REPORT ADDRESSED TO FRANÇOIS HOLLANDE,
PRESIDENT OF THE FRENCH REPUBLIC

ENERGY, A NETWORKED EUROPE

TWELVE PROPOSALS FOR A COMMON ENERGY INFRASTRUCTURE POLICY

MICHEL DERDEVET

La **documentation** Française

"Europe will not be made all at once, or according to a single, general plan. It will be built through concrete achievements, which first create a de facto solidarity."

Robert Schuman
9 May 1950

ISBN¬: 978-2 -1-009982-2

THE PRESIDENT OF THE REPUBLIC

Paris, 25 August 2014

Dear Secretary General,

Since 2012, I have wanted a new impetus be given to European energy policy, making it both more effective and better coordinated.

In this context, energy networks are called on to play a crucial role consisting of combining the diversity of the national energy choices, continuously balancing supply with demand and ensuring the security of supply.

Besides the cooperation already begun between Member States, the networks are in fact the means that will be used to drive forward two major developments. They will both have to ensure the interconnections that are essential to Europe, in particular with regard to the development of renewable energy, and contribute to the necessary improvement in energy efficiency through smart grids.

Europe cannot embark on this transformation combining energy and digital technology in a fragmented way, and should lay down a few priority programmes, bringing together the research and development efforts currently carried out separately in the Member States.

Therefore, I have decided to entrust to you with producing a report on the concrete avenues for strengthening economic and industrial cooperation, in particular within the Franco-German partnership, with regard to European energy networks.

With as a starting point, a review of the cooperation already existing, both with respect to electricity and gas, between the operators of the European transmission and distribution networks as your starting point, your task will be to estimate the needs for strengthening and developing European energy infrastructure up to 2030, providing a perspective according to different scenarios of the evolution of power generation and energy consumption in the Union.

I expect your report to produce concrete proposals, constructed through the hearing of experts and reference figures (national and European), that will identify the projects to be launched as a priority, in which our country will be able to take its full part, and that will be able to be submitted to the European institutions whose leaders will be renewed this autumn.

Mr Michel Derdevet
Secretary General, member of the Executive Board of ERDF

You will be able to rely on the competent services of the State, and to ask for assistance from the bodies and figures who you consider to be useful in this regard.

I would like to have your report by the end of 2014.

Please accept, my best regards.

Yours sincerely,
François HOLLANDE

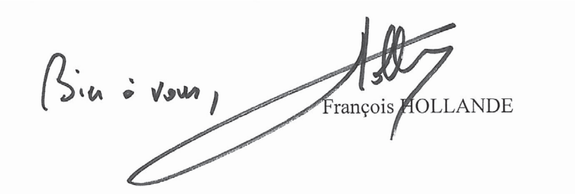


TABLE OF CONTENTS

Abstract

Just a few months before the next COP 21 in Paris, Europe has a particular responsibility to put forward proposals and to make this Conference a global success.

The Europeans were the first to make the fight against climate change a large structural policy of this half-century. As pioneers, we therefore find ourselves **in the front line in meeting the challenges that are technological** (deployment of new means of production, massive renovation of building stock, the invention of new local energy models), **societal** (acceptability of changes to life styles) and **economic** (activation of funding channels and mobilisation of savings) that structure the energy transition.

How these challenges can be met will depend on the choices made in each Member State (and even, increasingly in each region or community), but what the solutions found will have in common is that they will have to fit into **energy systems whose networks, covering millions of kilometres, already provide the architecture**. Continuing to "provide a system", thanks to the networks for delivering energy (gas or electricity) under the **best conditions of effectiveness and cost, is thus an absolute imperative for the security of supply for Europeans, their quality of life and the competitiveness of their businesses and therefore their jobs**. Europe is the area of the world that offers the best quality energy services; this advantage must be reinforced.

However, **the role required of Europe's energy networks is being profoundly reshaped** in this context of energy transition, since their organisation must now:

– ***Accompany decentralisation***, the means of renewable energy production being dispersed in hundreds of thousands of sites over all the territories. This requires radically reorganising the networks, in particular the distribution networks, which were not originally designed for this renewable energy collecting function.

– ***Managing complexity*** of a new kind due to the variability of certain renewable energies (wind, photovoltaic), but also the emergence of new uses, such as electric vehicles.

– ***Ensuring solidarity between the States and regions***, in a context where the technological uncertainties of the new sectors are added to the older ones of a geopolitical nature.

– ***Continuing to ensure equal access to energy services***, without the transition becoming a discriminating factor against those citizens who are economically the weakest.

Pooling knowledge and thinking to adapt the networks is a necessity if the Europeans want the energy transition to be a success.

Article 194 of the Treaty of Lisbon has already laid down the way to greater intervention by the Union in this regard. But the Europeans must go further and explore, as quickly as possible, areas of joint cooperation, innovation and investment.

The challenge is great since **hundreds of billions of euros of investment will have to be made between now and 2030**, and no argument is needed to convince oneself that, in a convalescent Europe, every euro will have to be invested with the greatest concern for effectiveness for our communities.

Finally, this "networked European energy", that we all wish for, will not only be a physical, technical and economic challenge. It must also embody these "**shared idiosyncrasies**" that today characterise the European energy space: the verticality of the national hierarchies will be followed by the horizontality of communication between the territories; the authority of the powers in place, by the legitimacy of the citizen, initiative and success; industrial uniformity, by the diversity of models of organisation; a situation of separate States, by exchanges within the European area.

The **twelve proposals** presented at the end of this report thus aim to promote the emergence of a coherent and pragmatic European approach in the field of networks, to solve today's problems and to meet tomorrow's challenges.

From this standpoint, these proposals are structured around **three main focus areas**:

– **Revising security of supply and cooperation** between the network companies, but also the local authorities involved in the energy transition,

– **Strengthening coordination of the regulations and the funding levers** to optimise the infrastructure costs, while investing in the territories crossed by this strategic infrastructure,

– **Promoting Europe as an energy innovation leader**, giving a new impetus and a new dimension to its R&D, in particular through standardisation, the creation of an energy data platform, the establishment of innovative mobility corridors and the foundation of a European Energy College.

***

Introduction
The energy transition, an opportunity for European leadership

European energy shows glimpses of great hopes for a Union that is a pioneer in the "low carbon" transition, but also great fears with the **persistence of alarm signals** (growing dependency on outside imports of fossil energies, a confused economic approach in its support for renewable energies, etc.), or **even crisis** with growing threats to winter electricity supplies, in particular in Belgium and in France.

This paradoxical situation is the result of an **old reality**, which has grown since Fukushima and has been exacerbated by the economic and financial crisis. The European Union has drafted an **extremely complex set of common goals** (a gradual liberalisation of the electricity and gas markets, energy-climate packages for 2020 and 2030 etc.) which nevertheless allows Member States decision-making over their basic energy choices in terms of the means of production.

This **lack of European "steering"** of the modus operandi is resulting in suboptimal use of industry, weakening the continental energy leaders, leading to "bubbles" in the development of certain renewable energy sectors, with dissonant price signals for investors. The Europeans discover, when all is said and done logically enough, that the European energy transition will not be achieved from 28 policies that are little coordinated.

This observation calls for clear thinking. It is pointless to continue to conceive a teleological vision of a unitary energy policy in Europe[1] ; switching to a single, totally integrated European energy policy is not really conceivable currently, given the differences between the Member States, both in their technical systems and in the existing institutional approaches.

That said, **the dual economic and ecological challenge** that faces Europe must be thought out jointly. From this standpoint, coordination of the national energy transition policies must be viewed as an **objective of industrial policy and competitiveness in order to re-establish the bases of a European leadership**.

This same observation calls for **identifying as quickly as possible the fields of cooperation that have a strong leverage effect**. The energy networks, both electric and gas, are in their essence an area of joint interest towards which efforts must be concentrated:

---

1 Cf. L'Europe en panne d'énergie, Michel Derdevet, Éditions Descartes & Cie, mai 2009.

• The long-distance transmission networks provide the interconnections. They allow the management of collective security to be optimised and its cost to be reduced, thus guaranteeing the functioning of a genuine internal energy market beyond national borders,

• The distribution networks are at the heart of the development of renewable energy, to which the great majority of generation is connected. They also constitute the digital interface from which tomorrow's "smart" cities will emerge and in which the shared lifestyles of European citizens will be invented.

By the end of the various waves of energy directives initiated in the mid-1990s, the functions of the European network operators had been **laid down and made considerably greater**, and these operators, whether in the electricity or gas field, already gave **substance to the idea of European energy (and the regulators likewise). The transmission system operators** (TSOs) are thus in charge of guaranteeing the long-term capacity of infrastructure and ensuring the security of supply. For their part, the **distribution system operators** (DSOs) must also guarantee the ability of the local network to deliver a quality service, available to businesses and households.

But the energy transition poses a challenge to the network companies by making **their missions more complex**. The systems are no longer limited to large generation units (large power stations) or imports (tanker terminals), but also include a myriad of small-scale units (wind, photovoltaic, biogas, etc.) spread out over all the territories and which turn the previous pattern upside down. This renewable energy is nearly always connected to the distribution networks (and not to the transmission network like the large units), which were not designed and do not have the capacity to deal with this collection function. The distribution networks see **their role** increased even more since, at the same time, **new uses** are developing, such as electric vehicles.

In a context of little economic growth and international competition that is putting the European economies under pressure, energy infrastructure is a **tremendous endogenous growth and competitiveness lever. Article 194 of the Treaty of Lisbon** already laid down the way to greater intervention by the Union in this regard. But the Europeans must go further and explore as quickly as possible areas of joint cooperation, innovation and investment.

The challenge is great since hundreds of billions of euros of investment will have to be made between now and 2030, and no argument is needed to convince oneself that, in a convalescent Europe, every euro will have to be invested with the greatest concern of effectiveness for our communities.

The purpose of this report is to identify **proposals that are practical and realistic**, aiming to transform this "mountain" of investment into an **industrial project**, and a source of **jobs and added value** for the Europeans.

We will report in three stages:

• The 1st part will be used to position the networks within the European energy dynamic in order to make an analysis leading to a necessary update.

• In the 2nd part, a detailed exploration of the investment challenges in the European energy networks by 2030 will be made.

• In a 3rd part, twelve proposals will be made to structure European energy into networks.

The whole aims to set in place a momentum designed to optimise investment costs, guarantee a high level of security of supply, ensure integration of the markets and assert the position of Europe as a leader in energy innovation.

If the Climate Conference of Paris 2015 opens with a commitment by everyone to participate in the energy transition, it will be important also for Europe to confirm on this occasion the coherency and efficiency of its own general approach in order to obtain the benefits of its own pioneering commitment.

This COP 21 thus offers the opportunity to demonstrate that European energy exists, has an across-the-board strategic vision, in particular with respect to energy networks, both for transmission and distribution, consistent with its history and acknowledged expertise[2] and its current wish to unite around these challenges.

2 Thus, in 1921, the CIGRE was formed in Paris (International Council on Large Electric Systems); since then, this association has become a benchmark organisation, gathering in Paris every two years over 8,000 leaders, experts and specialists of the international electricity sector, from 90 countries, with the aim of encouraging exchanges of information about new electricity transmission systems and innovations.

Part 1

THE NETWORKS INNERVATE EUROPEAN ENERGY CONSTRUCTION

Reminder of the basic facts

Construction of the European energy system goes back to the late 19th century for electricity and just after the Second World War for gas.

Limited originally to a few neighbourhoods and factories, access to electricity gradually spread to all the territories. The technologies initially available (coal-fired or hydraulic power stations and then natural gas and nuclear) **determined the configuration of the electricity networks**. The network was laid down according to a **tree logic**, transporting the energy from these large generation sites to consumer [1]. **Two networks** coexist: a first, so-called "transmission" one to carry significant amounts of electricity over long distances, and a second, so-called "distribution" one which provides the end service to the domestic consumer.

For natural gas, the logic was analogous: the transmission network was set up mainly from the national deposits (in particular Lacq in the Southwest [2]), then intra- and extra-European [3] to the distribution networks. Without forgetting, for the latter, the existence of urban manufactured gas that has existed for over a hundred years.

These general principles of organisation are designed **to guarantee the stability of the system and its security** according to the characteristics of the energy to be delivered.

Since electricity cannot be stored, the network operators must **ensure a balance between supply and demand in real time**. If this balance is not respected, there is a risk of a variation in frequency occurring and therefore damage to the electricity facilities. Which may require carrying out localised load shedding (temporary electricity cuts) to avoid a widespread black-out [4] occurring.

To maintain this balance, the network operators coordinate the electricity generation resources of the generating companies. They must also take into account possible bottlenecks in the regional transmission capacity [5].

1 Certain large industrial consumers are directly connected to the transmission network.
2 The Lacq deposit has no longer been exploited since late 2013.
3 In particular Russian, Algerian, Dutch, Norwegian and British.
4 Europe has suffered few serious incidents. However, to measure the extent of potential effects, it should be recalled that on 4 November 2006, 15 million Europeans suffered electricity cuts. The original incident, that occurred in Germany, had consequences as far away as North Africa, connected to Europe through the Iberian Peninsula and the straits of Gibraltar, and in particular led to 5 million consumers in France being left without electricity.
5 The Brittany and Provence-Alpes-Côte d'Azur regions, for example, suffer from a deficit of interconnections with the rest of France.

The gas network operators also face this type of constraint in the location of supply sources[6].

The connections between the different national networks, called **interconnections**, also play an essential role in the security of supply, the security of the system (by constituting a mutual insurance against unforeseen hazards and forecast errors) and reducing costs. As early as 1920, the emergence of Pyrenean hydroelectricity saw the appearance of the first projects of cross-border electricity connections of 150 kV between France and Spain[7]. This interconnection role is even more important in the gas sector, since imports represent nearly 90% of supplies to many European countries (compared to 10% for electricity).

The networks are used to transport energy over long distances and to distribute it locally.

The network operators are responsible for the security of the system and the quality of the energy supplied.

Interconnections strengthen the security of the system and reduce energy costs.

The gradual creation of a framework for managing the European networks

The process of **liberalising the European energy market** has been under way since the 1990s. **Three waves of directives** specified and extended the power of the network operators and dissociated the transmission activities from the generation and supply activities. This was to guarantee the independence and the neutrality of the networks, i.e. to ensure that the vertically integrated companies did not impede the growth of competition by discriminatory practices. And, thus, to preserve the interest of the end consumer.

The first European directives of 1996 for electricity[8] and of 1998[9] for gas thus assigned **three objectives** to the Member States:

– neutral, fair and non-discriminatory access by third parties to the networks,

– the separation of the accounts and management of the generation and transmission activities,

6 The stability of the networks implies remaining attentive to other parameters: for example, for electricity, this entails overseeing the "harmonics" or the reactive power generated by the generation facilities; for gas, analysing permanently the composition of the mix transported so that it remains within the limits of adjustability of the burners.

7 Cf. "Les réseaux électriques au cœur de la civilisation industrielle", Christophe Bouneau, Michel Derdevet, Jacques Percebois, Preface by the European Commissioner Andris Piebalgs, Timée 2007.

8 Directive 96/92/CE of the European Parliament and Council of 19 December 1996.

9 Directive 98/30/CE of the European Parliament and Council of 22 June 1998.

– the creation of independent transmission system operators, responsible for ensuring the proper operation of the electricity and gas systems.

The second directives of 2003 [10] increased the independence requirements of the operators by imposing a **legal and functional separation between the transmission and generation activities**.

At the same time, the vertically integrated companies had to produce **separate accounts** for their distribution activities, again for the purpose of avoiding distortions of competition.

These directives of 2003, moreover, made obligatory the existence of an **independent regulation authority in each Member State**. In France, this is the 'Commission de régulation de l'énergie' (Energy regulation commission - CRE). This authority is responsible for:

– regulating the networks by overseeing the conditions for accessing the infrastructure (that must be identical and non-discriminatory),

– overseeing the smooth operation and development of the networks,

– assessing the relevance of the investments,

– harnessing new technologies and improving the efficiency of the infrastructure.

Finally, the European Union in 2009 wanted to obtain [11] **ownership unbundling** between the supply and generation activities and the operation of the networks. This evolution has been enacted by a majority of Member States, but France and others have retained the networks within integrated companies, in return for a strengthening of the guarantees of independence. The third package was thus designed to provide:

– a strengthening of the independence of the national regulators and a standardisation of their competences,

– a reinforcement, through transparency rules, of access by third parties to the activities and storage facilities of natural gas and liquefied gas,

– an encouragement towards regional solidarity by requiring cooperation by the Member States in the event of serious cuts in supplies, by coordinating emergency measures and developing interconnections.

The establishment of these various directives has given rise to **cooperation between national institutions**:

– The national regulators are grouped within the Agency for the Cooperation of Energy Regulators (ACER), responsible especially for ensuring the implementation of development plans for the networks at a ten-year horizon,

– The transmission system operators are also grouped according to the same model: the *European Network of Transmission System Operators for Electricity* (ENTSO-E) *and the European Network of Transmission System Operators for Gas* (ENTSO-G). They define, in collaboration with the ACER, the detailed rules for network access and the technical codes, while ensuring

10 Directives 2003/54/EEC and 2003/55/EEC of the European Parliament and Council of 26 June 2003.
11 Directives 2009/72/EEC and 2009/72/EEC of the European Parliament and Council of 13 July 2009.

coordination of operations through exchanges of information and the establishment of security and emergency standards.

The energy liberalisation directives in Europe have legally enshrined non-discriminatory access to the networks and the independence of their operators.

The operators of European networks are responsible for coordinating energy transmissions between Member States and organising solidarity.

They are grouped into wide cooperation associations and coordinate their actions with the national regulators.

The current organisation of the European energy networks

Nearly 20 years after the adoption of the first energy directives, national specificities in terms of transmission, distribution and regulation however remain **very marked**, due mainly to the **institutional characteristics of the Member States** (in particular the apportionment of prerogatives between the central State and the regions) and to the nature of their energy mix.

As regards transmission, most European States (Belgium, France, Italy, Spain, etc.) rely on a single national operator for the electricity transmission network, whereas two operate in Austria[12], and four in Germany[13] and the United Kingdom[14]. Moreover, the scope of their missions varies a lot from one country to another.

Their **capital structure also differs** according to the countries or the energies:
– In France, gas transmission is shared between GRTgaz, a subsidiary of GDF SUEZ, and TIGF[15], whereas RTE Réseau de Transport d'Électricité (Electricity Transmission Network) is 100% owned by EDF,
– The capital of the Belgian transmission operator ELIA is owned for nearly 50% by PUBLI-T and PUBLIPART[16], with more than 50% of the free float capital,
– The Dutch TENNET is owned by the Dutch State. In 2010 it acquired the German transmission network E.ON,
– The German ENBW is owned by a consortium of municipalities (OEW) and for 45% by the Land of Baden-Wurtemberg (after EDF sold its shares to it).

12 Austrian Power Grid AG, Voralberger Übertragungsnetz GmbH.
13 TransnetBW GmbH, TenneT TSO GmbH, Amprion GmbH, 50Hertz Transmission GmbH.
14 National Grid Electricity Transmission plc, System Operator for Northern Ireland Ltd, Scottish Hydro Electric Transmission plc, Scottish Power Transmission plc.
15 A subsidiary of Total until 2013, now owned by the Italian operator SNAM (40.5 %), Singapore's Government Investment Corporation (31.5%), EDF (18 %) and Predica (10 %), Crédit Agricole Assurances.
16 PUBLI-T and PUBLIPART are subsidiaries of SOCOFE which groups Walloon community interests.

As far as the distribution system operators are concerned, the heterogeneity is even more marked:

– In France, the infrastructure is owned by local authorities, which licence out the management. ERDF (Electricity Network Distribution France), 100% owned by EDF, is the licence holder over 95% of the territory with the remaining 5% shared since 1946 between 150 local distribution companies. The logic is the one of equalisation that ensures access to electricity at a uniform tariff for consumers, For its part, GRDF operates in 9,500 municipalities and covers 96% of users, the rest being supplied by 22 LDCs[17],

– In Italy, the apportionment is comparable to France with a historic operator (Enel Distribuzione) serving 85% of the Italian market and a few hundred local concessions divided up between 150 distributors, owners of the facilities,

– In Germany, there are 880 distributors, of which a hundred have more than 100,000 customers. The prices are approved by the federal networks agency, BNetzA, for every distributor and without federal equalisation. Moreover, the municipalities are frequently operators of the networks, through Stadtwerke[18],

– In Belgium, distribution is organised by mixed inter-municipal enterprises[19], owned in part by Electrabel, and pure inter-municipal enterprises. In 2009, the Walloon mixed inter-municipal enterprises came together to form the Gas and Electricity Networks Operator.

These differences should be viewed in the light of the community objectives of security of supply, the energy transition and competitiveness of prices.

The opening up of the European markets recognised the specificity of the networks, confirmed their natural monopoly status and defined extremely precisely the role of their operators. But for the rest, Europe allowed free play to subsidiarity such that national choices have created a kaleidoscope and have left **little room for a common industrial approach**, a source of development and economic synergies between States.

The contrasts that remain between the missions entrusted to the various TSOs and DSOs and the diversity of the players and of their forms of organisation are problematic. They may lead to inertia, more difficult identification and lesser optimisation of the investments required to accompany the security of supply and the European energy transition, with an impact on tariffs that is not negligible.

17 Local distribution companies.
18 Local public municipal or inter-municipal enterprises.
19 A public enterprise created by municipalities to carry out public service missions in the public interest.

Figure 1: **The Europe of networks in figures**[20]

Transmission	TSO	Country	Km of lines	Consumers (in millions)	Consumption (in 2013)	Exchanges	Financing needs by 2020
ENTSO-E	41	34	307 000	532	3 307 TWh	390 TWh	€150 bn
ENTSO-G	46	26	247 000	117	461 billion m³	–	€70 bn

Regarding distribution, a detailed comparison proves to be more complex because of the multiplicity of the DSOs (Eurelectric identifies 2,400 for electricity in 25 countries of Europe and Norway, whereas Geode arrives at a figure of 1,200 for gas in 15 countries) and of their methods of governance. It appears however that investments could be four to five times greater than those necessary for transmission. Eurelectric thus evokes an amount close to 400 billion euros by 2020. This is explained by the length of the networks in question (10 million km of electricity lines) and the impact of the deployment of renewable energy (RE).

- In Germany, investment needs are estimated at between 25 and 50 billion euros by 2032.
- In France, investments by ERDF over the next 10 years are evaluated at 45 billion euros including renewals, improvement of the quality, the deployment of Linky and adapting the network to RE.
- In Italy, investments will be between 9 and 15 billion euros for smart networks between 2013 and 2020 and nearly 2 billion per year for maintenance.

These investment needs must be set against the turnover of the DSOs: 13 billion euros for ERDF, 11 billion euros for the distribution subsidiary of E.ON, 8 billion euros for ENEL Distribuzione, etc.

20 *ENTSO-E, ENTSO-E at a glance, 2014; TYNDP: Ten-year Network Development Plan; "Energy infrastructure priorities for 2020 and beyond - Blueprint for an integrated European energy network", European Commission, 2011; "Electricity distribution investments: what regulatory framework do we need?", EURELECTRIC, 2014; "Moderne Verteilernetze für Deutschland", BMWI, 2014; "La mise en œuvre par la France du Paquet énergie-climat", Cour des comptes, 2014; European Commission, Connecting Europe Facility, 2014. For the list of TSOs, refer to Annex 5.4.*

"Bonus-malus" of European energy construction

The networks serving energy convergence

Liberalisation has allowed a strengthening of **European integration of the energy markets**, in which the networks have played a key role. Recent studies have highlighted the savings offered by optimising capacity between the different countries. According to the Booz&Co report for the European Commission, the savings are estimated at between 12.5 and 40 billion euros per year by 2030 [21]. The European Climate Foundation assesses the potential savings at 426 billion euros between 2020 and 2030 [22].

The interconnections between European networks contribute to **optimising generation** by calling on the cheapest units (subject to the capacities of cross-border transmission). In addition to this market logic, interconnections contribute to securing supply in the event of a malfunction with the possibility of calling on the generation capacity of neighbouring countries. Increased coordination by the European transmission system operators has thus created **solidarity within the European Union** and reduced the energy isolation of the member countries.

This energy can be transferred via the transmission networks following transactions made within **energy exchanges** [23]. A meeting and negotiation place between supply and demand, the exchanges encourage a transparent market price to be set and ensure the monitoring of transactions [24]. These give rise either to deliveries within a day (or longer time), or are optional in nature.

In order to increase the fluidity and the competitiveness of the electricity sector and to better integrate the specific parameters of this market (difficulties of storage and management of the intermittency), the exchanges have agreed on **common processes, tools and algorithms**.

21 *"Benefits of an integrated European energy market", Booz&Co, 20 July 2013.*
22 *From Roadmaps to Reality*, European Climate Foundation, 2014.
23 France thus exports nearly 10% of its production. However, a significant part of cross-border flows may not concern transactions made through these markets, but other forms of contract (very long-term in the case of gas). For gas, two exchanges, NBP (United Kingdom) and TTF (Netherlands), alone concentrate 80% of the trade in Europe in these market places.
24 The European Commission has wished to guarantee the integrity and transparency of the energy market and reinforce its supervision. The legal concepts applied to the financial markets (market manipulation, insider trading, ...) have been adapted to the electricity and gas sectors to guard against any wrongdoing. With the intention of improving the supervision of the wholesale electricity and gas markets, this regulation specifies the methods of cooperation between financial regulators, the competition authorities and energy regulators. Regulation (EC) No. 1227/2011 of 8 December 2011.

Since 2014, 17 European countries[25] are even part of a unified **electricity market**, extending from the Algarve to Cape North, thanks to a coupling of the regions[26]. This market, created at the initiative of seven European energy exchanges (APX, Belpex, EPEX SPOT, GME, Nord Pool Spot, OMIE and OTE), is unique in Europe. It has contributed to the development of a price algorithm, called EUPHEMIA (European Section Hybrid Electricity Market Integration Algorithm). The European electricity exchanges can therefore buy and sell electricity on the day for the next day, in all the coupled European countries, within the limit of their electricity interconnection capacities.

Thus, on 4 February 2014, the electricity market of the Centre West Europe area (CWE) was coupled with those of Great Britain and the Nordic countries (Denmark, Estonia, Finland, Norway, Poland and Sweden), themselves coupled since 1993. Since 13 May 2014, all of the electricity markets of the regions of South West Europe (SWE), Centre West Europe (CWE) and North West Europe (NWE) that have been coupled. Italy is due to join this group in the near future, which will thus represent 75% of electricity consumption in Europe.

At the same time, the volumes exchanged in the exchanges are growing quickly. In 2014, 382 TWh was exchanged on the markets of EPEX SPOT, against 346 TWH in 2013, 339 TWh in 2012, 314 TWh in 2011 and 279 TWh in 2010[27].

The **economic benefits of the coupling** of the markets are easily quantifiable and are a **strong argument in favour of an energy Europe**:

– In 2013, prices presented a convergence rate of between 50 and 75% for the countries benefiting from a coupling and 15% for the others. As an example, the prices between France and Germany were equal for 53% of the time in 2014,

– The additional cost of French supply due to the lack of coupling was estimated at 128 million euros in 2013. In 2009, this same evaluation amounted to close to 300 million euros,

– Since the start of the France-England coupling in 2014, all the capacity was used 100% of the time in the direction from the cheapest price area to the more expensive area.

The coupling of the European markets has thus been described, accurately, as a "pillar of the energy transition" by the Franco-German Renewable Energy Office[28].

25 Germany, Austria, Belgium, Denmark, Spain, Estonia, Finland, France, Latvia, Lithuania, Luxembourg, Norway, Netherlands, Poland, Portugal, United Kingdom, Sweden.

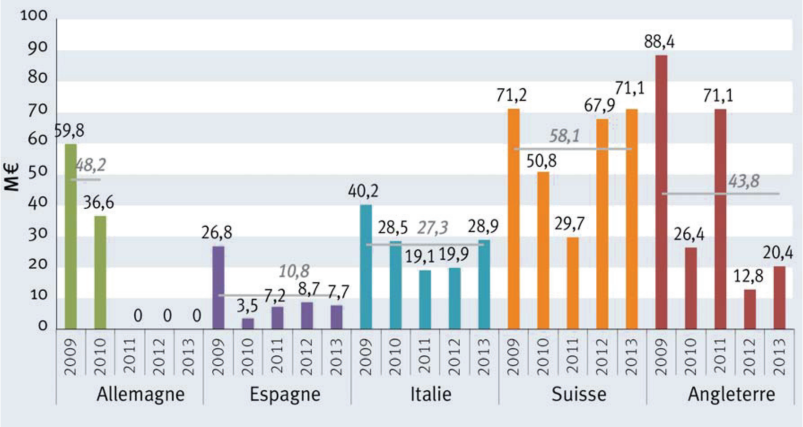
26 PCR Project: Price Coupling of Regions.

27 EPEX Spot, Press release of 15 January 2014.

28 *"Direct sale of renewable energy on the European electricity exchange", OFAER – EPEX SPOT, January 2015.*

The former German Minister of Energy, now Federal Minister, Director of the Federal Chancellery, Peter Altmaier made the observation, pertinently, that the European electricity exchange, EPEX SPOT is "one of the examples of successful French-German cooperation in the energy sector [29] ". Created in 2008 from the merger between equals of the French Powernext and the German European Energy Exchange, it operates in the German, Austrian, French and Swiss spot electricity markets.

Graph 1:
Estimate at the French borders of the additional cost of supplies due to lack of market coupling between 2009 and 2013 [30]



Source : Commission de régulation de l'énergie (CRE) 2014.

The interconnections between European networks have, thanks to increased fluidity of exchanges, contributed to optimising generation by calling on the most "efficient" units.

The coupling of the markets by the Member States, through exchanges and interconnections, produces substantial and measurable economic benefits.

29 During a visit to the EPEX SPOT 2 July 2013.
30 In the absence of coupling, the least costly offers are not used systematically.

A contrasted impact on wholesale and retail prices

The prospect of a fall in prices was one of the benefits emphasised at the time of the liberalisation of the energy markets, with closer ties between the European countries and the sending of a price signal that would lead to optimal allocation of the means of production. It is plain to see, twenty years later, that this objective shows results that are, at the very least, "contrasted".

To arrive at this conclusion, it is necessary first of all to recall that, in the electricity market, the means of production are activated in increasing order of their marginal cost of production according to a **so-called logic "of order of merit"**. In other words, the systems whose activation is the least costly, go into production first.

According to the level of demand, the market price is set to **cover the cost of generation of the last mobilised unit**. For renewable energies, such as photovoltaic and wind, this marginal production cost is almost nil (the sun and wind are available for free). Their increased part in the energy mix therefore leads to a **lowering of wholesale prices**.

The coupling of the markets of the countries of the north of Europe, having high capacities in terms of renewable energies, with the markets of the south of Europe tends to push prices down on the wholesale electricity market. This tendency has been reinforced further since the accelerated deployment of renewable energies in Germany with the adoption of the Energiewende in 2011 and with the fall in demand following the economic crisis. Thus, between 2011 and 2014, the wholesale price of electricity fell by nearly 40% in Europe.

Graph 2:
Evolution of wholesale prices of electricity in France

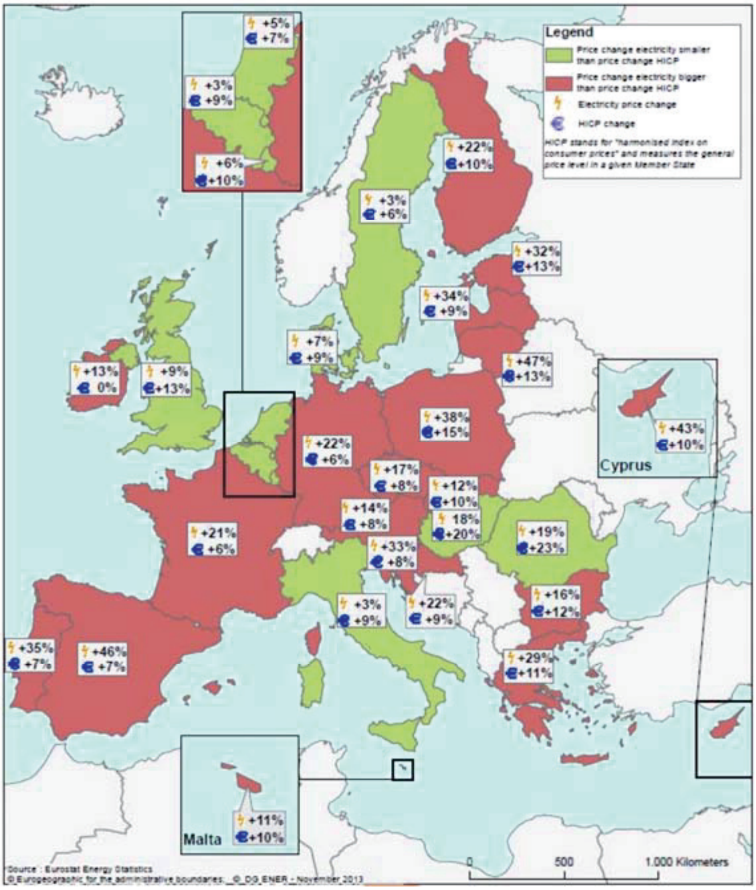
Source : European Energy Exchange.

However, households do not feel this fall, since the national taxation and support policies for renewable energies vary significantly. The **variation in the prices paid ultimately by the end consumers** is therefore wide, whereas the wholesale prices often only differ by a few euros per MWh. These price differences between countries (the price paid by a German consumer represents almost double the price paid by a French consumer) result from the pricing, which varies according to the cost of supply (generator), the transmission of the electricity (network operator) and energy tax. Ultimately, on the consumer's bill, the effect of the fall in the market prices is often offset by the increase in contributions financing the development of renewable energies.

In France, four taxes apply to the electricity sector: the transmission tariff contribution (CTA), the contribution to the public electricity service (CSPE), the electricity consumption end-use taxes (TCFE) and Value Added Tax (VAT).

➔ **The absence of European regulating mechanisms on these various components does not therefore allow a true convergence of electricity prices for European households.**

Graph 3 :
Evolution of retail electricity prices compared to inflation (2008-2012)



Source: *Energy Prices and Costs Report*, European Commission, 2014.

Regarding gas, the mechanism for forming prices varies significantly, given the importance of long-term supply contracts indexed to the oil price. However, the exchanges have led to a fall in prices in the short-term markets which has enabled many gas companies to renegotiate some of their long-term contracts.

The other components of the prices (transmission and taxes) not having changed (in particular because of the lesser impact of RE on gas prices), a more visible fall in the prices paid by the end consumers should be noted following the development of the European gas market.

However, this position does not prevent growing tension regarding the security of gas supplies.

Figure 2 : **Support for renewables: German EEG vs. French CSPE**

"In the case of Germany and France, the generation base has excess capacity, as shown by the number of mothballed conventional thermal power stations and the fall in the average load factor of the others. One can therefore consider that the market price [falling] represents, very approximately, the price excluding renewable generation. In both countries, the gap between the market prices and the prices guaranteed to the renewable generators is in the form of a clearly identified charge. In Germany, it is quantified by the "renewable energies' surcharge" (EEG Umlage) and in France as part of the Contribution to the Public Electricity Service (CSPE), that includes a specific section for aid for renewable sources. […] It should be noted that in both countries, a non-negligible proportion of consumers do not have to pay this additional cost in full thanks to a system of exemptions. The total additional cost to be shared out among consumers totalled 3.7 billion euros in France in 2014 (3.1 in 2013) and 19.4 billion euros in Germany (16.2 in 2013). The charge imposed on consumers subject to the full rate is estimated for 2014 in France at €9.9 per MWh (8 in 2013) and €62.4 per MWh in Germany (52.8 in 2013), where a clearing of the amount outstanding for previous years is included, which is not always the case on this side of the Rhine. These amounts should be compared to the "supply" component of a bill, which totals €57.7/MWh in France and €85/MWh in Germany for a domestic customer (price in January 2014). The "renewable" charge therefore increases this "supply" part by 74% in Germany and 17% in France. "Source: M.Cruciani, Le coût des énergies renouvelables, IFRI, 2014.

Coupling of the markets will not be able to resolve the contradictions of the European energy construction process, that leaves the Member States broad autonomy in determining their generation mix.

The convergence of electricity prices on the wholesale market has not led to a comparable movement in the retail market, where prices remain very heterogeneous. It is individual consumers who suffer from this situation.

The paradoxical resurgence of tensions about security

In the past few years, the European energy policy has revealed, an **incongruity between the promotion of a market logic at the level of the Union on the one hand and, the centripetal reflexes**, the preservation demanded by all of national sovereignty in energy choices, on the other hand.

This contradiction gives rise to **concerns about the security of delivery of energy services**. These tensions are the result of fears regarding gas supplies, such as during the various crises between Russia and the Ukraine.

Again recently, Vladimir Putin announced the abandonment of the South Stream project in southern Europe and the president of Gazprom, Alexey Miller, warned the Europeans "that they should construct as quickly as possible, and at their expense, gas pipelines if they wanted to continue to buy gas from it, since [Russia] no longer intended to supply them through the Ukraine[31] ".

This measure is not to be taken lightly, even if the geography of gas in Europe is highly "dispersed" and depends on the mix of the supply contracts. For France, Russian gas does not represent more than 16% of its supplies, against 40% in Germany, 77% in Poland and 90 to 100% in Finland, in the Baltic States, Slovenia, Hungary, Romania and Bulgaria.

Neither is the electric sector free from fears about the security of supply. One of the major obstacles is the difficulty the European energy markets constructed within the European framework have **in taking account of the long-term situation**. This tendency was observed when "combined cycle" power stations were shut down: these are a perfect complement to intermittent renewable energy and offer the flexibility required for the equilibrium of the systems[32].

➔ **These power stations have thus been the victims of a combination of factors:**
– The development of shale gases in the United States which has led to the fall in the prices of American coal and to mass exports of it to Europe,
– Gas has subsequently lost its competitiveness, especially as the price of a tonne of carbon on the European market (EU ETS [33]) collapsed at the same time, even though it contributed to making gas competitive in comparison to coal[34].

Through these shut-downs of power stations, and, more widely, because of the low price of the wholesale markets **the question of the security of supply over the long term** arises, i.e. the ability of the markets to encourage sufficient investments in terms of generation capacity. In fact, apart from the case of gas-fired power stations, the deployment of renewable energy has an impact on the funding of other generation capacity. Being financed through purchase obligations, they result in a decrease in the prices on the markets. Incentives to invest are therefore reduced. Currently, alerts are multiplying in Europe, and in particular in Belgium and in France[35], as to the conditions for getting through the winters of 2015 and 2016.

31 AFP, 14 January 2015.
32 The large enterprises of the "Magritte" group (that brings together about ten European energy producers) estimate that they have shut down 70 GW of generation capacity, i.e. capacity equivalent to 70 nuclear power stations.
33 EU Emissions Trading System.
34 Coal being a much greater emitter of CO_2 than gas for electricity generation.
35 RTE forecasts.

Different mechanisms have been envisaged for compensating for this lack of incentives in the long term:

– **The carbon market** firstly, even though it has not yet produced the expected price for CO_2. Based on allocations of quotas, it has been the victim of the economic crisis of these past few years; the collapse of European industrial production has brought down carbon prices with it,

– Secondly, the “**capacity mechanisms**”. They are designed to ensure that the generation capacity is always available in sufficient quantity to meet the demand. However, the countries have frequently chosen different systems (France favours a market approach, Germany is more directed towards strategic reserves) without being able to plan ahead for a high degree of complementarity. But, “the harmonisation of the methods for defining and evaluating the adequate level of security of supply, the timing of the actions undertaken and the management of the interconnections, consistent with the mechanisms in place must be carried out in tandem on both sides of the Rhine [36] ”.

What is occurring raises questions as to the **maintenance of a high quality level for the energy services delivered**. For the consumer, quality at the point of delivery is perceived through two criteria: the continuity of the power supply and the stability of the voltage (for electricity) or pressure (for gas).

On old electricity networks, the instability resulting from the injection of intermittent sources (solar and wind) increases the risk of short duration power cuts (lasting under three minutes). These cuts are harmful for the smooth operation of industrial facilities and electronic devices. Specific investments will be necessary to reduce the number of these incidents [37].

As regards voltage and gas pressure, their value at the point of delivery depends on adjusting facilities located upstream (electricity transformer substations and gas delivery stations) and the design capacity of the infrastructure to the end customer. Any injection of electricity or biomethane between the customer and the station upstream may require modifying the setting or design capacity of the infrastructure using devices able to track the volume injected when it is uncertain.

36 Energy Finance Carbon Master’s degree thesis, Christian Oeser, Paris Dauphine, 2014.

37 The current quality indicator (SAIDI), measuring the average interruption duration of current, only partly reflects the situation since it does not take into account voltage dips. On the SAIDI criterion, France was ranked ninth in Europe, with an average outage time of 80 minutes per year, masking however large differences since it reached 170 minutes in four departments in metropolitan France. Germany is ranked third, but 16% of company directors state having suffered at least a cut of short duration in the last 12 months (lasting less than three minutes), having seriously disrupted activity in half of cases.

The coupling of the markets is not sufficient to guarantee energy security in the long term.

The beginning of the 2010 decade highlights the insufficient coherency of the price signals to direct investments.

Europeans are threatened by a deterioration in the quality of the energy services that are delivered them

The energy transition implies an updating of the networks: the outline of a statement of work

Structure of the networks

The question of the ability of the networks to reduce these tensions is posed, since **the new distribution of the sources of production is destabilising their initial architecture**.

For electricity as for gas, the networks were designed to transport energy in a vertical way, from large electricity power stations, from tanker terminals (receiving liquefied gas) or a border import station to the end customer. However this structure has shown itself to be **unsuitable for the emerging configuration**, characterised by the increasingly important arrival of decentralised, widely spread-out energy, from renewable sources (wind, photovoltaic, biomethane). The need to adapt the networks applies equally to **basic facilities** (lines, pipelines, conversion stations, compression and injection stations) and **management facilities** (the devices relying on communication and information processing technologies).

This issue of ensuring the adequate design capacity of the networks is also valid for gas: the community rules have led to the development of short-term markets, that exploit the flexibility of the deliveries of natural liquefied gas, allowing a part of deliveries to be adjusted to occasional circumstances, peaks or dips in demand. The European texts also permit access without discrimination to storage in Europe to be envisaged and the implementation of common rules. However, the insufficient through-put of the gas pipelines linking the north and the south of France prevents, for example, the southern zone from fully benefiting from the more competitive prices observed in the north of Europe.

For a country such as Poland, that imports 77% of the gas that it uses, the development of gas interconnections is a major issue. To avoid untimely decreases in deliveries of gas from Eastern Europe (such as that which occurred between 8 and 10 September 2014[38]) and the volatility of the prices resulting from it, the construction of the LNG terminal of Swinoujscie and the acceleration of the interconnection work with Germany, Denmark, Lithuania, the Czech Republic, and Slovakia are a priority.

38 Relating to 20 to 45% of the deliveries from Gazprom.

The reversibility of the flows [39] and the ability to obtain supplies of gas from other European countries, notably Germany, will contribute to ensuring greater energy independence for it [40].

Investment statement of work

In all the countries of Europe, **massive investment is needed**, both to guarantee better security of supply, but also to optimise the use of the available sources of energy.

– **On the quantitative level:** in the absence of statutory constraints that would impose a specific location, new wind, solar, hydraulic, biomass or biogas installations will not be built near dense networks, but in places where the resource is available at the least cost. Extensions and strengthening of the existing infrastructure will therefore be necessary to enable the energy generated to be correctly injected into the networks.

– **On the quality level**: the enhancement of the networks is not limited to adding or replacing equipment used to transmit electricity (lines, transformers, disconnectors, etc.) or gas (pipelines, valves, delivery stations, etc.). By using information and communication technologies, one can also incorporate facilities allowing active management. These "smart networks" will allow, nearly in real time, the effect of thousands of injections and extractions to be measured.

Beyond the needs linked to the arrival of renewable sources and to deployment of new uses, investment in the networks is also necessary for other objectives [41] :

– The strengthening of infrastructure allows it to be modernised. Some lines and some pipelines, already old, require their components to be replaced and modern control devices to be added to them and this would be the case even in the absence of renewable energy.

– For electricity in particular, for transmission and distribution, it is also necessary to accelerate a strengthening of their resilience given the future climatic risks, with a multiplication and a worsening of extreme weather events.

– For gas and electricity, the building of new arteries reduces the risk of paralysis in the event of the failure of a major piece of infrastructure, while the entry into service of new interconnections with neighbouring countries broadens the range of available resources in the event of a difficult situation. One of course thinks of the geopolitical instability on Europe's borders, that may threaten gas supplies, but it is necessary also to include as a difficult position the effects of climate change, such as severe cold spells, heat waves or storms that weaken the network.

39 On the old gas arteries, the compression stations only allowed the gas to be "pushed" in a single direction (for example from Russia towards the West). By making them reversible, the flow direction can be changed if needed (for example from Germany to Poland). The development of flow capacity towards Central and Eastern Europe would increase the integration of these countries into the West European liquid market. Especially as these countries prove to be little resistant to the stress tests in the event of a disruption of supply with Russia, unlike Western Europe.

40 Poland consumes about 16 billion m3 of gas/year, 77% of which is imported from Russia.

41 "Electricity distribution investment: what regulatory framework do we need?", EURELECTRIC, 2014.

Figure 3 : **The consequences of the profusion of disseminated means of production on French territory**

Generation of renewable origin is most often made up of low power units, disseminated over the territory. In France, 95% of the electricity that they deliver is collected by ERDF's distribution network, as low or medium voltage. The power connected to the distribution network has increased very significantly in recent years, doubling in six years, to reach 17,258 MW by the end of 2014, or the equivalent of eleven nuclear reactors of the EPR type, but scattered in 325,000 facilities throughout the territory.

Most units are established in rural areas where, despite their modest size, generation often exceeds local consumption. The surplus is then "fed back up" to the transmission network. This requires **changes that are both technical** (to guarantee the security of the lines or gas pipelines working in a way that was unforeseen when they were built) **and functional** (the distribution network becoming, for the operator of the transmission network, both a customer and a supplier).

One of the main difficulties of the past few years relates to the fact that **the impact of the energy transition on the networks was underestimated**. The German issue of transporting electricity from the north, a place of large wind production, to the south, which is a large electricity consumer, is a good illustration of this. This is also true in Italy, but in the reverse direction: the large consumer cities of the north massively use the energy produced in the south.

Indeed, a difficulty that is specific to electricity regards maintaining the parameters of the current at a level as close as possible to the settings, in terms of frequency and voltage. With a conventional generation base (hydraulic, thermal, nuclear), the size of the turning machines ensures stability at the start point. When generation relies on a large number of small units, this benefit is eroded. Moreover, conventional power stations can be easily managed remotely, which is not always the case for renewable sources.

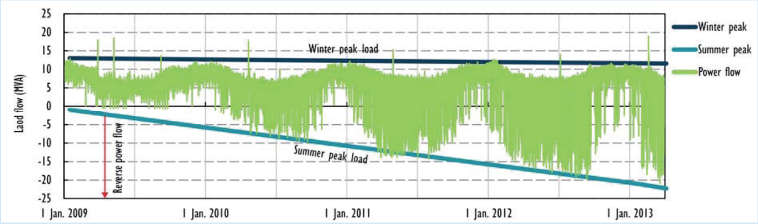
- ➔ **The investment choices between big infrastructure and decentralised sources will depend on technological breakthroughs and economic changes, since the sectors are in permanent competition, but are also increasingly complementary. The networks of tomorrow must be thought out through the future "hybrid" products (Power-to-gas, fuel cell, gas and hydrogen, etc.).**

- ➔ **The future will also be influenced by public policies. These remain ultimately responsible for the tenders punctuating the projects, market premiums and guaranteed purchase prices stimulating private initiatives, and local or national incentives linked to the development of the territory. This means that the renovation of public policies is a major condition for bring the networks up-to-date.**

Figure 4: **The impact of intermittent energies on the distribution networks**

Because of their intermittent nature, photovoltaic and wind are not necessarily in correlation with local electricity consumption. This is the traditional comparison between the peak of photovoltaic production at around 2pm and the average consumer peak that is at around 7pm. This requires being able to transmit the power surpluses generated locally to the transmission network, that then carries them to other consumption areas.

The following graph illustrates this phenomenon in a German transformer station. With the connection of photovoltaic power stations, the factor determining the design capacity is no longer the winter consumption peak, but the peak of summer photovoltaic generation for much greater flows. And it is no longer a matter of transporting electricity to local consumers (a positive flow on the graph), but sending it back (negative flow) to the higher levels of voltage to distribute it over all the territories.



Source : *The Power of Transformation – Wind, Sun and the Economics of Flexible Power Systems*, IEA, 2014.

Regulation

In most European countries, the regulation for network activities **was devised at the time of the liberalisation of the gas and electricity sectors**. The objective at that time consisted of favouring the development of competition upstream (electricity generation and gas imports) by encouraging the downstream part (consumers) to change supplier easily.

With this in mind, the regulatory authorities promoted tariffs that had two characteristics:
– they are based essentially on energy consumption and only include a small part for paying for the subscribed power capacity ("subscription"). In some countries, the distribution prices do not include any fixed part,
– they apply the principle of the postage stamp, independent of the distance inside an area. In the case of transmission, this area can be for a region or a whole country, with for example two regions for gas in France (north and south) and a single area for electricity. In the case of distribution, the perimeter is generally set at the size of the local authority, with France as an exception by having a single national tariff.

These two characteristics fit poorly with the **future outlook**, marked by **less predictable consumption** (under the combined effect of energy efficiency efforts and local generation) and by **very different costs** according to whether the energy generated is used on the spot or transported long distances[42].

One can measure the breadth of the future changes by recalling that the French energy transition law currently being debated in the French Parliament aims to create 200 "energy transition territories". These territories will eventually have to attain 100% renewable energy, but this will imply, given the issues of intermittent generation, large changes to the network in these territories to maintain the balances, manage the extra inputs and export surpluses. Another illustration of possible changes concerns the storage of decentralised electricity. The expected progress results in a multiplication of situations being envisaged in which the network will play an even greater "insurance" role.

➔ **These prospects invite one to reconsider the management and remuneration of the existing networks, both to allow the development of experiments and to avoid an unfair apportionment of the costs. A reflection on the financial consequences that a sustained pace of investment would cause. This involves smoothing the price changes that pass the costs onto the customers, while at the same time avoiding making these costs heavy by an overly-wide gap between spending and income.**

The signals of a European energy crisis have been gathering since the beginning of the decade.

Accelerated investment in the energy networks is one way out of the crisis "from the top".

A specific effort is required to accompany the energy transition, while preserving high levels of security in the energy services delivered to European companies and households.

This updating of the networks must be backed by a renewal of the relevant public policies, with a revision of the regulation and pricing principles.

42 "Electricity distribution investment: what regulatory framework do we need?", EURELECTRIC, 2014.

Part 2

2015-2030: TRANSFORMING AN INVESTMENT MOUNTAIN INTO A EUROPEAN INDUSTRIAL PROJECT

Assessment and direction of the investment efforts

Insufficient and short-termist European efforts in relation to the funding of the networks

The decisions taken at the European level have highlighted the **issues of collective security**:

– Beyond the environmental questions, the Energy Climate packages ("3 x 20" package of 200[1] eand the 2030 Climate Energy package of October 2014) have made the security of energy supply in the Union a priority,

– The communication by the European Commission "Security of energy supply in the EU and international cooperation" of 7 September 2011 led to the adoption of an "information exchange mechanism with regard to intergovernmental agreements between Member States and third countries in the field of energy" (CEF) on 25 October 2012,

– Article 194 of the Treaty of the Functioning of the European Union (TFEU) finally marks the will of the Member States to ensure the smooth functioning of the energy market and to guarantee the security of European supply through the development of interconnections in the strategic energy networks.

A **European investment plan** has thus been introduced for the next few years, for projects of common interest[2] provided for by Articles 171 and 172 of the TFEU. This involves essential infrastructure that will help the Member States to physically integrate their energy markets, to diversify their energy sources and for some of them to extricate themselves from energy isolation.

But a **discord** exists between awareness of the acuteness of the problem, its definition as a priority and the commitment of the E.U. as an entity (besides the efforts made by its members):

– On the one hand, investment needs in energy infrastructure are for around 1,100 billion euros over the next ten years, including 500 billion euros for generation, 400 billion euros for distribution and 200 billion euros for transmission [3]. According to the regulation of the European Parliament and Council of 17 April 2013 on guidelines for trans-European energy infrastructure, common projects must, as a priority, concentrate on the

---

1 Adopted by the European Council of 12 December 2008, the Climate Energy package aims to reduce emissions of greenhouse gases by 20%, to increase energy efficiency by 20% and to increase by 20% the amount of renewable energy in the total consumption of energy by 2020.

2 Regulation No. 347/2013 of the European Parliament and Council of 17 April 2013. To view these projects, go to Annex 5.3 section a.

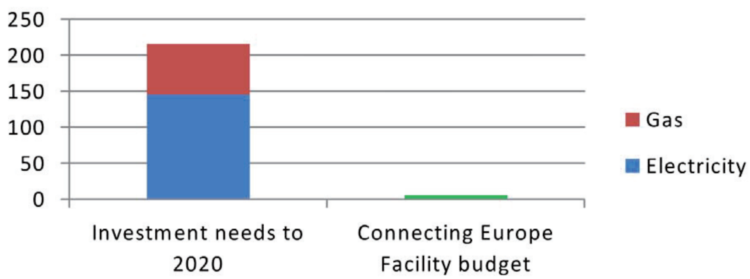
3 *European Commission, Une énergie durable, sûre et abordable pour les Européens, 2014; Presentation by J.M. Barroso to the European Council, 22 May 2013.*

creation of energy corridors. They are estimated to be 100 for the electricity field and 50 for the gas field, in the preliminary impact study.

– On the other hand, as part of the framework of the CEF, a budget of 6 billion euros only is earmarked for trans-European energy infrastructure in the 2014-2020 period. This budget is part of the Connecting Europe Facilities mechanism (33 billion euros, of which 26 for transport, 1 billion for telecommunications networks and 6 for energy).

➔ **The stated political "priority" for the consolidation of energy infrastructure in Europe is therefore not found in this Connecting Facility Europe budget, whose budget was cut from 9.1 billion to 5.85 billion euros in the negotiations for the multi-annual financial framework (2014-2020). The gap between the estimated investment need and the proposed European funding envelope [4] is particularly striking.**

Graph 4 :
The amount of the investments needed at the European level by 2020 in the light of the amount of the Connecting Europe Facility (billion euros)



Source : European Commission, *Connecting Europe Facility, 2012.*

Moreover, the European Commission announced on 29 October 2014 the granting of 647 million euros for "**large priority infrastructure projects**" for the CEF.

With the Russian-Ukrainian crisis, the **gas sector** is particularly affected by this funding aimed at reducing European dependency on Russian gas

4 Regulation No. 347/2013 of the European Parliament and Council of 17 April 2013.

(projects for liquefied natural gas terminals in the regions of the Baltic and in central and southeast Europe). 34 grant[5] were awarded on this occasion:

– Sixteen relate to the natural gas sector (for 392 million euros) and 18 to the electricity sector (for 255 million euros),

– Six are for construction work (for 556 million euros),

– Twenty-eight are allocated to studies, such as evaluations of the impacts on the environment (for 91 million euros).

However, Regulation No. 1316/2013 of 11 December 2013 establishing the CEF specifies that the planned financial budget must be **mainly allocated to electricity infrastructure projects**, "based on the expected preponderance of electricity in Europe's energy system over the next two decades".

As an example, whereas the European leaders had agreed on the "urgent priority" status of the Franco-Spanish electricity interconnection, the first series of funding by the CEF plans to allocate 0.5% of its funds to this project. The feasibility studies of the project will be funded for a maximum of 3 million euros, whereas, conversely, the Lithuanian-Polish gas pipeline (not a priority) benefits from a maximum of 295 million euros.

The priority given for the moment to the gas networks stems from **dealing with economic and political urgency**.

The development of corridors in the East and Southeast are favoured, emphasising the contra-flow capacity from the West to help better increase the integration and energy security of these countries. However, the uncertainties are great regarding the future place of gas in the European energy mix. According to the forecasts of the European Commission, its consumption could fall by 25% by 2030. In a context where the consequences of an energy shock from Africa are greater than that of a shock from Russia, an **important risk exists: that the gas pipelines financed by the CEF will be abandoned** [6].

➔ **The fluidity of the transmission of gas in Europe, combined with the rarity of congestion, thus argues in favour of an evidence-based approach for new investment. The next call for financing in 2015, for the CEF, should take into account these elements.**

---

5 In order to be eligible for a grant, a proposed action has to relate to a project included in the list of 'projects of common interest'. (published in October 2013). It consists of 248 energy infrastructure projects which, when completed, would each ensure significant benefits for at least two Member States; enhance security of supply, contribute to market integration and further competition as well as reduce CO_2 emissions. Under the first call for CEF-energy 64 eligible proposals have been received requesting in total €1.4 billion of financial support. The next call is scheduled for 2015.

6 id. The British think tank, E3G (Third Generation Environmentalism) underlines the risk of the waste of public money to support projects for which the long-term interest is far from being assured. It proposes that the funding of infrastructure should be guided by the European energy efficiency programmes, that the CEF commits to favouring electricity and that a part of the funding allocated to transport (26.25 billion Euros) is transferred to the energy sector.

➔ Since the place of gas in the future European energy mix deserves to be better defined, investment in the gas sector should meanwhile concentrate on **optimising the use of existing infrastructure** [7] and on the **development of R&D**, in order to enable the emergence of new innovative systems for gas [8].

➔ More generally, Europe should direct itself towards **improved management and local use of existing gas resources** and storage. A **better distribution of the supply points** over all the territories (local LNG terminals, local storage capacity, domestic production including renewable gases) would be more in line with the objectives of the energy transition.

At a time when the issues of energy security are identified as a priority, support from the E.U. for energy investment appears strangely moderate.

In addition, funding tends to favour gas infrastructure, in response to current geopolitical tensions rather than efforts decided in the light of developments in the European mix over the long term. These should result in greater support for the development of electricity infrastructure.

7 The 22 European LNG regasification terminals are currently used only at 25% of their capacity.

8 "Bio-methane gasification – assessment of the potential of production in France by 2020 and 2050", GrDF, 2013; "Market research on methanisation and the use of biogas", Ernst & Young, ADEME/GrDF, 2010.

Mapping out wide scale electricity corridors to improve security and optimise the use of the means of production

The meeting of the European Council of 23 October 2014 fixed at **10%, the minimum target for electricity interconnections by 2020**[9]. A target of 15% for interconnections is set for 2030 and must be achieved through the implementation of common interest projects[10]. In this context, the amount of investment needed has been estimated at € 100 billion by 2020 by the Commission and at € 150 billion by 2030 by ENTSO-E.

The association ENTSO-E is calling for the average rate of 15% to be differentiated for each of the Member States, according to each particular situation and the evolution of the national production base and places of consumption. In all, **interconnection capacity must double** according to ENTSO-E [11].

An organisation such as Greenpeace for its part, considers that, by 2030, 26,275 km of high and very high voltage lines (with a renewable energy penetration rate of 77%) will be needed, against 50,110 km for ENTSO-E (with a renewable energy penetration rate of 37%).

The interconnections between European electricity systems must be strengthened in order to **eliminate bottlenecks** (in particular in the Iberian peninsula) and the isolation of certain Member States (insularity, natural barriers). This massive investment policy must **improve the security of supply for** the European countries and develop **European energy solidarity**.

The **corridors identified as priorities** by the regulation of the Parliament of April 2013 are the following[12] :

– Network in the northern seas (Belgium, Denmark, France, Germany, Ireland, Luxembourg, Netherlands, Sweden, United Kingdom),

– North-South electricity interconnections in Western Europe (Austria, Belgium, France, Germany, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Spain, United Kingdom),

– North-South electricity interconnections in central and South-East Europe (Austria, Bulgaria, Croatia, Cyprus, Czech Republic, Germany, Greece, Hungary, Italy, Poland, Romania, Slovakia, Slovenia),

– Energy markets' Baltic Sea region for electricity interconnection plan (Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, Sweden).

9 This is the relation between the interconnection capacities of a country and its production capacities. This figure is below the 15% called for by Spain and Portugal, isolated by their peninsular situation, who do not find outlets for their overproduction of renewable energy.

10 "The European Commission, with the support of the Member States, will take urgent measures to achieve the 10% electricity interconnection minimum target, urgently, and at the latest by 2020 at least for those Member States which have not yet reached a minimum level of integration in the internal energy market, namely the Baltic States, Portugal and Spain, and for the Member States which constitute their main point of access to the internal energy market.".

11 ENTSO-E, Ten Year Network Development Plan, 2014.

12 Detailed list of projects of common interest by country: http://ec.europa.eu/energy/infrastructure/pci/doc/2013_pci_projects_country.pdf

➔ **One thing is certain: a unified and more interconnected energy market is decisive for integrating renewable production capacity in the European electricity system and, in the case of gas, providing better access to available storage systems and terminals for liquefied natural gas (LNG).**

> **The coverage of Europe by electricity highways is an imperative of collective security.**
>
> **It is also the condition for economic efficiency, both static (better use of the means of production) and dynamic (better integration of new means of production).**

Bringing about the energy revolution through the electricity and gas distribution networks

Bring the networks up-to-date must not be limited to the large interconnected transmission networks.

The distribution networks are at the heart of the energy transition, since 95% of renewable energy connects to them. They are thus tending to become large **collection networks**, something for which they were not originally designed. Besides the connections and extensions needed, investment made in the distribution networks will be characterised by **significant paradigm shifts**.

In 2011, the European Commission estimated that to achieve the targets set for 2020, nearly **400 billion euros needed to be invested in the gas and electricity distribution networks**, against € 200 billion for transport infrastructure [13].

• The British regulator, the Office of Gas and Electricity Markets (OFGEM) indicated in November 2014 that the six energy distributors of the United Kingdom would invest 24 billion pounds (30.7 billion euros) by 2023, to increase the reliability of their networks and to adapt them to renewable energy.

• The German case, much in advance in facing these issues, is also useful to examine. The investment needs related to the energy transition have recently been estimated by the Federal Ministry of Economy and Energy (BMWi) [14].

---

13 Response to ACER Public Consultation on Energy Regulation: A Bridge to 2025, EDSO, 2014. D'autres études ont précisé les montants intermédiaires, s'agissant de la distribution d'électricité, à 170 milliards d'euros à l'horizon 2020, puis 215 milliards d'euros à l'horizon 2025 : Integration of Renewable Energy in Europe, Commission européenne, 2014.

14 " Moderne Verteilernetze für Deutschland " - Forschungsprojekt Nr. 44/12, BMWi, 2014.

They are based on three scenarios assessing the share of renewable energy by 2032 at 128 GW ("Erneuerbare-Energien -Gesetz 2014" scenario" or "EEG 2014") and at 207 GW ("Federal Länder" scenario).

. According to the "EEG 2014" scenario, out of the 132,000 km of new lines needed, nearly 120,000 km relate to the distribution network, of which 50,000 km of low voltage and 70,000 km of medium voltage lines. This corresponds to respective increases of 5% and 14% to the current network. To this should be added nearly 15 GW of transformation capacity on the low voltage part and 43 GW on the medium voltage part, in order to allow the "flow back" to the higher voltage levels. At the same time, cables added to the low voltage part will be used mainly to make up for voltage gaps, following the integration of production capacity on a distribution network not designed for this collection function [15]. This is the least expensive scenario.

. The "Network Development Plan" (NEP) scenario uses the estimate of the transmission network operators. The assumption is that of installed renewable energy capacity of 139 GW in 2032 (65 GW wind power, 65 GW photovoltaic, 9 GW other sources).

. The "Federal Länder" scenario, for its part, assesses the needs at nearly 280,000 km of lines and 130 GW of transformation capacity. We find that extension needs grow more quickly than the development of renewable energy due to threshold effects. For example, the saturation of the network reception capacity: at a certain stage of deployment, all of existing capacity is used up and therefore new capacity must be created.

By 2032, the investment needs for the distribution networks to integrate renewable energy in Germany therefore vary from 23 billion ("EEG 2014" scenario) to 49 billion euros ("Federal Länder" scenario) [16].

In comparison, the past and future costs to reach the renewable energy targets (19 GW of wind power and 8 GW of photovoltaic) by 2020 in France are estimated at **4.3 billion euros for the distribution network and 1.2 billion euros for the transmission network** [17].

It should be noted that these amounts represent only a part of the investment by the operators of the distribution networks. Indeed, the bulk of the investment is allocated:

– to connections for new consumers,
– to changes and the renewal of infrastructure,
– to the improvement of the quality of the network.

The annual investment in the French distribution networks is thus nearly **4 billion euros**, i.e. the equivalent of the **total needed to be spent to adapt**

15 Ibid.
16 Ibid.
17 "La mise en œuvre par la France du Paquet Energie-Climat", Cour des Comptes, 2013.

the network to the 2020 targets. As renewable energy is developed and the reception capacity reaches saturation, the investment necessary to adapt the French distribution network to the energy transition will **undoubtedly be for greater amounts**.

For its part, the spending needed for the gas networks has not been assessed. However, facilities able to inject bio-methane into the French transmission or distribution networks are experiencing dynamic development, which should eventually lead to significant volumes, reaching 17% of the gas transported as early as 2020[18]. At the same time, the prospects offered by LNG and Compressed Natural Gas (CNG) in terms of mobility or the possible development of *Power-to-gas*[19] could contribute to an increase in investment in gas distribution networks in the medium term.

- ➔ Thus, **the investment to be made on the distribution networks is around several tens of billions of euros per year in Europe.**
- ➔ Moreover, we observe the extreme sensitivity of the **projections to the envisaged scenario,** even though some developments are only very little taken into account or treated separately. This is the case in particular of the deployment of electric vehicles or of smart meters.
  – In the French case, the target set by the bill on the energy transition for green growth to install 7 million charging terminals for electric vehicles by 2030 is estimated at 5 billion euros by ERDF.
  – To this should be added 5 billion euros by 2021 for the installation of 35 million Linky smart meters[20]. At the European level, the investment to be made for smart meters alone is estimated at 50 billion euros[21]. These amounts should also be applied to natural gas, since the deployment of 11 million Gazpar meters is estimated at 1 billion euros in France.
- ➔ Although the distribution networks will have to host new sources of production, they are also a central part of significant developments on the consumption side, whether this is the emergence of new uses such as electric vehicles or the prospects of reinforced management of demand with the emergence of smart grids. And

18 National debate on the energy transition, hearing of GrDF by sub-group 5 on 17 April 2013.
19 The "Power to Gas" expression means the production of synthetic methane using electricity from renewable sources outside consumption periods.
20 Hearing of Philippe Monloubou, President of ERDF, by the Commission of Inquiry on electricity prices, 29 October 2014.
21 "Staff working document SEC (2010) 1396", in "Energy infrastructure priorities for 2020 and beyond – A Blueprint for an integrated European energy network, Section 1.1.1. – Energy trends and infrastructure needs", European Commission, 2010.

these innovations of tomorrow go beyond national borders and the disparate organisations that govern them.

The distribution networks are at the heart of the financial and strategic industrial issues which must be tackled on a European scale.

They will in fact be the physical location of the energy transition, both for the integration of renewable energy (electricity and gas) and for the transfer of uses from fossil sources to electricity.

They will mobilise the bulk of the capital available for the networks for considerable amounts.

It is from them that innovations must emerge able to meet the challenges posed by the electricity system. These innovations will create international markets enabling growth and jobs in Europe.

Giving coherency to the industrial project

Identifying the priority R&D projectst

Europe has so far focused its spending on the deployment of **technologies** rather than on R&D. The support for renewable energy thus amounted to 30 billion euros in 2012 and the current trend suggests that it will amount to 60 billion euros in 2035[22]. In comparison, public spending on R&D in Europe (all sectors combined) is at a similar level, in real terms, to that of 1980 and contrasts with the U.S. or Japanese spending which has increased. In 2007, the European Commission established a Strategic Energy Technology Plan (SET Plan), but the European Council of 2008, which validated its principle, did not mobilise funding for its implementation. This weakened the initiative, which was designed to encourage coordination between the innovation players of the Member States and to promote the emergence of economically viable alternatives[23].

Since then, the situation has evolved and the many tensions weighing on the European energy system, both for integrating renewable energy and for ensuring the security of supply, require the relaunch of European cooperation for energy R&D.

Four major R&D "themes" stand out to meet the issues of tomorrow's energy networks:

– high-voltage direct current (HVDC),
– smart grids,
– mobility (these last three fields being strongly interdependent),
– storage.

The use of **high-voltage direct current** goes back to the origins of electrification. It has the benefit of being able to transport electricity over long distances with little loss. However, high-voltage direct current infrastructure is particularly costly and is therefore used only for certain underground or underwater connections.

We currently observe strong local resistance to the installation of conventional overhead lines (in particular for visual reasons). That is why burial thanks to direct current technology is often preferred, but for a cost that is seven

22 "European Policy Dialogue 2012", Public Launch supporting Policy Memo, ISH CER, 2012.
23 Opinion on the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "Technologies and energy innovation" - COM(2013) 253 final, TEN/528 Technologies and energy innovation, European Economic and Social Committee, 2013.

to eight times higher[24]. Although tens of thousands of kilometres of lines will have to be constructed in Europe in the next 20 years, **the issue of the reduction of these costs** has been raised to:

– improve the competitiveness of burial, or even to replace certain alternating current overhead lines by direct current capable of carrying greater amounts of energy,

– create a "supergrid" at voltages of around one GigaVolt and acting as electricity highways in Europe[25].

The second major focus lies in the **development of smart grids**, and more widely in the prospects of **managing demand** and for the **introduction of digital** technology in the public distribution network and in consumers' homes.

Managing demand consists of breaking out of the paradigm according to which the balance needed at any time between generation and consumption is assured by generation. Henceforth, the development of information and communication technologies offers the prospect of an **adjustment through consumption**, by shifting the times that electrical appliances are operated (heating, recharging of electric vehicles, etc.). This management of demand appears all the more crucial [26] since renewable energy is generally intermittent and does not contribute to the balance between supply and demand. There is thus a rapid increase in the volumes traded in the intraday markets, revealing the growing needs for flexibility [27].

More optimal management of demand could **save 60 to 100 billion euros per year by 2030**, enabling investment in production capacity, transmission and distribution infrastructure to be limited, and reducing operating costs[28].

However, the forms of action are varied, the business models still uncertain and the demonstrators in Europe both numerous and disparate. Be that as it may, smart grids are already a reality in many distribution facilities [29]. Since 2002, nearly 459 projects have involved hundreds of European players in 47 countries for a total investment of 3.15 billion euros. Of the 578 different sites concerned, 532 are on the territory of the European Union. Half of the projects are still in progress for a total budget of more than 2 billion euros. We also observe an increase in the size of projects over time[30].

---

24 Cf. the difference observed regarding the future Baixas - Santa Llogaia EHV connection between France and Spain.

25 "Integration of renewable energy in Europe", European Commission, 2014. These "electricity highways" appear to be necessary to evacuate and distribute the electricity from the large marine wind farms planned in the North Sea. They could also improve the profitability of the large conventional facilities which will be needed in the next few decades, and in particular nuclear power plants for those countries which will continue to use this energy.

26 DNV GL, Integration of renewable energy in Europe - Final report, European Commission, 12 June 2014.

27 OFAER – EPEX SPOT, "Direct sale of renewable energy on the European electricity exchange", January 2015.

28 Ibid.

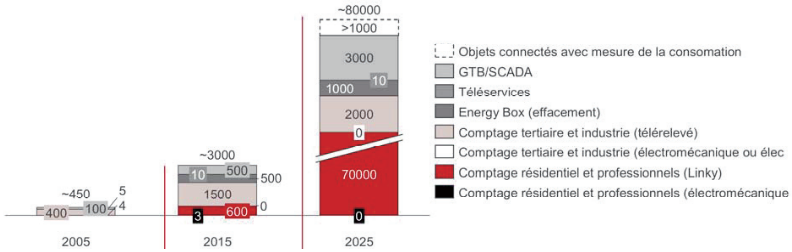
29 "Smart grids on the distribution Level – Hype or Vision? CIRED's point of view – final report", CIRED, 2013.

30 "Smart grid projects outlook 2014", European Commission, 2014.

Establishing smart grids will accelerate with the **deployment of smart meters**, of which almost 72% of European consumers [31] should be equipped by 2020. They will lead to a multiplication by 10,000 in the volume of meter data in the residential market, to which must be added the development of communicating objects. The modification of the energy value chain generated by this **irruption of Big Data** will be a **turning point for** all the European energy industries, and for the 500 million European consumers and citizens [32] !

Graph 5 :
The emergence of a Big Data logic

Annual production of electricity meter data [giga-bytes/year – rounded data]



Source : E-Cube Strategy Consultants, *Energy and digitisation – analysis of strategic issues*, July 2014.

The establishment of an ecosystem able to give value to these data and promote the emergence of "active consumers" participating in the smooth functioning of the energy system is an important issue for Europe. This requires simultaneously:

– guaranteeing security of the data,

– contributing to the emergence of future business models for managing demand,

– developing regulations that encourage this dynamic,

– ensuring the development of European industrial sectors that are competitive internationally.

Indeed, according to the firm Navigant, the global market for smart grids should double by 2020 reaching 55.8 billion euros annually [33].

31 Ibid.; "Benchmarking smart metering deployment in the EU-27 with a focus on electricity", European Commission, 2014.
32 Ibid.
33 Navigant, Smart grid technologies, November 2014.

Nevertheless, out of the 40 billion euros of investment that smart grids require by 2020, nearly 20 billion euros could be lacking according to the European Commission [34]. It is therefore urgent for Europe to **implement a strategy combining an increase in investment, adaptation of the regulations and better coordination of R&D**.

In addition, electric mobility and storage are two fields that are able to produce a leverage effect in order to accelerate the deployment of smart grids.

Mobility is a central issue of the energy transition, allowing the European oil bill and CO_2 emissions to be reduced.

One of the preferred channels in recent years relies on the development of vehicles running on electricity, but also natural gas and hydrogen. These various solutions each have a **strong impact on the energy networks**, and they must be considered in a combined way, because with the hybridisation of the networks, power to gas, France may be able to provide a mixed territorial response, intelligently combining the expertise of its electricity and gas distribution networks.

With regard to electric vehicles, charging them may prove particularly strenuous for the network. Two million electric vehicles in France would represent around only 1 to 2% of total electricity consumption, but could mean **significant power demand** should recharging be concentrated at the same time. Furthermore, since the charging infrastructure is all connected to the electricity distribution network, its impact on the management of this network and design capacity needs to be planned in advance. Indeed, the recharging speed determines the power and therefore the design capacity of the network.

Graph 6 :
Time and demand for charging electric vehicles

The full charge of a single electric vehicle for 150 km...	…requires power demand equivalent to
in 8 hours (3 kW)	a water heater
in 1 hour (22 kW)	a tower block
in 3 minutes (600 kW)	A city neighbourhood

Source : ERDF

In order to limit connection and reinforcement costs, the deployment of charging terminals must therefore be optimised and the charge must be regulated (to avoid bottlenecks at peak times). Charging at peak times

34 "Connecting Europe Facility - Investing in Europe's growth", European Commission, 2012.

would have a high carbon footprint, to such an extent that an electric vehicle "would emit" more CO_2 than a combustion-powered vehicle [35].

In other words, this means, as much as possible, managing charging in the same way as domestic hot water.

➔ **We see here the necessary interlinking of electric vehicles with smart grids and the potential uses that could be made of millions of batteries connected to the network to absorb the intermittency of renewable energy (Vehicle-to-Grid). This is work in progress that is seen particularly in Germany and Austria [36]. However, the prospects in this field remain extremely dependent on improving the cost and performance of the batteries.**

That is why **electricity storage** is generating high expectations, especially for the **flexibility** that it would offer the electricity system. Storage would compensate for the intermittent operation of the wind turbines and photovoltaic panels, ensuring a generation relay during peaks and developing self-consumption.

Although different solutions already exist, such as domestic hot water or PSPS [37], it appears, however, that the possibilities afforded by additional facilities are limited [38]. In addition, major hurdles to the expansion of new more flexible technologies remain, such as Lithium-Ion batteries or Power-to-gas. The main disadvantage lies in the **economic competitiveness** of these solutions which remains still a long way from market conditions, but also in the still very large size of the batteries. In its outlook vision, Ademe only forecasts **industrial expansion of stationary storage systems as of 2030** [39]. For its part, McKinsey believes that although the price of energy storage should fall in the future, the magnitude and speed of this reduction remains debatable. According to the consulting firm, the cost of a Lithium-Ion battery may fall from \$600/kWh to \$200/kWh in 2020 and \$160/kWh in 2025 [40].

➔ **Storage is a major component of the main smart grid projects launched in 2012 and 2013 [41] and it is essential for the development**

35 "Elaboration according to the principles of the LCAs of energy balances, of greenhouse gas emissions and other environmental impacts induced by all electric and combustion-powered vehicles, segment B PV (versatile compact) and LCV by 2012 and 2020", ADEME, 2013.
36 "Smart grid projects outlook 2014", European Commission, 2014.
37 A PSPS (Pumped Storage Power Station) a hydroelectric facility whose turbines are reversible. During periods of peak demand, the water is turbined from the higher lake to the lower lake to produce the electricity needed. During periods of low demand, the water is pumped back up with the turbine operating as a pump.
38 "Report on the development prospects for hydroelectric power generation in France", Ministry of the Economy, Finance and Industry, 2006.
39 "The systems of energy storage – strategic roadmap", Ademe, 2011.
40 "Battery technology charges ahead", McKinsey, 2012.
41 "Smart grid projects outlook 2014", European Commission, 2014.

of electric mobility. It is therefore important to strengthen and better coordinate, at the European level, the efforts aimed at increasing its performance and cost.

- ➔ The issue of **electric mobility is directly linked to that of the charging infrastructure.** Thus, the coordination and acceleration, at the European level, of the deployment of charging infrastructure is the key to achieving a **widespread supply shock** to open up industrial prospects. At the same time, a coordinated deployment plan for this infrastructure in Europe would enable the operators to take into account their hosting capacities as of today and would avoid them having to reinvest subsequently due to a lack of initial visibility.

- ➔ It appears that most R&D projects in Europe and in the world are concentrating on similar issues and opportunities [42]. Therefore Europe must quickly bolster its coordination and its investment, given the crucial role of R&D to allow the integration of renewable energy, reduce the costs of the energy transition, guarantee the security of the energy system and ensure the development of innovative sectors that are competitive internationally.

In Europe, the financial efforts have so far been concentrated on the deployment of technologies in order to speed up their maturity.

Comparatively, the intensity of R&D efforts has stagnated, whereas other areas of the world (China, U.S.A., Japan) have increased their investment.

4 major R&D "fields" must be made a priority in Europe, in order to anticipate the technological breakthroughs of tomorrow: high voltage direct current (HVDC), smart grids, storage and mobility.

Defining the model for standards and regulations

In response to the European challenges of securing supplies, reducing costs for integrating renewable energy and developing R&D, **regulation and standardisation play a key role**.

42 "Smart grids on the distribution Level – Hype or Vision? CIRED's point of view – final report", CIRED, 2013.

Differences in regulations in Europe lead **to divergent incentives according to the country**. The missions entrusted to the network operators vary, and with them, the prices applied.

• In France, for example, RTE's R&D costs are included in the TURPE (Use Tariff for Public Electricity Networks), which is not the case for all the transmission operators of the other countries.

• Likewise, the tariff structure in Germany and in France has led to subsidising self-consumers by exempting them from taxes (in particular the support for renewable energy) and by passing their costs onto other users[43].

Bringing together the missions entrusted to the network operators would in the long-term encourage **the convergence of transmission prices** (which may represent almost a third of customers' invoices). Most importantly, this convergence of the regulations needs to go hand in hand with increased tariff visibility.

One of the ways to reduce **the cost of investment** is indeed to decrease the risk premium. By providing **visibility and tariff guarantees** to investors, the cost of capital would be reduced. **Increasing the proportion of the subscribed power** in the prices would be an initial lever, since the network industry is one of fixed costs.

Furthermore, the **standardisation of the capacity mechanisms** appears crucial, for the purpose, potentially, of establishing a **capacity market in Europe**.

As it stands, the Europeans progress piecemeal, with the establishment of strategic reserves being preferred generally. Only France and the United Kingdom have opted for a capacity market.

In fact, establishing a capacity market on a European scale would appear to be complex due to issues that are different according to the country. In Germany, the challenge lies in managing the intermittency of renewable energy. In France, it is the ability to get through peak winter consumption.

The two situations call for different market models. However, it should be noted that **the structure of the French capacity market has the advantage of promoting consumption cut-off**[44], which involves controlling demand and whose role will undoubtedly grow.

The diversity of regulations and legal frameworks, as well as the uncertainties that accompany them, inhibit for example **the extension and reproduction of the results obtained from the smart grid demonstrators**[45]. European cooperation must be strengthened at the regulatory level, so that future developments lead not to divergent incentives, but on the contrary to

43 "Self-consumption in Germany – Feedback", OFAER, 2013.
44 "Capacity mechanism – Report accompanying the rules proposal" RTE, 2014. (LP: add a short explanation).
45 "Smart grid projects outlook 2014 ", European Commission, 2014.

a strengthening of the European energy market, such as to support the strategic objectives, particularly with regard to innovation.

A convergence of the regulations would help to create a **framework conducive to a strengthening of the European rules and standards**. Given the many projects, technologies and players, a convergent European approach would enable the required interoperability, while **strengthening Europe as a major global player** [46]. This need becomes crucial in terms of data, whose volume will grow sharply.

Behind these changes to the regulations certain **questions relating to the energy models** are appearing, related to the increased decentralisation of generation and the emergence of "*active consumers*".

Although the energy transition is in part a social aspiration, the extension of demonstrator projects is sometimes limited by **users' resistance to change** [47]. The establishment of **regulations encouraging ownership** by consumers of their energy use is therefore crucial, in particular by developing a framework conducive to innovation in terms of offerings and tools.

At the same time, the regulations must take into account the **rise of localness**, conducive to enhancing local energy potential, while ensuring that the **relevance of optimising the national and European energy systems** is maintained.

It has been clearly identified that **an uncoordinated decentralised approach generates high additional costs**, as the Federal Ministry of the Economy and Energy in Germany observes. The "Federal Länder" scenario thus gives an investment cost that is more than twice as much (49 billion euros) as the benchmark scenario (23 billion euros) [48].

➔ The issues of regulation and standardisation are essential for ensuring **optimised development of the networks at a lower cost**, but also for **meeting the challenges of innovation** and for **positioning Europe** in terms of standards. This in particular requires strengthening the visibility of the regulatory framework and its coordination at the European level.

The heterogeneity of the regulations and of the standardisation efforts, by fragmenting the investment spaces, increases the cost of transitions and inhibits the emergence of European champions

46 "Smart grids on the distribution Level – Hype or Vision? CIRED's point of view – final report", CIRED, 2013.
47 "Smart grid projects outlook 2014 ", European Commission, 2014.
48 "Moderne Verteilernetze für Deutschland , Forschungsprojekt" Nr. 44/12, BMWi, 2014.

What economic model(s) for directing investment in the networks?

Guaranteeing a competitive energy price and combating distortions between the Member States

We have seen above that, to improve the security of supply and allow the energy transition, **the pace of annual investment by the European Union** in the transmission and distribution gas and electricity **networks** should **double by 2020** [49].

In France, the network operators forecast a substantial increase in their annual commitments (nearly 20% for ERDF, excluding the Linky meter [50]). This increase will be reflected in the accounts of the companies, with the capital charges representing between 30% (ERDF, RTE) and 50 % (GRTgaz) of their expenditure, and therefore of the end consumer's invoice ("Transmission" section).

For a French domestic consumer, this "Transmission" share on average accounts for 36% of the bill excluding VAT for gas and 46% for electricity. Without corrective measures, an increase by 20% of annual investment in the networks would result in an increase of approximately 3% in the price of electricity and 5% in the price of gas. This result seems consistent with the estimates made for all the countries of the European Union [51].

The tariff increase stemming from investment in the networks remains modest, but could be added to other factors [52] increasing the bill and would thus contribute to a general movement resulting in 2020, according to the European Commission, in an average price that is **30% higher than its current level for electricity and 50% for gas**, reducing households' purchasing power and impacting employment [53].

For individuals, such a price increase would exacerbate the phenomenon of **fuel poverty**, which in 2014 affected more than one European citizen out of seven and between 3 and 6 million households in France, i.e. up to

49 "Report to the Prime Minister of 29 October 2014", Pierre Moscovici, 2014 (based on data from the European Commission).
50 Deliberation of the Energy Regulation Commission of 12 December 2013 relating to a decision on the use prices for a public electricity network in the MV or LV voltage fields.
51 Read for example: "Getting the European Electricity Transmission Infrastructure Financed", Florence School of Regulation, 2013.
52 These factors include the potential increase in the price of imported fuels, the renewal of a part of the conventional power station base, the upgrade of nuclear reactors to comply with new standards or support for renewable energy.
53 "Energy prices and costs report", SWD, 2014.

15% of the population of our country. Figures that have increased continuously for several years[54].

As for the **productive sector**, it would be negatively impacted in two ways:
– If the higher price is common to all the European countries, all exports outside of Europe would be disadvantaged. European industry has several energy intensive sectors (steel, chemicals, paper). These are already suffering from a competitive disadvantage due to common policy choices (promotion of renewable energy, introduction of CO_2 quotas, mainly auctioned). An increase in the price of gas and electricity related to investment in the networks would accentuate this handicap.
– If the price of energy rises less in some States of the EU than in others, the French companies would be penalised in the Community market. For electricity, French industry benefits from network costs that are lower than several of its main European competitors (greater however than those of Spain and Italy). The general loss of this benefit would be all the more detrimental to France since a major part of our country's exports are in the mid-range, to which the market is very price sensitive.

Since the need to invest in the networks is established, the cost of this investment needs to be optimised and the price impact compensated for by savings on other items of the bill.

This need is imperative for households suffering from fuel poverty and for the energy intensive industries, exposed to international competition.

An imperative optimisation of investment costs

The regulation of the network operators allows them rarely to accumulate **cash reserves** that are sufficient to fully self-finance their investments. These are therefore **financed by capital contributions, by borrowing, or by a combination of both**. We exclude from the outset subsidies from the budget of the State or local authorities, subject to intense constraints everywhere in Europe.

In order to attract external funding, it sometimes appears tempting to increase the rate of remuneration of the capital invested by increasing the networks' use prices, so as to offer dividends or higher interest rates. This response is contrary to the sought-after aim of avoiding price increases for users of the networks. It should be reserved for portions of infrastructure with specific commercial risks, such as the interconnections needed to strengthen the security of supply but rarely used in normal circumstances.

54 Cf. "Fuel poverty, a European priority", M. Derdevet, Géoéconomie No. 66, August- September-October 2013 ; "Access to energy in Europe", F. Bafoil, F. Fodor, D. Le Roux (ed.), 2014.

To make investments at an increased pace while limiting price increases, **the risks for investors need to be reduced**. Several measures can contribute to this:

– **A clarification and stabilisation of the regulations applicable to the network operators**, when these do not provide all the transparency required by the external providers of capital. As an example, the texts defining the prerogatives of the regulatory authorities were drafted at a time when the main objective was the development of competition, in a context of low investment requirements. A re-reading of these texts is currently desirable, since the priority now is a strengthening of the infrastructure.

– **A public guarantee could be made for a part of the funds provided by the lenders**. Although a payment default by network operators seems highly unlikely given the monopolistic nature of their activity, the uncertainties weighing on the energy sector as a whole remain strong enough to arouse fears among private investors. By reducing the risk, the required risk premium would also be reduced.

These two measures are complementary. They also remain **independent of the other measures** intended to attract the financial resources available in the capital markets to the network infrastructure, **such as bonds** issued by groups of operators, intermediate banking structures (EIB, CDC, KfW, etc.), or even States and allowing **the operators to be granted loans at preferential rates**. This type of initiative would benefit by being launched within a cooperative framework, at the European level or as a minimum by a group of volunteer countries. Although the European Commission has left the door open to mechanisms similar to State aid, such as loan guarantees, a common approach by several States would simplify their implementation[55].

A loan guarantee only includes a cost for the public budget in the event of a payment default. It therefore seems more advantageous for the European States than the principle of the "Master Limited Partnership" introduced in the United States to stimulate the transmission of gas and petroleum products. The latter consists of a tax exemption on profits for companies that reinvest them fully in this activity. It however releases significant capital at extremely low cost.

By reducing the cost of capital, the impact on the price borne by the end consumer would be contained. Three considerations also deserve attention to **limit the total cost**.

– **Completion time scales**. Everywhere in Europe, the projects for modernising and developing energy infrastructure come up against local obstacles, strong opposition, from local people and associations for the defence of the sites. Although the very high voltage line crossing the

55 The "Guidelines on State aid for environmental protection and energy 2014-2020" of 28 June 2014 (C 200/1) indicate, in sub-paragraph 207, that aid for network infrastructure will be subject to a case-by-case assessment.

Pyrenees (doubling the transmission capacity between France and Spain [56]) took more than 20 years to build, this is not an exceptional case:

. In Poland, the replacement and modernisation of the gas distribution networks can be spread over seven years,
. In Germany, 94 km of high-voltage lines were built in 2013 out of the 1,877 planned,
. In Italy, public opinion and the local authorities are contesting strongly both an oil pipeline project connecting Basilicata to the port of Taranto and the arrival in Puglia of the TAP gas pipeline project connecting Greece to Italy.

Everywhere, opposition is reflected in very long inquiries, and then judicial appeals, and finally obstructions during the work, three factors increasing the total cost of the projects. All avenues that may facilitate a local consensus being obtained on the siting of the infrastructure must therefore continue to be explored, taking advantage of successful experiments in neighbouring countries: technological solutions (increase in the power capacity of already existing lines), but also increased compensation for the disturbance generated by the infrastructure and overhauled democratic practices.

– **The relevance of the investments**. The needs are estimated according to the objectives envisaged for 2030, but technological breakthroughs or significant organisational changes are probable by then (progress on decentralised storage, on the management of networks or demand). Caution requires that at regular intervals the programmes be reassessed, according to new options opened up by the most recent innovations or developments. An example illustrates this way of working: the German experience shows that a regulatory change, allowing the operators of the electricity system to limit, on certain days of the year, the power injected by renewable sources, can greatly reduce the needs for strengthening the distribution networks. The costed data speak for themselves: a reduction of 5% per year of the energy injected allows a reduction of nearly 50% in the extension and strengthening needs [57];

– **The correct charging of expenditure**. This term refers to the allocation of costs to those responsible for them. We are thinking here more exactly of the extensions to and strengthening of the networks induced by the injection of electricity or gas of renewable origin. According to the country, the producers pay the entirety of the corresponding costs ("deep cost", including the connection to the nearest network and the strengthening of the infrastructure downstream) or only a part ("shallow cost", the rest being borne by the network operators). The first case is in line with the economic doctrine which recommends that the expenditure is borne by the party that creates it. It equates to a signal to site the project in the right place with its developers being encouraged to prefer areas in which the network is dense. In the second case, they will choose sites maximising the profit

56 From 1400 Mw to 2800 Mw, with the ultimate objective of reaching 8000 Mw by 2030.
57 BMWI, Moderne Verteilernetze für Deutschland , Forschungsprojekt Nr. 44/12, 12 September, 2014.

derived from generation, leaving to all consumers the network costs which are sometimes considerable.

The **pooling of studies and feedback** between volunteering countries is an irreplaceable tool to avoid errors and minimise costs. The work done in this spirit by the Franco-German Office for Renewable Energy is an excellent example, with programmes for sharing information defined both by the public authorities of the two countries and by the main industrial players. The positive cooperation initiated between the DENA (Deutsche Energie Agentur) and the ADEME (Agency for the Environment and Energy Management) , which could rapidly lead to a joint actions platform, should also be known about and recognised.

To make investments at an increased pace while limiting price increases, the risks for investors need to be reduced. Clarification and stabilisation of the regulations applicable to the network managers are desirable. A public guarantee granted to a portion of the funds could also meet such an objective.

By reducing the cost of capital, the impact on the price borne by the consumer would be contained. Three considerations deserve our attention to limit the total cost: a reduction in the completion time scales, the regular reassessment of the relevance of the investments (in particular according to technological developments), and the correct charging of expenditure (the allocation of costs to those responsible for them).

Putting the collective benefits in balance with the costs

The first objective of a strengthening of the energy networks is to **improve the security of supply**. Specifically, this is to **avoid load shedding or widespread malfunctions** ("black-outs").

As for any preventive policy, it is difficult to estimate the cost of an incident occurring in the absence of such a policy. However, the European Commission has put forward some figures derived from studies available on this subject[58]. It thus estimated a short interruption of electricity supply in Germany at **several billion euros** and recalled that stopping gas supplies to the countries of eastern Europe in 2009 cost them 1.65 billion euros. In both cases, the human costs are not taken into account (homes without heating, people stuck in trains or lifts). The Commission insisted on **the asymmetry of costs**: over-investment in the networks only increases the bill to the end consumer very slightly, whereas under-investment can lead to considerable cost if a failure occurs, even if its probability remains low.

58 "Staff Working Document SEC (2010) 1395 final", European Commission, 2010. Read chapter 5 "Analysis of Impacts" and in particular from page 35 onwards.

A second objective is **supply at the lowest cost, making the cheapest source accessible at all times**. Some countries currently have to operate power plants whose generation cost is high, while others of a lower cost remain idle due to insufficient capacity of the electricity lines connecting them to the areas of consumption. In a sample of 12 countries surveyed in 2008, the corresponding loss to society averaged 3 billion euros.

In the case of gas, it is estimated that British consumers paid an additional cost of around 2 billion pounds during the 2005-2006 winter, due to a lack of access to available reserves on the continent, less expensive than local production. On a smaller scale, the price of gas in the southern area of France (PEG Sud) remains significantly higher than in the northern zone (PEG Nord), due to a lack of gas pipelines of sufficient capacity between the two areas, which are supplied by imports whose prices are different.

In the case of communicating facilities, the objective is to **associate consumers with the management of the system**, by allowing them to reduce their consumption ("cut-off") when the generation conditions are costly or by shifting it to more favourable times.

With a growing share of electricity from non-programmable sources, such as the wind or the sun, the interest of **linking real time consumption with that of generation** is easier to see. But we can also see that the **benefit achieved depends on the precision of the signal received by the consumer**.

The deployment of "smart meters", able to transmit this signal with precision, **will be completed in Europe around 2020**, when 17% of electricity should be produced by a wind or photovoltaic source (12 % in France) [59]. In the decade that will follow, European consumers will thus have a tool giving them the possibility of moderating their bill. The simulations made in Europe and the experiments carried out in the United States put the **saving at between 5 and 15% on an average bill**. In the most favourable case, fewer losses on the networks will result, lower by 9% for the year 2020 at the trend level, i.e. a saving exceeding 7.5 billion euros for the whole of the European Union.

Without awaiting this future time, the experiments already carried out indicate that simply knowing in real time their consumption and the corresponding cost are sufficient incentives for consumers to reduce their demand. A test conducted in Amsterdam jointly by the companies NUON and IBM on 500 customers costed at 200 euros per household per year the benefit of this transparency [60].

---

59 *"Renewable Energy Projections", National Renewable Energy Action Plans of the European Member States, 2011. Read pages 97 (France) and 115 (European Union).*

60 The full report of the Amsterdam test is no longer available online on the Nuon website, but the result is mentioned in an IBM press release "Smarter meters: Better tools for tomorrow's energy". Refer also to the "Impacts of Information and Communication Technologies on Energy Efficiency" dossier by the European Commission , 2008.

- ➔ The potential savings achieved through improving the security of supply and access to the cheapest sources seem indisputable. However, caution needs to be taken about the announced saving with regard to reductions in consumption. In effect, the income of the network operators is mainly calculated in proportion to the energy delivered. If this were reduced although substantial investments have been made, it will be necessary to switch to a mode of remuneration that takes more account of the **subscribed power** (fixed or "subscription" part of the bill). This situation does not seem to have been taken into account in the assessments cited above.

- ➔ Sustained investment in the networks leads to the hope of positive **industrial knock-on effects**. Many emerging economies will need to deal with the needs of developing their own networks. The technological innovations and know-how acquired by the enterprises involved in a large scale programme of extensions and strengthening in Europe will help to meet these needs. Certainly, the misadventures of the European photovoltaic industry call for caution, since the specific character of emerging countries consists precisely of acquiring new technologies very quickly, but the opportunities for European companies would be even weaker if the level of investment remained low in their territory. The trading opportunities will firstly include facilities (especially for the high voltage and direct current lines, which still require research to develop some components), and secondly, the engineering related to smart networks, particularly the optimisation of transmission and the management of demand.

> The economic calculation relating to investments in the networks takes little or poor account of some of the economic benefits generated by these investments.
>
> To accelerate, on the basis of a more comprehensive cost-benefit analysis, the deployment of investments in the networks, better account needs to be taken of the effect of load shedding and black-outs that have been prevented, reductions in bills for companies and households related to the non-saturation of the interconnections, and the industrial effects induced by the development of new "sectors" (smart grids, mobility, low carbon, smart cities).

Part 3

TWELVE PROPOSALS TO STRUCTURE EUROPEAN ENERGY INTO NETWORKS

In the next fifteen years, European energy will face major challenges in terms of security of supply, adaptation to the low carbon transition and the financing and competitiveness of energy prices for industry and households. The energy networks must be placed at the heart of any comprehensive and coherent treatment of these issues.

The objective is to contribute to **a competitive European industry worldwide**, generating growth and jobs, today (investment in infrastructure) and tomorrow (investment in R&D), while reducing the costs of the energy transition thanks to the interconnections, to community funding at low interest rates and more visible, more flexible, European regulation.

From this standpoint, **three major focus areas** need to be explored or strengthened quickly:
– The **renovation of the framework** of the security of supply and cooperation between the network operators,
– The **regulatory convergence** and financial innovations needed to optimise the investment costs,
– The **positioning of Europe as a leader** in energy innovation, thanks to the establishment of greater cooperation with respect to R&D, standards, data and mobility.

These different initiatives must be based on **successful cooperation** and give priority to approaches that concentrate on exchanges between Member States, regions, or regional authorities.

The twelve proposals made here are structured around the **interdependence of the different issues**:
– The convergence of European regulations is thus very widely linked to a strengthening of cooperation between TSOs.
– The development of interconnections and investments in the distribution network are linked to the visibility of the tariff framework, itself dependent on regulation.

➔ **The whole aims to set in place a momentum contributing to optimising investment costs, guaranteeing a high level of security of supply, ensuring integration of the markets and asserting the position of Europe as a leader in energy innovation.**

Renovating the framework of the security of supply and cooperation between network operators

Proposal 1: strengthen coordination in relation to security of supply

Objectives and principles

For the past few years, **fears about European energy supply** have returned to centre stage, in particular following the Russo-Ukrainian gas crisis of 2009. They also concern (and more surprisingly) electricity. Indeed, the development of renewable energy and the closure of conventional thermal power plants **redraws the map of European generation capacity and the networks** which are linked to it, while requiring that the intermittent nature of renewable energy is taken into account.

The importance of the issue becomes even greater given that electricity consumption could grow[1], due to the development of information and communication technologies and transfers of usages from other energy sources, such as for example the use of electric vehicles.

Accordingly, **Europe must reconsider in full the issue of security of supply** one, of the parts of the "**energy trilemma**" (security of supply, acceptable price, decarbonised energy) and encourage a uniform and shared treatment of this issue.

Without this new appropriation of the question by Europe, which is the optimal size for its efficient treatment, there is a **risk of seeing the emergence of dispersed, uncoordinated visions, threatening the European market and resulting in additional costs for** consumers because of preventable overcapacity.

Enhanced coordination of the security of supply policies therefore appears essential.

It requires, in particular, using the work already undertaken as part of the Pentalateral Forum[2], of the ENTSOs and the ACER. The idea is to avoid the creation of a new expensive body, but to use **these various initiatives** and to build on the **synergies between the existing structures**, hitherto insufficiently exploited.

---

1 Be that as it may, the 2014 electrical balance of RTE shows a fall in gross consumption in most European countries during the past year and this is as much for reasons related to the weather and the economic crisis, as the result of energy efficiency measures.

2 The Pentalateral Forum comprises Austria, Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland.

This enhanced coordination should in particular aim to:
– promote the sharing of a common methodology for assessing the risks associated with the supply-demand balance and the rapid adoption of rules of the game able to prevent "black-outs" [3],
– organise exchanges on the energy forecast estimates of the Member States, beyond the networks' ten-year development plans. In effect, how would it be possible for Europe to agree on five, ten or 15 year strategic objectives without worrying about the corresponding national trajectories and the impacts related to the choices made by the Member States, which weigh on common security?
– develop shared and convergent objectives with regard to security of supply, taking into account the energy policies of the Member States (prospects for trading with neighbouring countries) and dedicated instruments (such as capacity mechanisms),
– provide recommendations for joint solutions respecting national sovereignty, in terms of energy mix,
– decide on the priority infrastructure projects in terms of security of supply and their eligibility for European funding.

Expected effects

- A better guarantee of the security of supply and a decrease in the risk premium.
- A strengthening of the integration of the markets.
- Help with convergence towards a techno-economic optimum.

3 For information, of the ten network codes selected for electricity under the 3rd Energy Package, none of them had been formally adopted by the end of 2014.

Proposal 2: **extend and concentrate cooperation between the operators of transmission networks: for European TSOs**

Objectives and principles

The transmission networks are at the heart of the security of supply and the integration of the European market thanks to the interconnections. They occupy an **essential role in optimising the generation base**, contributing to **reducing the energy bill**.

Although the activities of the transmission system operators are regulated, these operators also contribute widely to **developing regulations** due to their responsibilities in relation to the security of supply. Their cooperation in the framework of the two ENTSOs has thus resulted in significant progress.

However important differences remain between the countries. The missions which are entrusted to the operators often vary, and, by the same token, their prices too.

For a few years, **movement towards consolidation** has been taking place with respect to transmission activities, particularly of electricity [4]. This context opens up opportunities for the **formation of European TSOs**, in particular by means of cross-shareholdings. This would avoid a dilution of their capital, or even their control by extra-European players, which could affect this infrastructure of major importance [5] which is part of European energy sovereignty.

Réseau de Transport d'Électricité (RTE), which is geographically at the heart of 40% of European interconnections and which has actively participated for 15 years in European progress [6], may be the hub of this new dynamic.

Adjustments to the regulatory framework are needed. They must promote greater cooperation of this kind, on pragmatic and regional bases, consisting notably of:
– improving the planning and deployment of interconnections,
– contributing to the compatibility of tools dedicated to the security of supply (such as the capacity mechanisms), so that extra-national capacity can be taken into account, under the control of the European Agency for Energy Security,
– pooling the R&D efforts,
– accelerating the establishment of network codes,

4 Acquisition of Transpower by Tennet in 2009, of 50Hertz by Elia in 2010.
5 State Grid Corporation of China (SGCC) acquired 25% of the Portuguese transmission company REN in 2014, and 10% of Terna, the Italian TSO, in 2014.
6 Creation of the Holding Company of network transmission system operators (HGRT), of the Capacity Allocating Service Company (CCACS), of CORESO.

– relaxing the ITO rules (Independent Transport Operator) of the 3rd community package on the internal market [7], that in some aspects is penalising for the countries that have adopted them,
– promoting cross-shareholdings between TSOs.

Expected effects

• The establishment of an industrial base conducive to strengthened European regulation and standardisation.

• The acceleration of the deployment of interconnections, stimulating investment in the medium term.

• A reduction in the energy price through a better allocation of the generation bases.

• Reinforced European sovereignty for the transmission infrastructure.

• An increase in innovation efforts.

7 The 3rd Energy Package gave the possibility to Member States not wishing to separate the ownership of the gas and electricity transmission networks, to keep them within integrated companies, subject to constituting them into independent transport operators (ITO). The ITOs must comply with very strict rules of separation: certification of the ITO by the regulator, the establishment of a compliance officer, systematic approval of "sensitive" contracts between the ITO and the vertically integrated company (VIC) by the regulator, professional incompatibilities before and after the discharge of director functions for the ITO.

Proposal 3: **encourage cross-border cooperation between distribution system operators**

Objectives and principles

The importance of the distribution networks is still **under-estimated at the European level**. However, tomorrow's challenges will fall within their scope: connection of decentralised energy production (wind, photovoltaic, biogas), management of new generation and consumption modes (electric vehicles, self-consumption), the digital revolution (management of data produced by smart meters), coordination with the market players whose activities have an impact on the networks (aggregators).

Henceforth **the priorities of the Union** must be placed **on the deployment of intelligent energy networks**, i.e. on the medium and low-voltage electricity networks and the medium and low pressure gas networks.

No European tool currently allows this. The "Connecting Europe Facility", initiated in 2013 to identify projects of common interest, validated 248 infrastructure projects, only two of which were smart grid projects. Only one has just finally obtained the Union's financial support.

It could be envisaged that the European Commission, in a renewed approach to the subject, henceforth provides support for regional cooperation projects in the field of distribution, and that it encourages them in a specific way.

As such, **cross-border initiatives between DSOs** are desirable. They would allow, for example, all the benefits to be obtained from a possible cooperation between the Saarland and the Metz plant [8], or around the Rhine corridor, from Freiburg to Karlsruhe, with a French reference partner such as Électricité de Strasbourg.

We can also cite the CROME demonstrator project (Cross Border Mobility for Electric Vehicles), aimed at encouraging in the Franco-German region of the upper Rhine (Alsace and Moselle on the French side, from Karlsruhe to Baden-Baden, Freiburg and Stuttgart on the German side) the use of electric vehicles thanks to interoperable charging infrastructure and a cross-border roaming system.

Placed under the management of the Karlsruhe Institute of Technology (KIT) and different industrial partners [9], this project constitutes a first step toward a system of standard sockets, which will contribute to an increase in private investment in charging infrastructure and an increase in the size of the market. The close association of electricity distribution network operators in this type of initiative is essential. It allows charging behaviours compatible

8 The German STEAG utility company is thus planning a first Franco-German interconnection at the distribution network level, via the return into service of a 100 MVA/ 65kV interconnection station located on the border between the Saar and Lorraine, which would participate positively to a new approach in terms of cross-border capacity market.

9 Bosch, Daimler, EDF, EnBW, Porsche, PSA, Renault, Schneider Electric, Siemens in particular.

with the smooth operation of the electricity system to be developed, thus facilitating the integration of electric vehicles into the network and their participation in the energy transition [10].

In the field of gas, exchanges are many around professional practice, the fundamentals of gas safety and innovations. Power-to-gas in France and in Germany and its link with mobility are an example. The necessary transition of gas B to gas H in the North of France and in Belgium, Germany and the Netherlands, which will come about at the end of the exploitation of the Groningen fields, is also an opportunity for working together[11].

Expected effects

- An acceleration in the convergence of standards and regulations of the Member States.
- An increase in R&D efforts and the development of synergies.
- A strengthening of the European energy market.
- The development of European sectors and partnerships.

10 Cf. experiment conducted in Berlin on the storage capacity of parked electric vehicles, for the purpose of "smoothing" intermittent renewable production.

11 The different types of gas refer to different compositions and their distinct calorific values (lower in the case of gas B).

Proposal 4: **interconnect the pioneers of local energy governance. Create a European Forum of the territories**

Objectives and principles

The **players of the territories** have a major role to play in the energy transition under way in Europe. The European and national strategies for change will lead to a **broadening of their field of intervention** in the context of the deployment of renewable energies, the improvement of energy efficiency and the promotion of low carbon modes of transport. Moreover, the development of renewable energies, which will call for major investments in rural areas, is a formidable lever for rethinking and strengthening the links between them and the urban areas. Various initiatives, such as Energy cities or the 100 % RES communities network already usefully brings together the dynamic of positive energy territories at a European scale. As of 2008, 350 European mayors thus signed the Convention of Mayors and undertook to implement as a priority the Energy-Climate package in their territories.

In France, the bill on the energy transition for green growth provides for 200 volunteer territories to be encouraged to take an exemplary approach to promote the new French energy and ecological model (energy transition territories).

In recent months, exchanges between European cities and regions has increased, generating exchanges of ideas and the sharing of good practice.

To get the most out of this profusion of initiatives, publicising and putting into perspective the results obtained from **the "twinning" of territories and European regions** would be useful. This would encourage an exchange of information about the energy projects being undertaken and the best practice deployed to associate citizens.

But we could also consider the creation of a **European Forum of the territories**, a permanent structure of exchange at a European level.

– This Forum would help systematise feedback and the emergence of good practice initiated locally.

– It would facilitate thinking about the local regulations and how they fit in with the optimum national and European regulations. To succeed, the local energy measures taken in the territories must indeed be in line with the European and national policies.

– It would allow work on the issues of acceptability related to the various energy projects (means of production, developments of networks) to go ahead.

– Finally, it would work on the necessary solidarity that needs to be strengthened between urban and rural areas with respect to the energy transition.

This Forum could be backed up by a European institution (Committee of the Regions of Europe or European Economic and Social Committee).

Expected effects

- An acceleration of feedback and the dissemination of local innovation, in particular with respect to public debates and participatory initiatives.
- An acceleration of the deployment of general interest investments having a local impact.
- Directing the allocation of funding towards efficient local models.

Promote regulatory convergence and financial innovations

Proposal 5: **promote coordination of the regulations providing visibility and incentives**

Objectives and principles

Several hundreds of billions of euros of investment will be required in the next fifteen years in the distribution and transmission networks for gas and electricity. **The ability of the operators of the networks to make these investment**s at the lowest cost, **depends directly on regulation**, which in particular determines the tariff framework of these non-competitive activities.

Adapting the regulatory framework is needed, in order to reduce the costs of the energy transition, as well as its **stability**, in order to give long-term visibility to investors and to effectively mobilise private capital. The strengthening of the interconnections in Europe is therefore not dependent solely on the mobilisation of public or private funds. It also presupposes an **improvement in the coordination between the various national regulator** [12], and the **clarification/simplification of the time needed to obtain administrative authorisations**.

For example, the management of the networks is an **industry of fixed costs**, where tariffs are often shared out between a **main variable amount**, according to the quantity of energy supplied, and a **fixed lower amount**, relating to the subscribed power. A **rebalancing of these two elements** would constitute a signal to investors, particularly in a context of growth of self-consumption where the network could play a backup function rather than one of supply. But also, the regulatory framework could be adapted to encourage **R&D efforts** and the emergence of **innovative solutions**.

A **convergence of regulations around areas to be decided by the players** themselves would contribute to building a **resilient tariff framework**, guaranteeing an income base to the network operators, allowing the inclusion of current innovations and making the network use prices closer between countries. Such measures would help increase "**bankability**", i.e. the amount of funding made available by the banks and the duration of the loans.

The following changes could be envisaged as avenues to be explored:

12 Today, the multiplicity of regulators raises concerns about apportionment (how to allocate costs between users either side of national borders) and uncertainty (if, after the construction of an interconnection, the regulator of a country unilaterally changes the conditions for redeploying capacity).

– Increased Powers and Resources for the Agency for the Cooperation of Energy Regulators (ACER),

– Enhanced cooperation between national regulators,

– A public guarantee for a part of the funds provided by the lenders.

– Incentives to correctly site the means of production on the network to reduce the need for strengthening it,

– Authorisation for network operators to limit for short periods the power injected by renewable energy to increase the hosting capacity on the network of these resources,

– A greater share allocated to subscribed power in the tariff price,

– Taking the investment in R&D into account in the charges of the network operating companies.

Expected effects

• An increase in network investment.

• A limitation of costs for the users.

• A facilitation of the deployment of renewable energy through an increase in the hosting capacity.

• A limitation of deadweight effects.

Proposal 6: **create an investment fund for the territories crossed by strategic infrastructure**

Objectives and principles

For several years, energy infrastructure projects, in particular for electricity transmission, have come up against **problems of acceptance by the neighbouring populations** of this new infrastructure. This general interest infrastructure provides diffuse benefits to the whole of a country or to Europe, but concentrates inconveniences in particular areas, which see neither the interest nor the justification for them.

Accordingly, completing a project involves almost systematically **several years of consultation and appeals**, which contributes to extending their deployment time and increasing their cost. These obstacles now frequently lead to **burying lines** at a cost that is nearly seven to eight times greater than that of overhead lines. The legitimate desire to preserve the landscape by local people is thus accompanied by a significant additional cost for the community. And although the delay is difficult to translate into economic terms, the adaptation of the transmission network to the new requirements of security of supply and the development of renewable energy is a key issue.

The establishment of a **European investment fund** would reduce these additional costs, accelerate the time needed to complete projects and boost the activity of the territories affected through investments from the fund.

Such a fund should:

– invest in projects led by the affected territories, aimed at boosting their economic activities or providing more public facilities,

– make investment conditional on a shortening of the time limits for consultation and an absence of appeals by the communities affected,

– make investment conditional on approval by all of the local authorities crossed by the project and by a local referendum,

– fit in with the local governance changes referred to above (cf. Proposal 4),

– be supported by the Juncker plan for the funding of infrastructure, of which it is the territorial counterpart,

– include also non-cross-border lines when they have benefits for Europe (such as the EHV lines between the north and the south of Germany).

Expected effects

- A shortening of the period for the completion of transmission lines.
- A reduction in the cost of transmission infrastructure.
- An economic boost to the economy in the areas crossed by the transmission lines.
- A strengthening of the security of supply.
- A strengthening of the integration of the European energy markets.

Proposal 7: **reintroduce a long-term perspective to funding**

Objectives and principles

Although the improvement of the regulatory framework can contribute to facilitating investment in the networks and limit the costs, **other levers are indispensabl**e, given the extent of the amounts. As such, the **Juncker plan**, which provides, among other things, for the funding of strategic energy infrastructure, is an important, but insufficient, step. Especially as it is not added to the Connecting Europe Facility and to the Horizon 2020 programmes, but uses, on the contrary, their budgetary envelopes as guarantees.

Whereas interest rates are low, especially compared to the rates of remuneration for energy infrastructure, an **increase in public investment** is both a financial opportunity for the States and an industrial and strategic issue. Linked to the improvement referred to about price visibility, a **prospect of long-term remuneration and the relaunch of economic activity** thus emerges. And this is at a time when, according to the IMF, the currently sluggish macroeconomic context leads to high multiplier effects.

A synergy emerges here between:
– low interest rates,
– prospects for stable remuneration over the long term,
– multiplier effects of investment in infrastructure,
– strategic interests of the Member States and of Europe.

Such a programme should, in particular, have as its purpose the **building in the short term of critical infrastructure** as defined through the greater coordination with respect to security of supply (cf. Proposal 1). It would also be designed to function with the Juncker plan so as to strengthen its dynamic.

Possible measures could include:
– the amortisation, in the calculation of the public deficits, of investments made in energy infrastructure,
– the creation of a European savings book directed at energy infrastructure,
– the creation of a Franco-German fund for financing infrastructure and projects of joint interest (R&D), managed jointly by the Caisse des Dépôts and the Kreditanstalt für Wiederaufbau,
– changes to the content of Solvency 2 (adaptation of the financial regulation) so as to no longer assign the same capital charge to infrastructure, to private equity and to hedge funds.

Expected effects

- An acceleration in the deployment of strategic infrastructure.
- A reduction in the cost of infrastructure.
- Support for economic activity.
- Long-term remuneration for the States.
- The integration of the European energy market.

Put Europe at the forefront of energy innovation

Proposal 8: **pool the European efforts of R&D with respect to smart grids**

Objectives and principles

Given the challenges facing European energy, the importance of R&D appears crucial both to ensure the integration of renewable energy, and in particular the issue of their intermittency, and to offer new services to users and reduce the cost of the energy transition. These European challenges are occurring in a context of intense international competition, where many countries (China, United States, Japan) are investing heavily to stimulate innovation in the energy field, particularly in the networks.

However **the European budgets for energy R&D remain low**, at the same level in real terms as those of the 1980s. Moreover, there are many projects, but they are disparate and small in size. Finally, Europe has already established structures to coordinate and accompany its R&D initiatives with the SET Plan and the EEGI [13], but without giving them either the resources or the breadth that are adequate to counter the challenges it faces[14].

To ensure that Europe satisfies its ambitions in the field of energy, a strengthening of its investment in R&D is a necessity, as well as the rationalisation of its initiatives in this regard.

There is no need for a wide scale overhaul as this can be achieved simply by **using the existing structures, giving them the adequate breadth and resources**. In fact, future developments must be addressed at an international level.

To give a new impetus to R&D in the networks, there is a need in particular to:
– obtain feedback from the many smart grid demonstrators to identify those projects and technologies that can be deployed quickly in **trials of a greater breadth**,
– refocus the European R&D effort around **four priorities**: high-voltage direct current (HVDC), smart grids, storage and clean mobility,
– strengthen accordingly the budgets of the SET Plan and of the EEGI to reach R&D volumes in the networks that are equivalent to our international competitors,

13 European Strategic Energy Technology Plan (SET) and European Electricity Grid Initiative (EEGI).
14 Opinion on the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "Technologies and energy innovation" - COM(2013) 253 final, TEN/528 Technologies and energy innovation, European Economic and Social Committee, 2013.

– activate a specific wide scale programme (of the Apollo type) devoted to energy storage, to reduce its costs and encourage the emergence of "use cases",
– include R&D spending in the transmission and distribution tariffs set by the national regulators,
– establish a network of European energy laboratories and institutes, drawing on the successful example of the Franco-German European Institute for Energy Research (EIFER),
– strengthen the European presence within the ISGAN (Energy Agency [IEA] Implementing Agreement for a Co-operative Programme on Smart Grids).

Expected effects

- Position Europe as an innovation leader.
- Reduce the costs of investment in the networks in relation to the energy transition, security of supply, etc.
- Obtain new international markets.
- Strengthen the links between industry, universities and research institutes.

Proposal 9: **concentrate European standardisation efforts**

Objectives and principles

Standardisation also has an impact on both the security of supply and the integration of the energy markets in Europe as well as the competitiveness of European companies in global competition.

For example, for natural gas, the differences in standards of odorisation prevent reverse transmission (reverse flows) between France and Germany, thereby affecting the integration of the gas markets and potentially the security of supply.

However, the Community approach is currently little invasive, particularly with respect to the distribution networks. In terms of facilities, **the diversity of standards between the European States severely limits the prospects for the deployment of new technologies, and hinders the European companies in their international strategy**.

However, standardisation is a **powerful factor for speeding up the energy transition and for making economies of scale**, while at the same time contributing to improving trade between the European States. In addition, the increasing role of information and telecommunications technologies in the energy sector requires encouraging cooperation in terms of standardisation with the European Telecommunications Standards Institute (ETSI). Given its international structure, the ETSI is in a good position to be able to impose standards for the energy sector, whose approach to standardisation has up to now tended to remain national or even regional.

The standardisation issue calls for a **strong political impetus in favour of strengthening collaboration** between industry and research institutes, in particular on the emerging subject of smart grids. Europe can no longer satisfy itself with a "bottom up" approach and "interoperability" between its members as an afterthought. Like the major global players, it must set itself the strategic goal of defining and generalising common standards, making it the leader in the smart grid field.

Given the current lack of European structure, **the approach must be pragmatic, through bilateral collaboration**, in particular Franco-German, able to trigger a process.

To achieve this, it would be possible to:
– form a network of European laboratories overseen by the Joint Research Centre (JRC),
– place the standardisation work within a clear and unified European framework, with a single Directorate General of the Commission managing it, the DG Energy, and a single mission. All the existing European standardisation bodies would thus contribute to a common and shared strategy sponsored by the Union,

– focus on standardisation work related to communication protocols and cyber security, work that is strategic both in terms of protection of individual freedoms and global leadership,

– promote partnerships between facility manufacturers, in particular Franco-German ones [15], in order to strengthen cohesion in terms of standardisation and the development of common cross-border projects around smart grids,

– set up pre-standardisation European R&D,

– structure the standardisation issues upstream of the launch of the future SET Plan and of the EEGI,

– strengthen cooperation with the ETSI, especially in a transatlantic dimension (TTIP).

Expected effects

- An increase in the interoperability of facilities.
- A decrease in the cost of facilities.
- An acceleration of energy innovation.
- An improvement in the position of Europe within global competition.
- A strengthening of the security of supply.
- An acceleration of the energy transition.

15 Cf. Memorandum of Understanding, Zentralverband Elektrotechnik und Elektronikindustrie (ZVEI) and Groupement des Industries de l'Equipement Electrique, du Contrôle-Commande et des Services Associés (Gimélec), 2012.

Proposal 10: **create a European energy data platform**

Objectives and principles

With the deployment of smart meters and the arrival of connected objects, the **data available will probably grow exponentially**. The technologies for exploiting these data (Big Data), continuously progressing, open up **new prospects for the energy system**.

The **development of software** will come about at several levels, whether this is for smart grids, for the optimisation of investment, management by the State and the local authorities of their energy policies or in the fight against fuel poverty. It is imperative that Europe should tackle this issue proactively, because it concerns as much **cybersecurity** as that of the **competitiveness** of our industry and its ability to establish the standards and sectors of tomorrow. As the European Commissioner, Pierre Moscovici, rightly emphasised "the digital sector is an essential lever to ensure future growth; it is one of the most innovative sectors in Europe" [16].

A Franco-German impetus could be given with the establishment of an **energy data platform**. Different types of organisation and implementation processes are conceivable, the logic being however **to confer on the distribution system operators, the operators of a public service, a central role** because of their data collection and processing function, and the sensitive nature of these data. In addition, the DSOs interact independently with all the players of the system, from the local authorities through to the industrialists (energy as well as information technology industrialists), and including the individual customers.

Such initiatives would also involve control of the regulators, both for the data protection aspects, and for the definition of tools conducive to the emergence of business models. This platform would be able to fulfil the various missions at a regional level as a prelude to extending it Europe-wide:

– securing of European users' data, both with respect to cyber-attacks as with respect to guarantees of confidentiality during their exploitation,

– strengthening of European standardisation of data and their processing, like the CIM [17] or the Green Button initiative in North America [18],

– the establishment of a market data platform using the Amadeus model [19], for example with a view to developing consumption cut-off and, more widely, smart grids,

– the establishment of an Open Data portal for basic energy data,

---

16 "For a Europe of investment ", report to the Prime Minister, p. 37, 2014.
17 Developed by ENTSO-E, the Common Information Model aims to guarantee formats for the exchange of data that are compatible and approved.
18 The Green Button industrial initiative responds to a call from the White House for consumers to be provided with simple and secure access to their energy data.
19 Amadeus is a company processing bookings for the travel industry, created in 1987 by Air France, Iberia, Lufthansa and SAS. Since then, it has become a world leader in the sector.

– the establishment of networked incubators fostering the emergence of start-ups and related business models,
– the establishment of a joint research centre directed towards the processing of Big Data, cybersecurity and the protection of private data.

Expected effects

- The development of a European Big Data sector.
- The securing of data.
- An acceleration of the emergence of innovative solutions and their business models.
- A strengthening of the European energy market.
- Optimisation of the management of investment and assets.
- Improved management of generation and consumption.

Proposal 11: **map out European corridors for innovative mobility**

Objectives and principles

The **development of clean vehicles**, not emitting CO_2, is a key factor for achieving the European energy and climate targets and participates to reducing the share of petroleum products in end consumption (currently 35%).

The context is now favourable: **the range of electric vehicles should reach 300 km by 2020 and 500 km by 2030**, accordingly bringing up to 30 million the number of electric vehicles being driven in Europe. A recent directive moreover ensures the interoperability of the charging systems [20].

This development will have a **significant impact on the electricity distribution networks**, that it will be necessary to strengthen in proportion to these transfers of uses.

Regarding vehicles using compressed natural gas (CNG), France now has 350 charging stations (for 14,000 vehicles), Italy 1,000 (for 850,000 vehicles) and Germany plans to have 1,300 by 2020 (for a forecast base of 1.4 million vehicles). But, with the emergence of bio Natural Gas for Vehicles (NGV), a realisation of the circular economy may appear with the development of heavy or light vehicles using this technology.

One of the current obstacles for these new mobilities comes from the **limited number of charging stations** with the fear, for prospective purchasers, of a substantial loss of range. Conversely, it is understandable that recharging stations cannot be deployed as long as the vehicle base remains small. This "chicken and egg" situation is becoming an issue in Europe and creating a hurdle between political ambition, citizens' aspirations and the delays accumulated in their becoming a reality.

Specifically with regard to electric vehicles, the issue of long distance journeys is closely connected to that of the deployment of quick charging terminals, able to recharge a vehicle in a few minutes. These terminals have **extremely heavy impacts in terms of the design capacity of the network**.

Visibility on the deployment of charging terminals or, in the future, CNG fuel or hydrogen stations, is thus an imperative for optimising the management of investments. These corridors could thus take advantage of the gas interconnections of the European countries to move towards mixed solutions in term of clean mobility.

From this standpoint, **the creation of "European corridors for innovative mobility" would send a strong signal** to users and the car and energy industries.

20 AFI Directive ("Alternative Fuels Infrastructure"), Official Journal of the European Union, 28 October 2014.

It would entail covering 70,000 km of European motorways with charging stations every 80 km, in both directions, i.e. in total 1,750 stations [21].

The estimated cost, for the electricity part alone, of a large European project of this type, which would be relevant to all European citizens, would be around 450 million euros [22].

These "**green motorways**" would connect low carbon vehicles, without interruption, from Poland to Portugal and from Great Britain to Greece.

In addition, they would provide a **planning framework** for investment by the DSOs in the network and would provide an impetus to R&D on the potential role of electric vehicle batteries for the operation of the network.

These corridors could finally open up new prospects in the field of freight with, for example, electric-powered lorries able to recharge their batteries while driving, through catenaries, as experimented in Germany.

Expected effects

• A boost to innovative mobility, with the perception by users that long distance journeys are now possible.

• The strengthening of investment in mobility using natural gas or hydrogen.

• An acceleration in transfers of uses.

• The optimisation of investment in the distribution networks.

• The development of European networks of charging terminals.

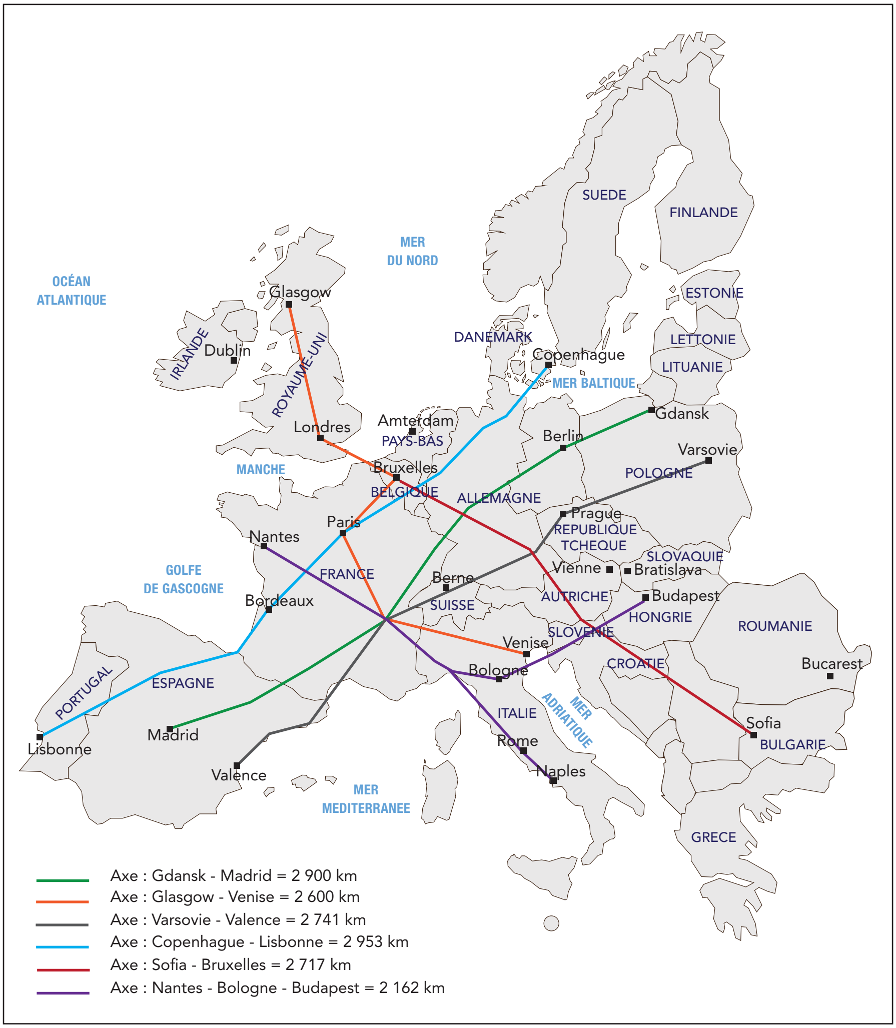
• European standardisation of charging terminals.

• A reduction in the oil bill.

• A reduction in pollution by fine particles.

21 This should be compared to the 60,000 petrol stations currently in service in Europe.
22 In these corridors, it can be estimated that 60% of journeys would be major road hauliers, 40% of users satisfying themselves with a local booster recharge; each station would therefore include four quick charging terminals and two accelerated charging terminals, for a unit cost of €260,000.

Graph 7 :
Proposal for European corridors for innovative mobility [23]



23 Refer to Annex 5.3 to view the details of the European corridors that we propose.

Proposal 12: **establish a Europe Energy College**

Objectives and principles

Recomposing the European energy landscape cannot not be reduced simply to a question of investment in networks, regulation or organisation. It implies also, and more than anything, a significant need for education, training and intellectual sharing.

The emergence of European excellence in innovation involves an increase in skills of thousands of employees, or future employees, of the energy sector and related sectors to best accompany the hundreds of billions of euros of investment that the energy transition requires.

Moreover, the energy system requires **cross-cutting approaches** combining the technical, economic, legal and sociological issues and taking into account the diversity of the situations in the Member States and the international context.

In 1949, following the congress at The Hague, facing an identical problem of sharing and innovation, figureheads of the European project, such as Salvador de Madariaga, Winston Churchill, Paul-Henri Spaak and Alcide de Gasperi, envisioned creating a college which young university graduates from different countries in Europe could attend to finalise their training, in a spirit of openness and exchange. This was the establishment of the College of Europe in Bruges, which since then has trained more than 400 young postgraduates every year and is a benchmark establishment for training connected to European affairs [24].

The creation in 2015 of a **Europe Energy College** could be an important lever for this upgrading of the skills of European energy professionals by offering:

– multidisciplinary curricula, in initial and continuing training [25],

– "interlinks" with the energy industries and research laboratories,

– a dedicated research centre - if possible in connection with that of the European data platform.

It should be noted that the establishment of this College would not exclude other types of exchange, that it would need to be encouraged and supported.

Thus, the Franco-German Research Centre EIFER, based in Karlsruhe, has for ten years undertaken close cooperation between the two countries in the field of research and innovation, particularly on fuel cells and on the "sustainable city". It could be the beginning of a twinning between the

24 It should be noted that, after the fall of communism and the changes that have occurred in central and eastern Europe, the College of Europe, in 1993, created a second campus at Natolin (Warsaw) in Poland, with the support of the European Commission and the Polish government.

25 In a similar way to what the IFPEN does in the areas of oil and gas.

German Academy of Sciences and the French Academy of Technologies around the energy systems of the future.

The work carried out as part of Euro-Case [26] and KIC InnoEnergy [27] should also be encouraged.

Expected effects

- Affirmation of the operational excellence of European energy professionals.
- Promotion of links between countries and between energy professionals.
- Improved understanding by the energy players of the issues of the other European countries.
- Strengthening of European identity.

26 Euro-Case brings together the national academies of Engineering, Applied Sciences and Technology of 21 European countries.

27 KIC InnoENergy is the European community dedicated to the promotion of innovation, entrepreneurship and education in the field of sustainable energy, bringing together academics, entrepreneurs and research institutes.

Thanks

I wish to express my appreciation to Laurent Fabius Minister of Foreign Affairs and International Development, Ségolène Royal, Minister of Ecology, Sustainable Development and Energy, Emmanuel Macron, Minister of the Economy, Industry and Digital Technology and Harlem Désir, Minister responsible for European Affairs, who have facilitated the writing of this report and the organisation of many meetings, without which its findings would never have seen the light of day.

I have been able to appreciate the flawless competence and availability of their teams, that I thank most warmly for their assistance. In particular, I would like to thank the support of the external services of the State, both economic and diplomatic, in organising European meetings in six Member States which have allowed me to hear more than seventy first-rate interlocutors (political, industrial and associative). My gratitude is addressed in particular to Emmanuel Puisais-Jauvin, Assistant Director of Internal Policies and Institutional Issues in the European Union Division of the Ministry of Foreign Affairs and International Development, and to its teams, as well as to Caroll Gardet (Rome), Laure Joya (Berlin), Patrick Auffret (Warsaw), Antonin Ferri (Brussels), Robert Mauri (Madrid) and Benoît Ronez (London) of the General Directorate of the Treasury.

My thanks go finally, and most importantly, to Patrice Geoffron, Professor of Economics at the University of Paris Dauphine, Director of the Geopolitics Centre of Energy and Raw Materials (CGEMP) and Director of the Economics of Dauphine (LEDa), Michel Cruciani, officer at the CGEMP, Stéphane Cossé, Lecturer at the Institute of Political Studies of Paris, and Christopher Fabre, officer at ERDF, whose contributions and wise advice have guided me throughout the writing of this report.

ANNEX

Annexe 1

List of persons interviewed

– Mr Tim Abraham, Head of European policies at the Department of Energy and Climate Change accompanied by Reuben Aitken, Senior Manager, European Electricity Transmission policy, Sue Harrison, Head of European Energy Markets and Eleanor Warburton, Head of gas supply security in the United Kingdom

– Ms Ana Aguado, Secretary General and Mr Christian Buchel, Vice-President, EDSO

– Mr Olivier Appert, President of the IFPEN

– Ms. Marie-Hélène Aubert, Adviser for international climate and environment negotiations to the President of the French Republic

– Mr Jean Bensaïd, member of the Executive Committee of ICADE

– Mr Ulrich Benterbusch, Director of the German Agency for Energy (DENA), with Ms Annegret-Cl. Agricola, Head of Division Energy Systems and Energy Services, and Ms Franca Diechtl, Communication Project Leader

– Mr Marc-Oliver Bettzüge, Professor at the University of Cologne

– Mr Jean-Paul Bouttes, Director of Strategy, EDF

– Mr Pierre Buhler, Ambassador of France in Poland

– Ms Marie-Claire Cailletaud, Federal Secretary CGT (FNME), member of the ESEC

– Mr Jan Chadam, CEO Gas System SA, Poland

– Mr Vincent Champain, President of the Observatoire du Long Terme

– Mr Jean-François Conil-Lacoste, CEO, EPEX SPOT SE

– Mr Pierre-Jean Coulon, Adviser, European Economic and Social Committee

– Mr Philippe David, Partner, PWC

– Mr Antoine Fleurieu, General Delegate of Gimelec, and Hugues Vérité, Deputy to the General Delegate

– Mr Matteo Del Fante, Administrator delegate of Terna, Italy, as well as Messrs Gianni Vittorio Armani, Director General of Terna Network and Stefano Conti, Director of Terna Network.

– Mr Claude Desama, former MEP and Chairman of the Commission of Energy, Research and Technology of the European Parliament, President of the Mixed Intercommunal gas and electricity companies of Wallonia (Intermixt), President of ORES (operator of gas and electricity networks)

– Ing. Gilberto Dialuce, Director General of the Security of Supply and Energy Infrastructure, Italian Ministry of Economic Development, assisted by Messrs Sebastiano Maria del Monte, Director of International Relations, Wolfgang D'Innocenzo and Marcello Capra.

– Mr Fabrice Dubreuil, Adviser for European issues to the Cabinet of the Minister of Foreign Affairs and International Development

– Mr Robert Durdilly, President of the French Union of Electricity (UFE), with Audrey Zermati, Deputy General Delegate and Anne Chenu, Director of Communication and European affairs

– Mr Philippe Esposito, CEO, Dhamma Energy

– Mr Philippe Etienne, Ambassador of France in Germany

– Mr José Maria Folgado, President of Red Electrica de Espana (REE), operator of the Spanish electricity network, with Mr Rafael Duvison, Director of Operations of REE and Mr Carlos Collante, Director General of REE Transmissions

– Mr Pierre Fontaine, Deputy Director Electricity Systems and Renewable Energies, DGEC

– Mr Patrick Graichen, Director of the Think Tank Agora Energiewende, and Dimitri Peschia, Senior Associate European Energy Cooperation

– Mr Pierre-Antoine Grislain, President of the Institute of Energy Transition

– Mr Jochen Homann, President of the Federal Network Agency (Bundesnetzagentur), and Achim Zerres

– Mr Winfried Horstmann, Minister Adviser at the Federal Chancellery of Germany, with Ms Anne Rosenthal and Dr Susanne Parlasca.

– Mr Luc Hujoël, Administrator of Fluxys, Director General of the Sibelga Intercommunal Company and of Brussels Network Operations

– Ms Isabelle Kocher, Director General Delegate, in charge of operations of the GDF SUEZ group

– Ms Malgorzata Kozak, Adviser to the President, Director of International Affairs, Office of Energy Regulation, Poland

– Ms Sandra Lagumina, Director General of GrDF

– Mr Philippe Léglise-Costa, Secretary General of European Affairs

– Mr Antonio LLarden, President of ENAGAS (operator of the Spanish gas network)

– Mr Jean-Bernard Levy, Chairman and CEO of EDF

– Mr Mieczyslam Lewandowski, CFO, Adam Jaskowski and Przemyslaw Gil, Directors, Polska Spolka Gazownictwa

– Mr Nick Mabey, Director General of the European Think Tank E3G, and Mr Jonathan Gaventa, Associate Director of E3G in charge of European Energy Infrastructure

– Ms Myriam Maestroni, President of Economie d'Energie (Energy Savings) SAS

– Mr Dominique Maillard, President of the Executive Board of RTE

– Mr Julien Marchal, Energy Adviser, Environment and Extractive Industries, Cabinet of the Minister for the Economy, Industry and Digital Technology

– Mr Didier Mathus, Chairman of the Supervisory Board of RTE

– Mr Michel Menny, Director General of Seifel

– Mr Eduardo Montes, President of the UNESA (Association of Spanish electricity companies) and Msr Marién Ladron de Guevara, Director of Communication of UNESA

– Mr Alberto Nadal, Spanish Secretary of State for Energy, Ms Teresa Manuel Baquedano, Director General of Energy Policies and of Mines, and Lorena Prado, Deputy Director General of International Energy Relations of the Spanish Secretariat of State for Energy

– Mr Dermot Nolan, Director General, OFGEM, accompanied by Ms Maxine Frerk, Head of governance and smart grids for the distribution networks

– Mr Alfonso Pascual, Director of Strategy and Regulation at GDF SUEZ Spain

– Mr Antoine Pellion, Technical Energy Adviser, cabinet of the Minister of Ecology, Sustainable Development and Energy

– Mr Jacques Percebois, Professor at the University Montpellier 1 (CREDEN)

– Ms Mélanie Persen, Director of the Franco-German Office for Renewable Energies, and Mr Sven Rösner, Deputy Director

– Mr Xavier Piechaczyk, Energy, Environment, Transport and Housing Adviser, Presidency of the Republic

– Xavier Pintat, Senator for the Gironde, President of the National Federation of Local Licensing Authorities and Utilities (FNCCR)

– Mr Emmanuel Puisais-Jauvin, Assistant Director of Internal Policies and Institutional Issues, European Union Division, Ministry of Foreign Affairs and International Development

– Mr Roberto Poti, Executive Vice-President , Edison Spa

– Mr Luc Remont, President of Schneider Electric France

– Mr Urban Rid, Director of Energy, German Ministry of Economics and Energy, and Philipp Jornitz

– Mr Fabien Roques, Associate Professor at Paris-Dauphine, Senior Vice-President, Compass Lexecon

– Mr Xavier Rouland, Director EDF FENICE Iberica

– Mr Dominique Ristori, Director General for Energy, European Commission

– Mr Bernard Salha, Director of EDF R&D

– Mr Johann Saathoff, MP, Bundestag, and Dr Gabriele Werner, Energy Coordinator of the SPD Group

– Mr Edouard Sauvage, Director of Strategy, GDF SUEZ

– Ms Virginie Schwarz, Director of Energy at the Directorate General of Energy and Climate (DGEC) of the Ministry of Ecology, Sustainable Development and Energy

– Mr Pierre Sellal, Permanent Representative of France to the European Union

– Mr Lawrence Slade, Chief Executive Energy UK, and Mrs Barbara Vest, Director of Generation Energy UK

– Mr Pascal Sokoloff, Director General of services of the FNCCR

– Mr Cezary Szwed, member of the Board of PSE S. A, and Mr Wlodzimierz Mucha, Director

– Mr Thierry Trouvé, Director General of GRTgaz

– Messrs Javier Villalba, Director General Networks, Francisco Martinez Corcoles, Director General Sales, Iberdrola Group, and Miguel Angel Sanchez, Director of Control Systems and Telecommunications

– Prof. Michael Weinhold, CTO, Siemens Energy Sector, with Dr. Udo Niehage, Senior Vice President, Head of Government Affairs Berlin

– Mr Nick Winser, Chief Executive Officer, National Grid, President of ENTSO-E

– Mr Ryszard Wnuk, KAPE, Polish National Energy Conservation Agency

– Mr Tim Yeo, former Minister, MP for South Suffolk, Chairman of the Audit Committee on Energy and Climate Change in the House of Commons, and Sarah Williams, Special Adviser

– Mr Alexandre Ziegler, Director of the Cabinet of the Minister of Foreign Affairs and International Development

Annexe 2

Glossary

Allocation: allocation of interconnection capacity in the market following explicit or implicit auctions.

Self-consumption: part of the production which is consumed in the building in which it is produced.

Biogas: fuel gas with high methane (CH4) content produced by the decomposition of organic matter.

Bio-methane: fuel gas produced from the purification of biogas, produced by the decomposition of organic matter providing a source of renewable energy and which respects in full the properties of natural gas.

Black-out: widespread power failure following supply not meeting demand. This may result from consumption vagaries, weather hazards, failures or outside attacks resulting in an overload in cascade, a collapse in frequency, a collapse in voltage or a loss of synchronism.

Congestion: for an interconnection, a situation of saturation of the available commercial capacity for interconnection where the demand for capacity is greater than the supply. Congestion is reflected in a non-nil explicit auction price, or by a non-zero price differential in the case of a market coupling. In both cases, the scarcity of capacity allows the formation of congestion income that is shared between the network operators. This income must, pursuant to Article 16.6 of Regulation 714/2009, be used to develop the availability of interconnections and exchange capacity, in particular through new investment.

Coupling of the electricity markets: optimisation method which seeks better use of available cross-border capacity and greater harmonisation of prices between regions through the use of a single platform for daily electricity transactions. Coupling allows the players to acquire quid pro quos without reserving exchange capacity in the interconnections.

Load shedding: temporary suspension of electrical power to a part of the network because of an imbalance between the generation and consumption of electricity. Load shedding prevents a greater or even total widespread loss of the electricity supply.

Interconnection: very high voltage transmission line connecting two national networks.

Linky: smart meter being rolled out until 2021 by ERDF to 35 million French consumers, able to receive and send data and orders without the physical intervention of a technician.

Capacity market: market in which the suppliers acquire from the generators certificates of generation capacity or from the cut-off operators certificates of cut-off capacity. This is to ensure the security of supply of the network, in particular in France during winter peaks, through a remuneration of the power stations or cut-off operators operating during these peaks.

Power to gas: technology used to convert electricity to gas (hydrogen or synthetic methane) by electrolysis. This technology has the advantage of allowing surplus electrical energy from renewable energy to be stored by taking advantage of natural gas storage capacity.

Smart grids: improvement to the flexibility and optimisation of the networks and sources of production and consumption, in particular through the integration of information and communication technologies.

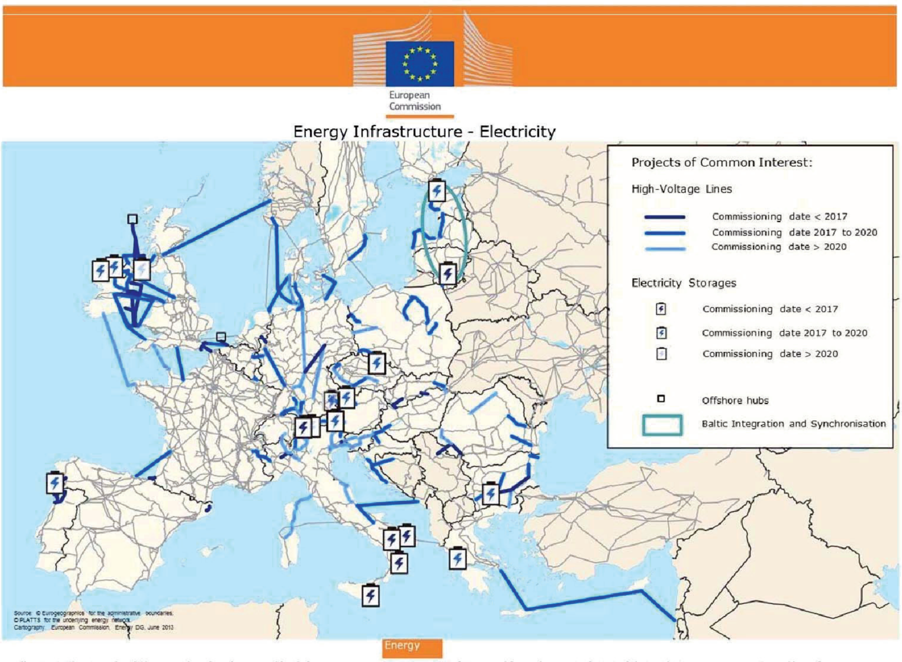
Supergrid: a high voltage direct current (HVDC) transmission network used to transmit energy over long distances.

Energy transition territory: territory which is involved in an approach designed to produce at least as much energy as it consumes.

Annexe 3

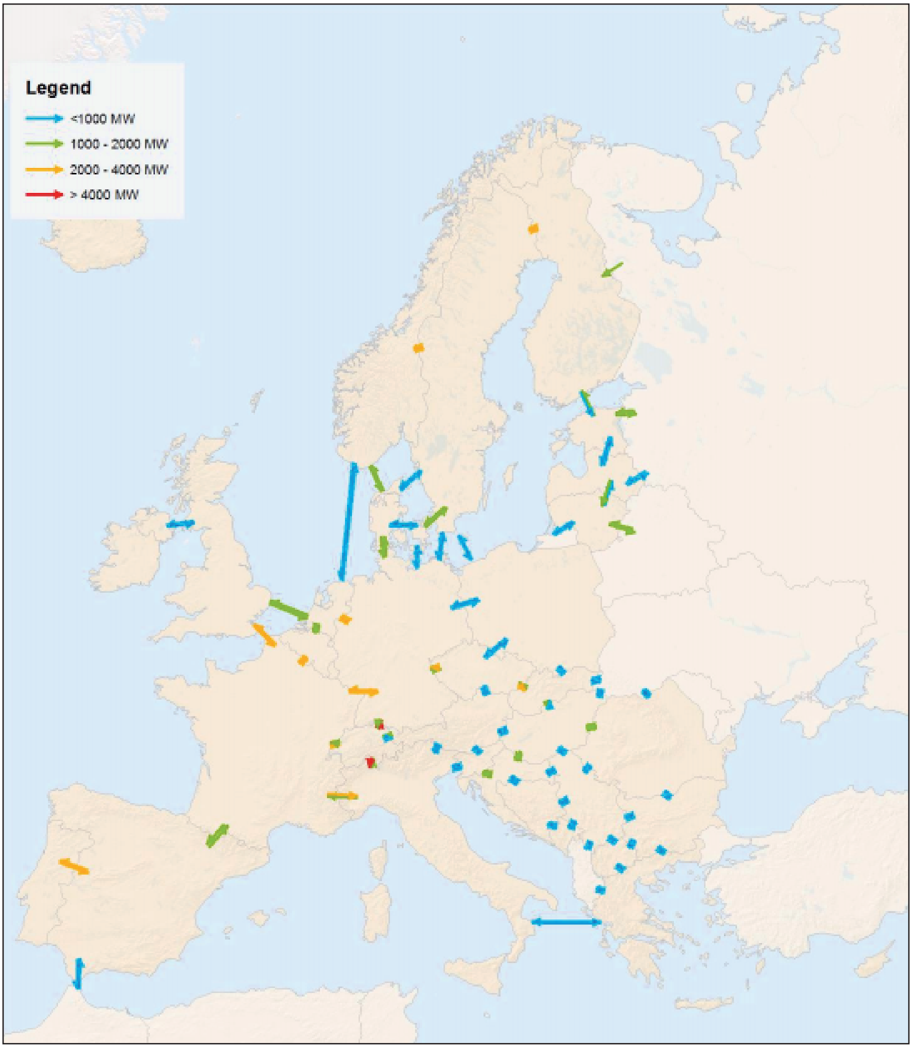
Maps

Map of Projects of Common Interest & TYNDP 2014

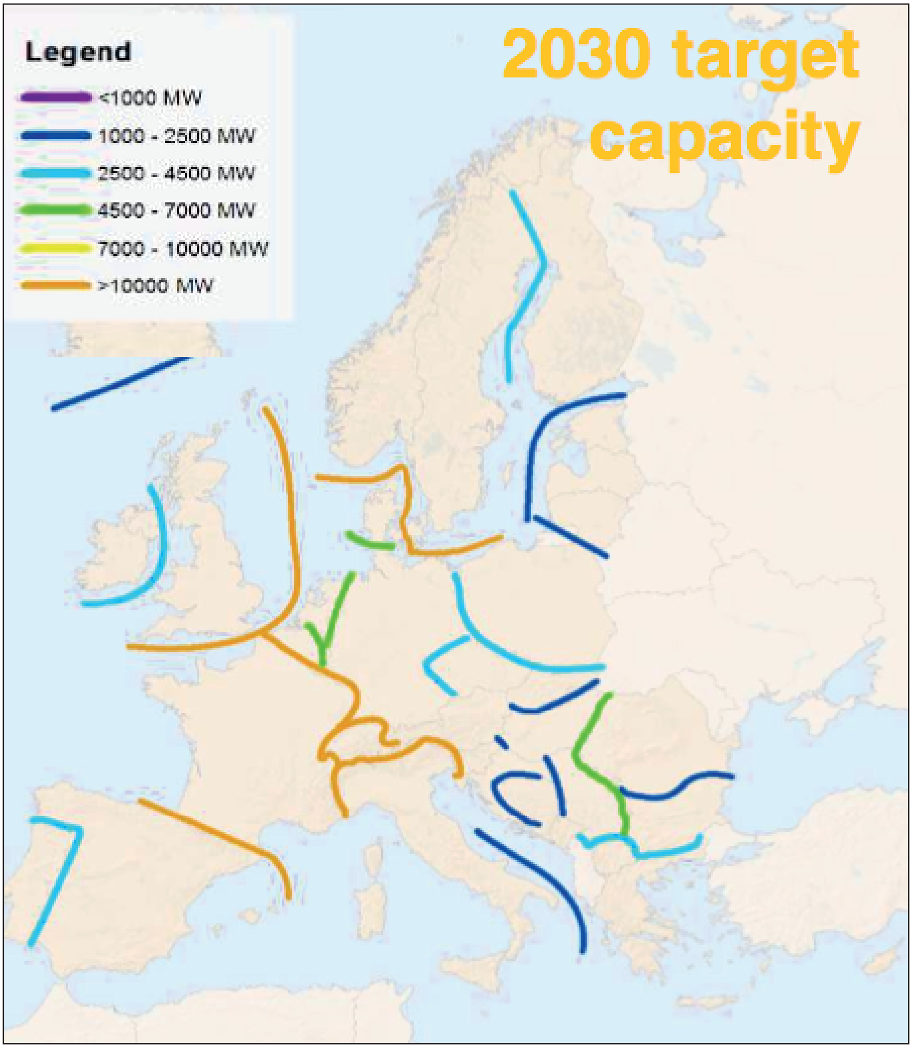


All potential routes should be considered and assessed both from an energy security point of view and from the point of view of their relative economic costs and benefits.

Map of current interconnection capacity and current targets by 2030 (according to the TYNDP) Source: ENTSO-E

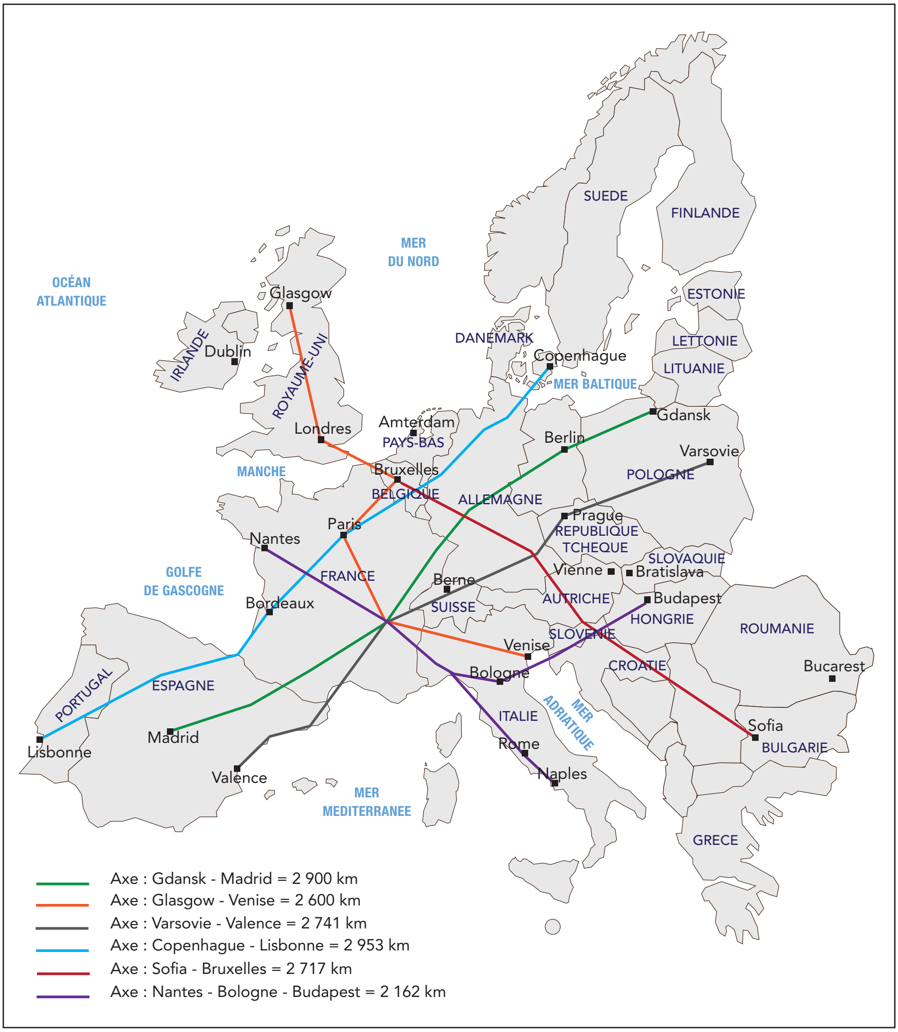


Source : ENTSO-E.



Source : ENTSO-E.

Maps of European corridors proposed for promoting eco-mobility



ROUTE: GDANSK - MADRID = 2,900 KM

ROUTE: COPENHAGEN - LISBON = 2,953 KM

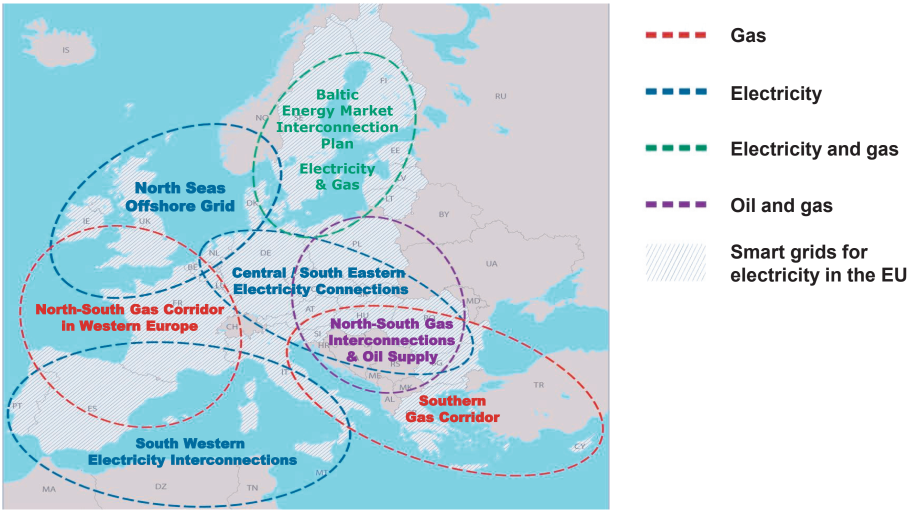
ROUTE: SOFIA - BRUSSELS = 2,717 KM

ROUTE: NANTES - BOLOGNA - BUDAPEST = 2,162 KM

ROUTE WARSAW-VALENCIA = 2,741 KM

ROUTE: GLASGOW-VENICE = 2,600 KM

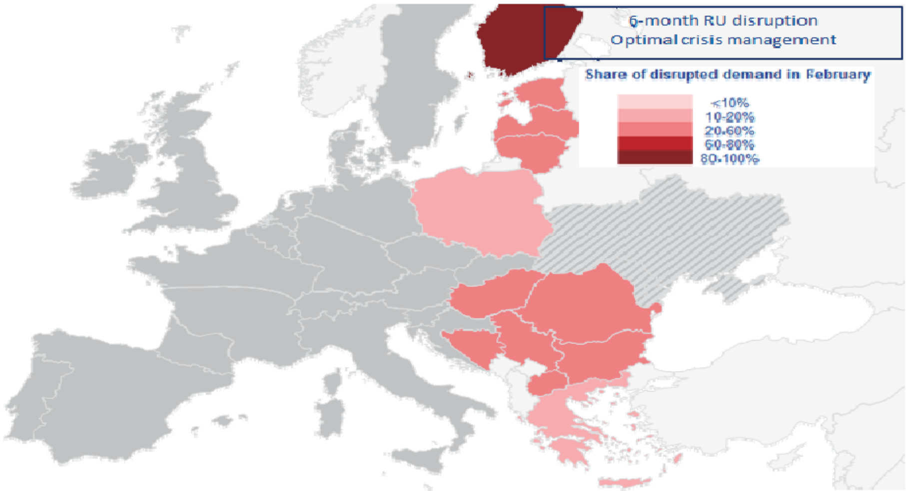
Large European project areas



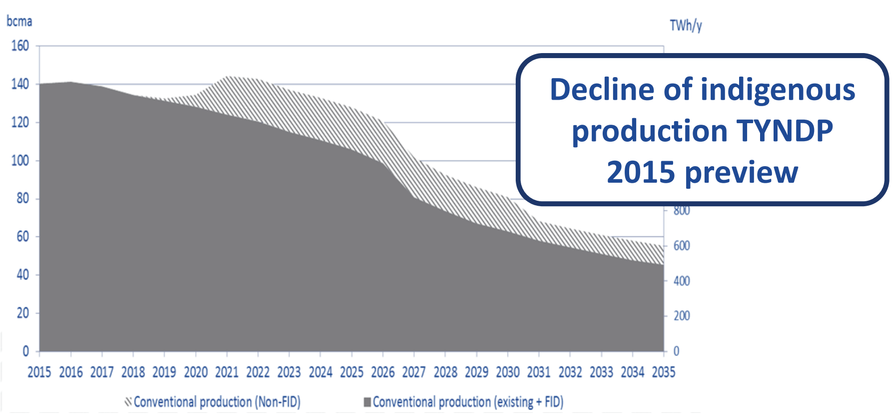
Presentation of J.M. Barroso to the European Council, 22 May 2013

Source: European Commission

The security of gas supply: exposure of the countries of the East to a break in Russian supplies

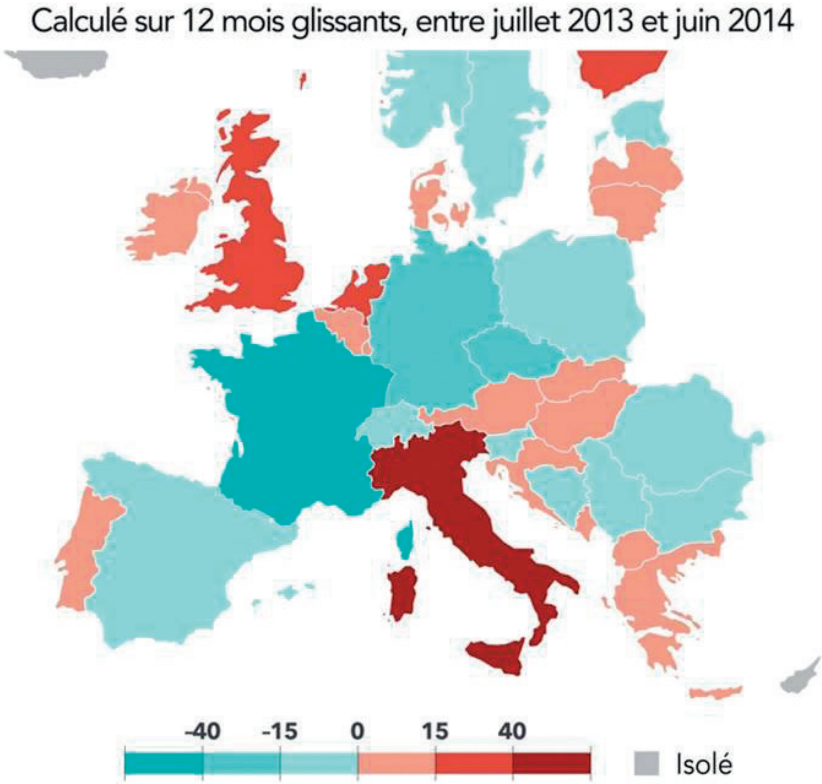


The decrease in European domestic gas production



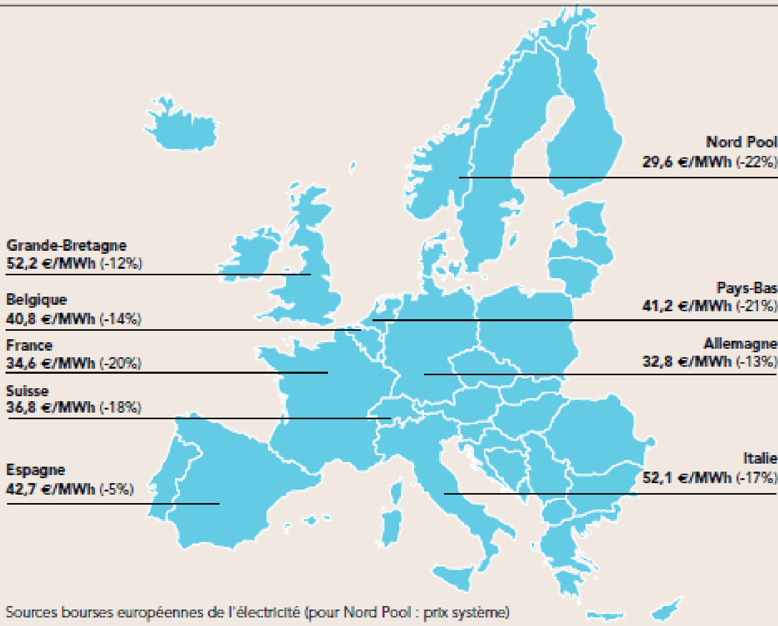
Source : *European Cooperation in Energy Networks*, Olivier Lebois, Presentation to the European Economic and Social Committee 26 January 2015.

Balances of physical exchanges of electricity in Europe



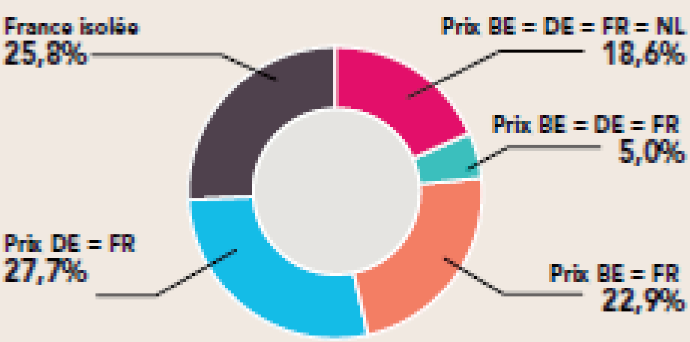
Source : Annual Electricity Balance – 2014, RTE.

Prix spot moyens sur les bourses de l'électricité en 2014 et évolution par rapport à 2013

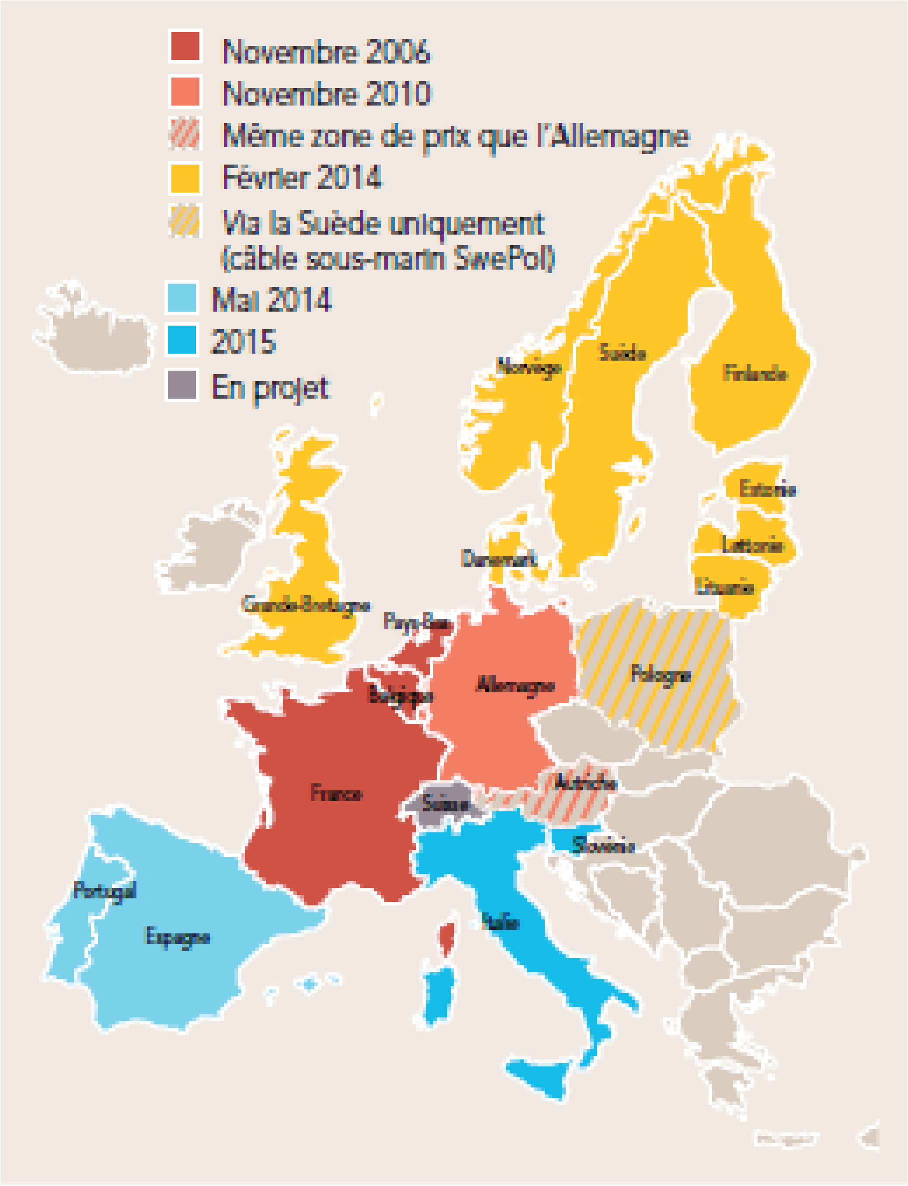


Sources bourses européennes de l'électricité (pour Nord Pool : prix système)

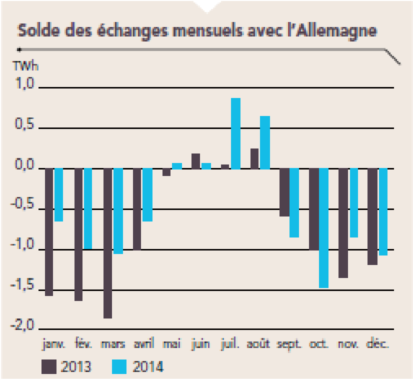
Convergence des prix de la zone CWE*

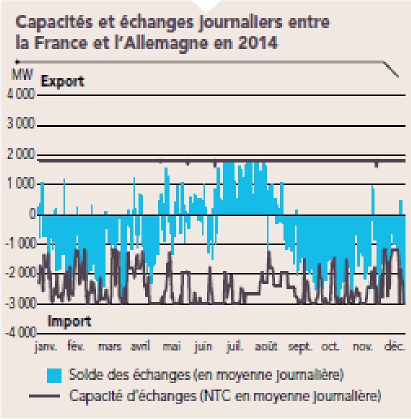


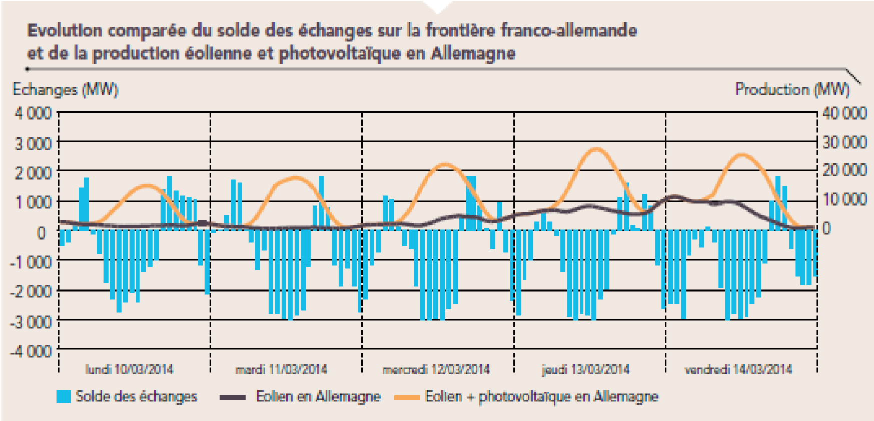
*Central West Europe, région comprenant la France, l'Allemagne, la Belgique et les Pays-Bas

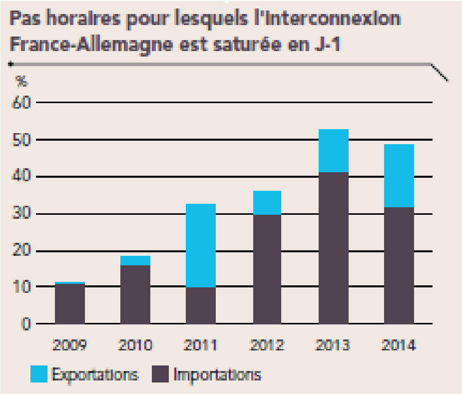

Novembre 2006
Novembre 2010
Même zone de prix que l'Allemagne
Février 2014
Via la Suède uniquement
(câble sous-marin SwePol)
Mai 2014
2015
En projet
Norvège
Suède
Finlande
Estonie
Lettonie
Lituanie
Danemark
Grande-Bretagne
Pays-Bas
Allemagne
Pologne
Belgique
France
Autriche
Suisse
Slovénie
Portugal
Espagne
Italie

Germany


Solde des échanges mensuels avec l'Allemagne
TWh
1,0
0,5
0,0
-0,5
-1,0
-1,5
-2,0
janv. fév. mars avril mai juin juil. août sept. oct. nov. déc.
2013
2014


Capacités et échanges journaliers entre la France et l'Allemagne en 2014
MW
Export
4 000
3 000
2 000
1 000
0
-1 000
-2 000
-3 000
-4 000
Import
janv. fév. mars avril mai juin juil. août sept. oct. nov. déc.
Solde des échanges (en moyenne journalière)
Capacité d'échanges (NTC en moyenne journalière)


Evolution comparée du solde des échanges sur la frontière franco-allemande et de la production éolienne et photovoltaïque en Allemagne
Echanges (MW)
Production (MW)
4 000
3 000
2 000
1 000
0
-1 000
-2 000
-3 000
-4 000
40 000
30 000
20 000
10 000
0
lundi 10/03/2014
mardi 11/03/2014
mercredi 12/03/2014
jeudi 13/03/2014
vendredi 14/03/2014
Solde des échanges
Eolien en Allemagne
Eolien + photovoltaïque en Allemagne


Pas horaires pour lesquels l'interconnexion France-Allemagne est saturée en J-1
%
60
50
40
30
20
10
0
2009
2010
2011
2012
2013
2014
Exportations
Importations

Annexe 4

List of members of ENTSO-E and ENTSO-G

ENTSO-E

Country	Company
AT **Austria**	Austrian Power Grid AG Vorarlberger Übertragungsnetz GmbH
BA **Bosnia and Herzegovina**	Nezavisni operator sustava u Bosni i Hercegovini
BE **Belgium**	Elia System Operator SA
BG **Bulgaria**	Electroenergien Sistemen Operator EAD
CH **Switzerland**	Swissgrid AG
CY **Cyprus**	Cyprus Transmission System Operator
CZ **Czech Republic**	ČEPS a. s.
DE **Germany**	TransnetBW GmbH TenneT TSO GmbH Amprion GmbH 50Hertz Transmission GmbH
DK **Denmark**	Energinet.dk
EE **Estonia**	Elering AS
ES **Spain**	Red Eléctrica de España S. A.
FI **Finland**	Fingrid Oyj
FR **France**	Réseau de transport d'électricité
GB **United Kingdom**	National Grid Electricity Transmission plc System Operator for Northern Ireland Ltd Scottish Hydro Electric Transmission plc Scottish Power Transmission plc
GR **Greece**	Independent Power Transmission Operator SA
HR **Croatia**	HOPS d. o. o.
HU **Hungary**	MAVIR Magyar Villamosenergia-ipari Átviteli Rendszerirányító Zártkörűen Működő Részvénytársaság

Country	Company
IE **Ireland**	EirGrid plc
IS **Iceland**	Landsnet hf
IT **Italy**	Terna – Rete Elettrica Nazionale SpA
LT **Lithuania**	Litgrid AB
LU **Luxembourg**	Creos Luxembourg S. A.
LV **Latvia**	AS Augstsprieguma tīkls
ME **Montenegro**	Crnogorski elektroprenosni sistem AD
MK **FYR of Macedonia**	Macedonian Transmission System Operator AD
NL **Netherlands**	TenneT TSO B.V.
NO **Norway**	Statnett SF
PL **Poland**	Polskie Sieci Elektroenergetyczne S.A.
PT **Portugal**	Rede Eléctrica Nacional, S. A.
RO **Romania**	C.N. Transelectrica S.A.
RS **Serbia**	JP Elektromreža Srbije
SE **Sweden**	Svenska Kraftnät
SI **Slovenia**	ELES, d. o. o.
SK **Slovak Republic**	Slovenska elektrizacna prenosova sustava, a. s.

ENTSO-G

Country	Company
Austria	Baumgarten-Oberkappel Gas Leitungsgesellschaft Gas Connect Austria Trans Austria Gasleitungsgesellschaft
Belgium	Fluxys Belgium
Bulgaria	Bulgartransgaz
Croatia	Plinacro
Czech Republic	NET4GAS
Denmark	Energinet.dk
Finland	Gasum Oy
France	GRTgaz TIGF
Germany	Bayernets Fluxys TENP GASCADE Gastransport Gastransport Nord Gasunie Deutschland Transport Services Gasunie Ostseeanbindungsleitung GRTgaz Deutschland Transport Services Jordgas Transport NEL Gastransport Nowega Ontras Gastransport Open Grid Europe terranets bw Thyssengas
Greece	DESFA
Hungary	FGSZ Natural Gas Transmission
Ireland	Gaslink Independent System Operator
Italy	Infrastrutture Trasporto Gas Snam Rete Gas
Luxembourg	Creos Luxembourg
Netherlands	Gasunie Transport Services
Poland	Gas Transmission Operator GAZ-SYSTEM
Portugal	REN-Gasodutos
Romania	Transgaz
Slovak Republic	eustream
Slovenia	PLINOVODI
Spain	Enagás
Sweden	Swedegas
United Kingdom **ASSOCIATED PARTNERS (3)** **Estonia – EG Võrguteenus** **Latvia – Latvijas Gāze** **Lithuania – Amber Grid** **OBSERVERS (4)** **F.Y.R.O.M. – GA-MA AD Skopje** **Norway – Gassco** Switzerland **– Swissgas** Ukraine **– UKRTRANSGAZ**	BGE UK Interconnector (UK) National Grid Gas Premier Transmission

Annexe 5

References – Recent works by the same author

"Comprendre le nouveau monde de l'énergie - Économie d'énergie et efficacité énergétique : le monde de l'énergie 2.0" (Understanding the new world of energy - Energy savings and energy efficiency: the energy world 2.0) co-written with Myriam Maestroni and Jean-Marie Chevalier, Editions Maxima, 2013.

"Les nouvelles régulations électriques – 2 tomes" (The new electricity regulations – 2 volumes), Lavoisier, September 2012.

"Le Traité de Lisbonne : De nouvelles compétences pour l'Union européenne ?" (The Treaty of Lisbon: new competences for the European Union?), Droit, Société et Risque, L'Harmattan, 20 April 2012.

"L'Avenir énergétique : cartes sur table" (The Energy Future: cards on the table), book co-written with Jean-Marie Chevalier and Patrice Geoffron, Éditions Gallimard, 23 February 2012 (2012 award for the best economics book by the Association of energy economists).

"L'Europe en panne d'énergie" (Europe's energy malfunctions), Michel Derdevet, Éditions Descartes & Cie, May 2009.

"Les réseaux électriques au cœur de la civilisation industrielle" (Electricity networks at the heart of industrial civilisation), book written in collaboration with Christophe Bouneau and Jacques Percebois, Timée-Editions, May 2007.

"Quelle politique de l'énergie pour l'Union européenne ?" (What energy policy for the European Union?), report written in collaboration with Jean-Paul Tran Thiet and Vincent Jaunet, Institut Montaigne, March 2007.

Annexe 6

References – List of mains works and documents consulted

ACER, Energy regulation: a bridge to 2025, 19 September 2014.

ADEME, Les systèmes de stockage d'énergie – feuille de route stratégique (The systems of energy storage – strategic roadmap), April 2011.

ADEME, Systèmes électriques intelligents – feuille de route stratégique (Intelligent energy systems – strategic roadmap, December 2013.

ALBERICI & Alii., Subsidises and costs of EU energy – Final report, European Commission, 2013.

ANDERSEN, Allan Dahl, "No transition without transmission: HVDC electricity infrastructure as an enabler for renewable energy?", in Elsevier, 15 September, 2014.

BMWI, Moderne Verteilernetze für Deutschland, Forschungsprojekt No. 44/12, 12 September 2014.

BMWI, Zweiter Monitoring-Bericht "Energie der Zukunft", March 2014.

BOOZ&CO, Benefits of an integrated European energy Market, 20 juillet 2013.

BUREAU, D., FONTAGNE, L., MARTIN, P., "Energie et compétitivité" (Energy and Competitiveness), in *Les notes du conseil d'analyse économique*, No. 6, May 2013.

CDC CLIMAT, Panorama des financements climatiques en France en 2011 (Overview of climate funding in France in 2011), October 2014.

CGSP, La crise du système électrique européen (The crisis in the European electricity system), D. Auverlot & alii, January 2014.

CIRED, Smart grids on the distribution level – Hype or Vision ? CIRED's point of view, 23 May 2013.

COLE, S. MARTINOT, P., RAPOPORT, S., PAPAEFTHYMIOU, G., GORI, V., Study of the benefits of a meshed offshore grid in northern seas region, European Commission, July 2014.

EUROPEAN ECONOMIC AND SOCIAL COMMITTEE, Opinion on the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions "Technologies and energy innovation" - COM(2013) 253 final, TEN/528 Technologies and energy innovation, Brussels, 16 October 2013.

REGULATORY COMMISSION OF ENERGY, Décryptages – La lettre de la Commission de régulation de l'énergie (Explanations - the letter of the regulatory commission of energy), No. 40, March/April 2014.

REGULATORY COMMISSION OF ENERGY, Délibération de la CRE portant recommandations sur le développement des réseaux électriques intelligents en basse tension (Deliberation of the CRE relating to recommendations on the development of low voltage smart electricity grids), 24 June 2014.

REGULATORY COMMISSION OF ENERGY, Dossier d'évaluation de l'expérimentation Linky (Assessment of the Linky experiment), June 2011.

EUROPEAN COMMISSION, Benchmarking smart metering deployment in the EU-27 with a focus on electricity, Brussels, 17 June 2014

EUROPEAN COMMISSION, Connecting Europe facility 2014-2020, September 2012.

EUROPEAN COMMISSION, European energy security strategy, COM (2014) 330 final, 28 May 2014.

EUROPEAN COMMISSION, Smart grid projects outlook 2014, JRC Science and policy reports, 2014.

CONSEIL FRANCAIS DE L'ÉNERGIE, Analyse théorique et modélisation de la formation des prix de l'électricité en France et en Allemagne (Theoretical analysis and modelling of the formation of the price of electricity in France and Germany), September 2014.

CRUCIANI, Michel, Le coût des énergies renouvelables (The cost of renewable energies), IFRI, September 2014.

DESAMA, Claude, Le secteur de l'énergie à la croisée des chemins, (The energy sector at a crossroads), Cercle de Wallonie, 15 February 2012.

DNV GL, Integration of renewable energy in Europe - Final report, European Commission, 12 June 2014.

E-CUBE, Énergie et digitalisation – Analyse des enjeux stratégiques (Energy and digitisation – analysis of strategic issues), July 2014.

ECF, From roadmaps to reality – A Framework for power sector decarbonisation in Europe, 2014.

ENERGY REGULATORY OFFICE OF POLAND, National report of the President, July 2014.

ENTSO-E, Annual report 2013 – TSOs cooperation and the internal energy marketing, 2014.

ENTSO-E, ENTSO-E Overview of transmission tariffs in Europe : Synthesis 2014, June 2014.

ENTSO-E, Research & Development roadmap – 2013-2022, December 2012.

ENTSO-G, Ten-Year Network Development Plan 2013-2022 – Main Report, 2013.

ESNAULT, Benoît, "European energy governance, lessons learned from the third legislative package", in Economies et Sociétés, Économie de l'Énergie series, EN No. 12, March 2013.

ESNAULT, Benoît, "Transition énergétique, les enjeux économiques et institutionnels de l'intégration dans les réseaux" (Energy transition, the economic and institutional issues of integration in the networks)", published in the proceedings of the symposium "Les transitions énergétiques dans l'Union européenne" (Energy transitions in the European Union), September 2014.

EURELECTRIC, Electricity distribution investments : what regulatory framework do we need?, May 2014.

EURELECTRIC, La distribution d'électricité en Europe (The distribution of electricity in Europe), 2013.

EVOLVDSO, Development of methodologies and tools for new and evolving DSO roles for efficient DRES integration in distribution networks, 10 July 2014.

FINON, Dominique, The transition of the electricity system towards decarbonization: the need for change in the market regime, Climate Policy, Vol. 13, No. S01.

GAVENTA, Jonathan, Energy security and the connecting Europe facility, E3G, September 2014.

GIMELEC, Livre blanc – Réseaux électriques intelligents (White paper – Smart grids), November 2010.

GLOBAL CHANCE, "L'énergie en Allemagne et en France – une comparaison instructive" (Energy in Germany and in France – an instructive comparison), in *Les cahiers de Global Chance*, No. 30, September 2011.

HARNSER GROUP, The financial aspects of the security of assets and infrastructure in the energy sector, 2012.

IEA, Energy supply security – emergency response of IEA countries, IEA/OECD, 2014.

IEA, Renewable energy – Medium-term market report, 2014.

IEA, The power of transformation – Wind, sun and the economics of flexible power systems, OECD/IEA, 2014.

IEA-RETD, Residential prosumers – Drivers and policy options, September 2014.

ISGAN, Smart grid drivers and technologies by country, economies, and continent, 29 September 2014.

JANIN, Lionel, DOUILLARD, Pierre, "Trois secteurs cibles pour une stratégie européenne d'investissement" (Three target sectors for a European investment strategy), in La note d'analyse, No. 18, France Stratégie, November 2014.

JOHANNESSON LINDEN, A. , KALANTZIS, F. , MAINCENT, E. , PIENKOWSKI, J. , Electricity tariff deficit: temporary or permanent problem in the EU?, Economic papers 534, European Commission, October 2014.

KEPPLER, J. -H., PHAN, S , LE PEN, Y , BOUREAU, C., The impact of intermittent renewable production and market coupling on the convergence of French and German electricity prices, European Electricity Markets Chair, July 2014.

MAISONNEUVE, Cécile, L'Europe de l'énergie : un contrat à refonder d'urgence (Energy Europe: a contract to be overhauled urgently, IFRI), April 2014.

MOSCOVOCI, Pierre, Pour une Europe de l'investissement – Rapport au Premier ministre (For a Europe of investment – Report to the Prime Minister), 29 October 2014.

OBSERVATOIRE DU LONG TERME, Pour une coopération énergétique franco-allemande (For Franco-German energy cooperation), 2014.

OFAER, Énergie citoyenne – Les différents modèles participatifs en Allemagne (Citizens' energy - The various participatory models in Germany), October 2014.

OFAER, Étude sur la rentabilité des installations solaires en autoconsommation pour le commerce et l'industrie en Allemagne (Study on the profitability of self-consumption solar facilities for trade and industry in Germany), March 2014.

OFAER – EPEX SPOT, Vente directe des énergies renouvelables sur la bourse européenne de l'électricité (Direct sale of renewable energy on the European electricity exchange), January 2015.

OFFENBERG, Philippe, "Taking stock of German energy policy in a european contexte", in Policy paper, No. 116, Jacques Delors Institut, 29 August 2014.

PERCEBOIS, Jacques, "Le gaz naturel : des perspectives contrastées selon les zones géographiques" (Natural gas: contrasting outlooks according to geographical area), in La revue de l'Énergie No. 616, November-December 2013.

PEREZ-ARRIAGA, I., et alii, From distribution networks to smart distribution systems: rethinking the regulation of european electricity DSOs, European university institute, June 2013.

ROLAND BERGER, Study regarding grid infrastructure development: European strategy for raising public acceptance, ENER/B1/2013/371, 23 June 2014.

RTE, Bilan prévisionnel de l'équilibre offre-demande en France (forecast outcome of the supply-demand balance in France), 2014.

SENCAR, Marko, POZEB, Viljem, KROPE, Tina, "Development of EU energy market agenda and security of supply", in Elsevier, 11 May 2014.

SIDO, Bruno & Le DEAUT, Jean-Yves, Rapport sur la transition énergétique à l'aune de l'innovation et de la décentralisation (Report on the energy transition with regard to innovation and decentralisation), Office parlementaire d'évaluation des choix scientifiques et technologiques (Parliamentary office for evaluating scientific and technological choices), 11 September 2013.

SMARTGRID GB, Smart Grid: a race worth winning?, April 2012.

TERRA NOVA, Nouveaux enjeux pour les marchés de gros de l'électricité (New challenges for the wholesale electricity markets), report 1/18, 9 October 2014.

TERRA NOVA, Une relance européenne par l'investissement : investir dans la transition énergétique (A European relaunch through investment: investing in the energy transition), 20 October 2014.

THINK, Some thinking on european energy policy, May 2013.

Annexe 7
List of Acronyms

ACER: Agency for the Cooperation of Energy Regulators

ADEME: Agency for the Environment and Energy Management

BMWi : Bundesministerium für Wirtschaft und Energie - Federal Ministry of the Economy and Energy

BNetzA : Bundesnetzagentur - Federal Networks Agency

CEF: Connecting Europe Facility

CNG: Compressed Natural Gas

CRE: Energy Regulatory Commissionw

CSPE: Contribution to the Public Electricity Service

CTA: Transmission Tariff Contribution

DENA: Deutsche Energie Agentur – German Energy Agency

DSO: Distribution System Operator

EEGI: European Electricity Grid Initiative

EIFER: European Institute for Energy Research

ENTSO-E: European Network of Transmission System Operators for Electricity

ENTSO-G: European Network of Transmission System Operators for Gas

EU ETS: EU Emissions Trading System

ITO: Independent Transport Operator

LNG: Liquified Natual Gas

RE: Renewable Energy

SET Plan: European Strategic Energy Technology Plan

TCFE: Electricity consumption end-use taxes

TFEU: Treaty on the Functioning of the European Union

TSO: Transmission System Operator