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Project "How to spend better together"

Financing Trans-European Energy Infrastructures – Past, Present and Perspectives

Christian von HIRSCHHAUSEN

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Financing Trans-European Energy Infrastructures – Past, Present and Perspectives

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1. Thanks to Christina Beestermöller, Jonas Egerer and Robert Wand for research assistance, the usual disclaimer applies.

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Presentation of the project: "How to spend better together"

Eulalia Rubio, Senior Research Fellow at Notre Europe

The negotiations of the post-2013 EU Multi-Annual Financial Framework take place at the moment when many member states are making extraordinary efforts of fiscal consolidation. In these circumstances, it is not surprising that calls for "applying austerity" at the European level resurge with force. And yet, due to its limited size (1% of the EU GNP and 2.5% of European public spending), we cannot expect major savings from cutting spending at the EU-level. A more intelligent response to the austerity challenge is to look at what we spent in aggregate terms – that is, at both national and EU level – and to explore whether we can have efficiency gains by re-organising spending tasks or better coordinating national and EU spending.

This is the purpose of the series of publications that *Notre Europe* launches under the title "How to spend better together". The analysis undertaken in these publications is original in at least three respects:

- First, the papers do not narrowly focus on what happens at the EU level but take into account what is spent in aggregate terms – that is, at both national and EU level – and explore potential synergies between EU and national budgetary interventions;
- Second, each paper focuses on a particular policy domain and it is written by an expert of this policy domain;
- Finally, the analysis goes beyond the question of "spending more or less" to address the question of "spending better". Thus, rather than focusing on the amount of euros spent or potentially saved, the authors reflect on the appropriate design of budgetary interventions in a given domain and the merits of public spending vis-a-vis other types of public interventions.

1. The aggregate approach: an intelligent response to the austerity challenge

As said above, one element that characterises these publications is the adoption of an aggregated approach to study ways of improving the efficiency of public finances in Europe. Thinking in aggregate terms means having a broad picture of how much is spent at the EU, national and sub-national levels in a given policy domain, as well as on how these different levels of spending interact with each other.

As explained by Amélie Barbier-Gauchard in her contribution to this project[1], adopting an aggregated vision of public finances in Europe has multiple advantages. In discussions about the EU budget, it is common to treat EU spending in a quasi-exclusive manner. Thus, it is for instance frequent to criticize the current profile of EU spending on the grounds that it does not adequately reflect the hierarchy of challenges and policy priorities set up by the EU authorities. These types of comments disregard the

1. Amélie Barbier-Gauchard, "Thinking the EU budget and public spending in Europe: the need to use an aggregate approach", *Policy Brief No. 29, Notre Europe*, June 2011.

fact that EU spending represents only 2.5 percent of all public expenditures in Europe. As Amélie Barbier-Gauchard rightly points out, a broader picture allows us to make more well-founded judgements on the hierarchy of resources devoted to different policy priorities in Europe. It also enables us to compare the composition of public spending in Europe with that observed in other confederal or federal entities (such as the USA).

But the aggregate approach can be also very useful to improve the efficiency of public spending in Europe. As said above, the EU budget is very small. It amounts to 1 percent of the EU GDP, while national spending in the EU-27 account in average for 50 percent of national GDP. Reducing the EU budget will thus not be the "panacea" to redress national public finances. A more promising approach is to explore whether we can have efficiency gains by re-organising spending tasks between the EU and the national level or better coordinating national and EU budgetary actions.

Re-organising spending tasks is in fact about asking one of the eternal questions in EU budgetary debates: "who should do what?". Many studies have addressed this question before. What distinguishes our exercise is that we focus on particular policy areas. Thus, rather than identifying the policy domains in which more supra-national action seems desirable, we try to identify, for one particular policy area (see §-2), which concrete spending tasks would be better carried out at the EU level than at the national level.

As concerning coordination, one should note that most EU spending is carried out in fields of competence "shared" with member states, and/or submitted to national co-financing. In these circumstances, improving the efficiency of EU spending depends very much on our capacity to organise in an efficient manner the overlapping involvement of EU and national spending action.

Finally, we believe there is a need for a serious reflection on ways to improve horizontal coordination between national budgetary actions. As pointed out by Amélie Barbier-Gauchard, we frequently hear about the need to use the EU budget to implement the EU2020 strategy, but we should not forget that implementing this strategy is mostly a national responsibility. Until recently, national efforts to achieve the EU2020 goals have been coordinated through the so-called Open Method of Co-ordination, but it is time to incorporate more explicitly the spending element in these efforts of coordination, including the national one. Beyond the framework of EU2020, coordination of national spending actions might also provide important efficiency gains in other policy fields characterised by large cross-country externalities or economies of scale (i.e. security and defence, immigration).

2. The sectoral approach: bringing sectoral expertise into EU budget debates

Another characteristic of this project is the fact that each publication focuses on a specific policy area and is written by an expert on this policy area. Our choice for a sectoral approach is based on various considerations.

First of all, EU spending debates are too much focused on numbers and money and very few on the content and design of the policies financed at the EU level. By offering a sector-based analysis, we aim to reverse this logic, that is, to put more emphasis on the rationale, goal and design of public interventions at both the EU and national level, and less on how much do they cost. In other words, we want to move beyond the question of "spending more or less" to address the question of "how to spend better". Notice that, by emphasizing the quality of spending over the amount of spending, we do not under-estimate the magnitude of the austerity challenge to which we are confronted. We see "better spending" as a more sustainable and sophisticated EU response to the "austerity challenge" than generalized cuts in EU finances. Unlike cuts, better public spending translates into better results in terms of growth, cohesion, security, welfare… which eventually turns into less spending needs in the future and, therefore, more sustainable public finances.

Another reason why we privilege the sectoral approach is that we believe the assessment of the fiscal federalism criteria needs sectoral expertise. Identifying spillovers from policies or the existence of economies of scale is not easy. A good knowledge of the public challenges and the nature of public interventions in a given domain is required in order to assess whether there are cross-national challenges requiring action at the supra-national level, whether public interventions are characterized by increasing returns to scale or what is the degree of heterogeneity in policy preferences among member states.

Finally, while we think sectoral experts provide an interesting insight to debates on EU spending, we are also aware of the limits of their analysis. Policy experts are not necessarily versed in issues of public finance. They may not know in detail the functioning and outcomes of EU spending programmes. Our goal hence is not to finish with precise propositions for the forthcoming EU financial perspectives, but rather to provide some reflections and general recommendations which can differ from those that circulate among EU budgetary experts.

3. The enlarged approach: looking beyond the EU budget

Lastly, while the project aims to contribute to current debates on the post-2013 EU financial perspectives, the analysis is not confined to the EU budget. The latter is treated as one amongst a broad spectrum of policy instruments available at the EU level, including political and regulatory interventions but also other types of EU financial interventions taking place out of the budget.

Adopting an enlarged approach is important for two reasons.

First, we believe that there is a scope to improve the efficiency of national spending through EU non-budgetary interventions (i.e. by removing barriers to competition or by strengthening the coordination of national budgets). By including non-financial EU action into the analysis, the authors can reflect on these other ways of improving the efficiency of public spending.

Second, contrary to what many people think, the EU budget is far from being the only tool used to finance EU actions. A non-negligible part of EU-level spending takes place out of the EU budget, be in form of funds or programmes managed by EU institutions but not included into the EU budgetary process – such as the European Development Fund, providing assistance for the so-called ACP countries, or the Athena mechanism, financing joint military operations – or in form of programmes created by intergovernmental agreements – such as the OCCAR, an intergovernmental mechanism financing joint programmes on military research and equipment[2]. To these various programmes and funds, one should add the use of other EU financial instruments, such as the loans provided by the European Investment Bank (which amounted to €72 billion in 2010) or the more recent "Marguerite Fund", a pan-European equity fund launched in 2010 to finance long-term energy, climate change and infrastructure investments in Europe. To have a complete picture of these various ways of "pooling resources" at the European level is important, as each type of instrument might be more appropriate in different domains.

2. Amélie Barbier-Gauchard, Yves Bertoncini, "Les dépenses européennes et non communautaires : une réalité substantielle et en devenir ?", *Note de veille n° 105, Centre d'analyse stratégique*, juillet 2008.

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Executive Summary

- **The energy sector plays a key role for the sustainable development of the EU economy**.

It is both a critical sector for the recovery and growth of industry in the EU, and also a major player in the decarbonisation strategy of the EU at the horizon 2020 and 2050.

The special role of the energy sector has been highlighted recently by the Communication on the European energy strategy towards 2020 (EC, 2010b), which was picked up and developed by a Communication on energy and climate policy towards 2050 (EC, 2010d). In this context, the so-called Energy Infrastructure Package (EIP) (i.e. the Commission's Communication "Energy infrastructure priorities for 2020 and beyond" of November 2010[1]) is the centerpiece of an infrastructure strategy to support the transforma-

1. COM (2010) 677/4.

tion of the energy system. However, important questions remain open, such as cross-border regulation and financing the future European energy infrastructures.

- **The transformation of the European energy system towards a low-carbon industry requires substantial investment and financing**.

On the one hand, the increasing geographical distances between electricity generation and consumption in a renewable-based electricity system require substantial network investment. On the other hand, the fluctuating generation patterns will also require new approaches for network stabilisation and the integration of new infrastructures, in particular control technologies, storage capacities for electricity, and a secure and reliable gas supply as a backup fuel.

Particularly, from a technical perspective, the integration of HVDC (High-Voltage Direct Current) technologies as so-called “overlay-networks” to the existing HVAC (High-Voltage Alternating Current) system will be necessary. Moreover, regulatory approaches will have major implications for financing these trans-national infrastructure projects.

- **Experience with current instruments for financing trans-European projects is mixed.**

The implementation of the Trans-European Networks for Energy (TEN-E) projects over the last 15 years remains insufficient given the EU goals for the year 2020. The staggered prioritisation of projects as (1) projects of European interest, (2) priority projects, and (3) projects of common interest has shown that there is a need to narrow the focus of TEN-E from the approximately 550 TEN-E projects to a reduced number of strategic priority projects.

Thus, new organisational models, a revision of the role of national and European regulators and adjusted regulatory and financing instrument designs are required.

- **According to the Energy Infrastructure Package (EIP), around one trillion euros must be invested in the European energy system until 2020** (EC, 2010b, p. 9).

Half of the amount is required for energy network investments (both transmission and distribution networks). Out of the €200 bn. required investment for transmission networks, only half of the capital will be provided by markets. This leaves a financial gap of approximatively €100 bn. and poses a question on the EU role in financing European energy infrastructure.

This question is not only crucial as a supplement to the existing national regulations, but also asks for a development of the existing EU budgetary instruments, which have been rather ineffective in the provision and financing of trans-national energy infrastructures to meet the EU's 2020 targets (both in the mid-term and in its long-term implications set by the EIP).

Thus, the EU and the Member States should adopt a more proactive role in infrastructure planning and financing to internalise the effects and make infrastructure cheaper.

- **This paper provides a survey of issues on the future financing of the energy sector, with a focus on infrastructure developments.**

It first provides an **overview of the long-term forecasts on energy supply and demand** in Europe and different scenarios on the way towards a 80% CO_2 reduction by 2050. We then focus on the **infrastructure needs** that are identified as an "enabler" of a sustainable development: our focus is on electricity, natural gas, and CO_2transportation infrastructures that are expected to become the backbone of a future single integrated European energy market. In discussing the infrastructure needs identified by various actors, we also highlight **potential discrepancies** between the social welfare effects at the European and cross-border level, and the national effects: these differences may suggest a more important role to be played by European institutions.

We then describe in section II the various instruments that exist at the EU level to **finance trans-national energy infrastructures**.

A **case study** in section III highlights different aspects related with future financing of trans-European energy infrastructures: we compare different network designs for the North Sea Offshore Electricity Grid, and their different financial and distributional consequences.

On the basis of this analysis, section IV addresses the question of the **appropriate financial instruments to support infrastructure investments**, both at the national level and at the European level, where such instruments are not yet sufficiently developed. We discuss advantages and potential obstacles to pooling financial resources at the EU level, and different possible institutional settings.

I. EU Energy Targets and Infrastructure Requirements

1.1. EU Energy Scenarios for 2030 and 2050

Under article 194 TFEU, the European Union has the explicit tasks of a) ensuring the functioning of the energy market; b) ensuring security of supply in the Union; c) promoting energy efficiency and energy saving and the development of new and renewable forms of energy; and d) promoting the interconnection of energy networks.

At present, the European energy policy is based upon the three pillars of sustainability, competitiveness, and security of supply, as agreed by the European Council in March 2007 and subsequently.[2] Binding targets have been set for 2020 concerning the level of greenhouse gas emissions (-20%, eventually -30%) and the percentage of energy coming from renewable

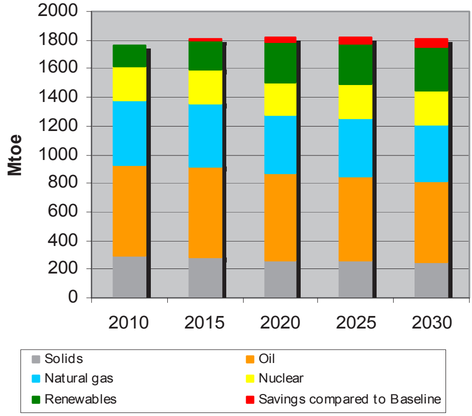
2. COM (2007) 1 endorsed by the Council on 15 February 2007 (C/07/24).

sources (20% of final energy consumption), and a non-binding target has been set for energy efficiency (-20% reduction in energy consumption, compared to the business as usual). The energy and climate "package" now includes the renewable energies directive[3], the third internal energy market package[4], the CCS-directive[5], as well as the regulation on the security of gas supply.[6]

Figure 1 shows the latest update of the Commission's energy forecasts for 2030 ("Energy Trends for 2030 – update 2009" based on a modeling framework set out by the European Commission called "PRIMES"). We present the "reference scenario", which is based on the legally binding targets in terms of greenhouse gas emission reduction and renewable share in final energy consumption (20% each). Curiously, for the period between 2020 and 2030, the model assumes no additional policy measures. Energy consumption is expected to remain almost constant over the next two decades, at about 1800 Mtoe (million tons of oil equivalents). Under this scenario, renewable energies would expand their share to 20% in 2020, and slightly beyond thereafter, whereas natural gas, oil, and solid fuels would slightly reduce. The contribution of nuclear energy would remain stable (about 14%).

3. Renewable Energy Directive (2009/28/EC).
4. Regulation (EC) no. 713/2009 of the European Parliament and of the Council of 13 July 2009 establishing an Agency for the Cooperation of Energy Regulators; Regulation (EC) no. 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003; Regulation (EC) no. 715/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No 1775/2005; Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC; Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC.
5. Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006.
6. Regulation (EU) no. 994/2010 concerning measures to safeguard security of gas supply and repealing Council Directive 2004/67/EC.

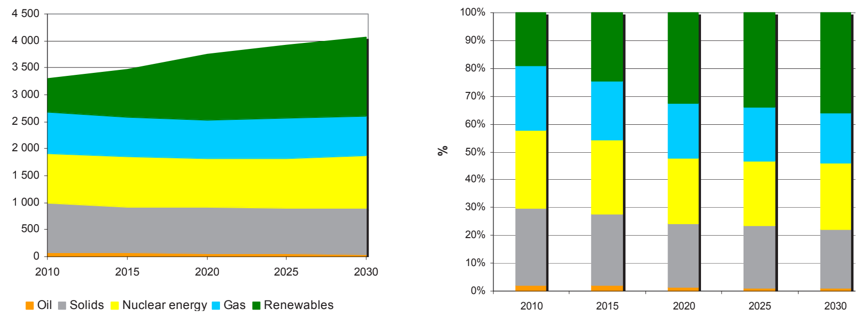
Figure 1: Primary energy consumption by fuel (Mtoe), PRIMES Reference scenario



Source: EC, 2010b, p. 21.

Electricity demand is expected to increase slightly under the reference scenario, from currently 3,362 TWh to 4,073 TWh in 2030 (a growth of about 20% over 20 years). While traditional electricity sources (solids, natural gas, and nuclear energy) would slightly reduce, the share of renewables in gross electricity generation is expected to be about 33% in 2020, and almost 40% in 2030 (see Figure 2).

Figure 2: Gross power generation mix 2010-2030 by source in TWh (left) and corresponding shares of sources in % (right), according to the PRIMES Reference scenario



Source: EC, 2010b, p. 23.

Intermittent renewable sources of energy-wind and solar are expected to represent 16% (20%) of electricity generation in 2020 (2030). Table 1 shows the expected contribution of renewables to electricity generation by 2020: 1,152 TWh, i.e. an 82% growth over 2010. Most of the expansion of wind energy is expected to take place in Germany, the UK, Spain, France, Italy, and the Netherlands, with solar expansion mainly taking place in Germany and Spain.

Table 1: Projected evolution of renewable electricity generation (TWh), 2010-2020

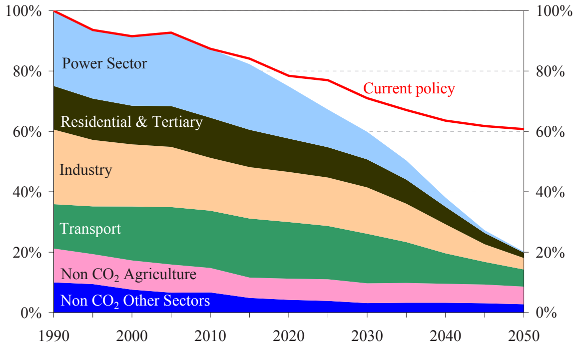
Ressource type	Generation 2010 (TWh)	Generation 2020 (TWh)	Share 2020 (%)	Variation 2010-2020 (%)
Hydro	342.1	364.7	32%	7%
Wind	160.2	465.8	40%	191%
Biomass	103.1	203	18%	97%
Solar	21	102	9%	386%
Other	6.5	16.4	1%	152%
Total	632.9	1151.9	100%	82%

Source: EC, 2010b, p. 23.

Still more ambitious targets are set out by the European Commission in its Communication "A Roadmap to 2050" of March 2011[7] which forecasts an almost total decarbonisation of the power sector by 2050. The only sectors that will be still allowed to emit greenhouse gases are industry, transport, and agriculture (Figure 3). Thus, infrastructure developments in Europe should adopt a 2050 perspective, with the existing targets for 2030 to be considered as an intermediate step.

7. COM(2011) 112 final, of 8 March 2011.

Figure 3: Decarbonisation strategy for Europe at the horizon 2050



Source: Commission'Communication "A Roadmap to 2050" (COM(2011) 112 final).

1.2. Overview of Energy Infrastructure Requirements

Various attempts have been undertaken to "translate" the forecasts on energy supply and demand into future energy infrastructure requirements. In general, these figures tend to overestimate the real infrastructure needs, because they tend to ignore demand-side reactions, inertia within the system, and other forms of adaption. Yet, the estimates provide a rough guideline of the order of magnitude of infrastructure investments to be required.

Table 2 summarises the needed infrastructure investments by sector for 2010 to 2020. If one takes the longer-term climate objectives seriously (80-95% reduction of greenhouse gas emissions), then even higher infrastructure investments may be required.

Note that in Table 2 not all of the "needs" are considered as "commercially viable" – i.e. investments for which the "cost-benefit analysis" results lead the concerned Transmission System Operators (TSOs) to submit the investment project for approval to the regulator (EU, 2010b, p. 33), or which are unable to secure commercial financing. Only €153 bn. of the total investment needs of €215.5 bn. are commercially viable (62.5%). In addition, due to obstacles in the implementation of this infrastructure, only a share of the infrastructure will indeed be delivered, which is referred to as "business-as-usual-delivery": this represents €102 bn. for the period 2010-2020, i.e. only 47% of total infrastructure needs.[8] This would leave a financing gap of about €100 bn.

Table 2: Business-as-usual, commercially viable and total needed investment by sector 2010-2020

Sector (investment 2010-2020, bn €)	Business-as-usual delivery	Commercially viable delivery	Total need
Electricity	45	90	142
Gas	57	63	71
CO_2 transport	0	0	2.5
TOTAL	102	153	215.5
Total (in %)	47%	71%	100%
Investment gap (in bn €)	113.5	62.5	0

Source: EC, 2010c, p. 34.

1.3. Electricity Infrastructure Requirements

Within the electricity sector, the largest infrastructure requirements relate to on-and-offshore electricity transmission infrastructure. The 10 year Network Development Plan (TYNDP) published by the ENTSO-E[9] stipulates about €70 bn. for transmission infrastructure, of which €28 bn. are assumed to be devoted to cross-border interconnections. Almost all of

8. This amount takes into account experiences with previously started projects that were not completed, not because of their commercial infeasibility, but other factors, often non-monetary.
9. The European Network of Transmission System Operators for Electricity (ENTSO-E) is an association of Europe's transmission system operators (TSOs) for electricity.

these cross-border interconnections are considered commercially viable (EC, 2010c, p. 34). The connection of 40 GW of offshore wind generation capacity implies the need of €32 bn. for offshore grid infrastructure. Most of this is not considered to be commercially viable, due to high uncertainty, but also due to multiple beneficiaries that complicate the allocation of benefits. In particular, investments in interconnection capacity are highly risky and complex (Kapff and Pelkmans, 2010, p. 11). Last but not least, about €40 bn. are earmarked for investments into "smart" grid infrastructure, both at the distribution and the transmission level, half of which are considered to be commercially viable.

With respect to the geographical scope, there is a clear focus within the Energy Infrastructure Package: Up to 12% of renewable energy generation in 2020 is expected to come from offshore generation capacities in the Northern seas. The offshore grid in the Northern seas and the electricity network in Northern as well as Central Europe are priority corridors for electricity network development. Further priorities for the electricity grid comprise the interconnections for South Western, Central Eastern and South Eastern Europe as well as the completion of the Baltic Energy Market Interconnection Plan (BEMIP). Moreover, ground-mounted solar and wind parks in Southern Europe as well as biomass installations in Central and Eastern Europe will deliver considerable electric energy.

These long-term projects reach beyond the TYNDP and, thus, have become part of the European Commission's priority corridors, which comprise:

1. Offshore grid in the Northern Seas and connection to Northern as well as Central Europe;
2. Interconnections in South Western Europe;
3. Connections in Central Eastern and South Eastern Europe;
4. The Completion of the Baltic Energy Market Interconnection Plan (BEMIP).

Whereas the former two priority corridors focus on the integration of renewable generation capacities, the latter may be justified by market integration and issues of security of supply. Concrete projects should be inferred from these priorities with the use of transparent and agreed criteria, forming a rolling program of priority projects as an input to the TYNDP every two years. In particular the projects should be evaluated according to their contribution to security of supply, increase of market integration and competition, energy efficiency, improved electricity use, and its capacity to connect renewable generation and major consumption/storage centres. The projects will be given a 'Project of European Interest' label which qualifies them to receive European financing (EC, 2010b, p. 13).

1.4. Natural Gas Infrastructure Requirements

Natural gas infrastructure also plays a major role in the fuel mix of the future. In effect, natural gas may become more important in the coming years as a backup fuel for increasingly variable electricity generation. Moreover, the EU's emphasis on source diversification as well as the reduction of intra-European congestions will require substantial infrastructure investments. Based on the regulation on security of gas supply (EC No. 994/2010), bidirectional and interconnected natural gas pipelines will be the key with a regional focus on Eastern Europe. Diversification of imports is one of the key issues, also resulting from additional storage and flexible supply capacities, such as liquefied natural gas (LNG) or compressed natural gas (CNG).

Priority corridors for (natural) gas infrastructures have been identified by the Commission for the implementation of the goal to "[...] allow gas from any source to be bought and sold anywhere in the EU, regardless of national boundaries" (EC, 2010b, p. 11). Moreover, the Commission suggests that every European region should have the infrastructure to allow access to at least different (natural) gas resources. These strategic priority corridors are:

1. A Southern Corridor for the further diversification of sources and to bring gas from the Caspian Basin, Central Asia, and the Middle East to the EU;
2. Linking the Baltic, Black, Adriatic, and Aegean Seas, particularly through the implementation of the BEMIP and the North-South Corridor in Central Eastern and South-East Europe;
3. A North-South Corridor in Western Europe for the removal of internal bottlenecks to increase short-term deliverability and optimise the existing infrastructure, in particular existing LNG plants and storage capacities.

As in the electricity sector, concrete projects will be inferred from these priorities. The projects will receive the status of a 'Project of European Interest' if they contribute to the diversification of (natural) gas sources, routes, and counterparts, and an increase of market integration and reduction of market concentration (EC, 2010b, p. 13).

A larger share of natural gas infrastructure is commercially viable. All of the €28 bn. for import pipelines should be commercially viable under current market and regulatory conditions. Likewise, the €21 bn. for intra-EU interconnectors are assumed to be commercially viable. Of the €21 bn. of storage investment, about two thirds are also expected to be commercially viable. Hence, the delivery rate for natural gas infrastructure is higher than for electricity transmission: €57 bn. out of the total needs of €71 bn. i.e. almost 80%, are expected to be delivered.

1.5. CO_2-Pipelines Infrastructure Requirements

Even though CO_2-capture, -transportation, and -storage (CCTS) features prominently in the Energy Infrastructure Package, the consequences in terms of a pipeline infrastructure roll-out are not clearly defined. In line with the PRIMES forecasts, a European-wide roll-out of this technology is expected by 2020, following a large number of pilot projects to be deployed in the coming decade. Under this scenario, the distribution of the storage potential for CO_2 would require a substantial network of CO_2-pipelines to capture, transport and store emissions from electricity generation (see EC, 2010b, and Arup, 2010). Assuming the commercial availability of CCTS technologies, the long-term financing instruments for a trans-national CO_2-pipeline system would require a substantial role of European financing, both for further research as well as for commercial roll-out of the technology after 2020.

In an alternative approach, Herold et al. (2010) have sketched out scenarios of CO_2-pipeline developments under different CO_2-prices and availability of on- vs. offshore storage sites. Both approaches derive similar conclusions: in the short- to medium-term, CO_2-infrastructure investment needs are modest. The European Infrastructure Priorities (EC, 2010b, p. 44) assesses them at about €2.5 bn., which is low compared to the other two sectors (electricity, natural gas). It should be noted, though, that the highest costs of the value-added claim (about 80%) occur in the CO_2-separation, that the transaction costs of siting the CO_2-pipeline infrastructure were not counted, and that storage, too, has high costs.

II. Past and Present Energy Infrastructure Financing in the EU

2.1. Overview

Currently, there are several sources of funding at the European level for financing energy network investments. These cover private and public funding as well as co-financing schemes and comprise (EC, 2010b): The EU and national budgets, the TSO's own resources (equity of 20-100% of the total investment required, depending on the investment scale), private equity, and bank loans (from the European Investment Bank, the European Bank for Recovery and Development or from private commercial banks).

At present, there is no specifically designed model of European infrastructure financing. The traditional instrument is TSO's own equity financing (as a public or a private company), complemented by loans from commercial banks and international financial institutions (mainly the European Investment Bank (EIB)). In principle, all domestic transmission (and distribution) infrastructure is subject to national regulation, and, thus, shielded from commercial risks. The situation is different for larger cross-border interconnectors (electricity) or multiple-country cross-continental pipeline projects (such as Nabucco), which involve more specific political, economic, and regulatory risks. The latter are sometimes financed on a project basis, with special purpose companies specifically set up. Common financing rules within Europe, namely proper cost and benefit allocation are necessary as no country has an incentive to finance interconnector capacity on its own (Notre Europe, 2010, p. 79). “Merchant” investments of electricity interconnectors, that have somewhat spread in the U.S., are still quite rare in the European context, but they exist in the North Sea, such as the NorNed Cable, for example *(see case study below)*.

Table 3 provides an aggregated picture of the total amount of public expenditure in the field of energy in Europe (both at national and EU level). As shown in the table, in 2009 the EU spent €900 million in energy-related projects. This quantity represented 4% of the total amount of public energy-related spending in Europe that year.

Table 3: Total amount of public expenditure in the field of energy (national and EU level), 2009

	Total (in millions €)	As percentage of total energy-related spending in Europe	As percentage of total public spending that year in each level of intervention
Member states	7,210	96	0.12
EU (EU budget)[10]	300.2	4	0.26
Total	7,510.2	100	…

Source: For the EU: European Union General Budget for the Financial Year 2010 (O.J L 68 of 15 mars 2011); for member states: COFOG statistics for 2009, Eurostat.

In particular in 2010, the share of energy- and other infrastructure-related spending in the EU budget was 1.8%. The budget of the Trans-European

10. Includes all energy-related spending in the EU budget (support to infrastructure, research, renewable energy) except the structural funds.

Networks (TEN's) is modest, representing 0.76% of the EU budget, a major share of which is devoted to finance transport projects. This is low if infrastructures are indeed considered a key element for a competitive European Union.

The following subsections provide a summary of the instruments which currently exist at the European level to (co-)finance energy infrastructures.

2.2. The European Investment Bank (EIB)

The major source of European infrastructure financing is the European Investment Bank. Created by the Treaty of Rome, the EIB is a EU body whose mission is to help implement the EU policy objectives by providing long-term finance to sound investment projects. In the field of energy, it plays an important role in facilitating the implementation of the Trans-European Networks for Energy (TEN-E), identified by the European Commission in cooperation with the Member States.

In 2007-2009, EIB senior loans to TEN-E projects amounted to €6 bn. (€3.4 bn. for natural gas, €2.6 bn. for electricity) (EC, 2010a).

In addition to the conventional EIB loan financing, the EIB uses a number of other financial products to finance TEN projects:

- The Trans-European Network Investment Facility (TIF) provides funding for priority TEN projects. It is designed to invest €75 bn. until 2013 on TEN-Transport projects and €0.5-1 bn. annually for TEN-Energy projects.
- The Structured Finance Facility (SFF) provides funding to projects having a high-risk profile. Established in 2001, this Facility was extended in 2006 to also cover sub-investment-grade TEN projects.

The SFF reserve volume in 2009 was €1.25 bn., with a maximum reserve available until 2013 of up to €3.75 bn.

- The EIB has also participated in Infrastructure Equity Funds in different European regions, though the amounts of these funds are modest.[11]
- Further to be mentioned are the programs JESSICA and JASPERS, two programs developed by the DG Regio in cooperation with the EIB and other financial institutions. JESSICA provides financial support (in form of equity, loans and/or guarantees) to sustainable urban development and regeneration programs. JASPERS provides technical assistance to cohesion recipients to enable them to better prepare major infrastructure projects.

11. Emerging Europe Convergence Fund (€50 mn., of which €16.5 mn. assigned to energy); Dexia Southern EU Infrastructure Fund (€ 25 mn., of which €6.25 mn. assigned to energy); and Dutch/Northern EU Infrastructure Fund (€15 mn., of which €9.9 mn. assigned to education and health and €5.1 mn. assigned to services).

Table 4: EIB Signed Loans for Energy Infrastructure of Trans-European Interest in the Period 2007-2009 (million €)

	2007	2008	2009	2007-2009
Electricity (amounts)				
TEN Projects of European interest	0	90	600	690
TEN Priority projects	140	140	0	280
TEN Projects of common interest	16.1	300	144.45	460.55
Other TEN projects	558	0	0	557.86
Loans allocated to a set of projects of various TEN priority levels	150	163	260	572.5
Gas (amounts)				
TEN Projects of European interest	185	50	0	235
TEN Priority projects	160	375	275	810
TEN Projects of common interest	255	183	0	438
Other TEN projects	0	642	337	979
Loans allocated to a set of projects of various TEN priority levels	0	574	371	945
TOTAL AMOUNTS				
TEN Projects of European interest	185	140	600	925
TEN Priority projects	300	515	275	1090
TEN Projects of common interest	271	483	144	898.55
Other TEN projects	558	642	337	1536.86
Loans allocated to a set of projects of various TEN priority levels	150	737	631	1517.5

Source: EC, 2010a, Annex, p. 50.

2.3. The TEN-Energy-Program

Another source of financing is the Community budget. At present, the heading 1a of the EU budget ("competitiveness and growth") includes a budget line for "Trans-European Networks (TENs)" which covers both TEN-T (transport) and TEN-E (energy).

EU budget's support to TEN-E projects has been low in the past. Commitments in the category of TEN-E in the period 2007-2009 amounted to €70 mn (see Table 5).[12] This funding was used to co-finance feasibility studies (up to 50%) and a maximum of 10% of eligible costs for works. In reality, however, TEN-E co-financing has rarely amounted to more than "peanuts" (› 1%) of total investment costs of projects (EC, 2010a). As we will see in section IV, the TEN-E program is currently under review.

12. Decision 1364/2006/EC lists projects eligible for Community assistance under Regulation (EC) No 2236/95 and ranks them in three categories:
    1. Projects of common interest relate to the electricity and gas networks referred to in the Decision meeting the objectives and priorities laid down in it. They must display potential economic viability. The economic viability of a project is assessed by means of a cost-benefit analysis in terms of the environment, the security of supply and territorial cohesion;
    2. Priority projects are selected from among the projects of common interest. To be eligible, they must have a significant impact on the proper functioning of the internal market, on the security of supply and/or the use of renewable energy sources;
    3. Certain priority projects of a cross-border nature or which have a significant impact on cross-border transmission capacity are declared to be projects of European interest. Also listed in Annex I, projects of European interest have priority for the granting of Community funding under the TEN-E budget and particular attention is given to their funding under other Community budgets.

Table 5: TEN-E Commitments in the Period 2007-2009 (in thousand €)

	2007	2008	2009	2007-2009
TEN-E Budget available	**21,200.0**	**22,260.0**	**26,045.9**	**69,505.9**
Global commitment	**21,200.0**	**22,248.8**	**26,034.3**	**69,483.1**
Individual commitments (total)	**21,200.0**	**22,248.8**	**26,034.3**	**69,483.1**
Electricity	15,175.5	9,781.6	15,302.9	40,260.0
Studies	*8,132.6*	*3,930.4*	*10,639.5*	*22,702.5*
Works	*7,042.9*	*5,851.2*	*4,663.4*	*17,557.5*
Gas	6,024.5	12,467.2	10,731.4	29,223.1
Studies	*4,024.5*	*9,648.2*	*8,799.6*	*22,472.3*
Works	*2,000.0*	*2,819.0*	*1,931.8*	*6,750.8*

Source: EC, 2010a, Annex, p. 52.

2.4. The European Economic Recovery Plan (EERP)

A special one-time impetus for energy infrastructure financing has come under the umbrella of the European Economic Recovery Plan (EERP). Adopted by the European Council in 2008, the EERP is a two-year extraordinary stimulus plan aimed at boosting European economies through a combination of short-term measures to stimulate demand and long-term investment in strategic sectors.

The EERP has allocated €3.98 bn. to energy infrastructure and technology, €2.37 bn. of which has been slated to support electricity and gas infrastructure projects (the remainder allocated to wind and carbon capture projects).[13] This accelerated support has gone to 47 projects *(see Annex)*. As stated in its regulation, the EERP support should not exceed 50% of the total costs of the projects financed (including construction works). Almost all of the beneficiary projects have been trans-European energy infrastruc-

13. Regulation (EC) no. 663/2009 of the European Parliament and of the Council of 13 July 2009 Establishing a Program to Aid Economic Recovery by Granting Community Financial Assistance to Projects in the Field of Energy, Brussels.

ture projects (of different priority). Another €1 bn. has been allocated to CCTS separation projects, but not to CO_2-infrastructure itself.

2.5. European Fund for Energy, Climate Change and Infrastructure (Marguerite Fund)

The European Fund for Energy, Climate Change and Infrastructure (Marguerite Fund) was endorsed in December 2008 by the ECOFIN Council and the European Council as part of the European Economic Recovery Plan (EERP). The idea was to bundle financial means and competences among EU and national development banks and to create a stable equity fund involving both private and institutional investors. The six core sponsors of the Marguerite Fund (€100 mn. contribution each) are the EIB, the Caisse des Dépôts, the Cassa Depositi e Prestiti, the KfW Group, the Instituto de Crédito Oficial and the PKO Bank Polski. Apart from them, the Fund counts with the participation of the European Commission (€80 mn.) as well as of smaller private sponsors. This equity fund is accompanied by a debt facility of €5 bn.

Target sectors of the Marguerite funds are TEN-E and TEN-T projects. In addition, the Fund invests on renewable energy projects, including sustainable energy production, clean transport infrastructure, energy distribution and systems for hybrid transport (e.g. wind, solar -CSP and PV-, geothermal, biomass, biogas, hydro and waste-to-energy projects). At least 65% of the fund's investments are targeted to 'greenfield' investments. The fund is set up for at least 20 years.

2.6. Other instruments

Energy infrastructure is also financed by other instruments, though their total contribution so far is relatively small. Among these are the Structural Funds, which co-finance energy infrastructure at approximatively €233 million per year (SRU, 2011, p. 325), the Instruments for Pre-Accession, the European Neighbourhood and Partnership Instrument (ENPI), the Neighbourhood Investment Facility (NIF) and the RTD Framework Programme (Research, Technology Development and Demonstration).

III. Case Study: Selected Issues in the North Sea Grid Project

We shall highlight some of the issues related with the future financing of the energy infrastructures with the help of a case study, which is based on a larger technical-socioeconomic analysis (see Egerer, von Hirschhausen, and Kunz, 2011).

3.1. The North Sea Grid: A Number 1 Priority for European Infrastructure

The "North Sea Grid" (NSG) is in the core of the No. 1 priority of the "European energy infrastructures for 2020 and beyond", which defines the objective to develop an "Offshore Grid in the Northern Seas and a connection to Northern as well as Central Europe" (EC, 2010b, p. 10). The objective is "to integrate and connect energy production capacities in the Northern Seas, including the North Sea and North-Western Seas, with consumption centres in Northern and Central Europe and hydro storage facilities in the Alpine region and in Nordic countries" (*Ibidem*, p. 10). This project is of strategic importance since it enables Continental Europe to accommodate large volumes of wind and water surplus electricity generation in and around the Northern and Baltic Seas, while connecting these new generation hubs with major storage capacities in Northern Countries (and the Alps) and with the major consumption centres in Central Europe (*Ibidem*, p. 12).

The project involves a large number of EU countries (UK, Ireland, Denmark, Germany, Netherlands, Belgium, France, Sweden, Poland) plus Norway. It thus constitutes a critical mass of Member States acting together with similar objectives.[14] The project involves countries that, while having quite distinct regulatory approaches, can establish new common ground for regulatory schemes that go beyond the more national perspective. Last but not least, the region can build upon quite a successful history of interconnection and renewable integration, starting with the French-UK interconnector, and then continuing with the Norway-Netherland interconnector (NorNed), and, most recently, the Norwegian-German interconnection project (NorGer).

The transmission capacity from existing interconnectors and the future elements of the North Sea Grid enforce the internal European market for electricity between the three highly separated markets of Scandinavia, the United Kingdom and Continental Europe. The offshore grid should consist of AC cables for close to shore wind farms and HVDC-VSC cables for connections of more than 120 km in length. Undersea links between the three markets should also be of HVDC technology with high voltage levels (Brackelmann and Erlich, 2009).

The "Masterplan" of the North Sea Grid is easily sketched out, and it includes the following elements:

14. One instrument that the EU has institutionalised in this context is the "High-level-group" (Adamowitsch, 2010).

- A connection of offshore wind generation into the existing system is required;
- Additional trade links between Continental Europe, the UK and Scandinavia are beneficial for a better market integration (internal European market for electricity);
- Market integration increases the security of supply (e.g. for Norway during years with very low hydro generation);
- The link to Scandinavian hydro reservoir storage can reduce the fluctuations in combined generation output with offshore wind (backup capacity);
- The connection of mostly separated markets causes price convergence and has winners and losers;
- The NSG could be an alternative to discussed onshore transmission investments by offshore bypasses.

3.2. Issues of Planning and Network Design

The discussion of alternative network designs of the North Sea Grid highlights the crucial role of longer-term planning and the potential controversies resulting thereof. Depending on who takes the decision of network design, how financing is structured, and also the regulatory setting, three very different developments are conceivable:

1. The *"radial scenario"* includes clustered offshore wind integration at national level. Depending on the distance to the onshore connection point either AC or DC submarine cables are used. The trade capacity between the markets of Scandinavia, the UK and continental Europe is not expanded and only includes the already existing connectors. No financing for trans-national offshore interconnection projects is required.
2. The *"trade scenario"* includes the offshore wind integration of the radial scenario. In addition, the capacity of DC connectors (each

directly built between two countries) is expanded with new lines to enforce the internal European market (Figure 4). These additional exchange capacities are planned and built separately from the offshore wind integration links and can be merchant lines motivated by existing price differences. The new trade connectors include an additional 5,300 GW km of offshore cables.

3. The *“meshed scenario”* assumes a combined wind and market integration approach leading to meshed elements in the North Sea Grid (Figure 4). Though the infrastructure project becomes more complex by multi-national involvement, the connection of the major offshore generation areas in the North Sea to one large cluster is considered beneficial. It can bring down intermittency in output as it allows on more flexible wind distribution and enforces the internal European market. The scenario only includes 5,500 GW km of additional offshore connections as some of the radial wind integration lines are utilised for trade purposes, as well.

In addition to the necessary wind integration costs of the radial scenario, the trade and meshed scenario require trans-national investments amounting to €10-20 bn. until 2030 while the meshed scenario is the more expensive one due to the required offshore hubs.

Figure 4: Trade scenario (left) and meshed scenario (right)

Source: Egerer, von Hirschhausen, and Kunz, 2011.

3.3. Overall Welfare Gains Contrast with Winners and Losers

The two extreme scenarios thus are a market-driven North Sea Grid with investments based on price differences in the three regions, and a regulated approach which involves an overall medium term expansion plan for the North Sea Grid developed by an overall "welfare maximiser" (one could think of a European institution). The change in the annual system welfare over all nodes of the three markets plus the offshore congestion rents is the basic indicator for the benefit of introducing new elements to the system.

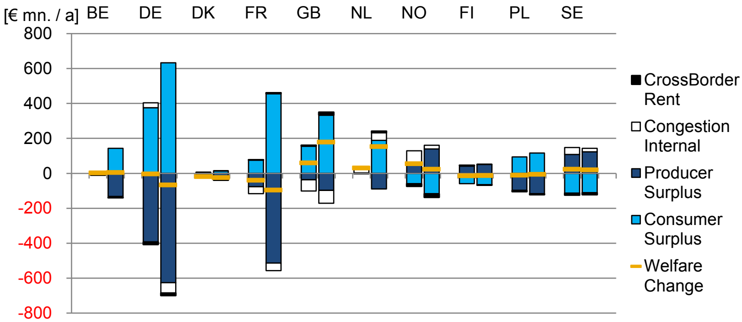
The model runs are done for the combination of the 2009 reference scenario and a "wind+" scenario (including additional wind generation) with the three different network scenarios. The resulting model outputs are the system welfare, the national welfare (further divided in consumer and producer surplus), the nodal prices and the trade flows in the network (especially within the NSG). For the offshore links of the North Sea Grid the congestion rents are determined, as well.

Our results confirm the dilemma of trans-national energy infrastructure in Europe: we find overall welfare gains generated by the North Sea Grid, whereas at the level of the individual regions there are winners and losers (Figure 5).[15] Comparing the two different grid layouts, the meshed scenario seems more promising as it shows high benefits even without additional wind capacity and justifies the increased investment costs by the additional welfare gains.

15. The modeling approach is based on the electricity model ELMOD, a bottom-up model of the European electricity market which builds upon the DC load flow (DCLF) approach (Leuthold, et al., 2011). It combines electrical engineering by including time resolution with variable demand and different levels of wind input. The objective function maximises welfare (quadratic problem) and the electricity network is included line sharp.

The distribution in consumer and producer surplus shows the rent shifting effect of the North Sea Grid. The results are driven by price convergence with higher prices in Scandinavia and lower prices in the other countries. For higher prices consumers lose and producers gain rents (e.g. Norway, Sweden) while lower prices cause higher rents for consumers and losses for producers (e.g. Germany, France). For many countries (e.g. Belgium and Germany) the redistribution of rents by additional transmission capacities is more than ten times higher than the national welfare effect.

Figure 5: Redistribution of Rents with Trade Scenario (left) and Meshed Scenario (right)



Source: Egerer, von Hirschhausen, and Kunz, 2011.

3.4. Limited Potential for Merchant Transmission Investment

The North Sea Grid is thus an important test case for different institutional options for financing high-voltage transmission lines, in particular the two extreme cases: private merchant transmission and regulated investment.

“Merchant” transmission is based on the idea that market forces are key to investment and expansion in transmission. Transmission investment is a lucrative business if it generates sufficient rents from the difference between buying and selling electricity at different ends of a merchant transmission line. The difference between locational marginal prices (LMPs, or "nodal" prices) therefore determines the incentives to invest into a specific transmission line.[16] On the other hand, in the (traditional) "regulated" approach the network operator is subject to a price revenue cap or a cost-based mechanism, where one objective of the regulator is to provide incentives for efficient management of the grid (OPEX-benchmarking).[17] There is a significant literature on the pros and cons of merchant transmission investment (see Joskow and Tirole, 2005), though no standard assessment has emerged thus for. One reason is that the nature of the nodal price differences largely depends on the network topology: in a two-node network, the transmission revenues are identical to the nodal price difference multiplied by the electricity transported additionally, since there are no loop flows. The more meshed a networks gets, the more indirect becomes the link between the transmission investment and potential electricity flowing precisely between these two nodes.

Our analysis indicates the limits of merchant transmission in the case of the North Sea Grid. Whereas the first cable in the North Sea, such as the NorNed interconnector between Norway and the Netherlands, proved to be highly lucrative, this will be much less the case for subsequent lines. While one or two additional lines could still be profitable, much of the investment will have to be regulated, if at all it comes about. Our result does not indicate a significant increase in congestion rents for the entire offshore scheme with the expansion of the connector capacity. Therefore, merchant investment alone will not provide sufficient trade capacities. It is not interested to surpass a certain limit where the profit from additional trade flows is more than compensated by the decreasing price per transported unit.

16. "While locational marginal prices, coupled with FTRs, provide a conceptual frame work for merchant transmission investments, a number of theoretical and practical differences must still be overcome." (Kirschen and Strbac, 2004, p. 228).
17. "Allocating the costs and benefits of transmission expansion to all the network uses is a major challenge" (Kirschen and Strbac, 2004, p. 228). Proposals for the allocation of costs within a regulated approach have been made by Olmos and Perez-Arriga (2009), e.g. in the form of the average revenue tariffication.

The lack of financial incentives for investors to resolve congestion causes problems of this approach to solve the design problem for offshore grids. Therefore, it is of high importance to find means to evaluate different offshore grid layouts according to a set of various benefits and install a regulatory framework under which the trans-national projects can be realised. This would also require the question of refunding for the required investments. This design is likely to have meshed offshore elements which seem to have a more beneficial character compared to individual trade links. A meshed network which connects the major offshore hubs is more flexible by wind integration to several offshore nodes and can also be utilised as bypass to onshore bottlenecks as for example at the east coast of the United Kingdom. The meshed character of DC grids and their interdependency with onshore AC transmission systems even increases the complexity of planning and operating issues.

3.5. Conclusion of the Case Study

The case study highlights a couple of issues on planning, network design and financing that might be of interest for other important European energy priorities (see Egerer, et al., 2011, for details):

- There is clearly a distinction between the overall benefits of the North Sea Grid project and the benefits at the national level. While the overall gains in social welfare are significant and certain, the benefits that each individual country obtains vary with the network design, the regulatory approach, and the assumptions on supply and demand. Thus, there is a high variance in the expected benefits for each country, which will limit their enthusiasm to engage in such a multilateral project;
- The case study also highlights that an infrastructure project has winners and losers, and that balancing the interests of different participating parties is a critical element of any transmission

expansion strategy. In this case, the exporters of low-cost electricity, i.e. Norway and the UK, are winners of a grid expansion, since they obtain higher prices in the region they export to (Continental Europe) than in their respective domestic markets. Continental European consumers also gain from the developments due to the price decrease they enjoy. On the other hand, electricity producers in the more expensive region (Continental Europe) lose market share and producer rent, while the consumers in the lower-price region also loose (consumer) rent: after the installation of the infrastructure, they have to pay a higher price than before;

- There is a complex issue of timing that drives a wedge between the public policy perspective and the interests of private investors. Even though the long-term effects of an integrated, meshed grid turn out to be the highest, they also occur after the longest project duration of all the different network designs. For a risk-averse, short-term profit oriented investor, a small investment into a point-to-point extension with predictable outcome will be more attractive than an engagement into a longer-term investment with less predictable outcome, albeit a high social welfare gain;
- Last but not least, the case study is a showcase for the difference between a profit-oriented merchant investment and a welfare-oriented regulated investment. The potential for merchant transmission is reduced the further the infrastructure investment proceeds and prices converge. In the case of the North Sea Grid, the opportunities for lucrative transmission investment are rapidly exhausted: perhaps one or two Norwegian-German cables (such as NorGer) will still attract private merchant transmission, but for the remaining transmission expansion projects, there is too little congestion rent to pay for the infrastructure investment.

The North Sea Grid project therefore is a good example for the need of a balanced approach between the European level and the Member States, and merits further analysis into regulatory and financial issues.

IV. Looking forward: How to ensure the Financing of Trans-National Energy Infrastructures in Europe?

4.1. The Need for a European Approach

Difficulties with the development of trans-European energy infrastructures have not remained unnoticed and policy measures are discussed both at the European and the national level.

The Energy Infrastructure Package "Impact Assessment" (EC, 2010c) provides rough estimates of the social costs of a slow implementation of infrastructure development. According to the EIP assessment, if transmission was optimised mainly at the national level rather than the EU-level, this would lead to higher energy costs. Reference is made to significant congestion rents within the 26 European electricity TSOs: about €1.21-1.95 bn. annually (EC, 2010c, p. 35). A study by Matti Supponen (2010) estimates the welfare losses due to congested interconnections and the subsequent price differentials (€15-29/MWh) at about €3.1 bn. annually. Transmission investment would also reduce the risk of system instability. The "Smart 2020" study (The Climate Group, 2009) estimates that emissions could be reduced by 15% thanks to smart grids (EC, 2010b, p. 37).

For natural gas, the main economic effect mentioned is increased reliability of supply brought about by an extended pipeline infrastructure network. Thus, for instance, the European Commission (2010c, p. 36) estimates the economic damage caused by the January 2009 gas supply disruption in South-East Europe (Slovakia, Hungary, Croatia, Serbia, and Bulgaria) at €1.65 bn. The costs of this supply disruption are significantly higher than the cost of the reverse flow projects and the Central-Eastern European interconnector and storage projects under way within the EEPR (corresponding to €1.2 bn). The competition effect of additional infrastructure can also have significantly positive social welfare effects. At present, there remain significant price differences between Italy, Eastern Europe, and the North-West European Zone, which would be mitigated by additional infrastructure.

The economic benefits of a CO_2-infrastructure are more difficult to access, because their effect is more uncertain and the benefits of a functioning CCTS-infrastructure are less clear. However, some stakeholders contend that the 2050 climate targets (80-95% reduction of greenhouse gases) will be difficult to meet without CCTS, at least in the industrial sector: while there may be cheaper mitigation options in the energy sector, the use of process heat and related CO_2-emissions in the industry sector (steel, cement and clinker, pulp and paper, refineries) will still be required for some time, and it requires an integrated CCTS value chain.

The European Commission (2010b, p. 37) also analyses the environmental impact of infrastructure development, with a focus on avoided CO_2-emissions. According to the Commission's analysis, the ambitious renewable objectives of the European energy policy (20%) will not be met without the underlying infrastructure. The PRIMES reference scenario, with the entire infrastructure in place, achieves a cumulated 2.500 mt (3%) reduction of CO_2-emissions between 2010 and 2030, compared to the Baseline scenario.

Last but not least, the European Commission (2010b, p. 36) insists on the potential danger of underinvestment into energy infrastructure, where the cost of electricity and gas transmission is relatively modest (ca. 2-4% of final gas price, about 10% of electricity costs). A lack of infrastructure could cause energy shortages, disruptions, or price increases with high economic and social costs. Moreover, investing in slight overcapacity could help avoid shortages and black-outs resulting into higher overall costs for the concerned Member States (higher compared to the costs of constructing interconnectors to obtain regional balancing).

The need for a European approach has been expressed quite explicitly by the February 2011 European Council.[18] In this meeting, the EU leaders have acknowledged that “major efforts are needed to modernise and expand Europe’s energy infrastructure and to interconnect networks across borders”. While recognising that “the bulk of the important financing costs for infrastructure investments will have to be delivered by the market”, the Council highlights that “some projects that would be justified from a security of supply/solidarity perspective, but are unable to attract enough market-based finance, may require some limited public finance to leverage private funding”.

The Council has invited the Commission to define clear and transparent criteria to select those projects requiring (limited) public financial support (e.g. non-commercial projects, justified for security of supply or solidarity reasons). Activities are currently under way to identify procedures for identifying concrete projects, and where the EU should play a more proactive role.

18. Conclusions on Energy, European Council of 4 February 2011.

4.2. Financing TEN-E projects: the “Connecting Europe Facility”

In the context of the ongoing negotiation of the European 2014-2020 financial perspectives there is a need for streamlining, consolidating, and expanding financial support to sustainable energy infrastructure. This has been recognised by the Commission, which published on 29th June 2011 the proposal for the budget 2014-2020. This proposal will serve as basis for the negotiation of the 2014-2020 budget among Member States, which will finish in 2012.

Until now, the financial role of the TEN-E program is modest, but the planning function is central. Thus, by providing political support to selected European projects of interests, the EU has an important saying on how trans-national infrastructure is developed. It would be logical, then, that its financial role correspond to that ambition, and that the financing and provision decisions be still better coordinated. TEN-E could facilitate the creation of interconnectors and therefore the realisation of an integrated European energy market. This would suggest that the TEN-E guidelines be revised and a clear role be attributed to designate responsibility for infrastructure planning and/or financing. At present, the financial role of the TEN-E program is not significant: the budget is limited and it was not intended to address today’s energy problems (CEPS, 2009, p. 33). On the other hand the planning function of TEN-E is essential which might be an inappropriate institutional setting for both functions and therefore needs to be substantially revised.

In its proposal, the Commission proposes a change in the modes of financing TEN-E. It proposes finishing with the current TEN program and creating instead another instrument, the “Connecting Europe Facility”. This “facility” would serve to finance TEN projects in transport, energy and broadband, by combining grants and market-based instruments.

The facility will have a single fund of €40 bn. for the period 2014-2020. €9,1 bn. would be reserved for energy infrastructures.

4.3. The EIB and Energy Infrastructure Bonds

The European Investment Bank (EIB) should assume a key role in the financing of European energy infrastructure. This can be done through (low-cost) debt to finance riskless operations, such as sunk investment and investment backed by regulated revenues. The EIB can also be engaged in equity operations where appropriate, though this would clearly require the definition of a specific role in each of the projects. The role as facilitator of public-private-partnerships (PPP) should be critically assessed, given that PPPs have so far not delivered the promise of higher efficiency. Special programs, like Marguerite, have been instrumental for specific purposes, but are not structured to provide long-term financial perspectives.

The issuance of energy infrastructure bonds have been pushed politically recently, amongst others by the EU-Energy Summit in February 2011. In fact, the "Connecting Europe Facility" *(see above)* is the first concrete outcome of the "Europe 2020 Project Bond" EU-plan to back infrastructure bonds issued by the private sector, launched jointly by the European Commission and EIB in early March 2011 (EC, 2011). The Project Bond Initiative suggests that the EU and the EIB could provide guarantees to private investors, using EU funds; another option is to provide direct loans at a subordinate level. In both cases, substantial risks would be shifted from private investors.

The advantages and disadvantages of different options have to be weighted carefully, in particular with respect to EIB financial instruments such as a separate infrastructure bank, equity participation and support to infrastructure funds, targeted facilities for project bonds, test option for advanced network related capacity payments mechanism, risk sharing facilities, and public private partnerships loan guarantees. The advantage might be easy accessibility, low financing costs, and high flexibility with respect to timing and volumes of financing. A disadvantage might be the "competition" with the Eurobonds currently under discussion as a solution to the financial crisis and the instability of the euro. The key question is whether the additional political and institutional reforms needed to establish EU-energy infrastructure bonds are justified to outperform the available instruments provided by EIB.

4.4. The reform of the EU Budget

The ongoing negotiation of the new multi-annual EU budget for the post-2013 period faces different challenges. On the one hand, the EU's role in implementing energy infrastructure of European interest is key. On the other hand, budgetary reforms, the economic situation in several Member States as well as the investment required for infrastructure limit the financial resources. Although the transformation and development of the energy sector is one of the key policy areas for the years to come (EC, 2010 f/g), its role is not yet fully defined.

The negotiations about the next multi-annual EU budget (2014-2020) will certainly place more importance on sustainable energy infrastructure. Apart from financing TEN-E projects, the EU budget should also provide support for further R&D and financing the demonstration of technologies, assisting the development of the trans-European energy networks and helping poorer regions and countries to invest in clean energy systems (CEPS, 2009, p. 32). At present, the main spending program co-financing energy infrastructure is the Cohesion Funds, with approximatively. €233 million per year (SRU, 2011, p. 325). Other, new budget lines for energy infrastructure may be considered. There is also a discussion about the modification of priorities within the budget. Current strategic priorities of the Cohesion Funds have now been expanded to sustainable development regarding energy efficiency and renewable energies.[19]

Regarding other sectors, CEPS[20] suggests investments in sustainable development of cities where Structural Funds can be converted into equity, loans or guarantees for investments in urban projects might be something worth considering. It could be seen as a precursor for the energy market – in any case the transferability remains to be tested.

As the raising of credit is still excluded from the opportunities of the European budget (Art. 311, Lisbon Treaty), a further option is private-sector bonds to foster large infrastructure projects. As seen before *(part 4.2.)*, this is the option put forward by the Commission through the "Connecting Europe Facility". The advantages of this approach remains to be examined as it might conceal conflicts of objective as well as problems of incentives.

19. Council Regulation (EC) No 1084/2006 of July 2006 establishing a Cohesion Fund and repealing Regulation (EC) No. 1164/94, Article 2. CAP and cohesion policy occupy 80% of the budget which is limited to 1.24% of EU gross national income (CEPS, 2009, p. 19).
20. This scheme by the EU is referred to as the Joint European Support for Sustainable Investment in City Areas, JESSICA (CEPS, 2009, p. 35).

Conclusion

This study has analysed past EU experiences and new perspectives for financing trans-national energy infrastructure at the European level. We have set out the framework for analysing such investments and we have reviewed past experience, the main focus being the perspectives. Clearly, Europe has a more active role to play in this regard, but the concrete formulation of this strategy is yet to be defined. In particular, the "Connecting Europe Facility" proposal needs to be reviewed and it needs to be proven that it can deliver results that could not be attained by the instruments currently available. The North Sea Grid is a good example for the need of a balanced approach between the European level and the Member States, and merits further analysis into regulatory and financial issues.

Given infrastructure as a key driver to respond to climate change and reach the EU's 2020 goals, the current European budgets for energy infrastructure seem insufficient. It seems that an increase in EIB's financing facilities could be justified, which corresponds to the investment for TEN projects.

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Annex

Table 6: EEPR-Projects in the Electricity Sector

Project	Description	EEPR Financing
INFRASTRUCTURE (Gas interconnectors (RF = Reverse Flow)		
Nabucco	The Union is co-financing the procurement of long-lead items (pipelines and compressors) for the Nabucco pipeline.	200,000,000 €
Poseidon	The Union is co-financing the technical studies (detailed engineering) and the pipes for the 210 km offshore pipeline between Greece and Italy.	100,000,000 €
Baltic – Poland	The Union is co-financing the construction of the onshore gas pipeline that extends from Świnoujście to Szczecin and the construction of the compressor station in Goleniów	50,000,000 €
SI	The Union is co-financing the construction works of Cerŝak – Kidricevo section of the gas pipeline (Slovenian pipeline running from the Austrian to the Croatian border).	40,000,000 €

BG – EL	Purchasing the equipment for Rogaska Slatina – Trojane section and Trojanes – Vodice section of M2/1 pipeline.	45,000,000 €
Store CZ 02	The Union is co-financing the connection of the underground gas storage (UGS) Tvrdonice to the transit system and improve gas sources available for reverse flow in case of possible future gas storage from the direction Ukraine.	35,000,000 €
HU	The Union is co-financing the purchase of raw material and compressor stations for the construction of a pipeline interconnection between the Hungarian and Croatian gas networks.	20,000,000 €
RO – BG	The Union is co-financing the construction of a pipeline gas interconnection between the Bulgarian and Croatian gas networks, including the construction of two gas metering stations.	8,929,000 €
Galsi	The Union is co-financing 140 km of pipe procurement and the laying activities on the seabed.	120,000,000 €
ES	The Union is co-financing the purchase of 251 km of pipeline to be laid down between Yela and Villae de Arnedo (including the construction compression station).	45,000,000 €
BE	The Union is co-financing the procurement of pipes and the construction works from Raeren (Eynatten) to Opwijk of a total length of 170 km.	35,000,000 €
CZ – PL	The Union is co-financing the first phase of the construction of a high pressure natural gas pipeline interconnection between Poland and the Czech Republic (i.e. Tranovice – Cieszyn – Skoczów).	14,000,000 €
PT	The Union is co-financing the building of 48 km gas pipeline from Mangualde to Celorico da Beira.	10,700,749.5€
RO	The Union is co-financing some construction works within three existing compressor stations on the Romanian territory. It will implement the reverse flow between Romania and Bulgaria.	1,560,000 €
AT 01	The Union is co-financing the upgrading of Baumgarten gas hub to allow transport of gas from Germany to countries adjacent to Austria, in particular in case of a disruption of supply of gas entering EU at the Ukraine / Slovak border.	1,854,000 €

AT 02	The Union is co-financing the upgrading of Baumgarten gas hub to allow for increased transport capacity for gas coming from western sources via the TAG pipeline.	425,000 €
AT 03	The Union is co-financing the upgrading of the Überackern Export Facility to allow for reverse flow from Germany (from SUDAL and/or ABG pipelines into PENTA West pipelines).	1,150,000 €
AT 04	The Union is co-financing the technical modification along the Trans-Austrian (TAG) pipeline, to allow for increased gas transport capacity toward the Baumgarten gas hub.	3,317,000 €
SK 01	The Union is co-financing the delivery and the construction of two parallel interconnection pipelines including relevant technical units and equipments to connect the two gathering stations of the existing Underground Gas Storage (UGS) Lab Complex between themselves and the two gathering stations above-mentioned as interconnected with the Central Station Gajary-Baden.	2,936,121 €
SK 02	The Union is co-financing the engineering, purchase and installation of specific technical equipments in two existing gas transmission facilities in Slovakia (at node Plavecky Peter and at the compressor station Ivanka pri Nitre).	664,500 €
CZ 01	The Union is co-financing the increase of the transmission capacity through the Czech Republic by 15 mcm/d in the northwest-east direction, from the Czech-German border toward Czech-Slovak border.	3,675,000 €
CZ 02	The Union is co-financing the connection of the underground gas storage (UGS Tvrdonice to the transit system and improve gas sources available for reverse flow in case of possible future gas shortage from the direction Ukraine.	2,300,000 €
LV – LT	The Union is co-financing the improvement of the infrastructure and equipment for bi-directional gas flow between Lithuania and Latvia.	12,940,000 €

INFRASTRUCTURE (Electricity interconnectors)		
Estlink 2	The Union is co-financing the construction of the second electricity interconnection between Estonia and Finland as well as the required grid reinforcement in Estonia.	100,000,000 €
Nordbalt 01	The Union is co-financing the interconnection of the Nordic and the Baltic electricity markets via a 400 km submarine cable (700 MW) between Sweden and Lithuania.	131,000,000 €
Nordbalt 02	The Union is co-financing the strengthening the Latvian transmission network and reducing bottlenecks within the Baltic states.	44,000,000 €
DE	The Union is co-financing the cable and the construction of the 140 km electricity interconnector Halle/Saale – Schweinfurt. It aims at coupling the North-East part and the South-Western part of Germany.	100,000,000 €
AT – HU	The Union is co-financing the new overhead line 400kV Wien (AT) – Györ (HU). Austrian side action is the new line; Hungarian side is substations modifications and extension.	12,989,800 €
PT 02	The Union is co-financing the extension of the 400kV line from Vaidigem towards Vermoim situated close to the Atlantic coast, the reinforcements of the overhead lines in the Douro Internacional area and the Extension of the 400kV line to the Douro Internacional region.	28,873,787 €
ES – FR	The Union is financing the construction of the interconnection between Spain (Santa Llogaia near Figueras) and France Baixas (Baixas near Perpignan). It includes the cables the converter stations and the tunnel.	225,000,000 €
IT	The Union is financing an additional 400kV line Italy mainland-Sicily, the installation of overhead lines on continent, the submarine cable and works at substations.	110,000,000 €
IRL - UK	The Union is co-financing the first submarine interconnection between Wales (UK) and Ireland: 500 MW HVDC cable plus converter stations.	110,000,000 €

MT – IT	The Union is co-financing the first submarine interconnection between Italy and Malta: 220kV HVAC cable (250MVA capacity).	20,000,000 €
INFRASTRUCTURE (Small island projects)		
CY	The Union is co-financing the necessary infrastructure (local natural gas network in the form of three pipelines) in Cyprus for the purpose of accommodating the future needs of natural gas users. It includes the construction of three pipelines connecting the future LNG terminal with the Three existing power stations.	10,000,000 €
MT	The Union is co-financing the extension of the distribution network to submarine cable.	5,000,000 €
FUNDS COMMITTED (Infrastructure)		1,651,314,957.5€
Offshore Wind Energy (OWE)		
COBRA CABLE	Large capacity interconnector between the Netherlands and Denmark. Investment in innovative designs for direct connection of offshore wind farms and the modular start of the North Sea Grid.	86,540,000 €
HVDC hub	Addition of an intermediate offshore platform on the planned HVDC link (between Shetland and Scottish mainland) for connecting offshore wind and marine generation.	74,100,000 €
BARD 1	Production of innovative tripile foundation system and production and installation of innovative cable in-feed system for a 400 MW offshore wind farm.	53,100,000 €
Nordsee Ost	Offshore wind farm installation of 6 MW wind turbine generators (monopole foundation) in challenging offshore circumstances, including innovative logistics and installation processes.	50,000,000 €
Global Tech I	Gravity foundations for deep water wind farm using efficient serial manufacturing and fast installation processes.	58,540,893 €
Borkum West II	Installation of 80 innovative 5 MW wind turbine generators (tripod foundation).	42,700,000 €

Thornton Bank	Optimised logistics for upscaling the far-shore deep-water Thornton Bank wind farm and demonstration of innovative substructures (jacket foundations) for deep water off shore parks.	10,000,000 €
FUNDS COMMITTED (OWE)		374,980,893 €
Carbon Capture and Storage (CCS)		
Belchatow	Demonstration of the entire CCS chain on flue gases corresponding to 250 MW electrical output in a new supercritical unit of largest lignite-fired plant in Europe. Three different saline aquifer storage sited will be explored nearby.	180,000,000 €
Compostilla	Demonstration of the full CCS chain using Oxyfuel and fluidised bed technology on a 30 MW pilot plant to be upscaled by December 2015 to a demonstration plant of more than 320 MW. Storage in a saline aquifer nearby.	180,000,000 €
Hatfield	Demonstration of CCS on a new, 900 MW IGCC power plant. Storage in an offshore gas field nearby. The project is part of the Yorkshire Forward initiative that aims at developing a CO_2 transport and storage infrastructure for the region.	180,000,000,€
Jänschwalde	Demonstration of the Oxyfuel and post-combustion technologies on an existing power plant. Two storage and transport options will be analysed.	180,000,000 €
Porto Tolle	Installation of CCS technology on a new 660 MW coal power plant. The capture part will treat flue gases corresponding to 250 MW electrical output. Storage in an offshore saline aquifer nearby.	100,000,000 €
Rotterdam	Demonstration of the full chain of CCS on a capacity of 250 MW equivalent using post-combustion technology. Storage of CO_2 in a depleted offshore gas field near the plant. The project is part of the Rotterdam Climate Initiative that aims at developing a CO_2 transport and storage infrastructure for the region.	180,000,000 €
FUNDS COMMITTED (CCS)		1,000,000,000 €
TOTAL EEPR FUNDS COMMITTED		3,026,295,850.5€

Source: Oettinger, 2010.

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Competition, Cooperation, Solidarity

Financing Trans-European Energy Infrastructures – Past, Present and Perspectives

The negotiations about the EU budget after 2013 can't ignore austerity concerns but, due to its limited size, we cannot expect major savings from applying austerity at the EU-level.

A more intelligent response to the austerity challenge is to look at ways to make savings by better coordinating EU and national-level spending or by re-organising spending tasks. To explore these potentialities for efficiency gains, *Notre Europe* launched a set of publications under the title "How to spend better together", which contains both transversal and sector-focused analysis.

In the context of this project, this Policy Paper by Christian von Hirschhausen focuses on the financing of trans-European energy infrastructures. After providing an overview of the long-term infrastructure needs and of the various instruments that currently exist to finance them, the author discusses various aspects related with the planning and financing of cross-border energy infrastructures with the help of a case study: the North Sea Grid Project. On the basis of the North Sea example, he highlights the importance of adopting a regulatory approach balancing European and Member States' interests as well as of streamlining and expanding the EU financial support to sustainable energy infrastructures.

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