the EU in the transition to a low carbon economy is increasingly debated. This debate has taken place in a context where various visions of the path to follow have been presented by stakeholders, and several member states have already started implementing policies to guide the transition.

The THINK project consists of a European scientific multidisciplinary think tank that improves the knowledge to support EU energy policymaking by assessing the potential impact of policy options available to the European Commission, as well as the role that the EU should play in the transition to a low carbon economy.



The THINK project will disseminate its results to increase awareness of the decision makers as well as of the general public concerning the potential impact of different policy options. This booklet summarizes the results of the first half of the project, where six topics proposed by the EU Commission have been covered:

- *Public Support for the Financing of RD&D Activities in New Clean Energy Technologies*. If the EU is to meet its 2050 climate objectives, the future energy mix will have to rely on a significantly increased share of low-carbon generation technologies, many of which are not yet competitive (nor even technically proven). Which format should apply any public support to additional RD&D activities in order to achieve the ambitious EU targets?
- *Smart Cities Initiative: Fostering a Quick Transition Towards Local Sustainable Energy Systems*. Cities are the place where most energy services are needed because urbanization is closely linked to high population densities and the concentration of economic activities and production. City smartness essentially stands for integrating concepts of sustainability in every policy decision that is made at a local level. Is there a systematic analysis framework that can be applied to the Smart Cities Initiative so that useful recommendations could be derived from it?
- *Transition Towards a Low Carbon Energy System by 2050: What Role for the EU?*

In March 2011, the European Commission released a roadmap indicating what the relative contributions of different sectors could be to reduce greenhouse gas emissions 80-95% below 1990 levels by 2050, which is setting the scene for new EU level policy actions. What rationale could be provided to the process of identification of priorities and definition of the advisable EU interventions regarding the 2050 Energy Roadmap that was finally released in December 2011?

- *The Impact of Climate and Energy Policies on the Public Budget of EU Member States.* In the current context, where public budgets are overstretched due to the economic crisis, there is a pressing need to understand the fiscal implications of climate policies. Policies intended to achieve decarbonization will impact both negatively and positively on a country's budget via changes in the tax levels and composition of taxes on the one hand, as well as transfer payments and direct investments on the other. What are the dominant effects of climate policy on public budgets, what is the estimated net budget impact and what differences are expected among Member States?
- *Off-Shore Grids: Towards a Least Regret EU Policy.* The development of an offshore grid may have a significant role in the accomplishment of EU energy and climate objectives. The number one priority project presently is the Northern Seas offshore grid. Regulation of this new type of infrastructure needs to be proactive, even if the volume and nature of the investments are still uncertain. Is offshore a different story from onshore in terms of economic features of the investment (economies of scale, cost uncertainties, market failures)? Is there a rationale to go towards combined solutions, or will we simply see a multiplication of standalone lines?
- *EU Involvement in Electricity and Natural Gas Transmission Grid Tarification.* Transmission tariffs presently account for a comparatively minor percentage of the end consumer electricity and gas prices, but both their level and their structure may have a strong impact on how these commodities are traded within and between countries. Do the current challenges in the energy sector warrant a stronger EU involvement in transmission tarification and, if so, what form could this involvement take and what might the potential role of the EU be in this process?

Madrid, January 2012

# Introduction to the THINK Project

**Jean-Michel Glachant** (European University Institute)
THINK Project Coordination, Chairman of its Steering Board and Director of the Research Unit

**Leonardo Meeus** (European University Institute)
THINK Project Coordination, Assisting its Steering Board and Research Team Leader

**Sophia Ruester** (European University Institute)
THINK Research Team Leader

THINK – a "**T**hink tank **H**osting an **I**nterdisciplinary **N**etwork to provide **K**nowledge support to EU energy policy making" – is our response to a call by the European Commission DG Energy in 2009 under the 7th Framework Programme. The call asked for proposals to set up a European, scientific and multidisciplinary think tank. The call did not specify the topics that the think tank was expected to research, instead, it challenged as to engage in the most convincing method of conducting research to support policy making.

THINK runs a novel and innovative report production process, along with a research team to drive the process.

*Report production process*

THINK's remit is to produce two reports every six months over a period of three years (June 2010 – May 2013), i.e. twelve reports in total. DG Energy prioritizes the topics of the reports periodically so that it receives policy advice where it is most needed when it is needed. We are currently halfway through the project, having produced six reports. Each of the reports follows the same process with two important milestones. The first milestone is a hearing after two months where the robustness of the preliminary thinking on a topic is tested with experts from industry, policy making and academia. The second milestone is a meeting with the THINK Scientific Council after three months to scrutinize the first draft of the report.

There is a permanent research team that supports the process, which begins with a set of slides for the Expert Hearing, followed by a draft report for the Scientific Council meeting, and a final report by the end of the semester. For each report, the team receives guidance from at least three members of the Scientific Council, one functioning as project leader, and two functioning as project advisors. The process is designed to produce a neutral report that identifies policy options, evaluates these options, and concludes with recommendations for the European Commission. To be fully transparent, Expert Hearing summaries and review reports by project advisors are added as independent annexes to the reports.

*Research team*

THINK is a Framework Programme funded project in the sense that the team consists of researchers in different disciplines from universities that are involved in this collaborative European research project. THINK is however exceptional because each of these researchers moves to Florence to be part of a permanent research unit hosted at the Florence School of Regulation.

In our experience, this is highly conducive to ensuring continuity, and to nurturing expert consultation and report writing excellence. The end result will be a body of knowledge in EU energy policy with twelve chapters, rather than a collection of twelve individual non-related think tank reports.



Florence, January 2012

# The Role of the Expert Hearings in the THINK Report Production Process

**Ronnie Belmans** (KU Leuven)

Chairman of the THINK Expert Hearings and Industrial Council and Member of its Steering Board

To enable exchange and debate between the project team (from inside the THINK Tank) and the wider expert community (ranging from enterprises, academia, or public or non-profit sector), the THINK Tank runs an “Expert Hearing” as soon as the report drafting team is able to give an overview of its project orientations (i.e. after 2 months). The timing is critical as at the end of each period of six months, two reports have to be ready. Therefore, after two months, the first lines of thoughts are presented to a group of experts, bringing together all stakeholders that are involved in the topics.

In depth debate on the primary orientations of the project team has shown to be a very powerful and very appropriate way to coordinate the existing sources of knowledge and information before making the provisional draft assessment report public. The invited experts have been sought from various groups of stakeholders (including academics, international and European organizations, European decision makers and regulators).

During the first 18 months (June 2010 – December 2011), the following experts have participated in the panels, reacting to the work in progress: Alexis Robert (OECD), Roberto Pagani (Politecnico di Torino), Michael Grubb (Cambridge University), Reinhilde Veugelers (KULeuven), Stephen Smith (University College London), Peter Taylor (International Energy Agency), Adrian Gault (UK Committee on Climate Change), Helen Donoghue (European Commission), Inge Bernaerts (European Commission), Isabel Apolinário (ERSE-CEER), Benoît Esnault (CRE-CEER), Norela Constantinescu (European Commission), Francois Meslier (CIGRE), Martin Crouch (Ofgem-CEER).

After the presentation of the preliminary lines of thoughts and input from the experts, a detailed discussion is held with representatives of the THINK Industrial Council. Specialists from companies which have an important place in the energy value chain give their insights on the topic. A wide variety of companies are represented:

- Suppliers of systems and components of energy systems
- Primary energy supply companies
- Electricity generators and suppliers
- Grid operators

The list of companies that contribute is quite impressive: ABB, Areva, BASF, EDF, Electrabel, Elia, Endesa, Enel, Eni, Exxonmobil, Fluxys, Gas Natural, GDF-SUEZ, Iberdrola, Infrabel, Laborelec, Renault, RTE, Amprion, SAP, Tennet, Total, Vattenfall. Their input ensures that the economic and technical boundaries are included in the THINK process.

This three-step approach: presentation of the preliminary results, expert comment and industrial discussion leads to a testing of the robustness of our preliminary thinking. We think that this approach is unique and feel that it is very efficient to operate in this way.

To keep a clear track of these debates, TECHNOFI independently minutes the Expert Hearings. At the end of each session, the first elements of the report are presented in order to round up the discussions. The minutes become a due annex of the dossier made public by the THINK Tank.

As a chairman of this part of the THINK tank process, I can only thank all contributors that have contributed and I look forward to continuing this endavour in the second part of the THINK project.



Leuven, January 2012

# The Role of the Scientific Council in the THINK Report Production Process

**William D'haeseleer** (KU Leuven)
Chairman of the THINK Scientific Council and Member of its Steering Board

A key stage in the THINK quality process is the open-minded scientific discussion within the THINK Scientific Council. Whereas the Expert Hearing aims to discuss matters with experts from the field in an early stage of the project, the Scientific Council performs a thorough review of the draft report prepared by the Project Team after three months.

After having received the draft report about a week before meeting, members of the THINK Scientific Council come prepared to the meeting (at which an entire half day is spent on a particular subject) and have a direct exchange of views "face-to-face". The subject is introduced and presented by the Project Team, after which the so-called Project Advisors take the role of discussants or prime reviewers. With all this 'baggage', the stage is set for fruitful exchange of views with all members present.

The THINK Scientific Council is made up of the lead experts of the formal THINK-project participants, clearly identified as individuals. To keep the coherence over the whole project focused and to guarantee the highest quality, no proxies are allowed. The Scientific Council experts are mostly university professors or senior top experts, from a variety of backgrounds in energy matters: energy engineers, energy economists, energy lawyers. Also, a wide geographical distribution of experts within Europe has been strived for to be able to capture regional differences; it is literally a club with experts from the North to the South and from the East to the West. The Council consists of Ronnie Belmans (Science & Technology – Belgium), Pantelis Capros (Market & Network Economics – Greece), William D'haeseleer (Science & Technology – Belgium), Eduardo de Oliveira Fernandes (Science & Technology – Portugal), Ottmar Edenhofer (Science & Technology – Germany), Matthias Finger (Regulation – Switzerland), Dörte Fouquet (Law – Germany), Jean-Michel Glachant (Regulation – France & Italy), Manfred Hafner (Policy Implementation – Italy), Leigh Hancher (Law – Netherlands), Thomas B. Johansson (Policy Implementation – Sweden), Peter Kaderjak (Regulation – Hungary), François Lévêque (Law – France), Wladyslaw Mielczarsky (Policy Implementation – Poland), Claude Mandil (Policy Implementation – France), Peter

Mombaur (Policy Implementation – Germany), David Newbery (Market & Network Economics – UK), Ignacio Pérez-Arriaga (Science & Technology – Spain), Pippo Ranci (Regulation – Italy), Jorge Vasconcelos (Regulation – Portugal), Nils-Henrik von der Fehr (Market & Network Economics – Norway), and Christian von Hirschhausen (Market & Network Economics – Germany). The detailed biographical data of these experts can be found at the end of the booklet.

This group of Top Experts also serves as the basket from which the Project Leaders for the different topics treated by the THINK and the Project Advisors are selected by the Steering Board (Ronnie Belmans, William D'haeseleer, Jean-Michel Glachant, Ignacio Pérez-Arriaga). The remaining colleagues perform the role of referee/reviewer. As Chair of the Scientific Council, I would like to thank all our Council members, and especially those who have already taken the special tasks as Project Leaders (Eduardo de Oliveira Fernandes, Manfred Hafner, François Lévêque, David Newbery, Pippo Ranci, Christian von Hirschhausen) and Project Advisors (Pantelis Capros, Dörte Fouquet, Christian von Hirschhausen and Nils-Henrik von der Fehr). All can testify to the fact that this process does work: by scrutinizing each other's work, and by confronting the ideas from different points of view and expertise, a rich debate develops. Such discussions are crucial to focus the goals (and try to estimate the impacts) of energy policy making.

Leuven, January 2012

# THINK Report
## Policy *briefs*

TOPIC 1

# Public Support for the Financing of RD&D Activities in New Clean Energy Technologies

**Project Leader**: David Newbery
**Research Team Leader**: Luis Olmos
**Research Team**: Sophia Ruester, Siok Jen Liong, Jean-Michel Glachant
**Project Advisors**: Christian von Hirschhausen, Pantelis Capros

## Highlights

– Substantial investments in RD&D in new low-carbon technologies are required to reach the EU climate objectives. Given existing market failures affecting clean innovation, developing a suitable portfolio of existing and new clean technologies will require both demand pull support measures – namely carbon pricing and the Renewables Directive, and direct public support to innovation.

– Innovation activities comprise research, development and demonstration and should be aimed at both (i) accelerating the decarbonization of energy systems to reach mid-term 2020 objectives by pushing especially more mature technologies and (ii) developing a diversified technology mix enabling the achievement of long-term 2050 objectives by supporting also still immature technologies.

– Cooperation, to agree increased budgets, and coordination, to ensure an efficient allocation of that budget, among Member State and EU support policies, have to be improved. The initiation of European Energy Research Alliances is a step into the right direction; their successful implementation should be fostered and progress monitored.

– The form of direct public support should be tailored to the characteristics of each innovation project – depending on both the technology targeted and its level of maturity – and to the type of entity best placed to undertake the RD&D.

– Financing instruments should encourage efficiency while not discouraging private sector participation. Funds should be allocated by competition and public funding should be output-driven whenever possible; the institutions set up to allocate funds should be designed to avoid institutional inertia and lock-in.

## Background

If the EU is to meet its 2050 climate objectives, the future energy mix will have to rely on a significantly increased share of low-carbon (low-C) generation technologies, much of which is not yet competitive (nor even technically proven). Substantial additional RD&D activities are required in order to achieve the ambitious target of limiting global warming to a maximum of two degrees Celsius above pre-industrial levels and cut emissions by 80% or more for industrialized countries.

An adequate portfolio of existing and new clean energy technologies will not develop without considerable additional public support: the current design of the EU emission trading scheme fails to provide the sufficiently high, credible and predictable future carbon price trajectory needed to reassure private investors. Moreover, there are important additional market failures that undermine the private incentive to invest in clean energy innovation. The two most important are that RD&D has, or should have, a large element of pure public good, as it is both unlikely and may be undesirable that innovators capture all the learning benefits; and second, that there are additional indirect benefits to the EU in encouraging other countries to adopt better low-C solutions to reduce global warming that impacts the EU, again captured neither by the innovator nor by the individual Member State. Given the fact that there is high uncertainty about future market revenues from the exploitation of new clean technologies, existing demand pull measures, namely carbon pricing and the Renewables Directive, will be insufficient to deliver an adequate and timely level of private RD&D. Thus, there is a need for direct public support to innovation.



The EU's SET Plan is a response to the evident need to stimulate research and development in low-C technologies (see Box 1). However, technologies to be developed within the SET Plan and the associated priority actions have been selected without directly considering the problem of securing adequate public financial resources. Hence, priorities have to be set and commitments for higher funding secured.

**Box 1 - The SET Plan**

The SET Plan is divided into eight *Industrial Initiatives* corresponding to eight technology fields identified as potential key contributors to a future clean energy technology mix allowing the EU to meet its 2050 climate targets. Within these Initiatives, strategic objectives have been formulated based on *Technology Roadmaps* that identify priority actions for the next decade (2010 to 2020). More specific *Implementation Plans* are developed for three-year periods. Authorities estimated a financing gap of €47-60 bn, comparing the current level of expenditure with that necessary to undertake the priority actions selected for the coming decade.

## Choosing RD&D projects to support the SET Plan

Public funds are limited. Hence, projects to be publicly supported should be carefully chosen to achieve energy policy objectives. A **suitable portfolio of innovation activities comprising research, development and demonstration** will support (i) the acceleration of decarbonization to reach mid-term 2020 EU climate objectives and (ii) the development of a diversified technology mix enabling the achievement of long-term 2050 objectives. Technologies of different levels of maturity reveal substantial differences in cost competitiveness and uncertainty about their expected market potential and long-run net revenues, which impacts the industry's incentive to conduct RD&D. However, technologies lacking any commercial near- or mid-term potential might become highly important in the longer term.

How to build this suitable portfolio? Even though EU climate policy objectives involve two different time horizons, project selection should be based on one single evaluation criterion that balances the importance of reaching the 2020 targets at least cost against the need to support immature technologies that hold greater promise for the longer term. One also has to take into account the probability of success of innovation projects, the impact of this success on the development of new technologies, and the expected contribution of the latter to the cost of emission reduction once they reach the deployment stage. At the same time, given limited public budgets, innovation expenditures need to be ranked so that the most promising are selected first.

More *mature technologies* with a large expected potential need to be brought to competitiveness quickly to reach 2020 objectives. The allocation of funds among technologies (i.e. "Industrial Initiatives") and within Technology Roadmaps should be based on detailed quantitative cost-benefit analyses building on objective estimates of technology success probabilities and the likely cost of $CO_2$ saving. Regular updates of the allocation of available funds within allocation periods, taking into account knowledge gains, are important. As the probability of success of particular technologies increases, funds should be more concentrated on that technology and competition among alternative research paths, at least at the level of substantial funding, becomes less relevant.

*Immature technologies*, which have the potential to play an important role in the future technology mix to achieve 2050 climate objectives, require more guidance and support in the research strategy. Project evaluation typically will be based on ordinal rankings according to the expected project contribution to the cost of $CO_2$ emission reduction, taking into account that early research mainly generates options for new low C technologies. Very high predicted $CO_2$ savings potential, and/or very cost-effective carbon reduction potential, in the event of successful innovation can justify the acceptance of rather low success probabilities and/or delays in the achievement of technological milestones. The lower the projects' success probabilities for a given expected benefit (probability of success times the value if successful), the more research path options should be investigated in parallel.

**Cooperation among innovators** (or their supporting Member States) might be needed to support worthy but higher-cost projects that otherwise would not be undertaken (fusion is the obvious example). For projects whose returns are subject to very high uncertainty, which involve large investments and address low-maturity technologies, coordination of RD&D activities among Member States and between them and the EU (joint programming) is recommended where that facilitates agreements for increased funding, since these projects can represent a challenge even for the bigger Member States. An agreed and committed centralized research strategy combined with committed funds can provide the necessary assurance to support this kind of R&D and capture the resulting knowledge spillovers for public benefit.

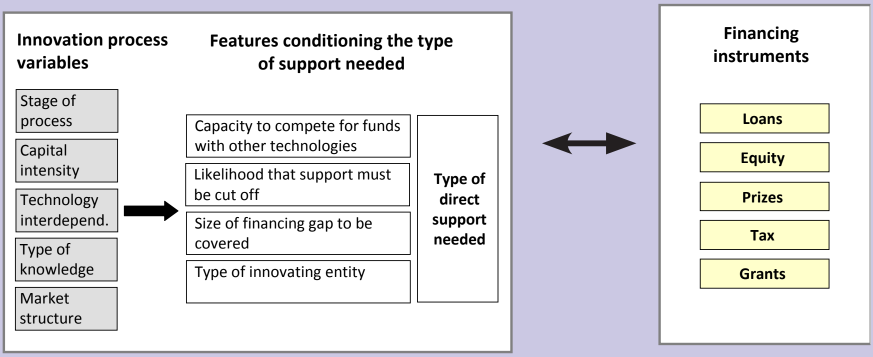
RD&D support takes place both in a decentralized manner on a Member State level as well as via a centralized distribution of EU and pooled Member State funds. However, support programmes are currently poorly coordinated if at all – neither between different Member States nor between them and the EU. This reduces the chances of agreed increases in collective funding, restricts knowledge sharing, and increases the likelihood of duplication of similar research that may fail to exploit potential benefits from economies of scale and scope via a pooling of resources and active networking. In order to achieve the SET Plan objectives, **cooperation and coordination among Member States and the EU to increase support for RD&D and to ensure its efficient deployment is needed**. The initiation of European Energy Research Alliances – aimed at conducting pan-European RD&D by pooling and integrating activities and resources, combining national and EU sources – is a step into the right direction. Their successful implementation should be fostered and progress monitored.

## Choosing appropriate financing policy instruments to induce innovation

**RD&D support instruments**. Direct support instruments should be designed to close the gap between the cost of innovation and funds private parties are willing to contribute in the least cost way. That requires tailoring their features to the characteristics of the innovation. Different forms of support (i) might be able to target specific technologies (public loans/guarantees, public equity, subsidies in the form of prizes, grants or contracts); (ii) show the required flexibility in (re-)directing funds to alternative innovation projects (which may be more difficult for public loans than for subsidies to RD&D investments); and (iii) might be better suited to support certain types of innovating entity. The aim of support is to maximize the amount of RD&D that can be publicly funded by leveraging private sector funding as far as possible, given the stage of project maturity. Box 2 summarises the analytical framework developed to select the form of low-carbon support.

*Public loans* are well suited to finance lower cost innovations with well quantifiable future market prospects carried out by large companies. They become relevant if the liquidity of the capital market is low or if the innovation targeted is related to activities where the public sector is more experienced. Public loans are also attractive in recessions when private credit markets' appetite for risk is unduly depressed. *Publicly owned equity* is suitable for financing risky but potentially profitable innovations, particularly if undertaken by small firms who lack access to the capital market (although one should check whether there is an important market failure in the supply of business "angels"). These investments should be of modest size, though they may be used to marginally fund expensive innovation to signal that it has a high potential. Subsidies in the form of *technology prizes* can be used to fund early low-cost innovation preferably undertaken by universities and research institutes. *Tax credits* and other *benefits related to RD&D investments* are best suited to support near-market, incremental innovation conducted by large companies. *Grants and contracts* – on the one hand the most attractive form of support from the innovators' perspective but on the other the most expensive instrument – should only be awarded to socially desirable clean energy innovation that would not be undertaken otherwise and where all other instruments would fail. This is clearly the case for most early-stage, capital-intensive processes as well as for many other pre-deployment RD&D activities.

**Box 2: Analytical framework for selecting support instruments**




Social welfare should be maximized by (i) matching the type of support needed with the support provided by instruments at lowest public cost; and by (ii) choosing the design of support instruments to avoid 'funding failure'.



**Support should be provided in a way that encourages efficiency while not discouraging private sector participation**. This implies that first, competition for funds should be used whenever possible in order to set incentives for high efficiency in RD&D and to minimize public intervention. The public sector should avoid having to identify 'winning technological options' and instead leave these decisions to the industry. Second, public funding should be output-driven providing that does not unduly discourage the engagement of innovators. This involves making the release of funds and their amount conditional on the achievement of some minimum objectives; i.e. linking support to performance. Funds should be provided either after a project's successful conclusion or sequentially based on the achievement of intermediate objectives in order to allow for early termination if the project is not delivering expected results or for a re-orientation if that improves the chance of success.

High initial project costs may require releasing at least part of the funding up-front. For low-risk projects this could be done on condition that funds are returned if the project is not undertaken as agreed. Support to projects with a low chance of success (but nevertheless sufficiently attractive if successful) are unlikely to warrant performance-based payments if they are to attract private investment (especially relevant for immature/early-stage capital-intensive innovation).

Finally, the institutions set up to allocate funds to clean energy RD&D should be lean and flexible enough to avoid institutional inertia and lock-in, which make it hard to reallocate funds when it becomes clear that the original projects turned out to be less promising than expected and other projects now look more promising. Staff on secondment or with limited contracts provides flexibility, while bureaucracies tend to be self-perpetuating. The risk of financial lock-in is especially high for early-stage immature technologies which appear to need a long learning period (but which may nevertheless reveal their poor prospects at an earlier stage).

TOPIC 2

# Smart Cities Initiative: How to Foster a Quick Transition Towards Local Sustainable Energy Systems

**Project Leader:** Eduardo de Oliveira Fernandes
**Research Team Leader:** Leonardo Meeus
**Research Team:** Vitor Leal, Isabel Azevedo, Erik Delarue, Jean-Michel Glachant
**Project Advisors:** Christian von Hirschhausen, Pantelis Capros

## Highlights

- The EU is subscribing to the international trend of local governments becoming more involved in climate change policy-making and higher levels of government encouraging this trend. With the Covenant of Mayors, the EU has already been successful in voluntarily committing city authorities to reduce their $CO_2$ emissions by at least 20% by 2020. The ambition of the Smart Cities Initiative is to speed up the transition towards local sustainable energy systems.
- A portfolio of smart cities that represents the population of European cities should be selected, consisting of cities with different geography/climate context, different energy fundamentals, a different political economy, and different institutional capacities.
- The cities in this portfolio need to be given the institutional flexibility (human and financial resources) to conceive and manage the implementation of concepts of city smartness, i.e. to lead by example (first level of city smartness: city as a public actor), to govern the actions by the private urban actors (second level of city smartness: city as a local policy maker), and to promote an integrated approach (third level of city smartness: city as a coordinator).
- To have an impact, the initiative needs to establish a strict performance reporting methodology (currently, city pioneer experiences are difficult to compare or replicate because of a lack of reporting, and pioneers that do report, use very different reporting methodologies), which would allow the creation of a good-practice forum or register.
- An EU level legislative initiative to require all cities to report about their progress or lack of progress is also recommended to further improve the impact of the initiative.

## Background

Currently, about four out of five Europeans live and work in a city, with the share of energy use in cities being about the same. A global solution for climate change, even if achievable, would rely on the participation of these citizens so that it is essential to have policies at multiple levels, including at city level. Therefore, if the EU is to meet its energy and climate objectives, cities will need to become "smart".

In the urban environment, the opportunities to improve the sustainability of a city as an energy system include:

- 1// opportunities within the building stock (such as thermal retrofit of the envelope and the use of solar thermal for domestic hot water);
- 2// transport and mobility opportunities (such as the shift from individual to collective modes of transport);
- 3// city management opportunities (such as the shift among energy carriers).

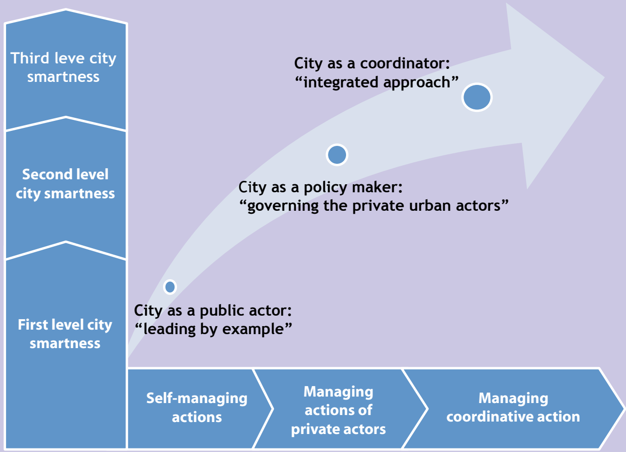
In what follows we discuss what makes a city smart and what makes a city initiative smart, respectively.

## What makes a city smart?

The term "Smart City" is commonly used, and depending on the sources, the term is associated with friendliness towards the environment, use of information and communication technologies as tools of (smart) management, or sustainable development. With regard to the achievement of the EU energy and climate objectives, cities can be "smart" in three ways (Box 1).

- 1// cities are actors themselves that can lead by example, e.g. public buildings and public procurement at the local level.
- 2// cities are policy makers that can govern the actions by private actors, e.g. via building codes, city entrance or parking charges, and land-use regulations.
- 3// cities are coordinators that can conceive and manage the implementation of an integrated approach.

**Box 1: Concepts of city smartness**




Thanks to a combination of local circumstances and interventions by higher levels of government increasing the awareness of local governments, enabling action by local governments, or requiring action by local governments, several examples exist of city pioneers that have already implemented the different levels of city smartness (Box 2).



**Box 2: Examples of city pioneers implementing the three levels of city smartness**

**First level of city smartness**: A well-know example is the opportunity cities have to lead by example in refurbishing public buildings such as offices, schools, hospitals and social housing to stimulate local businesses to develop so that it becomes easier for private actors to follow. Note that demand for space heating and cooling in buildings corresponds to 20% of the final energy use in the EU, and 75% of today's building stock will still be around in 2050.

**Second level of city smartness**: A well-known example is the opportunity cities have to use land-use regulations to improve city compactness. Compact cities have lower emissions from transport because their inhabitants travel smaller distances, but also because compactness is essential to create a critical mass for efficient collective transport systems. Copenhagen is an interesting example where the city authority planned densely developed fingers sticking out of the city with green areas in between to allow for a better development of the public transport system.

**Third level of city smartness**: A well-known example is the Covenant of Mayors. Cities that sign the Covenant are required to develop a baseline emissions inventory, set targets, list a set of actions to reach the targets, and report progress, with the build environment, the local energy networks, and the urban transport systems integrated in one plan.

## What makes a city initiative smart?

A city initiative is smart if it 1// addresses the institutional disincentives of cities to act; 2// accounts for the heterogeneity of cities in Europe; and 3// harmonizes the reporting methodologies that are currently being used by city pioneers.

### 1. Cities' institutional disincentives

Cities have institutional disincentives to take action, which can be simplified into "not in my term" and "not my business". And if they do take action, cities are confronted with private urban actors that are reluctant to follow. Considering that most of the initiatives part of the Strategic Energy Technology Plan and the European Economic Recovery Plan are already focusing on addressing the reluctance of actors to research, develop, and demonstrate sustainable measures, the Smart Cities Initiative fills a gap by focusing on city authorities as institutions and support them to become institutions that will accelerate rather than slow down the uptake of sustainable measures in the urban environment.



### 2. Heterogeneity of European cities

European cities are heterogeneous in their fundamentals that determine the consumption of energy services and the associated emissions (e.g. the urban form, the climatic zone, the availability of local natural resources and the socio economic conditions); their political economy (e.g. presence of a harbor, heavy industry, or car manufacturing industry); and their institutional capacities (i.e. human and financial resources, and legal and regulatory powers), which depend on the size of the city and on the multi-level governance structure the city is subject to.

It is therefore not enough to support existing pioneers for what they are already doing. The Smart Cities Initiative should encourage existing pioneers to conceive and implement integrated approaches, for instance combining city-scale infrastructure demonstrations that enable a smarter use of energy with actions by city authorities to ensure the use of the associated services (third level of city smartness), while the initiative should also support cities in clusters of groups of European cities where pioneers have not yet emerged.

### 3. Reporting methodologies

With the Covenant of Mayors, Europe is successful at voluntarily committing cities to follow an integrated approach using a common methodology, but this is only for cities that are willing to move, and the methodology allows cities to maneuver in how they measure and report progress so that it is difficult to compare performance and derive good practices.

It is a known problem that cities use different approaches in defining what sectors to include in their reporting, in establishing the city boundaries, as well as in aggregating data so that it is difficult to compare cities and replicate their achievements.

## Recommendations



Despite differences in institutional capacities, local governments currently have in common that they are not yet using their capacities, as they have institutional disincentives to act towards a more sustainable future. While if they do act, they might be confronted with urban actors that are reluctant to follow.

We recommend that a portfolio of smart cities is carefully selected and supported by the Smart Cities Initiative to increase the excellence of the current pioneers, while also giving opportunities to groups or clusters of cities with a promising potential, but where pioneers have not yet emerged.

We also recommend establishing a strict performance reporting methodology, which would allow the creation of a good-practice forum or register. An EU level legislative initiative to require all cities to report about their progress or lack of progress would later improve the impact of the initiative. This would allow cities with a large potential that are not yet moving to be identified.

TOPIC 3

# Transition Towards a Low Carbon Energy System by 2050: What Role for the EU?

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## Highlights

– The European Commission recently released a first roadmap that already indicates what could be the relative contributions of the different sectors to reduce greenhouse gas emissions 80 to 95% below 1990 levels by 2050, which is setting the scene for new EU level policy actions. A second roadmap should be released by the DG Energy 2050 later this year, 2011.

– Different stakeholders have already presented their vision of the path towards 2050 and different strategies to make it happen are emerging at member state level, which bring new risks for policy fragmentation, but also open new opportunities for cooperation among member states and for European added value.

– We provide a rationale for ten priority EU-interventions to add European value to member states' first steps on the road towards 2050. We distinguish three different types of EU involvement to 2050, i.e. "effort sharing", "harmonization", and "level playing field".

## DG Energy 2050 Roadmap

Following the European Council's target to reduce greenhouse gas emissions 80 to 95% below 1990 levels by 2050, the European Commission recently released a general roadmap that already indicates what could be the relative contributions of the different sectors. This is setting the scene for new EU level policy actions. In the policy area of transport, there is already a follow up roadmap which formulates priority actions.

We want to address the area of energy.

In what follows, we derive recommendations for the 2050 energy roadmap by addressing three questions. What are the key 2050 policy challenges? How are Member State pioneers dealing with these challenges? What is the role of the EU in addressing these common 2050 challenges?

## What are the key 2050 policy challenges?



Several stakeholders have presented visions of the low-carbon energy system they desire for 2050.[1] There are six key 2050 policy challenges to achieve these visions.

**Box 1: Main energy policy challenges**

| |
|---|
| **Energy efficiency**<br>Ambitious energy savings |
| **GHG emissions**<br>Decarbonisation the electricity sector |
| **Renewable energy**<br>Ambitious renewable energy penetration levels |
| **Energy infrastructure**<br>Electricity grid adequacy (expansion and smartening of the grid) |
| **Internal energy market**<br>Electricity supply security (timely investments and system flexibility) |
| **Technology innovation and R&D**<br>Technology development is a precondition for most of the above challenges |

1. We analyzed the visions of the European electricity industry association Eurelectric, representatives of the European gas industry (Gas Advocacy Forum), the European Climate Foundation, the International Energy Agency and a non-governmental environmental organization in cooperation with an association of the renewable energy industry (EREC/Greenpeace).

## How are Member State pioneers dealing with these challenges?

Several EU member states are already dealing with the key 2050 policy challenges, while they are in different stages of the political process. The Danish, German, and Irish governments have explored the policy options but the resulting strategies have not yet been legislated. In Finland, France, and the UK, a legal commitment has already been reached. The UK is the only member state that has reached the implementation stage of its legally binding 2050 strategy.

These **diverse strategies** emerging at member state level bring new risks for policy fragmentation, but also open new opportunities for cooperation among member states and for European added value. An example of possible **policy fragmentation** is the decision of the UK government to introduce a national carbon price floor for electricity generation from 2013 onwards. Another example is the possible introduction of purely national "generation capacity" mechanisms to address locally the security of electricity supply concerns in France and in the UK. However, an example of **new opportunities for cooperation** among member states is the apparent will of pioneering member states, such as UK or Germany, to further integrate their electricity transmission grid to enable their low-carbon energy strategies.



Pioneering member states have also in common the establishment of a **procedure to track progress** to allow the adaptation of their policies on the road towards 2050. For instance in France, the legislation foresees that the French government will need to report on the status of the implementation of its policy on a yearly basis. Also in Germany, the strategy foresees that the government will need to monitor and report on progress every three years. In the UK, the Committee on Climate Change makes an annual progress report, and the government is also required to present regular reports on progress. These reports have advocated stronger measures.

## What is the role of the EU in addressing these common 2050 challenges?

We have to distinguish three different types of possible EU involvement (Box 1) to derive beneficial EU actions to address the key 2050 policy challenges. A case-by-case approach is necessary because the potential value added created by the different types of EU involvement greatly differs in each policy area. In some areas, a combination of all the three types of EU involvement can be promising, while in other policy areas it seems more appropriate to focus on one type of EU involvement. The only rationale criterion is the actual value added to reach the 2050 targets.

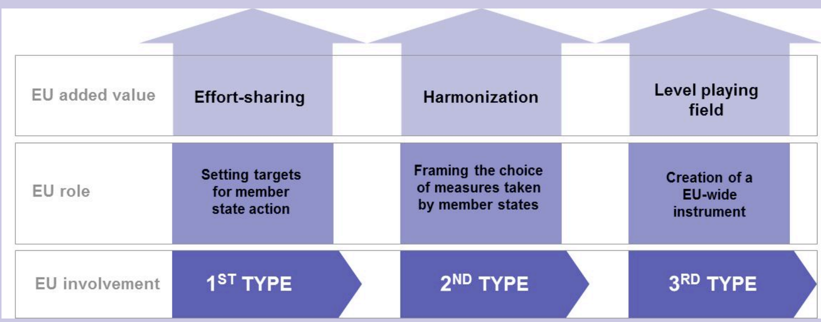
**Box 2: Case by case approach to derive promising European policy options**

**First type of EU involvement**: ("effort sharing" by setting binding targets for member state action). It can create EU added value when there is a common European interest that will not be pursued or that will be achieved too slowly/costly if not all member states contribute.

**Second type of EU involvement**: ("harmonization" by framing the choice of measures taken by member states). It can create EU added value when there is policy fragmentationand this situation is costly due to incoherence.

**Third type of EU involvement**: ("level playing field" by creating an EU-wide instrument). It can create EU added  value when a single approach is beneficial, and there is strong enough agreement among member states on what this most appropriate instrument is.






## Energy efficiency

1) *Making energy saving targets binding* is a promising first type of EU involvement ("Effort sharing"). The transition costs to 2050 are very sensitive to the energy saving ambitions. Moreover, there is a history of indicative energy saving targets not being achieved; and there is an increased risk of locking-in into energy inefficient technologies and assets with a long lifetime. This could be addressed by setting binding energy savings targets for 2020 and beyond (overall targets as well as sector specific targets).

2) *Mobilizing cities towards a low carbon future* is a promising second ("Harmonization") and third ("Level playing field") type of EU involvement. Measuring and report-

ing tools for cities could indeed be harmonized (second type), which would allow an EU city benchmarking so that cities are required to report about their progress or lack of progress (third type).[2]

### GHG emissions

3) *Strengthening the carbon price signal* is a promising first ("Effort sharing"), second ("Harmonization"), and third ("Level playing field") type of EU involvement. Binding GHG reduction targets beyond 2020, i.e. more stringent and credible long-term caps (first type); coherence between carbon pricing and renewable energy instruments (second type); and an EU carbon market repository, platform, and authority for EU-ETS are indeed complementary ways to strengthen the carbon price (third type).

### Renewable energy

4) *Integrating renewable energy technologies into the internal electricity market* is a promising second type of EU involvement ("Harmonization"). The massive deployment of renewable energy will indeed have a major impact on the electricity market, also due to the fact that this market will be more and more European. The natural support schemes for renewable energy could therefore be at least market conform in the sense that they could expose renewable technologies to wholesale market price signals.

5) *Creating a level playing field for renewable energy cooperation with non-EU countries* is a promising third type of EU involvement ("Level playing field"). The massive renewable energy sources just outside EU borders, in the Mediterranean area, are indeed attractive to develop in the 2050 context. Creating a level playing field for cooperation with these non-EU countries would help to progress these multilateral projects. This could be done by creating common bodies of Mediterranean regulators and transmission companies, as well as an EU RES trade platform for the Mediterranean.

### Energy infrastructure

6) *Harmonizing the regulation of distribution and transmission grids* is a promising second type of EU involvement ("Harmonization"). Smart grids indeed need smart regulation.[3] Regulators could for instance be mandated to enable the transition (e.g. supporting innovation in a Europeanization process) rather than being only responsible

2. See THINK Final Report Topic 2 "Smart Cities Initiative: How to Foster a Quick Transition towards Local Sustainable Energy Systems." and FSR Policy Brief Issue 2011/02 January 2011 on smart cities.
3. See FSR Policy Brief 2010/01, June 2010 on Smart grids.

for improving the cost efficiency of grids.

7) *Establishing an EU infrastructure investment cost recovery instrument* is a promising third type of EU involvement ("Level playing field"). The existing European cost recovery instruments are indeed inadequate, while transmission expansion is crucial to enable the transition. An EU regulated asset base for key European interconnections paid by an EU tariff component would be an advanced solution, while a reduced alternative could be to have an inter-TSO fund for key European infrastructure investment. Such a scheme exists already for costs compensation; and it has shown that it is too difficult for European stakeholders to find a consensus among them so the new financial scheme would need to be set at the EU level by an independent third party.

**Internal energy market**

8) *Creating an internal balancing market* leads to a promising first ("Effort sharing"), second ("Harmonization"), and third ("Level playing field") type of EU involvement. The existing stakeholders visions have in common that they project ambitious grid expansions across borders. This reduces the need for back-up capacity, but only if there is an internal balancing market, while today these real-time markets are mainly national in scope. The reservation costs of balancing services would need to be shared (first type), the services would need to be harmonized (second type), eventually leading to a level playing field with an EU internal balancing market code (third type).



9) *Harmonizing security of electricity supply mechanisms* is a promising second type of EU involvement ("Harmonization"). Regulators have indeed expressed concerns that Security of Supply measures are still mainly national in scope, and that possible external effects on neighboring countries and markets are often not considered. Harmonization could, for instance, include the provisions to permit demand resources to be able to participate in these balancing on equal footing with generation, which is not the case with existing conventional mechanisms.

**R&D**

10) *Complementing the Strategic Energy Technology Plan* (SET-Plan) is a promising third type of EU involvement ("Level playing field"). The plan is currently industry focused and based on a bottom-up approach; and so it needs to be complemented by a more top-down approach from a European point of view. An extended SET Plan should prioritize projects proposed by different industries and also improve the bal-

ance between early innovation to create new options and later stage innovation to push the most promising options into the market.[4]

## Recommendations

### Track progress

The path towards 2050 requires a continue following-up of investments and choices made by private actors, as well as policy implementation by policy makers, similarly to what several pioneering member states have already started doing at the national level.

**Ten priority EU-interventions to add European value to Member States' 2050 first steps**

| Reccomandations for the DG Energy 2050 roadmap | Type of EU involvement | | |
|---|---|---|---|
| | 1st | 2nd | 3rd |
| 1) Make energy saving targets binding | √ | | |
| 2) Mobilize cities towards a low carbon future | | √ | √ |
| 3) Strengthen the carbon price signal | √ | √ | √ |
| 4) Integrate renewable energy technologies into the internal electricity market | | √ | |
| 5) Create a level playing field for renewable energy cooperation with non-EU countries | | | √ |
| 6) Harmonize the regulation of distribution and transmission grids | | √ | |
| 7) Establish an EU infrastructure investment cost recovery instrument | | | √ |
| 8) Create an internal balancing market | √ | √ | √ |
| 9) Harmonize security of electricity supply mechanisms | | √ | |
| 10) Complement the Strategic Energy Technology Plan (SET-Plan) | | | √ |



4. See THINK Final Report Topic 1 "Public Support for the Financing of RD&D Activities in New Clean Energy Technologies" and FSR Policy Brief Issue 2011/01 January 2011 on RD&D.

TOPIC 4

# The Impact of Climate and Energy Policies on the Public Budget of EU Member States

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## Highlights

– In the current context, where public budgets are overstretched due to the economic crisis, there is a pressing need to understand the fiscal implications of climate policies. Policies intended to achieve decarbonization will impact both sides of a country's budget via changes in the tax levels and composition of taxes on the one hand, as well as transfer payments and direct investments on the other.

– Back-of-the-envelope calculations – comparing net public revenues in 2020 for a Baseline and an Enhanced Policy scenario – show that the additional revenues from carbon pricing and the reduction in revenues from excise taxes on fossil fuels clearly dominate other direct and indirect effects of policies on public budgets such as the additional expenditures dedicated to RD&D targeting low-carbon technologies.

– The aggregated net budget impact of all direct and indirect effects of new climate policies implemented in the Enhanced Policy Scenario on public budgets in 2020 for the EU-27 as a whole – given our simplyfying assumptions – amounts to additional net public revenues of about €12.6bn (0.09% in terms of the EU-27 GDP) under medium-level abatement costs. This makes a non-negligible impact which is nevertheless much lower than the impact on public accounts from changes in main macroeconomic variables over time.

– Differences among Member States mainly depend on the additional revenues they will obtain from carbon pricing, which are driven by three main factors: the carbon-intensity of the economy, which is positively correlated with the absolute value of the net budget impact of new policies; the share of non-ETS GHG emissions, which is positively correlated with the net budget impact; and the reduction in GHG emissions resulting from new policies, which is negatively correlated with this impact.

– Countries most significantly affected, both positively and negatively, are among the "new" Member States in the EU-27. In contrast, the impact of new climate policies on large EU-15 economies would be generally positive and typically in line with average EU values. Therefore, authorities from the EU-15 may consider the option of sharing the economic burden of the transition to a low-carbon economy among EU countries, taking into account their economic strength.

## Background

The transition to a low-carbon energy system will impact both sides of a country's budget, i.e. revenues (via e.g. changes in the composition of taxes or tax levels) and expenditures (via transfer payments or direct investments). In the current context, where public budgets are overstretched due to the economic crisis, there is a pressing need to understand the implications of climate policies on the fiscal situation. Climate policies increasing public revenues could help to reduce state debt, while policies significantly increasing public expenses could be difficult to implement.

To combat climate change and reduce energy import dependence, the European Council in 2007 agreed on "20-20-20" climate and energy targets to be met in the mid-term. The climate and energy package supporting the achievement of these targets came into law in 2009 (see Box 1). Our policy brief summarizes the main findings of a quantitative study we made to investigate the impact of the EU 2020 climate objectives on the fiscal balance of Member States in the year 2020.



**Box 1: Climate and energy policy package**

The so called 20-20-20 targets, on which the European Council agreed in 2007 include a// a reduction of EU greenhouse gas (GHG) emissions by at least 20% with respect to 1990 levels; b// meeting a minimum of 20% of EU energy consumption using renewable resources (RES); and c// the reduction of EU primary energy use by at least 20% compared to projected levels. The respective policy package came into law in 2009. It includes both a strengthening of policy tools already available and the implementation of new instruments, standing mainly on three pillars: 1// a revision and strengthening of the emissions trading system (ETS; Directive 2009/29/EC); 2// an Effort Sharing Agreement governing GHG emissions from sectors not covered by the EU ETS (Decision 406/2009/EC); and 3// binding national targets for renewable energy which collectively will raise the average RES share across the EU to 20% by 2020 with a sub-target of a 10% share in the transport sector (Directive 2009/28/EC).

Hence, whereas there are mandatory targets in place for RES and GHG emissions, the 20% target of a decrease in primary energy use is not yet legally binding. The climate and energy package does not address energy efficiency and energy savings explicitly, even though creating some indirect pressure to reduce energy consumption. However, in December 2010, the European Parliament voted in favor of a binding energy saving target of at least 20% by 2020.

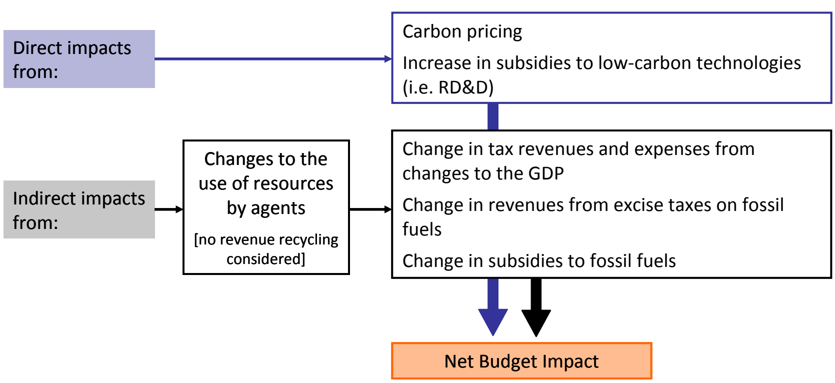
## Climate policies induce both direct and indirect effects

Assessing the impact of new energy and climate policy instruments on public budgets is a key issue both for analytical and policy purposes. Such new policies will directly impact public budgets by generating new revenue and new expenditure flows; governments might obtain additional revenues from carbon pricing and face an increase in expenditures associated with direct public support to RD&D targeting low-carbon technologies (assuming that feed-in tariffs or green certificates are expenses borne by private agents and therefore not affecting the state budget).

In addition to the direct effects, most climate policy instruments will also affect other decisions of individual economic agents on the use of resources, and the economy at large. Those indirect effects are harder to predict. They include changes in state revenues and expenses caused by the impact of climate policy on economic output (both its level and sectoral composition), prices and inflation, production and consumption, unemployment, or interest rates. Particularly relevant for the present purposes appear to be impact coming from the changes in GDP as well as the changes in state revenues from excise taxes on fossil fuels. Figure 1 summarizes all direct and indirect effects of climate policy on public budgets considered in our analysis.



**Figure 1:** Major direct and indirect impacts of climate policy on public budgets




Making use of publicly available data on the future equilibrium of the energy sector of EU Member States, we have determined through back-of-the-envelope calculations the difference between net revenues in 2020 in two situations: a Baseline scenario (mainly including a strengthening of ETS and energy efficiency regulations), and a more ambitious Enhanced Policy scenario (considering additional carbon taxation in non-ETS sectors, further support to RES deployment, and additional energy efficiency regulations)[1]. Computations make use of a number of simplifying assumptions that are necessary to quantify the respective impacts in a tractable way without using too complex simulation models (see Box 2).

**Box 2: Underlying assumptions**

The social cost of replacing high-carbon products with low-carbon ones is assumed to be equal to the costs incurred by industries when abating carbon. Based on this assumption, we estimate the isolated impact that the shift to low-C products will have on national GDPs.
We do not consider changes made to public policies other than climate policy ones. Hence, any recycling of state revenues or the sourcing of state expenses resulting from climate policies are not taken into account; in the same vein welfare (or distributional) effects are not treated.
Given the uncertainty about future levels of carbon abatement cost, we consider three different possible futures corresponding to three different abatement cost levels. Based on information in the literature and making use of simplifying assumptions, we have derived the level of carbon prices to be applied in each future and in our two respective policy scenarios:

| | Baseline scenario | Enhanced policy scenario |
|---|---|---|
| Low abatement cost [interval between zero and 45€/t$CO_2$ differing among MS] | ETS auction price of €25/t $CO_2$<br>No carbon tax for non-ETS sectors | Uniform price of €10/t $CO_2$ [weighted average of prices published in EC (2009) for ETS (€16.5/t $CO_2$) and non-ETS sectors (€5.3/t $CO_2$)] |
| Medium abatement cost [15…60€/t$CO_2$] | ETS auction price of €40/t $CO_2$<br>No carbon tax for non-ETS sectors | Uniform price (weighted average of prices in ETS and non-ETS sectors) of €25/t $CO_2$ |
| High abatement cost [30…75€/t$CO_2$] | ETS auction price of €55/t $CO_2$<br>No carbon tax for non-ETS sector | Uniform price (weighted average of prices in ETS and non-ETS sectors) of €40/t $CO_2$ |

1 These scenarios are reported in EC (2009, "EU Energy Trends to 2030"). Parameters characterizing the energy sectors of all 27 EU Member States in 2020 have been computed by a consortium led by the National Technical University of Athens (E3MLab) using the PRIMES and GEM-E3 models.

Among direct effects considered, additional revenues from carbon pricing clearly dominate the additional expenditures dedicated to RD&D targeting low-carbon technologies. Net public revenues in the year 2020 directly generated by climate policies applied in the Baseline scenario range between €52 and 123bn for the EU-27 as a whole depending on the carbon abatement cost level considered. Net incremental public revenues directly stemming from the application of new policies in an Enhanced Policy scenario range from a maximum of €71bn (0.55% in terms of the EU-27 GDP) in the case of high abatement costs, to a negative value of -€10bn (-0.06% of GDP) if abatement costs are low. Reaching a given objective in terms of emission reductions requires the application of higher carbon prices the higher carbon abatement costs are. This would result in higher revenues from carbon taxes and from the auctioning of ETS allowances, and therefore a more positive change in the net public budget given a level of innovation subsidies.

Within the indirect effects of the policies applied in the Enhanced Policy scenario, the most relevant ones are the decrease in excise tax revenues from fossil fuels and the decrease in tax revenues related to the impact of these policies on GDP. Changes in state revenues associated with changes in GDP probably are the main factor driving differences among countries. The overall net indirect impact of new policies ranges from a decrease in net public revenues in the EU-27 equivalent to 0.03% of the EU GDP (for low carbon abatement costs) to a decrease equivalent to 0.23% of the EU GDP (for high abatement costs).



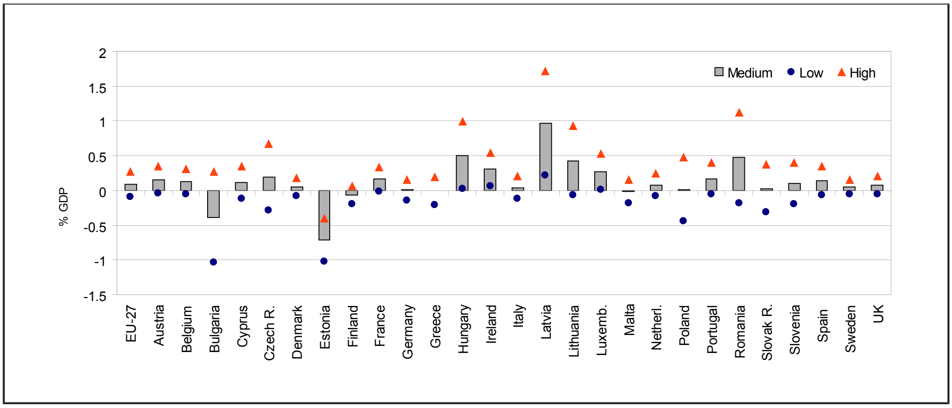
Given the assumptions made, all considered direct and indirect effects of new climate policies amount to a net increase in the public revenues of the EU-27 in 2020 of about €12.6bn (0.09% of the EU-27 GDP) for medium abatement costs. This makes a non-negligible impact which is nevertheless much lower than the impact of changes in main macroeconomic variables over time. The main factors contributing to the overall impact are the additional revenues from carbon pricing, the decrease in revenues from excise taxes on fossil fuels and that of revenues from general taxes caused by the impact of the new policies on GDP. Differences among countries are mainly related to differences in carbon pricing revenues, which are driven by three main factors: 1-the carbon intensity of the economy, which is positively correlated with the absolute value of the net budget impact of new policies; 2-the share of non-ETS GHG emissions, which is positively correlated with the net budget impact; and 3-the reduction in GHG emissions resulting from the new policies, which is negatively correlated with this impact.[2]

## Is there any need to support the EU climate policy implementation through cross-country burden sharing?

The impact of new climate policies on state budgets varies widely across countries (see Figure 2). Countries most significantly affected, both positively and negatively, are among the "new" Member States. Notably Bulgaria and Estonia are the two countries that, given our assumptions, could experience a decrease in net public revenues larger than 0.5% of their GDP in some of the scenarios considered. Both are countries with a small and highly carbon-intensive economy and a low GDP-per-capita. Thus, implementing ambitious climate policies in these countries may require external support. "New" Member States whose public accounts may be most positively affected by the implementation of new climate policy measures in any scenario are Hungary, Latvia, Lithuania, and Romania. If abatement costs are high, these countries could experience an increase in their net state revenues representing more than 1% of their GDP. The economies of these countries are also carbon-intensive and their GDP-per-capita is low. Thus, extra state revenues should be employed to their own country benefits instead of supporting the "losers" in the decarbonization process.



**Figure 2:** Net Budget Impact of new policies




Source: Own calculation assuming three levels of carbon abatement costs (high - medium - low)

2. Computed values have to be regarded with due reason; the absolute level of the budget impact of new climate policies in the Enhanced Policy scenario is quite sensitive to assumptions made within this analysis. However, our analysis allowed us to determine the order of magnitude of the main effects of new climate policies on public budgets. Besides, relative differences among countries (in the impact of new policies on their net public revenues) seem to be robust.

In contrast, the impact of new climate policy instruments on large economies from the EU-15 is expected to be relatively small, generally positive, and typically in line with average EU values. Taking into account their economic strength, state authorities may consider the option of sharing the economic burden that the transition to a low-carbon economy may represent for those countries most negatively affected.

Finally, the new climate policies have to be financed in a context of substantial budget adjustments necessary to correct large short-term deficits and to avoid an explosion of debt in the long-term. Therefore public finance variables like the fragility of state budgets, the level of fiscal pressure and the expected growth of economies may affect the implementation of climate policies. The higher the financial fragility of a country, the more difficult the implementation of expensive climate policies may be, while stronger expected growth rates could provide more room for the latter.

TOPIC 5

# Offshore Grids: Towards a Least Regret EU Policy

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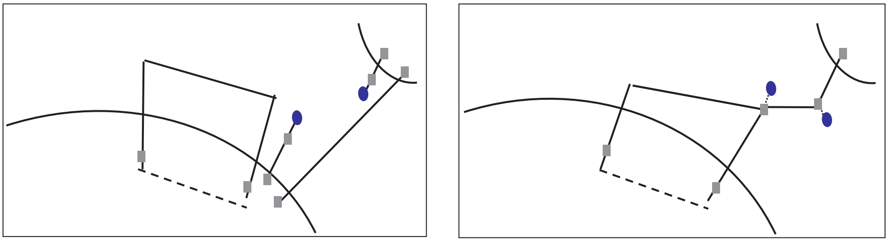
## Highlights

- The objective of the 5th report of THINK has been to formulate policy recommendations to the European Commission (DG Energy) on offshore grids, and this brief is derived from that report.
- The development of an offshore grid is able to play a significant role in the accomplishment of the EU energy and climate objectives. The total installed capacity of offshore wind farms is expected to increase from the existing 3 GW to about 40 GW by 2020. The number one priority project in the recently proposed EU infrastructure package is the Northern Seas offshore grid.
- There are two possible offshore grid developments (Figure 1): there could be a multiplication of standalone lines, which already exists today; or there could also be a transition towards combined solutions, which requires more advanced grid technology than what is currently on the shelf. The first would correspond to an increase of shore to shore investments to exchange energy across borders or to relieve congestion within an onshore grid, and an increase in farm to shore investments to connect offshore wind farms to the existing onshore grid. The second instead would imply mixed investments, combining the connection of offshore wind farms with the creation of interconnection capacity.
- The potential for EU added value depends on which of these alternative offshore grid developments will prevail. The economic case for combined solutions is still uncertain, but regulation needs to be proactive to avoid compromising this possible offshore grid development. It means that we have to address the fact that the currently mainly national regulatory frames for farm to shore and shore to shore investments are unsound, and the difficulties to design and develop combined solutions are tremendous.
- We recommend the European Commission to take initiatives to: 1// harmonize into economically sound regulatory frames for offshore transmission investments; 2// harmonize the renewable support schemes for offshore wind farms; 3// facilitate the ex-ante allocation of costs and benefits of offshore transmission investments; 4// speed-up offshore grid technology development; 5// adapt the Community-wide transmission planning to offshore grids, while also allowing regionalized solutions for the implementation of some of these remedies.
- A least regret EU policy on offshore grids indeed also implies giving a chance to regional initiatives, such as the North Seas Countries' Offshore Grid Initiative.

**Figure 1:** Alternative offshore grid developments




(Legend: • wind farm; ■ converter station; — HVDC cable; - - HVAC)

## Standalone lines

There are two types of standalone lines, i.e. shore to shore to exchange energy across borders (with a so-called interconnector) or to relieve congestion within an onshore grid (with a so-called bootstrap), and farm to shore to connect offshore wind farms to the existing onshore grid.



### Shore to shore

The economic features (i.e. the network externalities, cost and technology uncertainties, and economies of scale) of shore to shore investments are similar to onshore transmission expansions so that the regulatory frame offshore can be the same as onshore. The currently mainly national regulatory frames that apply to these investments are however economically unsound, i.e. they do not follow the three guiding principles to minimize the total investment cost of transmission and generation.

1. **Planning principle**: Planning is about coordinating transmission expansions with the demand for transmission, taking into account the strong economies of scale and network externalities of transmission investments. The most common procedure is that the Transmission System Operator (TSO) presents the costs and benefits of the proposed investments to the regulator who then decides which projects to approve. Despite the strong interdependencies between national grid investments, planning is currently done mainly at the national level, except for an indicative Community-wide planning procedure that has recently been introduced.

2. **Competition principle**: Tendering can be used to introduce competition, which is especially opportune when there are cost and technology uncertainties. Ten-

dering for the participation of third parties in part of the investment decisions incentivizes innovation and reduces the problem of information asymmetry between the TSO doing the planning and the regulator. Note that transmission expansions onshore, contrary to offshore, are typically incremental investments in an existing grid, which can be many small investments that are more difficult to delegate. The coordination cost of tendering could therefore be higher than the potential gain from adding competition, but an element of competition can also be added by allowing third parties to propose projects to the regulator so that the TSO can be contested. This is currently only possible for merchant projects, while it is also being considered for regulated projects in the UK.

3. **Beneficiaries pay principle**: Making the beneficiaries pay is important to signal the costs of their demand for transmission services. A combination of transmission access rights (making users of a line pay) and transmission tariffs (sharing costs among grid users) needs to be used to allocate costs to beneficiaries. Transmission tariffs are however national, while these types of projects create winners and losers beyond national borders. The ex-ante allocation of costs and benefits of offshore transmission investments is currently not facilitated at EU level, while it is clearly needed. The infrastructure package that has recently been proposed by the European Commission is a step in this direction.



### Farm to shore

The national regulatory frames to connect a generator are economically unsound. This was already a problem onshore, but is especially problematic offshore because the economic features of the investment to connect a generator can be stronger offshore than onshore, especially for the most recent development of farm-to-shore connections (Box 1).

1. **Planning principle**: The commonly used first-come-first-serve procedure to connect generators is not in line with this principle. The potential negative impacts offshore are stronger than onshore due to the significant economies of scale that can be achieved when clustering offshore wind-farms, i.e. to use a single line to connect several wind-farms to shore, and the strong impact that such projects might have on the existing grid (because of their larger scale compared to onshore investments).

2. **Competition principle**: Contrary to this principle, TSOs design and develop

the connection of a generator in most member states. Onshore, the disadvantage is limited due to the relatively limited cost level and limited cost and technology uncertainties of an onshore connection, but this is not the case offshore where connections tend to be more costly and based on less known technologies.

3. **Beneficiaries pay principle**: Regulatory practices in allocating these investment costs differ widely between member states, but so-called super shallow charging whereby the generator almost does not pay for its connection is not uncommon, while the generator is the main beneficiary. Generators that do not pay for their connection, do not have an incentive to proactively participate in connection planning, which is especially a problem offshore because offshore there are more opportunities to reduce the cost of connecting generators with planning.

Offshore wind pioneering member states have recognised the stronger economic features that farm to shore investments can have, and started to adapt their regulatory frames for these investments. The models of Germany, the UK and Sweden are good examples of how the first, second and third guiding principles can be implemented, respectively, but they are economically unsound from the perspective of at least one of the other principles.



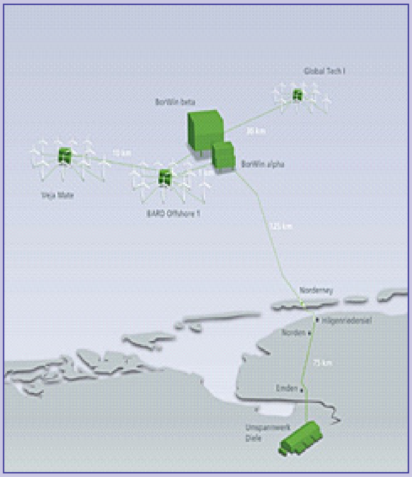
1. **German model**: This is a good example of how advanced connection planning can be implemented. Planning for the impact of offshore wind on the existing grid has been initiated in Germany by the so-called DENA studies, and clustering of offshore wind farms has for instance already been proactively implemented in the Borwin project (Box 1). The model is however far from being perfect because offshore wind farms do not pay for their connection and there is no competitive tendering for the design and/or development of connections.

2. **UK model**: This is a good example of how the competitive tendering can be implemented. Tenders have already been organized in the UK for the ownership and operation of connections developed by offshore wind generators, and they are envisaged to also include the design and development of future connections. The model is also sound from the perspective of the third principle because generators pay for their connection. The inclusion of advanced connection planning in this model is ongoing.

3. **Swedish model**: This is a good example of how the beneficiaries pay principle can be implemented. Generators in Sweden pay for their connection; they are even responsible for designing and developing their connection so that the Swedish model is

also sound from the perspective of the second principle. The model is however misbalanced because connection planning is missing.

**Box 1: Borwin project** *(Source: Tennet)*




**Cost and technology uncertainties**: Because of the large distance from shore, the traditional High Voltage Alternating Current (HVAC) transmission system cannot be used, instead, the lesser known High Voltage Direct Current Voltage Source Converter (HVDC VSC) systems need to be used.

**Network externalities**: There is a strong impact on the existing grid because 1200 MW in total needs to be connected close to shore where the existing grid is weak and often already congested. Note that Borwin will cost about 1200 m Euros, i.e. 400 MW in phase 1 in 2009 and 800 MW in phase 2 in 2012.

**Economies of scale**: HVDC systems consist of a DC cable with two converter stations, one to convert the AC output of the wind turbine into DC, and one to reconvert the DC output of the cable into the AC of the existing onshore grid. By coordinating the connection of three wind farms in Borwin in two phases, only 3 converter stations and once cable to shore need to be used, instead of 6 stations and 3 cables.

## Combined solutions

Combined solutions are mixed farm to shore (connection of offshore wind farms) and shore to shore (creation of interconnection capacity) investments. This type of offshore grid development is an alternative to standalone solutions and implies different recommendations in terms of regulation and EU involvement. Therefore, we first discuss the rationale for combined solutions and then provide recommendations for combined solutions.

### Rationale

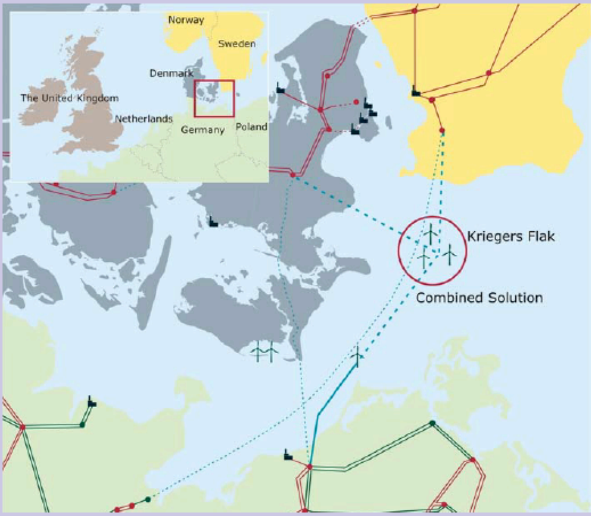
The rationale to combine is the same as to cluster, i.e. the possible reduction in the volume of assets, like in the Borwin project (Box 1). Contrary to clustering, the economic case for combined solutions is however uncertain because this alternative to standalone solutions requires more advanced grid technology than what is currently on the shelves.

In existing HVDC systems, the whole infrastructure stops working if a fault occurs in one of its components. A more sophisticated operation of HVDC systems would require more advanced grid technology that has not yet been tested in practice, i.e. including hardware (e.g. HVDC circuit breakers) and software (e.g. HVDC control systems).

In relatively small offshore grids, like Kriegers Flak (Box 2), it would still be manageable to shut down the entire grid to isolate a fault before reactivating part of it, so that combined solutions might already be opportune today. They may also become opportune on a wider scale in the future, depending on how the advanced grid technology develops.



**Box 2: Kriegers Flak project**




**Project**: the Danish TSO (Energinet.dk), a German TSO (50-Hertz), and the Swedish TSO (Svenska Kraftnätt) studied a combined solution, involving the connection of up to 1600 MW of offshore wind farms in an area that crosses the waters of their countries (Energinet.dk, 2009; E-Bridge, 2010; Jørgensen, 2011).

**Economic case**: The feasibility study argues that in this specific case, there is a net gain, but the study did not demonstrate that the net gain of this combined solution is superior to the net gain of a multiplication of standalone lines: "*It is not within the scope of this pre-feasibility study to make detailed comparisons between a combined solution at Kriegers Flak and other ways of providing additional transmission capacity across the Baltic Sea*."

**Remedies for the key difficulties**

There are five key difficulties to develop combined solutions under the current regulatory frame, which we will illustrate by referring to the Kriegers Flak project (Box 2). For each of these difficulties, we have also identified a remedy:

**1. Harmonizing into economically sound regulatory frames for offshore transmission investments**

Non aligned national frames for transmission investments make it difficult for stakeholders to cooperate in the development of combined solutions. For instance in the case of Kriegers Flak, the Danish and German TSOs are responsible for the interconnectors as well as for the connection of offshore wind farms in their waters, while the Swedish TSO is only responsible for interconnectors. A promising remedy would therefore be to harmonize the national frames towards the guiding principles of an economically sound regulatory frame for transmission investments (see above), which would include more harmonized planning responsibilities.



**2. Harmonizing the renewable support schemes for offshore wind farms**

Non aligned national renewable support schemes for offshore wind farms also make it difficult for stakeholders to cooperate in the development of combined solutions. For instance in the case of Kriegers Flak, this is not necessarily an issue, but the current project design only integrates three national solutions, whereby each country continues to import the offshore wind produced in its waters, which is not necessarily the best design. Therefore, a promising remedy would be to harmonize renewable support schemes for offshore wind farms, or at least to improve their compatibility.

**3. Facilitating the ex-ante allocation of costs and benefits of offshore transmission investments**

Even if the regulatory frames and renewable support schemes were harmonized, the development of combined solutions still requires cooperation between several stakeholders that do not necessarily benefit from this solution. For instance in the case of Kriegers Flak, three TSOs, three wind developers and three national regulatory authorities are involved. This multi-stakeholder setting is problematic because the distribution of benefits of offshore infrastructure is dispersed between many countries and between generators and consumers, with winners and losers that might need to be compensated. A promising remedy would therefore be the facilitation of the ex-ante allocation of the costs and benefits of the investment, which could prompt the implementation of the beneficiaries pay principle for combined solutions.

### 4. Speeding-up offshore grid technology development

The dependency on offshore grid technology development further complicates combined solution projects because this development is hampered by the typical market failures that apply to RD&D. For instance, the technology to use in combined solutions would typically be HVDC VSC, which is relatively new technology that has already been used for standalone lines, but not yet in a combined solution. As mentioned previously, the combined solution systems require more advanced hardware and software that still need to be developed and tested. Therefore, a promising remedy for the required offshore grid technology development would then be to coordinate and speed-up their development.



### 5. Adapting the Community-wide transmission planning to offshore grids

A final complication is that all the above difficulties have to be overcome in a context of uncertainty and irreversibility (e.g. dimensions of the offshore platform, cost of combining HVDC technologies that operate at a different voltage, etc.), while combined solutions are typically phased grid developments. For instance in the case of Kriegers Flak, the complete international solution with all offshore wind turbines spinning, all modules of the grid connection in operation, and electricity being traded, is still some years in the future, while the first building blocks and the most important decisions to enable a combined solution are not that far away. Therefore, a promising remedy could be to do more than only include offshore grid development in a Community-wide connection and transmission plan. We also need to develop new transmission planning methods, for instance to capture the value of investing today to create more options for possible incremental offshore grid investments.

## Recommendations

Our analysis shows that the added value of additional EU policy actions for offshore grids depends on whether the offshore grid will develop as a multiplication of standalone lines or whether there will be a transition towards combined solutions. Therefore, we provide recommendations for standalone lines and combined solutions separately in what follows.

### Standalone lines

Even though there is no need for a specific EU intervention for standalone lines, it is important to continue the following policy actions that are ongoing for grids, onshore as well as offshore:

1) It is important to continue the implementation of the third package, comprising a Community-wide transmission planning that already includes shore to shore investments. Additionally, it is worth mentioning that this still needs to be backed-up by an EU level facilitation of the ex-ante investment cost and benefit allocation, as proposed by the infrastructure package.

2) It is important to continue the experimentation with novel regulatory frames (e.g. Germany, the UK and Sweden) that have been fine-tuned for the connection of offshore wind farms. Note that, even if the currently imperfect fine tuning is not a problem from the EU perspective, the EU could add value by supporting this learning process, for instance, by benchmarking existing practices.

### Combined solutions

The least regret EU policy strategy would be to implement remedies for the tremendous difficulties faced by combined solutions (see above), while also giving a chance to the ongoing regional initiatives. So, where opportune, the EU should opt for a soft intervention, guiding and supporting the national and/or regional policy implementation of the remedies; and, where a regional solution is not viable, a stronger EU involvement is already recommended today. In the report we consider both options for each of the remedies, but here we only list the resulting recommendations for initiatives to be taken by the European Commission, in addition to the third package and the infrastructure package proposal:

1) **Harmonizing into economically sound regulatory frames for offshore transmission investments**: by providing indicative guidelines that encourage member states to follow the guiding principles of an economically sound regulatory frame (i.e. planning principle, competition principle, and beneficiaries pay principle) to reduce the distortions coming from the national frames (i.e., *soft type of EU involvement, supporting regionalized solutions*).

2) **Harmonizing the renewable support schemes for offshore wind farms**: by promoting the use of the renewable support scheme flexibility mechanisms for offshore wind farms (i.e. joint project and joint support scheme mechanisms) to reduce the distortions coming from the national schemes *(i.e., soft type of EU involvement, supporting regionalized solutions).*

3) **Facilitating the ex-ante allocation of costs and benefits of offshore transmission investments**: by organizing the approval of transmission investment project packages, complemented with a new mechanism to implement the beneficiaries pay principle for combined solutions (i.e., *strong type of EU involvement that could be complemented by partly regionalized solutions*).



4) **Speeding-up offshore grid technology development**: through the inclusion of an offshore grid technology roadmap in the SET-Plan, within an industrial initiative driven by HVDC manufacturers, focused on the speed-up of offshore grid technology development required for large scale combined solutions (larger than projects like Kriegers Flak). (i.e., *strong type of EU involvement*).

5) **Adapting the Community-wide transmission planning to offshore grids**: by developing improved transmission planning methodologies and applying them to elaborate on a twenty or thirty year network development plan that considers combined solutions (i.e., *strong type of EU involvement*).

TOPIC 6

# EU Involvement In Electricity and Natural Gas Transmission Grid Tarification

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## Highlights

- Current EU involvement in the regulation of TSO revenues and transmission grid tarification is rather limited and the existing heterogeneity among national regulatory practices and transmission tariff structures might be an obstacle for functioning competition and adequate investments in the grids.
- However, we see neither the need nor solid justification for an EU-wide harmonization of the *regulation of TSO revenues*. ACER should take the responsibility for benchmarking national regulatory practices. Transparency standards should be extended. Innovative solutions to trigger investments (e.g. competitive tendering or a European tariff component) need to be considered. The EU shall call for the removal of legal barriers that might impede grid investments; it is notably necessary that third parties can invest where incumbent TSOs do not show interest to realize the identified priority projects.
- To increase transparency, the cost components included in *electricity transmission tariffs* should be harmonized; they should only include costs related to transmission grid infrastructure. Locational signals providing reliable ex-ante signals should be introduced. To avoid a distortion in competition, the EU should fix an average share of the G/L-components; thus, introduce a minimum G-component. The behavior of grid users in the competitive sector must not be distorted, i.e. transmission tariffs covering the long-term cost of infrastructure should not be calculated based on energy transported (i.e. in €/MWh).
- In the European natural gas sector, there are more than 30 entry-exit zones with mainly administratively determined borders. The EU should set principles for determining the ideal size of entry-exit zones, but let the concerned NRAs and TSOs agree on the result. Once market areas are merged, there are good economic reasons to implement a system of common tarification. The role for the EU here should be limited to support sound agreements between the respective stakeholders.
- We recommend some harmonization in *natural gas transmission tarification* to ensure that the breakdown of costs among grid users and among entry and exit points respects the principle of cost-reflectiveness as much as possible. Adequate discounts on short-haul transports should be encouraged. Asymmetric re-allocation of costs, such that 'captive' domestic consumers have to bear disproportionately high costs, shall be prohibited.

## Background

The current EU involvement in the regulation of TSO revenues and transmission grid tarification is limited and mainly addresses issues related to interconnection and supply security as well as the definition of underlying principles for third party grid access and capacity pricing. Heterogeneity among national, or even local transmission tariffs might be an obstacle for functioning competition and adequate investments into the grids in the context of EU energy policy goals (i.e. "2014", "2020", and "2050"). Even though transmission tariffs account only for a small percentage of final industrial consumer electricity and natural gas prices, both their level and structure can have a strong impact on infrastructure investments and on how commodities are traded within and between countries.

In what follows, we derive recommendations on the future role of the EU and a potential need for harmonizing transmission grid tarification. We ask (1) whether existing heterogeneities in regulatory practice might hamper adequate investments or impede efficient competition and, if yes, (2) whether new EU legislation in place and new EU instruments notably from the Third Package – *once enforced* – provide an efficient solution. Increased trans-national involvement may have benefits, such as the better functioning of markets and the facilitation of infrastructure development, but it also comes at a cost, such as increased information asymmetry between individual decision makers and higher-level coordinating or regulating institutions. Both have to be weighed carefully. Practical and political implementability of the proposed solutions (both in the near- or long-term) is one of our key concerns.



**Analytical framework for the analysis of policy measures going beyond the national level**

Any EU involvement must not go beyond what is necessary to achieve the high-level objectives in the EU Treaties, except for areas of EU exclusive competences. To discover the need and pertinence of policy measures going beyond national level, three questions are to be answered:

1. First, whether EU involvement is justified on the grounds of subsidiarity. Any higher European level of decision-making shall avoid pre-empting any area of legitimate Member State involvement. From an institutional perspective, there is a shared

achievement of the European energy policy goals – i.e. the completion of the internal market, a sustainable and environmentally friendly energy system, and security of energy supplies (Art. 194, Treaty of the Functioning of the EU). It is then legitimate to look at this more closely to see if there are substantial economic benefits to be made from a renewed EU involvement.

2. Second, whether the achievement of policy targets is hindered by profound and permanent market failures. In the presence of strong (positive or negative) externalities, decentralized decision-making will not result in the socially optimal investments from a regional or an EU-wide perspective. Distributional concerns occur as soon as multiple stakeholders are involved and diverging interests can hamper efficient decision making. Trans-national involvement can also be important to stimulate information benefits we can get from various national regulatory authorities being learning from their diverse regulatory approaches.

3. And finally, whether the necessary regulatory actions could be decentralized among various local players and whether objectives could be achieved based on voluntary, regional cooperation, instead of being the result of top-down, centralised decision-making to get a workable implementation process.



## Regulation of TSO revenues: A national undertaking?

The observed heterogeneity in general price control mechanisms and instruments used to promote new investments probably does not hamper adequate investments in national infrastructures having no strong cross-border impact. Key parameters determining investment incentives are an adequate risk-reward ratio, regulatory stability and transparency, all issues national regulators can properly address. In addition, the current heterogeneity regarding instruments used to promote investments can actually provide valuable insights into 'functioning' models and might allow to discover 'best practice' for specific situations.

Cross-country comparability, however, has shown to be difficult due to the observed heterogeneity in national regulatory practices in terms of determining asset base and level of remuneration. This could result in higher cost of capital and additional risk from the point of view of external investors, whose funds are indispensable to meet the substantial financing needs in energy infrastructures in the coming decades. Moreover, different methodologies used to calculate the allowed revenue could actually hamper adequate investments regarding projects that have a regional (i.e. cross-border) impact. Especially in the electricity sector we face an increasing need to build long-distance transmission lines. Competition between corridors (and thus between TSOs from different Member States) can imply that the grid might be expanded where an investor gets a more favorable return. Finally, besides various exogenous factors that are beyond the control of TSOs and differences in internal operating efficiency, heterogeneity in national regulatory practices leads to a situation where for the same volume of assets different authorized revenues will be calculated, which in turn results in varying transmission costs and tariff levels.

*Our recommendations for future EU involvement:*

- We see neither the need nor solid justification for an EU-wide harmonization of the regulation of TSO revenues. Nevertheless, we recommend that decisions regarding the realization of projects with a pan-European impact should be taken on the EU level instead of being the result of a reaction to rates-of-return settled by national regulators in different Member States. Where a regionally specific solution has to be found (e.g. offshore grid), decentralized cooperation and coordination are appropriate.
- ACER should take the responsibility for benchmarking national practices and formulate an opinion about the appropriateness of various methodologies employed. Transparency (i.e. reporting) standards need to be extended.
- In view of the amount of predicted investment needs, innovative solutions to trigger investments (e.g. competitive tendering or a European tariff component) should be considered to become common tools, too.



## EU involvement in electricity transmission grid tarification

There is wide heterogeneity regarding electricity transmission tariff structures among EU Member States. This does hamper both adequate investments and efficient competition. While the EU has defined general principles of tarification, there is little EU involvement with respect to tariff design except for some harmonization of the maximal average G-component. The existing ITC mechanism is an ex-post instrument which is intended to compensate TSOs for the costs resulting from hosting cross-border flows of electricity. Apart from some methodological weaknesses, it is not designed to incentivize the timely realization of grid investments or to allocate costs of new infrastructures. These issues are expected to be addressed by the proposed Energy Infrastructure Package for projects of pan-European interest; however, we identified some factors that might hamper the successful implementation and effectiveness of this new regulation.

*Our recommendations for future EU involvement:*

- To increase transparency, the first area of harmonization should involve a clear definition of which cost components transmission tariffs should contain. They should only include costs related to transmission network infrastructure.
- Transmission tariffs should be allocated as far as possible based on the principle of cost causality. Locational signals should be introduced, taking into account national system specificities, being calculated based on sound methodologies and providing reliable ex-ante signals. The provision of time signals can be considered, too. To give economic signals to generators, obviously a certain share of the tariff needs to be paid by them. To avoid a distortion in competition, the EU should fix an average share of the G/L component; thus, introduce a minimum G-component.
- The behavior of grid users in the competitive sector should not be distorted, i.e. transmission tariffs covering the long-term cost of infrastructure should not be charged based on energy transported (i.e. in €/MWh) but instead be paid based on booked capacity or lump-sum, computed separately for different types of grid users in different areas so that charges properly reflect the network-related characteristics of the network users.
- The EU should call for the removal of the legal barriers that might impede grid investments where strong geographical asymmetries in costs (i.e. investment needs) and benefits occur. It is necessary that third parties can invest where incumbent TSOs do not show interest to realize identified priority projects.
- Finally, given the uneven distribution of benefits among stakeholders arising from increased interconnection capacities and the concern that national regulators tend to protect domestic consumers from rising prices, effective means have to be found to incentivize NRAs to support the development of identified priority projects.

## EU involvement in gas transmission grid tarification

In the natural gas sector, heterogeneity in tariff structures does not hamper adequate investments while it might hamper efficient competition. There are more than 30 entry-exit zones with mainly administratively determined borders. Furthermore, systematic bias exists in the form of a cross-subsidization between short-distance transmission and long-distance transportation; domestic consumers tend to cross-subsidize transit flows. Other obstacles to functioning competition include contractual congestion, inefficient pricing of non-standard products, a persisting lack of backhaul capacities, or the limited compatibility of capacity products offered. The implementation of new legislation (i.e. Third Package, Network Code on capacity allocation mechanisms) will substantially increase transparency and compatibility and facilitate natural gas trade and competition. However, it does not address all obstacles listed above.

*Our recommendations for future EU involvement:*

- The EU should set principles for determining the ideal size of entry-exit zones, but let concerned NRAs and TSOs agree on the result. Boundaries of price zones should reflect the technical and economic conditions rather than political borders; mergers of market areas shall be evaluated on a case-by-case basis based on expected economic benefits and costs. Once market areas are merged, there are good economic reasons to implement a system of common tarification. The role for the EU here should be limited to support sound agreements between the respective stakeholders. The actual implementation of harmonization of tariff structures and definition of a mechanism to compensate TSOs can be managed at the regional level.
- We recommend some harmonization in natural gas transmission tarification to ensure that the breakdown of costs among grid users and among entry and exit points is designed so that the principle of cost-reflectiveness is respected as far as possible. Adequate discounts on short-haul transports should be encouraged and an asymmetric re-allocation of costs such that 'captive' domestic consumers have to bear disproportionately high costs, shall be prohibited.
- The EU, through ACER, should formulate a set of 'good practice guidelines' regarding natural gas transmission tarification. Entry and exit charges should be actively used to provide locational signals to grid users wherever this is economically rea-

sonable. Commodity-related components should reflect short-run marginal costs in order to avoid distortions in the behavior of shippers in the commodity market and network tariffs should clearly be identified, containing only those cost elements that are related to the transmission activity (i.e. infrastructure investment and operation).

<table>
<tr><th colspan="4">Summary of the findings</th></tr>
<tr><th></th><th>Regulation of TSO revenues</th><th>Electricity transmission tariffs</th><th>Natural gas transmission tariffs</th></tr>
<tr><td rowspan="2">Heterogeneity hampers adequate investments?</td><td>Probably not for purely national infrastructures</td><td rowspan="2">Probably yes</td><td rowspan="2">Probably not</td></tr>
<tr><td>Probably yes for infrastructures with regional impact</td></tr>
<tr><td>Heterogeneity distorts competition?</td><td>Possibly yes</td><td>Probably yes</td><td>Probably yes</td></tr>
<tr><td>New legislation – once enforced – solves the issues?</td><td>Probably not</td><td>Probably not</td><td>Probably not</td></tr>
<tr><td>Recommendations on future EU involvement in a nutshell</td><td># No need for EU-wide harmonization<br><br># Decisions on realization of projects with pan-European impact to be taken at EU level; decentral cooperation of all relevant stakeholders where a regionally specific solution is required (e.g. offshore grid)<br><br># Benchmarking of national practices through ACER<br><br># Consideration of innovative solutions to trigger investment (competitive tendering, EU tariff component)</td><td># Definition of cost components to be included in tariff<br><br># Allocation based on principle of cost causality → implementation of locational signals and consideration of time signals<br><br># Introduction of a minimum G-component<br><br># Transmission tariffs covering long-term infrastructure costs not to be charged in €/MWh<br><br># Removal of legal barriers that might impede investment<br><br># Incentivization of NRAs to support development of identified priority projects</td><td># EU-wide principles for determination of ideal size of entry-exit zones<br><br># Breakdown of costs among grid users and among entry- and exit points such that principle of cost-reflectiveness is respected as far as possible<br><br># Formulation of 'good practice guidelines'</td></tr>
</table>

# THINK People

Scientific Council

Florence-based Research Team

# People
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Mechanical Engineering from University of Porto and PhD in Technical Sciences from EPF Lausanne, CH; Professor of Heat Transfer at the University of Porto and Director of the Institute of Mechanical Engineering (FEUP); President of the Energy Agency of Porto (2006 -…); Vice Rector of the University of Porto (1986-91); Expert on Energy in Buildings for DGXII (1988 - 1992); responsible for the Energy Concept for EXPO'98 in Lisbon (1993-98); President of ISES -International Solar Energy Society (1997-98); Member of the Steering Committee of the Environment Concerted Action on Indoor Air Quality at JRC-Ispra (1992-…); President of the Environment Council of EDP – Electricidade de Portugal (1991-2001); Secretary of State for Environment (1984-5); Secretary of State for Energy (2001-02); Board Member of GALP (Portuguese Oil Company) (2003-04).



## Nils-Henrik M. von der Fehr

Nils-Henrik M. von der Fehr is Professor of Economics and Head of Department at the Department of Economics at the University of Oslo, Norway. He holds a PhD in Economics from the University of Oslo. Professor von der Fehr specialises in auctions, industrial economics, energy and environmental economics, regulation and antitrust and has published extensively in these fields. He has wide experience as Consultant and Advisor to governments, organisations and private companies around the world, including Australia, Brazil, Colombia, Denmark, Guatemala, Honduras, Iceland, Italy, The Netherlands, New Zealand, Norway, Sweden and the UK, as well as for international organisations like the European Commission, Inter-American Development Bank and the World Bank. He was a member of the Dutch Electricity Market Surveillance Committee and has been a member and/or chaired a number of government commissions in his native Norway.

## Ottmar Edenhofer

Ottmar Edenhofer is Deputy Director and Chief Economist at the Potsdam Institute for Climate Impact Research (PIK). Furthermore, he is Professor of the Economics of Climate Change at the Technical University Berlin and Co-Chair of Working Group III of the Intergovernmental Panel on Climate Change (IPCC). At PIK he is leading Research Domain III - Sustainable Solutions - that focuses on research in the field of the Economics of Atmospheric Stabilisation. He is member of the Science-Industry Cooperation and member of the German National Academy of Sciences Leopoldina, Workgroup Climate, Energy and Environment. He has published articles in

Science, Nature, Energy Journal, Climatic Change, Energy Economics, Energy Policy and other peer-reviewed journals and authored a number of books. He was a lead author for the Fourth Assessment Report of the IPCC from 2004 until 2007 and recently co-edited the IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN). Ottmar Edenhofer's research explores the impact of induced technological change in mitigation costs and mitigation strategies, as well as the design of instruments for climate and energy policy and the science-policy interface.

## Matthias Finger

Matthias Finger has been Professor of Management of Network Industries at Ecole Polytechnique Fédérale Lausanne, Switzerland (EPFL) since 2002; he has also directed the transport area of the Florence School of Regulation since 2010. He holds a PhD in Political science from the University of Geneva and has been an assistant Professor at Syracuse University (New York) (1989-1991), an associate Professor at Columbia University (New York) (1992-1994) and Professor of Management of Public Enterprises at the Swiss Federal Institute of Public Administration (1995-2001). He is also a member of both the Swiss railway and Swiss electricity regulatory authorities. His main research interest is on the liberalization, the re-regulation, and the intelligent (thanks to the information and communication technologies) governance of infrastructures in the transport, energy, and communications sectors. He is the co-editor in chief of the Journal *Competition and Regulation in Network Industries*.

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Dörte Fouquet is a law partner at Becker Büttner Held Law Firm. Studies of Law at the Universities of Marburg and Hamburg. 1982-1988 Academic and Research Associate, Junior Lecturer at the University of Hamburg, Law Faculty. 1988-1991 Civil servant of the State of Hamburg, Ministry for the Environment and Energy. 1991-1993 Civil servant in liaison office of Hamburg and Schleswig-Holstein to the European Commission in Brussels. 1993-2010 Partner at Kuhbier law firm, Brussels, specialising in European and International law and consulting on European affairs in the fields of competition, energy, transport and environment. Since 2011 Partner at Becker Büttner Held law firm and head of the BBH Brussels office. Practice areas: energy, environmental and competition law. Frequent publishing and public speaking activities worldwide; regular consultant to Member States' governments as well as to the European Institutions.



## Jean-Michel Glachant

Jean-Michel Glachant is Director of the Florence School of Regulation and Holder of the Loyola de Palacio Chair at the European University Institute, Florence. He is Professor in Economics and holds a PhD from La Sorbonne University, Paris. Jean-Michel Glachant is Member of the EU-Russia Gas Advisory Council of Commissioner Oettinger (EC), he is or has been Advisor to DG TREN, DG COMP, DG RESEARCH and DG ENERGY of the European Commission and Coordinator/Scientific Advisor of several European research projects like THINK, SESSA, CESSA, Reliance, EU-DEEP, RefGov, TradeWind, Secure and Optimate. He is member of the Advisory Board of the E-Price project and Research Partner of CEEPR, (MIT, USA), EPRG (Cambridge University, UK), and Chief-Editor of the *EEEP: Economics of Energy & Environmental Policy*, a new journal of the International Association for Energy Economics.

### Manfred Hafner

Manfred Hafner coordinates energy policy activities at the Fondazione Eni Enrico Mattei (FEEM); is President for Europe, MENA, Russia and CIS at International Energy Consultants (IEC); and is Professor for Energy Economics, Markets and Geopolicy at the Johns Hopkins University (SAIS) in Bologna and at the Sciences Po Paris School of International Relations. He has also taught at the Ecole des Mines de Paris, the IFP-School, HEC-Paris, the Florence School of Regulation and the Geneva Graduate Institute of International and Development Studies. He has consulted extensively on energy issues for industry, governments and international organizations and was for many years the Scientific Director of the Observatoire Méditerranéen de l'Energie (OME). He is a member of the EU-Russia Gas Advisory Council and holds Master degrees in Energy Engineering, Economics and Policy from the Technische Universität München (Germany), the Insitut Français du Pétrole (France), the Université Paris2/Panthéon Assas (France) and the University of Pennsylvania (USA).

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Leigh Hancher is Professor of European law at the University of Tilburg and is also attached to the Amsterdam office of Allen & Overy as Counsel as well as Scientific Advisor to the Florence School of Regulation's EU Energy Law & Policy Stream. Her research interests are energy market regulation, EU state aids and energy market governance. Leigh has been a Professor since 1991, initially at the Erasmus University, Rotterdam. In 1996 she was Visiting Professor in "Natural Resources Law" at the University of Calgary, Canada. She has broad experience in energy regulation issues at the European and national levels. Her expertise as well as her academic research is focused on the changing role of the government in stimulating the liberalisation of traditionally heavily regulated sectors. Leigh studied law at the Universities of Glasgow and Sheffield, and at the EUI. In 1989 she obtained, with distinctions, her Doctorate in Law at the University of Leiden.



### Christian von Hirschhausen

Christian von Hirschhausen is Professor of Economics at the Workgroup for Economic and Infrastructure Policy (WIP) at the Berlin Institute of Technology (TU Berlin), and is also research professor at DIW Berlin (German Institute for Economic Research). Industrial engineer (Dipl.-Ing.) from Berlin University of Technology, MA (Economics) from the University of Colorado at Boulder, PhD in Industrial Economics from the Ecole Nationale Supérieure des Mines de Paris, previously Chair of Energy Economics at TU Dresden. Prof. von Hirschhausen focuses on the regulation and financing of infrastructure sectors, mainly energy, and is a regular Advisor to industry and policymakers, amongst them the World Bank, the European Commission, European Investment Bank, and several German Ministries. Recent participation in EU projects: ENCOURAGED: "Energy Corridor Optimisation, for the European Markets of Gas, Electricity and Hydrogen" (2005-2006); SESSA: "European Forum on Energy Regulation" (2004- 2006), and CESSA: "Coordinating Energy Supply Support Activities" (2007-2008).

### Thomas B. Johansson

Dr. Techn. in Nuclear Physics from Lund Institute of Technology, Sweden. Professor at Lund University, Co-Chair of the Global Energy Assessment, IIASA, Austria, and former Director of the International Institute for Industrial Environmental Economics (IIIEE) at Lund University. From 1994 through 2001 he was Director of the Energy and Atmosphere Programme at UNDP, where he initiated the use of energy as an instrument for socio-economic development and developed and launched the World Energy Assessment, 2000. Co-Chair, Global Network on Energy for Sustainable Development (GNESD) 2001-ongoing. He has chaired and has held memberships of a number of international and multilateral boards. He was Convening Lead Author of the IPCC Second Assessment Report from 1992 to 1996, and thus a co-recipient of the Nobel Peace Prize awarded to IPCC in 2007. He was awarded the Volvo Environment Prize in 2000.

## Peter Kaderják

Péter Kaderják is the Director of the Regional Centre for Energy Policy Research at the Corvinus University of Budapest (www.rekk.eu). He received his MSc in Economics from the Budapest University of Economic Sciences in 1987. In 1998 he was appointed Chief of Cabinet of the Minister of Economic Affairs and started to work on the liberalisation of the electricity and gas sectors in Hungary. In January 2000 he became the President of the Hungarian Energy Office, the national energy regulator. Between 2000 and 2004 he also served as the Chairman of the Energy Regulators Regional Association (ERRA), an association of energy regulatory institutions of countries from Central and Eastern Europe, the CIS and South East Europe. Since 2004 he has been serving as Training Director for ERRA's in-house energy regulatory trainings. He has also been directing a postgraduate program in Energy Economics at Corvinus University since 2010. He is a research partner in the "European Energy Institute" at University of Leuven and a regular lecturer at the Florence School of Regulation. He has directed several recent research efforts with regional relevance. In 2011 he was appointed as alternate member of ACER's (Agency for the Cooperation of Energy Regulators) Board of Appeal.

## François Lévêque



François Lévêque is Professor of Economics at Mines ParisTech. He graduated in Engineering from Agro, and holds a PhD in Economics. During the past fifteen years his research has focused on the assessment of policy instruments (e.g., tariffs in electricity transmission, covenants, merger control) and of policy reforms (e.g., gas and electricity French and EU laws, European Commission proposals for Community patent and software protection, modernization of EU competition policy). In 2007 he launched an academic blog, energypolicyblog.com. His consulting activity is aligned with his academic interests. He has been regularly commissioned by the French government, OECD and the European Commission to undertake consultancy and participate in advisory committees. François Lévêque has also founded Microeconomix, a Paris-based boutique specialised in Economics applied to law.

## Claude Mandil

Mandil is Former Executive Director of the International Energy Agency. Claude Mandil served a four-year term from to 2003 to 2007 as Executive Director of the International Energy Agency, based in Paris. While serving as Director General for Energy and Raw Materials at the Ministry of Economy (1990-1998), he was instrumental in arranging for France to become a member of the IEA in 1991 and served as the IEA Governing Board Chairman from 1997 to 1998. During this time he also represented France at the Nuclear Safety Working Group of the G7 (1991-1998). Before joining the IEA in 2003, Claude Mandil was Chairman and CEO of the Institut Français du Pétrole and, previous to that, Managing Director of Gaz de France. Earlier posts have included Director General of Bureau of Mines and Geology (BGRM) 1988-1990; and Advisor in the French Prime Minister's office, 1981- 1982. Now retired, Claude Mandil is advising governments and companies in the domain of energy policy. He is a graduate of France's Ecole Polytechnique and Ecole des Mines. He has been awarded Honorary Doctor of the KULeuven in Belgium.

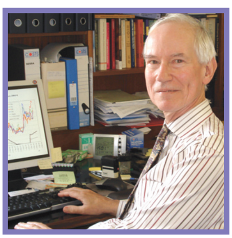
### Władysław Mielczarski

Władysław Mielczarski is a Life Professor in Electric Power Engineering nominated by the President of Poland in 2002 for his achievements in liberalisation of the power supply industry, in particular the design of the Polish electricity market structure and rules for planning and operation of the balancing market. He has over 30 years of professional experience in Poland, Australia, Singapore and Canada. Between 1999-2000 and 2005-2007 he was an energy Advisor to the Polish government responsible for designing the electricity market and the new structure of the Polish power industry. As the European Energy Coordinator in 2007-2011, he was responsible for the development of cross border power connections between Lithuania, Poland and Germany. He has published 10 books and over 150 journal and conference papers including books published by prestigious publishing houses such as Springer Verlag–Heidelberg and Nova Science Publishers in New York (2007-2008).

### Peter Mombaur

Peter Mombaur is honorary Professor of the University of Cologne. He is also an associate lecturer on the Practice of European Law at the University of Cologne since 2004. He is a former Member of the European Parliament and also gained ex-perience in the EU Convention on Fundamental Rights, and in a lengthy term as Deputy Member of the North Rhine-Westphalia Land Constitutional Court.





### David Newbery

PhD, ScD, FBA, is an Emeritus Professor, Faculty of Economics, University of Cambridge and Director of the Cambridge Electricity Policy Research Group. Educated at Cambridge with degrees in Mathematics and Economics, President of the European Economic Association in 1996, President-elect for the IAEE 2012, to be President in 2013. Occasional economic Advisor to Ofgem, Ofwat, and ORR, former member of the Competition Commission, chairman of the Dutch Electricity Market Surveillance Committee, currently member of the academic panel of environmental economists, DEFRA. He has recently advised DECC and the House of Commons on Electricity Market Reform. Recent books include *A European Market for Electricity?* (co-author), and *Privatization, Restructuring and Regulation of Network Utilities*. Guest editor of *The Energy Journal* (2005) issue on European electricity liberalisation, and recently honoured in "Papers in Honor of David Newbery: The future of electricity" in *The Energy Journal* (2008).

### Ignacio J. Pérez-Arriaga

MS and PhD in Electrical Engineering from MIT, and Electrical Enginer from Comillas University in Madrid, Spain. Professor and Director of the BP Chair on Sustainable Development at Comillas University, and founder and director for 11 years of its Institute for Research in Technology (IIT). Permanent visiting professor at the Center for Energy and Environmental Policy Research (MIT, Boston, USA). Commissioner at the Spanish Electricity Regulatory Commission (1995-2000), and presently Independent Member of the Single Electricity Market Committee of Ireland. Member of the Board of Appeal of the Agency for the Coordination of Energy Regulators (ACER) in the EU. Director of Training at the Florence School of Regulation, Italy. Review editor of the 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Member of the Advisory Group of the Energy Roadmap 2050 for the Energy Directorate of the European Commission.

## Pippo Ranci

Pippo Ranci was the first president of the Italian Regulatory Authority for electricity and gas (1996-2003) and Co-founder and Vice-President of the CEER. Then he set up and directed the Florence School of Regulation at the European University Institute (EUI) in Florence (2004-2008) where he is now a part-time Professor. Trained as an economist at the Università Cattolica in Milan and at Oxford University, he also holds an MA from the University of Michigan. In 1971 he co-founded the Istituto per la Ricerca Sociale, Milan, a private cooperative research institute, where he was President until 1981 and then part-time Research Director until 1996. He was also an associate professor at the Università Cattolica (1973-1986), full professor of Economic Policy at the Università di Bergamo, and then at the Università Cattolica (1987-1996). He was often a consultant to the Italian Ministry of Industry (1970s and 1980s) and the President of the Council of Ministers (1992-93). Having retired, he still teaches at the Università Cattolica in Milan and is guest professor at the Barcelona Graduate School of Economics.

## Jorge Vasconcelos

Dr.-Ing. in Electrical Engineering, University of Erlangen-Nuremberg. Chairman of NEWES, New Energy Solutions. Consultant to several international organizations and national authorities. Member of the Harvard Environmental Economics Program Advisory Board. Invited Professor at the Technical University of Lisbon (MIT-Portugal Program). Member of the Administrative Board of ACER nominated by the European Parliament. Special Advisor to EU Commissioner Andris Piebalgs. First chairman of the Portuguese Energy Regulatory Authority (ERSE). Co-founder and first chairman of the Council of European Energy Regulators (CEER). First chairman of the European Regulators' Group for Electricity and Gas (ERGEG). Co-founder of the Ibero-American Association of Energy Regulatory Authorities (ARIAE). Founder and member of the Executive Committee of the Florence School of Regulation. Prior to the regulatory experience, he was deputy secretary-general of EURELECTRIC, worked for AEG in Frankfurt and at several universities in Europe.

# People
## Florence-based Research Team

### **Isabel Azevedo //** Team Member

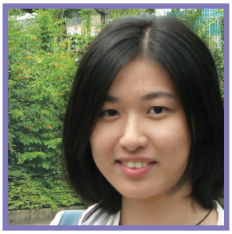
Isabel Azevedo is Research Assistant at the Florence School of Regulation. Isabel has obtained an MSc in Physics / Applied Mathematics (Astronomy) at the University of Porto, in Portugal. She has also spent one year of her studies at Lund University, in Sweden, under the Erasmus program. She has done post-graduation studies on sustainable development and energy systems, both at the New University of Lisbon and at the University of Porto. Isabel completed the Sustainable Energy Systems Advanced Studies course, within the MIT Portugal program, also at the University of Porto. In 2010, she worked in the Faculty of Engineering from the University of Porto as a research assistant. Isabel joined the Florence School of Regulation in January 2011.

### **Erik Delarue //** Former Team Member

Erik Delarue holds a MSc degree in Mechanical Engineering (2005) and a PhD in Mechanical Engineering (2009), both from the University of Leuven (KULeuven), Belgium. He has worked on the modeling of electricity generation systems, and made contributions to operational electricity generation models, modeling fuel switching under the EU ETS and portfolio theory modeling applied to power systems. In 2010, he joined the Florence School of Regulation at the European University Institute in Italy as a research assistant and member of the THINK team. His work focused on the decarbonization of the EU and on the Smart Cities Initiative. He is currently a post-doctoral research fellow from the Research Foundation - Flanders (F.W.O.) at the KULeuven, Department of Mechanical Engineering, Division of Applied Mechanics and Energy Conversion. He is working on the modeling.

### **Jonas Egerer //** Former Visitor

Jonas Egerer holds a degree in Industrial Engineering and Management from the Technical University of Dresden, Germany. He is currently working as a research assistant at the Workgroup for Policy Infrastructure of the TU Berlin, Germany. His research interests relate to infrastructure planning and expansion of the European electricity transmission network towards market and renewables integration. In those fields he focuses on welfare economics and techno-economic modeling approaches.



### **Xian He //** Team Member

Xian He is Researcher at the Florence School of Regulation. She holds an MSc in Economics and Management of Network Industries from University of Pontificia Comillas of Madrid, Spain, and from University of Paris Sud XI, France, where she studied in the Erasmus Mundus Master program during 2006-2008. Xian did her PhD research on Electric Energy Storage between 2008-2011 in the framework of collaboration between University of Paris Sud XI and EDF R&D, where she also worked as a PhD engineer. She defended her thesis on "Designing the Market for Bulk Electric Energy

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**Siok Jen Liong //** Former Team Member

Siok Jen Liong holds a Master's Degree in (EMIN) Economics and Management in Network Industries (2008) from Delft University of Technology, University of Paris Sud XI and University of Pontificia Comillas under a European Commission Scholarship. Her employment experiences include working as a project manager in the civil engineering industry, trainee engineer at Gas Natural Spain and lecturer at Swinburne University. She is currently working in Singapore with a solar company (Hooray Energy) as an assistant manager for business and project development.

**Claudio Marcantonini //** Team Member

PhD in Physics from MIT and Bachelor's Degree in Physics from the University of Perugia, Italy. He is a member of the Think team since January 2011. He did research on the European Emission Trading System for the OECD Nuclear Energy Agency where he worked as a consultant before joining the Florence School of Regulation. He estimated how carbon pricing affects the competitiveness of nuclear energy with respect to coal and gas. He also worked on costs of electricity at the MIT Joint Program on the Science and Policy of Global Change and at the MIT Centre for Environmental and Policy Research. He analyzed levelized costs of electricity and his work was included in the 2010 study "Projected Cost of Electricity" of the OECD Nuclear Energy Agency and International Energy Agency.



**Leonardo Meeus //** Scientific Coordinator, Team Leader

Leonardo Meeus is a research fellow of the Florence School of Regulation at the European University Institute in Italy, and a visiting professor at the KULeuven in Belgium. Leonardo is the scientific coordinator of the EU FP7 funded research project THINK that advises the European Commission (DG Energy) on energy policy (2010-13). He was the scientific coordinator of the Florence School of Regulation (2008-09) and of the European Energy Institute at the KULeuven (2006-08). He also worked in Ireland, heading regulatory affairs for an electricity interconnector developer (2008-09). Dr. Meeus has a Degree in Commercial Engineering (2002) and a PhD in Electrical Engineering (2006), both from the KULeuven in Belgium.

**Luis Olmos //** Former Team Leader

Luis Olmos holds a PhD degree in Electrical Engineering from Pontifical Comillas University, Spain. Luis currently is a senior researcher in the regulation and modeling areas of the Institute for Research in Technology at the same university, where he has worked on more than thirty research and consultancy projects for main electric and gas utilities and public entities like the European Commission. He has also been a research fellow at the Florence School of Regulation of the European University Institute, where he has advised the European Commission on energy technology policy issues (FP7 program project THINK). Luis' main research interests include the regulation and modeling of the electricity transmission activity, the integration of renewable generation and the development and deployment of clean technologies. He has written more than 20 research articles in international peer-reviewed journals and book chapters.

### **Sophia Ruester //** Team Leader

Sophia Ruester is a Researcher at the Florence School of Regulation (European University Institute, Italy) and Team Leader within the THINK project. Sophia studied Industrial Engineering at the Technical University of Dresden, where she also worked as a researcher from 2006 to 2010 as the Chair of Energy Economics and Public Sector Management, focusing on the institutional design of (liquefied) natural gas markets, supply security and corporate strategies. She defended her PhD on "Vertical Structures in the Global Liquefied Natural Gas Market: Empirical Analyses Based on Recent Developments in Transaction Cost Economics" in 2010 at the TU Dresden. She has published articles in different academic journals, such as the Journal of Institutional Economics, Utilities Policies, Energy Policy, and Energy. Sophia joined the Florence School of Regulation in February 2010.

### **Marcelo Saguan //** Former Visitor

Marcelo Saguan is a senior consultant in Economics and leads the Energy & Climate Practice at Microeconomix. He has extensive experience in infrastructure regulation, electricity and gas markets and environmental issues. He has produced several relevant reports for European energy utilities and has been involved in several studies produced for the European Commission. He has also been widely published in professional and academic journals on energy issues, including market power, congestion management, balancing market design and renewable energy integration in competitive markets. Marcelo was previously Jean Monnet Fellow at the RSCAS in the Loyola de Palacio Energy Policy Programme. He had postdoctoral position at University of Paris XI. He holds a PhD in Energy Economics (2007) from the University of Paris XI and the Ecole Supérieure d'Electricité (Supélec) and a Master's Degree in Industrial Engineering from ENIM (Metz) and from University of Cuyo, Argentina (2001).



### **Martina Sartori //** Former Visitor

Martina Sartori holds a Master's Degree in International Economics from Ca' Foscari University of Venice. In 2008 she started her PhD in Economics at the University of Milan. Her main research interests are about environmental economics, green accounting and CGE modeling for policy assessment. She was a research consultant at the World Bank (Washington, DC) in 2010 and her academic experiences include teaching as a lecturer at Ca' Foscari University (2008-2009 and 2011). She is currently collaborating with the Euro-Mediterranean Centre for Climate Change (CMCC) for the European WASSERMed project and with the Centre for Research on Energy and on Environmental Economics and Policy (IEFE, Bocconi University, Milan). She visited the Florence School of Regulation from January to May 2011 to collaborate in the 4th THINK Tank topic as an external consultant.

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