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Renewing energy production in Europe: an environmental, industrial and political challenge

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Introduction

Access to energy, the cornerstone of our transport and information society and an essential determining factor of industrial development, has become more indispensable than ever. But the growing awareness of dwindling fossil fuels and environmental issues throws a different light on consumer habits. Pressurised into taking action, our societies now have to try and reconcile potentially contradictory goals: to preserve the environment and security of supply while respecting each person's welfare and the competitiveness of the economy. This equation, which often appears impossible to solve, requires an adaptation of our energy policies in order to achieve sustainable development.

Aware that the issue needs to be addressed on a European scale, the Member States agreed at the informal European Council meeting held at Hampton Court in 2005, on the need to relaunch a common energy policy[1]. The European Commission, asked to define the outlines, presented the main guidelines and initial means of action in 2006 in its Green Paper, *A European Strategy for Sustainable, Competitive and Secure Energy*[2]. The Member States then set target figures at the European Council meeting in March 2007 and new measures were defined last September to speed up implementation. Despite the lack of a clearly defined legal basis, since the treaties do not envisage cooperation in this respect, the European countries have confirmed their desire to commit themselves within the framework of the European Union.

In addition to the geopolitical imperatives associated with security of supply, all the Member States are confronted with similar internal industrial issues. The equation which combines the preservation of sustainable development and the living standards of Europeans, even if they still vary within the European Union, is more or less the same for everyone. Europeans also share the common constraints and assets required to solve it. In addition to the long-term issue, which ultimately implies a change in our consumption patterns, the short and medium-term industrial imperatives of this adaptation are crucial, although rarely addressed. Yet the nature of our energy production and distribution infrastructure lies at the core of the energy issue: it must be able to meet the environmental challenge, while solving both supply and economic problems, since the price of electricity varies according to the technological mix of the power production capacity. It also raises important political and societal questions, particularly in relation to the acceptance of production technologies. Although the advantages of a common energy policy are often limited to geopolitical issues and the common market, which provides the flexibility essential to meeting energy requirements, the European scale is particularly pertinent for addressing the issues of production technology choices that cannot be solved by the development of a vast liberalised market alone. The European energy policy must address the renewal of the industrial capacity in the short and medium term. Without disregarding the specific geographical, political and social characteristics of each Member State, the European Union can determine a common strategy to define the indispensable framework for the coherent, complementary adaptation of the energy infrastructure. One of the major challenges of this policy is to clarify its scope in order to define precise medium-term goals to guide European stakeholders. In addition, multilevel governance, overseen by the Union, must be envisaged to optimise the action of the public authorities, playing a capital role in directing industrial initiatives, defining an adequate regulatory framework, regulating the market and guaranteeing public services. The linking up of short, medium and long-term goals and determination of the role of the public authorities should thus be the priorities of European reflection.

[1] The energy question was present from the beginning of European integration with the European Coal and Steel Community (ECSC) founded in 1951, then with Euratom instigated in 1957.

[2] Green Paper, European Commission, COM(2006) 1005 of 8/3/2006.

Identification of the foundations of a joint action and the determining factors of European vulnerability reveal the complexity of the three main European challenges: preservation of the environment, our living standards and the continuity of supplies. The short-term industrial issues relating to the development of production facilities are an indispensable prerequisite for meeting global challenges. A coherent, optimised European action should focus on extending and improving production and distribution networks by clarifying the Union's main orientations in order to provide better guidelines for industrial initiatives. The European energy policy must include the development of multilevel governance to provide guidance and regulation while remaining as close as possible to the industrial realities and issues of each European region.

The ideas presented here do not express an official position. They are personal reflections on European energy-related questions.

Summary

The definition of a global energy policy appears to be increasingly appropriate. Member States, which all share the same weaknesses, have enough in common to pool ideas about security of supply or how to overcome environmental challenges and stimulate competition. Although Community stakeholders have a vital role to play in combining best practices and taking the best advantage of the various types of approaches and specific national trends, a European framework must now be established in detail in order to correctly channel Member State initiatives and satisfy the need for transnational co-ordination.

The creation of energy markets comprises the first step in rising to these challenges but is not enough to guarantee the development of energy infrastructure on which the goals of the European energy policy are based. As far as electricity is concerned, the technological structure of production capacity is vital to both limiting CO_2 emissions and reducing primary energy requirements and costs.

Over the next few years an opportunity to renew the current production and distribution infrastructure will arise. Forty years after the power station boom in Europe we are now entering the initial phase of a major upgrading of our installations. A truly European strategy involving industry leaders and public authorities seems vital if this opportunity is to be seized. Although private stakeholders retain the greater share of the decision-making process in terms of new technology, public authorities have a vital role to play in reconciling industrial interests with environmental and public service requirements. They have the requisite means to guide the development of production facilities: they control the pace of power station closures by means of their regulation tools, they encourage investments by reducing long term risks and they can influence technological choices.

Although national prerogatives still weigh heavily in these areas, the European Union must define framework guidelines to optimise and co-ordinate Member States' action. It has an essential role to play in boosting R&D, in defining the political and regulatory environment that is condusive to investment, and in stimulating competition. It must also drive the evaluation and acceptation of the various technologies, so that each Member State can best contribute to the European energy mix, without systematically opposing any given solution and whatever the preferences of each Member State in its own country.

1. Providing a European response to energy and environmental challenges

In addition to the economic issue of a common energy market, the definition of a global energy policy appears to be increasingly appropriate within the European context. Despite their differences, the Member States share the same weaknesses and have enough in common to usefully pool their ideas. A European framework still needs to be defined in order to correctly channel Member State initiatives and satisfy the need for transnational coordination.

1.1. Strong similarities between European States in relation to energy and climatic issues

In the face of common environmental challenges, the global dwindling of natural fossil fuel resources and the uncertainty of supplies, European stakeholders share specific characteristics that stem from both their geographical heritage and a certain economic and social proximity.

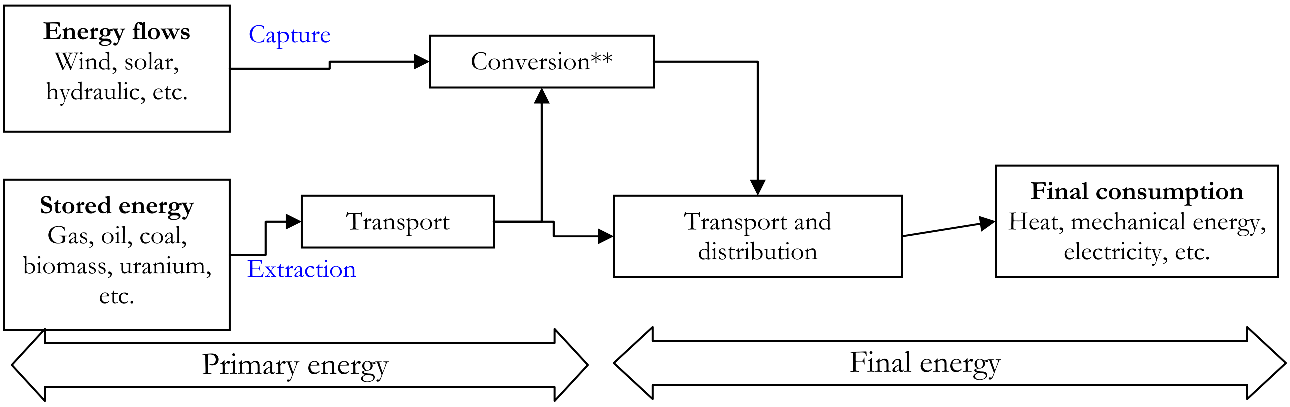
1.1.1. Reducing European vulnerability

a. Technical and political issues in relation to supply

Supply security: controlling the energy chain

The word "supply" is often used to mean one or several stages in the process used to route energy, initially in its natural form, to the end user (Figure 1). But it actually applies to the entire energy chain, each phase of which is essential in analysing the critical features of energy security.

Figure 1: Simplified flow chart of energy chain



** In the usual meaning of the term, energy production is the simple conversion of a type of primary energy into a directly deliverable form.

On a European Union level, the energy chain can be divided into two main steps: the supply of primary energy, which mainly depends on stakeholders outside the EU, and conversion and distribution processes, which concern European stakeholders (Figure 1). Failures in the system can be both external (shortage of gas or oil, interruption of delivery by gas pipeline) and internal (distribution grid breakdowns, insufficient production capacity to meet demand), but the first stage needs to be examined in order to determine the overall degree of vulnerability of the European Union.

Although this study is not intended to give a detailed examination of the various primary energy sources, it is important, in understanding the degree of dependency of the European Union, to distinguish between "stored energy" and "energy flows"[3]. In terms of current energy infrastructure, stored energy (gas, oil, coal and uranium) accounts for 94% of the primary energy consumed by the European Union[4] and has an import rate of 78%[5]. An analysis of its availability is therefore essential both to ensure short-term continuity of supply and to anticipate long-term requirements in terms of energy infrastructure.

Availability of fossil fuels: short-term production constraints are more problematic than dwindling resources.

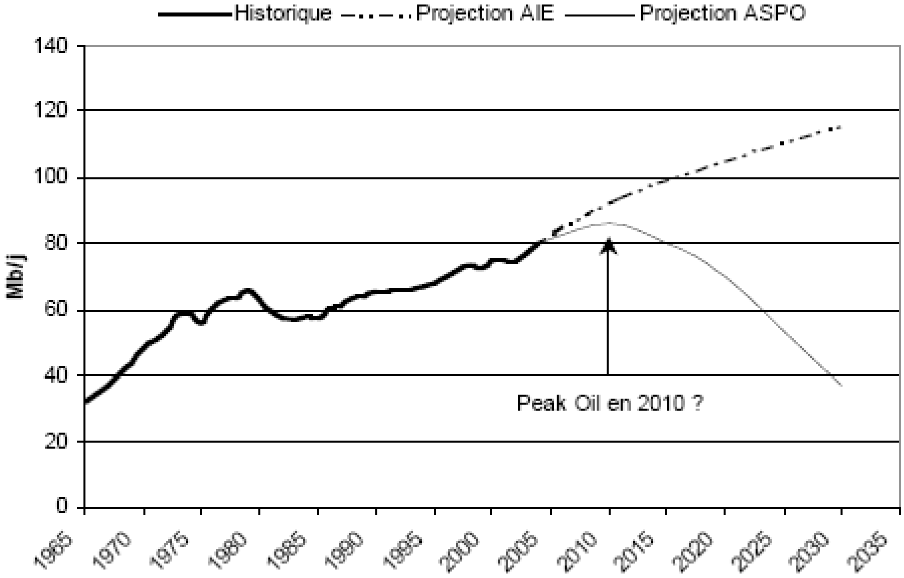
It takes hundreds of thousands of years to renew underground stocks of hydrocarbons, gas and coal, which is obviously incompatible with our current rate of consumption. Unless there is a radical change in our consumption patterns, their eventual depletion seems inevitable. Having said this, the lack of information as to the real situation concerning energy reserves and improvements in extraction technologies makes it impossible for the experts to predict when the last global resources will disappear. The resulting controversy means that the consequences of depletion cannot be anticipated[6]. To solve the problem of energy stocks, there will have to be a slow and difficult change in our energy infrastructure, which is still largely based on fossil fuel[7]. This means changing our consumption patterns and ultimately, the type of society we live in[8].

This issue, which is essential in the long term, must not mask the crucial question of short-term supply. Two main factors combine to threaten our supply security in the near future:

- the extraction of energy resources becomes increasingly difficult, for geophysical reasons, as they near depletion. This theory, put forward by M.K. Hubbert[9], implies that production will start to decrease well before total depletion of fossil fuel stocks. Given the growth in demand, this situation could lead to a serious supply crisis that the most pessimistic analysts believe will take place in 2010 for oil (ASPO, Figure 2). This threat should be of more concern to the European countries than the number of years until total depletion of stocks, particularly since their hydrocarbon and gas deposits, especially those in the North Sea, are rapidly dwindling.

[3] "Stored energy" is in geographically localised limited quantities, while "energy flows" can be considered to be unlimited.
[4] EU-25, Eurostat 2004.
[5] Calculated according to Eurostat 2004 data for EU-25.
[6] Depletion of an oil or gas deposit.
[7] Fossil fuel accounts for 70% of primary energy consumed by the Member States of the European Union (Eurostat 2004).
[8] Cheap energy is one of the premises on which the development of European industry, transport and urban planning is based.
[9] For hydrocarbons, this theory is known as Hubbert's Peak or Peal Oil.

Figure 2: World oil and peak oil production



Source: BP, Statistical Review of World Energy 2005, International Energy Agency, "World Energy Outlook 2005", ASPO www.peakoil.ie

- This leads to another observation which is also a cause for concern: the increase in our reliance on non-European producers. European production now only covers 37% of our gas requirements and 18% of our oil demand[10]. Although this reliance is not a danger in itself, it increases exposure to the risk of fluctuating natural resource markets, which are moving further and further away from their theoretical purpose and becoming increasingly complex.

The increasing power of the producing countries: "geopolitical peak oil"[11]

In the particular case of oil and gas, transactions on international markets only represent a small share of trade[12] and are mainly the subject of mutual agreements with producers. However, the scarcity of resources means that they are increasingly concentrated in a small number of countries. Figure 4 shows that 82% of the remaining proven reserves are in the hands of 10 countries, i.e. 21% of producers[13]. The possibilities of diversifying supply sources are therefore reduced, which increases the risk of disruption in supplies[14]. This decrease in the number of major producers accentuates cartels (OPEC), increases the market capacity of the major stakeholders, and therefore modifies the way in which the hydrocarbon markets operate.

Figure 3 shows the EU's reliance on a small number of producers, the most important of which is Russia, for all four energy sources.

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[10] Eurostat 2004.

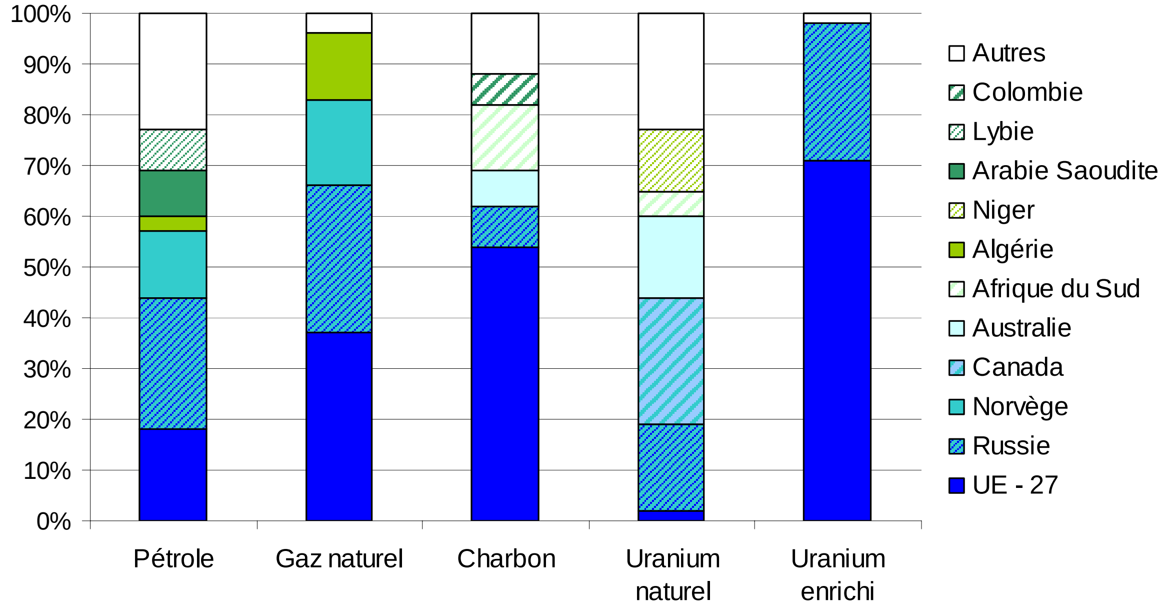
[11] To use the expression of Bonenfant and Kueny [10] who draw a parallel between the decrease in the number of products and peak oil.

[12] Although oil is the most traded item in the world (7.3% of goods exports in 2003), the main price markers only account for a very small share of commercial transactions (the Brent Blend, which is the marker crude, accounts for less than 1% of production). Sources: Bonenfant and Kueny [10] and Maurice Joël "Prix du pétrole", CAE report 05/2007.

[13] As defined in the "BP Statistical Review of World Energy", 2005.

[14] It is the lack of dependability of the producer and not the actual problem of energy dependency which is a threat to European supply. Note n° 30, Robert Schuman Foundation [1].

Figure 3: Geography of primary energy supply for EU-27



Sources: European Commission DG TREN, Eurostat, Euratom Supply Agency (2004)

This growing concentration of resources is accompanied by the politization of trade which is becoming increasingly bilateral. The purchase of hydrocarbons is not only an economic issue: it means that a political relationship must be established between producing countries and consumers to guarantee continuity of supplies. A contributing factor is the nationalisation of a number of major producers[15], particularly in Bolivia, Venezuela and Russia. These countries want to be able to control their resources and income.

Also, nationalisation reinforces disinformation about the real level of reserves and is often accompanied by measures to prevent foreign investments in production infrastructure. The political instability of the producing countries increases investment risks. These are decisive factors in all energy infrastructure projects which only become cost-effective in the long term. If the current situation does not improve, the lack of investment in production facilities could speed up the predicted onset of "peak oil"[16].

[15] In most cases, production is actually a monopoly controlled by States that are often politically unstable (Figure 4 and reference [15].

[16] Eighty percent of the substantial increase in world investments in exploration and production (annual increase of 22% since 2005, with an expected 312 billion euros n 2007) is due to rising costs. The problem of insufficient production infrastructure therefore remains significant both for exploration and production and refining (IFP, Les Echos, 09/10/2007).

Figure 4: Breakdown of proven reserves[17] at end of 2004 for the main producing countries

Oil

Country	% proven reserves
Saudi Arabia	22.1%
Iran	11.1%
Iraq	9.7%
Kuwait	8.3%
United Arab Emirates	8.2%
Venezuela	6.5%
Russia	6.1%
Kazakhstan	3.3%
Libya	3.3%
Nigeria	3.0%
Sub-total	**81.7%**

i.e. 82% of oil reserves concentrated in 21% of producing countries

Geographical areas	% proven reserves
Middle East	61.7%
Eurrasia (including Russia)	10.0%
Africa	9.4%
South and Central America	8.5%
North America	5.1%
Asia Pacific	3.5%
Europe	1.6%

Natural Gas

Country	% proven reserves
Russia	26.7%
Iran	15.3%
Qatar	14.4%
Saudi Arabia	3.8%
United Arab Emirates	3.4%
USA	2.9%
Nigeria	2.8%
Algeria	2.5%
Venezuela	2.4%
Iraq	1.8%
Kazakhstan	1.7%
Turkmenistan	1.6%
Indonesia	1.4%
Sub-total	**80.6%**

i.e. 81% of gas reserves concentrated in one quarter of the producing countries

Geographical areas	% proven reserves
Middle East	40.6%
Eurrasia (including Russia)	31.9%
Africa	7.9%
South and Central America	7.8%
North America	4.1%
Asia Pacific	4.0%
Europe	3.8%

Coal

Country	% proven reserves
USA	27.1%
Russian Federation	17.3%
China	12.6%
India	10.2%
Australia	8.6%
South Africa	5.4%
Sub-total	**81.2%**

i.e. 81% of coal reserves concentrated in 20% of producing countries

Geographical areas	% proven reserves
Middle East	32.7%
Eurasia (including Russia)	28.0%
Africa	20.7%
South and Central America	11.1%
North America	5.6%
Asia Pacific	2.2%

1 – The 20% /80% rule applies to the three types of energy: 80% of proven reserves are located in 20% of the producing countries.
2 – Coal is more evenly distributed among the geographical areas than gas and oil, with 70% concentrated in the Middle East and Russia. However, it is not an exception to the rule of concentration of resources in a small number of producing countries.
3 – Coal reserves are greater than gas reserves, which are higher than oil reserves. However, an estimation of reserves in terms of the number of years is a subjective exercise since it requires modelling of consumption over several decades and thus an anticipation of future technologies and consumption habits.

Source: BP Statistical Review of World Energy, 2005

[17] Proven reserves are defined as the volumes of oil to be extracted using current technology under today's economic conditions with a probability of more than 90% [10]. This notion differs from that of resources, i.e. geological data which measure the quantity of oil present in the ground without taking technical and economic considerations into account.

Energy delivery in Europe: common reliance on non-European countries.

Due to its exorbitant installation costs, onshore energy transport facilities, i.e. oil and gas pipelines, are few and far between and highly vulnerable because their correct operation depends on satisfactory relations with transit countries. The dispute between Ukraine and Russia in January 2006 is an excellent illustration.

The size of the gas market also depends on the density of the gas pipeline network. As LNG develops[18], this particular constraint, which currently divides up global markets and increases European reliance on Russian gas, should gradually disappear.

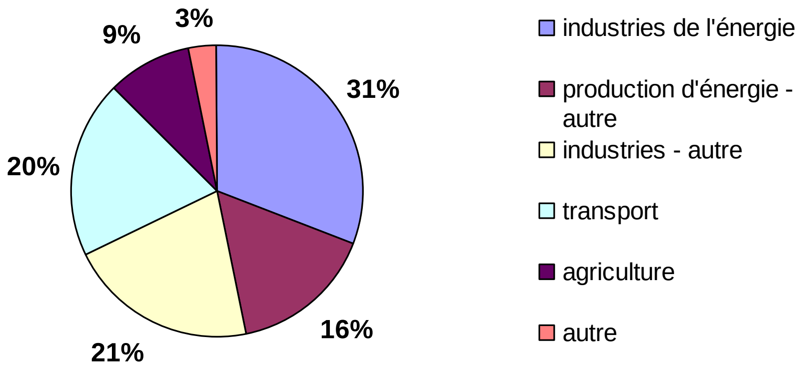
The lack of information on reserves and the increasing threat to the continuity of supply, in terms of both production and transport, lead to a very high volatility of oil and gas prices and a rise in world markets[19]. In the short term, by building up strategic reserves, each Member State can protect itself from market fluctuations. Pooling stocks on a European level provides an additional guarantee: the supply sources of the European Union as a whole are far more diversified than those of any one of its members. In addition to this internal solution, the development of a European supply policy requires reflection on the EU's diplomatic role. The difficulty of 27 countries reaching an agreement on international issues puts a further limit on the benefits of this approach. Supply also depends on the negotiating power of private companies, and the oil majors in particular. Total, for example, negotiates most of its contracts with foreign producers, even nationalised companies, on its own. Whatever the situation, exposure to supply risks can only be reduced by adopting a policy to limit demand and diversify supplies. Consuming less or consuming differently are therefore related to the internal dimension of the European supply issue and require joint reflection.

b. A growing perception of environmental vulnerability

The energy sector: the main source of CO_2 emissions.

CO_2 emissions of human origin mostly stem from the combustion of fossil fuels (gas, oil, coal), which mainly come from energy producers, but also from transportation and other industries, as shown in Figure 5.

Figure 5: Main sources of CO2 emissions in EU-25



Source: Eurostat, 2005

[18] LNG (Liquefied Natural Gas) is a technology used to transport gas by sea in methane carriers.
[19] When uncertainty is high, the economic stakeholders are very sensitive to the announcement effect.

Geographic extension of perception of the environmental risk

The perception of environmental risks has undergone a profound change in the last two decades. Initially local (fog in the United Kingdom due to coal dust, heating up of rivers near power plants), it then became regional (with the discovery of acid rain (SO_x and NO_x) in particular and the Chernobyl nuclear power plant accident), before reaching a global level. Awareness of global warming as the result of human activity is the main expression of this last stage. Although many types of pollution are still the responsibility of local public authorities[20], this geographical extension of the environmental issue calls for a legitimate transnational collective response[21], and therefore European action.

A difficult threat to estimate in the long term

The general issue of climate change and that of the lifetime of nuclear waste also require an assessment of the very long term environmental risk. In addition to their immediate consequences, the threats posed to future generations by climate change are of increasing concern.

Given the time frame involved, it is very difficult to estimate the consequences of these risks. Although the initial effects of global warming are currently being felt, its impact on the earth system is not easy to quantify. These questions are addressed by scientific experts[22] and are not always easily understood by the general public, which reinforces the feeling of vulnerability.

Reducing the environmental impact: a European lifestyle choice

In the face of global warming, the decision to take action is the result of a change in the balance between environmental requirements and the needs of society. It may not be possible to prevent global warming, but we can at least reduce the scale of its effects. Two main options can be envisaged:

- We can take the risk of letting global warming happen and hope we will be able to adapt. This option is based on the supposition that global warming does not endanger the survival of the species and that the different populations will be willing and capable of taking action when the time comes.

- We can do everything possible beforehand to reduce global warming.

This choice depends on the viewpoint of the person concerned, the time frame being considered, and a comparison between the effort needed to adapt to global warming and that required to restrict emissions. The diversity of the cost/benefit analyses illustrates the difficulty involved in assessing the damage (Figure 6). According to Christan Gollier[12], "most of the differences expressed by the economists (...) are due to problems relating to the way in which risk and time are processed in their models".

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[20] See action taken by the municipalities of the main European capitals against car pollution with the implementation of city tolls in London, for example.

[21] Human-caused greenhouse gas emissions, such as CO2, have no doubt resulted in one of the quickest global warmings in the history of the earth. The human impact, although low, has lastingly destabilised the equilibrium of the climatic system. By causing a shift in climate, global warming leads to the migration of species and plants hundreds of kilometres away. It is therefore a transnational issue which concerns all neighbouring countries, and consequently a European issue.

[22] The international scientific community set up the Intergovernmental Panel on Climate Change (IPCC) in 1988.

Figure 6: Comparison of a few cost/benefit analysis results

Author	Estimation of cost induced by global warming
Nicholas Stern	- 10% of world GDP (between – 5% and – 20%)[23]
William Nordhaus	- 3% of world GDP
Dale Jorgenson	Increase of 1% of American GDP
IPCC – 2007	From -1 to - 5% of the world GDP for a global warming of 4°C
Christian Gollier	- 6% of world GDP[24]

Author	Estimation of cost of emission reduction
Nicholas Stern	1% of world GDP
IPCC – 2007	< 3% of world GDP stabilisation at 445-535 ppm CO_2 equiv.
IPCC - 2007	0.6 % of world GDP stabilisation at 535-590 ppm CO_2 equiv.

Source: Gollier [12] and IPCC, 4th report of group II, 2007

Among the latest cost/benefit assessments, the Stern report[25] recommends immediate action by demonstrating that the adaptation choice is more costly. In practice, measures need to be taken both to limit global warming and adapt to it, as the process is already underway.

The problem of global warming requires worldwide action. Given the technical and economic disparities, local responses must necessarily be different. But although the question of survival of the species is a powerful factor of convergence, political action will ultimately depend on an intergenerational change offering an alternative to the preference for the present.

Given the reticence of certain countries in accepting emission reduction programmes as part of international climate negotiations, the European Union also plays a key role in demonstrating the feasibility of certain solutions. The fifteen Member States at the time agreed to a collective goal and defined the terms and conditions of transnational coordination within the framework of the ETS (Emissions Trading System). This pilot role is therefore essential in combating global warming even though the EU only produces 15% of world CO_2 emissions.

In addition to supply problems and an increasing awareness of the consequences of global warming, energy prices continue to rise, despite the development of liberalised electricity and gas markets[26]. This threefold economic, environmental and supply-side vulnerability is not the only point of convergence for Member States. The European approach has the added legitimacy of having a certain number of similarities which are undeniable assets because they offer an effective response to current threats by pooling approaches and know-how across Europe. To define the terms and conditions of a political action in Europe, the common features of the European States need to be determined, without overlooking national differences.

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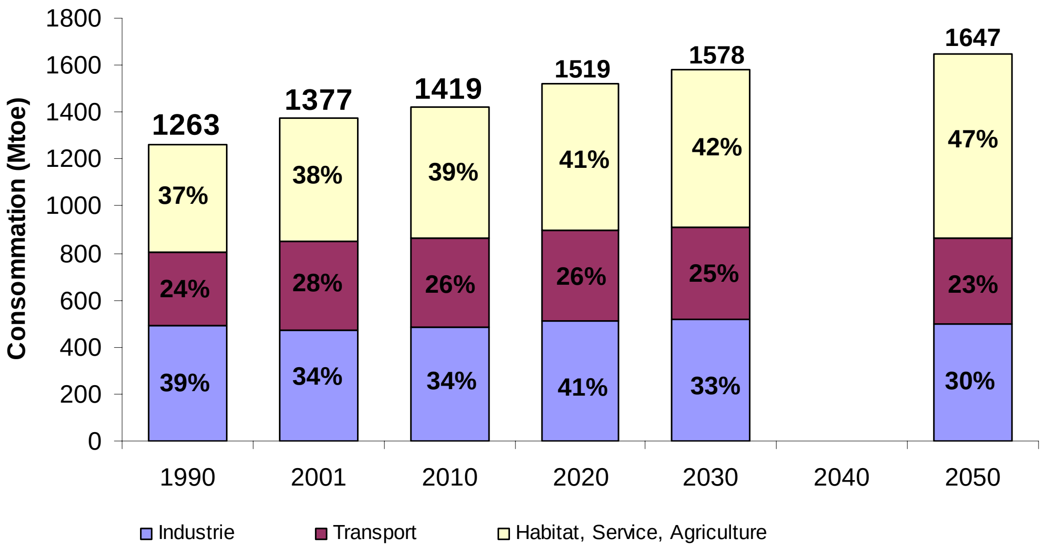
[23] The Stern Report indicates that the greenhouse effect has repercussions on generational well-being equivalent to an immediate, lasting drop of 10% in the world GDP, but it also points out that an important impact on our economies is not to be expected for at least 50 years (-2.9% in 2100 and -13.8% in 2200 at best estimation) [21].
[24] i.e. an ongoing decrease in the GDP growth rate of 0.1% per annum.
[25] Nicolas Stern, "Stern Review on the Economics of Climate Change", Cambridge University Press, 30th October 2006 [21].
[26] Robert Schuman Foundation, European Issues n° 66 on Opening of the European Electricity Markets to Competition [3].

1.1.2. The assets of a common heritage

An analysis of the breakdown of European energy consumption by sector (Figure 7) shows the growing importance of housing and services and the relative stability of the industrial sector and transportation.

Figure 7: Breakdown of final European consumption per type of consumption



Source: World Energy Technology Outlook – WETO H2, 2006, "business as usual" scenario

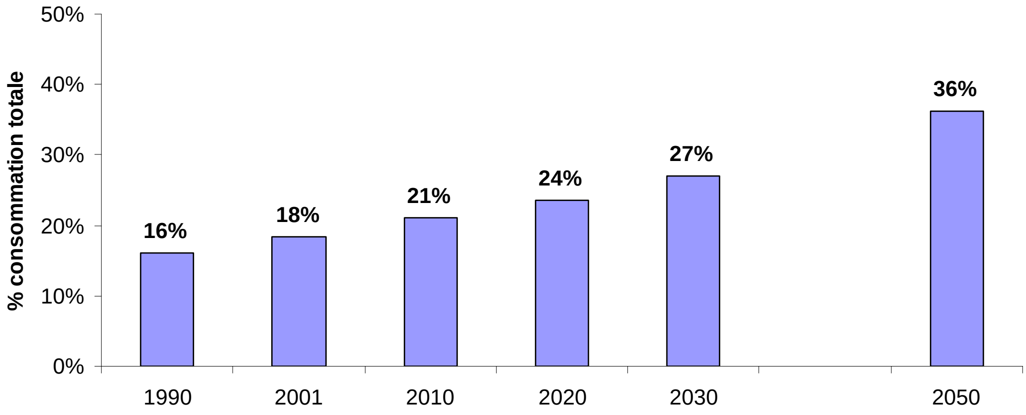
The growing importance of electricity

The increase in the energy consumption of housing and services partly reflects the greater use of electricity due to our digital data society. As various scenarios demonstrate (Figure 8), this trend is getting stronger and the share of electricity in energy consumption should double by 2050 compared to 2001 according to WETO's "business as usual" scenario[27].

The increase in consumption in the housing sector (Figure 7) is also explained by the ageing of housing resources. With a renewal rate of about 1% per year, it is difficult to rapidly introduce energy-efficient technologies that will limit consumption to any real extent, since they already exist and are well controlled. The problem is the same for most of the housing in Europe.

[27] World Energy, Technology and Climate Policy Outlook – European Commission.

Figure 8: Estimated growth of the share of electricity in final energy consumption in Europe

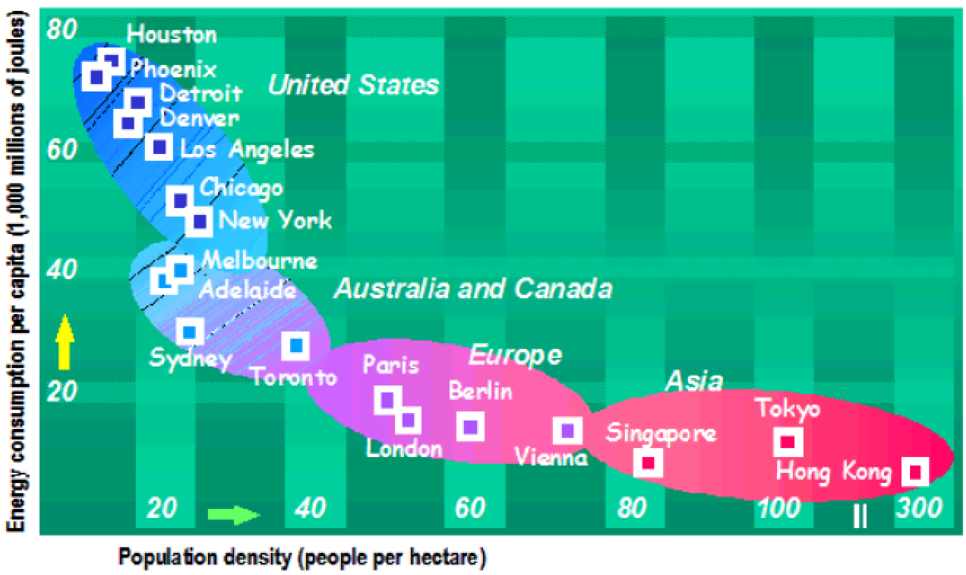


Data calculated from the World Energy Technology Outlook's "business as usual" scenario – WETO H2, 2006

Similar resource planning and development approaches

Energy consumption for transportation depends on town and country planning and population density. Despite regional differences, strong geographical similarities can be identified on a European scale in terms of urban spread and the distance between towns (Figure 9). These characteristics determine the choice of transportation and explain, for example, why rail transport is so important in Europe.

Figure 9: Relationship between energy consumption and population density (Newman and Kenworthy's hyperbole)



Source: P-N Giraud, B Lefèvre, *Les défis énergétiques de la croissance urbaine au Sud, le couple « Transport - Urbanisme » au cœur des dynamiques urbaines*, October 2006.

Lastly, although tertiarisation of the economy has led to the relocation of manufacturing industries and reduced energy needs per industrial stakeholder, the energy consumption of the industrial sector has not diminished due to the ongoing presence of energy-intensive heavy industries, such as metallurgy and cement production. Given the sensitivity of these sectors to energy price rises, these industrial stakeholders play a major role in reflecting on ways to control production costs, particularly since the creation of common gas and electricity markets.

The Member States therefore share enough similarities for joint reflection to be pertinent. The rich industrial fabric of the European energy sector is an additional asset for finding effective answers to economic and environmental issues.

A complementary, diversified fabric of energy industries

The European States share important technological assets. Competition and collaboration between the main industrial stakeholders such as oil companies Shell, BP, Total and ENI, and component manufacturers Siemens, Alstom, ABB and Areva, stimulate the development of know-how. Joint ventures are becoming increasingly popular to meet common technological challenges and pool added value. However, these majors are only the invisible part of the iceberg.

The wealth of the European industrial fabric is based on a myriad of companies of varying sizes and a wide diversity of industrial sectors. The oil majors thus operate in conjunction with engineering consultancies such as Technip and Saipem (a subsidiary of ENI) and prospecting companies, such as CGG (Compagnie Générale de Géophyique). Equipment manufacturers are highly diversified, with Bouygues and Vinci in civil engineering and Nexans in electrical cables. New stakeholders are emerging in the wind-energy sector, such as the Danish company, Vestas. Construction material manufacturers, such as Vallourec, also play a decisive role, because of their drive to overcome increasingly high technical limits, such as maximum temperatures in turbines and wear-related problems that reduce the service life of power plants. The dynamic character of this industrial fabric is a European asset which needs to be maintained and stimulated. In addition to R&D issues, the development of industrial production and growth capabilities are essential in guaranteeing positive spin-off in terms of both economy and employment in the Member States.

Given the similarities of European energy issues and the wealth of this industrial fabric, it seems of capital importance to shift benchmarking to the energy and environmental policy. Community stakeholders will then play an essential role of coordination and proposal-making to pool best practices and benefit from the diversity of Member State approaches and national tendencies.

Differences persist nevertheless between Member States, for both structural and political reasons. Up until present, energy policies have been national. The terms and conditions of European cooperation therefore need to be defined according to the advantages they are likely to contribute.

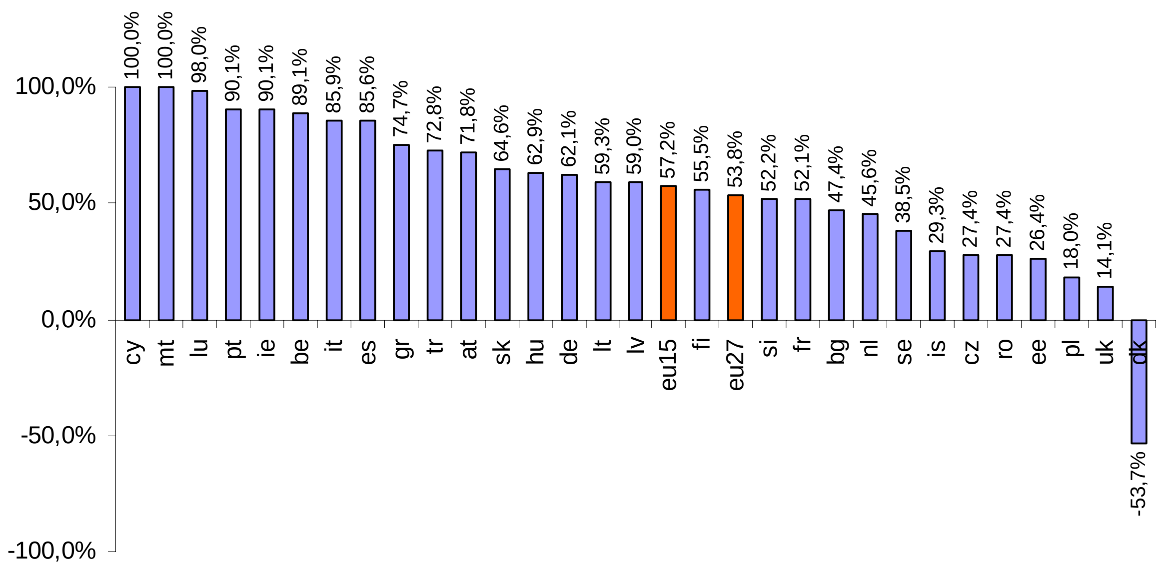
1.2. Better coordination of energy policy: clarifying aims and decision levels

1.2.1. Different national choices

Economic and structural differences

The energy policy of the Member States is based on very different trends, particularly in terms of technological choices. There is an obvious correlation between the sensitivity of each State to supply risks and its reliance on primary energy imports (Figure 10), which can vary from 14% to 100% (except for Denmark) depending on national natural resources, the energy mix chosen and patterns of consumption. An expected dependency rate of 70% for the European Union in 2030 relativises the importance of this disparity and reinforces collective European vulnerability in the long term.

Figure 10: Energy dependency (weight of imports) in 2005



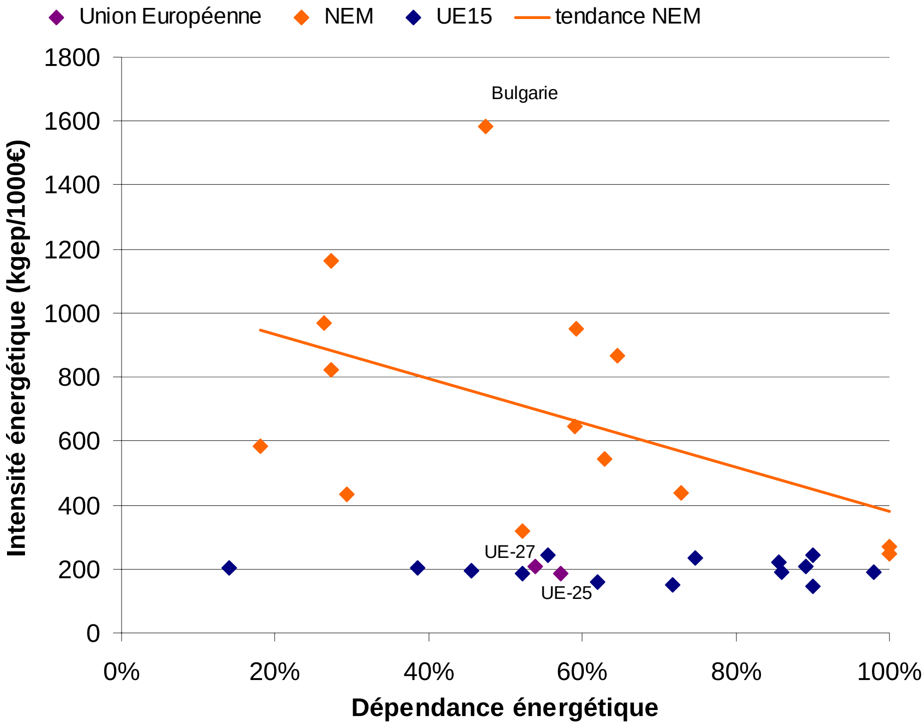
Source: Author's calculations based on net primary energy imports in MtOE, Eurostat 2005

This structural difference is accompanied by very different levels of energy intensity, which determines the reliance of an economy on energy consumption. The cleavage between the old and new Member States (Figure 11) corresponds to a difference in economic development, inefficient energy infrastructure and the larger share of heavy industry in central and Eastern Europe.

Having said this, the level of reliance on energy imports (Figure 11) is not sufficient to explain the diversity of energy intensity. The share of the GDP earmarked for energy is not a very decisive criterion. Although lower energy intensity reduces the repercussions of rising energy prices on the economy, it does not have any effect on the results of a disruption in supplies. It also implies a transition from heavy industry to a service industry. It is possible that the increasing reliance of the European Union on imports encourages Member States to converge towards lower energy intensities. Although it can be envisaged in the medium term, based on the experience of the Member States since the 1980s, is it pertinent to replace our energy dependency with reliance on heavy industry product imports?

These structural differences partly explain the different perceptions of energy risks and national political choices. The variety of energy mixes does not necessarily correspond to an opposition between Member States or the refusal to adopt a common policy. It is the result of specific national histories and the need to take different natural heritages into account.

Figure 11: Correlation between reliance on imports and the energy intensity of EU-27



Source: Eurostat 2005, author's calculations.

Deep-rooted technological divergences

Deep-rooted divergences exist, and mainly stem from varying degrees of acceptance of certain types of technology. While some countries, such as Austria, refuse to use nuclear power and others, such as Germany, have scheduled its gradual elimination, Finland is building the first EPR reactor[28], and Latvia, Estonia and Lithuania are examining the possibility of building a nuclear power plant together[29]. Coal-fired technologies are also perceived differently according to the country and wind energy sometimes meets with fierce local opposition. These positions are determined by each country's perception of the issues involved, its tolerance of the pollution caused by adaptation and the trust placed in industrial stakeholders and public authorities.

1.2.2. Reconfiguration of the energy sector

Greater interdependence between the various stakeholders but a watering down of responsibilities

The global dimension of environmental issues makes it difficult for a Member State to effectively meet energy challenges on its own. This leads to international projects, such as the Kyoto protocol and the implementation of a CO_2 quota exchange in the European Union. In addition, other stakeholders are playing an increasing role in this sector. The creation of a European energy market, resulting in the liberalisation of the electricity and gas sector, has globally limited the Member States' scope for action by reducing their influence on the energy sector. Their direct control of prices has thus been replaced

[28] European Pressurized Reactor

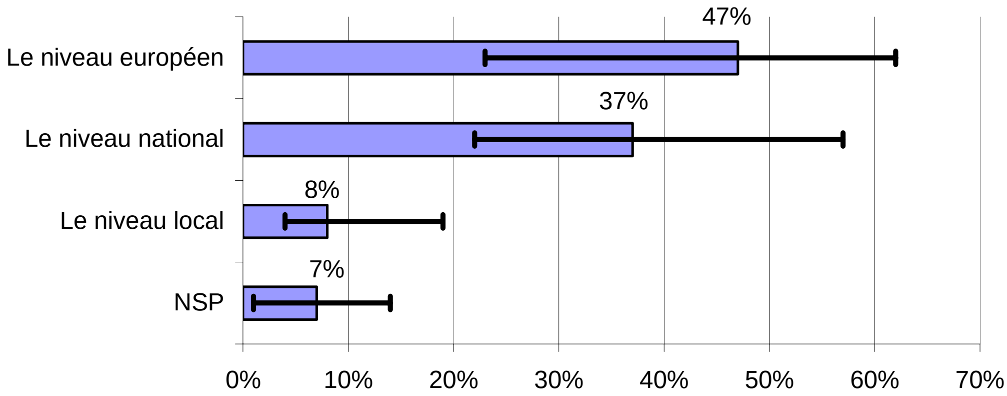
[29] See Special Eurobarometer 271 – February 2007, Europeans and Nuclear Safety.

by an even more difficult multi-party regulation system[30]. This industrial reorganisation has reinforced the role of private companies, producers and operators, which are now an integral part of energy management. The increasing awareness of energy and environmental risks is forcing local authorities to take a stance in this respect. The survey in Figure 12 illustrates the increasing acceptance of multi-level governance by the people of Europe.

The European Union is shown to be a major stakeholder. Although it would seem to have the requisite size and structure to respond to energy and climate challenges, its prerogatives are limited for the present, and it must take into account the divergences of its Member States. The choice of resources is thus a national prerogative defined in the current Treaties[31]. However, these difficulties do not prevent the Union from playing a major role, particularly in developing the goals of an energy policy on a European scale. The increase in the number of interdependant stakeholders, often with very different objectives, makes decision-making complex and reinforces the need for coordination. The content of the EU's action policy remains to be determined.

Figure 12: Perception of the most pertinent level on which to act in the field of energy

Answers to the question: In order to respond to the new energy challenges that we have to face for the years to come, what is, according to you, the most appropriate level to take decisions?



Source: Eurobarometer Special Survey n° 247/Vague 64.2 – TNS Opinion & Social, Attitudes towards energy, publication January 2006.
The bar indicates the arithmetical mean of the responses of all the EU-25 countries and the segment represents the spectrum of responses on a national level.

1.2.3. The choice of indicators: a language to clarify the goals of the energy policy

In its Green Paper published in March 2006[32] entitled "A European Strategy for Sustainable, Competitive and Secure Energy", the European Commission tackled the question of reducing its threefold economic, environmental and supply-side vulnerability. To do so, it defined a trilogy of core objectives to provide a basis for Community actions and national policies: sustainability, competitiveness and security of supply.

30 In France, the market price is aligned on the highest marginal production cost of the network, which is rarely that of a French power plant.
31 European Council, 8th and 9th March 2007, paragraph 28, "fully respecting Member States' choice of energy mix and sovereignty over primary energy sources". European Issues n° 66, The Opening of the European Electricity Markets to Competition: genesis and perspectives of an ambitious project [3].
32 European Commission, Green Paper, March 2006, COM (2006), 105 final.

Pursuing these core objectives does not necessarily mean defining compatible medium-term goals. As a result, the priorities chosen by the Member States differ. Although this may not affect long-term convergence, it is nonetheless crucial to clarify the European trilogy of core objectives and agree on pertinent, attainable indicators, while recognising that different efforts will be required on the part of each Member State.

The choices resulting from the European trilogy will then be open to debate. The consensus shared by the Member States is certainly a step in the right direction in that it recognises and formalises the different facets of the energy issue. However, it seems that this diagnosis is not always sufficient to make the right choice from among the solutions proposed. Although most energy policy decisions concern one or several of these core objectives, attaining one of them often takes place to the detriment of the other two. The reduction in greenhouse gas emissions, for example, requires a complete overhaul of energy production infrastructure, which is mainly based on fossil fuels, and the upgrading of numerous facilities. This, however, reduces the competitiveness of the companies concerned: it results either in an increase in the price of energy, to the detriment of the consumer, or in a decrease in the operator's profit margins. This does not only apply to the competitiveness/sustainability duo, but to any combination of the three core objectives[33]. It therefore seems essential to define and hierarchise these goals in order to clarify decision-making in the Member States.

a. Clarification and hierarchisation of goals

The concept of competitiveness[34] defined by the European Union includes the notions of affordable prices, investments, jobs in the energy sector, innovation and a knowledge-driven economy. Although it is broad enough to arrive at a consensus, it is too imprecise and leads to decisions that are too dispersed. Pertinent, directly usable goals therefore seem necessary. There are many possible indicators, such as the share of energy in the household budget or the cost of production technologies.

Once these goals have been clearly defined, the priority given to each of them corresponds not only to a lifestyle choice, but also, and more especially, to preference for the present. The time frame used in decision-making is essential. Implementation of the European CO_2 quota allocation and emissions trading system[35] enables long-term goals to be achieved, for example, but increases the cost of converting fossil fuels into electricity in the short-term, at the expense of both industrial users and consumers. Arbitrating between the immediate benefit of an action and the promises offered by a decision in the future is essential for both the energy and environmental aspects of the issue. It depends not only on an estimation of the risks incurred and the social well-being achieved, but also on the perception of intergenerational links. It is a highly subjective and rarely consensual evaluation. The perception of global warming is perhaps an exception in that it is a threat to survival of the species, but the question remains complex, implying an estimation of the impact of an action in the long term. However, the uncertainty of decision-making is correlated to its time frame, which fuels debate on what would seem to be simpler issues.

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[33] Supply security suggests the grouping together of operators to negotiate better conditions for supply contracts, which often goes against the rules of competition and therefore competitiveness. Competition between economic stakeholders can weaken investments in the long term (see Pjoskow, Competitive Electricity Markets and Investment in New Generation Capacity. Mimeo). Other analyses are available such as that of Röller and Delgado [15].

[34] Found in the Commission's communication [5].

[35] EU-ETS

Although it cannot be denied that a longer-term view is preferable, the European Member States do not necessarily make the same choice between a natural preference for the present and a political comittment aimed at sustainable development. In the new Member States in particular, the difference in economic and social development can legitimately tip the scales in favour of a short-term action aimed at improving comfort.

The European Union has an essential role to play. Although it cannot impose the goal of sustainability, it can attenuate the importance of other political actions by guaranteeing a minimum social and economic level by means of structural funds and harmonisation policies. It therefore enables new Member States to increase the time frame of their decision-making and take sustainable development issues into greater account as a result. This very simple reasoning can, of course, be extended to encompass a much wider geographical area. Integrating an environmental policy into development aid is a coherent approach, particularly when it is combined with a certain flexibility of the European CO_2 emissions quota system. Since the European Union is the largest provider of public development funds, it already has the requisite means to include the environmental aspect in its cooperation programmes to a larger extent[36].

b. Selection of pertinent indicators

Indicators: a common simplified language

Because of the large number of stakeholders, the technical complexity, the implications of energy in every sector of activity and the wide variety of situations, the energy issue is difficult to study and even harder to explain. To clarify and simplify the debate, a common language needs to be adopted. Based on the descriptive and analytical work of experts, the choice of pertinent indicators, which is a political act, has to express a particular view of the energy issue.

Example: the choice of an indicator to improve energy efficiency. Should the amount of primary energy consumed be minimised or only its carbon content?

To reduce supply tensions, a global approach could be adopted, for example, and the decision made to keep primary energy consumption to a minimum. This indicator does not enable fossil fuels, whose supply is uncertain, to be distinguished from other more secure sources, which means that the use of non-fossil fuels might be decreased at the same time. Yet, the energy issue also involves the reduction of CO_2 emissions, and consequently, the consumption of fossil fuel. This does not necessarily reduce primary energy consumption, but it does reduce the uncertainty of supplies. Keeping the carbon content of primary energy to a minimum therefore seems more pertinent than simply reducing primary energy consumption. When choosing between the construction of a gas-fired power plant with cogeneration and a nuclear power plant of equal capacity, the above difference in viewpoint will lead to two different choices irrespective of economic considerations (this, of course, is a somewhat simplistic view). If it is decided to keep primary energy consumption to a minimum, the choice will go to the gas-fired power plant, which has an efficiency rate of 75 to 85% and therefore consumes less energy. On the other hand, if the decision is made to keep the carbon content of the energy consumed to a minimum, the obvious choice is the nuclear power plant since natural gas contributes to CO_2 emissions.

[36] Communication from the European Commission - An energy policy for Europe, paragraph 3.9.1. January 2007, and Conclusions of the European Council, March 2007, paragraph 34 [4].

Although indicators can be defined politically to provide guidelines, they can only become an energy policy tool for the European Commission if the Member States agree to commit to quantified targets. This step was taken during the European Council meeting in March 2007 and three goals were defined:

- Reduction in greenhouse gas emissions by at least 20% in 2020 compared to 1990 levels;
- Increase in energy efficiency to save 20% of the EU's energy consumption with respect to 2020 forecasts;
- Increase in the share of renewable energy in the EU's overall energy mix to 20% by the year 2020.

European indicators still limited

Should the target be renewable energy or no carbon fuels?

The European Council's commitment to the goal of 20% renewable energy in 2020, however, seems somewhat simplistic even if the share of these new technologies in the energy mix needs to be considerably increased. The Commission emphasises that this measure, which corresponds to the European trilogy of core objectives, is also aimed at stimulating investment and innovation. It purposely excludes the other no carbon fuels, such as coal-fired power plants with CO_2 capture and storage, and nuclear power. Given the potential of these technologies, it would have seemed more appropriate to set a more ambitious no carbon fuel goal instead of only fixing a 20% renewable energy target for 2020. The silence on the subject is mainly explained by the absence of a strong consensus among the European countries in relation to these technologies.

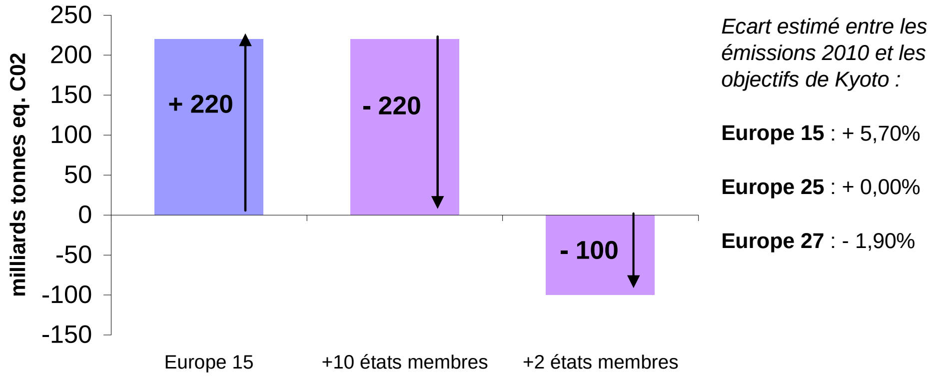
Commitment to the reduction of CO_2 emissions

Due to the threat of global warming, specific goals must be fixed to reduce greenhouse gas emissions. The widening of the European Union and the Kyoto flexibility mechanisms complicate the monitoring of European commitments and illustrate the limits of oversimplifying the indicators when developing energy policies.

In view of the statistics on the emissions of each Member State and short-term forecasts, it appears that the 15-member EU will overshoot the emission goals set by the Kyoto Protocol by nearly 6% (Figure 13). It is only because of the reduction of emissions in the new Member States that the European Union as a whole can claim to meet its commitments. This calls for two remarks:

- in terms of form, the monitoring of European commitments must be made more visible;
- in terms of content, the effort to reduce the carbon content of the energy consumed must become a priority for the Member States.

Figure 13: Differences between the Kyoto goals and CO_2 emission estimates in 2010



Source: KB Intelligence (Hauet), June 2006

Although indicators are an efficient means for making European policies converge, they are still based on conventions or political choices. They must therefore be handled with care.

A European scale policy can therefore be justified by the sharing of vulnerabilities and major assets in the face of energy and environmental issues. In this respect, the common market is a good economic convergence and development tool. However, it is not sufficient to achieve the common goals of the Member States. Although a geopolitical approach seems essential in securing supply and influencing the global warming debate, it cannot solve the EU's energy issues on its own. The internal issue is capital. In addition to a deep-seated change in consumption patterns, a European policy must urgently be defined in order to develop energy production and distribution infrastructure, and thus address the main issues confronting the European Union today.

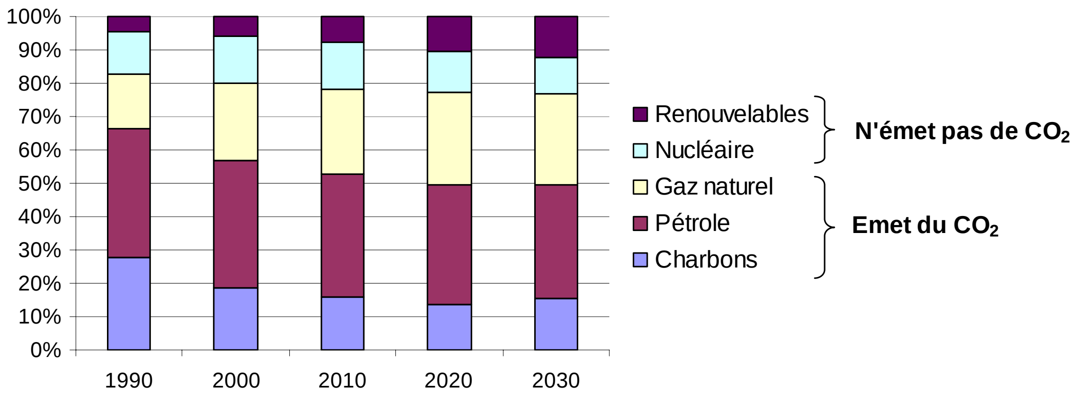
2. Controlling electricity production capacity, an indispensable prerequisite for addressing European energy issues

To reduce CO_2 emissions in the energy sector, all industrial combustion processes need to be controlled. Several options can thus be envisaged:

- The replacement of fossil fuels by other non-CO_2 emitting resources;
- Improvement of the efficiency of current combustion processes to limit the consumption of fossil fuel while producing the same final amount of energy;
- The development of CO_2 capture and storage during energy production.

Since hydrocarbon and natural gas supplies remain uncertain in the medium term, their replacement with other no carbon fuels[37] seems to be the most efficient option. The only problem is that alternative technologies represent a very small share of primary energy consumption (Figure 14), although their use has been increasing for many years. The question needs to be examined further and methods for developing no carbon fuels analysed.

Figure 14: Breakdown of primary energy consumption EU-27 (1800 MtOE in 2004)[38]



Source: EC DG TREN, Eurostat, annex to 2006 Green Paper
Note: certain types of renewable energy from biomass can emit CO2. However, their contribution to the increase in CO2 concentration is nil because they capture as much as they emit.

2.1. A difficult, but necessary change in energy infrastructure

2.1.1. Developing the grid to reduce power plant construction needs

The problem of replacing fossil fuels with other energy sources is complex and largely dependant on technical and economic constraints.

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37 "Carbon" fuels contain carbon and emit CO2 during use. They include oil, gas, coal and biomass. As their name indicates, "no carbon" fuels contain no carbon.
38 The data after 2010 are estimations based on a "business as usual" scenario. As a result, they do not take the 20% renewable energy by 2020 goal into account.

The technical constraints of energy distribution

The predominance of fossil fuels, and hydrocarbons in particular, can be explained not only by consumption patterns[39], but also by the particular properties of petroleum, which is an excellent energy vector. This notion is essential in understanding the constraints imposed on the energy chain.

Although the question of supply is essential, the main constraints on the energy sector do not come from the type of energy source, which can be extremely varied, but from consumption patterns. Energy is ultimately used in three forms: thermal (boiler heat), mechanical (transport) and electrical. None of these can be stored easily[40]. If energy cannot be produced from local natural resources[41], it must be routed to the site of consumption when needed, or produced on-site using another form of stored energy. This common sense observation has basic repercussions: certain types of energy must be transportable and storable[42]. These are called energy vectors. Their properties not only depend on the type of end use, but also on the type of upstream production: if the vector is transportable and storable, distant resources can be used and energy tapped at a different rate from consumption. If this is not possible, production must be instantly adapted to demand. For reasons of efficiency and the economics of scale, it is therefore preferable to pool production sources by connecting them to energy grids.

With the exception of biomass, storable energy sources are rarely distributed across the country in a uniform way. Given that local production based on non-storable energy (wind and solar energy) is often insufficient to meet fluctuations in consumer needs, another country-wide source of energy is often needed. These distribution constraints automatically limit the energy sources that can be used.

Reinforcing existing grids: a priority for Member States

To satisfy needs and develop the energy sector, a suitable means of transport had to be set up for each energy vector. While hydrocarbons are easy to handle and store because they come in liquid form and have a high energy density, other vectors such as electricity and gas required the construction of immense energy grids during several decades of industrial revolution. This very expensive infrastructure creates natural monopolies and the construction of a parallel network is not an economical solution. Organisation of the industrial fabric and the satisfaction of all consumers depend on the reliability and the density of the grid. Only a well-developed network can be efficient.

Thus, the development of new energy vectors, such as hydrogen, not only comes up against a production cost barrier, due to the immaturity of the technology, but also requires the development of a distribution network in the medium term which is sufficiently dense and ramified to satisfy energy needs[43]. These new solutions, which could modify the upstream activities of the energy sector and preserve the environment without changing our level of consumption, are therefore difficult to implement. Not only is the feasibility of this solution uncertain, but it would also take time to set up. This type of network can only be envisaged in the long term, yet the decision to implement it must be made in the immediate future. In the long term, however, it is also possible to change consumption

[39] Many sectors such as the automobile industry were developed on the basis of cheap, abundant petroleum and their use is now difficult to replace.
[40] That is, reasonable costs with existing technology.
[41] For example, geothermal energy for heating or wind for sailing boats.
[42] The dispersion of resources reinforces transport needs and the discrepancy between availability of the resource user needs requires storage.
[43] Apart from the network issue, the replacement of all the end user equipment used for another different type of energy takes time. In the case of hydrogen, and provided that storage problems have been solved, penetration of the automobile market by this type of technology will not take place suddenly, but at the same rate of renewal as private vehicles.

habits; this means that consumption patterns must be studied and change initiated. So in the end run, it seems more appropriate to develop the existing grids than to develop a new energy vector. The existing networks have a high potential for upgrading and are sufficient to diversify supply sources. Electricity grids and district heating networks (which have little possibility of extension) not only have wide and varied uses (transport, heat, communication, etc.) but also accept highly diversified production technologies, which is an important factor in securing supply. The first to be developed were coal-fired and oil-fired thermal power plants, followed by hydroelectric power plants (dams), then gas-fired power plants, nuclear power plants, wind turbines, biomass systems and solar panels.

Large-scale R&D investments are therefore required to come up with new solutions when hydrocarbons are particularly difficult to replace, such as in car transport. However, it seems preferable to give priority to development technologies using current energy vectors, such as electricity, with rechargeable hybrids, or biofuels. In the long term, the use of private motor vehicles will need to be reconsidered.

In the short and medium term, changing consumption patterns therefore means upgrading energy production and distribution infrastructure for existing energy vectors. In the long term, reflection on the development of consumption patterns remains a prerequisite for any decision to invest in a large-scale technological change.

2.1.2. Improving efficiency and increasing energy production

Improving the efficiency of energy production to satisfy growing needs while reducing consumption

The efficiency level[44] of the various transformation and distribution phases of the energy chain, from natural resources to final consumption (Figure 1), is often very low. Satisfying identical needs can therefore require highly variable quantities of primary energy depending on the efficiency of the process used. Extraction, transformation (electricity production) and transport techniques can be improved. By making the most of these potential energy savings, the depletion of fossil fuels could be slowed down, CO_2 emissions reduced and our reliance on energy suppliers decreased.

Operating efficiency improves as technology develops. For coal-fired power plants, considerable progress has been made, up from 30% for power plants built in the seventies to 42% using best current technology. This 12% increase in operating efficiency reduces both the amount of energy consumed and CO_2 emissions by 29% for the same fuel. At the current emission reduction rate, this is an excellent performance, but additional efforts need to be made to achieve the ambitious long-term goals that have been fixed[45]. Improving the efficiency of current production facilities is therefore a major issue, both for supply security, since primary energy needs are lower, and for the emission reduction.

Although this is an important solution for developing sustainable consumption patterns, it is difficult to quantify the potential improvement in the efficiency of current production facilities. Operating efficiency depends on numerous technical parameters and can vary considerably between two plants

[44] The efficiency of a process is the ratio of the useful energy, that is, the energy available at the end of the process, and the energy consumed, that is, the energy introduced into the process.

[45] The example for coal can be applied to nuclear energy: the efficiency rate of 3rd generation EPRs, for example, is two points higher than for previous technologies and the forecasts for the 4th generation are expected to add another 10 points, giving a maximum efficiency of 45%.

built at the same time (difference between "current plants" and "best available technology" in Figure 15).

Figure 15: Possible increases in the efficiency* of different technologies

	Old power plant	Current power plant	Best available technology	Forecast
Coal**	30%	36%-42%	46%	50-55%
Combined gas cycle	50%	56%	58%	60%
Nuclear	33%	35%	37%	45%***

Current operating power plant capacity can be broken down into three main categories: "old plants" which are still operating, "current plants" which are fairly recent and "Best available technologies" which are the most efficient but are not systematically used when building new power plants.
These values correspond to electricity conversion efficiencies, that is, the ratio of the electrical energy produced to the primary energy consumed.

*Indicative values
** The efficiency of these power plants depends to a large extent on the quality of the coal used (and more especially on its heat capacity which is the heat released by the combustion of a piece of coal).
***Maximum target of 4th generation nuclear technology

Source: Mitsui Babcock, AREVA, Forum GenIV, Alstom, General Electric

First of all, the efficiency of a country's production facilities is largely linked to the age of its power plants. And the energy production capacity in Europe is ageing. In the case of coal, for example, new technologies only apply to a very small number of facilitites and the new capacities installed do not always use the "best available technologies". The main problem concerns the upgrading of existing facilities. The production facilities in Europe are getting older[46], which is slowing down their replacement rate and putting increasing emphasis on the environmental issue. The pace at which production facilities are changed or replaced and the methods used to do so are therefore essential for upgrading energy infrastructure in Europe.

Increasing production capacities

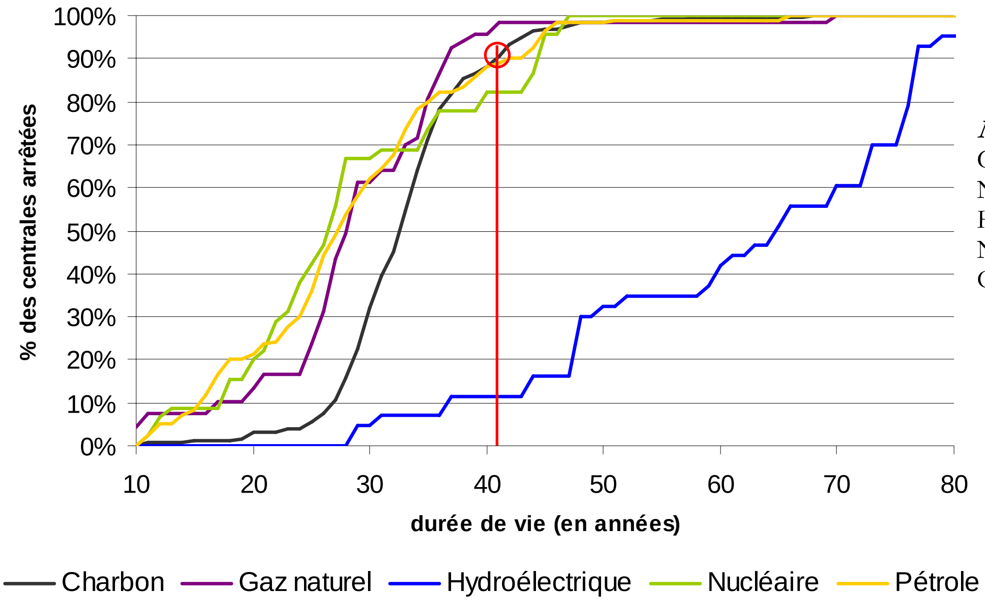
The amount of energy produced is not the only criterion which determines the capacity of a country's production facilities to meet electricity demand. They must satisfy both "basic" needs during off-peak hours and "peak" needs during high-load hours. The most appropriate indicator is therefore a quantity of energy per unit of time or the installed capacity, which is much more restrictive than the amount of energy produced. This is the unit most widely used to define an installation. To give an idea of the order of magnitude, a wind turbine can produce up to 5 MW[47], while a nuclear power plant can reach 1700 MW[48].

Essentially, we need to know: Is the installed power sufficient to satisfy needs? At what rate are new technologies introduced into the production capacity? Is it sufficient to meet energy security and environmental requirements?

[46] This remark applies to most OECD countries.
[47] The largest wind turbines installed have a capacity of 5 MW (this applies to the two Repower offshore wind turbines). A 7 MW project is currently underway in the US, in partnership with the Department of Energy and General Electric, and another 10 MW project is in the R&D stage in Europe.
[48] EPR: European Pressurized Reactor. Two power plants are currently under construction: the first in Olkiluoto in Finland and the second in Flamanville in France.

An analysis of the development of production capacity depends not only on new constructions, but also on the service life of existing power plants. This is particularly difficult to assess because the notion of service life is both technical and economic. By updating preventive maintenance procedures, the nominal service life of power plants can be largely exceeded while maintaining both reliability and availability. As a result, the decision to shut down a power plant depends on both its profitability, calculated according to the difference between the market price and production costs, and the regulations, particularly environmental and safety requirements. In practice, the regulatory aspect is very often the main criterion in making the plant closure decision. An analysis of decommissioned power plants (Figure 16) gives an order of magnitude for the service life of each type[49].

Figure 16: Observed service life of power plants per technology



Median service life:
Coal: 33 years
Natural gas: 28 years
Hydroelectricity: 65 years
Nuclear power: 27 years
Oil: 27 years

Note: This graphic means "90% of coal-fired plants decommissioned had been operating for less than 41 years". It is therefore the cumulative distribution function of power plants decommissioned in Europe.
Source: Author's calculations according to Gaia data base (AREVA) – WEPP2006/Platts

If simulations are carried out according to reasonable technological hypotheses to evaluate the sensitivity of power production installations to variations in the service life of power plants (Figure 17), it can be observed that more than half of all current installations will need to be renewed[50] in order to maintain production capacity at current levels and without taking the increase in demand into account. It is a two-edged sword however. Although the need for renewal provides the opportunity to modify the structure of the existing production capacity and to implement non-CO_2 emitting technologies that take dwindling resources into account, such as renewable energy, clean coal[51] and nuclear power, its implementation is an enormous challenge and requires the immediate mobilisation of everyone concerned.

The rise in demand combined with the growing share of electricity in final consumption (Figure 8) increases the need for new power plants and makes the situation even more urgent.

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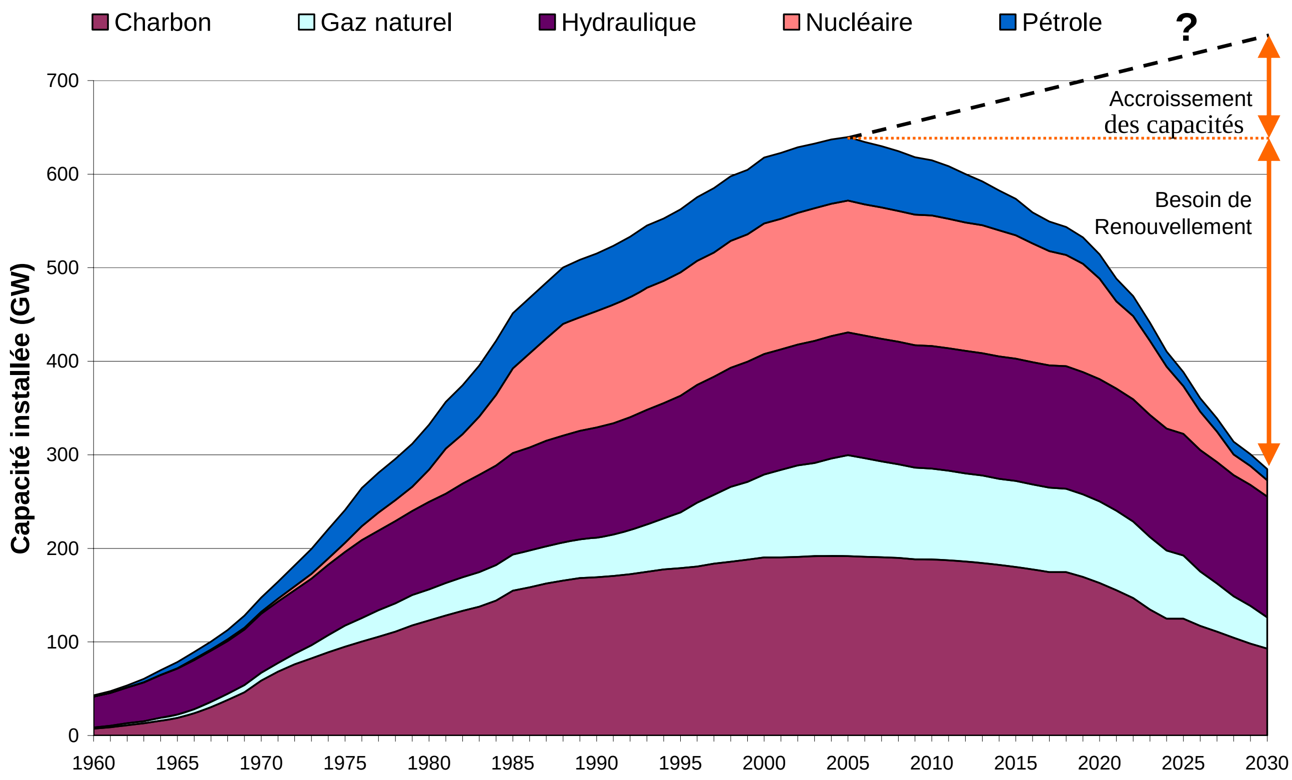
[49] These figures should be considered as minima since recent power plants are better designed (materials supporting much higher temperature and which are also more wear resistant) and benefit from preventive maintenance which increases service life.
[50] i.e. nearly 4% renewal per year. In France, this corresponds to the construction of two nuclear power plants per year.
[51] With capture and storage of CO2.

A strategy including industrial stakeholders and the Public Authorities therefore seems to be essential in developing the production capacity in Europe in order to achieve the three goals of competitiveness, sustainability and supply security.

Figure 17: Modelling of development of electricity production facilities without renewal according to expected service life



Service life in reference scenario:

Technology	Service life
Coal	40 years
Oil	40 years
Gas	30 years
Hydraulic	100 years
Nuclear	40 years

Notes:
- Wind power was not included in the model because of its low hit rate in the data base used.
- This vision is optimistic in that the service life estimations in the reference hypothesis are high.

Source: Author's calculations according to Gaia data base (AREVA) – WEPP 2006 –Platt's)

2.2. A strategy to develop production infrastructure

The production infrastructure development strategy is based on three focal points:

- Optimisation of the distribution network to reduce the need for new power plants;
- Extension of the service life of the most efficient power plants in order to slow down the urgent need for renewal;

- The development of an industrial and financial context which is condusive to the construction of new power plants.

The main difficulty stems from the very short time frame required to develop this strategy.

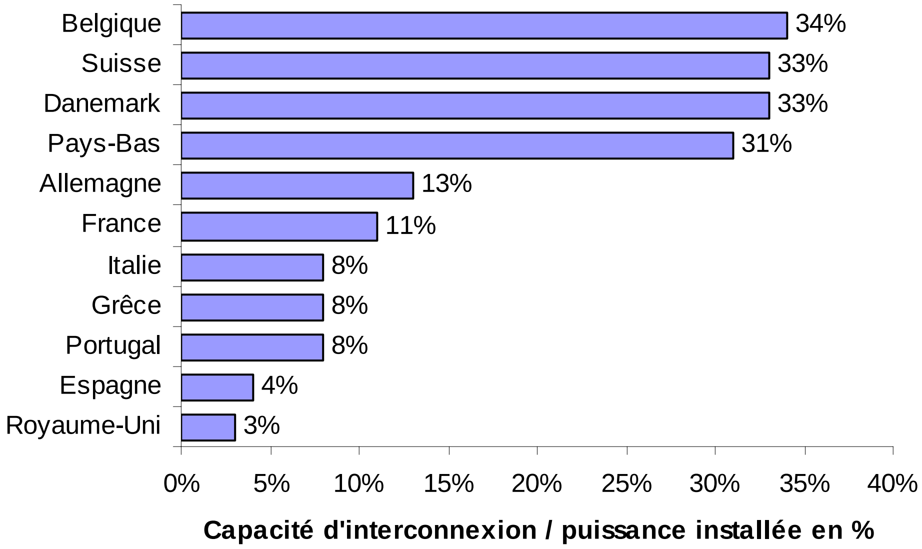
2.2.1. Developing the network to reduce the need to build power plants

The constant quest for a balance between supply and demand requires the maintenance of back-up plants that are at a standstill most of the time. In certain areas, the saturation of high voltage lines makes electricity supplies uncertain, reduces the responsiveness of production facilities and encourages the creation of additional "back-up" plants, particularly since the overall electricity demand is increasing.

To reduce the European need for "peak consumption" plants, the existing facilities need to be operated more efficiently by pooling their capacities and reducing variations in demand. Development of inconnecting networks on a European level seems essential in this respect[52]. Meeting variations in demand over a larger area would reduce the need to build these plants. Extension of the network would also incorporate the behaviour of a wide variety of consumers and this "packing factor" would reduce the variation in demand and supply constraints[53].

At the present, the possibility of pooling resources is only used when the stability of the network is threatened, within the framework of agreements between national operators. There is little cross-border trade and it mostly corresponds to long-term contracts. The flexibility potential of the grid therefore remains largely under-utilised.

Figure 18: Low interconnection capacities



Source: ETSO 2006

52 See Robert Schuman Foundation. European Issues by André Merlin, 27th November 2006 [2].

53 The reinforcement of UCTE transnational interconnection infrastructure can lead to a reduction of up to 10% in fossil fuel consumption (16 billion euros per year) and thus reduce CO_2 emissions by 100 Mt per year. Source: CESI, CIGRE 2006 session.

While a perfectly integrated fluid network on a European scale involves very heavy investments, the creation of regional trading areas is entirely envisageable and to be encouraged[54]. However this requires the implementation of common network managers with the power to regulate transborder trade[55].

2.2.2. New power plants

A large number of new power plants need to be built in Europe not only to replace the old ones[56] but also to meet the increasing peak demand which can only be satisfied if the grids are extended (Figure 17). Very pragmatic requirements will determine the construction processes.

Size of power plants and coordination of production units

- Investments in small production units are not as high and are accessible to small operators, who are the most numerous.

- An increase in the number of small power plants in a network increases production flexibility while reducing the number of units that have to adapt to seasonable consumption fluctuations. The overall efficiency of the network is therefore improved.

- As far as current technology goes, decentralized operating modules, such as self-regulating "smart" networks, are still in the R&D stage. Centralised coordination is particularly well suited to high capacity production units. Although a large number of small power plants makes management more complex, a number of grids have demonstrated their technical feasibility[57].

- The time required between the decision to build a power plant and its commissioning[58] is not necessarily shorter in the case of small production units. For example, more than a decade was needed for certain wind turbine projects to be completed[59]. It therefore seems unrealistic to expect an explosion in the number of small power plants to meet emergency needs.

- Large-scale high capacity units are mainly thermal power plants that operate on either fossil fuels or nuclear power. The emission reduction requirement therefore calls for a wider reflection on the best technologies to be implemented in addition to renewable energy, and a debate on the use of nuclear power and clean coal. Every technological innovation available is therefore needed to meet the challenge of production capacity renewal.

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[54] At present, regional networks cover all the Member States. Poland, the Czech Republic, Hungary and Rumania, for example, are interconnected with other countries in the UCPTE including Slovenia and are also connected to each other via Centrel, a group of clean electricity companies which goes as far as the Baltic States.
[55] This proposal is part of the European Commission's energy package of September 2007.
[56] According to the simulation reference hypotheses, 350 GW will need to be built in Europe by 2030, i.e. 70,000 x 5 MW wind turbines, 350 x 1,000 MW gas-fired power plants or 200 EPR nuclear power plants (1700 MW).
[57] In Denmark, for example, the large share of wind energy is compatible with its centralised network management.
[58] This includes both the construction time and the time required to obtain the administrative authorisations needed to connect them to the grid.
[59] C-Power's Thornton Bank project, led by EDF Energie Nouvelle, took nearly 10 years.

Is the number of power plants to be built compatible with current industrial capacities in Europe?

The current industrial capacities of electric power plant constructors limit the development of production facilities to a large extent. Wind turbine constructors have full order books and most manufacturing plants have reached saturation point. Installers[60] are working to full capacity. It is therefore difficult to reserve a ship to install new wind turbines off-shore or carry out repairs. These "management" constraints are not to be taken lightly.

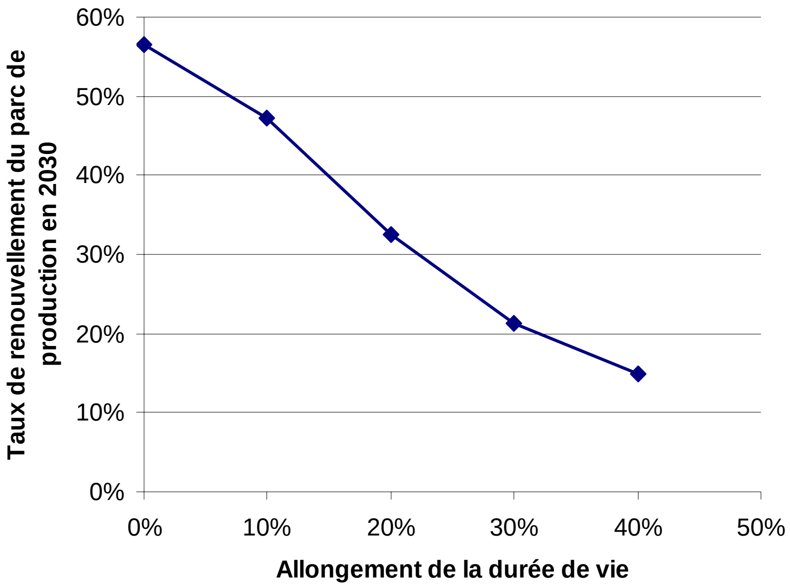
For other technologies, the limits are mainly due to a slowdown in business over the last few years. Many manufacturers no longer have enough human and material resources to carry out a large number of projects.

This means that the entire energy industry in Europe will need to be mobilised to meet the challenge of renewing its production facilities and that it will no doubt be necessary to call on manufacturers outside the European Union to achieve our goals.

The service life of the most efficient power plants must be extended

Given the construction time of power plants and the investments required to increase current industrial capacities, extending the service life of the most efficient power stations seems an essential factor in postponing the renewal of production capacity. An increase in service life of 20% with respect to the reference forecasts would reduce the need for renewal to about 30% of current facilities (Figure 19). Enormous investments are needed to upgrade the energy production and environmental performance of these installations and meet climatic and energy security goals.

Figure 19: Decrease in the renewal rate of production facilities according to the plant service life



Source: Author's calculations according to Gaia data base (AREVA) – WEPP 2006 (Platt's)

[60] Companies responsible for installing wind turbines.

Whatever the circumstances, upgrading energy infrastructure requires large-scale investments and reflection on the best technologies to be adopted. Since the ultimate decision-makers are the operators and private investors, it is important for the Public Authorities to understand the factors that determine these choices, so that regulations and guidelines can be provided.

2.3. The determining factors behind energy infrastructure investment decisions

In a liberalised market context in which investment decisions are not based on State planning but on the demands of industry leaders and investors, the main decisive factor is the balance between the risk level and the profitability of a given project.

2.3.1. Understanding the risks in order to create good investment conditions

Given the construction time and service life of energy infrastructure, the risks, which are particularly high for investors, are of several types: construction risks, market risks, regulation risks and even political risks.

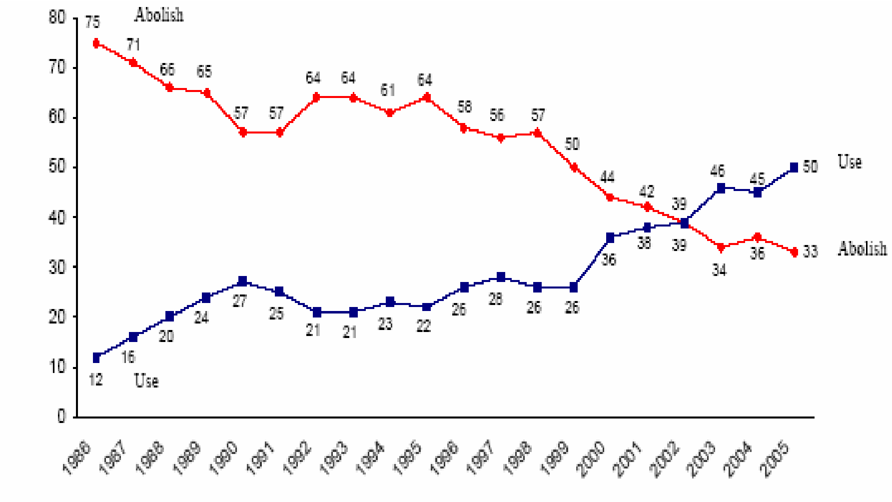
The construction risk varies according to the construction time, the level of technical difficulty, problems in coordinating the different trades and the experience of the constructor. In addition to the know-how to be developed within the company, coordination between industrial leaders and different nationalities and cultures is of capital importance. The construction of a conventional thermal power plant can involve Bouygues for the civil engineering, Babcock for the boiler, Siemens for the turbine and Alstom for the alternator, all of whom are overseen by the electricity producer.

The regulatory risks concern potential changes in the legal framework during the project. The spectrum of possibilities is very broad: amendment of the electricity market access rules, a change in the tax system and incentives or tightening of environmental standards. In this last case, the risk is particularly high as it can lead to the immediate, permanent closure of a production unit. Limitation of the emission threshold of NO_x, which is responsible for acid rain, has reduced the use of certain coal-fired power plants to just a few hours a year[61]. Since the different technologies are not all subjected to the same regulatory risks, this is a discriminating criterion which is specific to a particular country or area.

The political risk mainly stems from the acceptance of technologies and energy policy choices. Nuclear power is a classic example. In the wake of certain political stances, a number of power plants were decommissioned before their dismantling date. A lack of political commitment can also slow down the administrative phase of construction projects and create hindrances. The swing in public opinion in Sweden over the last 20 years concerning the acceptance of nuclear power (Figure 20) is a good example of the volatility of public opinion. It is therefore particularly difficult to make a commitment over several decades to build energy infrastructure.

[61] Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants.

Figure 20: Survey on the use of nuclear power as a primary energy source in Sweden (Göteborg University, 2006)



The market risk corresponds to the uncertainty of electricity sales prices and fuel purchasing prices. Although a detailed analysis of the "basics" of these markets does not come within the framework of this study, a few specific features must nevertheless be explained in order to understand the main issues:

- In the short term, the price of electricity is highly volatile, oscillating between the base price and the peak price[62]. The high amplitude of these variations is due to the low elasticity of demand and the lack of availability of electric power plants. In the long term, prices should theoretically approach complete production costs and therefore depend on the technological composition of the production facilities.

- The long-term demand is difficult to evaluate because it depends on the success of measures aimed at controlling it, particularly through the development of energy efficiency and incentives to change consumption patterns. Given the high renewal needs, the risk of production overcapacity seems low. However, it cannot be ruled out, due to the uncertainty of the service life of current power plants.

It is possible to hedge the market risk by signing long-term supply contracts with major electricity-intensive industry leaders, local authorities, and "pure" electricity distributors. However, the equilibrium constraints of the distribution grid do not allow all power plants to use this type of protection.

The role of the Public Authorities seems important when examining decisive investment factors. The regulatory and political risks require the clarification of the positions of all local, national and Community stakeholders on questions of technological choice and regulatory stability.

2.3.2. Understanding the decisive factors of profitability in order to make industrial interests and collective interests converge

Profitability mainly depends on the estimation of sales prices, the operating rate of the power plant, production costs, the period considered and perception of the risk associated with the project[63]. It is

[62] During high-load hours when all the production capacities are used to meet demand, the companies charge the highest marginal cost for the technologies used.

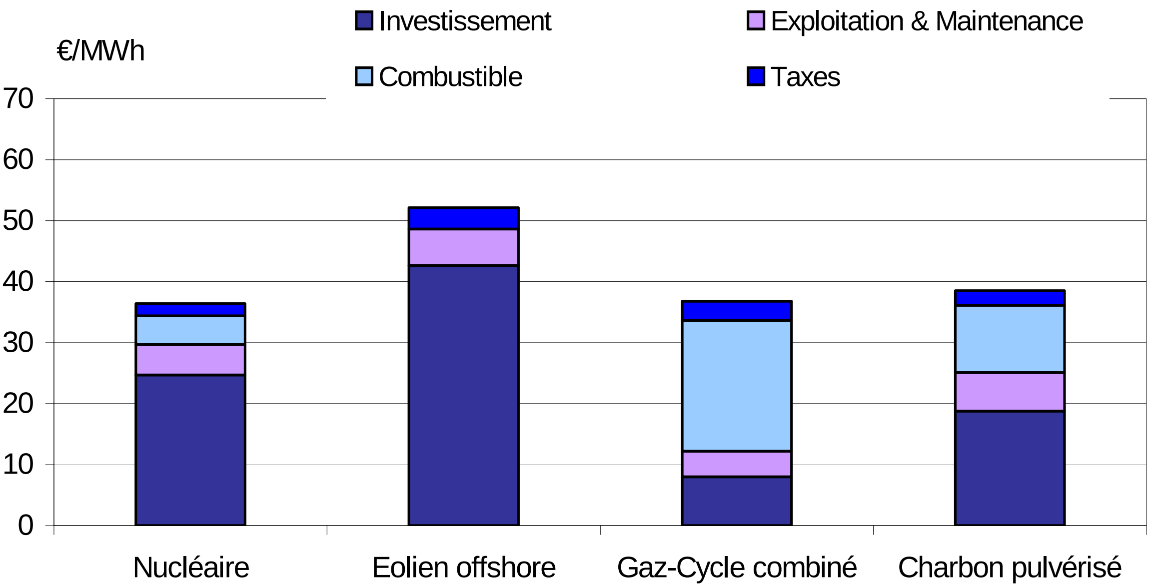
[63] Claude Riveline, "Evaluation des coûts, éléments d'une théorie de la gestion", Ecole de Mines de Paris, October 2005.

difficult to evaluate and there is a lack of consensus as to its exact definition. The production cost, in particular, is highly subjective since it depends on the viewpoint of the person making the calculation[64].

The two electricity production cost approaches

From the viewpoint of the electricity producer taking the investment decision, the production cost includes the cost of fuel, the operating expenses, the initial investment and taxes[65]. Since these expenses are spread out over time, evaluation of the cost of a kWhr[66] also depends on the so-called "private" risk-adjusted discount rate which translates the investor's preference for the present and takes their perception of the risk into account. The results are obtained with a risk-adjusted discount rate of 11%[67] (Figure 21). Since the complete cost is extremely sensitive to variations in the different parameters, the choice between coal, gas and nuclear energy is not based on this indicator.

Figure 21: Comparison of electricity production costs from the producer's viewpoint



Source: DGEMP 2003 data[68] with a discount rate of 11%

From the viewpoint of the Public Authorities who want to optimise their production facilities according to the three goals of sustainability, competitiveness and security of supply, calculation of the production cost does not take taxes into account, but includes externalities. These correspond to the costs of the negative effects of electricity production on the population and the environment that are

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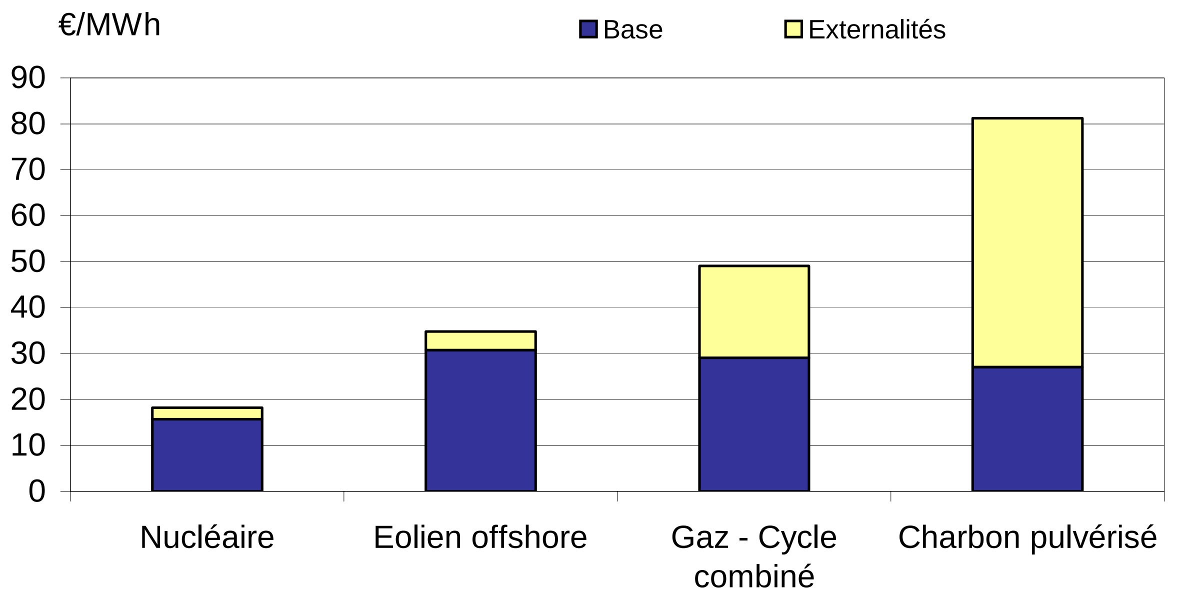
64 Strictly speaking, the cost for the investor of making the decision to construct a power plant using a certain technology, rather than doing nothing, should be defined.
65 The sum of these costs is sometimes called the "complete production cost".
66 kWh: kilowatt-hour, which is the basic unit of electricity consumption.
67 A risk-adjusted discount rate of 11% is justified by the cost of private capital: the shareholders expect a minimum financial return, which can be increased by a risk premium.
68 The reference costs for electricity production, French department of energy and raw materials (DGEMP), 2003. Production costs can vary considerably from one country to the next.

not assumed by the producers, but by society[69] (Figure 23). The results are based on a risk-adjusted discount rate of 3% (Figure 22).

This cost approach is shared by consumers in that those costs that are not directly invoiced by the producer are transferred to either their taxes or their living conditions. This simplistic approach corresponds to a very different perception from that of the investor and leads to radically different technological choices. If these criteria were also those of the investor, the result would be optimum production facilities with a minimum impact on the environment and the production costs.

Figure 22: Comparison of electricity production costs from the viewpoint of the public authorities



Source: Source: DGEMP 2003 data (68) with a discount rate of 11%

Without necessarily internalising all the externalities, as this would weigh too heavily on the competitiveness of the private sector, the Public Authorities must therefore create tools so that the choice between the different technologies will be the same regardless of the stakeholders involved.

However, the distinction between the major types of power plants (gas, nuclear, coal, wind) is deceptive because it does not take into account the wide variety of technologies used within each category. An exhaustive description of the advantages and drawbacks of best available technologies in each production chain would be necessary. However, since the scope of this study does not allow for such digression, we will simply make a few remarks that seem particularly important concerning coal-fired plants and nuclear power stations since these two technologies spark heated debate even though they meet the supply security requirement and are proving essential for the renewal of production facilities across Europe.

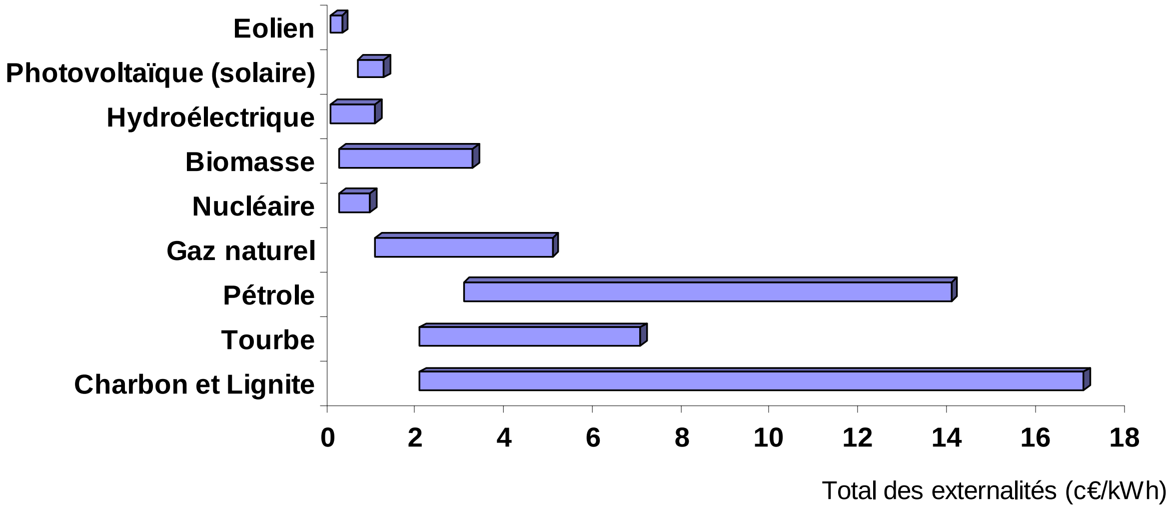
The detractors of coal-fired plants emphasise their impact on the environment, and greenhouse gas emissions in particular. They contest the term "clean coal" sometimes used to designate technologies which are "less dirty". However, the development of CO_2 capture and storage processes, which are still

[69] The costs incurred by pollution due to power plant emissions are examples of externalities: acid rain, impact on health. These costs were evaluated as part of the European Commission's External Programme.

in the demonstration stage, are effective in reducing the pollution caused, and provide an entirely acceptable technology within the framework of European commitments to reducing global warming.

The choice of nuclear power is not unanimous either. While recognising the importance of the waste issue, the disastrous consequences of an accident or the question of proliferation, an evaluation of the externalities nevertheless shows that the environmental impact of the secure, controlled use of the atom is much lower than that of all the other technoloiges (except wind power, Figure 23). Given the level of uranium reserves and expected efficiency of 4^{th} generation nuclear power plants, this technology cannot be reasonably dismissed.

Figure 23: Evaluation of externalities of existing technologies in Europe



Source: European Commission – DG RES – External Programme – 2003

These technoloigcal aspects must also be compared with the renewal and development time required for production facilities. There is no question that diversity of the energy mix is necessary not only to diversify supply but also to efficiently meet demand. The problem is knowing when these promising new technologies will be available.

By 2010, wind power will be largely developed, particularly off-shore which reduces acceptance issues and makes it possible to build more powerful turbines. The share of gas will remain relatively high with more efficient combined cycle plants. However, the dwindling of European reserves will increase reliance on imports, reinforcing risks of supply disruptions and the economic impact of price rises. In terms of nuclear power, only 3^{rd} generation plants will be available by then. With respect to coal, CO_2 capture and storage technologies will not be operational before 2020 and the so-called "clean" power plants currently being constructed have considerably reduced their overall emissions, but not their CO_2 emissions. If R&D is sufficient up until 2020, that will no longer be the case in 2030, and the range of available technologies will be wider. By then, photovoltaic energy will also be more economical due to improvements in materials, and 4th generation nuclear power plants will increase the number of years of available reserves. Technological upgrading is therefore a prerequisite for the development of our energy production capacity.

The Public Authorities will therefore be required to play an essential role in directing the development of production capacity. Through their regulatory framework, they can control the rate of closure of power plants and thus define the renewal rate of production capacity. They also have the requisite means to facilitate the investment of industry leaders by reducing long-term risks and they can influence technological choices by encouraging or penalising different types of production.

3. A new European industrial policy

In the face of energy infrastructure renewal and development issues, the role of the Public Authorities is essential in driving R&D, creating a political and regulatory framework condusive to investment and stimulating competition. Although national prerogatives remain strong in this respect, the Community level offers new prospects and is a basic decisive factor in the performance of the European energy sector.

3.1. An optimised R&D policy

Technological innovation is a basic premise of European energy strategy insofar as it is essential in achieving the environmental, competitiveness and supply security goals fixed by the European Union.

3.1.1. R&D priorities: combining technological changes and upgrading existing capacity

R&D is essential for every segment of the energy chain, from extraction to production and distribution, not only to develop new solutions but also to improve existing technologies. Without being exhaustive, a few important points need to be emphasised.

In the production segment, research must be focussed on technologies that use existing energy vectors, particularly electricity and liquid fuels, to prevent the long and costly development of new grids. While mainly concentrating on the development of new non greenhouse gas emission technologies, in order to make them more competitive and efficient, applied research must also consider the power plants currently under operation. The improvement of flue gas emission reduction devices for gas and coal-fired plants could reduce their environmental impact, for example, and therefore increase their service life[70]. Fundamental research must result in the long term in radical technological changes both in the field of nuclear power, for 4th generation power plants or nuclear fusion with the ITER project, and that of solar electricity and fuel cells.

In the electricity distribution segment, R&D is vital for optimising network management. The increasing share of unpredictable sources, essentially wind turbines, the multiplication of low power reactors and the increasing interconnection of networks, pose new problems of coordination with operators.

Despite the rapid dwindling of European fossil fuels, it seems important to step up research on advanced oil, gas, coal and uranium extraction techniques. European expertise is an important asset in negotiations with producing countries as they do not always have sufficient skills to operate their own complex deposits[71].

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[70] Service life is not only a technical and economic notion, but also regulatory: a change in environmental standards can result in the decommissioning of a power plant.

[71] There are many examples: Kashagan in Kazakhstan, deep offshore in the Gulf of Guinea, extraction of tar sands and other unconventional types of oil in Canada and Venezuela. European interests are represented through the technical know-how of the oil majors.

Investments must also be made in innovation downstream of production and distribution in order to improve the energy efficiency of all end user equipment[72]. Economic and sociological research is therefore essential in understanding and facilitating changes in consumer behaviour.

3.1.2. Managing and financing R&D: a combined effort on the part of the public authorities and private sector

Given the scope of certain research programmes, multinational collaboration is essential for ensuring financing and the pooling of sufficient scientific skills. Although a number of international projects lie outside the European framework[73], the European Union is still of essential importance in pooling and sharing national know-how.

The Public Authorities have the requisite means to guide this research because they provide the funding. The Community stakeholders have a decisive role to play as financial backers[74]. However, divergences between Member States in relation to technologies to be developed lead to the dispersal of European funds to the detriment of the more efficient research focussed on a small number of solutions practised in the United States[75]. Also, the involvement of private stakeholders often remains insufficient. It is thus surprising to learn that only five European companies[76] develop CO_2 capture and storage, although it is a decisive technology for the use of coal in the coming decades[77]. And none of these are major operators in the electricity sector, such as EdF and E.ON. To remedy matters, national energy regulation commissions should be able to require that operators make minimum investments in R&D to support certain priority projects.

This joint research aimed at transforming production facilities across Europe in order to implement the best available technologies thus requires prior reflection on intellectual property.

3.2. The essential role of government support in developing the energy mix

3.2.1. Backing the development of new technologies

The use of new technologies is a decisive factor in the development of production facilities. In a liberalised electricity market where mature technologies have achieved low production costs that are difficult to compete with, it seems essential to help new technologies to be competitive. Several government support and incentive schemes such as feed-in tarrifs and tax credits, coexist in the

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72 Better lighting, reduction in the consumption of household appliances, optimisation of air-conditioning and heating.

73 Collaboration on the ITER research project on nuclear fusion goes beyond the European framework and includes Japanese and American researchers.

74 The 7th Framework Programme for Research and Development (FPRD) has earmarked 2,350 million euros for energy and 1,890 million euros for the environment, i.e. 4.7% and 3.7% respectively of the total budget of 50,521 million euros for the period from 2007-2013. This amount is lower however compared with the budget of the US Department of Energy (DoE) which amounted to 9,110 million dollars in 2006 (source: DoE).

75 The European Union has developed technological platforms for hydrogen, coal and, more recently, nuclear energy (Sustainable Nuclear Energy Technology Platform).

76 BP (UK), Total (France), GdF (France), Repsol (Spain) and Rohoel (Austria).

77 This type of technology could become compulsory for new installations as of 2020 (COM(2006) 843 of 10.1.2007, Sustainable Power Generation from Fossil Fuels).

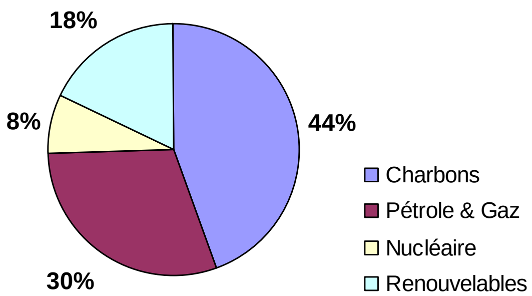
Member States[78]. As was pointed out in the CAS report ([22] p.130), the difficulty lies in "optimising the use of that rare resource, public funding". In this respect, choices for the allocation of government support often oppose two categories of public funding. The first is aimed at accelerating the maturation of technologies to make them more rapidly competitive. It is therefore temporary and supposes a decreasing learning curve for production costs. The second contributes to the use of technologies that will not be profitable for private stakeholders under current market conditions, but are considered to be necessary to achieve environmental and supply security goals[79]. This seems less sustainable but is open for discussion insofar as the cost of public policies should also take the impact of externalities into account.

3.2.2. Clarifiying and homogenising funding schemes

According to the European Environment Agency (Figure 12), 74% of subsidies in Member States are used for CO_2 emitting technologies. This is obviously incompatible with the environmental goals of the European Union, but can be explained by the difficulties of the coal industry in the face of international competition.

Although it is important to leave regional and national public authorities room for manoeuvre with respect to this type of tool in order to take local characteristics into account, it nevertheless seems important to clarify and homogenise the many schemes implemented by the Member States. They have a considerable influence on the decisions taken by economic stakeholders despite the fact that they are often in direct opposition to environmental and supply security goals to the benefit of fossil fuels.

Figure 24: Estimation of government support for energy in the Member States (EU-15) in 2001



	Government support (billions of €)	
	Direct	Indirect
Coal	6.4	6.6
Oil and gas	0.2	8.5
Nuclear	1	1.2
Renewable	0.6	4.7
Total	**8.2**	**21**

Source: EEA Technical report 1/2004, Energy subsidies in the European Union: A brief overview, p14

This aspect of the industrial policy is therefore essential in ensuring the durability of certain technologies and pointing the energy mix towards more efficient energy sources with lower emission levels. The investment question is of prime importance in ensuring the renewal and development of production capacities.

78 European Environment Agency (EEA), A Technical Report, Energy subsidies in the European Union: A brief overview, 1/2004.

79 This is particularly so for wind energy in numerous Member States.

3.3. An industrial policy to encourage investment

The investment decision is determined by an estimation of the expected profitability and risk associated with each energy infrastructure project. An analysis of sources of uncertainty shows the weight of the public stakeholders who define the regulatory framework and technological guidelines.

3.3.1. Creating investment conditions

Legal instability and political changes in relation to technological choices are unfortunately difficult to avoid and provide a particularly uncertain environment for investors. To offer investors long-term prospects, it would be ideal to stabilise regulatory conditions and clarify political positions on technological choices once and for all. But that is no doubt wishful thinking.

In relation to environmental issues, for example, changes in rules and regulations are often dictated by the discovery of a new threat to which a solution must be found immediately. Likewise, political stability seems difficult to guarantee. When there is a change of government, it is both legitimate and important for the new political power to be able to question the choices of previous governments.

However, a few remarks will suffice to indicate ways in which the public authorities can reduce regulatory and political risks.

If a series of measures are planned when drawing up new regulations, it is important to define the time frame rapidly. This point is important for European directives relating to the environment.

The Community stakeholders should clarify their positions concerning their choice of production technologies. Since the European Union represents the interests of a greater number, it could legimately advise and guide the different governments in their decisions for change.

The regulatory risk could be partly borne by the stakeholder that caused it. The creation of strictly controlled compensation mechanisms should thus encourage a larger number of investors to finance energy infrastructure.

The role of the local authorities is decisive in ensuring outlets for a power plant's electricity production and facilitating acceptance of technologies. As representatives of a large number of clients, they can commit themselves to long-term supply contracts which will cover the service life of the power plant and are ultimately the best guarantee that the investor will get a good return on investment. As the only beneficiaries of the power production, they can define the production technologies themselves by directly including the end user in the choice.

The investment level of the operators and producers depends largely on their borrowing capacity and the size of their assets. In the particular case of European gas distributors, the transport networks are their main assets. The full ownership unbundling (separation between supply and networks) recommended in the European Commission's "energy package" of September 2007 is therefore a threat to investment because it reduces the stakeholders' borrowing capacity. The role of Community stakeholders is therefore decisive in opening up to competition.

3.3.2. Backing investment

Ensuring that investments are sufficient

The mechanisms of the electricity market encourage operators to maintain a slight undercapacity in order to create tension on the market and cause prices to rise. It is essential to give the regulation commissions the requisite means to detect when these market strategies are being used and to counteract them. The competition authorities should thus be able to force certain network operators and managers to make the necessary investments in production capacities and electricity grids. This issue has an important European dimension in the management of cross-border networks.

Sources of investment: a strategic issue

The question of investment financing sources is important to maintain European control over networks and ensure energy security in the long term. If the regulators need to be able to control the participation of foreign investors in financing the main infrastructure, they must also be in a position to propose alternative financing solutions which can include public stakeholders. This aspect of the question is particularly important for the new Member States who do not always have the internal financial means needed to invest in their infrastructure.

In the case of nuclear power, the above investment questions were anticipated in the Euratom treaty[80]. The possibility of granting Euratom loans, guaranteed by the Community with respect to the European Investment Bank (EIB), was adopted by a Council decision to encourage investments, then broadened (and subsequently almost exclusively used) to improve the safety of power plants in central and Eastern Europe[81].

All the Public Authorities therefore have an important role to play in order to benefit from the opportunity to renew their production capacity. They guarantee that the technologies will be rapidly available while improving the regulations so that operators will direct their choices towards environmental, competitiveness and supply security goals. Given the advantage offered by a highly interconnected network and the centralised coordination of power plants, these issues require European coordination.

[80] In chapter II of the substantive provisions, article 2c of the Euratom Treaty indicates that the Community's task is "to facilitate investment and ensure the establishment of the basic installations necessary for the development of nuclear energy in the EU".

[81] Euratom decision n° 77/270 authorises the Commission to contract loans in view of contributing to the financing of high-power nuclear power plants. This framework decision was also amended in 1994 to authorise the Commission to finance the updating of the safety and efficiency of nuclear power capacity in countries outside the EU, located in central and Eastern Europe.

Conclusion

In an increasingly complex global energy context, the Member States share similar environmental, supply vulnerability and economic problems. In the face of these common issues, the European Union has proved to be of fundamental importance in developing an optimised answer. It seems essential to develop a European strategy in relation to the technological composition of production facilities, which is the core of the European energy equation. It is a decisive internal factor in reducing supply constraints, meeting the Union's environmental goals and controlling production costs.

The next few years offer the opportunity to renew the electricity production and distribution infrastructure across Europe. Forty years after the power plant construction boom in Europe, we are at the dawn of the first major renewal phase. Although privake stakeholders now hold most of the decision-making power in terms of technological choices, the European Union must define umbrella guidelines to optimise and coordinate the European Public Authorities whose role of regulation remains essential and who have at their disposal the requisite means to drive this renewal.

The European Union must therefore encourage reflection on different technologies in order to guarantee the coherence and pertinence of the energy choices of the Member States across Europe.

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