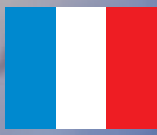
International Energy Agency

Energy Policies of IEA Countries



FRANCE

2009 Review

Energy Policies of IEA Countries

FRANCE 2009 Review

The energy policy of France seeks to achieve a balance between the environmentally responsible production and use of energy, the growth and competitiveness of the economy, and secure and competitively priced energy and infrastructure. To meet these objectives, the French government in 2007 launched an impressive environmental programme, *Grenelle de l'Environnement*, which sets ambitious targets, particularly in the buildings and transport sectors. The government has also made commendable efforts in enhancing gas supply security and forwarding initiatives to expand infrastructure and interconnections with neighbouring countries. These efforts should make regional electricity and gas markets more stable and secure. In the nuclear power sector, France has created an independent Nuclear Safety Authority and established a comprehensive framework for managing all kinds of radioactive waste and materials.

Notwithstanding its policy successes, France faces a number of challenges. Its targets aimed at combating climate change are very ambitious. While greenhouse gas emissions in France are lower than the average among IEA countries due to the important role of nuclear power in electricity generation, emissions in the transport and buildings sectors increased from 1990 to 2008. Effective implementation of the announced policies and measures will be imperative for meeting France's international and national commitments. In the electricity sector, the co-existence of regulated tariffs and market prices may impede mobilising the investment needed for maintenance and life extensions of nuclear power plants. The country also needs to boost the flexibility of electricity networks in order to achieve a structural balance between base load generation and increasing demand for peak-load.

This review analyses the energy challenges facing France and provides sectoral critiques and recommendations for further policy improvements.

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INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its mandate is two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply and to advise member countries on sound energy policy.

The IEA carries out a comprehensive programme of energy co-operation among 28 advanced economies, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency aims to:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
- Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
- Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

IEA member countries:

Australia
Austria
Belgium
Canada
Czech Republic
Denmark
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Japan
Korea (Republic of)
Luxembourg
Netherlands
New Zealand
Norway
Poland
Portugal
Slovak Republic
Spain
Sweden
Switzerland
Turkey
United Kingdom
United States

The European Commission also participates in the work of the IEA.

International Energy Agency

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EXECUTIVE SUMMARY AND KEY RECOMMENDATIONS

EXECUTIVE SUMMARY

Since the last IEA in-depth review in 2004, the French government has enacted several laws and introduced a plethora of policies and measures aimed at reducing energy consumption, enhancing energy security and combating climate change. The four key principles of France's energy policy have not changed since the last review; they are: *i)* security of energy supply, *ii)* competitive energy supply, *iii)* sustainable energy development and *iv)* equal level of energy service to all territories and all citizens. Energy policy in France is increasingly adapting to global energy and climate challenges, the EU-driven introduction of competition in the electricity and natural gas sectors, and the growing regionalisation of the energy sector in Europe. Energy security remains a key priority, and France continues to fulfil its IEA emergency stockholding obligations.

In 2008, nuclear power accounted for nearly 80% of France's electricity generation and over 40% of total primary energy supply (TPES). France imports nearly all of its oil, gas and coal requirements, but its fossil fuel imports are well diversified. Recent developments have enhanced awareness in EU27 countries that security of supply is increasingly becoming a regional issue, and France's geographical location enables it to support and benefit from the growing interconnections between markets.

The French government faces several challenges in fulfilling its energy policy objectives. Its goals and targets aimed at combating climate change are very ambitious: a 75% reduction in CO_2 emissions by 2050 and a reduction in GHG emissions in the transport sector to 1990 levels by 2020. The government needs to address the coexistence of regulated tariffs and market prices in the electricity sector which may impede investment in new capacity and prove to be an obstacle to market liberalisation. Interregional connection points are currently saturated and the domestic electricity transmission system has recently shown its fragility, potentially hampering the development of an integrated European market and increased competition.

STRONG COMMITMENT TO COMBATING CLIMATE CHANGE

France is one of the least CO_2-intensive industrialised economies, thanks to the substantial role of nuclear. Greenhouse gas emissions have been declining since 2005 from an already relatively low base. By 2007, France had reduced its total

GHG emissions below the level of its Kyoto target. Energy-related CO_2 emissions started declining in 2006 after several years of slow but stable growth.

The Energy Law of July 2005 set a target to cut France's CO_2 emissions by 75% between 1990 and 2050, at the same time setting specific targets for energy efficiency and renewable energy sources. In addition, the French government has developed an environmental programme, *Grenelle de l'Environnement*, which puts forward a framework of policies and measures, setting ambitious targets for specific sectors and energy sources, and guidelines for strengthening R&D on clean energy technologies. Priority areas outlined in the Grenelle laws include reducing emissions in the buildings and transport sectors, and reducing the CO_2 footprint of energy production and consumption. For example, GHG emissions in the transport sector must be reduced to 1990 levels in 2020. Grenelle also introduces measures to support renewable energy sources and, encouragingly, it puts emphasis on supporting renewables-based heating.

The French government should be commended for prioritising the transport and buildings sectors in its energy and environment strategy. In particular, the transport sector emits the highest share of CO_2 emissions in France, more than one-third of all emissions in 2008. Reducing energy intensity and energy-related emissions in this sector is very challenging for all IEA countries. Thanks to its low-cost and low-carbon electricity supply, France has the opportunity to reduce transport sector emissions by focusing on electricity-based technologies, such as high-speed rail and electric vehicles.

In 2007, the French government created the Ministry of Ecology, Energy, Sustainable Development and the Sea (*Ministère de l'Ecologie, de l'Energie, du Développement durable et de la Mer*, MEEDDM) to address energy, environment, land-use and transport issues. The new institution represents an opportunity to develop and implement policies in an integrated and coherent manner. Given the complex structure of the new ministry, however, it is very important to ensure close co-operation between its different directorates, specifically for analysis, including data collection.

The French government should implement its planned policies and measures in a timely and comprehensive manner. Specifically, it should carefully monitor the implementation of the measures outlined in the Grenelle laws. The low, regulated electricity prices in France carry the risk of insufficient incentives for energy savings. Thus, an evaluation of the cost-effectiveness of proposed measures is necessary given the ambitious targets in place in France.

THE ROLE OF NUCLEAR IN A LIBERALISED MARKET

France, like the whole of Europe, has experienced a period of high electricity wholesale market prices, partly due to the introduction of the European Union Emissions Trading Scheme (EU-ETS) for carbon emissions. This resulted in

substantial profits for electric utilities, in particular those based on nuclear and hydropower. The real or perceived difference between the full costs of the nuclear park and current market prices has fanned a debate about the correct distribution of the "nuclear rent" in the context of liberalised electricity markets. Current costs of nuclear power in France are significantly below European wholesale market prices and have the ability to generate substantial profits. So far, the French government managed the issue by requiring Electricité de France (EDF) to offer electricity to retail customers at a regulated tariff, covering full costs, which for most of the past years was substantially below prices in neighbouring countries.

The transition to a more competitive market in France has been challenging because of the regulated tariffs and the dominant role of the incumbent utility. While the generation and retail sectors are fully open to competition, in line with EU directives, competition is rather limited. The situation on the French electricity market is further complicated by the existence of the so-called transitional regulated market adjustment tariff (TaRTAM) for industrial customers, which is set below the wholesale market price.

It is questionable whether the current tariff structure is sustainable. It may pose a threat to organising the substantial medium-term investments needed for maintenance and life extensions of the nuclear park, and the substantial long-term investments needed for the renewal and expansion of France's reactor fleet.

In September 2009, the government announced proposed legislation to essentially implement the main recommendation of the Champsaur report[1]: allowing all electricity suppliers in France to have access to EDF's "historic" nuclear power capacity at a regulated tariff. The report also recommended that the TaRTAM be phased out in 2010. The proposed reform constitutes a significant step for more competition in French electricity markets. The Champsaur Commission stresses that the volumes are for national use only. This is expected to enhance competition on the retail market, so the regulated tariffs can be eliminated for large consumers. It is not certain, however, that the proposals of the Champsaur Commission will enable the healthy development of both France's electricity sector and its nuclear industry.

Effective market reform requires that cost-reflective pricing is implemented so that markets can provide effective price signals regarding production and investment. France and its major industrial champions have committed themselves irreversibly to a market-oriented organisation of the power sector in a European context. Developing adequate nuclear capacity is therefore dependent on electricity prices reflecting the full costs of nuclear power production, including its development cost.

1. The French government asked the former president of the telecommunications regulatory office, Paul Champsaur, to resolve the issue of regulated tariffs. A commission was established in November 2008 which provided recommendations to the government.

The French government's decisions regarding future market reform in the electricity sector could provide a valuable lesson for other countries. Although nuclear development is not without challenges, there has been a renewed interest in nuclear among IEA member countries, and globally as well. Nuclear technology is currently, apart from hydropower, the only large-scale, baseload, electricity source with a low carbon footprint. France's massive production of nuclear baseload electricity and its historic overcapacity have made it a natural exporter of baseload energy to its European neighbours in the past. The French government, however, should clarify its position on the contribution of nuclear power exports to the emerging European electricity market. This would allow its neighbours to take investment decisions which optimise their future energy demand and supply balances. The French government should also continue to strengthen efforts in international co-operation, both at the European and at the global levels, with special attention to countries that are considering or reconsidering the nuclear option, to enable nuclear power to be part of a global diversification of energy sources and long-term actions to limit GHG emissions.

Nuclear power is expected to play a key role in efforts to reduce CO_2 emissions in many countries, and public concerns over waste management need to be taken seriously. France's vast experience and expertise with nuclear power provides an opportunity for the government to take the lead on setting sound and sustainable policies for radioactive waste management. In this regard, the issue of waste management was addressed by the French government in the 2006 Planning Act. The act defines a national policy for the management of waste and asserts that the responsibility for nuclear wastes rests upon waste producers, who are liable for financing the costs of disposal. This act should be strictly enforced and regularly updated. Public debate concerning the construction of a disposal facility for high-level radioactive waste in the north-east of France is expected to commence in 2012.

INTERCONNECTION AND INFRASTRUCTURE DEVELOPMENT NEEDS

For both electricity and gas, the growing interconnections between markets in Europe are contributing to regional security of supply. France's situation as a large country in the centre of Europe makes it well positioned to support and benefit from this trend. The Pentalateral Energy Forum between France, Germany and the Benelux countries provides political backing for regional integration of electricity markets towards complying with EC directives for a European energy market. Cross-border trade and further market integration through interconnections increase both efficiency and security of energy supply for all countries involved and as such should be encouraged and facilitated. However, several gas interconnection points are currently commercially saturated, hindering the development of an integrated European market and increased competition.

The French electricity system also faces issues related to meeting peak demand, which has increased faster than energy demand in recent years. The system has surplus baseload capacity that enables France to play a significant role in the European electricity export market. Electricity demand, however, is increasingly "peakier" because of growing heating loads. This structural imbalance between strong baseload generating capacity and peakier demand may be amplified by low availability factors of nuclear reactors, increasing risks of supply disruptions in some regions more than others.

In addressing these challenges, France's involvement in several regional initiatives is to be lauded. In the framework of these initiatives, open seasons (or tenders) have been or are about to be launched in order to increase cross-border interconnection capacity. Notwithstanding the importance of domestic interconnections, continued participation in regional initiatives and co-ordinated regional transmission planning should be pursued by the French government. In addressing the structural imbalance between surplus baseload capacity and increasingly peakier demand, the French government should boost investments in peaking capacity and in demand-side measures, and enhance the flexibility of the power grids.

Investments in cross-border transmission systems increase the potential for reserve sharing, enhance grid flexibility to cope with wider fluctuations in supply and demand, and provide greater access to competitive generation sources. In France, the Energy Regulatory Commission (CRE), the transmission system operator (RTE), and government entities should closely monitor and facilitate the development of multijurisdictional transmission projects to ensure that they are implemented in a timely manner and are cost-effective. Significant progress has been achieved regarding the Spain-France interconnection.

From a broader policy perspective, transmission should be considered as a critical part of the mix of solutions to facilitate the transition to a more secure, competitive and sustainable power sector. Power systems are evolving and there are key emerging trends that will shape the power system of the future: increasing share of variable renewable electricity, distributed generation, demand participation, hybrid and electric vehicles, and smart grid technologies. In this context, there is a need to develop a vision of sustainable power systems and how the transmission system can be effectively developed to contribute to sustainability.

ENSURING GAS MARKET SECURITY AMID RISING DEMAND

France should be commended for having implemented various measures to secure gas supply since the last in-depth review. It has diversified sources and routes, including liquefied natural gas (LNG) terminals. Except for Norway, no country accounts for more than 20% of total supply. Gas security has been improved through long-term contracts with producing countries, infrastructure

development, last-resort supplier for specific customers and a comprehensive emergency plan for potential gas supply disruptions.

The share of gas in the energy mix in France is expected to increase, especially in the electricity generation sector. It is essential to increase interconnection capacity and create an attractive environment for the necessary related investments, given the usefulness of gas-fired plants in meeting peak demand and extreme peak loads.

The merger in January 2009 of three balancing zones in the north of France into the sole northern GRTgaz zone represents a key first step in reducing congestion in gas infrastructure. However, additional investments are needed to further reduce congestion and to allow gas to flow efficiently from Northern to Southern Europe and vice versa.

KEY RECOMMENDATIONS

The government of France should:

- *Strive for timely implementation of policies and measures established by the Grenelle de l'Environnement process; monitor their effectiveness; and ensure that the Ministry of Ecology, Energy, Sustainable Development and the Sea capitalises on the opportunity to implement coherent and integrated strategies for the transport and buildings sectors.*

- *Implement as quickly as possible measures to enhance competition in the electricity generation and retail sectors and promote investment; consider abolishing the regulated tariffs for non-residential customers as a first step and then work towards market pricing for all customers; and clarify its position on the contribution of nuclear power exports to the emerging European electricity market.*

- *Promote the development of transmission networks, both at cross-border interconnection points and within France, as soon as possible, in order to facilitate trade and improve reliability with neighbouring countries; enhance security of electricity and gas supply; and boost the flexibility of electricity networks and expand investment in order to achieve a structural balance between baseload generation and "peakier" demand.*

- *Develop a strategic vision for electricity network infrastructures taking into account key emerging trends such as demand-side management, electric vehicles and the increasing share of renewables-based and distributed generation, making full use of the potential of smart metering and smart grid capabilities.*

PART I

POLICY ANALYSIS

Figure 1

Map of France

Note: The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

GENERAL ENERGY POLICY

OVERVIEW

France is in the centre of Europe, sharing borders with Belgium and Luxembourg to the north, Germany, Switzerland and Italy to the east, and Monaco, Spain and Andorra to the south. It has a land mass of 552 000 square kilometres, making it the geographically largest of the EU27 countries, with significant coastlines along the Mediterranean Sea, the Atlantic Ocean and the English Channel. The climate is strongly influenced by maritime proximity, with moderately cool winters and generally mild summers. France has a population of some 64 million people.

Political and economic power in France is centralised compared to many other OECD countries. France has a republican government with a President, a Prime Minister and a bicameral Parliament. Local regions are organised into 22 administrative regions and further subdivided into 96 departments. In addition, the country has a number of overseas territories, including the departments of French Guiana, Guadeloupe, Martinique, La Réunion, New Caledonia and French Polynesia.

French energy policy over the past decades has been characterised by a centralised approach with strong government involvement. This key approach has not changed significantly since the last in-depth review. However, as with all EU27 member states, French energy policy is more and more governed by EU directives. For example, energy policies and measures in France have been recently driven by the introduction of competition into the electricity and natural gas sectors, and by the growing regionalisation of the energy sector in Europe as it moves towards a single market.

The four key principles of French energy policy have not changed since the last IEA review:

- security of energy supply;
- competitive energy supply;
- sustainable energy development;
- energy service to all territories and all citizens.

Following the oil crises of the 1970s, France adopted a comprehensive policy to develop its nuclear industry to reduce its dependence on energy imports. In 2008, nuclear accounted for 77% of France's electricity generation and 43% of TPES. As a result, the share of oil in TPES has dropped from nearly two-thirds in the 1970s to less than one-third in 2008. France imports most of its oil and gas requirements and all of its coal. Its energy imports, however, are well diversified.

The French government has recently brought together several institutions into one Ministry of Ecology, Energy, Sustainable Development and the Sea (MEEDDM) that now deals with energy, environment, land-use and transport, under a broad "sustainable development" banner. The goal of this change is to address these

issues in a more integrated and coherent way. The powers of the energy regulator, CRE, have been reinforced, but the government still makes the final decision regarding tariffs: it can approve or reject them. Significant progress has been made in France since the last in-depth review (in 2004) on electricity and gas market liberalisation. Both markets are now fully open to competition.

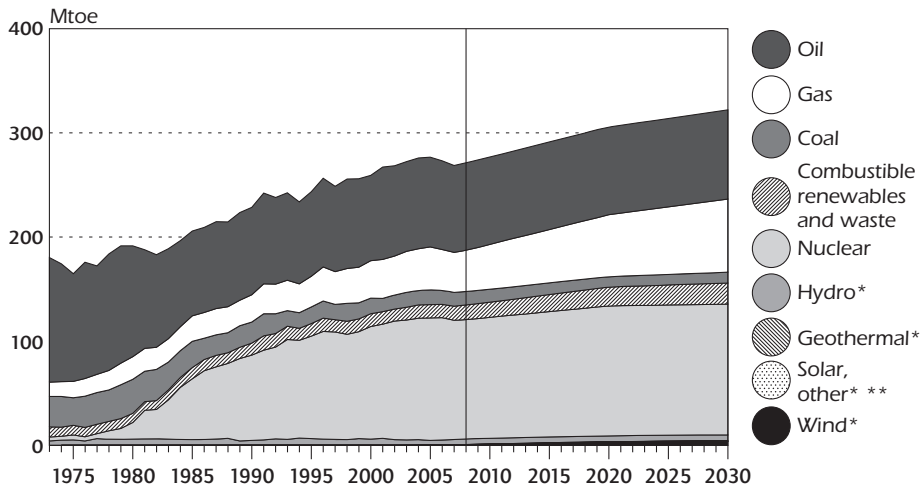
However, the incumbents still have a dominant position and consumer switching rates are very low. Historically, France has had a strong public service tradition and the State plays a very strong role in the energy sector. Moving away from the dominance of the former state monopolies is quite slow. The French government still has significant stakes in GDF Suez (35.6%) and EDF (84.8%). The government has created Pluri-annual Investment Plans (PPI) to evaluate investment decisions in the electricity and gas sectors.

DEMAND

In 2008, total primary energy supply (TPES) was 266.9 million tonnes of oil equivalent (Mtoe) (Figure 2). This represents a 1.2% increase compared with TPES in 2007. From 2000 to 2008, annual growth in TPES averaged 0.7%, half the average annual growth of 1.2% from 1990 to 2000. In 2008, nuclear energy accounted for 43% of TPES in France, the highest share among IEA countries (Figure 3). Oil accounted for 31%, natural gas (15%), coal (5%), biomass (5%), hydropower (2%), geothermal, solar and wind power (0.3% combined). Over the last ten years the percentage shares of French TPES have not changed substantially.

Figure 2

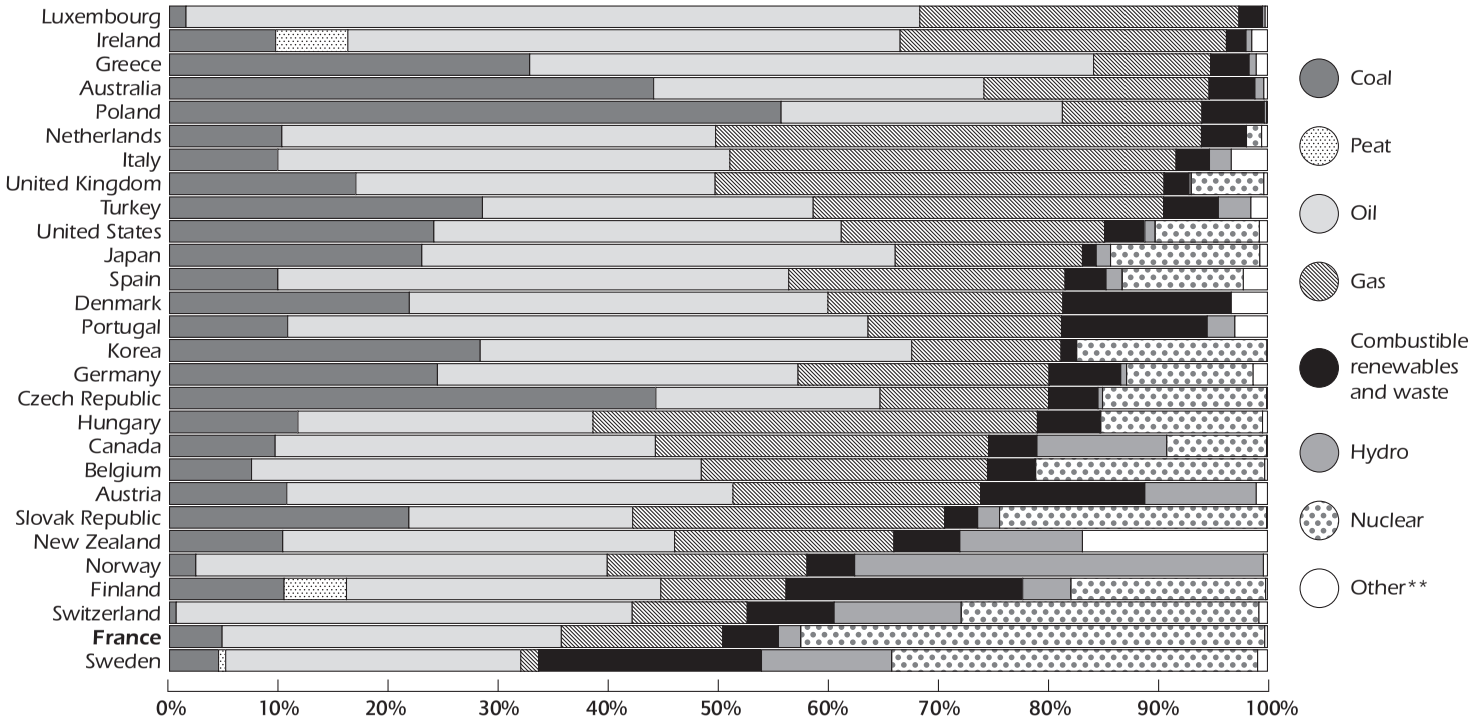
Total Primary Energy Supply, 1973 to 2030



* negligible.
** other includes tide and wave.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009 and country submission.

Figure 3

Total Primary Energy Supply in IEA Member Countries, 2008*



* estimates.

** includes geothermal, solar, wind, and ambient heat production.

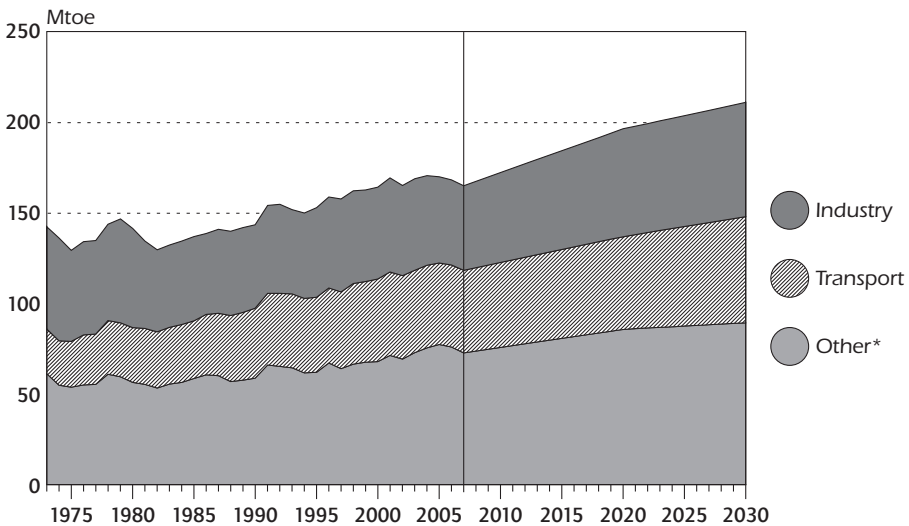
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009.

In 2007, total final consumption (TFC) of energy was 165 Mtoe in France. From 1990 to 2005, TFC rose by an average annual rate of 1.1%. The rate of increase has slowed considerably in the last decade, and between 2005 and 2007 actually declined by nearly 1.5% per year. This slow-down is attributed to declines in energy demand in the industry and agriculture sectors and a significant deceleration in demand in the transport sector (by 0.7% per year in 2005-2007 compared to over 1% per year in 1990-2005).

While oil is still the dominant final energy source used in France, accounting for 47% of TFC in 2007, its share of the total has fallen steadily since 1973 when it accounted for nearly 70% of TFC. Coal has also reduced its share of TFC, going from 9.2% in 1973 to 2.2% in 2007. Both electricity and natural gas have increased their percentage shares of TFC over this period and these long-term trends have continued in recent years. In 2007, gas accounted for 19% of TFC and electricity for 22%. The transport and industry sectors are the largest final energy users, both accounting for 28% of TFC in 2007 (Figure 4).

Figure 4

Total Final Consumption by Sector, 1973 to 2030



* includes residential, commercial, public services, agriculture, forestry, fishing and other non-specified sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009 and country submission.

SUPPLY

In 2007, nuclear energy accounted for 85% of energy production in France (total production of 135.45 Mtoe). Biomass and waste accounted for some 10% of domestic production and hydropower nearly 4%. When nuclear

is taken into account, France's overall energy self-sufficiency (domestic production) is about half of TPES. Nevertheless, France imports 98% of its gas demand, 99% of its oil demand and 100% of its coal demand. France is a net exporter of electricity, but net exports have declined recently, because of cold winters and the country's reliance on electricity for space heating.

KEY ENERGY POLICIES

Since the last IEA in-depth review, the French government has enacted several laws and introduced a plethora of policies and measures aimed at reducing energy consumption and enhancing energy security. The most important of these include:[2]

- 2000-2004: Transposition of EU Liberalisation Directives;
- 2004: Law 2004-803 concerning the public service of electricity and gas companies;
- 2004: Climate Plan 2004-2012;
- 2005: Energy Law of 2005 (Law 2005-781 of 13 July 2005, entitled *Programme fixant les orientations de la politique énergétique*, "POPE") with measures to encourage energy efficiency, the development of renewable energy and more research and development, and to maintain France's nuclear power generation;[3]
- 2006: Two new laws on nuclear for the creation of an independent safety authority and the management of radioactive materials and waste;
- 2006: Revision of the Climate Plan 2004-2012;
- 2006: Law 2006-1537 on financial incentives for the energy sector;
- 2006-2007: Privatisation of Gaz de France and merger with Suez;
- 2007: Creation of a new energy and environment ministry, currently called the Ministry of Ecology, Energy, Sustainable Development and the Sea (MEEDDM);
- 2007-2008: "Environment Round Table" *(Grenelle de l'environnement)*, which defines policies and measures and good practices on environmental issues;
- 2009: Law of Grenelle and its application with objectives for reducing energy consumption in buildings; reducing CO_2 emissions and atmospheric pollution; improving energy efficiency: and energy rationalisation at the sectoral level: *Plan Biocarburants; Plan Bâtiment; Plan Particules; Plan Déchets and Fonds Chaleur*;
- 2009: New revision of the Climate Plan 2004-2012.

2. For more information, see the relevant chapters.
3. The Energy Law sets short-term targets (for example 10% of energy from renewable sources by 2010), medium-term targets (for example a decline in energy intensity by 2.5% per year by 2030) and long-term targets (for example reducing national GHG emissions by 50% by 2050).

MEEDDM

The Ministry of Ecology, Energy, Sustainable Development and Town and Country Planning (MEEDDAT) was established in June 2007. The name was changed to Ministry of Ecology, Energy, Sustainable Development and the Sea (*Ministère de l'Ecologie, de l'Energie, du Développement durable et de la Mer*, MEEDDM) in 2009 (Figure 5). Combining the separate institutions focusing on transport, urban development, climate change and energy was a presidential priority and the ministry now ranks third in size and importance after the President's and the Prime Minister's offices. The new structure, which is unique among the EU27 countries, creates an opportunity for more coherence in policy formulation and greater cost-effective implementation of the country's ambitious policies and measures.

The Directorate-General for Energy and Raw Materials (DGEMP), previously attached to the Ministry of Economy, Finance and Industry, was changed to the Directorate-General for Energy and Climate (DGEC) in 2008. The climate section of the Interministerial Mission for the Greenhouse Effect (MIES), the previously independent National Observatory for Climate Warming Effects (ONERC) and the Office of Air Quality were added to DGEC. DGEC had a staff of some 220 in 2009.

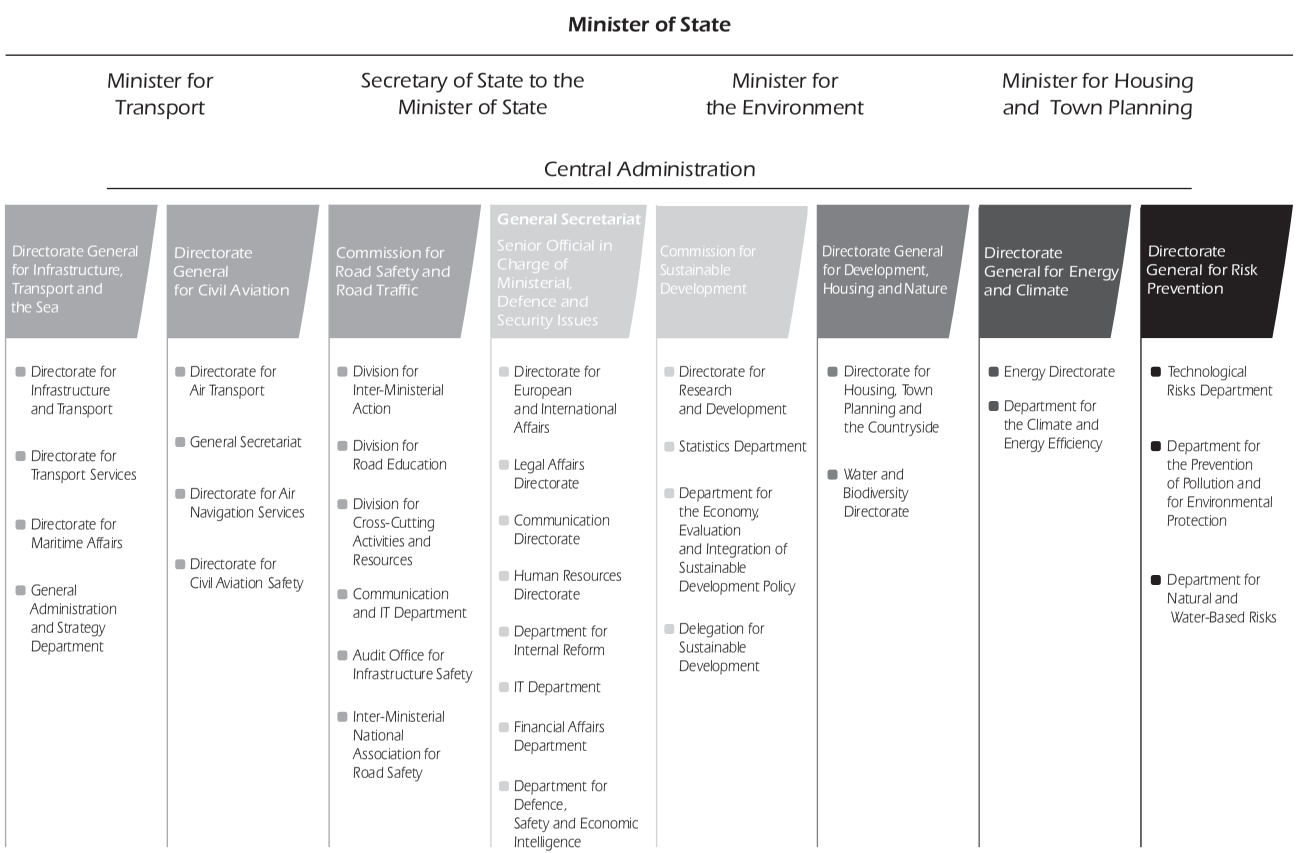
While there are numerous advantages that these new institutions represent in terms of development and implementation of policies in an integrated manner, some challenges still need to be addressed. For example, the new DGEC has many missions, including the development of a comprehensive air-climate-energy policy and low-carbon transport systems, as well as policies related to energy markets, security of supply, renewable energy and nuclear power. To effectively fulfil these complex missions, DGEC needs competences related to data collection and analysis (formerly performed by the National Observatory, ONERC) and international relations. These activities have been transferred to the *Commissariat général au développement durable* and to the *Secrétariat général* within MEEDDM.

OTHER KEY INSTITUTIONS

The French Energy Regulatory Commission (*Commission de régulation de l'énergie*, CRE) is an independent regulatory board created in March 2000 with responsibility for the opening of the energy markets. While it originally dealt only with the electricity market, its powers were expanded to include the gas market in 2003. The CRE is responsible for ensuring open access to all transmission and distribution networks (for electricity and gas) for all eligible suppliers to customers and the independence of these networks from any

Figure 5

Institutional Framework of MEEDDM



Source: MEEDDM.

historical or ownership influences. It proposes transmission and distribution tariffs in both the electricity and gas sectors to the government which then has the authority to accept or reject them.

The Agency for the Environment and Energy Efficiency (*Agence de l'environnement et de la maîtrise de l'énergie*, ADEME) is a government institution under MEEDDM and the Ministry of Higher Education and Research (MESR). ADEME implements energy policy regarding sustainable development in the fields of energy and the environment. While it works in seven distinct areas, its energy-related mandates include developing techniques to encourage efficiency in industry, transport and buildings, while also promoting renewable energy technologies.

The Nuclear Safety Authority (*Autorité de sûreté nucléaire*, ASN) is an independent administrative authority set up to deal with issues concerning nuclear transparency and safety. It also contributes to public awareness of nuclear power.

The Atomic Energy Commission (*Commissariat à l'énergie atomique*, CEA) is a government agency specialising in development and innovation in the fields of nuclear energy, technologies for communications and health, and national defence. The CEA develops synergies between fundamental and technological research and is involved in setting up collaborative projects with many partners around the world. In the energy field, CEA looks at ways to optimise France's nuclear park and find solutions for the treatment of nuclear waste. CEA has programmes for hydrogen, photovoltaics, biomass and nuclear fusion.

MARKET REFORM

Since the last in-depth review, the gas and electricity markets in France have been fully opened to competition. In November 2004, the two incumbents, EDF and GDF became limited companies with a board of directors. In 2005, their capital was opened. The State now holds 84.4% stake in EDF. GDF merged with Suez in July 2008. The State holds 35.7% stake in GDF Suez. Transmission and distribution of natural gas and electricity were unbundled and negotiated third-party access to underground storage of natural gas was introduced. Consumer protection was considerably strengthened with the establishment of a mediator for gas issues (which already existed for electricity). CRE's powers were strengthened, although, on a few subjects such as tariffs, the government still has final decision. This, however, is limited to approval or refusal, but not modification of the CRE's proposal. There is still the potential risk in such a situation of politically motivated decisions. Powers for the settlement of disputes and penalties have been strengthened with the creation of CoRDiS, the Standing Committee for CRE disputes and sanctions, which was created in 2006.

The legal unbundling of the transmission and distribution systems led to the creation of the following entities:

- RTE, manager of the electricity transmission system, a subsidiary of EDF;
- GRTgaz, manager of the gas transmission system, and subsidiary of GDF;
- TIGF (formerly PSM), manager of the gas transport network in south-west France, and subsidiary of Total;
- ERDF, manager of the electricity distribution system, and subsidiary of EDF;
- GrDF, manager of the gas distribution system, and subsidiary of GDF.

Moreover, the non-nationalised distributors which serve more than 100 000 customers have also implemented the requirement of legal separation.

A major obstacle to competition on the retail market is the persistent coexistence of regulated tariffs and market prices. For electricity, the government considers that the difference in the fuel power mix in France compared with neighbouring countries and increasing regional integration will keep prices high on wholesale electricity markets and thus not benefit its consumers. In this situation, the government uses regulated tariffs as an effective way to maintain stable and low prices to consumers.

Concerning gas, the merger on 1 January 2009 of the east, north and west balancing zones, accompanied by the maintenance of firm entry capacity in the future large north area, allows a significant improvement of market functioning. It will enhance competition and attract new players on the French gas market. The "Gas Platform" initiative is an intergovernmental policy between Germany, the Benelux countries and France that aims to create a regional gas market in North-West Europe, as an intermediate step towards a single European gas market (see section on Natural Gas in Chapter 5). The "Gas Platform" will also focus on maintaining and improving security of supply. In electricity, the "Pentalateral" coupling between France, Belgium, the Netherlands, Germany and Luxembourg is in progress (see Chapter 7).

PLURI-ANNUAL INVESTMENT PLANS

For the gas and electricity sector and for heat production from renewable resources, entities are required to develop pluri-annual investment plans (PPIs) to evaluate investment choices and to ensure that they are in line with objectives with respect to desired future developments in the energy sector. The French government has adopted these plans in line with its four main energy policy objectives. In the electricity sector, if the objectives of the PPI are not attained, the government can issue invitations to tender for the commissioning of production facilities. To develop the PPI, the Minister of Energy bases the objectives on the projected balance between supply and

demand of electricity produced by the transmission system operators, with the aim of keeping electricity demand stable over the next few decades. The estimate indicates the development needs of production capacity to meet infrastructure gaps resulting from an imbalance between supply and demand.

As for network infrastructure, the pluri-annual investment plans take into account the imperatives of energy security and competition, with the approval of the regulator. In the gas sector, the main transmission operator has established a mechanism whereby unused capacity is returned to the market for balancing the network and this "gas exchange" contributes to improve both its own profitability and market liquidity.

ENERGY PRICES AND TAXES

Energy products and services are subject to a VAT of 19.6%. However, the fixed part of contracts for the distributed supply of electricity, natural gas and liquefied petroleum gas benefits from a reduced value-added tax (VAT) rate of 5.5%. Unlike wood, which is subject to no specific tax apart from VAT, coal, natural gas and petroleum products are subject to additional taxes. Since 2007, there has been a domestic consumption tax (TICC) of EUR 1.19/MWh on coal.[4] The tax is payable on delivery of coal, lignite and coke used as fuel, and is applied on the amount of product actually delivered. The tax is payable by the coal supplier or the ultimate consumer if supplies are for own consumption. Several types of exemptions may be granted in accordance with EU Directive 2003-96 on the taxation of energy.

Natural gas is also subject to a domestic consumption tax (TICGN) of EUR 1.19 per megawatt-hour (MWh). The TICGN applies to natural gas used as fuel and is payable by the natural gas supplier or the ultimate consumer if supplies are for own consumption. Several types of exemptions may also be granted in accordance with the same EU Directive 2003-96.

The TICC and TICGN do not apply to residential customers.

Petroleum products are subject to an internal tax on petroleum products (TIPP). Since 2008, natural gas has been exempt from this tax if it is used as fuel for vehicles. The national TIPP rates have not changed since 2004. However, this tax has undergone significant change with the advent in 2007 of a regional share of TIPP. Regional councils and the Assembly of Corsica now decide to share TIPP applicable in their territories in addition to the national share. This proportion cannot exceed EURcents 1.77 per litre for unleaded petrol and EURcents1.15 per litre for diesel. In 2009, all regions apply the maximum rate, with the exception of Poitou-Charentes and Corsica. Table 1 shows TIPP rates in 2009.

4. The following exchange rate is used throughout this book: EUR 1 = USD 1.393.

Table 1

Internal Tax on Petroleum Products (TIPP), 2009

	Unit	*Euros*
Unleaded petrol 95/98	100 L	60.62
Diesel	100 L	42.79
Heating oil	100 L	5.66
Aviation oil	100 L	35.90
LPG	100 L	5.99
Heavy fuel oil	Tonne	18.50

Source: MEEDDM.

The tax difference between gasoline and diesel in France is EURcents17.8/L, one of the greatest differences among the countries of the European Union. There is thus a strong incentive in France to buy diesel vehicles, reinforced by the bonus-malus scheme introduced in 2008 with the sole award criterion being the emission of CO_2/km. In 2008, diesel vehicles accounted for 57.7% of the national fleet and 73.9% of newly registered vehicles. The higher efficiency of diesel cars should be enough to motivate buyers, particularly since the tax preference does not account for local pollution levels (see Chapter 5, section on Oil).

Biofuels benefit, within the amounts approved, from a lower tax (Table 2). The General Tax on Polluting Activities (TGAP), established in 1999, was extended in 2005 to automotive fuels that do not meet annual biofuel targets.

Table 2

Biofuels Tax Reductions

	(MJ/hl)	*Taxation (EUR/hl)*	*Reduction (in EUR/hectolitre)*			
			2008	*2009*	*2010*	*2011*
FAME	3 302		22	15	11	8
EMHA			22	15	11	8
Synthetic biodiesel			22	15	11	8
ETBE*	2 691		27	21	18	14
Ethanol	2 128		27	21	18	14
EEHV			27	21	18	14
Unleaded petrol	3 239	60.62				
Diesel	3 595	42.79				

*Part ethanol.

FAME: fatty acid methyl esters; ETBE: ethyl tertiary butyl ester; EEHV: *ester éthylique d'huiles végétales*.

Source: MEEDDM.

At the national level, apart from VAT, electricity tariffs include a component directed to public service electricity (CSPE, *contribution au service public de*

l'électricité). The CSPE was EUR 4.5/MWh in 2008. This tax is paid by all end-users except autoproducers who produce over 240 GWh per year. The CSPE aims to offset the additional costs resulting from electricity production by co-generation, contract purchases of renewable energy, charges resulting from the application of uniform tariffs in areas that are not interconnected, and social provisions.

SOCIAL TARIFFS

The social tariffs for electricity and natural gas are available to residential customers whose income is less than or equal to EUR 7 440 per year (EUR 620 per month). The social tariff for electricity only applies to rates offered by EDF and local, non-nationalised distributors. In contrast, the social rate for gas is required of all natural gas suppliers (including new entrants). The social tariff for electricity takes the form of a discount of 30% to 50% on the first 1 200 kWh annually. The allowance increases with the number of persons in the household (Table 3). The social rate for gas takes the form of a lump sum in euros, including taxes or deducted from an individual invoice or in the form of a check to beneficiaries residing in collective buildings heated by natural gas. The lump sum increases with annual consumption and household size.[5]

Table 3

Consumption Range for the Social Tariff for Electricity

(standard deduction based on household composition in EUR per year)

	Individual			*Collective*
	0-1000 kWh/ year [cooking]	*1000-6000 kWh/year [hot water]*	*>6000 kWh/yr [heating]*	*[heating]*
One adult	17	51	71	54
Adult with child Couple with no or one child Adult with two children	22	68	94	72
Couple with two or more children	28	85	118	90

Source: MEEDDM.

The number of households who could potentially benefit from the social tariff for electricity is estimated to be 2 million and for gas 1 million. In late 2008, the number of actual beneficiaries was 715 000 for electricity and 200 000 for natural gas. The number of beneficiaries at end-2009 was estimated to be around 800 000 for electricity and 400 000 for gas. The gap

5. See section on Gas in Chapter 5 for more information on social tariffs for gas consumption.

between potential and actual beneficiaries is substantial and indicates that the government needs to increase public awareness about the availability of social tariffs.

For electricity, the total cost of the social tariff was EUR 40 million in 2008 and approximately EUR 45 million in 2009. For gas, the estimated overall cost was EUR 12.8 million in 2008 (application of tariff on the first half of the year) and EUR 44.1 million in 2009. For electricity, the estimated costs resulted in a required contribution of EUR 0.10/MWh in 2008 and EUR 0.11/MWh in 2009. The CSPE is paid by the consumer and appears on the electricity bill. For natural gas, expenses for implementing the social rate resulted in a required contribution of EUR 0.026/MWh in 2008 and EUR 0.089/MWh in 2009.

ENERGY SECURITY

Energy security is a prominent concern for French energy policy makers. Alerted by the oil shocks to the dangers of over-reliance on energy imports, and oil imports in particular, the government undertook plans to reduce dependence with the goal of producing 50% of French energy needs domestically. The decisions taken over the past decades, as well as European and international commitments (opening of markets and the Kyoto Protocol), have certainly enhanced energy security and France has attained its goal of self-sufficiency in energy supply.

France aims to enhance energy security through improving energy efficiency, increasing support for renewable energy sources, further diversifying gas suppliers, increase interconnection capacity in gas and electricity markets and building two new European pressurised water reactors (EPRs). The diversification of routes of delivery of energy reflects an increased regional solidarity on the part of France.

In the oil sector, France continues to fulfil its emergency stockholding obligations and has a fairly well diversified import portfolio. In the electricity sector, bilateral co-operation and the involvement of a European co-ordinator helped spur investment in interconnection between France and Spain. Gas facilities between the two countries have also been improved, after several bilateral meetings. Moreover, the 2008/09 gas crisis has had an impact on France's gas supply strategy. The government takes the main lesson from the crisis to be the need for increased transparency and improved and expanded infrastructure. The key issues for France in the new regulation proposed by the European Commission is the need for shared objectives: improve transit network capacity to reverse flows; security of supply standards; subsidiarity; need for emergency plans; and more co-operation at the regional level.

As part of the strategy to ensure the security of supply in the gas and electricity sectors, the French government has also been developing pluri-annual investment plans (PPI). These plans identify a range of indicative targets for the types and amounts of new capacity to be built by 2020.

CRITIQUE

Since the last in-depth review in 2004, France has made substantial progress in its energy policies, from a starting point that was already quite sound. The French energy policy is characterised by strategic continuity and its key four principles have not changed over the last years. They still are: *i)* security of energy supply, *ii)* competitive energy supply, *iii)* sustainable energy development and *iv)* equal level of energy service to all territories and all citizens. At the same time, the French energy policy has been increasingly adapting to the global energy and climate challenges, to the EU-driven introduction of competition in the electricity and natural gas sectors, and to the growing regionalisation of the energy sector in Europe. More recently, French policy decisions have been influenced by the global economic crisis. The government has responded well to these challenges through a recovery plan including various initiatives related to energy and climate policies.

KEY POLICY DEVELOPMENTS

France has significantly enhanced its efforts to combat climate change. The comprehensive public consultation and decision-making process, *"Grenelle de l'Environnement"*, has resulted in the development of an impressive environmental programme. As part of its pledge to become one of the leading nations in addressing climate change and other energy and environmental issues, France has launched profound institutional reforms. One major development has been the creation of MEEDDM. Driven by the growing understanding that energy, environment, land-use and transport issues must be addressed simultaneously in a coherent fashion, this new ministry has been given the mandate to deal with all these questions under a broad "sustainable development" banner. The fact that MEEDDM has been given a very important status in the overall institutional framework highlights France's commitment to sustainable development, which is to be commended.

The new institution represents opportunities to develop and implement policies in an integrated and coherent manner, but some challenges still need to be addressed. Given the complex structure of the new ministry, it is very important to ensure close co- operation between its different divisions.

MARKET REFORM

Significant progress has been made since the last in-depth review on electricity and gas market liberalisation. Since July 2007, both markets are fully open to competition. Incumbents EDF and GDF have become limited companies and listed on the stock exchange. The accounting and legal unbundling of the transmission system operator (TSO) and distribution system operators (DSOs) is fully completed. Yet, the ownership of the system operators remains largely in the hands of incumbents. The role of the Energy Regulatory Commission (CRE) has been strengthened, particularly with respect to the monitoring of the wholesale market as well as tariff-setting. CRE also plays an active role in regional initiatives for co-operation between European regulators, which have recently emerged in the framework of the "Pentaforum", in particular to take action with regard to improving the functioning of energy markets.

However, with respect to transport and distribution tariffs for both gas and electricity, the CRE's proposals are subject to government approval. The fact that the government still has the final say regarding tariffs creates potential risk of politically motivated decisions. A regulator that has decisive powers has more tools to ensure a well-functioning market and to provide a fair and stable regulatory environment. This encourages existing market participants to operate competitively and potential participants to enter the market, which will help to alleviate any high concentration in the market.

This is not the case in France yet. The incumbents still have a dominant position; and switching rates are still very low, particularly in the electricity sector. The situation appears more encouraging in the gas sector. The government should attempt to increase stability, transparency and coherence of the regulatory framework to promote investment in transmission and distribution. It should also intensify dialogue with regulators in neighbouring countries to remove regulatory barriers to an open energy market.

Among the obstacles to the development of effective competition, the most important one is the maintenance of regulated tariffs that coexist with market prices. The regulated tariffs are determined by the government on advice of the regulator. Consumers are free to choose between offers on the free market or the regulated prices proposed by the historical operators. The situation on the French electricity market is further complicated by the existence of the so-called transitional regulated market adjustment tariffs (TaRTAM) for industrial customers, which is set below the market price. This measure has been extended until mid-2010.

Regulated prices, if they are not cost-reflective, are a source of market distortion, are not conducive to energy saving and efficient use of electricity, and do not provide proper signals for investments. Maintaining tariffs with no genuine link to the market price, even if they are cost-reflective, is not the best solution. Indeed, this practice may raise questions of funding but also of administrative complexity that may constitute barriers to entry by

potential competitors. In addition, TaRTAM may reduce the number of players participating in the wholesale market by pushing major customers away from market offers. Finally, such a mechanism does not encourage customers to become accustomed to market mechanisms and competition.

The French government, recognising these shortcomings, has appointed a commission headed by Paul Champsaur to propose an electricity market design guaranteeing an increase in competition, consumer protection and the financing of investment needs (see Chapter 8 on Nuclear Power). The conclusions of the Champsaur Commission are currently being publicly debated. The efforts of the French government to find a solution to the market dysfunction are praiseworthy and should certainly be pursued.

To address social problems in the context of energy prices, France has established social tariffs for electricity and gas for low-income households. These are granted on request and are based on the income of consumers in the form of a discount on the energy bill. To provide a level playing field, a mechanism of social support has also been established for heating oil. These mechanisms are administratively very burdensome, and many consumers remain without adequate energy access.

The creation of the National Mediator for Energy in 2006 could have a positive impact on competition. The Mediator helps to improve the functioning of the energy market through *i)* disseminating information to help consumers make their choices and *ii)* mediating in disputes between energy providers and residential customers and small businesses. The Mediator's mandate covers only the execution of signed contracts, which somewhat limits its action because some conflicts occur in pre-contractual situations.

ENERGY SECURITY

Energy security remains the key priority area of the French energy policy. Regarding oil, France continues to fulfil its emergency stockholding obligations and has a fairly well diversified import portfolio.

As for gas, France should be commended for having implemented various measures to secure gas supply since the last in-depth review. It has been diversifying sources and routes, including planning of LNG terminals. Except for Norway, no country accounts for more than 20 % of total supply. Long-term contracts with producing countries, development of infrastructure, last-resort supplier for specific customers, and a comprehensive emergency plan for eventual gas supply disruptions have also contributed to improving gas security. The role of gas industry, further development of infrastructure and regional co-operation are key factors to secure gas supply.

As the electricity market is becoming increasingly liberalised and internationalised, the uncertainty of supply and demand increases. The pluri-annual investment plans can therefore be a useful mechanism providing

guidance for market players on investment needs and demand and supply balance. As for calls for tenders, they can be an effective means to stimulate investment in renewable and other environment-friendly technologies. It can be questioned, however, whether it is worth using this mechanism for mature and completely commercialised technologies, which could affect market functioning. The government is advised to continue its security of supply measures while avoiding any such market distortions.

For both gas and electricity, security of supply is increasingly becoming a regional – rather than national – issue owing to the growing interconnections between markets in Europe. France's situation as a large country in the centre of Europe makes it well positioned to take advantage of this trend. Cross-border trade and further market integration through interconnections increase both efficiency and security of energy supply for all countries involved and as such should be encouraged and facilitated.

RECOMMENDATIONS

The government of France should:

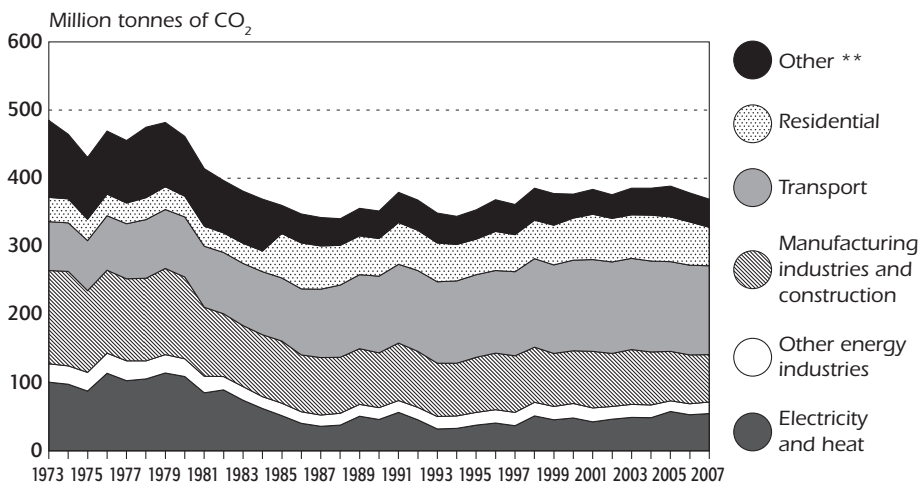
- *Continue to pursue an integrated policy approach, particularly the energy and climate policies in MEEDDEM and ensure that the Directorate-General for Energy and Climate develops strong expertise in international relations and in the collection and analysis of energy data.*
- *Consider strengthening the powers of the Energy Regulatory Commission, in particular by granting it the final decision on approval of transmission and distribution tariffs and enabling it to intervene directly with the incumbent.*
- *Consider expanding the mandate of the Mediator to include all energy consumers as well as pre-contractual negotiations.*
- *Phase out transitional regulated market adjustment tariffs (TarTAM) by 2010, as currently planned.*
- *Continue efforts to improve the functioning of electricity and gas markets and consider abolishing the regulated tariffs for non-residential customers as a first step and then work towards market pricing for all customers.*
- *Simplify the operation of social tariffs through greater transparency and rationalisation, and facilitate access to social tariffs.*
- *Monitor the implementation of the pluri-annual investment plans (PPI) with a view to the supply and demand balance and investment trends while minimising the distortion of investment decisions and avoiding impact on economic efficiency.*

OVERVIEW

France has placed the fight against climate change at the top of its energy policy agenda. The government is committed to achieving a fourfold decrease in CO_2 emissions between 1990 and 2050. CO_2 is the most important greenhouse gas in France, accounting for 74.2% of total national GHG emissions in 2008. In 2008, total energy-related emissions were 368.9 Mt of CO_2, a 0.2% increase from 1990. The main driver behind this increase in emissions was the transport sector (Figure 6). CO_2 emissions from oil combustion accounted for more than 60% of total CO_2 emissions in 2007, compared with 40% for the average across EU27 countries.

Figure 6

CO_2 Emissions by Sector*, 1973 to 2007



* estimated using the IPCC Sectoral Approach.

** includes emissions from commercial and public services, agriculture/forestry and fishing.

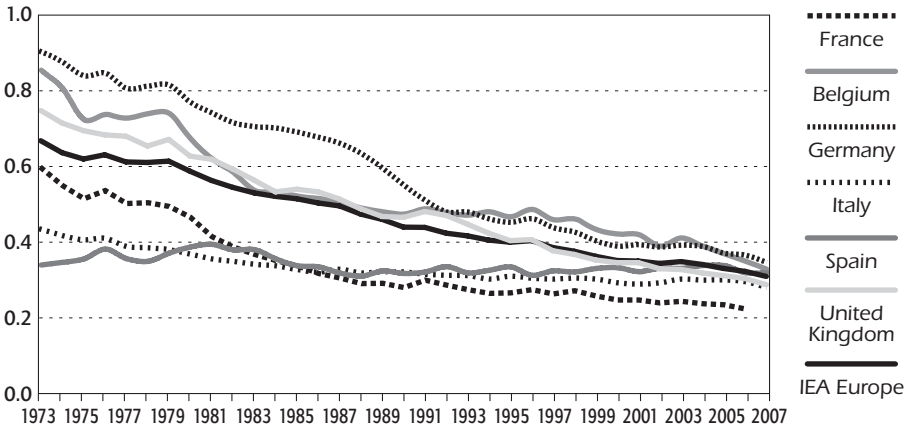
Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2009.

The level of CO_2 emissions in France is lower than in other IEA countries (Figure 7). There are several reasons for this, including the continued importance of nuclear power in France's energy mix (thus avoiding the need for more carbon-intensive electricity generation), policies that have slowed the growth in emissions from the transport sector, and emissions reductions in sectors such as industrial processes and waste.

Figure 7

Energy-Related CO_2 Emissions per GDP in France and in Other Selected IEA Member Countries, 1973 to 2007

(tonnes of CO_2 emissions per thousand USD/GDP using 2000 prices and purchasing power parities)



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009 and *National Accounts of OECD Countries*, OECD Paris, 2009.

Between 1990 and 2008, GHG emissions from the energy sector in France increased by 0.2% A substantial decline in industrial emissions compensated increases in emissions in the transport sector (13.5%) and the buildings sector (11.5%) over this period. The increase in transport emissions, however, has slowed in recent years.

GHG emissions in France are down 0.6% for 2008 compared to 2007. For 2008 they are estimated at about 527 million tonnes of CO_2 equivalent ($MtCO_2eq$). The decline in 2008 followed a decrease of 2% recorded in 2007. Emissions in France are 6.4% below the ceiling set by the Kyoto Protocol for the period 2008-2012.

LEGISLATIVE AND POLICY FRAMEWORK

The Energy and Climate Package, adopted in December 2008 by all EU27 states, calls for a reduction in the EU's GHG emissions to 20% below 1990 levels by 2020. The package also implements the EU's target of more than doubling the share of energy generated from renewable sources to 20% by 2020. The measures agreed will contribute towards meeting the EU's goal of improving energy efficiency by 20% by 2020. This new legislation requires emissions reductions at the European level of 21% by 2020 below the 2005 level for sectors covered by the EU Emissions Trading Scheme (EU-ETS). France has to meet the following requirements: a 14% reduction for sectors not

covered by the EU-ETS; an increase in the share of renewable energy in final energy consumption to 23% by 2020, including a specific 10% target in the transport sector.

The French government aims to go further than the EU requirements and has set a voluntary target under the Energy Law of 2005 (Loi de programme du 13 juillet 2005) to cut CO_2 emissions by 75% between 1990 and 2050, implying an average annual decrease of 3% (the so-called "factor-four target"). The Climate Plan 2004-2012 includes concrete plans to stabilise GHG emissions in 2008–2012 at 1990 levels. The Climate Plan was updated in 2006 to strengthen actions in the transport and buildings sectors. It includes a range of policies and fiscal incentives. The Climate Plan was updated again in 2009 with the measures taken under *Grenelle de l'Environnement*.

GRENELLE DE L'ENVIRONNEMENT

In October 2007, the *Grenelle de l'Environnement* (Round Table on the Environment) brought together all the major stakeholders – the government, unions, civil society, employers, non-governmental organisations and local authorities – to discuss environmental issues. As a result of this process, the Grenelle 1 bill was approved with almost unanimity in August 2009. This bill is a planning law establishing the general principles of the government's environmental programme. Grenelle 1 puts forth an operational framework and policies and measures to tackle climate change and other objectives. At the local level, municipalities with more than 50 000 inhabitants are required to develop integrated regional plans, Energy-Climate-Air. The Grenelle 2 law is an implementation law establishing concrete measures in different areas and was adopted by the Senate in November 2009. It will be discussed in the National Assembly in early-2010.

The main policies in Grenelle 1 are:

- an ambitious retrofitting programme for older buildings;
- stricter energy consumption requirements in the construction of new buildings;
- expanded carbon labelling for appliances and vehicles;
- a reduction in transport emissions to 1990 levels by 2020;
- promotion of sustainable cities;
- an increase in the share of renewable energy in final energy consumption to 23% by 2020;
- an energy-climate tax (see Box 1); and
- more funding for energy R&D.

INSTITUTIONAL FRAMEWORK

The French government created a new ministry in 2007 to integrate energy, environmental and climate change policy (currently called the *Ministère de l'Ecologie, de l'Energie, du Développement durable et de la Mer*, MEEDDM, see Chapter 2). MEEDDM manages the registry for the European Union Emissions Trading Scheme (EU-ETS).

Box 1

Carbon Tax in France

Along with all the countries of the European Union, France has implemented a cap-and-trade emission allowance for the largest emitting sectors. A single price per tonne of CO_2 at the European level has emerged. However, this mechanism only covers 38% of CO_2 emissions in France and is not a suitable instrument for reducing emissions from diffuse sources. In this context, a commission of experts met in July 2009 in order to establish a price signal on emissions of CO_2 generated by sectors not covered by the EU-ETS. The goal was to extract the price of carbon from overall energy prices so that businesses, households and governments would be encouraged to reduce their emissions. The tax is intended to support certain sensitive sectors, to allow them time to adapt to more energy-efficient practices and to avoid penalising their competitiveness *vis-à-vis* foreign competitors, who do not face a similar tax. In this regard, the agriculture and fisheries sectors would be only gradually subject to the tax (over a five-year period). Freight transport would also receive an exemption based on vehicle size.

The carbon tax was envisaged to be calculated from a cost per tonne of carbon fixed at EUR 17 in 2010, about the value of carbon per tonne on the European market. The tax was expected to generate revenue of some EUR 4.5 billion per year. The carbon tax would be fully refunded to consumers. For households, it would be redistributed in the form of tax credits. For businesses, the business tax burden on investment will be exempt. The compensation would be paid in lump sum increments and, subsequently, would not hinder the incentive effect of the carbon tax, *i.e.* the tax would be revenue-neutral.

In its decision of 29 December 2009, the Constitutional Council of France rejected the proposed carbon tax, claiming that the exemptions applying to industries, already included in the EU-ETS, created a "breach of equality" since the allowances under the EU-ETS were allocated free of charge until 2013. Following this decision, the government launched a new consultation on the different options.

The French Agency for the Environment and Energy Efficiency (*Agence de l'environnement et de la maîtrise de l'énergie*, ADEME) is involved in policy implementation through support for the promotion of renewable energies and energy efficiency as well as financing demonstration projects. Several other ministries and bodies are also involved in implementing policies, including the Ministries of Agriculture and Industry, as well as regional and local governments. MEEDDM, with the help of ADEME, manages the evaluation of the impact of climate change policies and measures. The French Development Agency is also involved as part of its "climate strategy".

The Inter-ministerial Committee for Sustainable Development is under the chairmanship of the Prime Minister and includes all ministers concerned with issues of sustainable development and climate change in France. At the territorial level, the regional prefects and departments are responsible for implementing climate change policies, including through the new centres of expertise "Environment and Sustainable Development", based on a local strategy. Local and regional agencies are encouraged to develop their own climate change strategies.

EU EMISSIONS TRADING SCHEME AND NATIONAL ALLOCATION PLANS

The EU-ETS limits the amount of CO_2 emissions from installations in six energy-intensive industries: power and heat; iron and steel; cement and lime; glass and ceramic construction materials; pulp and paper; and oil refining. Each installation is allocated emission allowances and must hold allowances to cover its total CO_2 emissions. If its emissions are higher than expected, it can purchase more allowances on the allowance market to avoid a penalty. If it needs fewer allowances than it holds, it can sell them. Allocation in the first two phases of the EU-ETS is based on a National Allocation Plan (NAP) that is prepared by the French government and approved by the EU Commission.

The EU-ETS was launched in 2005 and its first commitment period ran until the end of 2007. France completed its second NAP for the phase 2008-2012 in 2006 and submitted the new plan in 2008. For 2008-2012, the second commitment period, the NAP covers roughly 23% of France's target under the Kyoto Protocol. France can allocate 132.1 Mt CO_2 allowances per year of which 124.7 Mt CO_2 corresponds to incumbents' installations, 4.71 Mt CO_2 per year to installations not included in NAP1 and included in NAP2, and 2.7 Mt CO_2 per year to new entrants reserve (NER). The quota allocations by sector in the first and second National Allocation Plans are presented in Table 4.

Table 4

Allocation of Emissions Quotas by Sector between NAP 1 (2005-2007) and NAP 2 (2008-2012)

	Sector	*NAP 1 (Mt CO_2)*	*NAP 2 (Mt CO_2)*
	Heating	7.86	5.61
	Combustion plants	0.59	0.38
	Electricity	36.76	25.59
	Gas transport	0.88	0.84
	Coke ovens	0.34	0.25
	Refining	20.16	16.54
Energy	*Sub-total*	*66.59*	*49.21*
	Combustion agro-food	7.33	5.93
	Other combustion	3.89	2.87
	Combustion chemicals	11.26	14.37
	Combustion outsourced	3.99	2.65
	Combustion industry	1.62	1.09
	Steel	29.28	25.74
	Cement	14.37	15.4
	Lime	3.19	3.18
	Glass	4.00	3.73
	Ceramic	0.02	0.02
	Tiles and bricks	1.42	1.11
	Paper	4.93	4.20
Industry	*Sub-total*	*85.3*	*80.29*
Total		**151.89**	**129.5 (excluding NER)**

NER: new entrants reserve.

Source: MEEDDM.

GREENHOUSE GAS EMISSIONS AND KYOTO TARGETS

France ratified the Kyoto Protocol in May 2002. Its target under the Protocol is to stabilise GHG emissions at the 1990 level by 2008-2012. In 2008, GHG emissions in France were 6.4% below the Kyoto target.

Total GHG emissions excluding emissions and removals from land use, land-use change and forestry (LULUCF) decreased by 6.4% between the base year and 2008. Important declines in emissions were recorded in the industrial processes (29.1%), agriculture (7.8%) and waste (6.4%) sectors. Emissions of methane (CH_4) and nitrous oxide (N_2O) decreased over the same period by 17.5% and 29.2%, respectively. In contrast, CO_2 emissions excluding net CO_2 from LULUCF decreased only by 1.1% in the period 1990–2008.

France's Fifth National Communication was submitted in December 2009 to the United Nations Framework Convention on Climate Change (UNFCCC). The projections in this communication showed that France would meet its Kyoto emissions reduction commitments without the use of flexibility mechanisms. The GHG emission projections include a "with measures", a "with additional measures" and a "without measures" scenario until 2020 (Table 5).

Table 5

Summary of Greenhouse Gas Projections

	Greenhouse gas emissions (Mt CO_2 eq per year)	*Change in relation to base year level (%)*
Inventory data 1990*	566.4	0.4
Inventory data 2006*	546.5	–3.1
Kyoto Protocol base year	563.9	–
Kyoto Protocol target	563.9	0.0
"With measures" projections for 2010	544	–3.5
"With additional measures" projections for 2010	517	–8.3
"With measures" projections for 2015	549	
"With additional measures" projections for 2015	476	
"With measures" projections for 2020	553	
"With additional measures" projections for 2020	437	

*France's 2008 greenhouse gas inventory submission; excluding LU-LUCF.

Source: *Report of the centralized in-depth review of the fourth national communication of France*, UNFCCC, September 2008 and Rapport mécanisme de surveillance, March 2007.

France's climate policies have been considerably strengthened as reflected in the decline in projected emissions for 2010. In addition, the French government has made considerable progress since the last IEA in-depth review in making economic studies on the cost-effectiveness of measures aimed at mitigating climate change. MEEDDM has developed a tool for estimating the impact of emissions and is in the process of providing an estimate of costs. The evaluation of the cost-effectiveness of proposed measures is necessary given the ambitious targets in place in France. In the Grenelle process, new measures were proposed with a horizon to 2020. These measures are translated into laws which were to be implemented after 1 January 2008. The government is in the process of quantifying their impact. Initial results have been presented in the Fifth National Communication.

LOCAL AIR POLLUTION

The Grenelle bill sets out an ambitious target to reduce the level of particulate matter $PM_{2.5}$ by 30% by 2015 compared to the 2009 level. This target

is included in the *Plan Particules*. The French government has already implemented policies to reduce local air pollution; $PM_{2.5}$ concentrations were reduced by 25% in 2009 compared with 2000 levels. The *Plan Particules* includes stricter requirements on the level of particulate measurements in the residential sector (*e.g.* wood stoves, boilers), in the industry and business sectors (*e.g.* tighter emission standards, particle emissions), in the transport sector (*e.g.* areas with low emissions, truck mileage tax), and in the agriculture sector (*e.g.* reduced use of fertilizers, lower ammonia emissions).

The directive of 15 December 2004, which came into force in February 2007, encourages the monitoring of polycyclic aromatic hydrocarbons and $PM_{2.5}$, in addition to sulphur dioxide, nitrogen oxides, ozone and fine particulate matter PM_{10}. With regard to PM_{10}, since 1 January 2007, the French government has used calculations of levels equivalent to those obtained by the method of reference set by European regulations. The combination of this change and specific weather conditions led to higher concentrations of PM_{10} than in previous years.

The Gothenburg Protocol, signed by France in 1999, established local pollutant emissions levels in EU countries. Following the same approach, in 2001, the European Commission prepared the *Directive on the national emission ceilings for certain atmospheric pollutants*, covering sulphur dioxide (SO_2), nitrous oxides (NO_X), volatile organic compounds (VOCs) and ammonia (NH_3). Emission caps were set for each member state, generally more stringent than those established under the Gothenburg Protocol. In accordance with this directive, the French government prepared a revision of the National Programme to Reduce Emissions of Air Pollutants in 2006. This revision includes an assessment of the implementation of measures adopted, an evaluation of their effect, the estimated emissions for 2010, and the definition of additional measures to meet the emission ceilings.

CRITIQUE

Energy and environment policies have seen outstanding developments since the last in-depth review in 2004. France's greenhouse gas emissions have been declining since 2005 from an already relatively low base. By 2007, France had reduced its total GHG emissions below the level of its Kyoto target. As for energy-related CO_2 emissions, they started declining in 2006 after several years of slow but stable growth.

Being already one of the least CO_2-intensive industrialised economies, France has announced its aspiration to become a global leader in combating climate change. As part of this challenge, it has established very ambitious goals and developed comprehensive plans to achieve them. The programme law of July 2005 set a target to cut France's CO_2 emissions by 75% between 1990 and 2050, at the same time setting specific targets for energy efficiency and

renewable energy sources. During the French presidency of the European Union, an Energy and Climate Package was adopted in December 2008 with another set of ambitious targets for France and other EU members.

In order to meet its commitment to reduce GHG emissions fourfold by 2050, in spring 2007 France launched a comprehensive public consultation and decision-making process known as the *Grenelle de l'Environnement*, which brought together all major stakeholders. The Grenelle laws will put forward an unprecedented framework of policies and measures for energy and the environment. The Grenelle sets ambitious targets for specific sectors and energy sources. It also aims to strengthen France's research and development (R&D) programme on clean energy technologies.

The choice of priority areas outlined in the Grenelle laws is very encouraging. They include reducing GHG emissions in buildings and transport, and reducing the CO_2 footprint of energy production and consumption. France should be commended for the very ambitious initiatives in the buildings and transport sectors. The government should implement the planned policies and measures in a timely, coherent and comprehensive manner. Effective implementation of the announced measures will be imperative for meeting France's international commitments. The government should carefully monitor the implementation of the measures outlined in the Grenelle plan and enforce it if necessary. According to government forecasts, full implementation of the Grenelle measures will lead to a 22.8% reduction of GHG emissions in France in 2020 compared to 1990 levels, a level of reduction significantly below the targets established for France by the EU directives.

France is to be praised for its efforts to tackle different key issues such as climate change and air pollution in an integrated manner. It is currently updating its Climate Plan 2004-2012 and at the same time developing a *Particulates Plan* to address the air pollution problem. An integrated approach is important given that some measures can help addressing both the climate change and air pollution problems while others do not necessarily do so. For example, the current taxation of oil products, along with the bonus-malus scheme, encourages the use of diesel cars, which generally emit less CO_2 but more local air pollutants. Similarly, biomass use for heating is relatively CO_2-friendly but contributes to local air pollution. Finding the right balance between different policy objectives and adapting the policies accordingly is not an easy task, and efforts in this direction should certainly be pursued. It is very important to ensure that the separate divisions of MEEDDM as well as other institutions working on different environmental and energy issues co-operate closely.

There are strong interactions between policies to promote GHG reductions, renewable energy and energy efficiency. Policies that support renewable energy development and energy savings at the same time facilitate the achievement of the country's climate policy objectives. Energy efficiency improvements and

the consequent reduction (or stabilisation) of energy demand make relative targets for renewables easier to achieve. The French government is therefore encouraged to continue its efforts towards an integrated approach to the development and implementation of policies to address GHG, renewable energy and energy efficiency challenges simultaneously.

France has many fiscal incentives in place, targeting both households and companies, to stimulate renewables and energy efficiency, thus contributing to meeting the country's climate change objectives. These incentives will be further enhanced or improved with the adoption of the Grenelle laws. In addition to the existing measures, France is considering a carbon tax to stimulate the use of environment-friendly products and technologies. Public debate is currently ongoing about the implementation details of this tax.

In principle, this tax can be a very positive measure capable of leading to energy savings and GHG emissions reductions, particularly in "diffuse" sectors difficult to reach through other policies and measures. However, to take full advantage of its potential benefits, it is important to proceed carefully with the tax design and implementation. In designing the new environmental taxation, fiscal neutrality is important for avoiding distortions and with respect to social acceptance. Care should be taken not to put an extra burden on economic actors already covered by other policies and measures, and not to reduce the competitiveness of industry and services, and the well-being of households. If well designed and implemented, this new climate-energy tax can replace a number of less effective instruments that currently exist in France.

RECOMMENDATIONS

The government of France should:

- *Ensure timely implementation of policies and measures established by the Grenelle de l'Environnement process and monitor their cost-effectiveness.*
- *Continue efforts to address different energy and environment challenges such as climate change and air pollution in an integrated manner.*
- *Persist in efforts to develop a holistic approach towards GHG emissions reduction, energy efficiency and renewable energy targets, and further enhance co-ordination between institutions working on these issues.*
- *Pursue the public consultation process on carbon taxation with a view to possibly replacing less effective instruments to improve energy efficiency and reduce energy demand.*

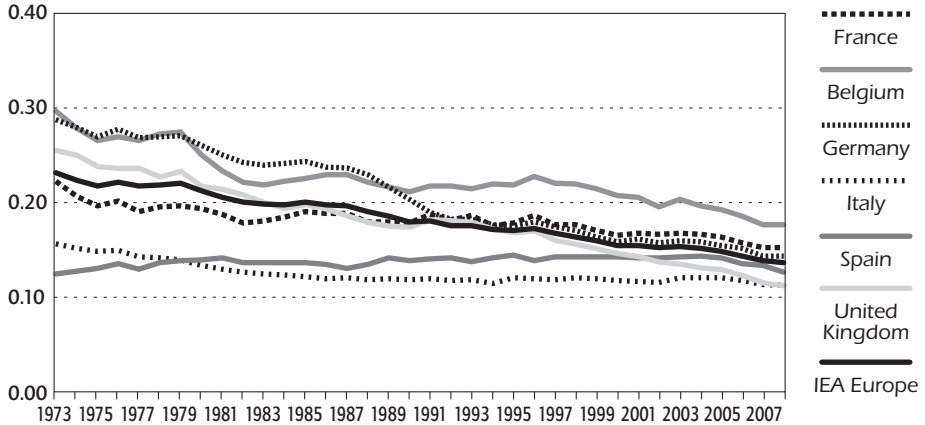
OVERVIEW

In 2007, aggregate energy intensity, as measured by a ratio of TPES in tonnes of oil equivalent (toe) over GDP (in thousands of 2000 USD purchasing power parities), was 0.18 in France. This was less than the average over all IEA countries, but 20% higher than the average for IEA European countries. In 2007, France's TPES per capita was 4.15 toe, or 19% higher than the IEA European average. Figure 8 compares French national energy intensity to the IEA European average as well as to other European countries.

Figure 8

Energy Intensity in France and in Other Selected IEA Member Countries, 1973 to 2008

(toe per thousand USD at 2000 prices and purchasing power parities)



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009 and *National Accounts of OECD Countries*, OECD Paris, 2009.

Energy intensity has been steadily decreasing in France. Final energy intensity (TFC/GDP), adjusted for purchasing power parity (PPP), decreased on average by 1.1% annually between 1990 and 2007. In 2007, manufacturing energy use[6] per value added in France was the sixth-lowest among IEA countries and energy use per passenger-kilometre (all modes) was the second-lowest, after Italy. Just under half of annual intensity improvements from 1990 to 2006

6. Energy consumption in manufacturing accounts for about a quarter of total industrial energy consumption in France.

were due to energy efficiency gains; the rest was due to structural changes in the economy.[7]

Energy efficiency currently forms a key part of France's climate change mitigation, energy security and environmental policies. France is committed to achieving EC objectives for energy efficiency and, in particular, the target of 9% energy savings by 2016 (Directive 2006/32/EC), which is part of the broader objective of a 20% improvement in energy efficiency by 2020. French policies and measures include: regulations on appliances and new buildings; market-based instruments (such as emissions trading schemes. white certificates); incentives (*e.g.* fiscal incentives, subsidies); and information and training.

LEGISLATIVE FRAMEWORK

Energy efficiency policy in France is guided by EU directives and non-binding goals. The Directive on Energy End-Use Efficiency and Energy Services (2006/32/EC) contains an indicative national energy savings target of 9% up to 2016, to be reached by way of energy services and other energy efficiency improvement measures in the sectors that are not part of the EU-ETS. The Directive on the Energy Performance of Buildings (EPBD, 2002/91/EC) sets requirements for more energy-efficient building codes. In France, building codes are supported by mandatory energy labelling and whole building energy performance requirements. Requirements for energy labelling of household appliances, in turn, are based on several directives adopted over the past fifteen years. Over the longer term, the Directive Establishing a Framework for the Setting of Ecodesign Requirements for Energy-Related Products (2009/125/EC) will improve the energy efficiency of all new products outside the transport sector. The EU-ETS has an indirect effect on energy efficiency in heavy industry and the heat and power sector. Under the EC "Energy-Climate Package", EU27 countries are required to reduce energy consumption by 20% by 2020 through energy efficiency policies and measures.

At the national level, the Energy Law (2005-781) of 13 July 2005 created the system of white certificates (see below), which has been integrated into Directive 2006/32/EC. The law also sets targets for France to reduce energy intensity by 2% per year by 2015 and 2.5% per year by 2030. The *Grenelle de l'Environnement* plan prioritises energy efficiency improvements in the buildings and transport sectors, with concrete goals and action plans. The new law sets up an ambitious programme for new buildings and an unprecedented retrofitting programme for existing buildings. In the transport sector, the new law targets a 20% decrease in GHGs in 2020 relative to the 1990 level and the construction of 1 500 km new tram or bus lines by 2020, 2 000 km of high-speed railway by 2020; and two high-speed railways for freight by 2020. The government aims to achieve faster gains in energy efficiency

7. *Implementing Energy Efficiency Policies*, IEA Paris, 2009.

improvements than its EU neighbours. National legislation goes beyond the disclosure requirement imposed at the EU level as indicated by the targets set out in the POPE legislation. France has imposed an energy label to encourage consumers to buy less-polluting vehicles, and has set up a bonus-malus scheme and stricter regulations for lighting. France should have no difficulty in meeting EU targets; national energy efficiency targets will likely be more challenging.

INSTITUTIONAL FRAMEWORK

Energy efficiency is the responsibility of MEEDDM and specifically its DGEC, the Directorate-General for Energy and Climate. The Climate and Air Quality division of DGEC co-ordinates and co-operates with other divisions of DGEC and with the Directorate-General for Development, Housing and Nature (*Direction générale de l'aménagement, du logement et de la nature*, DGALN), the Directorate-General for Infrastructure, Transport and the Sea (*Direction générale des infrastructures, des transports et de la mer*, DGITM), the Commission for Sustainable Development (*Commissariat général du développement durable*, CGDD) and the Directorate-General for Risk Prevention (*Direction générale pour la prévention des risques*, DGPR). Their work is supported by the French Environment and Energy Efficiency Agency (*Agence de l'environnement et de la maîtrise de l'énergie*, ADEME).

ADEME is an independent public agency under the joint supervision of MEEDDM and the Ministry of Higher Education and Research (MESR). Its mission is to encourage, supervise, co-ordinate, facilitate and undertake operations with the aim of protecting the environment and managing energy use. Priority areas are energy efficiency, renewable energy, air, noise, transport, waste, polluted soil and sites, and environmental management. ADEME has over 900 employees, including some 360 engineers. It is represented by three regional offices in Angers, Paris and Valbonne and 26 regional branches. There are also three offices in the overseas territories and one in Brussels. The 2009 budget for ADEME was EUR 638 million, with EUR 81 million allocated to operating and administrative expenses. Of the remaining budget, 57% is earmarked for implementation of measures under the Grenelle law.

ADEME's main objectives with respect to energy efficiency are to:

- Mobilise players at all levels:
  - Engage the territorial government in the development of energy strategies and operational programmes, relying in particular on indicator analysis (ODYSSEY).
  - Develop local services to provide information and advice to households.
  - Contribute to and promote the emergence of financial tools appropriate for developing energy conservation.

- Contribute to developing a range of energy efficiency services which guarantee energy savings.
- Provide support to governments and stakeholders for the development, dissemination and monitoring of licences for energy efficiency improvements.
- Evaluate the effectiveness of economic instruments or incentives.
- Strengthen R&D on technologies aimed at energy conservation.

- Improve energy efficiency in the buildings sector:
  - Encourage owners and tenants of apartments and households to choose and use efficient equipment.
  - Increase the skill level of construction professionals, including through training programmes.
  - Facilitate the application of thermal regulations and prepare future regulations.
  - Strengthen the structure of R&D related to emerging construction technologies.
- Reduce energy consumption in the transport sector:
  - Support operations to reduce the demand for road freight.
  - Provide information on more efficient travel plans.
  - Promote efficient modes of transport and vehicles.
  - Promote the penetration of biofuels and alternative energy sources.
- Improve the energy efficiency of industrial and agricultural processes:
  - Improve the performance of industrial and agricultural processes.
  - Promote the emergence of significant innovations in industrial processes and new energy technologies.
  - Assess the performance of different technologies.

WHITE CERTIFICATES SCHEME

The white certificates scheme (*certificats d'économies d'énergie*, CEE) was set up by the 2005 Energy Law and implemented in 2006. The scheme aims to stimulate improvements in energy efficiency through the use of market-based instruments. The scheme was initially targeted on energy savings in the residential sector. Energy suppliers are free to choose what actions they will undertake to fulfil their obligations. Based on supplier obligations (electricity, natural gas, heating oil, liquefied petroleum gas, district heating and cooling), the current scheme is opened to other participants (local authorities and businesses) under certain conditions. Once the savings are achieved, energy suppliers receive "white certificates" which can be traded. If, at the end of the period, energy suppliers cannot meet their obligations (by implementing energy-saving measures or by buying certificates) they must pay a penalty of EUR 0.02/kWh.

In the first phase, 2006-2009, energy suppliers were obliged to promote energy-saving measures to achieve a reduction of 54 TWh (of lifetime cumulated energy savings). In fact, actual savings were greater than the target; as of July 2009, energy savings of more than 65 TWh of lifetime-cumulated energy was achieved. The French government plans to extend the scheme for a second period 2010-2012 through implementation of the Grenelle 2 law. The energy savings objective is expected to be more than five times higher than in the previous period. In addition, liquid fuel suppliers will also be under this obligation. As of February 2010, Grenelle 2 was still under discussion in the French Parliament and laws guiding implementation had not yet been written.

There is uncertainty as to whether these new obligations will be achieved in a cost-effective way. As new market players enter the certificates market, the system could become more difficult to administer and monitor; and transaction costs may rise. Recognising these potentialities, the French government designed the Grenelle 2 to alleviate the administrative burden of the scheme, through the introduction of thresholds to reduce the number of energy suppliers and minimum standards for energy savings.

GOVERNMENT ENERGY EFFICIENCY POLICIES BY SECTOR

APPLIANCES AND LIGHTING

France has fully transposed the EU regulations and directives related to appliances and lighting. In December 2008, the French government implemented the EU regulation n°1275/2008 regarding ecodesign requirements for stand-by and off-mode electric power consumption of electrical and electronic household and office equipment, which was based on the 2005 framework directive to limit stand-by power to one watt across all electronic appliances.

The French government adopted the draft regulation on energy consumption for televisions on 22 July 2009. Because the market for televisions is expanding rapidly, the Minister of Energy has commissioned a taskforce to look for ways to reduce energy consumption of TVs, such as a bonus-malus scheme or equivalent. The French government is seeking to strengthen its implementation of EU regulations through the introduction of more national incentives, such as tax measures and information campaigns. The government supports requirements that individual and networked devices enter low-power modes automatically.

France collaborates in international efforts, *i.e.* energy star and eco-design products, to reduce energy consumption of appliances, and the country has transposed the Framework Directive on Energy Labelling (7 July 1994)

as amended by the Decree of 8 April 1998 for refrigerators, dryers, washing machines, washer-dryers, dishwashers, lamps, electric ovens and air-conditioners.

In the area of lighting, France's building codes specify installed lighting energy limits. ADEME provides advice to city managers on ways to reduce costs for street lighting. A European regulation which came into effect in 2009 sets performance thresholds for household and street lighting, and products that do not meet these thresholds are banned. The regulation for a total ban on incandescent light bulbs was adopted on 18 March 2009. The French government has decided to accelerate the ban in France through a voluntary agreement with national retailers.

BUILDINGS

Establishing a more sustainable approach to the buildings sector is essential to any aggressive climate change policy and provides benefits in terms of enhanced energy security, reduced fuel bills and improved living conditions. In France, this sector accounts for nearly one-quarter of all CO_2 emissions and is at the top of the list of France's priorities in its drive to become the EU's most energy-efficient economy between now and 2020. Grenelle 1 sets out the two main pillars of France's strategy to reduce energy consumption in the buildings sector:

- limit energy consumption to less than 50 kWh per square metre and per year in all new buildings starting from the end of 2012 (or from the end of 2010 for public and service-sector buildings); and
- reduce energy consumption in existing buildings by 38% between now and 2020.

To achieve the first target, the French government is in the process of strengthening the thermal regulations for new buildings. The new regulation, RT 2012, is expected to be published in summer 2010. Maximum consumption in new buildings is now 15% lower than the previous regulation (RT 2005 vs RT 2000). The use of renewable energy will be encouraged. For positive energy buildings, local authorities will be able to sell electricity to the network. A long-term objective is for all new dwellings to be passive or energy-positive by 2020. The government plans to achieve the second target by rehabilitating 400 000 houses annually (twice the current rate) and renovating 800 000 public housing units that are currently in poor condition. Average annual energy consumption of public housing units is currently 170 kWh of primary energy per square metre and per year.

These ambitious objectives are now implemented in the *Plan Bâtiment*. The core incentive programme, the *éco-prêt à taux zéro* (zero-interest loans), will help spur investment to improve energy efficiency in existing private homes.

France has had innovative financing products for the buildings sector since 2007, when, in partnership with banks, low-interest loans for energy conservation projects were offered and financed through a tax-free savings account. The new energy efficiency policies are backed by strong additional government incentives, including tax credits and "sustainable development" loans. Funding for the zero-interest loan for energy efficiency improvements doubled as part of France's economic stimulus plan. In addition, the 2009 Finance Law provides a zero-interest loan for the purchase of a new or existing home. These loans are much greater if the home exceeds current building code requirements. Tax credits for interest paid on home acquisition or construction loans have been modified to ensure all construction meets the latest thermal efficiency standards, and loans are preferential when current standards are exceeded. These monetary incentives will be supplemented by a greater emphasis on professional training programmes and public awareness campaigns.

The French government has also addressed non-economic barriers in the buildings sector. Under the Grenelle laws, two decrees were published in November 2009 which allow owners of social housing and private dwellings to share the savings from energy efficiency improvement with their tenants, if the energy performance of the housing is significantly improved.

The French government is aware that its data on energy efficiency in the buildings sector could be improved and that studies of barriers in this sector are urgently needed. Thus, under Grenelle 2, ADEME has been tasked with collecting information on energy efficiency in existing buildings and on barriers to energy efficiency improvements. The collection of "diagnostic" energy data (so-called energy performance certificates in Directive 2002/91/EC on the Energy Performance of Buildings) is expected to significantly improve knowledge of existing building stock. This information could be used to develop a comprehensive policy package of measures to improve the energy efficiency of the new and existing building stock on the basis of targets set in the Grenelle strategy.

TRANSPORT

In order to reduce greenhouse gas emissions by 20% between now and 2020, the French government aims to lessen the dependence of the transport sector on hydrocarbons. In the freight transport sector, the Grenelle strategy aims to:

- develop routes by sea and rail to Spain, Portugal and Italy;
- introduce a per-kilometre eco-licence for lorries using the national road network to take effect in 2011;
- increase the percentage of journeys made by modes of transport other than road and air from 14% to 25% by 2022; and

- achieve 25% growth in the non-road freight market share between now and 2012.

To reduce hydrocarbon demand for personal transport, priority will be given to public transport systems, through:

- investment of EUR 2.5 billion in the first stage of a programme to develop exclusive urban transport systems at the local level (not including the Ile-de-France region);
- construction of 2 000 km of high-speed rail lines between now and 2020, with a further 2 500 km under consideration; and
- 50% reduction in fuel consumption and carbon dioxide emissions in the air transport sector.

An EU cap for fleet average CO_2 emissions of 130 g/km from new passenger cars will apply in full from 2015. A complementary objective of 95 g/km has been set for 2020. An extension of this agreement for light commercial vehicles less than 3.5 tonnes was proposed by the European Commission in 2009.

France has introduced a bonus-malus scheme, which provides monetary support to consumers purchasing cars with emissions equal to or below 130 g CO_2/km and requires purchasers of cars emitting over 160 g CO_2/km to pay an extra lump-sum tax. The programme has contributed to energy savings and CO_2 emissions reductions in the transport sector but it has been more expensive than anticipated. The scheme may be extended to favour "green" tyres, under EC legislation for tyre labelling, which improve fuel economy through better design. Reform of the vehicle registration tax scheme in France (now CO_2-based) led to an immediate shift in vehicle purchases towards lower CO_2-intensive vehicles. The scheme includes a plan to lower the thresholds every two years, which has been attributed to its success.

Reducing energy intensity in the transport sector is challenging for all IEA countries. France has one of the lowest energy intensity in the transport sector, but there are still gains to be made. France is planning to implement 60% of the IEA recommendations (see Box 2) for improving energy efficiency in the transport sector but so far none of the recommendations have been fully or substantially implemented.

INDUSTRY

The French government has evaluated the reduction potential of industrial energy consumption to be 10 Mtoe, or 6.5% of current consumption, by 2020. Efficiency gains by autoproducers are expected to account for a 4 Mtoe decrease and more efficient processes and technologies for the rest.

The main policies and measures to improve energy efficiency in the industry sector are:

- energy audits with assistance from ADEME;
- mandatory biannual inspection of boilers over 400 kW;
- 12-month amortisation for energy-saving equipment and renewable energy production;
- a 50% reduction on the base of the business tax for energy-saving equipment and renewable energy equipment;
- subsidies from ADEME for the integration of renewable energy into industrial plants and heating networks; and
- an expansion of the repository of good practice in the energy industry, first published in March 2006 by the government, in partnership with AFNOR, the French organisation for standardisation, and ADEME.

Further energy efficiency improvements will be introduced in the legislation for industrial installation through the Grenelle 2 law.

CRITIQUE

France is placing energy efficiency at the forefront of its energy policy. With the Grenelle strategy, the government laid down targets and measures for national energy efficiency policy. Plans to reduce energy consumption are also driven by the indicative and mandatory EU targets. Ambitious targets are helpful not only because they set a baseline from which changes can be measured, but also because they provide an impetus to focus attention on actions to improve energy efficiency over the long term. France shows clear commitment to realise the triple dividend of energy efficiency improvements: lowering energy costs, reducing import dependence and avoiding greenhouse gas emissions.

To achieve its energy efficiency targets, France has made use of fiscal incentives and innovative instruments such as the "white certificates" system. Since the last in-depth review, France has significantly improved its policy approach and implemented various policies and measures. In the industry sector, implementation of the European Union Emissions Trading Scheme (EU-ETS) has reduced emissions. In the areas of lighting and appliances, France has implemented the EU regulations and directives; additional national programmes have also been implemented and contribute to the overall target. More work is needed, however, in evaluating the cost-effectiveness of these policies, particularly the white certificates scheme and financial incentives such as zero-interest loans.

To stimulate energy efficiency improvements it is important to provide the right price signals in order to influence individuals' behaviour. The low, regulated

electricity prices in France do not create sufficient incentives for energy savings. Energy-climate taxation (see Chapter 3) could be an effective economic instrument to boost energy savings and investments in energy efficiency. An energy-climate tax could also help to overcome the obstacle of high fixed costs of energy-efficient technologies, since consumers would be likely to take into account full life-cycle costs when variable costs increase.

However, price signals alone are not enough. Various non-economic barriers to energy efficiency improvements also need to be overcome. One major problem is lack of information. Another is conflict of interests: for example, landlords lack incentives to invest in efficiency improvements because their tenants pay the energy bills. Encouragingly, the French government has addressed this conflict through recent decrees which facilitate the sharing of expenses for energy efficiency improvements. For businesses, regulatory and administrative hurdles may limit the adoption of new technologies. The government has rightfully acknowledged that identifying and reducing such non-economic barriers is a major but necessary task.

Energy efficiency potential varies among different sectors of the French economy. The highest potential lies in buildings and transport, which the French government has identified as priority sectors. Potential for energy savings in the power sector, however, should not be ignored.

An intensified effort to reduce energy consumption in the buildings sector by encouraging consumers to change their behaviour is a major emphasis of the French government. The government should continue, with the help of ADEME, to offer information and advisory support to consumers. However, the established targets are extremely ambitious and require that the implementation of policies and measures is strictly enforced.

The target of the first trading period of the white certificates scheme (*certificats d'économies d'énergie*, CEE) has been fully achieved. However, with Electricité de France (EDF) being the major player holding a share of approximately 55% of total obligations in the first period, a fully competitive market for certificates has not yet evolved. The level of future obligations in the second phase of the scheme has not yet been decided, but the government has indicated that obligations may be at least five times higher than in the first period. Some stakeholders express concern that these new obligations might be difficult to achieve in a cost-effective way. The French government plans to include fuel distributors in the period 2010-2012, thereby making the white certificates scheme an instrument for both priority sectors, buildings and transport. However, when more market players enter the certificates market, the system could become even more difficult to administer and monitor; and transaction costs may rise. These concerns have been addressed by excluding certain small businesses in the Grenelle 2 law. The government should therefore monitor closely the development of administrative and transaction costs of the system and work towards a reduction of these costs.

RECOMMENDATIONS

The government of France should:

- *Continue efforts in energy efficiency improvement, especially in buildings and transport, paying particular attention to addressing non-economic barriers.*
- *Ensure that energy efficiency policy measures are adjusted with regard to the interactions with other energy policies such as energy taxes and subsidies.*
- *Evaluate the cost-effectiveness of white certificates and their real impact on energy consumption.*

Box 2

IEA Energy Efficiency Recommendations

The IEA has prepared a set of energy efficiency policy recommendations covering 25 fields of action across seven priority areas: cross-sectoral activity, buildings, appliances, lighting, transport, industry and power utilities. The fields of action are outlined below.

1. The IEA recommends action on *energy efficiency* across sectors. In particular, the IEA calls for action on:
   - Measures for increasing investment in energy efficiency.
   - National energy efficiency strategies and goals.
   - Compliance, monitoring, enforcement and evaluation of energy efficiency measures.
   - Energy efficiency indicators.
   - Monitoring and reporting progress with the IEA energy efficiency recommendations themselves.
2. *Buildings* account for about 40% of energy used in most countries. To save a significant portion of this energy, the IEA recommends action on:
   - Building codes for new buildings.
   - Passive energy houses and zero-energy buildings.
   - Policy packages to promote energy efficiency in existing buildings.
   - Building certification schemes.
   - Energy efficiency improvements in glazed areas.

3. *Appliances and equipment* represent one of the fastest growing energy loads in most countries. The IEA recommends action on:
   - Mandatory energy performance requirements or labels.
   - Low-power modes, including stand-by power, for electronic and networked equipment.
   - Televisions and set-top boxes.
   - Energy performance test standards and measurement protocols.
4. Saving energy by adopting efficient *lighting* technology is very cost-effective. The IEA recommends action on:
   - Best-practice lighting and the phase-out of incandescent bulbs.
   - Ensuring least-cost lighting in non-residential buildings and the phase-out of inefficient fuel-based lighting.
5. About 60% of world oil is consumed in the *transport sector*. To achieve significant savings in this sector, the IEA recommends action on:
   - Fuel-efficient tyres.
   - Mandatory fuel efficiency standards for light-duty vehicles.
   - Fuel economy of heavy-duty vehicles.
   - Eco-driving.
6. In order to improve energy efficiency in *industry*, action is needed on:
   - Collection of high-quality energy efficiency data for industry.
   - Energy performance of electric motors.
   - Assistance in developing energy management capability.
   - Policy packages to promote energy efficiency in small and medium-sized enterprises.
7. *Energy utilities* can play an important role in promoting energy efficiency. Action is needed to promote:
   - Utility end-use energy efficiency schemes.

Implementation of IEA energy efficiency recommendations can lead to huge cost-effective energy and CO_2 savings. The IEA estimates that, if implemented globally without delay, the proposed actions could save around 8.2 Gt CO_2/yr by 2030. This is equivalent to one-fifth of global energy-related CO_2 emissions in 2030 under the IEA Reference Scenario, in which no new policies are adopted or implemented. Taken together, these measures set out an ambitious road-map for improving energy efficiency on a global scale.

The IEA published its evaluation of the performance of all member countries, including France, in 2009 (available at www.iea.org/w/bookshop/add.aspx?id=368).

PART II

SECTOR ANALYSIS

NATURAL GAS

OVERVIEW

The current share of gas in TPES in France is low compared with other IEA European countries because of the large role of nuclear for power generation and the country's relatively low population density. There is some uncertainty about the future of gas demand; its share is expected to increase in the power sector but to decline in the residential/commercial sector thanks to projected energy efficiency improvements. MEEDDM has developed indicative pluri-annual investment plans (PPI, see Chapter 2) which forecast future gas demand and indicate investment needs in the gas supply chain. However, contrary to the PPI for the electricity sector, the government does not issue tenders for new gas infrastructure projects. All investments will be carried out by market players.

The gas transmission system operated by GRTgaz, a 100% subsidiary of GDF Suez, covers 87% of the country. In the south-west, there is a separate network operated by Total Infrastructures Gaz France (TIGF, 100% subsidiary of Total). In 2004, there were eight balancing zones[8] in France; now there are three. The government is currently considering ways to further facilitate access to the French gas market, such as moving from three to two zones. Several interconnection points are currently saturated, hindering the development of an integrated European market and increased competition. Open seasons (or tenders) have been launched to develop interconnections with Germany, Belgium and Spain, in order to increase cross-border interconnection capacity.

DEMAND

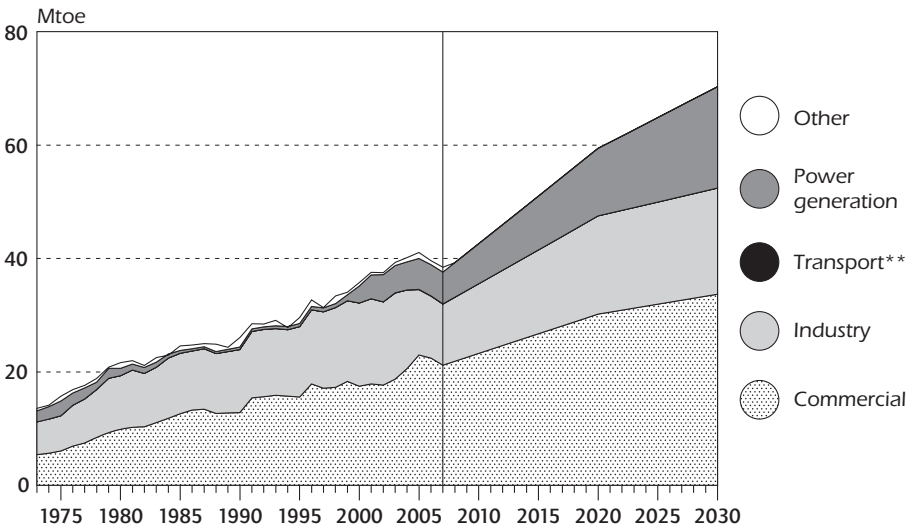
In 2008, natural gas accounted for nearly 15% of TPES, up from 12% in 1990 but still well below the IEA European average of 25%. In a base case scenario, the French government projects that the share of gas demand in the power sector will increase from less than 4% today to over 10% in 2020, with the building of new combined-cycle gas turbines (CCGTs) and new co-generation plants based on natural gas (see Chapter 7). Future gas demand in the residential sector, however, is uncertain and will depend on the evolution of the building stock and its competitiveness *vis-à-vis* electricity. If objectives laid

8. A balancing zone is a geographic gas transmission system zone within which gas injections and offtakes must be balanced.

out in the Grenelle laws are achieved, major gains will be made in energy efficiency improvements, and gas demand will decline over the next couple of decades in the residential sector. In the industry sector, gas demand will also depend on advancements in energy efficiency but also on the future price per tonne of CO_2, which will encourage producers to substitute gas for fuel oil and coal. The recent economic crisis has had a dampening effect on gas demand in the industry sector.

Figure 9

Natural Gas Supply by Sector*, 1973 to 2030



* total primary energy supply by consuming sector. Other includes other transformation and energy sector consumption. Industry includes non-energy use. Commercial includes residential, commercial, public services, agriculture/forestry, fishing and other final consumption.

** negligible.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009 and country submission.

SUPPLY

In 2008, France produced 0.9 billion cubic metres (bcm) of gas. Net imports were 44 bcm. The government forecasts that all domestic production will cease by 2013. More than 97% of gas is imported, mainly through long-term contracts (over 10 years), which represent 90% of supply. Table 6 summarises gas import sources. The four largest suppliers are Norway (32%), the Netherlands (18%), Algeria (16%) and Russia (15%). Natural gas supplies in France are more diversified than most other European countries. Egypt supplied its first LNG cargoes to France in 2005. Nigeria has also recently supplied LNG.

Table 6

Imports of Natural Gas

(bcm)

	2000	*2005*	*2006*	*2007*	*2008*
Pipeline					
Norway	12.99	11.50	13.61	14.19	15.19
Netherlands	5.14	8.08	8.91	8.35	8.57
Russia	12.37	9.72	7.52	6.12	6.96
Germany	–	–	–	–	–
LNG					
Algeria	10.45	7.96	7.56	8.04	7.80
Egypt	–	1.55	2.33	1.19	1.04
Nigeria	–	–	0.54	0.50	0.43
Qatar	–	–	–	0.30	0.43
Other	**0.72**	**3.38**	**1.02**	**1.39**	**1.94**
Short-term purchases	**1.94**	**3.82**	**2.69**	**2.54**	**3.57**
Swap	**–**	**3.77**	**3.85**	**2.74**	**2.06**
TOTAL	**43.62**	**49.79**	**48.04**	**45.34**	**47.98**

GAS SECTOR POLICIES

There have been many positive policy developments in the gas sector in France since the last in-depth review, including:

- the provisions of Directive 2003/55 were fully transposed;
- the gas market is fully open to competition since 1 July 2007 in compliance with EU rules;
- operators are subject to public service obligations;
- third-party access to storage has been established;
- a social tariff has been established for gas consumers in greatest need;
- a procedure for the provision of last resort has been established for public service institutions (*e.g.* hospitals and schools) whose supplier is defective;
- a pluri-annual indicative plan was developed by MEEDDM.

France has fully implemented the EU directive which expedites legal unbundling of the gas network transmission operator. There is now equal access to the gas market for all market players after the legal separation of GRTgaz and the strengthening of the powers of the Energy Regulatory Commission (CRE). However, like in the electricity sector, the dominance of the incumbent, GDF Suez, is still very strong. The coexistence of regulated tariffs and free market prices, and the government's control over access to storage present additional challenges (see below).

Imported gas enters/exits the French territory either via pipeline from Dunkerque (Franpipe), Taisnières, Obergailbach, Biriatou or at LNG regasification terminals in Fos-sur-Mer and Montoir (Figure 10). The gas is then transported under high pressure in two networks: the main network (which joins the boundary points with foreign operators and storage and provides transit to other countries), and the regional network (which delivers natural gas to distribution networks and the largest industrial consumers).

Currently there are three balancing zones in France: Northern GRTgaz, Southern GRTgaz and TIGF. In 2009, the north, east and west balancing zones were merged into the Northern zone. Any supplier must balance the volumes of gas entering and leaving each zone. In each balancing zone, virtual gas exchange points (*point d'échange de gaz*, PEG) have been in place since 2005. To facilitate trading and increase liquidity, Powernext has launched a new gas spot and futures exchange market in November 2009. The capsquare platform, in association with Fluxys TSO in Belgium, started in 2009 for trading in secondary capacity. Northern GRTgaz covers an annual consumption of 280 TWh and is mainly connected to the LNG terminals and major European hubs.

France is an important transit country for Norwegian gas destined for Spain and Italy. About 45 GWh of gas exits France to Spain daily and a further 125 GWh per day enters Italy. Norway has long-term contracts to supply 2.4 bcm of gas to Spain per year until 2030 and 3 bcm to Italy until 2026.

TIGF and ENAGAS, the Spanish grid operator, initiated the first co-ordinated sales procedure of gas transportation capacity between Spain and France in 2008. Similarly, TIGF and GRTgaz agreed a co-ordinated sales process so that shippers have simplified access to a single, combined offering of GRTgaz and TIGF capacity. The two transmission system operators have organised an "Open Subscription Period" during which shippers could submit their requests for interconnection capacity either to GRTgaz or TIGF.

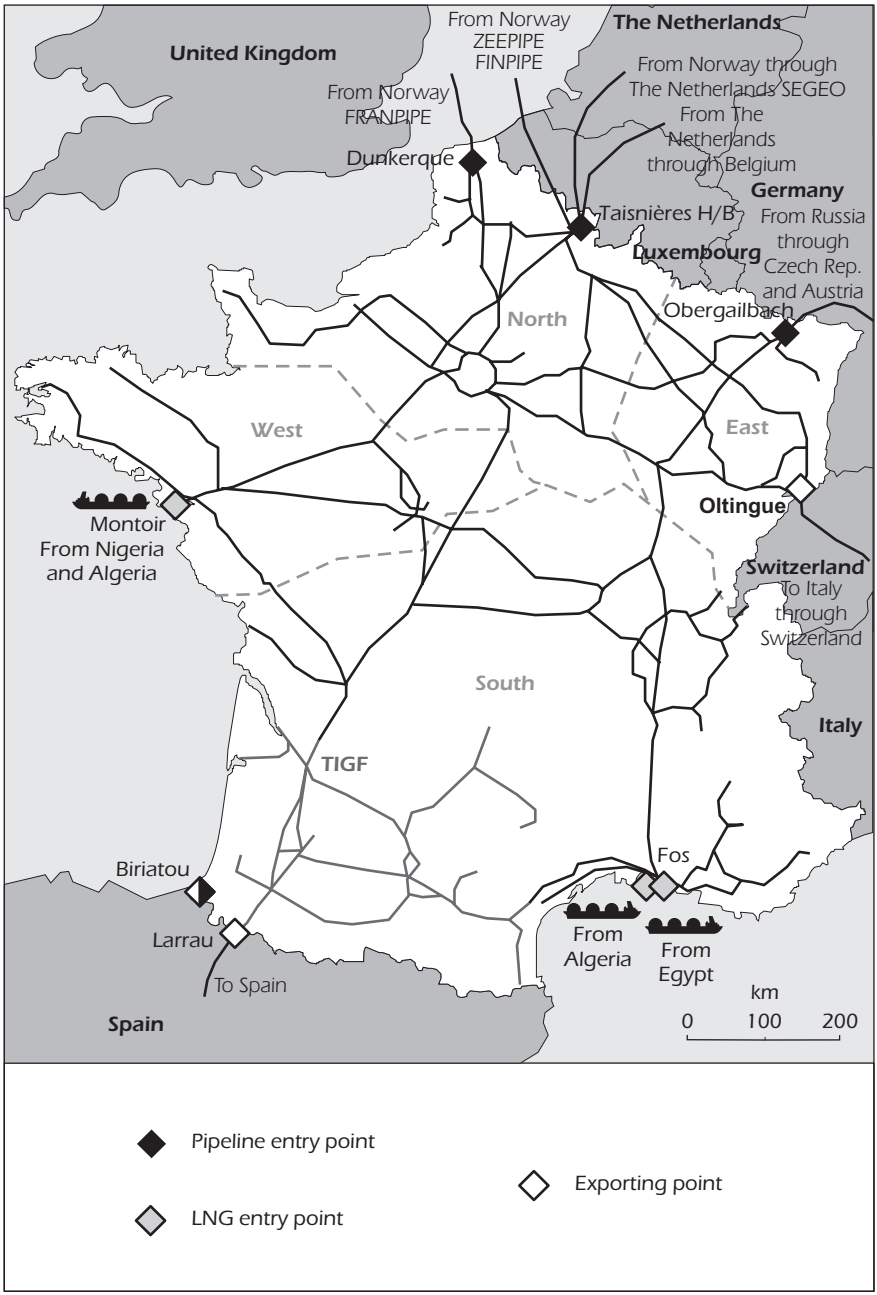
In 2008, import capacity was 2 387 GWh per day, 76% from pipeline and 24% from LNG terminals.

For the period 2009-2011 various investments have already been approved. They will increase import capacity by 21% or 510 GWh per day. They correspond to the entry into service of terminal Fos-Cavaou, the development of interconnections between Spain and France and the expansion of capacity at Obergailbach. Other longer-term developments are expected to increase capacity by more than 50% between 2012 and 2017.

The development of new supply infrastructure (pipelines and LNG terminals) and expanded interconnections with Spain and Italy are likely to affect transit flows in the future. The current direction of transit flows, north to south, could thus be reversed. There was a recent tender to develop gas interconnections

Figure 10

Natural Gas Transmission System with Entry/Exit Points



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Source : *Commission de Régulation de l'Energie* Activity Report.

between France and Spain from 2013 which ended on 30 October 2009. The capacity through Larrau (Pyrénées-Atlantiques) will be increased to 5.5 bcm per year and will eventually allow reverse flows of gas from Spain to France, thus enhancing security of supply in the European Union. The expansion of the interconnection point at Biriatou (Basque Country) was not conclusive and additional capacities of approximately 2 bcm per year have not yet been approved. There will be a second call to market in 2010. An open season for the MidCat project, an eastern link between France and Spain, is planned for 2010, with capacities expected to be available in 2015.

The CRE has compared the volumes traded on the platform of brokers with volumes delivered to the gas exchange point and found that, in 2007, most transactions on the French wholesale gas market were bilateral agreements without intermediaries. In 2007, seasonal and monthly revenue accounted for more than 60% of volumes traded. Day-ahead volumes accounted for almost 15% and annual revenues for less than 10%.

INDUSTRY STRUCTURE

Transmission

GRTgaz operates, maintains and develops about 87% of the gas transmission grid in France. Since 1 January 2009, GRTgaz has been directly responsible for its gas supply acquisition, a function previously centralised within GDF Suez. GRTgaz is a limited company, a wholly-owned subsidiary of the GDF Suez Group resulting from the merger between Gaz de France and Suez, in which the State holds a 35.6% stake. GDF Suez is vertically integrated and a dominant player in the French gas market. The GDF Suez Group has the largest gas transport network in Europe which is managed by specialised subsidiaries in France, Belgium, Germany and Austria.

Total Infrastructures Gaz France (TIGF) operates the gas grid in the south-west region of France and gas storage facilities. TIGF, with about 13% of the network, is the second gas transmission operator. TIGF is a wholly-owned subsidiary of the Total Group, the result of merging transmission business activities with the storage business activities of the Total Group.

The networks of the two operators are interconnected in Castillon-la-Bataille (Dordogne) and Cruzy (Hérault).

GRTgaz sells transmission services on its system in the form of unrestricted access to entry/exit zones. From 1 January 2009, GRTgaz revamped its service to offer: a reduction in the number of entry/exit zones from four to two; a single link between GRTgaz's north and south zones; a single link between GRTgaz's south zone and TIGF, with joint sale of capacity. These changes were a very positive development for new entrants and for trading as they simplified access to the system for shippers and consumers and increased the potential for diversification of gas supply sources.

Table 7

French Gas Transport Network in 2008

	Total	*GRTgaz*	*TIGF*
Main network	7 200 km	6 600 km	600 km
Regional network	28 800 km	24 500 km	4 300 km
Interconnections			
in 2008	7 + 2 LNG terminals	5 + 2 terminals	2
in 2009	7 + 3 LNG terminals	5 + 3 terminals	2
Balancing zones			
in 2008	5	4	1
in 2009	3	2	1

Source: MEEDDM.

GRTgaz is responsible for network development planning. Investment decisions taken for the period 2009-2011 include a 21% increase in import capacity from the completion of the LNG terminal in Fos-Cavaou, development of interconnections between Spain and France as well as additional capacity at Obergailbach. Its most recent Ten-year Development Statement (2009–2018) envisages GRTgaz laying almost 1 600 km of additional large-diameter pipelines and building or upgrading more than 20 compressor and/or interconnection stations.

TIGF has drawn up an indicative development plan for the network for 2008–2017. TIGF will focus on developing the west corridor for the five years 2008 to 2013, to provide reversibility of flows between France and Spain. This includes works on: the LACAL pipeline (Lacq–Calahorra), the Béarn Pipeline Artery (Lussagnet–Lacq), increased capacity on the Guyenne Pipeline Artery and on the EUSKADOUR pipeline (Coudure–Arcangues). This pipeline corridor will, for the next few years, increase gas exchanges between northern Spain and southern France and enhance integration of these two markets.

New fees for network use of natural gas transmission came into force on 1 January 2009 and are defined in the Decree of 6 October 2008. The new fees retain the basic principles of the existing tariff structure: pricing based on capacity purchased, type of entry/exit to the main network and the distance on the regional network. The main changes include the reduction in the number of balancing zones (5 to 3), enlargement of the tariff period to give visibility to operators and suppliers. These changes result in increased costs of transport, mainly justified by three factors:

- the significant investment programmes undertaken by operators to expand their network;
- the operating expenses related to building safety standards and environmental protection;
- higher gas prices.

Distribution

Distribution networks are owned by local communities. The length of the networks in France totals 193 700 km, the second-longest network after Germany's. They are exploited through concession agreements linking local authorities to GrDF (subsidiary of GDF Suez), the 22 local distribution companies (located in the south-west and the east mainly) and Antargaz (newly certified, which operates the distribution network in the town of Schweighouse).

Table 8

Distribution Networks

	Distribution (km)
GrDF	186 000
Local distribution companies	7 700
Total	**193 700**

Source: MEEDDM.

Storage

There are two storage managers operating underground storage facilities in France (Figure 11):

- Storengy, a subsidiary of GDF Suez created in early 2009, operates a fleet of 12 sites in France, including nine in aquifers (in the Paris basin) and three in salt caverns (in the south-east), representing a total volume of 108.9 TWh (80% of capacity);
- TIGF operates two sites in aquifers in the south-west: Izaute and Lussagnet, representing a total volume of 27.9 TWh (20% of capacity).

Decree No. 2006-1034 dated 21 August 2006 laid out the principles for natural gas storage access and use. It also assigned access rights to storage capacity providers who supply to final customers. The amended order of 7 February 2007 determined the amount of storage rights associated with each customer on the basis of the characteristics of its consumption.

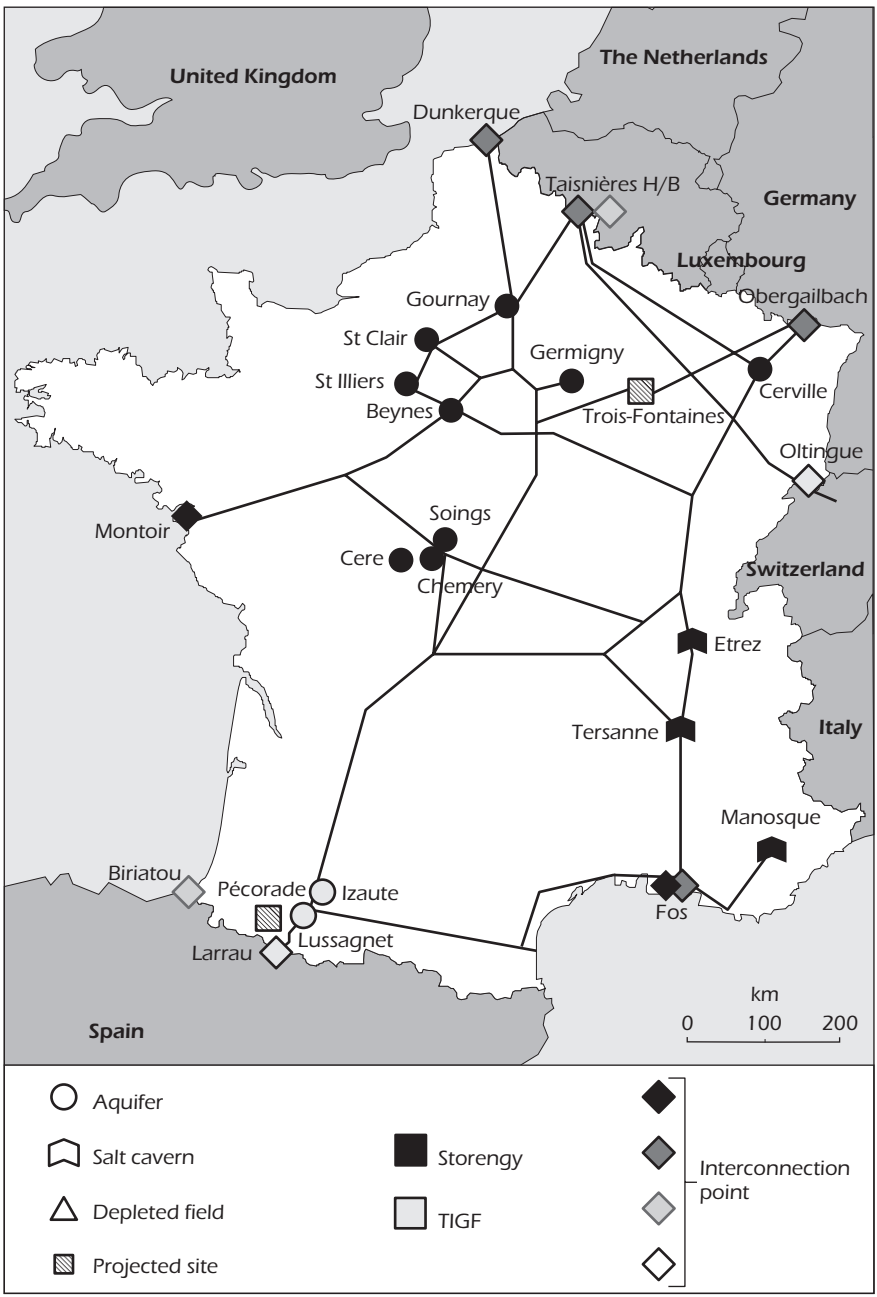
Most of the storage facilities are in aquifers which are more suited to meet seasonal variation. The salt cavern facilities are located in the south-west. As natural gas-fired generation expands, more flexibility will be required to meet potential variable demand and this will pose a challenge for the current storage infrastructure in France.

There are two plans to expand existing storage sites and four plans for new sites. Expansions are:

- extension of storage capacity by TIGF at Lussagnet of 2.4 bcm to 3.5 bcm by the decree of 9 April 2008;

Figure 11

Gas Storage



The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

Source: *Commission de Régulation de l'Energie* Activity Report.

- extension of storage and saline aquifers by Storengy which will add capacity of some 1.4 bcm in 2018, about 30% on sites and 70% in saline aquifers.

Planned storage sites are:

- *Pécorade:* the site is a source of hydrocarbons (oil), which could provide a capacity of 8 TWh (some 740 million cubic metres). The withdrawal of this advanced project, estimated at 70 GWh/day, would be relatively limited. TIGF now considers this project to be expensive and difficult. If an investment decision is taken, the project is not expected to be completed for about six years.
- *L'Abbaye Trois Fontaines:* this site is located near Saint-Dizier, Haute-Marne, occupying a former natural gas field and eventually providing about 80 mcm storage. The extraction peak will be relatively small (some 6 GWh/day). Work on this site began in 2008 and its planned commissioning date is 2010.
- *Hauterives:* this site will be in salt caverns near Tersanne. Initially, two cavities are being developed for about 150 mcm in 2017. The possibility of creating additional cavities is being studied. The commissioning of surface facilities for the holding of the first cavity is expected in 2012.
- *Southern Alsace:* Storengy is currently conducting a project on a salt cavern storage site in Alsace. This project is currently facing a public inquiry for the mining concession. It represents an additional volume of 160 mcm, for a maturity date after 2017.

Liquefied natural gas

Two LNG terminals are currently operating in France at Fos-Tonkin and Montoir de Bretagne (Table 9).[9] Both are owned by Elengy, a subsidiary of GDF Suez created in early 2009.

Table 9

Regasification Capacity

	Capacity	*Put in service*	*End of life (or renovation)*	*LNG source*
Fos-Tonkin	5.5 bcm per year (7 bcm per year until 2009)	1972	end 2014	Algeria Egypt
Montoir de Bretagne	10 bcm per year	1980	end 2035	Algeria Nigeria

Source: MEEDDM.

9. Fos-Cavaou started operating in 2009, but at only 20% of its nameplate capacity.

A third terminal, Fos-Cavaou, is under construction at Fos-sur-Mer and its services will be commercialised by the Société du Terminal méthanier de Fos-Cavaou, although it will be operated by Elengy. The terminal can handle vessels up to 210 000 m^3 and will have a regasification capacity of 8.25 bcm per year. The first test cargo at the Fos-Cavaou terminal was received in October 2009 after obtaining permission from local authorities to operate the new facility at 20% of nameplate capacity. GDF Suez is in discussion with the local Préfet over full operation rights, and the company is aiming to start commercial operation in 2010.

The development of a competitive gas market requires that all market players have access, under transparent and non discriminatory rules. Third-party access to LNG terminals is guaranteed by the law of 3 January 2003. However, the utilisation rate of French terminals (close to 80%) is very high and almost all capacity is already booked. The regulator, CRE, has asked operators to publish on their websites the information relating to maximum capacity, available firm capacities and interruptible flows recorded daily. The regulator has also asked operators to produce a general note describing the methodology of calculation of the maximum capacity and to supply details of the methodology and calculations leading to these results. Finally, the regulator has asked the operators to update the schedule on a monthly basis. In mid-2009, CRE decided to change the terminal access tariffs, and the new tariffs have been applied since January 2010.[10]

The construction of new terminals is open to any player. Three proposed new LNG terminals are under consideration with a final investment decision expected in 2010 and a start-up date of 2013:[11]

- *Dunkerque:* this project is supported by EDF and the Port of Dunkerque and represents an annual shipping capacity from 10 bcm to 13 bcm;
- *Le Havre-Antifer:* this project is supported by Gaz de Normandie created by POWEO (73%) and Compagnie Industrielle Maritime (CIM, 27%). It represents an annual shipping capacity of 9 bcm of natural gas;
- *Fos-sur-Mer:* this project is being undertaken by Shell and Vopack. Expected capacity is 8 bcm per year and it is projected to start operation in 2015. A public debate will be held in 2010 on this project.

There are also opportunities to expand capacity at existing terminals. At Montoir, two scenarios are envisaged. The first is to build additional regasification units, which would increase capacity to 2.5 bcm per year. The second would increase capacity to 16.5 bcm per year by adding a fourth

10. See Note_technique_Terminaux_methaniers_Elengy_en.pdf, on CRE website.
11. A project to build a fourth terminal at Verdon has been abandoned.

tank. After an open season held in 2007/08, GDF Suez determined that demand was insufficient to carry out this expansion, but it has not ruled out the possibility of expanding it in the future. At Fos-Cavaou, opportunities for expansion would achieve a doubling of capacity. Finally, at the terminal Fos-Tonkin, activity could be extended beyond 2014 to maintain capacity at 5.5 bcm per year (replacement of two small reservoirs with a medium one) or to expand capacity back to 7 bcm per year. In mid-January 2010, CRE launched a market consultation to study these different options.

MARKET REFORM

Wholesale market

The existence of a dominant player in the supply of gas, GDF Suez (36.5% owned by the State), and the strong vertical integration between upstream activities and supply constrains the ability for other market players to supply to the French natural gas wholesale market. Over 75% of GDF Suez's natural gas needs are covered over the next ten years by secure supplies, including more than 20% of long-term LNG contracts.

The French wholesale market is dominated by transactions on a bilateral basis. Volumes traded on the French market through intermediaries, although limited in terms of the size of the physical market, increased significantly in 2007 (latest data available). The Energy Regulatory Commission reported, however, that volumes of gas traded on the intermediated market remained well below 10% of total gas consumption. About 70% of transactions have involved spot intraday and day-ahead trading. By volume, seasonal and monthly products together accounted for more than 60% of volumes traded. Almost all of the activity (80% of transactions, 89% volume) focused on the Northern GRTGaz balancing zone.

The merger on 1 January 2009 of three balancing zones (east, north and west zones), accompanied by the maintenance of firm entry capacity in the future large north area, led to a significant improvement in market functioning. It is expected to enhance competition in suppliers and build up liquidity to encourage new entrants to the French gas market. Moreover, the "Gas Platform" initiative is an intergovernmental policy (Germany–Benelux-France) that aims to create a regional market in the North-West, as an intermediate step towards a single European gas market.

Retail market and prices

France opted for a gradual market opening in the gas sector:

- 20% of market opened in August 2000 (600 sites >237 GWh/year);
- 37% of market opened in August 2003 (1 200 sites >83 GWh/year);

- 70% of market opened in July 2004 (640 000 professional sites);
- 100% of the market opened on 1 July 2007 (about 11 million domestic customers).

Since 1 February 2009, 88 suppliers are allowed to supply natural gas in France, including 64 new entrant suppliers. At the national level, new providers are allowed to supply residential consumers and small businesses (*i.e.* Altergaz, Direct Energy, Electricité de Strasbourg, Gaz de Bordeaux, EDF, E.ON, and Enerest POWEO). One of the largest new providers is EDF.

New providers represent 18.3% of demand in the non-residential sector but only 4.1% of demand in the residential sector (Table 10).

Table 10

Distribution of Retail Natural Gas Sites by Number and Volume

	Residential		*Non-residential*	
	As of 30 September 2009	*As of 30 June 2009*	*As of 30 September 2009*	*As of 30 June 2009*
Number of sites	10 700 000	10 800 000	680 000	680 000
– Market	*1 153 000*	*1 118 000*	*232 000*	*226 000*
– Alternative suppliers	*615 000*	*586 000*	*108 000*	*105 000*
Share of market covered by alternative suppliers (%)	5.7	5.4	15.9	15.4
Annual consumption (TWh)	139	139	355	355
– Market (TWh)	*13.1*	*12.1*	*209*	*207*
– Alternative suppliers (TWh)	*5.6*	*5.1*	*65*	*64*
Share of market covered by alternative suppliers (%)	4.1	3.7	18.3	17.9

Source: CRE.

A new social tariff was introduced by the Act of 7 December 2006 which amended the law of 3 January 2003. The decrees implementing the law were published on 14 August 2008:

- Decree No. 2008-778 of 13 August 2008 on the supply of natural gas at a special rate of solidarity;
- Decree No. 2008-779 of 13 August 2008 on compensation for public service expenses for the supply of natural gas at special price of solidarity.

Regulated tariffs relate to subscription customers at about 1 500 industrial sites. They are offered by GDF Suez, the company TEGAZ (subsidiary of Total) and four local distribution companies: Enerest (Strasbourg), Gaz de Bordeaux, Grenoble and Vialis (Colmar, Alsace). Administered tariffs relate to individual customers and small businesses at about 11 million sites. These rates are offered by GDF Suez and 22 local distribution companies. In the context of open markets for natural gas, when a consumer chooses to change supplier, he must forgo the regulated tariff. However, it is possible for domestic consumers to return to regulated tariffs until 1 July 2010 under these conditions:

- domestic consumers of natural gas settled on a site for which the previous occupant exercised eligibility can claim the benefit of a return to regulated tariffs;
- all new sites for domestic customers can be supplied at regulated tariffs if they are connected before 1 July 2010.

For infrastructure access, the regulated tariff is set by the Ministries of Energy and the Economy, Finance and Employment on the basis of proposals put forward by the regulator. The tariff structure proposed by the regulator reflects the revenue required by the transmission operator to cover its operating and investment costs.[12]

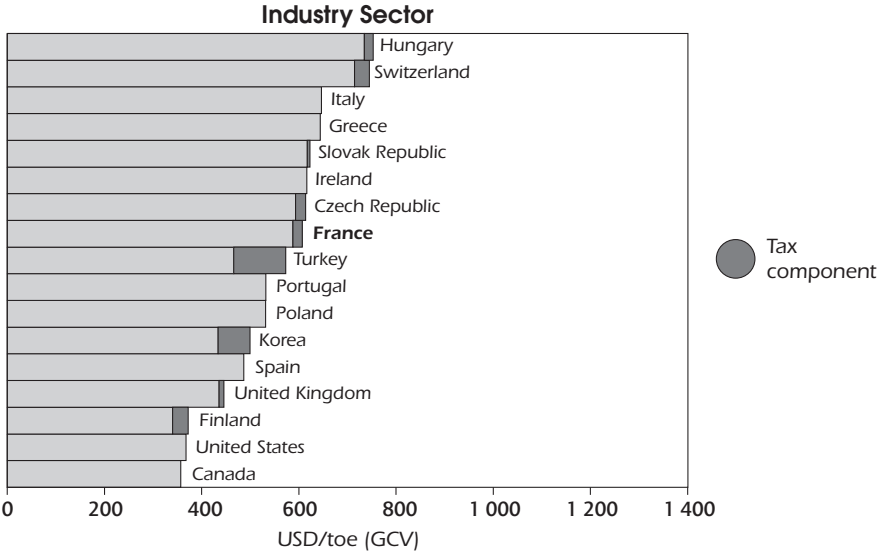
For final consumption, there are two types of administered prices: the public distribution rates for individual customers and small businesses (those consuming less than 4 GWh/year) and a subscription rate for industrial customers (consuming more than 4 GWh/year). Market rates for natural gas are set freely by the supplier. At the end of 2009, the French government changed the rules to set these tariffs. By the decree of 18 December 2009, every supplier has to set a formula, representing its full costs, which is controlled by the regulator and the ministries. After obtaining the agreement, the supplier is free to change its tariffs, according to the formula, during the year. The implementation of the formula will be controlled annually.

Gas prices for households and industry in France fall in the middle of the range on IEA countries (Figure 12).

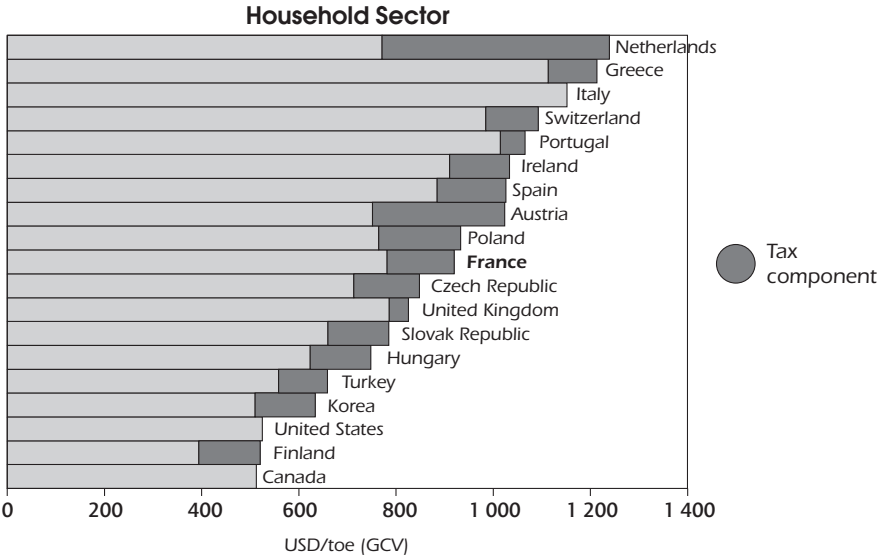
12. A new method of setting regulated gas prices for households was established in a public service contract agreed between the government and GDF Suez in December 2009. Price changes will now be introduced after consultation with CRE and not by decree.

Figure 12

Gas Prices in IEA Member Countries, 2008



Note: Tax information not available for the United States. Data not available for Australia, Austria, Belgium, Denmark, Germany, Japan, Luxembourg, the Netherlands, New Zealand, Norway and Sweden.



Note: Tax information not available for the United States. Data not available for Australia, Belgium, Denmark, Germany, Japan, Luxembourg, New Zealand, Norway and Sweden.

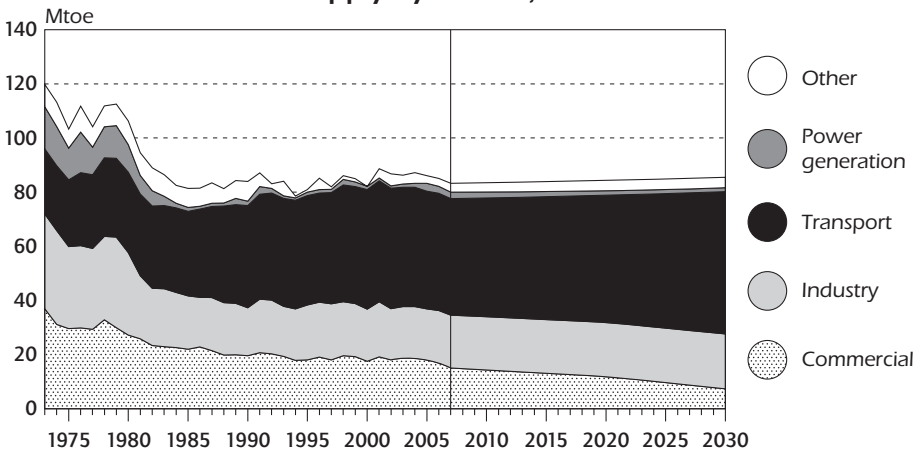
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2009.

DEMAND

Primary oil and oil product supply in France was 83.25 Mtoe in 2007 (Figure 13). Demand has been relatively stable since the 1990s, although its share in TPES has declined by about six percentage points over the same period. Oil use for power generation is minimal and accounts for only 1.1% of total electricity generation. Final demand for oil represents some 93% of oil TPES. The transport sector accounts for over half of final oil demand.

Figure 13

Oil Supply by Sector*, 1973 to 2030



*total primary energy supply by consuming sector. Other includes other transformation and energy sector consumption. Industry includes non-energy use. Commercial includes residential, commercial, public services, agriculture/forestry, fishing and other final consumption.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009 and country submission.

Oil demand in the industry sector, mainly in the petrochemical and non-metallic mineral industries, has remained relatively stable over the past decade. The French government forecasts that oil demand will decline in the industry sector along with the introduction of policies to further reduce CO_2 emissions. The share of oil in total demand in the residential and commercial sectors is currently about 20%, compared with 33% in 1990. In the 1980s, heating oil accounted for almost 40% of total consumption for heating, but it is about 22% today. The rise in the use of electricity and gas for heating has been the main driver behind this trend.

Road transport accounts for 96% of total transport oil demand, although this share has declined slightly recently with government policies that have encouraged rail, *e.g.* expanded high-speed rail (TGV) services. Oil demand for air and sea travel is expected to increase in the future. In 2007, 9.86 Mt of

gasoline and 32.96 Mt of diesel were consumed in France. On 1 January 2008 the French fleet was composed of 37.1 million vehicles, of which 21.4 million (58%) were diesel. In 2007, 73.9% of new registrations were diesel vehicles, while in 2008 the share rose to 77.3%.

TRADE

In 2008, oil production in France was 0.97 million tonnes as in 2007. Oil production peaked in 1988 at 3.73 Mt (70 000 b/d). To meet domestic demand requirements, France imports annually more than 80 Mt of crude oil. France's oil import dependence is 99%.

Table 11

Oil and Oil Products Imports by Source

(Mt)

	1995	*2000*	*2005*	*2006*	*2007*	*2008*	*Share (%)*
Middle East	34.8	31.6	22.4	22.7	20.5	18.4	22.12
North Africa	5.1	6.3	10.2	7.9	8.1	11.2	13.4
Africa (other)	8.3	7.6	8.9	9.5	10.0	13.1	15.7
North Sea *	23.2	31.9	22.2	20.3	17.7	16.4	19.7
Former USSR	6.3	8.0	19.6	20.0	23.8	23.8	28.6
Other	0.4	0.3	0.9	1.5	0.9	0.4	0.4
Total	**78.0**	**85.6**	**84.2**	**82.0**	**81.2**	**83.2**	**100.0**
Of which OPEC	*42.0*	*39.9*	*34.0*	*34.2*	*28.7*	*31.9*	*38.4*
OPEC excluding Iraq	*42.0*	*32.6*	*32.5*	*30.7*	*25.8*	*28.0*	*34.8*
Principal suppliers							
Norway	13.6	21.1	16.1	13.4	12.5	12.7	15.2
Russia	6.1	5.0	9.6	9.8	10.6	11.8	14.2
Kazakhstan	–	2.2	8.6	8.1	9.4	9.2	11.0
Saudi Arabia	20.4	15.2	10.3	8.7	6.9	7.5	9.0
Iran	10.5	5.2	6.9	6.7	6.6	4.5	5.4
Libya	1.7	2.4	4.5	4.2	5.2	6.8	8.2
Angola	0.7	1.9	4.2	3.2	4.9	5.7	6.8
United Kingdom	9.3	9.9	4.4	6.5	4.8	3.1	3.7
Azerbaidjan	–	0.6	1.4	2.2	3.8	2.9	3.5
Iraq	–	7.2	1.4	3.5	3.0	2.9	3.5
Nigeria	5.7	4.8	2.8	4.0	2.2	4.4	5.3
Algeria	2.6	3.5	5.4	3.5	2.1	3.7	4.5

* United Kingdom. Norway. the Netherlands and Denmark.

Source: MEEDDM.

Supply sources are almost equally divided among four regions: the countries of the former USSR (29%), the Middle East (22%), Africa (25%) and the North Sea (20%). The main import countries are Norway (15.2%), Russia (14.2%), Kazakhstan (11.0%), Saudi Arabia (9.0%) and Libya (8.2%). The shares of the Middle East and the North Sea have been declining while those

of Africa, mainly Libya, Nigeria and Angola, and the countries of the former Soviet Union have been increasing.

REFINERY SECTOR

France has 13 refineries. Total operates seven of them. ExxonMobil and Petroplus each operate two. Total distillation unit capacity is 53 Mt per year. Trade in refined products is significant in France because the refineries produce more gasoline than domestic demand and because the French market is skewed to diesel. France exports a large portion of its gasoline to the United States, representing a surplus of production of over 24% in 2008, and imports large quantities of diesel. Recent high oil prices and the global economic recession have decreased demand in the United States and lowered exports. In addition to the diesel/petrol mix, French refineries also produce greater quantities of fuel oil for international marine bunkers and heating oil than are needed domestically. Net imports of gas oil, mostly from Russia, accounted for 35% of consumption in 2008.

These product imbalances have become increasingly worrying for the French refining industry. Despite new investment and operating at maximum capacity, refineries in France have not been able to bridge the gap between production and demand for diesel fuel, or to reduce the gap between production and demand for premium grade gasoline.

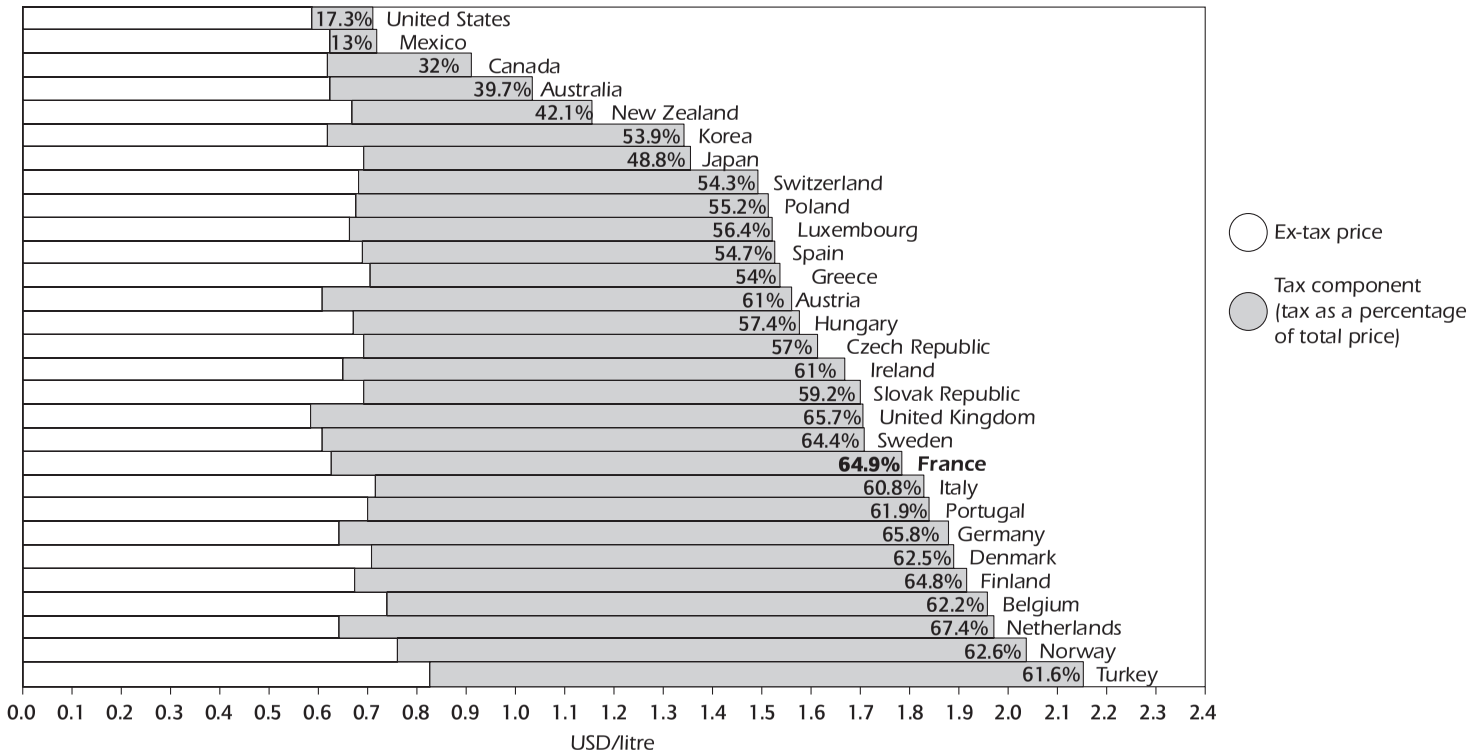
RETAIL MARKET AND TAXES

France has an extensive pipeline network for inland refined product transportation. The French motor fuel retail market is highly competitive, with the supermarket/hypermarket segment having a market share of almost 60%. This situation results in a very low retail margin.

The excise duties on motor fuels have not been modified since the last in-depth review in 2004. Current automotive diesel taxes put France in the lower half of the range of OECD countries, while taxes on unleaded gasoline puts France in the upper half (Figures 14 and 15). The tax difference between gasoline and diesel in France is EUR cents 17.8 per litre. This differential gives a clear preference to the purchase of diesel vehicles. The bonus-malus scheme also favours diesel vehicles as it focuses solely on CO_2 emissions, which are lower from diesel engines. The preferential tax rate for diesel creates a supply and demand imbalance for refiners. But an even more important concern is the impact on local emissions of the dieselisation of the French car park. The government should carry out a comprehensive study of the impact of the tax differential on CO_2 and local emissions, and of the impact on industry, and should design policies and measures that minimise environmental and economic costs.

Figure 14

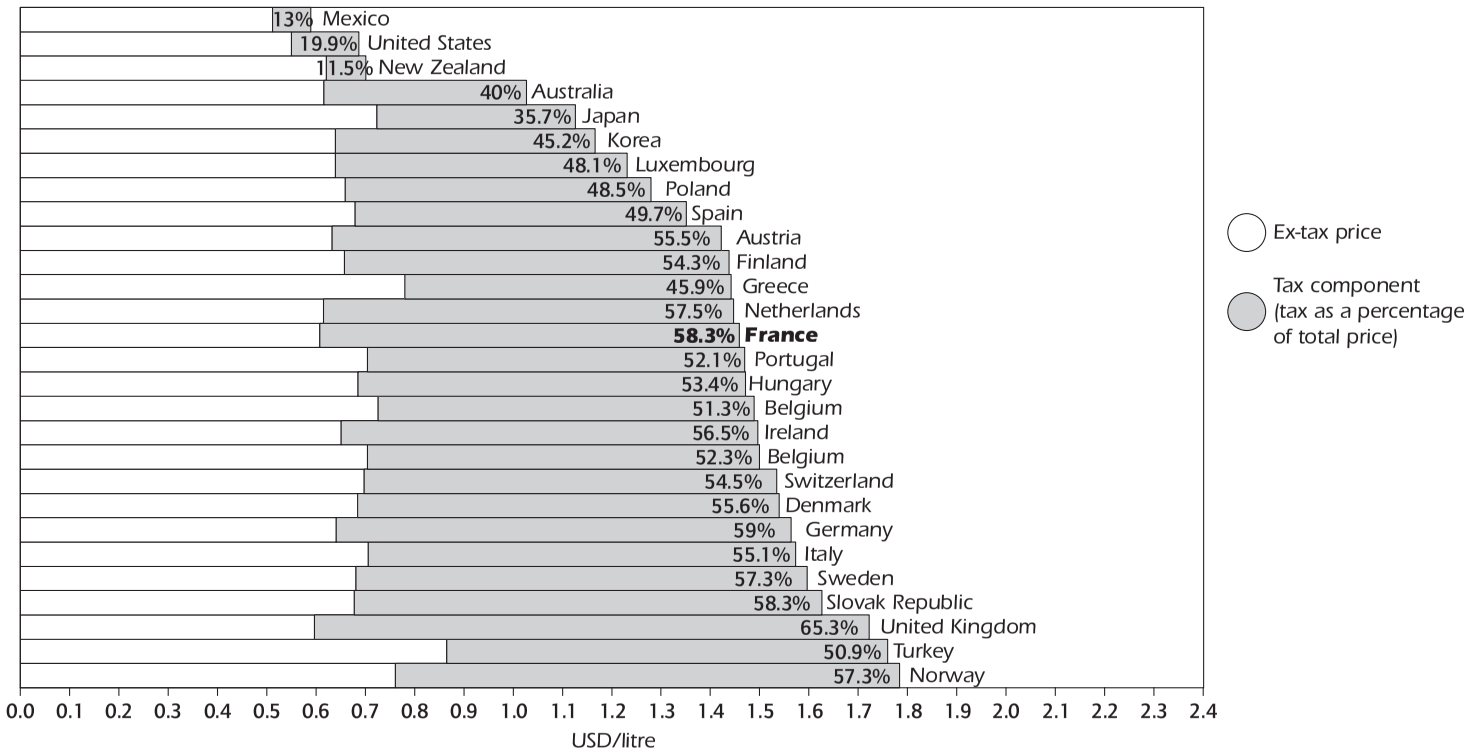
OECD Unleaded Gasoline Prices and Taxes, Third Quarter 2009



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2009.

Figure 15

OECD Automotive Diesel Prices and Taxes, Third Quarter 2009



Note: data not available for Canada.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2009.

Emergency response policy for hydrocarbon supply is under the responsibility of the Directorate-General for Energy and Climate (DGEC), which is part of MEEDDM. The Directorate for Energy (DE), within the DGEC, is responsible for supply security, including the monitoring of strategic stocks, management of supply crises and co-ordinating with the IEA.

The use of emergency oil reserves is France's primary response measure in an oil supply disruption. France places a minimum stockholding obligation on industry operators and requires that a significant part of this obligation be delegated to its public stockholding agency, CPSSP/SAGESS. As the product mix of emergency reserves reflects domestic demand patterns, it consists mainly of gas/diesel oil. At the end of 2008, agency-held stocks represented 60 days of net imports, while overall coverage in France stood at 99 days.

The Administration has considerable leeway in how it may implement an emergency stock-draw. As with the 2005 IEA collective action following Hurricane Katrina, oil operators can be given the ability to draw on stocks below the minimum levels they are normally required to cover directly, giving them greater flexibility in responding to market needs. Alternatively, the Administration may choose to release specific products from agency stocks depending on the particular crisis.

Industry stockholding obligation

Compliance with minimum stockholding obligations of both the EU and the IEA is met by placing an obligation on all industry operators to cover 27% of oil deliveries to the domestic market. The stockholding requirement covers four product categories: motor gasoline, gas/diesel oil, kerosene jet fuel, and fuel oil. Companies are able to substitute the product obligation with crude oil, as EU legislation allows. No financial assistance or public funding is provided to industry in order to maintain emergency reserve requirements.

In meeting the 27% stockholding requirement, industry operators are obliged to hold a portion of the oil through a central stockholding agency, CPSSP/SAGESS. They may choose to delegate either 56% or 90% of their stockholding commitment to the agency. In such a way, these companies are obliged to be directly responsible for either 44% or 10% of their strategic reserve obligation. Typically, industry participants such as hypermarkets (which have an obligation since they sell vehicle fuels) choose to delegate the maximum amount possible to the agency, and can meet their remaining obligation through the use of tickets. Operators such as refiners typically choose the option of holding 44% of their obligation, and are able to commingle this amount with their operational stocks.

Structure of French stockholding companies

The Professional Committee for Strategic Petroleum Stocks (CPSSP) oversees the stockholding strategy. It is managed by a board of directors composed of six refiners, four other oil industry operators, and representatives from four government agencies, including the Directorate for Energy (DGEC-DE), with the right of veto. Each year the agency calculates the obligation of the individual operators, incorporating the previous year's consumption, and the fees necessary for building and maintaining the designated stock levels. The new obligation level becomes effective as of 1 July 2010. Industry participants must pay CPSSP a fee to cover the storage costs of the oil delegated to the agency, with a slightly higher rate per tonne for the 90% option.

SAGESS (*Société anonyme de gestion des stocks de sécurité*) is a privately owned and managed entity with the function of holding and maintaining emergency reserves under the direction of CPSSP. It was created by the main market participants (Total, Shell and BP) in order to find efficiencies in meeting the stockholding obligation. SAGESS provides the technical role of managing the publicly held reserves in France, such as monitoring the depots eligible for strategic stockholding, managing product stock turnover and organising the rental of additional storage capacity from domestic industry participants.

Oil storage capacity

All storage capacity in France is owned by industry, and is located primarily at the refineries and close to the main oil ports. Stocks held to meet the emergency reserve obligation must be stored in depots approved by government through CIDH (an inter-ministerial committee). However, there is no obligation to have these separated from commercial stocks. In order to maintain a wide geographical cover of emergency reserves, CPSSP/SAGESS holds gasoline and middle distillates reserves in each of the seven defence zones that comprise the French territory. Reserves in each zone contain enough stock to cover no less than 10 days of gasoline consumption and 15 days of middle distillates consumption.

The Manosque site in the south-east of France provides underground storage capacity of up to 37.7 million barrels (6 mcm) in salt caverns for crude and finished products. This storage site was developed for strategic reserves following a 2003 study on stockholding strategy by CPSSP/SAGESS. The potential technical capacity of the salt domes at Manosque is close to 63 mb (10 mcm), thus providing the possibility for future expansion. The storage is connected by pipeline to the Fos-sur-Mer oil-processing hub, with a capacity of some 300 thousand barrels/day.

COAL

In 2008, primary coal and coal products demand was 12.9 Mtoe, or 4.8% of TPES. This percentage share has declined in France, from 16.2% in 1973 and 9% in 1990. Net imports of coal have been relatively stable (between 7 and

15 Mt) since 1973, but domestic production ceased entirely with the closure of the La Houve mine in April 2004, after 250 years of operation. Production is now limited to recovered products (277 kilotonnes in 2008). French coal policy has not undergone major changes since the cessation of coal mining.

Société des ressources minières du Massif Central (SRMMC), a subsidiary of the UK-based ATH Resources plc, has rights over a series of six existing coal concessions in south-central France, covering an area of 36 km^2 with an estimated resource of approximately 4.5 million tonnes of recoverable coal. Other private developers have proposed new opencast coal mining projects in the Massif Central region. Separately, the *Société d'exploitation des ressources énergétique du Nivernais* (SEREN) has sought a concession and mining licence at Cossaya-Lucenay to mine coal for a proposed 1 000 MW power plant. To date, none of these projects have secured the necessary approvals to proceed.

Coal imports are well diversified. Most of this coal is delivered to ports along the coasts of France, thus ensuring flexibility in supply (Figure 16). A new coal import terminal has been proposed at Cherbourg. Annual consumption is some 20 million tonnes, mainly for power generation (51%) and industrial use, notably in the iron and steel sector (35%). Electricity generators and the steel industry are exempted from the coal tax, introduced on 1 July 2007 in compliance with the European Directive on Energy Taxation. France keeps coal stocks of around seven million tonnes.

Table 12

Coal Imports by Source, 1995 to 2008

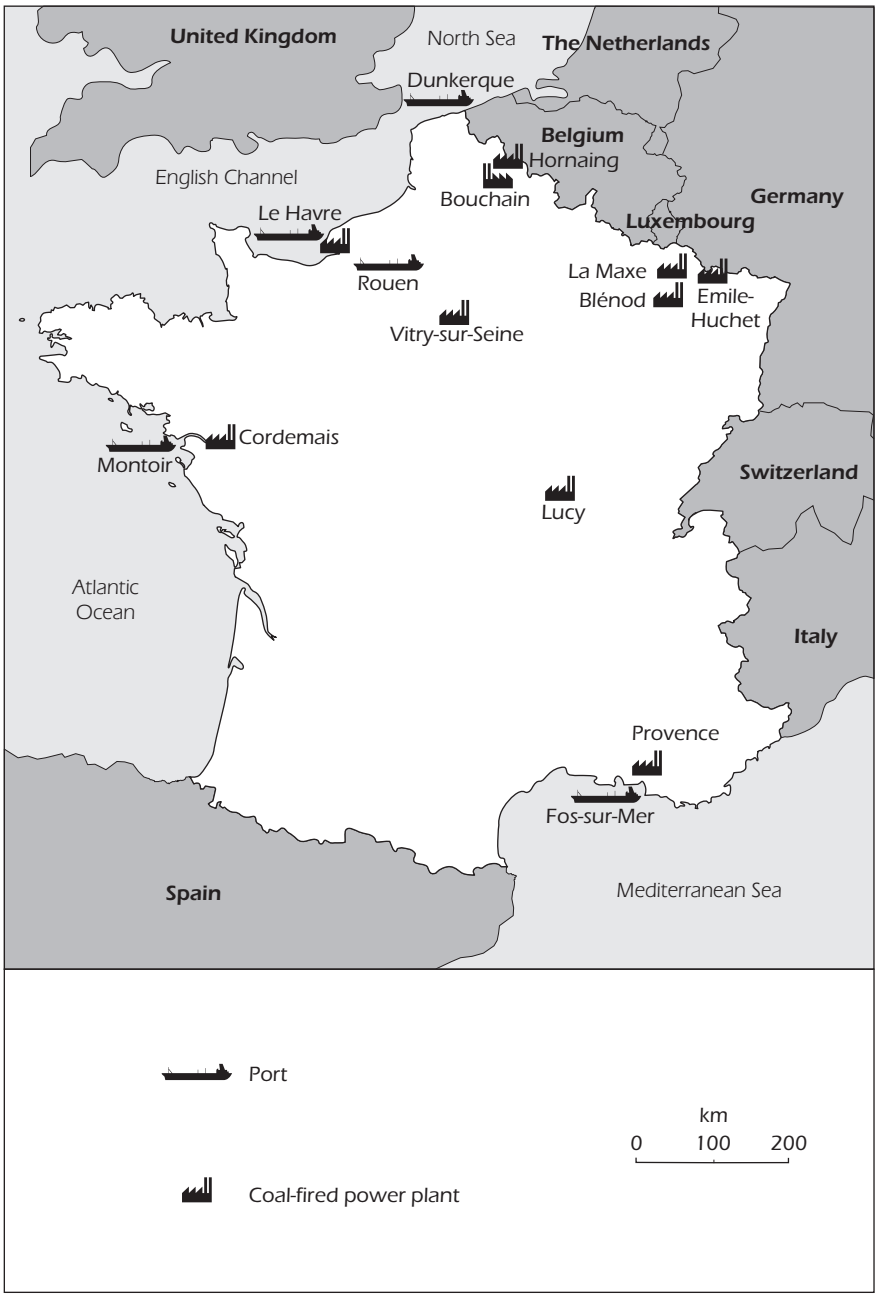
(million tonnes)

	1995	*2000*	*2005*	*2006*	*2007*	*2008*	*Share in 2008 (%)*
Australia	2 586	3 840	5 309	5 725	6 082	6 319	28
United States	3 944	3 092	1 928	2 000	1 862	4 072	18
South Africa	2 130	5 870	4 225	4 239	3 971	3 317	15
Colombia	930	1 173	2 516	2 251	1 813	1 956	9
Russia	302	392	927	1 148	1 132	1 838	8
Belgium	92	798	1 063	1 195	1 704	1 525	7
China	1 250	1 480	473	508	672	731	3
Canada	51	577	491	474	585	563	2
Poland	1 059	1 091	1 530	1 015	484	288	1
Other	1 636	1 981	2 437	2 400	1 890	2 167	10
Total	**14 223**	**20 560**	**21 530**	**22 010**	**20 195**	**22 775**	

Source: MEEDDM.

Figure 16

Coal Unloading Ports and Coal-Fired Power Plants in France, Operational in 2010



The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

Australia is the largest exporter of coal to France, with 28% of the market, followed by the United States (18%), South Africa (15%) and Colombia (9%). Combined imports from the European Union countries of Belgium, Poland, the Netherlands and Germany account for 13% of coal imports in France, mostly imported coal in transit from the ARA ports (Amsterdam, Rotterdam and Antwerp). Russia is emerging as a significant coal exporter and France's imports from this country doubled over the past three years. Supplies from China have fallen off considerably. Coal imports increased by 13% in 2008, because of restocking.

In 2008, electricity generation from coal accounted for about 4% of total electricity production. France has fully transposed the EU Large Combustion Plant Directive (2001/80/EC), adopting a hybrid approach that sees the older smaller plants opting out, some larger plants meeting the directive's emission limit values (ELVs), and the three plants at Cordemais and Le Havre being pooled with oil-fired plants under a national emissions reduction plan to achieve reductions equivalent to the application of ELVs. Of today's coal-fired plants, generating 7.1 GW, owned by EDF and SNET (a subsidiary of E.ON), some 3.5 GW will be decommissioned by 2015. The French government estimates that the share of coal-fired plants in total generation will then fall to 2%. There will be only five plants, with an average age of 30 to 40 years, in operation in France in 2015. Planned investment will ensure that these remaining plants will fully comply with EU directives.

The Grenelle 1 law, which was passed on 3 August 2009, requires any new coal-fired plant to be equipped with carbon capture and storage (CCS) technology, and to implement a CCS demonstration programme.

France is very active in CCS development, which is a priority in energy and research policies. There are three projects under construction or planned:

- Total Lacq basin CO_2 pilot project: based on a 30 MW oxy-fuel plant at Lacq, south-west France, the project will store 150 000 tonnes of CO_2 per year in a depleted gas field nearby. The company is investing EUR 60 million in the project.
- Veolia Environnement pilot CCS plant at Claye-Souilly: 200 000 tonnes of CO_2 per year will be captured from a biogas plant and will be stored in a deep saline aquifer.
- Suez, in association with Alstom and IFP *(Institut français du pétrole)* among others, is planning to build a pilot plant to study post-combustion technology and storage in a deep saline aquifer in the Paris basin.

The French Institute of Petroleum (IFP) is the leader of the COACH project (Cooperation Action within CO_2 Capture and Storage China-EU) aiming at studying CCS projects in China.

The government-owned company, *Charbonnages de France*, was dissolved in 2007, and the coal industry liquidated over a period of three years, according to Decree n° 2007-1806 of 21 December 2007.

Table 13

Coal-Fired Power Plants in France, Operational in 2010, with Status under EC Large Combustion Plants Directive (LCPD), Including Recently Closed Plants

Plant name	*Location*	*Owner*	*Capacity, MW_e*	*Units, MW_e (commissioned)*	*Fuel*	*LCPD*	*Notes*
Albi 1	Pelissier, Tarn, Midi-Pyrénées	EDF	–	1 x 250 (1969)	bituminous coal	–	closed (2006)
Blénod 2, 3 & 4	Blénod-lès-Pont-à-Mousson, Lorraine	EDF	750	3 x 250 (1966-69)	bituminous coal	opt-out	OFA (1991) on Unit 2
Bouchain 1	Valenciennes, Nord-Pas-de-Calais	EDF	250	1 x 250 (1970)	anthracite	opt-out	Unit 2 (250 MW) closed in 1995
Champagne-sur-Oise 1 & 2	Ile-de-France	EDF	–	1 x 240 (1961) 1 x 250 (1965)	bituminous coal	–	closed (2003)
Cordemais 4 & 5	Loire-Atlantique	EDF	1 200	2 x 600 (1983/84)	bituminous coal	SNR	FGD/SCR (1998)
Emile-Huchet 4, 5 & 6	Carling, Saint-Avold Nord, Lorraine	SNET	1 068	1 x 125 (1959) 1 x 343 (1973) 1 x 600 (1981)	bituminous coal/ reclaims/coal-water slurry/gas	opt-out opt-out ELV	CFBC (1990) 3 x 17 MW GTs FGD/SCR (2008)
Hornaing 3	Valenciennes, Nord-Pas-de-Calais	SNET	250	1 x 250 (1970)	bituminous coal/ petcoke/reclaims	opt-out	
La Maxe 1 & 2	Metz, Moselle, Lorraine	EDF	500	2 x 250 (1971/71)	bituminous coal	opt-out	
Le Havre 1, 2 & 4	Haute-Normandie	EDF	1 450	1 x 250 (1968) 2 x 600 (1969/83)	bituminous coal	opt-out opt-out/SNR	FGD (1998) on one unit
Loire-sur-Rhône 1 & 2	Lyon, Rhône-Alpes	EDF	–	2 x 250 (1965/68)	bituminous coal	–	closed (2004)

Table 13

Coal-Fired Power Plants in France, Operational in 2010, with Status under EC Large Combustion Plants Directive (LCPD), Including Recently Closed Plants *(continued)*

Plant name	*Location*	*Owner*	*Capacity, MW_e*	*Units, MW_e (commissioned)*	*Fuel*	*LCPD*	*Notes*
Lucy 3	Montceau-les-Mines, Saône-et-Loire	SNET	270	1 x 270 (1971)		opt-out	
Montereau 1 & 2	Ile-de-France	EDF	–	2 x 250 (1964/65)	bituminous coal	–	closed (2004)
Penchot 1	Boisse-Penchot, Decazeville, Aveyron	SNET	–	1 x 60 (1960)	sub-bituminous coal	–	closed (2001)
Pont-sur-Sambre 3	Maubeuge, Nord-Pas-de-Calais	EDF	–	1 x 250 (1967)	bituminous coal	–	closed (1998)
Provence 4 & 5	Gardanne, Bouches-du-Rhône	SNET	850	1 x 250 (1967) 1 x 600 (1984)	sub-bituminous coal/petcoke	opt-out ELV	CFBC (1995) FGD (1984) SCR (2008)
St Louis 1 & 2	La Réunion	GQF	60	2 x 30 (1995/95)	coal/bagasse	n/a	
Vaires-sur-Marne 1 & 2	Ile-de-France	EDF	-	2 x 250 (1962/66)	bituminous coal	-	closed (2005)
Vitry-sur-Seine 3 & 4	Ile-de-France	EDF	500	2 x 250 (1970/71)	bituminous coal	opt-out	LNB (1992) on one unit
Total			**7 148**	**(3 488 MW opted-out)**			

Notes: CFBC – circulating fluidised bed combustion; EDF – Electricité de France; FGD – flue gas desulphurisation; GQF – Groupe Quartier Français SA; GT – gas turbine (exhaust into conventional coal-fired boiler at Emile Huchet Unit 5); LNB – low-NO_x burner; n/a – not applicable; over-fire air NO_x reduction; SCR – selective catalytic reduction; reclaims – coal reclaimed from spoil heaps at former mine sites using mobile washing plant; SNET – Société Nationale d'Electricité et de Thermique (owned by E.ON since 2008); SNR – national emissions reduction plan (*schéma national de réduction*).

CRITIQUE

NATURAL GAS

The French government should be commended for its efforts in developing the gas sector, enhancing gas supply security and opening the market to competition.

France's geographical location makes it a key player in the European gas market. The country's involvement in several regional initiatives, with Germany and the Benelux countries in the north-west and with Spain and Portugal in the south is to be lauded. Under the framework of these initiatives, the "Open Subscription Period" has been launched and other "open seasons" or tenders are about to be launched in order to increase cross-border interconnection capacity. Today, several interconnection points are commercially congested, hindering the development of competition. The recent decision of the European Commission related to GDF Suez's commitments to release long-term capacity of transmission network and LNG should alleviate the situation in 2010.

LNG plants can play an important role in increasing the diversity of supply sources by adding more entry points to the system. France has LNG plants at Montoir and Fos-sur-Mer, and a third plant at Fos-Cavaou should become operational in 2010. There are four additional projects envisaged, and a final investment decision on each of them is expected in the next couple of years. In considering these projects, the lessons learnt during the past winter gas crisis should be borne in mind. However, investing in LNG facilities should be matched with sufficient capacity to deliver the gas to consumption points. Moreover, France's gas transmission network capacity also needs to be expanded.

The share of gas in the energy mix has increased over the last years and is expected to grow further, especially in the electricity generation sector. There are nine gas-fired plants under construction and ten additional projects under consideration. It is therefore essential to increase interconnection capacity in France and to maintain an attractive environment for the necessary investments, given the usefulness of gas-fired plants in meeting peak demand and extreme peak loads.

The merger in January 2009 of three balancing zones into one Northern GRTgaz zone represents a key first step in promoting a liquid gas market. However, additional investments are needed to further reduce congestion and to allow gas to flow efficiently from Northern to Southern Europe and vice versa. A consultative process has been launched by the Energy Regulatory Commission to assess the options for merging two of the three balancing zones which remain in France. The French government should encourage this process. Merging the balancing zones would improve the efficiency of the transmission network and promote market competition.

The creation of Capsquare, a trading platform connecting Fluxys (Belgian TSO) and the GRTgaz systems, and the gas exchange managed by Powernext are

to be commended. Although these tools have only been put in place recently, and their performance should be further monitored, they will eventually contribute to increase liquidity and transparency in a market that is currently characterised by operating on a bilateral basis.

GDF Suez has legally unbundled transmission and distribution activities, and created subsidiaries responsible for storage activities, Storengy, and LNG facilities, Elengy. These are very positive developments. However, GDF Suez is still a vertically integrated and dominant player in the French gas market and its activities currently limit competition in this market. The French government should continue to ensure that new entrants have access to storage and should consider increasing the share of storage offered through auctions. Currently, Storengy manages 80% of gas storage capacity in France and TIGF manages 20%.

OIL

France's indigenous oil production is insubstantial and is continuously decreasing; its oil import dependence has been above 98% in recent years and is expected to grow even further. Crude oil imports are well balanced and diversified between OECD, OPEC and non-OPEC countries. France continues to fulfil its stockholding requirement relying on the one hand on the central stockholding agency (CPSSP/SAGESS) and on the other hand on the industry.

Middle distillates constitute a dominant share of the oil demand in the country. With diesel cars comprising 77% of newly registered cars, the dieselisation tendency continues. The current tax regime gives a clear preference to diesel by imposing a significantly lower excise tax on it compared to gasoline. This tax advantage results in a lower end-user price for diesel, although the pre-tax production cost of gasoline is significantly lower. Since the refineries are not able to increase diesel production and reduce their gasoline output at the same time, France imports a significant quantity of its diesel consumption and exports gasoline.

France is making vigorous efforts to reduce demand and GHG emissions in the transport sector. Under the Grenelle law, GHG emissions in this sector must be reduced to the 1990 level by 2020. The government is using a combination of regulation, investment, tax incentives and voluntary measures to meet this objective. More specifically, the Grenelle law mandates new infrastructure for high-speed rail for passenger and freight travel, new tram and bus lines, an eco-tax on road freight travel, an increase in the use of biofuels and demand-side measures. While these policies are to be lauded, the government should evaluate its plans for the future use of white certificates in the transport sector and strengthen the co-ordination between vehicle policies and public transport policies in a holistic manner (see Chapter 4). Meeting these objectives will require a very ambitious infrastructure development and investment plan, an important part of which will be funded by the recovery plan that France launched in 2009 to face the economic crisis. Moreover,

the government is right to look for public-private partnerships to support its environmental objectives.

COAL

The French government has established a national plan to transpose the EC Large Combustion Plants Directive (2001/80/EC). This will see the closure before 2015 of plants that do not comply with emission standards laid out in the directive. France plans to decommission certain smaller coal-fired plants and install pollution abatement equipment in the ones that will remain in operation.

The government passed the Grenelle law in 2009 that requires all new coal-fired plants to be CCS-ready. However, it has not clearly articulated this proposal and any potential investors would naturally be wary in this uncertain environment. The government should consider what part it can play in launching the 20 large-scale CCS demonstration projects that G8 leaders committed to support at their July 2008 meeting in Hokkaido, Japan.

RECOMMENDATIONS

The government of France should:

Natural gas

- *Promote the development of transmission networks, both at cross-border interconnection points and within France, as early as possible.*
- *Foster the development of a single balancing zone while strongly encouraging investments in infrastructure.*
- *Implement the measures of the new third package on the internal energy market and strive to advance further in the same spirit to ensure effective competition.*

Oil

- *Consider balancing excise tax differential for gasoline and diesel in order to take into account industrial and environmental issues at both local and global levels.*
- *Continue to develop a comprehensive long-term strategy for reducing oil consumption in the transport sector.*

Coal

- *Clarify the "CCS-ready" requirement for new coal-fired plants that must be built with the option for CO_2 capture and storage and with a CCS demonstration programme.*

PRODUCTION

In 2007, renewable energy supply in France was 18.7 Mtoe, 7.1% of total primary energy supply (TPES) (Figure 17). Since peaking at 9% in 1977, the share of renewables in TPES has ranged between 7% and 8%, although it dipped to under 6.5% in 2002. The share of renewable energy in electricity production in 2007 was 12%, with hydropower accounting for over 85% of this percentage.

France ranks second in the EU27 in production of biofuels. It also has the second-largest wind power potential in Europe, although wind has yet to penetrate the market to any great extent. Solid biomass resources are abundant. France has centred its support for renewable energy sources around feed-in tariffs and calls for tender.

Table 14 shows renewable energy supply and electricity generated from renewable sources in 2007. Renewable combustibles and waste, including solid and liquid biomass, renewable municipal waste and biogas, accounted for the highest share of renewable TPES (68.7%), followed by hydropower (excluding pumped storage) (28.1%). Wind power represented about 2%.

Table 14

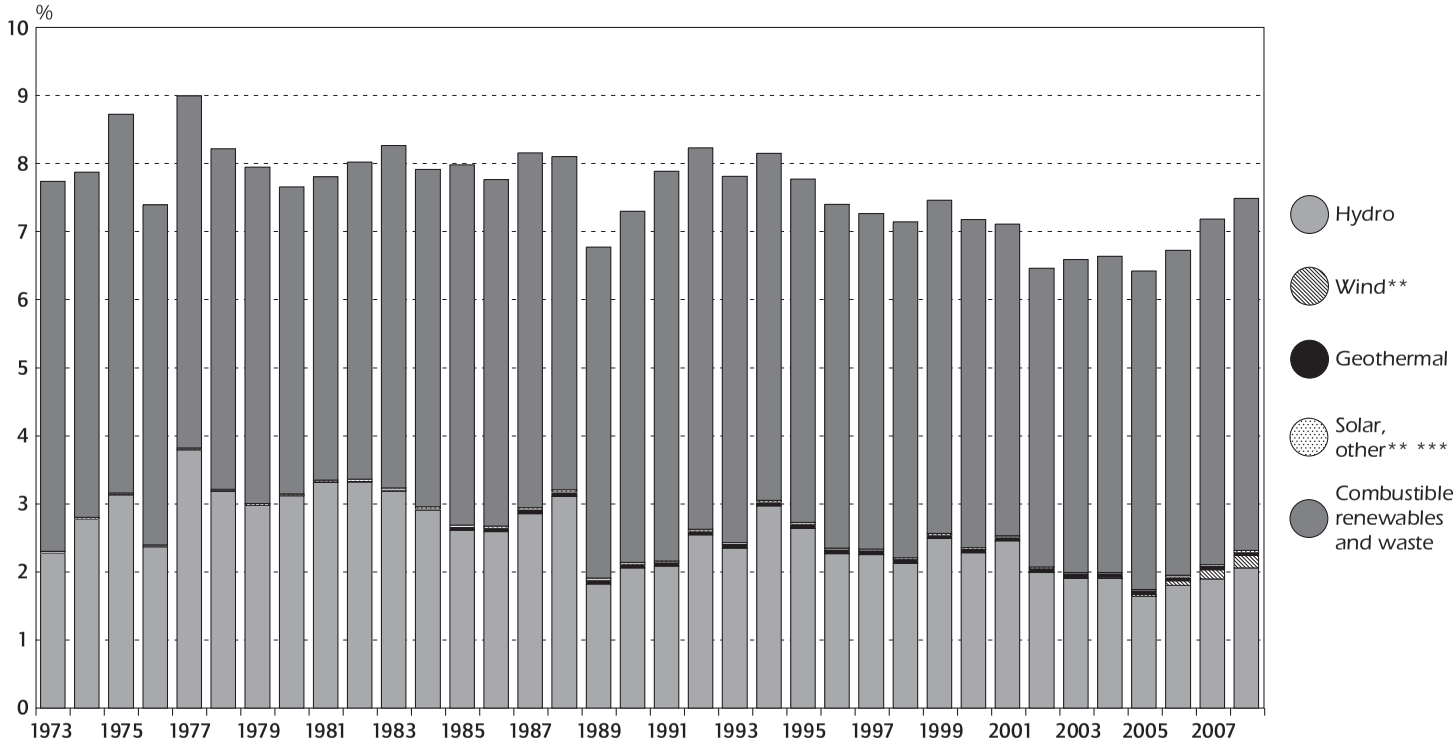
Primary Energy Supply and Electricity Generated from Renewable Sources in France* in 2007

	Share of renewables in TPES (%)	*TPES (ktoe)*	*Electricity generated (GWh)*
Solid biomass	51.87	9 233	1 370
Hydropower**	28.10	5 004	58 187
Windpower	1.96	349	4 052
Geothermal	0.73	130	–
PV solar	0.01	1	16
Thermal solar	0.20	35	–
Renewable municipal waste***	6.41	1 141	1 753
Landfill biogas	1.83	325	577
Sludge biogas	0.29	51	53
Other biogas	0.15	27	8
Biogasoline	1.48	264	–
Biodiesel	6.71	1 194	–
Tidal power	0.25	45	519
Total	**100**	**17 800**	**66 535**

* France including Monaco, excluding overseas departments. ** Does not include pumped storage.
*** Does not include non-renewable municipal waste.
Source: IEA/OECD, *Renewables Information 2009*, pp. 31 and 180.

Figure 17

Renewable Energy as a Percentage of Total Primary Energy Supply, 1973 to 2008*



* 2008 = estimates.

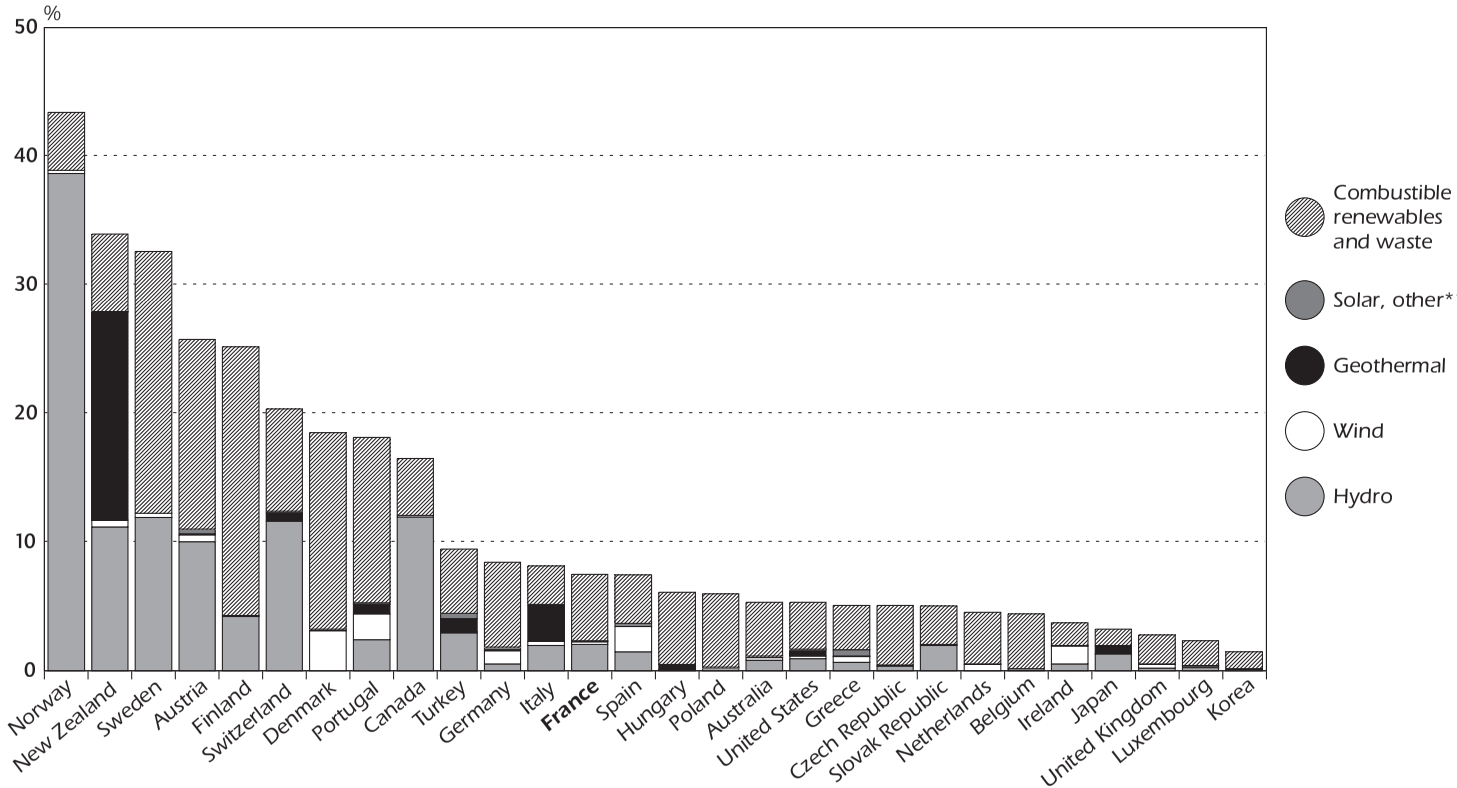
** negligible.

*** *other* includes tide and wave.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009.

Figure 18

Renewable Energy as a Percentage of Total Primary Energy Supply in IEA Member Countries, 2008*



* estimates.

** *other* includes tide and wave.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009.

France ranks second in total renewable energy production in the EU27, primarily because of its heavy reliance on hydropower for power generation and on solid biomass for heating. However, in 2008, the share of renewable energy in TPES (7.1%) puts France in the thirteenth position among a ranking of the 28 IEA member countries (Figure 18).

RENEWABLE ENERGY SOURCES

SOLID BIOMASS

Solid biomass, mainly wood and wood waste, is the most important source of renewable energy in France. It accounts for some 52% of all renewable energy production. In 2007, the 9 233 ktoe of biomass produced in France represented 14% of total energy production from solid biomass in the EU27. An additional 196 ktoe, exclusively sugar cane residues, was produced in 2007 in France's overseas departments. About 80% of solid biomass production in France is consumed by households, mainly for heating. France ranks twelfth in solid biomass energy production per capita in the EU27.[13] Gross electricity production from solid biomass in 2007 was 1 370 GWh.

HYDROPOWER

In 2007, installed hydropower capacity of 25 GW supplied 58.2 TWh of electricity; 2% of this was generated in autoproducer electricity plants. France's small hydropower capacity (<10 MW) is the second-largest in the EU27 after Italy. With production of 6.2 TWh in 2007, France is the third-largest producer of electricity from small hydro plants, after Italy and Germany. In 2007, it raised its feed-in tariffs for small hydropower plants and added a new financial bonus for these facilities. In spite of these incentives, the contribution of hydropower is not expected to increase significantly in the future because remaining sites face stiff environmental restrictions.

WIND POWER

Wind power production from onshore and offshore installations in France, including Corsica and overseas departments, increased from 2.2 TWh in 2006 to 4.1 TWh in 2007, a growth of 82%. This was nearly three times higher than the average growth among EU27 countries.[14] Five per cent of total production in France was supplied by autoproducer electricity plants. Wind power capacity increased from 1 737 MW in 2006 to 2 455 MW in 2007. As a result of the Grenelle 2 law, wind parks will be classified as ICPE (*Installations classées*

13. EurObserv'ER 2008.
14. EurObserv'ER 2008.

pour la protection de l'environnement) and therefore subject to more complex administrative procedures. This could have a dampening effect on the growth of wind energy capacity and lower the possibility that the government's ambitious goals for increasing the share of renewable energy will be met by 2020.

GEOTHERMAL POWER

France produces geothermal power in two installations in Bouillante, Guadeloupe. In 2007, capacity was 14.7 MW_e. There are plans to build a third geothermal power plant in Bouillante and a pilot plant (of 1.5 MW_e using hot dry rock technology) in Soultz-sous-Forêts in Alsace. These two plants would increase geothermal electricity capacity to 36.5 MW_e.[15]

GEOTHERMAL HEAT

Geothermal heat is mainly exploited through the use of heat pumps. France ranks third in the EU27, after Sweden and Germany, in the number of heat pumps in use. At the end of 2007, there were 105 056 heat pumps in France, with a total capacity of 1 156 MW_{th}. Geothermal heat pumps, while more expensive than aerothermal heat pumps, are more energy-efficient. However, from 2006 to 2008, financial incentives for heat pumps in France did not distinguish between the two types. Consequently, the growth in sales of aerothermal heat pumps (24.3%) from 2006 to 2007 was much faster than growth in sales of geothermal heat pumps (5.9%).[16]

Geothermal heat is also directly exploited from subterranean aquifers. In 2007 this type of heat generated 307 MW_{th} in France, mainly for the district heating network in the Ile-de-France region.

PHOTOVOLTAIC

PV capacity in France, including Corsica and overseas departments, increased from 34 MW_p in 2006 to 47 MW_p in 2007. This capacity represents just 1% of total PV capacity in the EU27. Growth in PV has been stymied in France by the long delays in obtaining grid access. Because of attractive feed-in tariffs, on-grid PV is preferred to off-grid. From 2006 to 2007, growth in demand for on-grid PV systems was twenty times higher than for off-grid systems. In 2007, on-grid PV systems generated 16 GWh of electricity, accounting for 0.01% of renewable energy supply in France. PV capacity is expected to increase, however, thanks to financial incentives for its uptake, including a low VAT, a high income-tax credit and attractive feed-in tariffs, in particular for building-integrated power plants (see Table 15).

15. EurObserv'ER 2008.
16. EurObserv'ER 2008.

CONCENTRATED SOLAR POWER

France built the Themis concentrated solar power plant in the 1980s for research purposes. There are plans to modernise the tower at the Themis plant and to build two additional small-scale research facilities devoted to this technology. A commercial 12 MW concentrated solar power plant, being constructed in the Hautes-Alpes region, is planned to be commissioned in 2010.

THERMAL SOLAR COLLECTORS

In 2007, thermal solar collector capacity in France, including overseas departments, was 1.4 million m^2 and production was 1 005 MW_{th}. France ranks fourth in collector capacity in the EU27.[17] Excluding overseas departments, some 35 ktoe of solar thermal energy was produced in 2007, 91% of this for the residential sector. Thanks to attractive national and local financial incentives, the French market for thermal solar collectors ranks second in the EU27, after Germany. Through its offer of a 50% income tax credit, the French government has a goal of equipping 730 000 detached homes with thermal solar collectors by 2012 and 4.3 million by 2020.

RENEWABLE MUNICIPAL SOLID WASTE

Energy production from renewable solid municipal waste in France is the highest in the EU27. In 2007, 130 incineration plants produced 1 141 ktoe. This primary energy was converted into gross heat production of 9 474 terajoules (TJ); 75% of this was used in combined heat and power plants (CHP). Gross electricity production from renewable solid municipal waste was 1 753 GWh in 2007.

BIOGAS

In 2007 biogas energy supply was 403 ktoe in France, extracted from landfill (85%), sewage sludge (13%) and other organic waste sources (1%). Gross electricity production from biogas was 638 GWh.

BIOFUELS

Biofuel demand in the transport sector doubled in 2007 from its 2006 level. Given the higher share of diesel in the vehicle mix, it is not surprising that biodiesel accounts for 82% of total biofuels production in France. The country is the second-largest producer of biofuels in the EU27, after Germany.

17. EurObserv'ER 2008.

The share of biofuels in road transport consumption was 5.75% in 2008, implying that France met the target defined in its *Plan Biocarburant* of 2005. Future targets – a share of 7% in 2010 and 10% in 2015 – are more ambitious than the targets defined by the EU Directive 2003/30/CE. On current trends, it seems likely that France will achieve the 7% target in 2010. To address the debate over the sustainability of biofuels production, ADEME will publish a report in the first half of 2010 on the GHG emissions reduction potential of all biofuels produced and consumed in France.

OCEAN ENERGY

France has the only major tide-powered electricity generating station in the world, the 240-MW La Rance plant in Brittany, in operation since 1966. This plant generates 90% of global electricity production from ocean energy. France views marine energy as a strategic energy resource and supports R&D in this technology. For example, the government funds the marine pilot farm near Brittany where EDF is analysing the characteristics of three OpenHydro marine turbines, with 1.5 MW capacity, exploiting ocean and tidal currents.

GOVERNMENT POLICIES AND MEASURES

The French government has recently enacted two laws which impact renewable energy use. First, the POPE energy law of 13 July 2005 (*Loi de programme fixant les orientations de la politique énergétique*) defined targets of a 10% share of renewable energy sources in TPES and a 21% share of renewables in gross electricity consumption. According to the objectives in the EU White Paper, both targets must be met by 2010. In 2007, the share of renewable energy in France's gross electricity consumption was only 12%, thus making it extremely challenging for France to meet the 2010 target.

The 2009 « Grenelle 1 » (*Loi de programme relatif à la mise en œuvre du Grenelle de l'Environnement*) was the result of a national debate on sustainability called *Grenelle de l'Environnement* that started in 2007. The corresponding budgets will be defined by a second law "Grenelle 2" (*Loi portant engagement national pour l'environnement*), to be implemented in 2010. Table 15 provides the targets for renewable energy in 2020 specified by Grenelle 1. These targets reflect the EU targets on renewable energy as defined in its Energy-Climate Package, adopted by the European Parliament in December 2008. France is expected to achieve a share of 23% renewables in its final energy consumption in 2020, whereas this share was 7% in 2007.

The French government is planning to invest heavily in solid biomass, wind power and biofuels. It also intends to expand its industrial potential by investing in innovative technologies for photovoltaic power and marine energy.

These objectives are specified in the 2009 pluri-annual energy investment programme (*Programmation pluriannuelle des investissements*, PPI) as:

- heat from renewable energy sources: 19.7 Mtoe in 2020, or +10.1 Mtoe relative to 2006;
- electricity from renewable energy sources: 12.9 Mtoe in 2020, or +12.9 Mtoe relative to 2006;
- biofuels: 4 Mtoe in 2020, or +3.3 Mtoe relative to 2006.

In order to reach these ambitious targets, the French government is encouraging each of its regions to set up their own climate and energy plans and targets (*schémas régionaux du climat, de l'air et de l'énergie*) based on regional technological and geographical potential. These programmes define zones for wind energy deployment (*zones de développement éolien*) and articulate the need for additional investments in electricity distribution grids in each region.

Table 15

Renewable Energy Production (2006) and Grenelle 1 Targets (2020)

	Production 2006 (Mtoe)	*Target 2020 (Mtoe)*	*2006-2010 (%)*
Renewable energy		**23% renewables in final energy consumption**	
Solid biomass heat	8.8	15	+ 6.2
Solid biomass power	0.2	1.4	+ 1.2
Hydropower	5.2	5.8	+ 0.6
Wind power onshore	0.2	3.6 Installed capacity of 19 GW	+ 3.5
Wind power offshore	0.0	1.4 Installed capacity of 6 GW	+ 1.4
Geothermal heat	0.4	2.3 2 million homes equipped	+ 1.9
PV solar power	0.0	0.5 Installed capacity of 5.4 GW	+ 0.5
Thermal solar collectors	0.0	0.9 4.3 million homes equipped	+ 0.9
Municipal solid waste	0.4	0.9	+ 0.5
Biogas	0.0	0.6	+ 0.5
Other (ocean and geothermal power)	0.0	0.1	+ 0.1
Biofuels	0.7	4.0	+ 3.3

Source: MEEDDM.

The French government's renewable energy action plan (*50 mesures pour un développement des énergies renouvelables à haute qualité environnementale*), launched on 17 November 2008, outlines fifty measures for enhancing the development and deployment of renewable energy in order to reach the renewable energy targets formulated by the Grenelle de l'Environnement. The plan summarises the renewable energy targets in Table 15 and the support mechanisms described below.

FEED-IN TARIFFS

The most important support mechanisms for renewable energy in France are the highly attractive feed-in tariffs for renewable energy electricity plants with capacity less than 12 MW (Table 16). These tariffs were imposed on the utility EDF by the decree of 10 February 2000. The system is financed through the CSPE (*contribution au service public de l'électricité*), which is funded through a contribution added to the electricity bill of each French electricity consumer. Under Grenelle 2, purchase obligations and feed-in tariffs will also benefit local authorities.

TENDER SCHEMES

In order to stimulate investments in large-scale renewable energy plants, France initiated a series of calls for tenders in 2004. The first three tender offers in 2004 concerned 200 MW for solid biomass, 50 MW for biogas, 500 MW for offshore wind plants and two separate offers each for 500 MW of onshore wind power. As of mid-2009, only one offshore wind park had obtained a permit (near Veulettes-sur-Mer on the Normandy coast).

At the end of 2008, the French government launched a call for tenders for photovoltaic power plants. Its objective was to build at least one PV plant in each region before 2011, with a capacity depending on the region and ranging from 5 MW to 20 MW, adding up to a total capacity of 300 MW.

Since 2008, annual calls for tenders have been launched for large renewable heating systems (>1 ktoe), paid for by the new renewable heat fund (*Fonds chaleur renouvelable*). This fund was created as a result of the Grenelle I law and is managed by ADEME. The fund aims to increase the deployment of renewable heat from solid biomass, biogas, geothermal and thermal solar systems in collective housing units, offices and industry. The fund was set up with EUR 1 billion for three years and is intended to increase the supply of renewable heat from 2.0 Mtoe in 2006 to 7.5 Mtoe in 2020.

Table 16

National Feed-in Tariffs for Renewable Electricity*, 2009

	Decree date	*Contract length*	*Feed-in tariffs (in eurocents/kWh)*
Hydropower	1 March 2007	20 years	6.07, plus 0.5 to 2.5 bonus for small hydropower (<12 MW) plus bonus of 0 to 1.68 for production regularity in winter time.
Wind power	10 July 2006	15 years - onshore	Onshore: 8.2 if installed in "zone développement éolien" for the first ten years, then 2.8 to 8.2 for the next five years, depending on site.
		20 years - offshore	Offshore: 13 for the first ten years, then 3 to 13 for the next ten years, depending on site.
Geothermal	10 July 2006	15 years	12 in metropolitan France, plus a bonus of 0 to 3 for increased energy efficiency.
			10 in overseas departments, plus a bonus of 0 to 3 for increased energy efficiency.
PV solar power	10 July 2006	20 years	Non-digressive base tariff of 30, plus 25 bonus in metropolitan France if building-integrated **.
			In Corsica and overseas departments 40, plus 15 bonus if building-integrated.
			Specific tariff of 45 for professional buildings if integrated, even when installed capacity is more than 12 MW.
Biogas and methane	10 July 2006	15 years	7.5 to 9, plus 0 to 3 energy efficiency bonus plus 2 methane bonus.
Solid biomass	16 April 2002	15 years	4.9, plus 0 to 1.2 energy efficiency bonus.
Methane gas	16 April 2002	15 years	4.6, plus 0 to 1.2 energy efficiency bonus.
Geothermal	13 March 2002	15 years	7.62, plus 0 to 0.3 energy efficiency bonus.
PV solar power	13 March 2002	20 years	15.25 in continental France and 30.5 in Corsica and overseas departments.
Animal waste	13 March 2002	15 years	4.5 to 5, plus 0 to 0.3 energy efficiency bonus.
Landfill biogas	3 October 2001	15 years	4.5 to 5.72 according to capacity, plus 0 to 0.3 energy efficiency bonus.
Municipal solid waste	2 October 2001	15 years	4.5 to 5, plus 0 to 0.3 energy efficiency bonus.
Co-generation	31 July 2001	12 years	6.1 to 9.15 depending on gas price, length of service and capacity.
Hydropower	25 June 2001	20 years	5.49 to 6.1 according to capacity, plus 0 to 1.52 bonus for production regularity in winter time.
Wind power	8 June 2001	15 years	8.38 for the first five years, then 3.05 tot 8.38 for the next ten years, depending on site.

*Applies only to facilities equal or less than 12 MW (exception: PV solar on professional buildings).

**Tariffs indexed on both prices and costs of work in industry. Feed-in tariff 2008 was EURc 31.19/kWh and EURc 57.19/kWh in case of building-integration.

Source: MEEDDM.

INCOME TAX CREDIT SCHEMES

The French government encourages households to replace inefficient domestic appliances with more efficient ones through an income tax credit scheme. The income tax credit on thermal solar collectors and PV collectors is fixed at 50% and will be valid until 2012, or possibly later. The income tax credit for heat pumps was fixed at 40% in 2009. The tax credit for aerothermal heat pumps (excluding air/air) will be reduced to 25% from 2010. It will also be reduced to between 15% and 25% for condensing boilers. France has one of the most attractive tax credit schemes in the EU; French households bought 435 000 wood-burning heating appliances, 133 000 heat pumps and 28 000 thermal solar boilers in 2007.

TAX EXEMPTIONS FOR BIOFUELS

Transport fuels, containing at least 5.75% biofuels in 2008 and 7% in 2010, are exempt from the 2005 General Tax on Polluting Activities (TGAP, *taxe générale sur les activités polluantes*). Bioethanol and biodiesel are also partly exempted from the National Consumption Tax (TIC, *taxe intérieure de consommation*) (see Energy Prices and Taxes in Chapter 2). The French government promotes the use of E85 (petrol with 85% bioethanol) by offering a lower VAT and by providing tax benefits for the purchase of cars adapted for E85. The price of E85 is EUR 0.80 to 0.85 per litre. Thanks to these incentives, an additional 300 petrol stations offered E85 in 2009. Twenty-one biodiesel production plants, four ethyl tertiary butyl ester (ETBE) plants and 20 bioethanol plants were also built in 2009. France produces more than 3 Mt of biodiesel and 1 Mt of bioethanol per year.

CRITIQUE

Since the 1980s, the share of renewable energy in the French energy mix has remained fairly stable thanks to the contribution of hydropower for electricity generation and biomass for heating. However, the contribution of new energy technologies like wind energy and PV has been minimal. In 2006/07, the French government took action to change this situation by introducing attractive feed-in tariffs. This has led to a substantial increase in the use of wind and PV over the past couple of years. Other key support measures for renewable energy sources include fiscal incentives (*e.g.* tax credit schemes) and calls for tenders. The feed-in tariff system obliges EDF to purchase renewables-based power. For most renewable energy technologies, feed-in tariffs have stimulated demand, especially the high tariff granted to PV. On the contrary, the feed-in tariffs for biomass-fired combined heat and power (CHP) systems and offshore wind parks appear to be insufficient to boost their deployment in France.

The feed-in tariff systems for co-generation and renewable energy are covered by respective funds created by the CSPE (*contribution au service public de l'électricité*). The CSPE-contribution is paid by the end-users as part of their energy bills. In 2006-2009, the CSPE-contribution was not increased. Because of this, the budget for renewable energy is at risk of being insufficient to cover the costs of the feed-in tariffs. The French government should re-evaluate the feed-in tariffs as well as the structure of the CPSE-contribution in order to ensure that the funds created by the CPSE-contribution are sufficient to cover the renewable feed-in tariff system.

In 2009, France adopted the 23% renewable energy target as proposed by the 2008 EU Energy-Climate Package. Renewable energy is an important component of the Grenelle de l'Environnement, and the target has been quantified for the period 2009-2020 in specific goals confirmed by the Pluri-annual Investment Plan. These renewable energy targets by technology are very ambitious. It is crucial to develop and apply an adequate, continuous and transparent monitoring process in order to analyse regularly to what extent the targets have been met and to adapt government policy if necessary.

In addition to existing mechanisms, the Grenelle law introduces other measures to support renewable energy sources. Encouragingly, it plans to put a large emphasis on supporting renewables-based heating. France should be commended for introducing this support. In many IEA countries, support measures focus only on electricity, neglecting heating and cooling. The Grenelle strategy also mentions the need to adapt electricity transmission and distribution networks to renewable energy sources, which is very praiseworthy.

France's renewable energy policy is intertwined with its industrial policy. PV, while costly, has been selected as one of the strategic sectors, largely because France sees opportunities for developing a national PV industry. PV is promoted by substantial R&D support, by the National Solar Energy Institute (INES) and by the obligation for each region to build a solar park of about 50 MW.

Wind power faces numerous barriers. The procedures to obtain a permission to build a wind park have become more complex and lengthy in 2008/09 because of the obligation that wind turbines are only to be installed in specified zones (*zones de développement éolien*). This risks hampering the development of wind power in France, assumed to be 25% of all renewable energy in 2020.

France has strongly promoted bio-based transport fuels since 2003, aiming to achieve shares of biofuels which are higher than the EU targets. In 2009, the French government started to reconsider its policy regarding first-generation biofuels. It is commendable that the government is considering measures to promote second- and third-generation biofuels.

Certain adverse effects such as atmospheric pollution due to combustion of biomass, the impact of wind parks on landscapes and flooding related to hydro projects often hamper more active deployment of renewable energy technologies. France should assess these possible negative effects at an early stage and adjust its policy instruments in order to prevent them.

RECOMMENDATIONS

The government of France should:

- *Review the level and method of funding for feed-in tariffs through the contribution to public service electricity (CSPE) with a view to making the system more transparent and cost-reflective.*
- *Develop and apply a suitable monitoring process and instruments in order to follow the degree of realisation of the targets set for the various types of renewables and to adapt its policy when needed.*
- *Simplify the administrative procedures and hence shorten the lead time for obtaining the necessary permits to construct onshore and offshore wind parks.*
- *Take into account at an early stage the possible adverse effects of certain types of renewable energy and adjust its policy instruments in time to address them.*

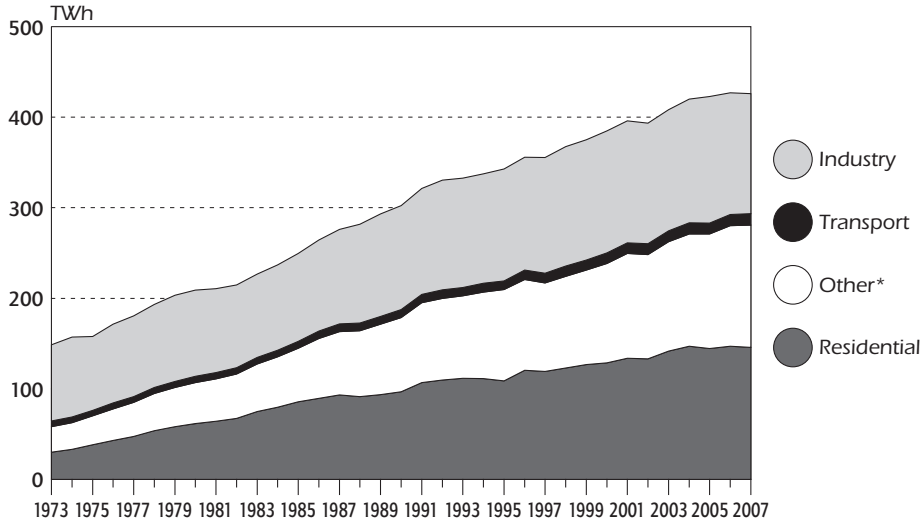
DEMAND

France is the second-largest electricity consumer in OECD Europe after Germany. Over the period 2000-2007, electricity consumption increased by 10.6%, driven mainly by growth in demand in the commercial/public service sector (25.4%) and the residential sector (13.3%). The residential sector accounts for the largest share of electricity consumption, 34% in 2007. The industrial and commercial/public service sectors account for about 31% each of total consumption. Electricity demand is highly seasonal, with peak demand in the winter owing to heating loads. Peak load was 89 GW in 2007.

Despite the beginning of the global economic crisis, electricity demand in France increased by more than 1% in 2008. Industrial demand, however, trended downward, from a peak of 139.5 TWh in 2005 to 132.6 TWh in 2007. Because of the economic recession, industrial demand is not expected to return to the pre-crisis level for several years. In the Generation Adequacy Report 2009, RTE, the French transmission system operator, projects a growth rate of electricity demand in the baseline scenario of 0.9% per year over 2008-2015 and 0.8% over the following decade. Under this scenario, demand is expected to reach 516 TWh in 2015 and 559 TWh in 2025, compared to 426 TWh in 2007.

Figure 19

Final Consumption of Electricity by Sector, 1973 to 2007



*includes commercial, public services, agriculture, forestry, fishing and other non-specified sectors.
Source: *Energy Balances of OECD Countries,* IEA/OECD Paris, 2009.

CAPACITY

As of January 2009, installed generating capacity stood at 117.7 GW of which 63.3 GW is nuclear. France has the second-largest nuclear fleet among OECD countries and in the world, after the United States. Most capacity additions in recent years have been in wind power. For the off-grid areas (Corsica and overseas departments), there is a programme initiated by EDF to replace diesel-fuelled generating capacity. Table 17 provides the composition of France's current generating fleet.

Table 17

Installed Generating Capacity, January 2009

(GW)

	Installed capacity
Nuclear	63.3
Hydro	25.4
Fossil fuels	24.7
Wind	3.3
Other renewables	1.0
Total	**117.7**

Source: RTE, Generation Adequacy Report 2009.

Most of the planned or under-construction projects are for nuclear, natural gas and renewable energy power plants,[18] although about 500 MW of oil-fired combustion turbines are under construction to help meet peak demand. A 1 630 MW European pressurised water reactor (EPR) is under construction in Flamanville by EDF for planned start-up in 2012 and there are plans to build a second EPR, to be completed in 2017 (see Chapter 8). Since 2007, over 5 684 MW of gas-fired capacity was approved under the Electricity Law 2000 (Table 18). Some projects still need environmental permits and/or firm investment commitments.

Table 18

Gas-Fired Capacity Authorised under the Electricity Law

Location	*Company*	*Capacity (MW)*	*Date of authorisation under the «Electricity Law» 2000-108*
Bayet (03)	Atel	440	30/08/2007
Martigues (13)	EDF	465	04/09/2008
Martigues (13)	EDF	465	04/09/2008
Blénod la Maxe (54)	EDF	435	04/09/2008
Verberie (60)	Direct Energie	446	13/01/2009
Verberie (60)	Direct Energie	446	13/01/2009
Fos/Mer (13)	Electrabel	438	12/03/2007

18. Targets for renewable energy power plants are provided in Chapter 6.

Table 18

Gas-Fired Capacity Authorised under the Electricity Law (continued)

Location	*Company*	*Capacity (MW)*	*Date of authorisation under the «Electricity Law» 2000-108*
Fos/Mer (13)	GDF	424	24/01/2007
Montoire (44)	GDF	435	03/08/2007
Pont/Sambre (59)	POWEO	436	09/06/2006
Beaucaire (30)	POWEO	440	13/06/2007
Beaucaire (30)	POWEO	440	13/06/2007
Toul - Croix de Metz (57)	POWEO	400	30/01/2008
Carling (57)/Emile Huchet 7	SNET	400	23/09/2005
Carling (57)/Emile Huchet 8	SNET	400	23/09/2005
Hornaing 4 (59)	SNET	400	23/09/2005
Os-Marsillan 1 (64)	SNET	400	18/12/2007
Os-Marsillan 2 (64)	SNET	400	18/12/2007
Lucy 4 (71)	SNET	400	23/09/2005
Gardanne 4 (13)	SNET	400	23/09/2005

03, Allier ; 13, Bouches-du-Rhône ; 30, Gard ; 44, Loire-Atlantique ; 54, Meurthe-et-Moselle ; 57, Moselle ; 59, Nord ; 60, Oise ; 64, Pyrénées-Atlantiques ; 71, Saône-et-Loire.

Source: MEEDDM, 2009.

GENERATION

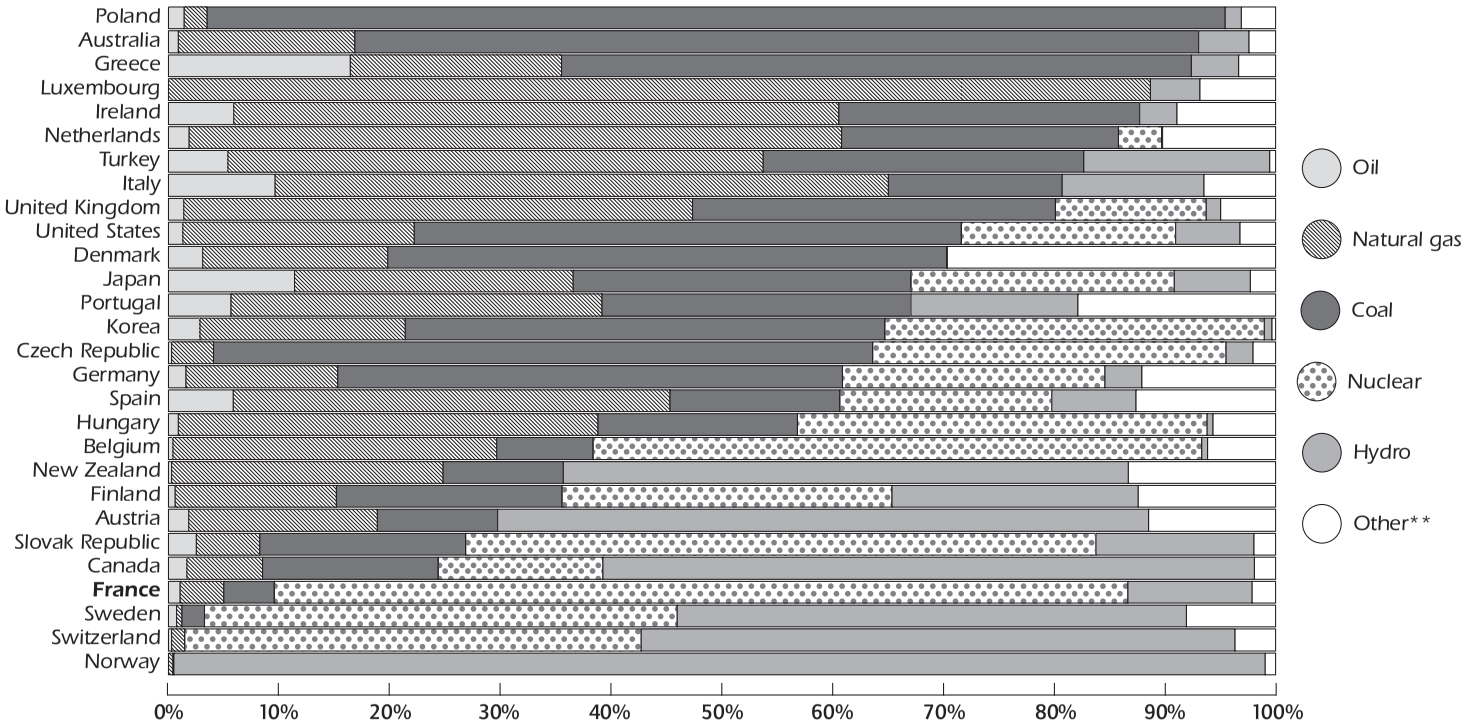
France's combined share of nuclear and renewables in its generation mix ranks among the highest in IEA countries (Figure 20). In 2008, total generation reached 574.5 TWh of which close to 77% from nuclear power plants. Hydro accounts for about 10% and fossil-fuelled generation also for some 10%. Non-hydro renewable electricity generation (mostly wind) has increased substantially since 2000, reaching 5.7 TWh in 2008 (about 1% of total generation). The significant increase in intermittent generation sources has had an impact on system operation and reliability. But the availability of cross-border interconnections has proved to be a source of flexibility, enabling a larger penetration of variable renewable energy which could possibly limit the need for gas-fired backup power.

Although accounting for a small share in generation (about 3% or 18 TWh annually), combined heat and power (CHP) experienced rapid growth in capacity between 1998 and 2002, during which time almost 4 GW of new natural gas-fired installations were commissioned. This development was mainly driven by feed-in tariffs. In 2008, total CHP installed capacity amounts to 5 GW of which 4.7 GW are covered by guaranteed purchase contracts.

The cost of the CHP support scheme is significant (EUR 650 million in 2006). Since the feed-in tariffs are applied for a 12-year period from the commissioning date, most will expire between 2010 and 2014. When contracts expire, facilities over 12 MW (if not connected to a district

Figure 20

Electricity Generation by Fuel in IEA Member Countries, 2008*



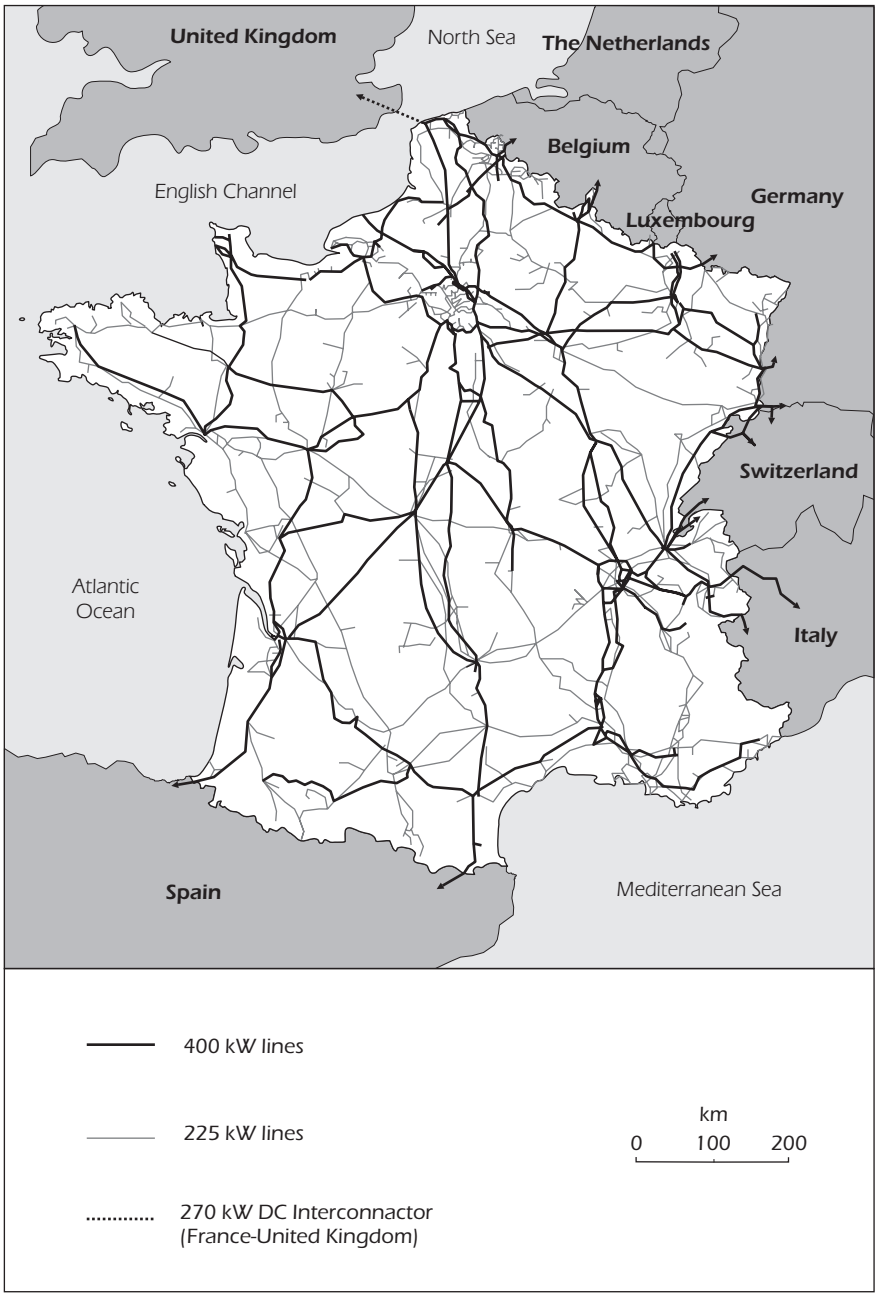
*estimates.

** includes geothermal, solar, wind, tide/wave/ocean energy, combustible renewables and waste, etc.

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2009.

Figure 21

Electricity Transmission Lines



The boundaries and names shown and the designations used on maps included in this publication do not imply official endorsement or acceptance by the IEA.

Source: MEEDDM.

heating network) will need to market their electricity output themselves. All facilities connected to a district heating network will have the option of renewing their feed-in tariff for a second period of 12 years, provided refurbishments are carried out. The fleet of gas-fired co-generation facilities is expected to decline in the coming years as the government pursues growth in biomass-based co-generation facilities.

In France, the PPI (*programmation pluriannuelle des investissements*) identifies investment needs in electricity generating capacity from the point of view of energy security. The PPI also sets up objectives for new capacity: by technology, by energy source and by geographic zone. If actual installed capacity of a certain generating technology exceeds the desired amounts, the government has the option to temporarily suspend authorisations or, in the case of a technology with a feed-in tariff, suspend the signature of new guaranteed purchase contracts, thereby preventing companies from building that type of plant. If the installed capacity does not meet the minimum amount specified for a certain technology, the government has the option to issue bids for tenders for plants of the desired type. The winning bidder would receive a long-term contract that guaranteed its return on investment in the new plant.

INDUSTRY STRUCTURE AND MARKET OPERATION

GENERATION AND COMPETITIVE STRUCTURE

France's generation sector is highly concentrated, with Electricité de France (EDF) accounting for 88.1% of total generation in 2007. The State has a majority ownership of EDF (84.8%).

Table 19

Market Shares in Electricity Generation, 2007

Generators	*Shares in total electricity generation (2007)*	*Generation sources*
EDF	88.1 %	Nuclear, coal, hydro, oil
CNR	2.8 %	Hydro
ENDESA (inluding Soprolif and Sodelif)	1.4 %	Coal
GDF (DK6)	0.7%	Natural gas
SHEM	0.3 %	Hydro
Hydro generators other than EDF, CNR and SHEM	0.9 %	Hydro
Conventional thermal generators other than EDF and SNET	5.1 %	
Wind and solar generators	0.7%	
Total	100 %	

Source: MEEDDM, 2009.

TRANSMISSION

The French transmission network extends over 100 000 km and has some 2 500 transformer stations. The main voltages are 400 kV, 225 kV, 90 kV and 63 kV. The network is mainly composed of alternating current (AC) overhead lines with a limited number of underground cables at voltages varying from 63 kV to 400 kV. The French transmission network is 100% owned and operated by the French transmission system operator, RTE or *Gestionnaire du réseau*, a subsidiary of EDF. The distribution network is majority-owned by ERDF, a subsidiary 100% owned by EDF. The remainder of France's distribution assets is owned by local distribution companies.

RTE is mandated to ensure connection and non-discriminatory access to transmission networks to third parties. Any access refusal needs to be justified and notified to the *Commission de régulation de l'énergie* (CRE). RTE publishes on its website the capacity of reception of electricity by transformer station for new generation sources. RTE owns and manages the transmission network in France. The operator also plans the development and manages the high-voltage grid and guarantees open and fair third-party access to the transmission grid. Transmission tariffs are set by the CRE and approved by the government.

Transmission network fees are established on a postage stamp basis, thus independently of distance. Access charges paid by consumers depend on key technical parameters, including voltage level, amount of power contracted and amount of energy consumed. On the other hand, producers connected to the 225/400 kV grid pay access charges that depend on the amount of energy injected.

Planned domestic transmission investments include:

- a double circuit 165-km, 400-kV line from Cotentin to Maine;
- grid connections for new generation sources (*i.e.* Montoir, zone de Fos);
- projects to ensure reliability of electricity supply (*e.g.* Escaillon-Néoules, Hyères, Peltre, Morbihan).

CROSS-BORDER INTERCONNECTIONS

Cross-border interconnections play a critical role in enabling trade and competition by increasing power system flexibility and enhancing market efficiency. With a total cross-border electrical interconnection of 15 750 MW, France is reasonably well interconnected with neighbouring countries. Table 20 shows transfer capacities between France and neighbouring countries in 2008.

Table 20

Cross-Border Capacities between France and Neighbouring Countries, 2008

France – Belgium	3 200 MW
France – Italy	2 650 MW
France – Spain	1 400 MW
France – Germany	3 300 MW
France – Britain (undersea cable)	2 000 MW
France – Switzerland	3 200 MW

Source: MEEDDM.

Additional cross-border capacity is being planned to alleviate transmission congestion and enhance trading opportunities, as follows:

Interconnection with Spain: in a final report published in June 2008 and ratified by the French and Spanish governments, European Co-ordinator Mario Monti proposed the choice of underground cables extending over 60 km, using direct-current (DC) technology at 400 kV along existing corridors through the Pyrénées. Underground installation was intended to address public concern on the French side, but will also be applied to the Spanish part of the project. The cost of underground cables was estimated five times higher than overhead lines. The project is in the stage of licensing and environmental impact study. Financing and implementation will be carried out by a joint venture between RTE and Red Eléctrica de España (REE), the Spanish transmission system operator. The line will be commissioned by 2013, with a maximum capacity of 1 400 MW. This will be the first interconnection to be built between France and Spain in nearly 40 years. In January 2008, France and Spain reached an agreement on expanding interconnection capacity by up to 4 000 MW.

Interconnection with Italy: in co-operation with Terna, the Italian transmission system operator, RTE is conducting a feasibility study for a DC interconnection along the corridor of the Fréjus tunnel.

Interconnection with Belgium: an upgrade of the Moulaine-Aubange interconnection is a priority project of European interest. Conversion into a double circuit 225 kV line between Moulaine and Aubange will result in a significant increase of cross-border capacity with Belgium. Start-up is planned in 2010.

Cross-border transmission capacity is allocated through market-based auctions for various time horizons (annual, monthly, daily, intra-day). Available capacity for specific time horizons is published on the RTE website. French authorities, together with RTE and CRE, participate in four regional European Initiatives aimed at harmonisation of cross-border congestion management and capacity allocation.

Efforts have been pursued to improve cross-border congestion management on Spanish-French interconnections. In June 2006, REE and RTE initiated the operation of their new system of joint monthly, daily and intra-day capacity

auctions for the France-Spain interconnection congestion management. On 14 December 2006, the operators held the first annual capacity auction to allocate rights for 2007. On 1 July 2007, a new version of the capacity allocation rules for the Spanish-French interconnection (the "IFE Rules") was put in place.

CROSS-BORDER TRADE

Its geographical location, significant cross-border connections with neighbouring countries, and competitive nuclear generation make France a strategic trading partner and principal electricity exporter in Western Europe. In 2009, France's net exports totalled 24.6 TWh (Table 21). France mostly exports baseload electricity, while its imports mainly occur during peak periods. In 2009, France reportedly became a net importer of electricity for an entire month for the first time in the last 27 years. Imports amounted to 458 GWh in October 2009. This situation reflected the temporary shut-down of reactors, mainly owing to disturbances in the maintenance planning following strikes earlier in the year; 18 of the country's 58 reactors were not in operation at end-October. EDF expects that nuclear generation in 2009 will have been at its lowest level in the past ten years.

France is also an arbitrage hub for Germany, Italy, Spain, Switzerland and the Benelux countries. This role is most noticeable through auctions at interconnections with Germany and Italy where prices in Germany are less than prices in France which are in turn less than prices in Italy. In 2008, the traded volume on the spot-day-ahead was 51.6 TWh. The volumes traded on Powernext, the French investment firm which designs and operates electronic trading platforms for spot and derivatives markets in the European energy sector, reached 91 TWh.

Table 21

Electricity Exports and Imports, 2005 to 2009

(TWh)

	2005	*2006*	*2007*	*2008*	*2009*
Exports	90.9	89.9	83.0	81.4	68.0
Imports	32.3	28.0	27.5	34.8	43.4
Net exports	58.6	61.9	55.5	46.6	24.6

Source :Solde des échanges contractuels suivis par RTE.

The trilateral market coupling France, Belgium and the Netherlands has yielded positive results with price convergence 66% of the time in 2008. Initiatives to achieve further coupling with related markets are being pursued. For example, the *Pentalateral Energy Forum* between France, Germany and the Benelux countries provides political backing for regional integration of electricity markets towards complying with EC directives for a European energy market.

MARKET REFORM AND REGULATION

Electricity market liberalisation in France as in other countries in the European Union (EU) is driven by the directives of the European Parliament and of the Council (Directive 96/92/EC and Directive 2003/54/EC). The directives lay down the general conditions that should be in place to assure the creation of a single internal electricity market (IEM) in Europe. The three major implementation aspects of the directives relate to market opening, third-party access and the independent system operator:

- all non-household customers are eligible from 1 July 2004 and all consumers are eligible from 1 July 2007;
- regulated third-party access is imposed and it is required to appoint a regulator, who has to approve the tariffs, monitor congestion management and act as a dispute-settlement authority;
- transmission and distribution companies have applied legal unbundling from 1 July 2004 and 2007, respectively.

WHOLESALE MARKET

The development of the French wholesale electricity market (created since 2001) has achieved significant milestones over the last decade:

- June 2004: launch of the Powernext *futures* market;
- January 2006: implementation of explicit capacity auctions on interconnections (except for Switzerland);
- November 2006: launch of the market coupling between France, Belgium and the Netherlands;
- July 2007: launch of Powernext *intraday* and *continuous* markets;
- April 2009: Merger of Powernext and the European Energy Exchange (EEX) and launch of EPEX Spot and EPD for *futures c*ontracts.

Most of the wholesale activity in the electricity market takes place over-the-counter (OTC), through direct transactions or through intermediaries (brokers and trading platforms). Delivery volumes resulting from OTC transactions were 56.3 TWh in the second quarter 2009. They decreased by 4.5% compared to the previous quarter, and fell by 12.6% compared to the same quarter in 2008. Volumes represented about 53% of national consumption in the second quarter 2009, against 41% in the first quarter 2009.

DISTRIBUTION/RETAIL MARKET

The seven largest distribution system operators are Electricité Réseau Distribution France (formerly EDF Réseau de Distribution), Electricité de

Strasbourg, Gaz et Electricité de Grenoble, URM (formerly Usine d'Electricité de Metz), SICAE de l'Oise, Sorégies Deux-Sèvres (formerly Régie du Sieds) and Sorégies. These network operators cover over 98% of French sites and national electricity consumption connected to the distribution networks. They are considered "incumbent utilities" in the current market framework. Competitors to the incumbent utilities include POWEO, Direct Energie and GDF Suez, and the foreign utilities E.ON, Enel and Endesa.

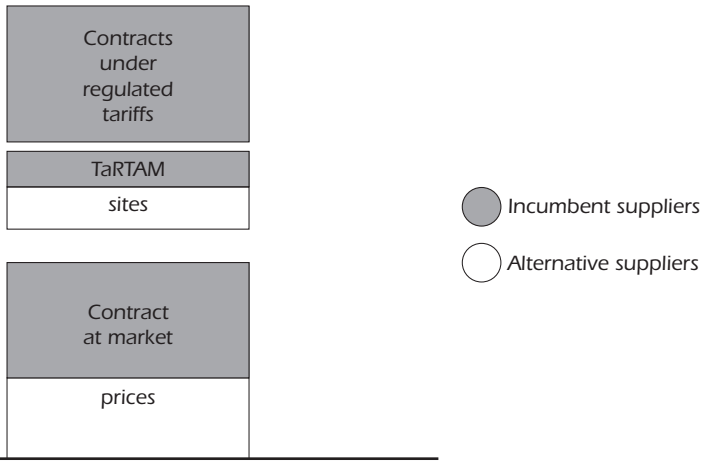
Market liberalisation in France was carried out progressively. Eligibility to choose supplier was first offered in France in 2000 to the largest consumers, those using more than 16 GWh/year. From 2003, consumers with an annual consumption higher than 7 GWh have been eligible. Eligibility was extended in 2004 to all companies and local government agencies. Since July 2007, and in compliance with the EC directive, all electricity consumers in France are eligible to choose their supplier.

Under the current market regime, each French electricity customer has a choice among three types of contracts:

- contracts under regulated tariffs (offered by incumbent suppliers only);
- contracts at market prices (offered by incumbent suppliers and alternative suppliers);
- contracts based on a transitional regulated market adjustment tariffs (TaRTAM) (available for a limited period to customers who previously subscribed a contract at market price).

Figure 22

Distribution of Electricity Contracts



Source: Commission de Régulation de l'Energie, France.

In December 2008, the alternative supplier's market share was 2.3% (or 3.3 TWh) in the residential sector (in terms of volume) and 11.6% (or 34 TWh) in the non-residential sector.

As of 30 September 2008, 16% of non-residential customers had contracts at market prices, of which 8.8% from historical suppliers and 7.2 % from alternative suppliers. In the residential sector, only 1.8% of customers had contracts at market prices, mainly with alternative suppliers. The number of customers with contracts at market prices increased from 621 400 in the second quarter 2006, to 788 000 in September 2008.

The French retail market consists of four segments:

- **Large non-residential sites**: sites whose subscribed power level is at least 250 kW. These sites include large industrial sites, hospitals, hypermarkets, large buildings, etc. (with an annual energy consumption generally over 1 GWh).
- **Medium-sized non-residential sites**: sites whose subscribed power level is between 36 kVA and 250 kW. These sites correspond to SME premises, for example (with an annual consumption generally between 0.15 GWh and 1 GWh).
- **Small non-residential sites**: sites whose subscribed power level is below 36 kVA. These sites correspond to the professional mass market (private professionals, trades, etc.). Their annual consumption is generally under 0.15 GWh.
- **Residential sites:** residential sites whose subscribed power level is below 36 kVA. Their annual consumption is generally under 10 MWh.

Table 22

Status of Retail Market Distribution, December 2008

	Residential sites		*Non-residential sites*	
	As of December 2008	*As of September 2008*	*As of December 2008*	*As of September 2008*
All sites (TWh)	140	139	292	295
Sites at market prices (TWh)	4	2.4	134	137
TaRTAM sites (TWh)	–	–	82	85
Altenative suppliers (TWh)	3.3	2.4	34	36
Share of alternative suppliers (%)	2.3	1.7	11.6	12.4

Source: CRE, Electricity and Gas Market Observatory, 4th Q 2008.

As of 31 December 2008, about 160 suppliers are active within France, including the incumbent local suppliers (*i.e.* local distribution companies). These suppliers operate locally or regionally and offer contracts to one or more segments of customers.

REGULATION

In France, the electricity and gas markets are regulated by the Energy Regulatory Commission or *Commission de régulation de l'énergie* (CRE), an independent administrative body. It works to guarantee smooth and efficient operation of the electricity and natural gas markets and the absence of discriminatory practices, cross-subsidies or restrictions on competition. The powers vested upon CRE by the laws of 10 February 2000 and of 3 January 2003 are part of the range of powers generally devolved upon independent administrative authorities responsible for regulating a market or a sector that is opening up to competition. These powers include:

- powers of decision, approval or authorisation;
- settlement of disputes (art.38 law of 10 February 2000);
- power of penalty (art.40 law of 10 February 2000);
- powers of proposal;
- information and powers of inquiry (art.33 law of 10 February 2000);
- additional powers to those of the minister;
- consultative powers.

The CRE approves the annual investment programme of the transmission electricity grid operator. CRE may take regulatory decisions in several other areas, including missions of system operators, rules of connecting to systems, conditions of access and use of systems, programmes of appeal and balancing, system access contracts and protocols, and principles of account unbundling. The CRE can also make proposals, particularly with regard to: rates for the use of public electricity grids; the annual amount for expenses chargeable to public service missions; the amount for the contribution applicable per kilowatt/hour and the amount of refunds that operators with public service responsibilities receive; the necessary protective measures for ensuring the security and safety of public electricity grids and guaranteeing the quality of their operation. The CRE publishes an annual report on compliance with the codes of conduct by operators of transmission and electricity distribution systems, as well as an assessment on their independence. It proposes, as necessary, measures that will guarantee the independence of these operators.

The CRE issues a recommendation on the social tariff rate mechanism intended to guarantee the right to electricity for people with financial difficulties. If generating capacities do not meet the government's objectives through operators' initiatives, the Minister for Energy may resort to a call for tenders. The CRE has the responsibility of implementing this call for tenders. CRE thus drafts specifications, sorts out the offers and issues a recommendation on the applicants. The final choice of applicant is made by the minister.

Every year, CRE suggests to the Minister for Energy a sum for public service expenses and a sum for the contribution applicable per kilowatt per hour. It also suggests to the Ministers for the Economy and Energy the amount of reimbursements made in favour of operators with public service responsibilities.

The CRE is the guarantor of the independence of the transmission system operator (TSO). It approves the TSO's annual investment programme; issues a recommendation on the long-term development outline of the operator's system and the transmission grid; and approves the rules of activities: *e.g.* account unbundling between generation, transmission and electricity distribution and other activities of integrated operators of electricity.

ELECTRICITY PRICING

In France, there are different types of contracts for electricity consumers at regulated tariff or at market prices. According to the law, regulated tariffs cover the full costs. In recent years, the wholesale market price of electricity has increased substantially, whereas the tariffs, based on average costs, have remained relatively stable. As a result, certain users are enjoying tariffs significantly below the wholesale market price.

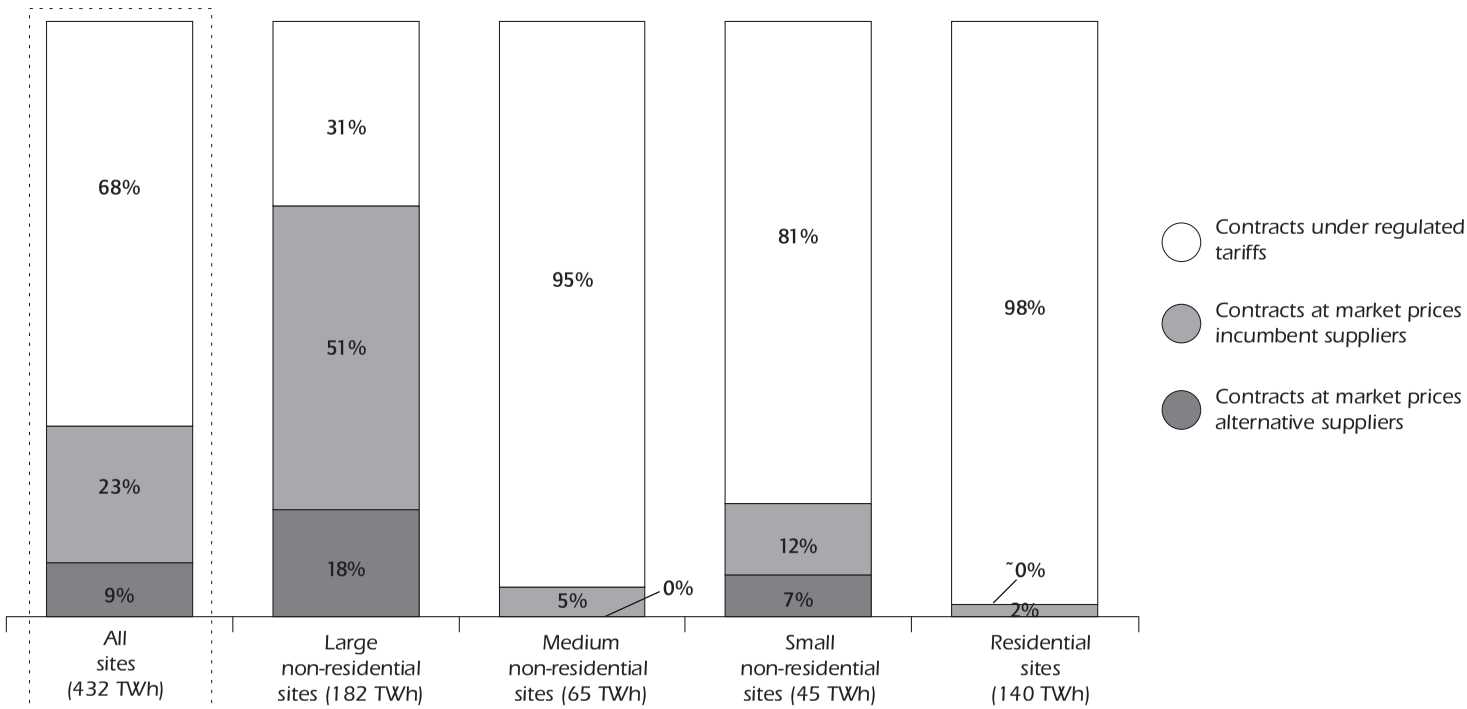
A social rate was established by law N° 200-108 dated February 2000. It was implemented according to Decree N° 2004-325 dated April 2004.[19]

Until the beginning of 2007, clients who had left the regulated market could not return to it: the choice of the liberalised market was irreversible. In 2007, the French authorities made such return possible, under certain conditions, by creating the "TaRTAM" system (transitional regulated market adjustment tariffs). Under this system, clients who had left the regulated tariffs for the liberalised market can ask to benefit again from a transitional regulated tariff for a period of two years. In 2008, the law was amended to maintain the possibility for customers if they make the request to their supplier before

19. See Chapter 2, section on Energy Pries and Taxes, for more information on social tariffs.

Figure 23

Share of Consumption for Each Type of Contract, 31 December 2008



Source: CRE, Electricity and Gas Market Observatory, 4th Q 2008.

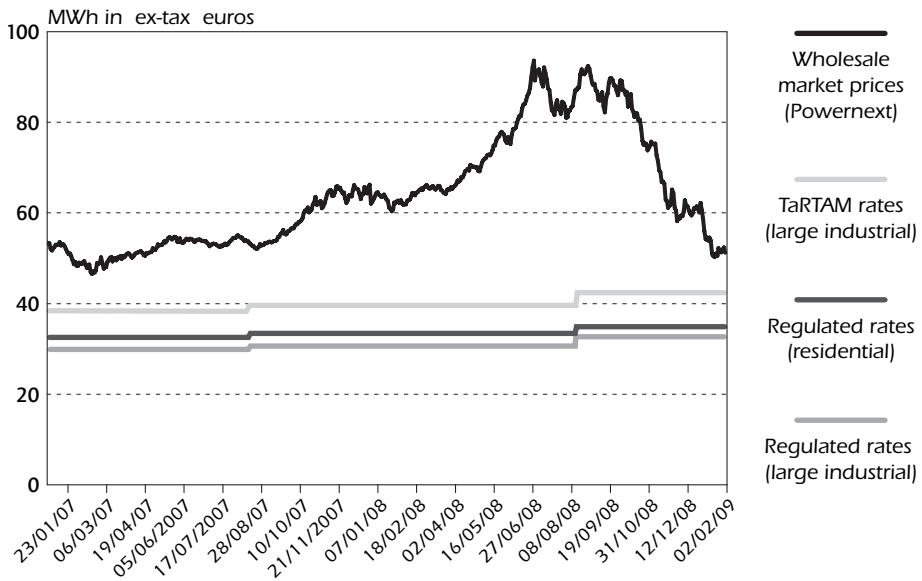
30 June 2010. The TaRTAM rate is equal to the regulated retail tariff exclusive of tax, increased by a percentage between 10% and 23% depending on the class of tariffs. Thus, the pricing system is complex.

To finance the TaRTAM system, France has introduced two levies, one payable by all French electricity consumers, and the other payable by the large producers of electricity from nuclear and hydropower. The TaRTAM system is costly for EDF because the company not only has to offer the tariff but also has to pay into the fund that subsidises it. EDF reported that in 2008 TaRTAM reduced its profit by EUR 783 million after tax, and estimated that the pre-tax cost of the TaRTAM regime would be EUR 2 billion between 2006 and 2010.

At the end of 2008, around 3 370 non-residential sites benefited from the TaRTAM. They represented an annual consumption of 82 TWh, or 61% of the consumption of non-residential sites with contracts at market prices. There were 796 000 non-residential sites and 699 000 residential sites which have contracts at market prices.

Figure 24

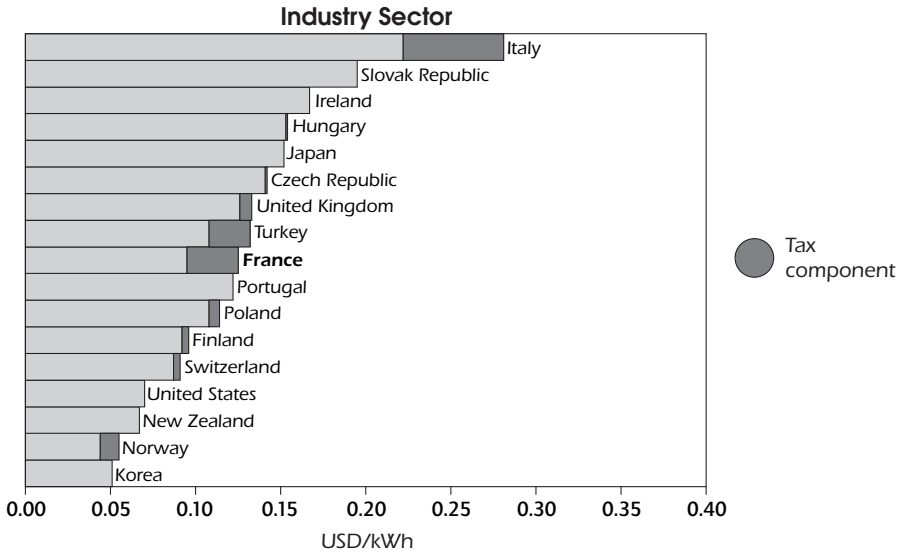
Illustrative Comparison of the Costs of Electricity Supply, Based on Market Prices, TaRTAM and Regulated Prices



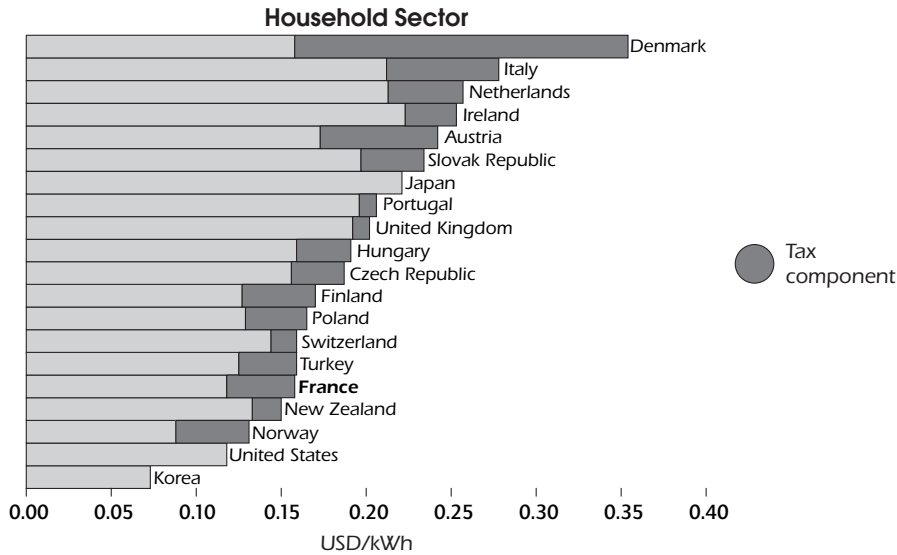
Source: Commission de régulation de l'énergie, France.

Figure 25

Electricity Prices in IEA Member Countries, Second Quarter 2009



Note: Tax information not available for Korea and the United States. Data not available for Australia, Austria, Belgium, Canada, Denmark, Germany, Greece, Luxembourg, the Netherlands, Spain and Sweden.



Note: Tax information not available for Korea and the United States. Data not available for Australia, Belgium, Canada, Germany, Greece, Luxembourg, Spain and Sweden.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2009.

CRITIQUE

France has achieved commendable progress in the electricity sector since the last IEA in-depth review, including full market opening since July 2007, reduction of state control in generation assets, improved generation transparency, a broader mandate for an independent regulator (CRE), creation of a mediator, substantial increases in wind power capacity, significant generating capacity under construction and planned, and milestones achieved in transmission investments. The Grenelle initiatives, the Champsaur Commission (see Chapter 8 on Nuclear Power), and recent announcements by the government to pursue further reform of the electricity market are notable achievements. The government plays an active role in this strategic sector to ensure security of supply, affordability and high quality of service to all consumers. The government should continue to press forward with electricity market reforms.

However, some key challenges remain. Probably the most pressing one is to improve the market framework to achieve greater competition in electricity supply. The issue of regulated electricity tariffs resulting in market distortion needs to be addressed. Transmission development should be pursued, both domestically and across borders. The French government should put more emphasis on its role as a market facilitator by providing clear policy directions and an adequate institutional framework, and support the role of cost-reflective pricing in investment decisions. While France is relatively well positioned to address climate change given its high share of low-carbon generation, concerns about electricity security deserve special attention.

MARKET REFORM

The transition to competitive markets has been particularly challenging because of the regulated tariffs and the dominant role of the incumbent utility. While the generation and retail sectors are fully open to competition, in line with EU directives, competition is rather limited. EDF controls a large nuclear fleet, with production costs lower than wholesale electricity prices. This gives EDF a significant competitive advantage and limits the scope for its competitors to develop market share. Asymmetry of information is another factor constraining competition. An investigation by the Energy Regulatory Commission (CRE) revealed that EDF intervened in the market with privileged information on 18 October 2009, which saw prices reaching EUR 3 000 per MWh. Following the CRE press release, EDF announced on 23 November 2009 a forthcoming improvement in data related to generation transparency. Mid-term predictions and real-time information about available capacity will be released, unit by unit (with capacity greater than 100 MW).

Electricity wholesale prices reflect marginal generation cost. Because the average European generation mix is constituted primarily of gas and coal-fired generation units, electricity prices follow the evolution of international

coal and gas prices. Hence, in most countries, wholesale market prices are in line with marginal generation costs. This is not the case in France. The French electricity market is unique compared to markets in other European countries since its generation is predominantly based on nuclear. Fuel costs represent only 5% of the total cost of nuclear generation.

In this market environment, new entrants have no choice but to buy electricity on the liberalised wholesale market, or invest in coal and gas plants that are more costly to operate than nuclear plants. Consequently, competition is limited. A switch from regulated tariffs (based on average costs) to tariffs linked to wholesale market prices may not necessarily enhance competition, since the incumbent operator would still benefit from a comparative advantage (related to nuclear technology). For these reasons, eliminating regulated tariffs would not necessarily meet the objective of fully competitive markets.

In April 2009, the Champsaur Commission proposed that all suppliers in the market be given access to the low-cost electricity generated by EDF's fleet of nuclear reactors at a regulated price. This tariff should be set at the average cost of production, incorporating maintenance costs, costs for the life extension of existing nuclear plants. The commission stresses that the volumes are for national use only. A key impact of Champsaur's proposed system is that each supplier would be able to compete with the incumbent operator. This is expected to enhance competition on the retail market, so that the regulated tariffs can be eliminated for large consumers, and allow EDF to finance life extensions of its nuclear power plants.

In September 2009, the government announced proposed legislation to essentially implement Champsaur`s main recommendation, *i.e.* allowing all electricity suppliers in France to have access to EDF's "historic" nuclear power capacity at a regulated price. The reforms will have to be voted upon in Parliament by July 2010. The proposed reform constitutes a significant step for more competition in French electricity markets. The IEA applauds France's commitment to phase out regulated tariffs for large and medium-sized companies. These tariffs have been subject to investigation by the European Commission.

TRANSMISSION

The expansion of cross-border interconnections would facilitate the development of an internal electricity market thanks to France's strategic geographical location and its role as a trading hub. Notwithstanding the importance of domestic interconnections, continued participation in regional initiatives and co-ordinated regional transmission planning should be pursued. Significant progress has been achieved regarding the Spain-France interconnection. It would be essential to pursue efforts on both sides of the border to build the line as quickly as possible, while carefully managing the risks associated with the high construction cost of underground cables.

Investments in cross-border transmission expansion enhance energy security and market efficiency through increased potential for reserve-sharing, enhanced grid flexibility to cope with wider fluctuations in supply and demand, and greater access to competitive generation sources. It would be important for the Energy Regulatory Commission, the transmission system operator and government entities to closely monitor and facilitate the development of multi-jurisdictional transmission projects, often more complex and more time-consuming, to ensure they can be implemented in a timely manner and are cost-efficient. The experience of the Spain-France interconnection indicates that social acceptability may cause very long and costly delays. Efficient transmission planning requires a co-ordinated approach and regional consideration.

Planned transmission investments include the construction of underground cables. These cables may reduce delays in siting and permitting. At high voltages, the costs of underground cables can be substantially higher than those of overhead lines, which put upward pressure on electricity prices. This is an area that merits monitoring, especially considering the limited international experience to-date for long distances and voltages at 400 kV and higher.

From a broader policy perspective, transmission should be considered as a critical part of the mix of solutions to facilitate the transition to a more secure, competitive and sustainable power sector. Power systems are evolving and there are key emerging trends that will shape the power system of the future: increasing share of variable renewable electricity, distributed generation, demand participation, hybrid and electric vehicles, and smart grid technologies. In this context, there is a need to develop a vision of sustainable power systems, and how the transmission can be effectively developed and contribute to sustainability.

STRUCTURAL IMBALANCE AND ELECTRICITY SECURITY

The French electricity system also faces issues related to meeting peak demand, which has increased faster than energy demand in recent years. On the one hand, the system has surplus baseload capacity that enables France to play a significant role in the European electricity export market. On the other hand, electricity demand is increasingly "peakier" owing to growing heating loads. The latest peak demand in France was set on 7 January 2009, when consumption reached 92 400 MW with temperatures dropping to -10°C in some places.

This apparent structural imbalance between strong baseload generating capacity and peakier demand may be amplified by low availability factors of nuclear reactors, increasing risks of supply disruptions in some regions more than others. The situation can only worsen if no proper course of action is taken through, for example, increased interconnections, more investments

in peaking capacity, or demand-side measures. From an electricity security perspective, France might want to asses the desired level of diversification of its generation mix and the most cost-effective ways to meet peak loads.

The *Grenelle de l'Environnement* calls for significant increase in renewable electricity, especially wind power which is expected to increase from about 4 000 MW currently to 25 000 MW by 2020 (see Chapter 6). Wind farm developers face significant challenges related to the complexity of the permitting process, and to public opposition. With many jurisdictions involved in the permitting process, at various government levels, regulatory and administrative duplication should be avoided.

To achieve a large-scale wind power development, the permitting process should be improved. Furthermore, significant penetration of intermittent energy resources poses issues related to grid operations, including voltage stability and system balancing. Effects on network security can be mitigated through revised grid rules and/or through an increased flexibility of the networks. Flexibility can be improved by allowing larger supply-and-demand balancing areas, unconstrained cross-border interconnections, demand-side measures, trading closer to real time, and storage.

Markets should be guided by clear, long-term energy strategies to ensure security and sustainability of supply while meeting the needs of customers. While there is a clear emphasis on renewables, it is unclear what potential role could be attributed to French nuclear power in the emerging European internal electricity market. Clear policy directions would help to ensure a healthy investment climate in energy infrastructures.

Although nuclear development is not without challenges, and an important one is risks of construction cost overruns, there has been a renewed interest in nuclear among IEA member countries, and globally as well. Nuclear technology is currently, apart from hydropower, the only large-scale, baseload electricity source with a near-zero carbon footprint. Thanks to a surplus of baseload generation, France has played an important role in exports, contributing to electricity security of interconnected regional markets. It seems appropriate for France to assess and clarify the strategic role of nuclear power in the emerging internal electricity market.

THE ENERGY REGULATORY COMMISSION

Initiatives to strengthen and clearly define the role of the CRE, including that of market monitoring, are commendable. The CRE is broadly involved in the regulation of electricity matters. Its monitoring of the market has been effective. However, the regulator is not fully independent because it has only an advisory and consultative role in some areas. Its proposals on electricity

rates of transmission tariffs are subject to government approval.[20] This lack of decisional power may have an impact on the level of confidence in markets and on investments. An independent regulator is necessary to ensure a well-functioning market. The current reliance on legal and accounting unbundling of network assets underscores the need for a strong regulator and close oversight.

The French government's pursuit of experimental and commercial implementation of smart grid technologies is encouraging. The design of the nationwide roll-out of smart grids, however, has to be decided upon. Co-ordination of the different existing regional projects for smart grids should be harmonised to reach a minimum efficient scale. The regulator can play a proactive role in helping set the standards, and proper incentives for smart grid investments and consumer participation.

RECOMMENDATIONS

The government of France should:

- *Implement as quickly as possible measures to enhance competition in the generation and retail sectors.*
- *Promote and support timely expansion of cross-border interconnections to facilitate trade and to improve reliability, security of electricity supply and economic efficiency.*
- *Address the growing structural imbalance between surplus baseload capacity and increasingly "peakier" demand by investing more in peak capacity, boosting demand-side measures and enhancing the flexibility of the power grids.*
- *Streamline the permitting process of generation facilities, especially for wind parks, through regulatory harmonisation, process standardisation as well as clear and stable criteria for granting approvals.*
- *Develop a strategic vision for electricity network infrastructures, taking into account key emerging trends such as demand-side management, electric vehicles and the increasing share of renewables-based and distributed generation, making full use of the potential of smart metering and smart grid capabilities.*

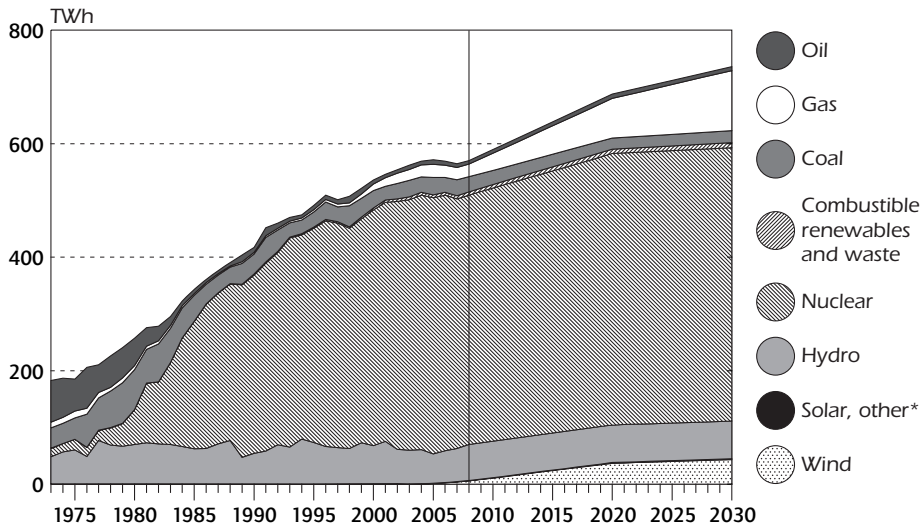
20. The government can approve or reject tariffs, not modify them.

OVERVIEW

France's nuclear reactor fleet of 58 pressurised water reactors (PWRs) on 19 sites providing 63 GW of installed capacity is highly standardised and was constructed during the relatively short period 1977-1996. The capacity of individual units ranges from 900 MW to 1 450 MW and the average age of the fleet is 23 years. In 2007, the share of nuclear power in total primary energy supply was 44% and its share in electricity production was 78% (Figure 26).

Figure 26

Electricity Generation by Source, 1973 to 2030



** other* includes tide and wave (negligible).

Sources: *Energy Balances of OECD Countries,* IEA/OECD Paris, 2009 and country submission.

According to the Pluri-annual Investment Plan (PPI) of the Ministry of Ecology, Energy, Sustainable Development and the Sea (MEEDDM), the relative contribution of nuclear energy to French power production will decline to about 70% in 2020. This is principally due to government's support for the strong development of renewable energies, whose contribution to electricity production is expected to more than double. The construction of two new European pressurised water reactors (EPRs) in Flamanville (to be commissioned in 2012) and Penly (to be commissioned in 2017) is included

in this trend. It is foreseen that a number of European energy companies such as Enel, GDF Suez, E.ON or Total will be associated in both projects as minority partners. Alongside the commissioning of these two EPRs and the surge in production from renewables, two other challenges that are laid out in the PPI are to stabilise the demand of electricity at its current level and to succeed in keeping existing nuclear power plants in operation beyond the 40-year original lifetime. The construction of a third EPR before 2020 was shown to be unnecessary to meet this specific scenario. Nevertheless, the possibility of constructing a third EPR before 2020, perhaps with another company as project manager, was not entirely ruled out given the uncertainties surrounding the baseline scenario. While the baseline scenario for the French national supply and demand balance would not require a third EPR, a broader European perspective or the wish to maintain industrial competences could lead to a share of over 70% nuclear in the energy mix beyond 2020.

RECENT KEY DEVELOPMENTS

In June 2006, France enacted two major new laws regarding its nuclear sector. The Act on Transparency and Security in the Nuclear Sector created an independent Nuclear Safety Authority, the *Autorité de sûreté nucléaire* (ASN) as well as a High Committee for Transparency and Information on Nuclear Security, the *Haut comité pour la transparence et l'information sur la sécurité nucléaire* (HCTISN).

The 2006 Planning Act concerning the Sustainable Management of Radioactive Materials and Waste defines a national policy for the management of radioactive wastes and materials. Under this act, a National Agency for Radioactive Waste Management (ANDRA) is in charge of long-term operations for radioactive waste management. Under this Planning Act, a National Plan for the Management of Radioactive Materials and Waste (*Plan national de gestion des matières et des déchets radioactifs* (PNGMDR)) establishes a comprehensive framework for managing all kinds of radioactive waste and materials. The Planning Act also asserts that the responsibility for nuclear wastes rests upon waste producers, who are liable for financing the costs of waste disposal. Of particular interest in this context is the disposal of long-lived high-level nuclear waste of French origin (foreign wastes will not be accepted), for which the law specifies a reference management solution, namely reversible disposal in deep geological structures (see Box 3 below). The PNGMDR will be updated in 2010.

INSTITUTIONAL AND INDUSTRIAL FRAMEWORK

Several ministries participate in the definition of the French nuclear policy, in particular the ministry in charge of energy and of the environment (MEEDDM), and the ministry in charge of higher education and research (MESR). Notably,

compliance with safety and radiation protection rules is not controlled by the government itself. This mission is carried out by an independent Nuclear Safety Authority (*Autorité de sûreté nucléaire,* ASN).

The ASN is responsible for ensuring compliance with the rules and regulations which apply to activities under its control, providing advice to the government on draft decrees and ministerial decisions and disseminating information to the public, including in the case of an emergency. In this case, the ASN is responsible for informing the public about the safety status of the installation concerned and any discharges into the environment and risks to human health and the environment. The ASN will play an important role in the development of the French nuclear sector since it decides on the commissioning, the operational safety and the lifetime extension of nuclear plants.

The Institute for Radiation Protection and Nuclear Safety (*Institut de radioprotection et de sûreté nucléaire*, IRSN), an autonomous public body, is the principal public source for research and expertise on nuclear and radiological risks in France. IRSN contributes to public policies relating to nuclear safety and protection of human health and environment with respect to ionising radiation. One of its main tasks is to provide technical support for the public authorities, including ASN, and reports to the MEEDDM and four other ministries.

The *Commissariat à l'énergie atomique* (CEA) is a public organisation created in 1945 in order to carry out and support all developments and applications in both civilian and military uses of nuclear energy. It is a key player in research, development and innovation in the fields of low-carbon energy (nuclear, new energy technologies), defence, information technologies, communication and health technologies. Its activities include advising the French government in matters of foreign nuclear policy and representing France in international nuclear organisations such as the International Atomic Energy Agency (IAEA). The CEA played a crucial role in developing different nuclear reactor designs in France and is now in charge of the R&D needed for developing the fourth generation of reactors (see hereafter section on Nuclear Research). The French President has recently announced that the CEA will become the Atomic and Alternative Energy Commission in order to reflect the evolution of its activities in low-carbon energy.

The National Agency for Radioactive Waste Management (*Agence nationale pour la gestion des déchets radioactifs*, ANDRA) is the national organisation for radioactive waste management.

Electricité de France (EDF) is the majority owner and operator of all the commercial nuclear power plants in France.

AREVA is a world leader in nuclear energy and the only vertically integrated company that covers all aspects of the fuel cycle, from mining through to waste treatment.

THE NUCLEAR "RENT" AND THE CHAMPSAUR COMMISSION REPORT

France, like the whole of Europe, has experienced a period of high electricity prices in the wholesale market, partly because of the introduction of the European Union Emissions Trading Scheme (EU-ETS) for carbon emissions. This resulted in substantial profits for electricity utilities, in particular those based on carbon-free nuclear and hydropower. This has fanned a historic debate about the correct distribution of the "nuclear rent", the real or perceived difference between the full costs of the nuclear fleet and current market prices in the context of liberalised electricity markets.

The part-privatisation of EDF posed the question of whether the value generated by its nuclear reactor fleet belongs to its shareholders, the French taxpayers or French electricity consumers. The investment in France's nuclear reactors benefited from considerable government support, in particular in the form of long-term loan guarantees, and their construction costs have by now been largely written off. Their current (variable) costs are significantly below European market prices and have the ability to generate substantial profits. So far, the French government managed the issue by requiring EDF to offer electricity to retail customers (households and small and medium-sized enterprises) at a regulated tariff, based on the cost, that for most of the past years was substantially below market prices. This tariff was considered by the European Commission as an obstacle to market liberalisation.

In this situation, the French government convened a commission to develop alternative proposals which were published in April 2009. Its key proposal was to abolish electricity tariffs except for small consumers but to require EDF to sell an unspecified amount of nuclear power at "the economic conditions of the historic nuclear fleet, including the investment needed for their lifetime extensions" to a number of competing distributors to encourage downstream competition. A proposal for a new law on this basis is currently under development. As an estimate for this price, a non-binding proposal by the French Association of Electricity Suppliers (*Union française de l'électricité*, UFE) advances a range of EUR 35 to 45 per MWh to compare to the projected cost data, provided by EDF, of a new reactor at around EUR 55 per MWh.

NUCLEAR PLANT LIFETIME EXTENSIONS

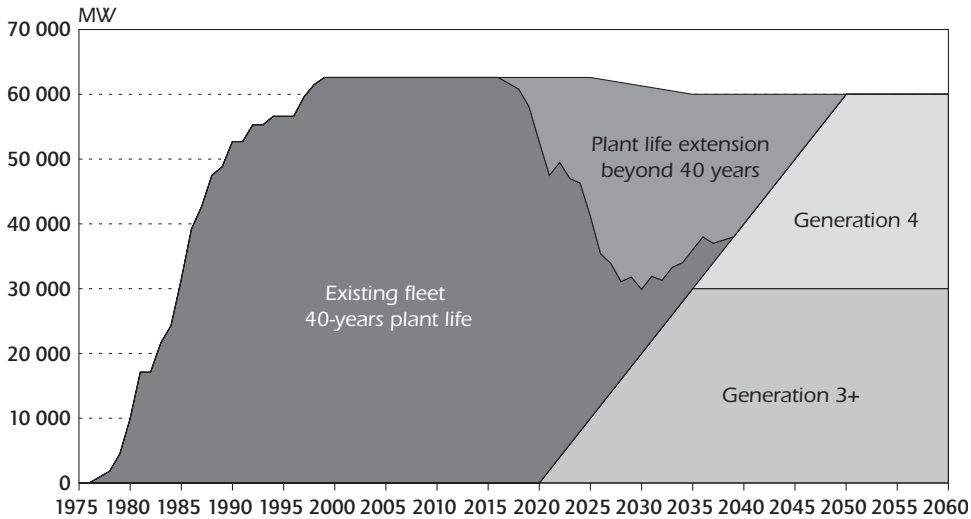
Lifetime extensions of nuclear reactors need to be validated by the ASN. While its decision is not legally binding, it would require exceptional circumstances for the government to go against the advice of the ASN. The ASN will begin deliberating on the fourth round of ten-year operating licences for the 34 reactors of 900 MW, the first of which reaches 40 years of operation in 2017, but is conscious of the issue and seems well prepared (Figure 27).

A dialogue with EDF, which operates all nuclear reactors in France but is exploring co-operative deals with several European utilities for its two new EPRs, has begun and is facilitated by MEEDDM.

While most nuclear power plants are designed to operate for at least 40 years, lifetime extensions beyond that limit are not a forgone conclusion. The decision to build two new plants was also taken to generate a safety margin for electricity supplies in case lifetime extensions beyond 40 years would not be forthcoming across the board. The question thus remains open whether additional nuclear reactors will be needed. In recent years, France has increasingly relied upon electricity imports during wintertime to cover demand.

Figure 27

The Composition of the Nuclear Reactor Fleet over Time



Note: Generation 3+ designs are those which offer significant improvements in safety and economics over the Generation 3 advanced reactor designs. Generation 4 reactors are a set of theoretical nuclear reactor designs currently being researched; most of which are generally not expected to be available for commercial construction before 2030.

Source : Hédin, F. and J. Roux (2007), "Enjeux industriels et réexamen de sûreté", *RGN Revue Générale Nucléaire*, No. 2, every two months, Paris, France.

THE GLOBAL DIMENSION

France's nuclear industry also has a strong global dimension. AREVA, the French supplier of nuclear reactors, intends to participate fully in any global nuclear revival. Estimations of future demand vary greatly but between the replacement of existing plants and genuinely new builds, the size of the global market for new reactors by 2030 is estimated to be roughly equal to the

existing capacity of 390 GW. Both EDF and AREVA are already involved in a number of projects to construct new nuclear plants in China.

The French government has offered its assistance to countries wanting to develop nuclear energy and has created in May 2008 the French International Nuclear Agency (*Agence francaise nucléaire internationale*, AFNI) that helps interested countries to create the technical and institutional infrastructures necessary for the operation of nuclear power plants. France also supports the development of a European directive on nuclear safety, but wishes that its brief remain confined to general guidelines rather than specific regulations.

NUCLEAR FUEL CYCLE

France has a fully developed fuel cycle strategy for the entire supply chain (covering uranium, conversion, enrichment and fuel fabrication). Reprocessing of spent fuel remains an essential part of this strategy. It provides long-term security through the recycling of plutonium and reprocessed uranium, whose output currently accounts for 10% of EDF's nuclear electricity output, with the share expected to rise to 20% in 2010. High-level waste is confined in vitrified casing, and stored in interim storage facilities, until geologic disposal is available. The main stakeholders in the nuclear fuel cycle are outlined by activity in Table 23. Nuclear fuel cycle operations in France strive for both cost efficiency and operational excellence. To cover uranium requirements, France has pursued a policy of geographic diversity of supply since its domestic mines closed in the 1990s, and made significant investments in exploration and mine development in key producing countries, including Canada, Namibia, Niger and Kazakhstan. The high-level waste issue remains a key challenge.

Table 23

Main Stakeholders by Activity

Cycle	*Activities*	*Company*
Upstream	Mining	AREVA NC
	Conversion	COMURHEX
	Enrichment	EURODIF
		SET *
Reactors	Reactors and services	AREVA NP **
	Fuel	FBFC
		CERCA
	Electricity production	EDF
Downstream	Treatment	AREVA NC
	Recycling	MELOX
	Waste management	ANDRA

* AREVA has opened the capital of the *Société d'enrichissement du Tricastin* (SET) to shareholders who could hold up to 20% of capital.

** Siemens announced in January 2009 its intention to rescind the capital of AREVA NP.

Source: MEEDDM.

The disposal facility for low- and intermediate-level radioactive waste (CSFMA) has operated since January 1992 and is located in eastern France (in the Aube department). It took over from another disposal facility that was closed in 1994. ANDRA will monitor this closed facility for 300 years. The disposal facility for very-low-level waste (CSTFA) has been in operation since 2004. Regarding long-lived, low-level waste, studies and investigations are currently under way to determine a suitable disposal solution. In June 2008, the government launched a call for applications from local communities to host a disposal facility. ANDRA is conducting investigations and initiating procedures for consultation, while local authorities are developing regional projects in partnership with radioactive waste producers and state services.

Table 24

Management Solutions Developed under the National Plan for the Management of Radioactive Materials and Waste for Different Categories of Waste

<table>
<tr><th></th><th>Very short life (<100 days)</th><th>Short life (<30 years)</th><th>Long life (>30 years)</th></tr>
<tr><td>Very low level</td><td rowspan="4">Radioactive decay</td><td colspan="2">Surface disposal (repository for very low activity waste in the Aube department)</td></tr>
<tr><td>Low level</td><td rowspan="2">Surface disposal (repository for low- and medium-level waste in the Aube department)</td><td>Near-surface disposal (research conducted under the Act of 28 June 2006)</td></tr>
<tr><td>Intermediate level</td><td></td></tr>
<tr><td>High level</td><td colspan="2">Deep disposal (research conducted under the Act of 28 June 2006)</td></tr>
</table>

Source: MEEDDM.

High- and intermediate-level wastes come mainly from reprocessing of spent fuel in the power sector. They are currently stored at the reprocessing plant at the sites of La Hague and Marcoule. The national strategy is to eventually dispose of the waste in north-east France (see Box 3).

With respect to financing, the 2006 Planning Act maintains the principle of "producer pays" for radioactive waste throughout its lifetime. Moreover, to guarantee that money is available when needed, operators of basic nuclear facilities are required to secure the financing of decommissioning and of radioactive waste management by allocating dedicated assets to cover long-term nuclear charges. The choice was made to leave the funds in each company to enhance accountability, both in terms of assessing costs and managing assets.

Box 3

Disposal of High-Level Nuclear Waste

Together with Finland and Sweden, France is one of the first OECD countries to tackle comprehensively the issue of final disposal for spent fuel and high-level nuclear waste. In the framework of the 2006 Planning Act on the sustainable management of radioactive materials and waste, ANDRA is currently prospecting an area of 250 km² (in the Meuse and Haute-Marne departments in north-east France for the final disposal of high-level and long-lived intermediate-level nuclear wastes most of which are currently stored on-site. In this zone, ANDRA already runs a research laboratory, which conducts experiments and geological research in a clay formation with low water permeability at 500 metres depth. Investigations will now focus on a restricted area (Interest Zone) of 30 km² in which the disposal facility will be located.

The following timetable is currently considered:

2010-11	Comprehensive survey of the Interest Zone
2012-13	Public debate
2013	Final site selection in the Interest Zone
2015	Application for construction licence
2017	Start of construction if the authorisation is granted.

If the current timetable is kept, the first waste containers could be disposed of from 2025 onwards.

Source: ANDRA.

NUCLEAR RESEARCH

Most of France's nuclear research, both civil and military, is managed by the *Commissariat à l'énergie atomique* (CEA). The CEA is restructuring some of its activities under a new heading of "non GHG-emitting technologies" which includes renewable energies and fusion. It remains, however, fully committed to the development of fourth-generation nuclear reactors in the context of the Generation IV International Forum (GIF). Another important research area concerns advanced fuel cycles, including partitioning and transmutation of minor actinides. It is preparing a government decision on a sodium-cooled fourth-generation demonstration reactor for 2012 (the ASTRID project) and is going ahead with the construction of the Jules Horowitz research reactor (JHR) that is expected to begin operations in 2014. In addition to its research function, the JHR would, in principle, be able to produce medical radioisotopes, thus providing a supplementary medium-term option for addressing the current global shortage. France was selected in 2005 to build

the International Thermonuclear Experimental Reactor (ITER) on the site of Cadarache, inland from Marseille. The agreement on the establishment of the ITER fusion energy was signed in November 2006 by the French President. The CEA is undertaking applied research in the optimisation of the industrial use of nuclear energy in co-operation with EDF and AREVA as well as in information and health-care technologies. Significant efforts are also being made to enhance training in the nuclear field. For example, an Advisory Committee on training in science and nuclear technology has been created to develop and co-ordinate training activities.

CRITIQUE

Between the opening of European power markets on the one side and, on the other, the perspective of a global nuclear revival prompted by concerns about climate change and security of energy supply, France has begun to implement important institutional reforms to consolidate the framework conditions for its nuclear power sector. The creation of ASN and the commitment to open a waste disposal facility are important steps in the right direction in this context.

A similar clarification and consolidation needs to take place with respect to the market conditions under which France's 58 nuclear power reactors continue to ensure reliable electricity supplies at the national and, increasingly, the European level. Currently, the sector is exposed to contradictory signals from international power markets on the one hand and political demands to provide nuclear power to national consumers at a cost that reflects the economic conditions of France's historic nuclear fleet, on the other. This tension is not helpful in organising the substantial medium-term investments needed for the maintenance and life extensions of France's reactor fleet, and the substantial long-term investments needed for its renewal and expansion. Nuclear energy has served France well. Continuing its development now requires two conditions. The first would be a clarification of the economic framework in which nuclear energy will operate in the coming years. The second would be an intensification of international co-operation at the level of the European electricity market while ensuring the safe and sustainable use of nuclear power in the global context of an increased demand for low-carbon power, where France's scientific expertise and operational experience has much to contribute.

It is not certain that the proposals of the Champsaur Commission will enable the healthy development of both France's electricity sector and its nuclear industry. Since it requires EDF to sell below market price, this will delay providing a solid economic footing for the French nuclear sector in a competitive market environment. If a nuclear rent exists, then it should be returned to the French public in a market-compatible manner. Either the French government, still by far EDF's largest shareholder (85%), should insist

on higher-than-average dividends for a specified period, or EDF should be required to return the nuclear rent as a lump-sum payment to the French public, possibly earmarked to fund a social tariff. Both options would allow France's nuclear operator subsequently to charge market prices for its output and thus to fund its future development through the market.

Nuclear power produces baseload electricity. The historically low utilisation rate of French nuclear power plants, which fell below 80% in 2008, is due partly to technical problems but also partly to the fact that nuclear energy is occasionally used for mid-load electricity. The addition of large amounts of intermittent renewable energies might pose additional problems for the stability of the French transmission supply system, given the relative inflexibility of nuclear plants.

France's massive production of nuclear baseload electricity and its historic overcapacity make it a natural exporter of baseload energy to its European neighbours. In return, France is increasingly importing peakload power, especially during cold winter days, when the temperature sensitivity of its electrically heated building stock is at its highest. Exports and imports to and from its European neighbours are also clearly seen by the French authorities as a buffer for uncertainties in the wake of the ambitious Grenelle programme to reduce French electricity demand. However, this is not always acknowledged in public debate in France. French nuclear power has a European dimension, which needs to be sufficiently articulated to its European neighbours.

In the long run, the question of the future adequacy of France's nuclear fleet cannot be separated from the organisation of its electricity sector. Despite lingering reservations, France and its major industrial champions have committed themselves irreversibly to a market-oriented organisation of the power sector in a European context. Developing adequate nuclear capacity is therefore dependent on electricity prices reflecting the full costs of nuclear power production, including its development cost. The current tariff structure does not ensure coverage of the development costs of new nuclear capacity and may pose a medium-term threat to ensuring sufficient future industrial investment in nuclear capacity.

RECOMMENDATIONS

The government of France should:

- *Build on the institutional reforms in the French nuclear sector (ASN, ANDRA, 2006 Planning Act, the corporatisation of EDF, etc.) and continue creating the conditions for building new nuclear power plants in an open market situation.*

- *Clarify its position on the contribution of French nuclear power exports to the emerging European internal electricity market.*
- *Resolve the debate about the distribution of historic nuclear rents through a one-off transfer, to put the development of nuclear power on an economically and commercially sound footing.*
- *Continue to prepare the critical post-2020 period, when the majority of French nuclear power plants will reach 40 years of operation, by exploring all possibilities of lifetime extension, improved availability or new build.*
- *Pursue its R&D effort in developing fourth-generation reactors aiming at a far better use of natural resources and the minimisation of high-level radioactive waste requiring disposal.*
- *Strengthen efforts in international co-operation, both at the European and at the global levels, with special attention to emerging nuclear energy countries, to enable nuclear power to be part of a global diversification of energy sources and long-term actions to limit GHG emissions.*

PART III

ENERGY TECHNOLOGY

GENERAL R&D POLICY STRUCTURE

In 2005, France began a series of reforms under the POPE Act (*Loi de programmation fixant les orientations de la politique énergétique*) which reorganised the country's research structure and strategy. Research activities and their funding were separated into individual institutions. A number of new institutions have been created as part of the public R&D reforms. The reforms aim to improve co-ordination on allocation of public R&D spending and a systematic post-project evaluation has been put in place.

OSEO (*Soutient l'innovation et la croissance des PME*) was created in 2005 and brings together the functions of ANVAR (the French innovation agency) and BDPME (small and medium-sized enterprise development bank). The institutions' mission is to provide assistance and financial support to small and medium-sized enterprises and companies focused on early stage innovation. OSEO is responsible to the Ministry of Economy, Finance and Industry and the Ministry of Higher Education and Research. The *Agence de l'innovation industrielle* (AII) was created in 2005 to support technology projects and was later merged in January 2008 with OSEO.

The *Agence nationale de la recherche* (ANR) was created in January 2007 as a funding agency for research projects. Its goal is to increase the number of research projects from the scientific community. Funding is allocated on the basis of calls for proposals and a peer review selection process. ANR also aims to promote greater collaboration between public and industry laboratories. In 2007, ANR's research budget totalled EUR 825 million. Sustainable energy and environment is one of six thematic areas covered by ANR.

NATIONAL STRATEGY FOR ENERGY RESEARCH 2007

Adopted in 2007, the National Strategy for Energy Research (SNRE) aims at increased energy security and combating climate change. The SNRE is currently being revised to take into consideration the new *Grenelle de L'Environnemen*t. The Operational Committee (COMOP) on research introduced article 19 to the Grenelle 1 which identified the following focal points for research:

- renewable energy;
- energy storage;
- fuel cells;
- carbon capture and storage (CCS);

- energy efficiency in buildings;
- low-carbon vehicles and transport systems;
- second-generation biofuels;
- new nuclear power generation.

SNRE aims to improve the efficiency of research and innovation and to foster the creation of technology integration centres for the technologies identified under Grenelle 1. The government has committed EUR 1 billion to R&D for clean energy technologies over the next four years. Special emphasis has also been placed on the need to improve education and training for new energy technologies. SNRE builds on the European programmes and the technology demonstrators in the implementation of the Strategic Energy Technology Plan (SET-plan).

RESEARCH DEMONSTRATION FUND

As part of the *Grenelle de l'Environnement*, the French government has set up a EUR 400 million demonstrator fund to support the development of new energy technologies. This fund will be distributed over four years and can be used for the financing of projects in renewable energy, CCS, low-carbon transport, zero-emission buildings and smart grids. The fund is managed by ADEME under the supervision of the Ministry of Ecology, Energy, Sustainable Development and the Sea (MEEDDM), the Ministry of Higher Education and Research (MESR) and the Ministry of Finance. The allocation of funds follows a top-down approach based on a strategic technology road-map. ADEME publishes a call for projects on a given technology area and proposals are submitted for review.

To qualify for funding, projects must: *i)* be organised by an industrial company as the project leader; *ii)* regroup at least two companies; *iii)* conduct R&D tasks; and *iv)* refer to clear innovation, potentially via disruptive technologies. The project must also clearly show that there is an identifiable risk that such project may have not been conducted by industry without public support.

In 2008 three calls for projects were completed for low-carbon vehicles, second-generation biofuels and CCS, receiving a total of approximately EUR 200 million. A second call for projects for low-carbon vehicles was launched in 2009 as well as a call for marine energy and smart girds.

HEAT FUND

In addition to the demonstrator fund, France has also introduced a new EUR 1 billion heat fund to support the Grenelle Plan goal of increasing the

annual production of renewable heat by 10 Mtoe by 2020. Disbursement of the fund commenced in 2009 and will cease in 2011. Almost 70% of this fund is earmarked for biomass heating. The remainder will support geothermal and heat pump technology, solar and waste, and biogas heating.

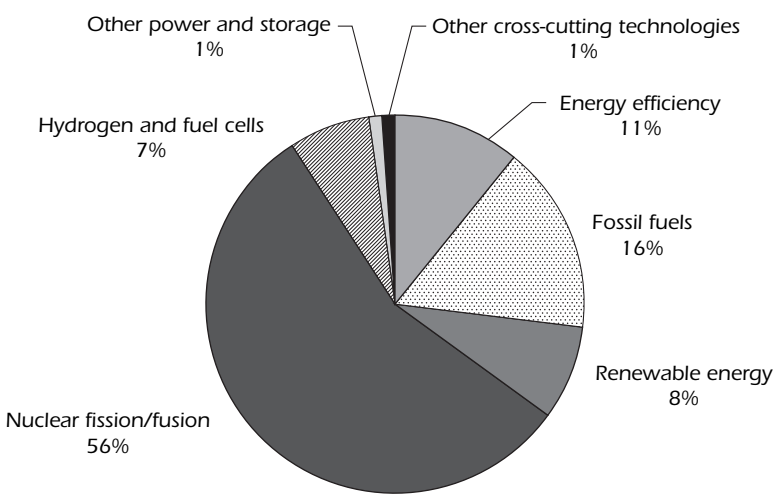
The heat fund is aimed at collective buildings, industry, agriculture and tertiary sectors. The overall objective of the fund is to reduce the price of renewable heat so that it is 5% less than heat from fossil fuels.

ENERGY R&D FUNDING

Until recently, France's energy R&D budget has been dominated by funding for nuclear power. The country has committed to increase its R&D effort towards new energy technologies and aims to reach parity between R&D spending on new energy technologies and its nuclear R&D budget by 2012. The diversification of France's energy R&D budget is a positive step towards building a more diversified portfolio of low-carbon technologies. A total of EUR 1 billion has been committed for R&D on new energy technologies.

Figure 28

R&D Budget 2007

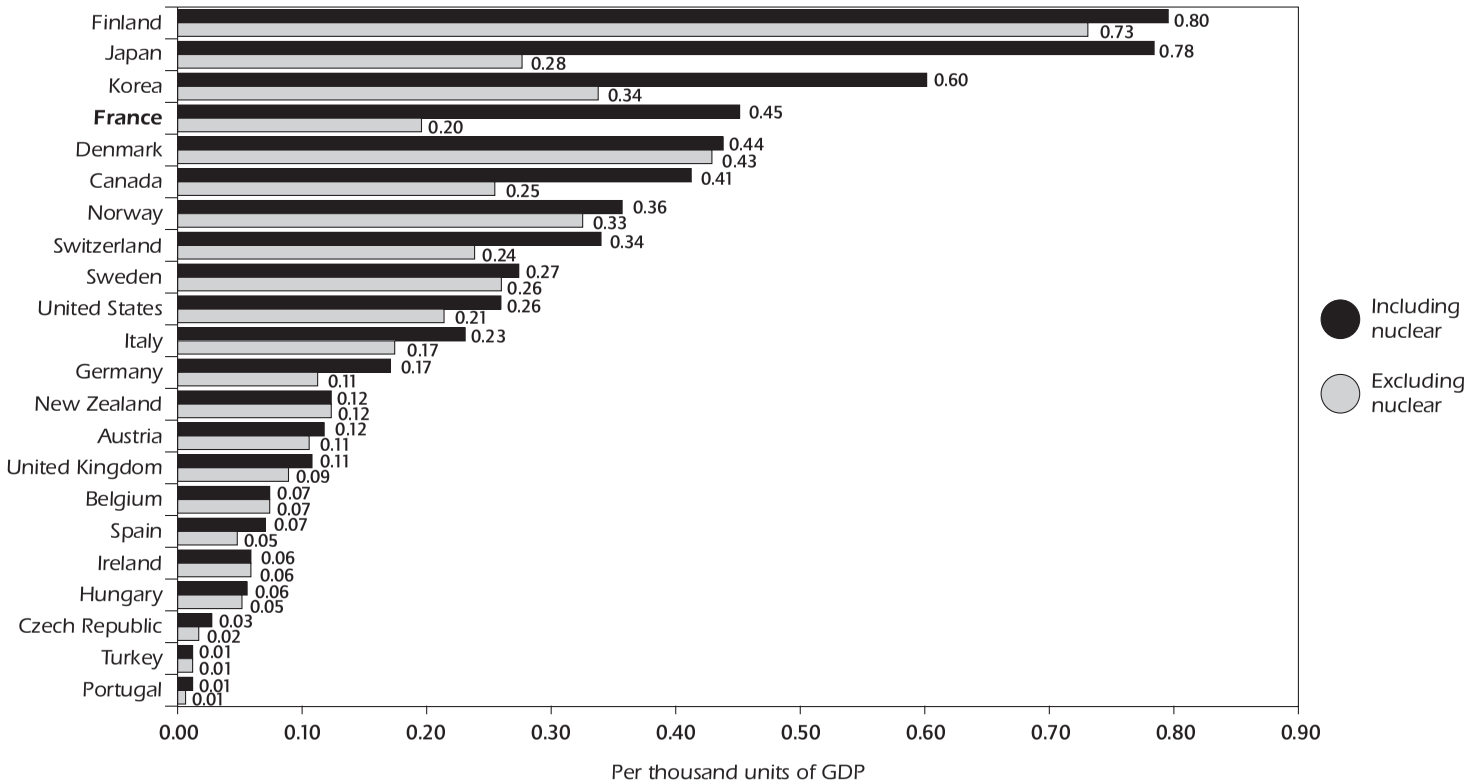


Total: USD 1 277 million
(2008 prices and exchange rates)

Source: Country submission.

Figure 29

Government R&D Budgets in IEA Member Countries, 2007



Data not available for Australia, Greece, Luxembourg, the Netherlands, Poland and the Slovak Republic.
Sources: *OECD Economic Outlook, OECD Paris*, 2009 and country submissions.

Table 25

Public Energy R&D Funding

(EUR million)

	2002	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*
Energy efficiency	54.2	53.2	57.4	64.5	83.9	100.8	125.7
Fossil fuels	177.3	172.0	148.1	142.5	139.9	136.6	135.1
Renewable energy	28.4	25.4	30.7	42.6	53.5	70.1	91.2
Nuclear fission and fusion	509.0	501.5	483.2	491.2	493.4	482.9	477.4
Hydrogen and fuel cells	21.1	26.0	22.9	45.0	51.1	57.7	58.1
Other power and storage technologies	0.8	3.1	4.2	2.6	2.8	11.9	25.0
Other cross-cutting technologies	11.9	13.8	8.7	7.4	6.5	7.2	9.5
Total	**802.7**	**795.0**	**755.2**	**795.8**	**831.1**	**867.2**	**921.9**

Source: MEEDDM.

Between 2002 and 2005, public spending on energy R&D remained relatively unchanged at approximately EUR 300 million per year. In 2006, 2007 and 2008 spending rose by 10.8%, 13.8% and 15.7% respectively. Although the rise in R&D spending over the last few years is encouraging, it is still significantly below the levels reached after the first oil crisis in the late 1970s. Compared to other IEA countries, France spends more on a per-GDP basis. In 2007, spending reached 0.45% of GDP, the fourth-highest among IEA member countries.

RESEARCH INSTITUTIONS

Publicly funded R&D is conducted by research institutions, universities, technology centres and private enterprises. There are three main publicly funded energy research institutions in France.

CEA (*Commissariat à l'énergie atomique*) is a key player in research, development and innovation in the field of nuclear energy, defence, information technologies and health. In the area of energy research, CEA aims to maintain the French nuclear industry's leading position and to develop a strategy for new energy technologies. In 2008, CEA's energy research budget reached EUR 1.67 billion of which EUR 1.35 billion was related to nuclear power and just EUR 0.12 billion for new energy technologies. CEA has over 15 000 employees and nine research centres.

As a result of the Grenelle Plan, CEA has increased its research efforts in new energy technologies in two domains: buildings and transport. Among the building technologies, emphasis is on solar energy (thermal and PV), electrical and thermal systems, energy storage, energy efficiency, renovation methodology, and convergence of building-transport requirements. CEA is

a founder of the French National Solar Energy Institute (INES) which aims to support industrial partners along the whole PV chain, from material to systems integration. In transport, CEA is focusing on advanced batteries, fuel cells, hybridisation, energy recovery, fuel efficiency, hydrogen production, hydrogen storage, and biofuels.

IFP (*Institut français du pétrole*) is an independent research institute focusing on industrial development, education and training, and information centre specialised in the fields of oil, natural gas and light-duty vehicles. IFP's mission is to contribute to the emergence of new industries in the fields of energy, transport and environment that are likely to foster future economic growth and job creation. The institute's research focuses on five strategic areas: *i)* controlled CO_2 (CCS), *ii)* diversified fuels, *iii)* fuel-efficient vehicles, *iv)* clean refining, and *v)* extending oil and gas reserves.

Between 2006 and 2010, IFP plans to double its R&D effort in the area of new energy technologies. In particular it will encourage research on CCS, increased R&D for biofuels and aims to develop the hydrogen economy. Historically, IFP's research has been heavily focused on up- and downstream oil and gas extraction. In recent years the institute's focus has been rebalanced in favour of the transport sector. The transport sector accounted for just one-third of IFP's 2005 budget of EUR 74 million and should receive just under half of the targeted EUR 124 million in 2010. ADEME's demonstrator fund will be a driving force for fostering IFP's focus on new energy technologies.

The **Bureau of Geological and Mineral Research** (*Bureau de recherches géologiques et minières*, BRGM) is the leading public research centre for geosciences. In 2009 the centre has a budget of EUR 13 million for research on geothermal energy, CO_2 storage and nuclear waste storage. In the area of CO_2 storage, the centre's top priority is risk assessment and assessment of storage capacity in deep aquifers which is now at the demonstration phase. BRGM is part of the EU CO_2GeoNet project. The centre's research on geothermal energy is focused on low-grade resources for space heating, including geothermal heap pumps. Total funding for geothermal energy reached EUR 6.6 million in 2009.

In addition to the three public energy research centres, **EDF**, the state-owned integrated electricity company, also undertakes significant R&D activities. EDF has over 2 000 employees working in three research labs in France and an annual R&D budget of EUR 375 million. The company's research spans a number of different areas, including energy management, electricity generation, environment and renewable energy, customers, electricity networks and information technologies, and digital simulations.

France participates in 21 IEA Implementing Agreements (Table 26).

Table 26

France's Participation in IEA Implementing Agreements

End-use technologies		Renewable energy technologies	
Buildings		Bioenergy	X
Buildings and Community Systems	X	Geothermal	X
District Heating and Cooling		Hydrogen	X
Efficiency Electrical End-Use Equipment	X	Hydropower	X
Energy Storage	X	Ocean Energy Systems	
Heat Pumping Technologies	X	Photovoltaic Power Systems	X
Electricity		Renewable Energy Tech. Deployment	X
Demand-Side Management	X	Solar Heating and Cooling	X
Electricity Networks Analysis, R&D	X	SolarPACES	X
High-Temperature Superconductivity		Wind Energy Systems	
Industry		**Fusion power**	
Emissions Reduction in Combustion		ASDEX-Upgrade	
Industrial Energy Technology Systems		Environment, Safety, Economy of Fusion	
Transport		Fusion Materials	
Advanced Fuel Cells	X	Large Takamaks	
Advanced Materials for Transportation		Nuclear Technology Fusion Reactors	
Advanced Motor Fuels	X	Plasma Wall Interaction TEXTOR	
Hybrid and Electric Vehicles	X	Reversed Field Pinches	
Fossil fuels		Spherical Tori	
Clean Coal Sciences		Stellarator Concept	
Enhanced Oil Recovery	X		
Fluidized Bed Conversion	X	**Cross-cutting**	
Greenhouse Gas R&D Programme	X	Climate Technology Initiative	
IEA Clean Coal Centre		Energy Technology Data Exchange	
Multiphase Flow Sciences		Energy Technology Systems Analysis	X

FIELDS OF RESEARCH

ENERGY-EFFICIENT BUILDINGS

By 2030, France aims to achieve widespread diffusion of high energy performance buildings and to make the technology available for constructing positive energy buildings with low additional costs. ADEME is responsible for co-ordinating and implementing research for energy-efficient buildings and will spend an estimated EUR 30 million to EUR 35 million in this area. R&D

is focused on technology options which will achieve the proposed efficiency targets of 50 kWh/m^2/year for new buildings and 90 kWh/m^2/year for existing buildings.

TRANSPORT

A road-map to 2030 has been developed in France for electric vehicles and plug-in hybrid electric vehicles. In January 2009 an automotive plan, *Etats généraux de l'automobile,* was launched. This plan is supported by a EUR 300 million budget in 2009. The plan includes promotion and public information campaigns, research on industrial development in battery technology and electric traction. More than EUR 400 million has been given to the Programme of Research and Innovation in Land Transport (*Programme de recherche et d'innovation dans les transport terrestres*, PREDIT) and ADEME to intensify research in this area. Funding for electric vehicles is in addition to the funding which has been allocated via the Grenelle funds.

The government believes that the biggest barrier for electric vehicles will be the creation of a network of recharging stations and battery development. The goal is to reach an efficiency of 5 to 7 km/kWh and to develop recharging networks at home, at service stations, in quick drop-offs, at work and other locations. A number of different networks will be required to meet the different charging times and needs and to allow consumers greater flexibility. R&D efforts are focusing on three types of recharging needs: normal (charged in 4 to 7 hours), fast (less than 1 hour), and quick drop (in just a few minutes).

Under France's electric vehicle road-map, the 2015 goal is to reach a 10% penetration of new vehicles sales, which is equivalent to 250 000 vehicles. By 2020 the goal is to reach 2 million vehicles or 7% of the total vehicles stock. To reach such ambitious levels of diffusion will require standardisation and normalisation for plugs and charging networks.

RENEWABLES

ADEME is the main agency in charge of the implementation and allocation of financing for renewable energy R&D. The development of photovoltaic systems and their integration into buildings and maximising biomass resources has been identified as the two key focal areas for renewable energy R&D. Between 2007 and 2010, ADEME's budget for renewables is estimated at between EUR 45 million and EUR 50 million.

For renewable power generation, the main fields of research focus on increasing efficiency, lowering costs and resolving the problems linked to the intermittent nature of resources and the diffuse character of output. Research

in the area of bioenergy will focus on improving the efficiency and lowering the cost of enzymatic hydrolysis for biofuels production, on evaluation of exploitable biomass resources, on hydrogen production from biomass and on the development of biorefineries with high value-added bioproducts.

INTELLIGENT ELECTRICITY GRIDS AND ENERGY STORAGE

ADEME will develop a research programme on intelligent grids and storage. This programme will have an estimated budget of EUR 12 to 16 million from 2007 to 2010 and aims to fulfil the following objectives: *i)* advance the development of renewable electricity; *ii)* improve the energy efficiency of the power grid; *iii)* improve grid-management tools to optimise demand-side management (DSM); and *iv)* develop innovative storage solutions to optimise energy systems.

CARBON CAPTURE AND STORAGE

In France all new coal-fired plants are required to be CCS-equipped. France also plans to implement a full-scale CCS demonstration programme. Additional R&D focusing on reducing costs and addressing safety issues around CCS are undertaken by public research centres such as BRGM, the *Centre national de la recherche scientifique* (CNRS) and the *Institut français du pétrole* (IFP). It has been placed as one of the top priorities for BRGM and IFP. A number of private companies including Arcelor Mittal, Total, Alstom, Air Liquide, Veolia, Schlumberger, Lafarge, Suez Gas de France and EDF are also looking at CCS in the electricity, refineries, steel and cement sectors. In 2002, Club CO_2 was formed under the presidency of ADEME and includes major stakeholders in industry and public research centres.[21]

ANR (*Agence nationale de la recherche*) launched four calls for CCS projects between 2005 and 2008. Since then, 33 projects have received approximately EUR 27 million in funding. Total has launched a EUR 60 million integrated CCS project in south-west France to capture CO_2 from a gas-processing plant at Lacq and inject it into a nearby depleted gas field. This project will capture 120 000 tonnes of CO_2. Oxygen is used for combustion to obtain a more concentrated CO_2 stream. In the steel sector, Arcelor Mittal's CO_2 capture project has been preselected within the European Recovery Plan for large-scale CCS.

Today, public awareness is very low in France for CCS and public acceptance is seen as a major barrier. The government is aware of this and has taken steps to increase communication initiatives on both a national and international

21. www.clubco2.net

basis. In 2005 a booklet was published explaining what CCS is and a number of stakeholder workshops on CCS acceptance have been organised. More effort will be needed to gain public-wide acceptance for this option.

CRITIQUE

In 2007, France released a comprehensive energy research and development strategy which clearly outlined the country's objectives, identified key stakeholders and set clear targets for technology development. The strategy is a good example of how a country's energy strategy should be matched with its technology and energy R&D strategy. It also highlights the need for regular updates to ensure that changes in national energy policies are compatible with R&D policies. An evaluation is needed to ensure that France's R&D strategy is sufficient to meet the targets set under the new *Grenelle de l'Environnement* programme.

This programme calls for significant changes in France's R&D funding with a commitment to invest equally between nuclear and the new energy technologies needed to achieve the country's ambitious targets for energy efficiency and CO_2 emissions reduction. Such a dramatic shift in the country's energy R&D programme should be carefully monitored to ensure that programmes are designed effectively to support technology innovation with a clear move from basic science, R&D, demonstration through to full commercialisation.

The goals outlined for 2020 under the Grenelle Plan assume very ambitious targets for energy efficiency in buildings which may benefit from additional R&D support to reduce costs and further facilitate the diffusion of these technologies. Particular attention should be paid to technologies aimed at retrofitting the existing building stock.

Targets for biomass use are extremely ambitious and care should be taken to ensure that the deployment programmes (*e.g.* the renewable heat fund) aimed to support these targets do not result in unintended consequences. Significant technical progress is needed to increase the efficiency of current biomass technologies and to develop a new generation of technologies, including biomass gasification and combined cycle which could incorporate carbon capture technologies when these become available. Biomass supply chain optimisation deserves special attention. Countries such as Sweden and Finland, with significant biomass use, could provide important lessons for France.

France has allocated large resources for the demonstration and deployment (diffusion) of low-carbon technologies. Of particular note are the EUR 400 million in the demonstration fund and EUR 1 billion for the renewable heat fund. These support schemes are commendable, but

there is a need to monitor and evaluate the effectiveness of these programmes to ensure that such schemes are achieving their goals and that the limited demonstration and deployment funds are used efficiently. Monitoring and evaluation will also be needed for assessing the effectiveness of R&D programmes.

Carbon capture and storage (CCS) has been identified as a key technology to achieve France's ambitious CO_2 reduction targets. Of the EUR 400 million demonstration fund, EUR 100 million has been targeted towards demonstration of CCS. Capture technologies for power seem less relevant for France today given the country's large nuclear park and ambitious targets for renewable power generation. Capture technologies for industry and fuel transformation applications could be a more efficient use of limited demonstration funds. The country's experience with natural gas storage in aquifers creates natural advantages for France to develop identification and verification technologies for CO_2 storage.

France's nuclear R&D is managed by the *Commissariat à l'énergie atomique* (CEA), which is progressively including research on other "non GHG-emitting technologies" but remains fully committed to research in optimising the industrial use of nuclear energy, fourth-generation nuclear reactors as well as partitioning, transmutation and conditioning of high-level nuclear waste in co-operation with ANDRA. It is preparing a final government decision on a sodium-cooled fourth-generation demonstration reactor for 2012 (the ASTRID project) and is going ahead with the construction of the Jules Horowitz research reactor (JHR) that is slated to begin operations in 2014. In addition to its research function, the JHR would be able to produce also medical radioisotopes, thus addressing the current global bottleneck. CEA also participates actively in a number of international research forums.

France is heavily investing in research on electric vehicles. A programme has been set up in the new transport division in MEEDDM, co-ordinating work being carried out in other ministries. Electric buses will be deployed in 2010 in niche markets and the goal is to have 100 000 electric vehicles on the road by 2020. In the long term, the penetration of electric vehicles will require huge investments, particularly in infrastructure, and might have significant impact on electricity network operations. These aspects need to be assessed.

RECOMMENDATIONS

The government of France should:

- *Continue reviewing its energy R&D strategy to ensure coherence with the objectives outlined in the Grenelle Plan. In particular, consider increasing focus on R&D for* i) *efficient biomass technologies (including adequate*

R&D in forest management and biomass supply chain optimisation) and ii) *energy efficiency in buildings (especially retrofit options) to reduce costs and increase diffusion of these technologies.*

- *Regularly assess the effectiveness of R&D programmes and evaluate whether there is continuity between R&D, demonstration and deployment programmes. Assessment should cover all stages of technology development to ensure a holistic approach. In particular, develop mechanisms to evaluate the efficiency of demonstration and deployment funds.*
- *Consider focusing CCS research and development on CO_2 storage (site identification, monitoring and verification) as well as capture technologies for industry applications and fuel transformation.*
- *Continue its active collaboration in international research, development, deployment and demonstration, and increase engagement with industry.*
- *Further develop a complete framework for the deployment of electric vehicles with a particular focus on the necessary infrastructure.*

PART IV
ANNEXES

ORGANISATION OF THE REVIEW

REVIEW CRITERIA

The *Shared Goals* of the IEA, which were adopted by the IEA Ministers at their 4 June 1993 meeting held in Paris, provide the evaluation criteria for the in-depth reviews conducted by the IEA. The *Shared Goals* are set out in Annex C.

The in-depth review team is grateful for the co-operation and assistance of the many people it met during the visit. Thanks to their open hospitality and willingness to share information, the visit was both highly productive and enjoyable. The team wishes to give warm and sincere thanks to Mr. Philippe Guillard, Deputy Director for Energy, and all his colleagues for the unfailing helpfulness they displayed in preparing and guiding the visit. The team also wishes to express its gratitude to Director-General of Energy and Climate, Mr. Pierre-Franck Chevet, as well as to Mr. Pierre-Marie Abadie, Director for Energy, and Mr. Pascal Dupuis, Head of Department for Climate and Energy Efficiency, for their personal engagement in briefing the team on current energy policy issues in the country.

The members of the team were:

IEA Member Country Experts

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Elena Merle-Béral organised and managed the review team visit. Teresa Malyshev drafted the report with the exception of Chapter 6 on Renewable Energy drafted by Carolien van Hemel, Chapter 7 on Electricity drafted by

Francois Nguyen, Chapter 8 on Nuclear Power drafted by Jan Horst Keppler and Chapter 9 on Energy R&D drafted by Cecilia Tam.

The report also benefited from comments of many IEA experts including Ulrich Benterbusch, Anne-Sophie Corbeau, Ian Cronshaw, Jason Elliott, Rebecca Gaghen, Didier Houssin, Elena Merle-Béral, Brian Ricketts, Philippine de T'Serclaes and Aad van Bohemen.

Monica Petit and Bertrand Sadin prepared the figures. Karen Treanton and Alex Blackburn provided support on statistics. Viviane Consoli provided editorial assistance and Marilyn Ferris helped in the preparation of the publication.

ORGANISATIONS VISITED

The team held discussions with the following energy and environment stakeholders:

- MEEDDM, Ministry of Ecology, Energy, Sustainable Development and the Sea
- RTE, transmission system operator
- GRTgaz, manager of the gas transmission system
- Uprigaz
- Anode
- Afelins, Association of Electricity Suppliers
- EDF
- GDF Suez
- CRE, Energy Regulatory Commission
- The National Energy Ombudsman
- CNAFAL, *Conseil National des Associations Familiales Laïques*
- ADEME, Agency for the Environment and Energy Efficiency
- SER, Renewable Energy Syndicate
- CEA, Atomic Energy Commission
- IFP, French Institute of Petroleum
- BRGM, Bureau of Geological and Mineral Research
- UFIP, Union of French refiners
- AREVA
- ANDRA, National Agency for Radioactive Waste Management
- ASN, Nuclear Safety Authority
- Fondation Nicolas Hulot
- MEDEF

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY

	1973	1990	2005	2006	2010	2020	2030
TOTAL PRODUCTION	**44.2**	**112.5**	**137.8**	**137.7**	**135.5**	**152.1**	**155.9**
Coal	18.0	8.2	0.4	0.3	0.2	0.1	–
Peat	–	–	–	–	–	–	–
Oil	2.1	3.5	1.3	1.1	1.1	–	–
Gas	6.3	2.5	0.9	1.1	0.9	–	–
Comb. Renewables & Waste[1]	9.8	11.6	12.8	12.7	13.1	18.1	20.3
Nuclear	3.8	81.9	117.7	117.3	114.6	124.6	125.5
Hydro	4.1	4.6	4.5	4.8	5.0	5.7	5.7
Wind	–	–	0.1	0.2	0.3	3.1	3.7
Geothermal	0.0	0.1	0.1	0.1	0.1	0.2	0.3
Solar/Other[2]	0.0	0.1	0.1	0.1	0.1	0.3	0.4
TOTAL NET IMPORTS[3]	**138.3**	**113.7**	**134.7**	**131.7**	**127.1**	**149.0**	**164.1**
Coal Exports	1.3	0.6	0.6	0.6	0.7	–	–
Imports	10.8	13.7	14.1	14.4	13.0	9.9	10.3
Net Imports	9.5	13.0	13.5	13.8	12.3	9.9	10.3
Oil Exports	13.6	14.6	27.6	27.9	26.3	12.1	12.6
Imports	142.2	100.5	121.5	120.3	117.3	104.3	106.2
Int'l Marine and Aviation Bunkers	7.2	5.7	8.2	8.5	8.8	7.9	8.1
Net Imports	121.5	80.2	85.8	83.9	82.2	84.3	85.5
Gas Exports	0.1	0.3	0.9	0.7	0.8	–	–
Imports	7.6	24.7	41.6	40.1	37.9	59.4	70.3
Net Imports	7.6	24.4	40.7	39.5	37.1	59.4	70.3
Electricity Exports	0.6	4.5	5.9	6.2	5.8	4.6	2.0
Imports	0.4	0.6	0.7	0.7	0.9	–	–
Net Imports	–0.2	–3.9	–5.2	–5.4	–4.9	–4.6	–2.0
TOTAL STOCK CHANGES	**–2.3**	**–1.7**	**–1.1**	**–1.8**	**1.2**	**–**	**–**
TOTAL SUPPLY (TPES)[4]	**180.1**	**224.5**	**271.4**	**267.7**	**263.7**	**301.1**	**320.0**
Coal	29.2	20.2	14.3	13.2	13.3	10.0	10.3
Peat	–	–	–	–	–	–	–
Oil	119.8	83.9	86.1	85.0	83.3	84.3	85.5
Gas	13.6	26.0	41.1	39.6	38.5	59.4	70.3
Comb. Renewables & Waste[1]	9.8	11.6	12.7	12.8	13.4	18.1	20.3
Nuclear	3.8	81.9	117.7	117.3	114.6	124.6	125.5
Hydro	4.1	4.6	4.5	4.8	5.0	5.7	5.7
Wind	–	–	0.1	0.2	0.3	3.1	3.7
Geothermal	0.0	0.1	0.1	0.1	0.1	0.2	0.3
Solar/Other[2]	0.0	0.1	0.1	0.1	0.1	0.3	0.4
Electricity Trade[5]	–0.2	–3.9	–5.2	–5.4	–4.9	–4.6	–2.0
Shares (%)							
Coal	*16.2*	*9.0*	*5.3*	*4.9*	*5.1*	*3.3*	*3.2*
Peat	–	–	–	–	–	–	–
Oil	*66.5*	*37.4*	*31.7*	*31.8*	*31.6*	*28.0*	*26.7*
Gas	*7.5*	*11.6*	*15.1*	*14.8*	*14.6*	*19.7*	*22.0*
Comb. Renewables & Waste	*5.4*	*5.2*	*4.7*	*4.8*	*5.1*	*6.0*	*6.3*
Nuclear	*2.1*	*36.5*	*43.4*	*43.8*	*43.5*	*41.4*	*39.2*
Hydro	*2.3*	*2.1*	*1.6*	*1.8*	*1.9*	*1.9*	*1.8*
Wind	–	–	–	*0.1*	*0.1*	*1.0*	*1.2*
Geothermal	–	–	–	–	–	*0.1*	*0.1*
Solar/Other	–	–	–	–	–	*0.1*	*0.1*
Electricity Trade	*–0.1*	*–1.7*	*–1.9*	*–2.0*	*–1.9*	*–1.5*	*–0.6*

0 is negligible. – is nil. .. is not available.

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1973	1990	2006	2007	2010	2020	2030
TFC	**142.2**	**143.3**	**169.9**	**168.2**	**165.0**	**196.3**	**210.9**
Coal	13.1	7.5	3.9	3.9	3.6	6.0	6.0
Peat	–	–	–	–	–	–	–
Oil	96.0	75.0	80.4	79.6	77.6	78.8	80.2
Gas	11.2	23.9	34.5	33.4	32.0	47.5	52.4
Comb. Renewables & Waste[1]	8.9	10.2	10.4	10.7	11.1	16.1	18.0
Geothermal	0.0	0.1	0.1	0.1	0.1	0.2	0.3
Solar	–	0.0	0.0	0.0	0.0	0.2	0.3
Electricity	12.8	26.0	36.3	36.7	36.6	47.5	53.7
Heat	0.3	0.5	4.2	3.9	3.8	..	..
Shares (%)							
Coal	*9.2*	*5.2*	*2.3*	*2.3*	*2.2*	*3.1*	*2.8*
Peat	–	–	–	–	–	–	–
Oil	*67.5*	*52.4*	*47.3*	*47.3*	*47.0*	*40.1*	*38.0*
Gas	*7.9*	*16.7*	*20.3*	*19.8*	*19.4*	*24.2*	*24.8*
Comb. Renewables & Waste	*6.3*	*7.1*	*6.1*	*6.3*	*6.7*	*8.2*	*8.5*
Geothermal	–	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Solar	–	–	–	–	–	*0.1*	*0.1*
Electricity	*9.0*	*18.1*	*21.4*	*21.8*	*22.2*	*24.2*	*25.5*
Heat	*0.2*	*0.3*	*2.5*	*2.3*	*2.3*	..	..
TOTAL INDUSTRY[6]	**56.3**	**46.1**	**47.5**	**47.1**	**46.7**	**59.4**	**63.0**
Coal	7.2	5.9	3.4	3.5	3.2	6.0	6.0
Peat	–	–	–	–	–	–	–
Oil	35.0	17.8	18.9	19.5	19.6	20.0	20.2
Gas	5.8	11.1	11.5	10.9	10.8	17.3	18.7
Comb. Renewables & Waste[1]	1.2	1.5	1.7	1.7	1.7	2.6	2.8
Geothermal	–	–	–	–	–	–	–
Solar	–	–	–	–	–	–	–
Electricity	7.2	9.9	12.0	11.5	11.4	13.5	15.3
Heat	–	–	–	–	–	–	–
Shares (%)							
Coal	*12.7*	*12.7*	*7.2*	*7.4*	*6.9*	*10.1*	*9.5*
Peat	–	–	–	–	–	–	–
Oil	*62.1*	*38.5*	*39.8*	*41.4*	*41.9*	*33.7*	*32.1*
Gas	*10.2*	*24.1*	*24.2*	*23.1*	*23.1*	*29.1*	*29.7*
Comb. Renewables & Waste	*2.1*	*3.2*	*3.5*	*3.6*	*3.7*	*4.4*	*4.4*
Geothermal	–	–	–	–	–	–	–
Solar	–	–	–	–	–	–	–
Electricity	*12.8*	*21.4*	*25.2*	*24.5*	*24.4*	*22.7*	*24.3*
Heat	–	–	–	–	–	–	–
TRANSPORT[4]	**24.7**	**38.5**	**45.0**	**45.2**	**45.6**	**51.2**	**58.6**
TOTAL OTHER SECTORS[7]	**61.2**	**58.8**	**77.3**	**76.0**	**72.7**	**85.7**	**89.3**
Coal	5.8	1.7	0.4	0.4	0.4	..	..
Peat	–	–	–	–	–	–	–
Oil	37.0	19.6	17.9	16.8	15.0	11.9	7.4
Gas	5.4	12.8	23.0	22.4	21.2	30.2	33.7
Comb. Renewables & Waste[1]	7.7	8.8	8.4	8.2	7.9	10.6	10.9
Geothermal	0.0	0.1	0.1	0.1	0.1	0.2	0.3
Solar	–	0.0	0.0	0.0	0.0	0.2	0.3
Electricity	5.0	15.4	23.3	24.1	24.2	32.6	36.7
Heat	0.3	0.5	4.2	3.9	3.8	..	..
Shares (%)							
Coal	*9.5*	*2.8*	*0.5*	*0.5*	*0.5*	..	..
Peat	–	–	–	–	–	–	–
Oil	*60.4*	*33.3*	*23.2*	*22.1*	*20.7*	*13.9*	*8.3*
Gas	*8.8*	*21.8*	*29.7*	*29.5*	*29.1*	*35.2*	*37.7*
Comb. Renewables & Waste	*12.6*	*14.9*	*10.8*	*10.8*	*10.9*	*12.4*	*12.2*
Geothermal	–	*0.2*	*0.2*	*0.2*	*0.2*	*0.2*	*0.3*
Solar	–	–	–	–	–	*0.2*	*0.3*
Electricity	*8.2*	*26.1*	*30.1*	*31.7*	*33.2*	*38.0*	*41.1*
Heat	*0.4*	*0.8*	*5.4*	*5.1*	*5.3*	..	..

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1973	1990	2005	2006	2007	2020	2030
ELECTRICITY GENERATION[8]							
INPUT (Mtoe)	**36.7**	**98.3**	**140.1**	**138.9**	**137.0**	**153.0**	**160.9**
OUTPUT (Mtoe)	**15.7**	**35.9**	**49.1**	**49.0**	**48.5**	**59.1**	**63.3**
(TWh gross)	182.5	417.2	571.5	569.3	564.4	687.3	735.5
Output Shares (%)							
Coal	*19.7*	*8.5*	*5.4*	*4.6*	*5.0*	*2.9*	*2.9*
Peat	–	–	–	–	–	–	–
Oil	*40.2*	*2.1*	*1.4*	*1.3*	*1.1*	*1.1*	*0.9*
Gas	*5.5*	*0.7*	*4.0*	*3.8*	*3.9*	*10.1*	*14.4*
Comb. Renewables & Waste	*0.1*	*0.4*	*0.9*	*0.9*	*1.0*	*1.1*	*1.2*
Nuclear	*8.1*	*75.3*	*79.0*	*79.1*	*77.9*	*69.5*	*65.5*
Hydro	*26.1*	*12.9*	*9.1*	*9.9*	*10.3*	*9.7*	*9.0*
Wind	–	–	*0.2*	*0.4*	*0.7*	*5.4*	*5.9*
Geothermal	–	–	–	–	–	–	–
Solar/Other	*0.3*	*0.1*	*0.1*	*0.1*	*0.1*	*0.2*	*0.2*
TOTAL LOSSES	**38.1**	**76.6**	**101.7**	**99.8**	**98.7**	**104.8**	**109.1**
of which:							
Electricity and Heat Generation[9]	20.8	62.0	86.8	86.1	84.6	93.9	97.6
Other Transformation	5.3	2.7	2.1	1.8	1.6	4.0	4.1
Own Use and Losses[10]	12.1	11.9	12.7	11.9	12.5	6.9	7.4
Statistical Differences	**–0.2**	**4.6**	**–0.1**	**–0.4**	**0.1**	**–**	**–**

INDICATORS

	1973	1990	2005	2006	2007	2020	2030
GDP (billion 2000 USD)	703.39	1091.83	1442.29	1473.60	1505.62	2023.48	2540.13
Population (millions)	53.30	58.17	62.82	63.20	63.57	66.42	67.69
TPES/GDP[11]	0.26	0.21	0.19	0.18	0.18	0.15	0.13
Energy Production/TPES	0.25	0.50	0.51	0.51	0.51	0.51	0.49
Per Capita TPES[12]	3.38	3.86	4.32	4.24	4.15	4.53	4.73
Oil Supply/GDP[11]	0.17	0.08	0.06	0.06	0.06	0.04	0.03
TFC/GDP[11]	0.20	0.13	0.12	0.11	0.11	0.10	0.08
Per Capita TFC[12]	2.67	2.46	2.70	2.66	2.60	2.96	3.12
Energy-related CO_2 Emissions (Mt CO_2)[13]	484.8	352.1	388.5	378.3	369.3	411.1	441.0
CO_2 Emissions from Bunkers (Mt CO_2)	22.4	17.3	24.8	25.8	26.7	23.9	24.5

GROWTH RATES (% per year)

	73–79	79–90	90–05	05–06	06–07	07–20	20–30
TPES	1.1	1.4	1.3	–1.4	–1.5	1.0	0.6
Coal	1.7	–4.2	–2.3	–7.7	1.1	–2.2	0.3
Peat	–	–	–	–	–	–	–
Oil	–1.0	–2.6	0.2	–1.3	–2.1	0.1	0.1
Gas	7.4	2.0	3.1	–3.5	–2.9	3.4	1.7
Comb. Renewables & Waste	–0.5	1.8	0.6	0.6	4.7	2.4	1.2
Nuclear	18.1	20.6	2.4	–0.3	–2.3	0.6	0.1
Hydro	5.7	–1.9	–0.3	8.5	3.6	1.0	–
Wind	–	–	–	126.5	85.1	18.3	1.8
Geothermal	46.8	24.4	1.1	–	–	3.4	4.1
Solar/Other	–1.8	4.4	–0.1	7.4	11.0	10.6	2.9
TFC	0.5	–0.2	1.1	–1.0	–1.9	1.3	0.7
Electricity Consumption	5.4	3.7	2.3	1.0	–0.2	2.0	1.2
Energy Production	1.3	8.1	1.4	–0.0	–1.7	0.9	0.2
Net Oil Imports	–1.1	–3.1	0.4	–2.2	–2.0	0.2	0.1
GDP	3.1	2.3	1.9	2.2	2.2	2.3	2.3
Growth in the TPES/GDP Ratio	–2.0	–0.9	–0.6	–3.2	–3.8	–1.2	–1.7
Growth in the TFC/GDP Ratio	–2.6	–2.5	–0.7	–3.4	–3.5	–1.0	–1.5

Please note: Rounding may cause totals to differ from the sum of the elements.

FOOTNOTES TO ENERGY BALANCES AND KEY STATISTICAL DATA

1. Combustible renewables and waste comprises solid biomass, liquid biomass, biogas and municipal waste. Data are often based on partial surveys and may not be comparable between countries.

2. Other includes tide and wave.

3. In addition to coal, oil, gas and electricity, total net imports also include combustible renewables.

4. Excludes international marine bunkers and international aviation bunkers.

5. Total supply of electricity represents net trade. A negative number in the share of TPES indicates that exports are greater than imports.

6. Industry includes non-energy use.

7. Other Sectors includes residential, commercial, public services, agriculture, forestry, fishing and other non-specified sectors.

8. Inputs to electricity generation include inputs to electricity, CHP and heat plants. Output refers only to electricity generation.

9. Losses arising in the production of electricity and heat at main activity producer utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of approximately 33% for nuclear and 100% for hydro, wind and photovoltaic.

10. Data on "losses" for forecast years often include large statistical differences covering differences between expected supply and demand and mostly do not reflect real expectations on transformation gains and losses.

11. Toe per thousand US dollars at 2000 prices and exchange rates.

12. Toe per person.

13. "Energy-related CO_2 emissions" have been estimated using the IPCC Tier I Sectoral Approach from the *Revised 1996 IPCC Guidelines*. In accordance with the IPCC methodology, emissions from international marine and aviation bunkers are not included in national totals. Projected emissions for oil and gas are derived by calculating the ratio of emissions to energy use for 2007 and applying this factor to forecast energy supply. Future coal emissions are based on product-specific supply projections and are calculated using the IPCC/OECD emission factors and methodology.

INTERNATIONAL ENERGY AGENCY "SHARED GOALS"

The member countries* of the International Energy Agency (IEA) seek to create conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and to the well-being of their people and of the environment. In formulating energy policies, the establishment of free and open markets is a fundamental point of departure, though energy security and environmental protection need to be given particular emphasis by governments. IEA countries recognise the significance of increasing global interdependence in energy. They therefore seek to promote the effective operation of international energy markets and encourage dialogue with all participants. In order to secure their objectives, member countries therefore aim to create a policy framework consistent with the following goals:

1. **Diversity, efficiency and flexibility within the energy sector** are basic conditions for longer-term energy security: the fuels used within and across sectors and the sources of those fuels should be as diverse as practicable. Non-fossil fuels, particularly nuclear and hydro power, make a substantial contribution to the energy supply diversity of IEA countries as a group.

2. Energy systems should have **the ability to respond promptly and flexibly to energy emergencies.** In some cases this requires collective mechanisms and action: IEA countries co-operate through the Agency in responding jointly to oil supply emergencies.

3. **The environmentally sustainable provision and use of energy** are central to the achievement of these shared goals. Decision-makers should seek to minimise the adverse environmental impacts of energy activities, just as environmental decisions should take account of the energy consequences. Government interventions should respect the Polluter Pays Principle where practicable.

4. **More environmentally acceptable energy sources** need to be encouraged and developed. Clean and efficient use of fossil fuels is essential. The development of economic non-fossil sources is also a priority. A number of IEA member countries wish to retain

* Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States.

and improve the nuclear option for the future, at the highest available safety standards, because nuclear energy does not emit carbon dioxide. Renewable sources will also have an increasingly important contribution to make.

5. I**mproved energy efficiency** can promote both environmental protection and energy security in a cost-effective manner. There are significant opportunities for greater energy efficiency at all stages of the energy cycle from production to consumption. Strong efforts by governments and all energy users are needed to realise these opportunities.

6. **Continued research, development and market deployment of new and improved energy technologies** make a critical contribution to achieving the objectives outlined above. Energy technology policies should complement broader energy policies. International co-operation in the development and dissemination of energy technologies, including industry participation and co-operation with non-member countries, should be encouraged.

7. **Undistorted energy prices** enable markets to work efficiently. Energy prices should not be held artificially below the costs of supply to promote social or industrial goals. To the extent necessary and practicable, the environmental costs of energy production and use should be reflected in prices.

8. **Free and open trade** and a secure framework for investment contribute to efficient energy markets and energy security. Distortions to energy trade and investment should be avoided.

9. **Co-operation among all energy market participants** helps to improve information and understanding, and encourages the development of efficient, environmentally acceptable and flexible energy systems and markets worldwide. These are needed to help promote the investment, trade and confidence necessary to achieve global energy security and environmental objectives.

(The Shared Goals were adopted by IEA Ministers at their 4 June 1993 meeting in Paris.)

GLOSSARY AND LIST OF ABBREVIATIONS

In this report, abbreviations and acronyms are substituted for a number of terms used within the International Energy Agency. While these terms generally have been written out on first mention, this glossary provides a quick and central reference for many of the abbreviations used.

ADEME	Agency for the Environment and Energy Efficiency (Agence de l'environnement et de la maîtrise de l'énergie)
AFNOR	Association française de normalisation
ANDRA	National Agency for Radioactive Waste Management (Agence nationale pour la gestion des déchets radioactifs)
ASN	Nuclear Safety Authority (Autorité de sûreté nucléaire)
bcm	billion cubic metres
b/d	barrels per day
CCGT	combined-cycle gas turbine
CEA	Atomic Energy Commission (Commissariat à l'énergie atomique)
CRE	Energy Regulatory Commission (Commission de régulation de l'énergie)
DGEC	Directorate-General for Energy and Climate (Direction générale de l'environnement et du climat)
DSO	distribution system operator
EDF	Electricité de France
EEX	European Energy Exchange
EPR	European pressurised water reactor
EU-ETS	European Union Emissions Trading Scheme
GDF	Gaz de France
GDP	gross domestic product
GIF	Generation IV International Forum
kt	kilotonne
kW	kilowatt, or 1 watt $\times$ 10^3

LNG	liquefied natural gas
mcm	million cubic metres
MEEDDM	Ministry of Ecology, Energy, Sustainable Development and the Sea (Ministère de l'Ecologie, de l'Energie, du Développement durable et de la Mer)
MESR	Ministry of Higher Education and Research (Ministère de l'Enseignement supérieur et de la Recherche)
Mt	million tonnes
Mtoe	million tonnes of oil equivalent; see toe
MW	megawatt, or 1 watt × 10^6
ONERC	National Observatory for Climate Warming Effects
PPI	Pluri-annual Investment Plan (Plan pluriannuel des investissements)
PPP	purchasing power parity: the rate of currency conversion that equalises the purchasing power of different currencies, *i.e.* estimates the differences in price levels between countries
R&D	research and development, especially in energy technology, may include the demonstration and dissemination phases as well
RTE	French transmission system operator
TaRTAM	transitional regulated market adjustement tariffs
TFC	total final consumption of energy
TIC	national consumption tax (taxe intérieure de consommation)
TIPP	domestic tax on petroleum products (taxe intérieure sur les produits pétroliers)
toe	tonne of oil equivalent; defined as 10^7 kcal
TPA	third-party acces
TPES	total primary energy supply
TSO	transmission system operator
UNFCC	United Nations Framework Convention on Climate Change
VAT	value-added tax

International Energy Agency

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