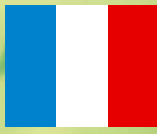
INTERNATIONAL ENERGY AGENCY

Energy Policies of IEA Countries



FRANCE

2004 Review

OECD

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INTERNATIONAL ENERGY AGENCY
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The International Energy Agency (IEA) is an autonomous body which was established in November 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme.

It carries out a comprehensive programme of energy co-operation among twenty-six* of the OECD's thirty member countries. The basic aims of the IEA are:

- to maintain and improve systems for coping with oil supply disruptions;
- to promote rational energy policies in a global context through co-operative relations with non-member countries, industry and international organisations;
- to operate a permanent information system on the international oil market;
- to improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use;
- to assist in the integration of environmental and energy policies.

** IEA member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, the Republic of Korea, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, the United States. The European Commission also takes part in the work of the IEA.*

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996), the Republic of Korea (12th December 1996) and Slovakia (28th September 2000). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

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SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

French energy policy over the past decades has been characterised by a centralised, nation-based approach with strong government involvement. This philosophy has been largely successful: French consumers of all classes enjoy some of the cheapest energy prices in the OECD, security of supply for all energy sources is sound and the country has one of the lowest levels of greenhouse gas emissions (GHG) per unit of GDP in the world. Nonetheless, the context in which French energy policy historically operated has changed dramatically in recent years, driven by two main forces: the introduction of competition into the electricity and natural gas sectors, and the growing internationalisation of the energy sector in Europe as it moves towards a single market. The present objective for French energy policy-makers is to adapt to and benefit from these changes. The two sector-specific areas currently receiving considerable attention are the liberalisation of the electricity sector and the efforts to reduce GHG emissions.

Regarding electricity, France has taken a number of important steps to establish a sound legal and regulatory framework for a liberalised market. It has created a largely independent transmission system operator (TSO), introduced non-discriminatory third-party access to the network for all eligible players, and developed a regulator with adequate resources, experienced personnel and significant independence although the government has the final authority in tariff-setting based on the advice from the regulator. A promising French electricity exchange, Powernext, has opened. France has now transposed the European Union directive on the internal market, giving it a current market opening of 37% (by volume) to be expanded to all commercial customers in July 2004 and all customers regardless of size in July 2007. The incumbent vertically integrated, state-owned Electricité de France (EDF) will be transformed from an *établissement public industriel et commercial* (EPIC) into a *société anonyme* (SA) in 2004, pending a Parliament vote. This would put it on a more equal footing with new entrants.

These are all commendable steps in line with a successful liberalised market. By addressing some of the still remaining issues, the country will be able to more fully enjoy the benefits of competition. Two significant remaining issues are the continued market power of EDF and the government's potential role in influencing the timing of capacity additions. EDF currently generates over 90% of the electricity for the French market, which could act as an impediment to true competition. Among the various options available for addressing this issue, the most promising solution would be to develop stronger interconnections with neighbouring countries and thus expand the market, effectively reducing EDF market share in the process.

The second issue to be addressed is the government's potential involvement in influencing the magnitude and timing of additions to the generating portfolio. As part of its responsibility to provide for energy security, the government has instituted the Long-term Investment Programme for Electricity Production. The government is to be commended for its focus on energy security, especially during the transitional phase towards competition. The short-, medium- and long-term projections of supply adequacy are instrumental for policy-makers to assess security. Under the Long-Term Investment Programme, the government establishes ranges of capacity for different technologies that it would like to see built by certain dates. If investors attempt to build more than the allotted amount of a given technology, the government has the option of denying the permits for the plants. If insufficient capacity is built, the government has the option of launching tender offers and guaranteeing acceptable rates of return for the winning bidder. While renewable energy and combined heat and power (CHP) policy will influence the generating mix, care should be taken that government policies beyond that result in minimal market distortion which could decrease the economic efficiency of the system as a whole. The government is advised to continue with its security of supply measures while monitoring and minimising any such market distortions.

Under the EU burden-sharing agreement, France is obliged to keep its GHG emissions at 1990 levels by the Kyoto Protocol's 2008-2012 commitment period. While France's total GHG emissions in 2001 were roughly equal to 1990 levels, energy-related carbon dioxide (CO_2) emissions rose by 9.1% between 1990 and 2001 and are expected to rise further to 2010 and especially in the longer term (*e.g.* to 2030). This is primarily due to continuing emission increases in the transport and residential sectors, as well as to assumed greater penetration of natural gas in France's electricity generation mix. Reversing the course of GHG emissions is one of the greatest challenges for the French energy policy, especially given the limited scope of emissions reduction potential in the power sector resulting from the current large share of GHG-free power generation (mainly nuclear). The measures in the first climate change mitigation strategy in 2000 are not sufficient to meet the target. Another Climate Plan which was supposed to come out in 2003 has not been released as of mid-May. In addition, France (along with a number of other EU countries) is late in releasing its National Allocation Plan for the coming EU emission trading system scheduled to start in 2005. The government needs to make this issue a greater priority by deciding upon and releasing these documents as soon as possible. The new Climate Plan should provide clear signals for market players and be backed with thorough cost-benefit analysis.

The government has already announced several highly ambitious goals that would reduce emissions. Among these are the desire to maintain final energy

consumption at 2003 levels by 2015, building up to 10 000 MW of wind power by 2010 and reducing CO_2 emissions by 75% by 2050. The government is to be commended for the long-term scope and vision these objectives represent. At the same time, the difficulties and expenses of reaching these goals pose huge challenges and need to be better explored. More cost-benefit studies examining the positive and negative aspects of these goals for the energy sector and the overall economy are needed with their results disseminated widely to the public.

The primary new measure to be introduced to help reach the energy consumption stabilisation goal by 2015 is the energy efficiency white certificate system. Under this system, consumers or suppliers that use energy more efficiently will receive certificates equal to their level of savings. Certain energy suppliers will be obliged to obtain a pre-determined number of certificates, thus creating a market that values them and encourages energy-efficient behaviour among all energy users. The government is to be commended for launching this innovative system and is encouraged to proceed with its implementation. A number of administrative questions remain to be answered, such as how savings will be measured and who will issue certificates and administer the system. It will be important to keep administrative costs low, so as to not outweigh the system's benefits. France is encouraged to pursue this promising programme, seeking to simplify and standardise procedures wherever possible. More emphasis should be placed on the transport sector where energy use per GDP, as well as CO_2 emissions, are continuously rising.

France has the most renewable energy production of any EU country, helping it lower emissions and augment energy security; 98% of French renewable energy comes from hydropower and biomass, sources developed for their cost advantages rather than as a result of government support. Policy-driven support for non-hydro renewables has thus far not resulted in substantial renewable capacity, at least in relation to other countries. This may change in the future as the government has announced a number of ambitious goals to expand the use of renewables. Installations below 12 MW can receive above-market feed-in tariffs and those above 12 MW can bid for long-term electricity sales contracts. The government is encouraged to look at the experience of other countries that used the bidding system to support renewables (*e.g.* Ireland and the UK) where the proffered contracts often failed to lead to sufficient installed capacity. Plant siting is key to the future of renewables in France, particularly for wind plants. The government must respect the desires of local communities but effectively weigh them against the national benefits that renewable energy technologies can bring.

The government is taking commendable steps to liberalise the natural gas sector. Currently, all customers with an annual consumption above 283 000 million British thermal units (MBtu) – around 600 customers

representing 37% of the market by volume – are eligible to choose their supplier. In July 2004, all commercial customers will be eligible to change suppliers and all customers regardless of size will be free to do so in July 2007. A sound regulatory framework has been put in place, including rules for third-party access and a gas regulator. The primary concern at this point is providing new entrants non-discriminatory access to the network, at the entry points into France and internally in the southern part of the country. The government should continue to promote development of the gas infrastructure to eliminate physical bottlenecks. Legal unbundling of network transport operator should be implemented as mandated by the EU directive. In addition, the dominant position of the incumbent, Gaz de France (GDF), in gas storage facilities should be closely monitored.

France has the second-largest integrated system of nuclear power plants in the world, with 58 production units accounting (in 2001) for 41% of total primary energy supply and 77% of electricity generation. Nuclear power has served France well and while a decision on long-term storage for the radioactive waste has not yet been taken, the government is expected to rule on this issue in 2006. France has developed a substantial technological resource in the abilities of companies and individuals to build, operate and maintain nuclear facilities. It is prudent to ensure this capability is preserved in order to maintain the nuclear option.

This nuclear capability can be maintained in a number of ways. For example, the leading French nuclear company, AREVA, has recently sold a 1.6 GW, €3 billion plant with European pressurised water reactor technology in Finland to come on line in 2009. In addition, according to IEA data, the French government has spent an average of €455 million per year from 1992 to 2001 on research and development (R&D) in nuclear fission technology. The government has recently proposed a "demonstration" unit for the European pressurised water reactor (EPR) technology to be completed around 2012. Maintaining the nuclear option by sustaining the country's technological resources is sound policy. Regarding the "demonstration unit", the government should ensure that any such plant would be built under market conditions whereby companies invest in the plant solely as a profitable venture in a liberalised market.

France has a tradition of contributing substantially to energy R&D and in 2001, spent more than any other European country in this area. However, funding has dropped in recent years, with 2001 expenditures nearly 30% below 1999 levels, and it is hoped that this decrease does not represent a long-term downward trend. France is encouraged to develop a clear energy R&D policy with priorities and allocations integrated into the overall energy policy goals. For example, despite the ambitious efficiency targets for renewable energy and energy efficiency, a relatively small portion of government R&D funding went to these areas in 2001.

RECOMMENDATIONS

The government of France should:

Energy Market and Energy Policy

- *Explore the benefits of adopting a more regional approach to energy security within the context of the evolving European policy framework. While maintaining the option for the government of influencing fuel mix (*e.g. *renewable energy), take into account the increasingly open European market where players make their own fuel choices, and thus any given energy mix cannot be guaranteed by government.*

- *Continue to monitor the supply-demand balance and investment trends of the energy supply sectors. Ensure that the manner of implementing the system of tendering for power plants will not send perverse incentives to market players.*

- *Further improve the design of market reform by completing full legal unbundling at both the transmission and distribution levels (in electricity and gas) and further strengthen the powers of the regulator by allowing it to fix the regulated tariffs.*

- *Move as quickly as possible to change the legal status of EDF and GDF to ordinary companies and, after this step has been taken, consider allowing "opening up" of their capital which is important to strengthen domestic competition in both the electricity and gas markets.*

- *Increase transparency in the energy field, especially by defining the different roles (and their limits) played by the government: as shareholder, law maker, regulator and financier of public research.*

- *Undertake additional economic studies on the feasibility of far-reaching climate change and efficiency targets and examine the cost-effectiveness of measures to reach them.*

Energy and the Environment

- *Finalise and publish, as soon as possible, the government's plan to meet the GHG stabilisation target, including the contribution sought by different actors of the economy, to send clear signals for investments by market players.*

- *Seek to maximise cost-effectiveness and flexibility in the development of the government's strategy to meet GHG objectives. Carefully assess and regularly monitor the costs and impacts of the climate change policies and measures. Share the results with the stakeholders.*

- *Undertake additional economic studies on the cost-effectiveness of climate change mitigation policies and measures, particularly with respect to meeting France's GHG target for 2050. Disseminate the results as widely as possible, with a focus on benefits of such a strategy and the possible implications for the energy and energy-intensive sectors.*

- *Carefully monitor the emissions market and develop its strategy with respect to purchases in order to take advantage of periods of low emission prices to avoid the potential risk of needing to buy during a price spike.*

- *Expedite discussions on the national allocation plan for installations covered by Phase I (2005-2007) of the European Union Emission Trading Scheme (EU-ETS), with the objective of ensuring that a timely, appropriate and clear signal is sent to the market, while also looking forward to Phase II (2008-2012) of the EU-ETS. Work with other EU countries to ensure a level playing field in the EU-ETS.*

Energy Efficiency

- *Continue to make efficiency activities in the transport sector a priority.*

- *Evaluate the feasibility and economic costs of stabilising energy consumption at 2003 levels by 2015.*

- *Develop the administrative framework of the "white certificates" programme, including standardised and clear methods for the issuance of energy efficiency certificates and a follow-up function to monitor the results.*

Renewable Energy

- *Assess the most effective policies for achieving renewable energy goals, evaluating and disseminating information on the costs and benefits involved in meeting such ambitious targets. Draw upon experiences of other countries.*

- *Ensure that the tender offer system results in substantial timely installed renewable capacity; while allowing significant time for the system to work and to give investors confidence, do not exclude the possibility of other market-based options if results are not satisfactory.*

- *Co-ordinate between the relevant authorities to ensure that the siting of wind plants and associated transmission lines can proceed without undue delay to achieve national objectives while still taking into account local concerns.*

- *Resolve the pending debate on water rights and hydroelectric plants to determine how much, if any, hydroelectric capacity will be lost and make plans accordingly.*

- *Adopt a unified approach to the renewable energy programme (both electricity and thermal) and those other programmes that could confer similar advantages, notably energy efficiency.*

Fossil Fuels

- *Promote the development of cost-effective gas transport infrastructure, to better accommodate competition in the gas sector through appropriate tariff structures.*

- *Maintain regulatory oversight of GDF's and Total's dominant gas storage position until sufficient alternative capacity becomes available.*

- *Implement the EU directive to expedite legal unbundling of a network transport operator with strong regulatory oversight to ensure equal access to the gas market for all market players.*

- *Send a clear signal on future excise tax differential for diesel and gasoline to allow industry and consumers to take appropriate investment decisions.*

Electricity

- *Monitor potential obstacles to the development of competition, including fair access to all networks and existence of market power; consider all options to remove such barriers.*

- *Ensure that government policies have minimal market distortions by using market forces as much as possible to determine the choice of power sources in line with traditional cost-benefit analysis and within the framework of policies for renewable energy, CHP, etc., thus boosting market confidence and opportunities for new entrants.*

- *Continue to integrate the idea of* service public *into the liberalised market, taking steps to avoid its becoming a barrier to entry.*

- *Facilitate further cost-effective investments in interconnections and thus continue to develop an EU-wide electricity market,* e.g. *by addressing local siting concerns wherever possible.*

- *Consider the use of existing and future demand-response mechanisms as a way to mitigate the effects of peak demand periods.*

Nuclear Power

- *Favour maintaining nuclear power as an option by authorising the building of a demonstration unit in an open market situation.*

- *Explore all possibilities of lifetime extension, power uprates and improved availability to increase the production capacity taking into account the climate policy and safety standards.*
- *Continue developing high-level radioactive waste management solutions, respecting the time schedule defined in 1991 and ensure that the entire waste management and decommissioning system is fully funded by the waste producers.*
- *Continue efforts in international co-operation in developing new nuclear power systems as part of diversification of energy sources and long-term actions to limit GHG emissions.*

Energy Research and Development

- *Clarify the allocation method (how, how much, in which fields and to which institutions) for public spending on energy R&D.*
- *Define a clear energy R&D policy that supports government long-term energy objectives, particularly in the fields of transport, energy efficiency and renewable energy.*
- *Assess the effectiveness of R&D programmes in a broader concept of energy policy, for example in comparison with the effectiveness of public budget allocated to market introduction of renewable energy.*
- *Monitor R&D expenditure in the industrial sector.*

CONCLUSIONS ET RECOMMANDATIONS – SYNTHÈSE

Au cours des dernières décennies, la politique énergétique de la France s'est caractérisée par une approche centralisée, d'envergure nationale, doublée d'un fort engagement de l'État. Cette philosophie a connu un franc succès. En effet, tous les consommateurs français bénéficient de prix de l'énergie parmi les plus bas de l'OCDE, d'une garantie de fiabilité en matière d'approvisionnement, toutes sources d'énergie confondues, et la France affiche l'un des plus bas niveaux d'émissions de gaz à effet de serre (GES) par unité de PIB au monde. Néanmoins, le contexte dans lequel cette politique énergétique a évolué par le passé a radicalement changé ces dernières années – un changement occasionné sous l'effet de deux forces principales : l'ouverture à la concurrence dans les secteurs de l'électricité et du gaz naturel d'une part ; l'internationalisation croissante du secteur de l'énergie en Europe d'autre part, avec l'évolution vers un marché unique. L'objectif des décideurs en matière de politique énergétique française vise désormais à s'adapter et à tirer profit de ces changements. L'attention se porte aujourd'hui sur deux aspects précis du secteur, la libéralisation de l'électricité et les efforts pour réduire les émissions de GES.

S'agissant de l'électricité, la France a pris un certain nombre de mesures importantes pour se doter d'un cadre juridique et réglementaire solide en vue d'une libéralisation du marché. Elle a mis en place un gestionnaire de réseau de transport (GRT) indépendant, introduit un accès libre et indépendant au réseau pour tous les acteurs éligibles et mis au point une autorité de réglementation indépendante, possédant les ressources nécessaires et du personnel expérimenté, même si *in fine* le gouvernement reste toujours maître pour fixer les tarifs, en se fondant sur les conseils de l'autorité de régulation. Powernext, bourse française de l'électricité dont l'avenir semble prometteur, vient de voir le jour. La France a transposé la directive européenne à l'intérieur de ses frontières, avec un marché actuellement ouvert à hauteur de 37 % (en volume) qui devrait s'étendre à l'ensemble des entreprises en juillet 2004 et à tous les consommateurs, quelle que soit leur taille, en juillet 2007. Electricité de France (EDF), puissante entreprise publique intégrée verticalement, passera du statut d'établissement public industriel et commercial (EPIC) à celui de société anonyme (SA) en 2004, suite au vote du Parlement. Ce changement de statut rendra la situation plus équitable par rapport aux nouveaux entrants.

Il s'agit de mesures souhaitables, nécessaires à la réussite d'un marché libéralisé. En réglant les questions encore en suspens, la France sera capable de tirer pleinement profit des avantages de la concurrence. Il reste cependant deux grands problèmes à traiter, à savoir le pouvoir de marché toujours réel d'EDF et l'éventuelle influence du gouvernement sur la planification des

extensions de capacité. EDF génère actuellement plus de 90 % de l'électricité destinée au marché français, ce qui pourrait constituer un obstacle à une véritable concurrence. Parmi les différentes options possibles pour résoudre ce problème, la solution la plus prometteuse consisterait à développer des interconnexions plus solides avec les pays voisins et à étendre ainsi le marché, un processus qui réduirait nettement la part de marché d'EDF.

La deuxième question à régler réside dans l'influence potentielle du gouvernement sur l'ampleur et la planification de l'augmentation du portefeuille de production. Au titre de son obligation à garantir la sécurité énergétique, le gouvernement s'est doté d'un Programme d'investissement à long terme pour la production d'électricité. Le gouvernement doit être félicité pour son orientation en matière de sécurité énergétique, notamment au cours de la phase transitoire vers l'ouverture à la concurrence. Les projections à court, moyen et long terme sur les capacités d'approvisionnement aident le législateur à évaluer la sécurité des approvisionnements. Selon ce Programme d'investissement à long terme, le gouvernement fixe des plages de capacité pour les différentes technologies qu'il voudrait voir développées à certaines dates. Si les investisseurs tentent de développer une technologie donnée dans des proportions supérieures à la quantité autorisée, le gouvernement a la possibilité de refuser le permis desdites installations. En cas de développement insuffisant, il peut également faire un appel d'offre public et garantir des taux de rentabilité acceptables au soumissionnaire retenu. Alors que la politique sur les énergies renouvelables et la cogénération va influencer la combinaison d'offre énergétique proposée, il faut veiller à ce que les politiques gouvernementales, au-dessus de celle-ci, aboutissent à une altération minimale du marché, qui ne réduise pas l'efficacité économique du système dans son ensemble. Il est conseillé au gouvernement de poursuivre ses mesures de sécurité des approvisionnements, tout en contrôlant et en minimisant la distorsion de marché qu'il crée ainsi.

En vertu de l'accord européen sur le partage du fardeau, la France doit maintenir ses émissions de GES au niveau de 1990, conformément au paragraphe sur l'engagement 2008-2012 signé dans le cadre du protocole de Kyoto. Alors qu'en 2001 les émissions totales de GES en France avoisinaient les niveaux de 1990, les émissions de dioxyde de carbone (CO_2) liées à l'énergie ont connu une hausse de 9,1 % entre 1990 et 2001 et elles devraient augmenter jusqu'en 2010, et plus encore sur le long terme (c'est-à-dire jusqu'en 2030). Ce résultat est principalement dû à une augmentation continue des émissions dans les secteurs des transports et résidentiel, ainsi qu'à une plus grande pénétration *a priori* du gaz naturel dans la production d'électricité en France. Inverser le cours des émissions de GES est l'un des grands défis de la politique énergétique française, surtout au vu de la marge restreinte concernant la réduction potentielle des émissions dans le secteur de l'électricité, conséquence de la part actuellement importante d'électricité produite sans émission de GES (principalement avec le nucléaire). Les mesures

associées à la première stratégie de lutte contre le changement climatique de 2000 ne sont pas suffisantes pour atteindre l'objectif fixé. Un autre Plan climatique, qui devait voir le jour en 2003, n'a pas encore été publié à la mi-mai 2004. En outre, la France (ainsi qu'un certain nombre d'autres pays de l'Union européenne) a pris du retard pour publier son plan national de quotas pour l'instauration par l'UE d'une bourse d'échange des émissions, qui devrait être lancée en 2005. Le gouvernement doit en faire une de ses priorités en se mettant d'accord sur ces documents et en les publiant au plus vite. Le nouveau Plan climatique devrait donner des signaux précis aux acteurs du marché et être soutenu par une analyse coût-bénéfice approfondie.

Le gouvernement a déjà annoncé plusieurs objectifs très ambitieux de réduction des émissions. Parmi ces objectifs figure la volonté de maintenir la consommation d'énergie finale à son niveau de 2003 d'ici 2015, de produire jusqu'à 10 000 MW par énergie éolienne d'ici 2010 et de réduire les émissions de CO_2 de 75 % à l'horizon 2050. Ces objectifs sont louables pour la vision de long terme qu'ils apportent. En parallèle, les difficultés et les dépenses associées à la réalisation de ces objectifs posent d'importants défis et doivent être mieux étudiées. Il est nécessaire d'effectuer davantage d'études coût-bénéfice de la mise en œuvre de tels objectifs sur le secteur de l'énergie et l'économie dans son ensemble ainsi que de divulguer, à grande échelle, leurs résultats auprès du public.

La principale nouvelle mesure qui doit être introduite afin d'atteindre l'objectif de stabilisation de la consommation d'énergie d'ici 2015 porte sur le système des certificats d'économie d'énergie. En vertu de ce système, les consommateurs ou fournisseurs consommant de l'énergie de manière plus sobre se verront attribuer des certificats correspondant à leur niveau d'économie. Certains fournisseurs d'énergie seront obligés d'obtenir un nombre de certificats prédéterminé, créant ainsi un marché qui les valorise et favorise un comportement économe en matière énergétique parmi ces consommateurs. Le gouvernement, qui doit être félicité pour le lancement d'un système aussi innovant, est encouragé à poursuivre sa mise en œuvre. Un certain nombre de points administratifs restent encore en suspens, tels que la manière dont les économies seront mesurées et l'institution qui délivrera les certificats et administrera le système. Il sera important de minimiser les coûts administratifs afin de ne pas compromettre les bénéfices acquis grâce au système. La France est invitée à poursuivre ce programme prometteur, en cherchant à simplifier et à normaliser les procédures autant que possible. Il convient d'accorder une grande attention au secteur du transport où l'énergie consommée par PIB, ainsi que les émissions de CO_2, sont en augmentation constante.

La France affiche la plus importante production d'énergies renouvelables de tous les pays de l'UE, ce qui lui permet de réduire ses émissions de GES et d'augmenter sa sécurité énergétique ; 98 % de l'énergie renouvelable produite en France provient de l'énergie hydraulique et de la biomasse,

deux sources d'énergie développées en raison de leurs coûts avantageux, et non d'un soutien gouvernemental. Le soutien public apporté aux énergies renouvelables d'origine non hydraulique n'a donc pas réellement débouché sur des capacités de production conséquente de ces énergies, tout du moins par rapport aux autres pays. Cette situation pourrait changer à l'avenir car le gouvernement a annoncé un certain nombre d'objectifs ambitieux pour élargir le recours à ces sources d'énergie alternatives. Les installations en dessous de 12 MW peuvent recevoir des tarifs de rachat supérieurs au prix du marché et celles dépassant 12 MW peuvent faire l'objet d'un appel d'offres pour un contrat de vente d'électricité à long terme. Le gouvernement est invité à prendre en compte l'expérience des autres pays qui ont utilisé le système des appels d'offres pour soutenir les énergies renouvelables (par exemple l'Irlande et le Royaume-Uni) là où les contrats présentés n'ont souvent pas permis d'aboutir à des installations de capacité suffisante. L'implantation de capacités de production est essentielle pour l'avenir des énergies renouvelables en France, en particulier pour ce qui est de l'énergie éolienne. Le gouvernement doit respecter les désirs des collectivités locales, mais il doit, en réalité, les mettre en balance avec les avantages au plan national que peuvent apporter les technologies renouvelables.

Le gouvernement prend des mesures louables pour libéraliser le secteur du gaz naturel. Actuellement, tous les utilisateurs dont la consommation annuelle dépasse 283 000 MBtu – millions d'unités thermiques britanniques – (environ six cents consommateurs, représentant 37 % du marché en volume) sont habilités à choisir leur fournisseur. En juillet 2004, toutes les entreprises auront le droit de changer de fournisseur et tous les utilisateurs, quelle que soit leur taille, seront autorisés à faire de même en juillet 2007. Un cadre réglementaire solide comprenant des règles pour l'accès de tiers et une autorité de réglementation du gaz a été mis en place. A ce stade, la principale préoccupation consiste à fournir un accès libre au réseau aux nouveaux entrants, aux points d'entrée en France et, à l'intérieur des frontières de l'Hexagone, dans le sud du pays. Le gouvernement devrait continuer de promouvoir le développement des infrastructures gazières afin de supprimer certains goulets d'étranglement. La séparation juridique des opérateurs de transport du réseau devrait être mise en œuvre, conformément à la directive européenne. En outre, la position dominante actuellement détenue par Gaz de France (GDF) sur les sites de stockage de gaz doit faire l'objet d'une surveillance étroite.

La France possède le deuxième parc de centrales nucléaires au monde, avec cinquante huit réacteurs représentant (en 2001) 41 % de la fourniture totale d'énergie primaire et 77 % de la production d'électricité. L'électricité nucléaire a été utile à la France et bien qu'une décision sur le stockage à long terme des déchets radioactifs n'ait pas encore été prise, le gouvernement devrait statuer sur ce point en 2006. La France a développé d'importantes ressources technologiques concernant les capacités des sociétés et des

particuliers à construire, exploiter et entretenir des installations nucléaires. Il est prudent de s'assurer du maintien d'une telle capacité pour conserver l'option du nucléaire.

Le maintien d'une telle capacité nucléaire s'effectue de plusieurs manières. Par exemple, le leader français du nucléaire, AREVA, a récemment vendu à la Finlande, moyennant 3 milliards d'euros, une centrale d'une capacité de 1,6 GW, munie de la technologie EPR (*European Pressurised Water Reactor*, réacteur à eau pressurisée) ; celle-ci devrait être opérationnelle en 2009. En outre, selon les données de l'AIE (Agence internationale de l'énergie) le gouvernement français a dépensé, en moyenne, 445 millions d'euros par an entre 1992 et 2001 pour la recherche et le développement (R-D) dans les technologies de la fission nucléaire. Le gouvernement a récemment proposé un réacteur de « démonstration » de la technologie EPR, qui devrait être terminé vers 2012. Maintenir l'option nucléaire en assurant la durabilité des ressources technologiques du pays est une politique saine. Concernant « le réacteur de démonstration », le gouvernement devrait s'assurer que toutes les centrales de la sorte sont construites conformément aux conditions du marché, en vertu de quoi les sociétés investissent dans une centrale uniquement en tant qu'entreprise lucrative dans le contexte d'un marché libéralisé.

Par tradition, la France apporte une contribution conséquente à la R-D dans l'énergie et, en 2001, elle a dépensé plus que tout autre pays européen dans ce domaine. Cependant, les financements ont chuté ces dernières années et les dépenses consenties en 2001 étaient inférieures de près de 30 % à celles de 1999. Il faut espérer que cette baisse n'est pas le signe d'une tendance à long terme. La France est invitée à développer une politique claire en matière de R-D dans l'énergie avec des priorités et une allocation des moyens correspondant à ses objectifs généraux de politique énergétique. Par exemple, malgré d'ambitieux objectifs d'économie en matière d'énergies renouvelables et d'efficacité énergétique, seule une petite part des fonds gouvernementaux de R-D a été attribuée à ces domaines en 2001.

RECOMMANDATIONS

Le gouvernement français devrait :

Marché de l'énergie et politique énergétique

- *Examiner les avantages à adopter une approche plus régionale de la sécurité énergétique dans le contexte du développement du cadre européen. Tout en gardant l'option, pour le gouvernement, d'influencer l'offre d'énergies proposées (énergies renouvelables par exemple), celui-ci doit prendre en compte l'ouverture croissante du marché européen où les acteurs choisissent eux-mêmes leur énergie,*

ce qui ne permet pas au gouvernement de garantir une combinaison d'offres énergétiques prédéterminée.

- *Continuer de contrôler l'équilibre entre l'offre et la demande, ainsi que les tendances des investissements dans le secteur de la fourniture d'énergie. S'assurer que la manière dont est mis en œuvre le système d'appels d'offres pour les centrales électriques n'encouragera pas les acteurs du marché dans le mauvais sens.*

- *Améliorer encore la conception de la réforme du marché en achevant une séparation juridique complète, tant au niveau de la transmission qu'au niveau de la distribution (d'électricité et de gaz) et renforcer encore les pouvoirs de l'autorité de réglementation en l'autorisant à fixer des tarifs réglementés.*

- *Avancer aussi vite que possible dans la modification des statuts juridiques d'EDF et de GDF pour en faire des sociétés ordinaires et, une fois cette mesure prise, se pencher sur l'autorisation d'« ouvrir » leur capital – une étape importante dans le renforcement de la concurrence tant sur le marché domestique de l'électricité que sur celui du gaz.*

- *Accroître la transparence dans le domaine de l'énergie, notamment en définissant les différents rôles (et leurs limites) joués par le gouvernement : actionnaire, législateur, autorité de régulation et financier de la recherche publique.*

- *Entreprendre des études économiques supplémentaires sur la faisabilité des objectifs du plan de changement climatique d'une part et des objectifs d'efficacité d'autre part, et sur les coûts et bénéfices des mesures envisagées pour les atteindre.*

Energie et environnement

- *Finaliser et publier, dès que possible, le plan du gouvernement pour atteindre l'objectif de stabilisation des émissions de GES, notamment la contribution recherchée par différents acteurs économiques, afin d'envoyer des signaux précis pour les investissements réalisés par les acteurs du marché.*

- *Maximiser le rapport coût-efficacité et la flexibilité des mesures prises dans le cadre de la stratégie gouvernementale pour atteindre les objectifs d'émissions de GES. Evaluer méticuleusement et contrôler régulièrement les coûts et l'impact des mesures et politiques de changement climatique. Partager les résultats de ce suivi et des évaluations avec les parties prenantes.*

- *Entreprendre des études économiques supplémentaires sur le rapport coût-efficacité des mesures et politiques visant à l'atténuation du changement climatique, particulièrement en ce qui concerne l'objectif d'émissions de GES pour la France d'ici 2050. Diffuser les résultats à grande échelle, autant que*

possible en insistant sur les atouts d'une telle stratégie et sur les implications possibles pour le secteur de l'énergie et les secteurs à forte intensité énergétique.

- *Contrôler étroitement le marché des émissions et mettre au point une stratégie d'achats afin de tirer parti des périodes où les prix sont bas et d'éviter le risque potentiel d'être contraint d'acheter pendant une période de cours élevés.*

- *Finaliser les discussions sur le plan national d'allocation des quotas pour les installations couvertes par la Phase I (2005-2007) du système européen d'échange de quotas d'émissions de GES, pour assurer qu'un signal précis et approprié soit envoyé au marché en temps voulu, tout en anticipant également la Phase II (2008-2012). Travailler avec les autres pays de l'UE afin de garantir un ensemble de règles équitable au sein de ce marché.*

Efficacité énergétique

- *Continuer d'accorder la priorité aux activités économes en matière d'énergie dans le secteur du transport.*

- *Évaluer la faisabilité et les coûts de la stabilisation de la consommation d'énergie à son niveau de 2003 d'ici 2015.*

- *Développer le cadre administratif du programme des « Certificats d'économie d'énergie », avec des méthodes claires et normalisées pour la délivrance de ces certificats d'efficacité énergétique et une fonction de suivi pour en évaluer l'efficacité.*

Energies renouvelables

- *Evaluer les politiques les plus efficaces pour atteindre les objectifs en matière d'énergies renouvelables, en considérant et en diffusant les informations sur les coûts et les bénéfices induits par la réalisation d'objectifs aussi ambitieux. Se baser sur l'expérience d'autres pays.*

- *Garantir que le système d'appels d'offres aboutisse à des capacités conséquentes en matière d'énergies renouvelables et à leur déploiement en temps voulu ; tout en accordant assez de temps au système pour bien fonctionner et donner confiance aux investisseurs, ne pas exclure la possibilité d'autres options basées sur le marché si les résultats ne sont pas satisfaisants.*

- *Assurer la coordination entre les autorités compétentes afin de garantir que l'implantation d'éoliennes et des lignes électriques correspondantes puisse se poursuivre sans délai pour atteindre les objectifs nationaux, tout en prenant toujours en compte les préoccupations locales.*

- *Mener à terme les débats en cours relatifs aux droits sur l'eau et les centrales hydroélectriques afin de déterminer le cas échéant quelle proportion de la capacité hydroélectrique sera perdue et établir des programmes en conséquence.*

- *Adopter une approche uniforme pour le programme des énergies renouvelables (à la fois électrique et thermique) et les autres programmes susceptibles de générer des avantages similaires, notamment en termes d'efficacité énergétique.*

Combustible fossile

- *Promouvoir le développement d'une infrastructure rentable de transport du gaz afin de favoriser la concurrence dans ce secteur par le biais de structures tarifaires appropriées.*

- *Maintenir une surveillance par le régulateur des positions dominantes détenues par GDF et Total dans le stockage du gaz jusqu'à la mise à disposition d'autres capacités suffisantes.*

- *Mettre en œuvre la directive européenne pour accélérer la séparation juridique d'un opérateur du réseau de transport, avec une surveillance du régulateur suffisante pour garantir l'égalité d'accès au marché du gaz à tous les acteurs du marché.*

- *Envoyer un signal clair sur les futurs différentiels entre les taxes appliquées sur le gazole et l'essence afin de permettre au secteur et aux consommateurs de prendre des décisions d'investissement appropriées.*

Electricité

- *Surveiller les obstacles potentiels à la concurrence, ce qui inclut l'accès équitable à tous les réseaux et l'existence d'un pouvoir de marché, prendre en considération toutes les options pour supprimer de tels obstacles.*

- *S'assurer que les politiques gouvernementales ont des impacts minimes sur le marché en utilisant les forces du marché, autant que possible, afin d'orienter le choix des fournisseurs d'électricité correspondant à l'analyse traditionnelle coûts/avantages et en s'inscrivant dans le cadre des politiques d'énergie renouvelable, de cogénération, etc., ce qui dynamiserait la confiance du marché et les opportunités pour les nouveaux entrants.*

- *Poursuivre l'intégration de l'idée de service public dans un marché libéralisé, en prenant des mesures pour éviter qu'il ne devienne un obstacle aux nouveaux entrants.*

- *Faciliter davantage les investissements rentables dans les interconnexions et continuer ainsi à développer un marché de l'électricité à l'échelle de l'Union*

européenne, par exemple en répondant aux préoccupations locales lorsque cela est possible.

- *Envisager l'utilisation de mécanismes d'ajustement de l'offre à la demande actuelle et future comme un moyen d'atténuer les effets inhérents aux périodes de pic de demande.*

Energie nucléaire

- *Favoriser le maintien de l'énergie nucléaire comme option, en autorisant la construction d'un réacteur de démonstration dans un contexte de marché ouvert.*

- *Explorer toutes les possibilités d'extension des durées de vie des équipements, d'augmentation de la puissance installée et de la disponibilité afin d'accroître la capacité de production, en tenant compte de la politique climatique et des normes de sécurité.*

- *Continuer à développer des solutions de traitement des déchets à haute radioactivité, en respectant le programme défini en 1991 et en s'assurant que le système complet de traitement et de déclassement des déchets soit entièrement financé par les producteurs de déchets.*

- *Poursuivre les efforts de coopération internationale pour le développement de nouveaux réacteurs nucléaires comme partie intégrante de la diversification des sources d'énergie et des actions à long terme pour limiter les émissions de GES.*

Recherche et développement dans l'énergie

- *Clarifier la méthode de répartition des dépenses publiques de R-D dans le domaine de l'énergie (comment, combien, dans quels secteurs et pour quelles institutions).*

- *Définir clairement une politique de R-D dans le domaine de l'énergie qui soutienne les objectifs gouvernementaux à long terme, particulièrement dans les secteurs du transport, de l'efficacité énergétique et des énergies renouvelables.*

- *Evaluer l'efficacité des programmes de R-D dans le cadre d'un concept plus vaste de politique énergétique, par exemple par comparaison avec l'efficacité du budget public alloué à l'introduction des énergies renouvelables sur le marché.*

- *Surveiller les dépenses en R-D dans le secteur industriel.*

ORGANISATION OF THE REVIEW

REVIEW TEAM

The 2004 IEA in-depth review of the energy policies of France was undertaken by a team of energy specialists drawn from IEA member countries. The team visited France from 11 to 16 January 2004 to meet with government officials, energy suppliers and energy consumers. This report was drafted on the basis of those meetings and the government's official response to the IEA's policy questionnaire. The team greatly appreciates the openness and co-operation shown by everyone it met.

The members of the team were:

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Jonathan Coony managed the review and drafted the report with the exception of the Energy and Environment chapter which was drafted by Martina Bosi, and the nuclear chapter which was drafted by Timo Haapalehto. Monica Petit and Bertrand Sadin prepared the figures, and Sandra Martin provided editorial assistance.

ORGANISATIONS VISITED

The team held discussions with the following:

- Ministry of Economy, Finance and Industry (*Ministère de l'Economie, des Finances et de l'Industrie, MINEFI*)
- Ministry of Ecology and Sustainable Development (*Ministère de l'Ecologie et du Développement durable*)
- Ministry of Equipment, Transportation and Housing (*Ministère de l'Equipement, des Transports, du Logement*)
- Ministry of Research and New Technologies (*Ministère de la Recherche et des nouvelles Technologies*)
- Parliamentary Group on the study of energy
- Inter-ministerial Mission on the Greenhouse Effect (*Mission interministérielle sur l'effet de serre, MIES*)
- Electricité de France (EDF)
- The French Association for Hydrogen (*Association française de l'hydrogène, AFH_2*)
- The French Petroleum Industry Association (*Union française des industries pétrolières, UFIP*)
- National Centre for Scientific Research (*Centre national de la recherche scientifique, CNRS*)
- Commission of Energy Regulation (*Commission de régulation de l'énergie, CRE*)
- Gaz de France (GDF)
- The Regional Directorate for Industry, Research and the Environment (*Direction régionale de l'industrie, de la recherche et de l'environnement, DRIRE*) for Ile-de-France
- Agency for the Environment and Energy Management (*Agence de l'environnement et de la maîtrise de l'énergie, ADEME*)
- French Petroleum Institute (*Institut français du pétrole, IFP*)
- Renewable Energy Association (*Syndicat des énergies renouvelables, SER*)
- Suez
- Association of French Business (*Mouvement des entreprises de France, MEDEF*)

- The Atomic Energy Commission (*Commissariat à l'énergie atomique, CEA*)
- AREVA
- The National Agency for Radioactive Waste Management (*Agence nationale pour la gestion des déchets radioactifs, ANDRA*)
- The Directorate for the Nuclear Safety and Radiation Protection (*Direction générale de la sûreté nucléaire et de la radioprotection*)

REVIEW CRITERIA

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

ENERGY MARKET AND ENERGY POLICY

COUNTRY BACKGROUND

France is centrally located within Europe, sharing borders with eight other countries (including Monaco and Andorra), five of which are members of the European Union (EU). It has a land mass of 552 000 square kilometres, making it the geographically largest EU country, 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. The country consists of flat plains or gently rolling hills in the north and west, with heavily mountainous areas along the Spanish border (the Pyrenees) and in the south-west (the Alps). In 2003, France had a population of just over 60 million people, making it the second-largest EU country by population.

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 *départements*. In addition to metropolitan France, the country has a number of overseas *départements* (French Guiana, Guadeloupe, Martinique and Réunion) and territories (New Caledonia and French Polynesia). France was one of the six founding members of the EU.

Economic growth in France was robust at the end of the 1990s with gross domestic product (GDP) growth averaging 3.6% annually from 1998 to 2000. Since that time, France's economy has slowed with GDP growth falling to 1% in 2002 and 0.5% in 2003. The economy is expected to recover, however, with projected GDP growth of 1.4% in 2004 and 2.3% in 2005. In 2002, French unemployment stood at 9.0%. Since the late 1980s the government has opened a number of previously 100% state-owned companies to private capital in the transport, telecommunications, financial, electronics and industrial sectors.

SUPPLY – DEMAND OVERVIEW

ENERGY SUPPLY

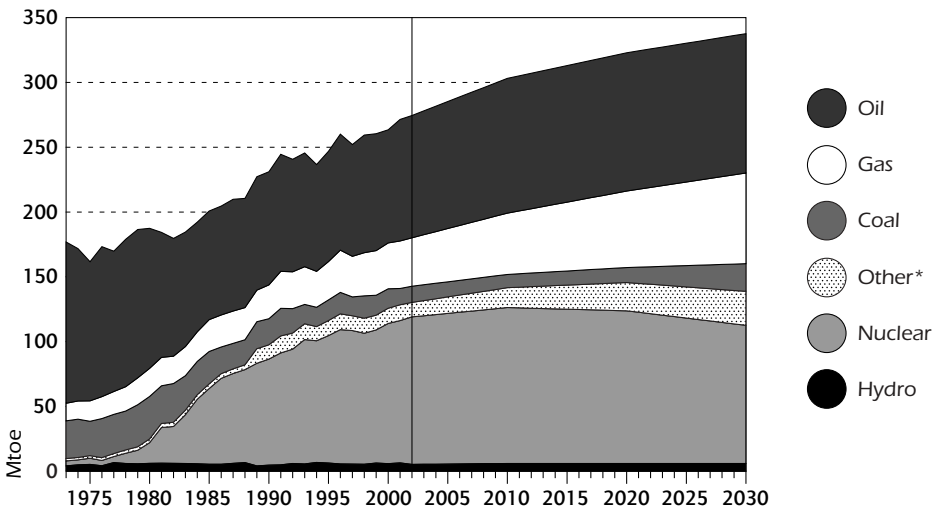
In 2001, French total primary energy supply (TPES) was 266 million tonnes of oil equivalent (Mtoe). This represents an increase in TPES of 3.3% over 2000. From 1997 to 2001, TPES growth averaged 0.8%, while from 1990 to 2001, it averaged 1.9%.

In 2001, nuclear energy accounted for 41% of French TPES, followed by oil (35%), natural gas (14%), coal (5%), biomass (4%), hydropower (2%), geothermal (0.1%), and solar and wind power (0.03% combined). In the same year, France exported electricity equal to 2.2% of its TPES and 13% of domestic electricity generation. By way of comparison, oil was by far the largest TPES contributor for the IEA countries as a whole in 2002 with 41% of the total, followed by gas (21%), coal (21%), nuclear (12%), biomass (3%), hydropower (2%), geothermal (0.4%), and solar, wind and other sources (0.1% combined).

Over the last ten years, the percentage shares of French TPES have not changed substantially. The most noticeable trend in recent years has been the decline of coal's share of TPES, largely being replaced by natural gas. From 1997 to 2001, coal's share of TPES fell from 5.9% to 4.8% with natural gas increasing its share from 12.7% to 14.0%. Over the longer term, the major trend has been the replacement of oil with nuclear power. In 1973, oil and oil products accounted for 70% of TPES with nuclear at 2.2%, while in 2001 oil had been reduced to 35% and nuclear had reached 41%. This transition resulted from a concerted government effort to reduce French dependence on imported oil by building a substantial nuclear park. In 2001, nuclear power accounted for 77% of France's electricity generation.

Figure 1

Total Primary Energy Supply, 1973 to 2030

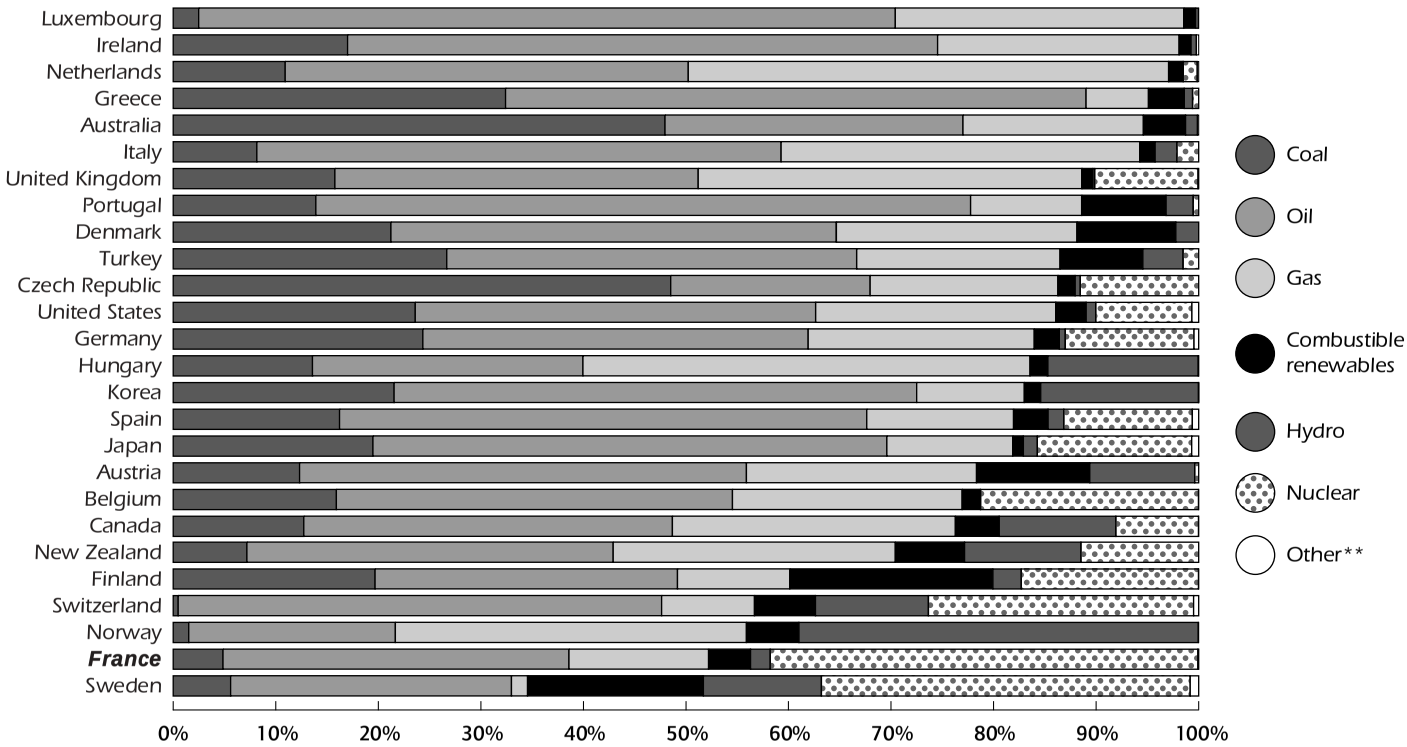


* includes geothermal, solar, wind, combustible renewables and wastes.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2003; and country submission.

Figure 2

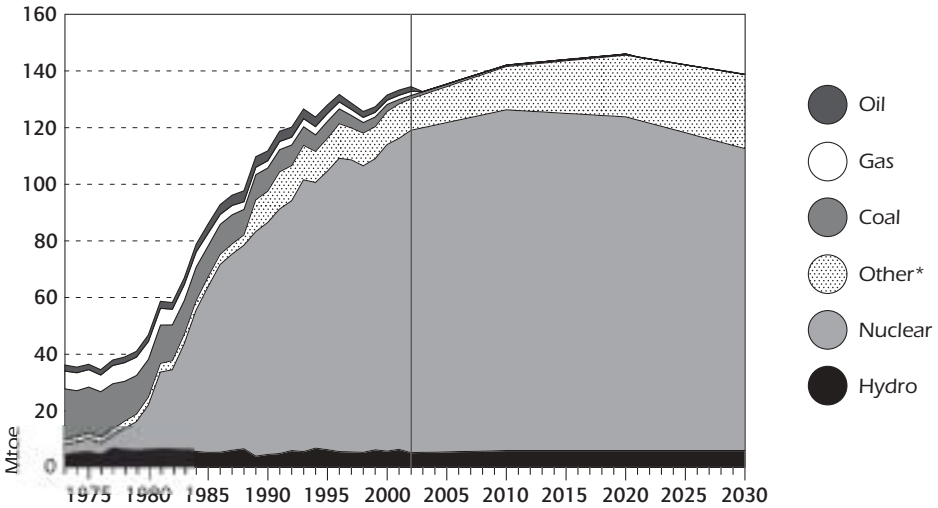
Total Primary Energy Supply in IEA Countries, 2002*



* preliminary data.
** includes solar, wind and ambient heat production.
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2003.

Figure 3

Energy Production by Source, 1973 to 2030



* includes geothermal, solar, wind, combustible renewables and wastes.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2003; and country submission.

The country's main domestic fuel is biomass, followed by hydropower. Altogether, 91% of French TPES is imported if nuclear power is considered an imported fuel, and 50% is imported if nuclear is considered a domestic source.

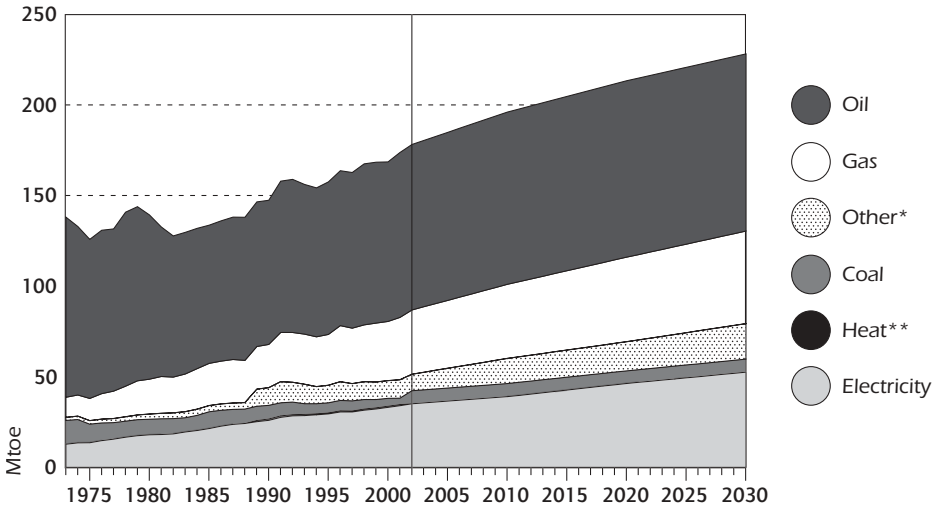
ENERGY DEMAND

In 2001, French total final consumption (TFC) of energy was 174 Mtoe. From 1997 to 2001, TFC rose by an average annual rate of 1.2% and, over the longer term, from 1973 to 2001, TFC has risen at an annual average rate of 0.9%. By way of comparison, the TFC of all IEA European countries rose at an average annual rate of 0.8% from 1973 to 2001 and the TFC of IEA countries as a whole rose at an annual average rate of 1.0% over the same period.

While oil is still the dominant final energy source used in France, accounting for 52% of TFC in 2001, its share of the total has fallen steadily since 1973 when it accounted for over 70% of French TFC. Coal has also reduced its share of TFC, going from 9.5% in 1973 to 2% in 2001. Both electricity and natural gas have increased their percentage shares of TFC over this time and these long-term trends have continued in recent years. In 2001, both gas and electricity accounted for 20% of French TFC. In IEA Europe, oil is the dominant end-use fuel, accounting for 50% of TFC in 2001, followed by natural gas at 22% and electricity at 19%.

Figure 4

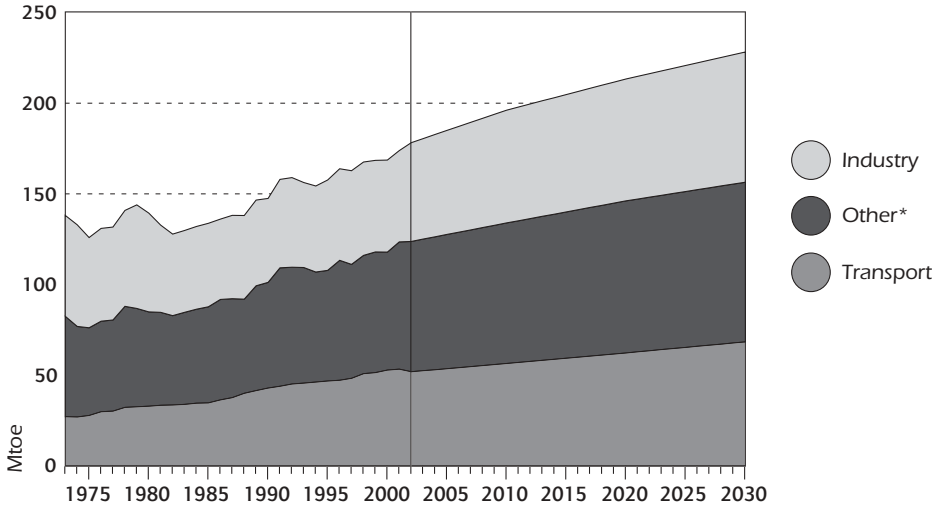
Total Final Consumption by Source, 1973 to 2030



* includes geothermal, solar, wind, combustible renewables and wastes.
** negligible.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2003; and country submission.

Figure 5

Total Final Consumption by Sector, 1973 to 2030



* includes commercial, residential, public service and agricultural sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2003; and country submission.

The transport sector is the largest final energy user in France, accounting for 31% of TFC in 2001. Of this amount, road transport makes up 83%. Transport is followed by the industrial sector (26%), the residential sector (24%) and the commercial sector (14%). Over the long term, transport energy demand has risen the most dramatically, increasing by over 96% from 1973 to 2001. By contrast, industrial energy demand has fallen by 5% over the same period. Transport energy continues its robust growth. From 1997 to 2001, demand in that sector rose by 2.5% annually. In IEA Europe, industry accounted for 33% of TFC in 2001 and transport for 29%.

GENERAL ENERGY POLICY OBJECTIVES

The principles of French energy policy have been stable for several decades and are based on attaining four main goals:

- **Security of Energy Supply**
  The oil shocks of 1973 and 1979-1980 demonstrated to French policy-makers the risks behind the country's strong dependence on imported fossil fuels. As a result, much of the country's energy policy is driven towards minimising and managing this dependence. The government has established as a goal that 50% of energy supply be produced domestically.

- **Competitive Energy Supply**
  The government places importance on providing competitively priced energy to both industry and households. For industry, internationally competitive energy prices are seen as a crucial component of success in international markets, and for residences, access to reliable energy at reasonable prices is regarded as a necessity.

- **Environmental Protection**
  Energy production, transformation and use must be done in a way that limits negative effects on the environment, whether they be local (*e.g.* urban pollution) or global (*e.g.* climate change).

- **Energy Service to all Territories and all Citizens**
  French energy policy acknowledges the disparity in energy supply infrastructure throughout the country, including the overseas territories. It strives to provide an equal level of energy service to all areas, regardless of the level of resources or the infrastructure available. At the same time, energy policy must allow the lower-income households access to energy to provide for essential needs such as heating, lighting and transport.

French energy policy-makers employ a number of means to achieve their goals:

- Energy efficiency management through rational use of energy resources.
- Promotion of the diversification of energy sources and their geographical origin.
- Technical support for the nuclear park and keeping the nuclear option open.
- International co-operation.
- Establishing objectives for government-owned energy companies and regulation of energy-related technical bodies such as ADEME and CEA.

France is in the process of discussing a major new energy law (*Loi d'orientation sur l'énergie*[1]), which will set the general course of energy strategy for the next thirty years. On 7 November 2003, the government released the *Livre Blanc sur les énergies*, which was provided as an information summary of the *Débat sur les énergies* (described below). The *Livre Blanc* reiterates the four principal goals of French energy policy, as outline above, and proposes three major axes for meeting France's energy challenges over the next thirty years:

- **Energy Efficiency**
  The *Livre Blanc* proposes that measures be taken to maintain French energy consumption at 2003 levels by the year 2015. Among other measures proposed to meet this target, the report discusses a system of tradable energy efficiency certificates, termed white certificates, to decrease energy consumption.

- **Renewable Energy**
  Renewable energy will receive additional support to meet two of the country's objectives, namely, to increase the production of renewable thermal energy by 50% from 2003 to 2015, and that 21% of the electricity generation is to be derived from renewable resources in accordance with EU Directive 2001/77, including an installed base of approximately 10 000 MW of wind power.

- **Development of Energy Plans to 2020**
  This axis consists primarily of looking at the probable renewal of France's nuclear park in anticipation of the closure of a number of existing nuclear power plants. France wishes to maintain the nuclear option in order to have all available options ready when the choice on the next generation of plants is made between 2012 and 2015.

1. The *Loi d'orientation sur l'énergie* was released and debated at Parliament too late to be included in a comprehensive fashion in this report. However, the letter and the spirit of the law as originally proposed by the government to the Parliament is consistent with the major precepts of the *Livre Blanc*.

In part as a preparation for the coming law, the government launched the *Débat national sur les énergies*, or Energy Debate. This consisted of a series of six public meetings held around the country running from March 2003 to May 2003, a number of initiatives at the local level and a web-site with information. Government officials presented the issues and the public was free to comment. The purpose of the debate was three fold:

- Respond to questions from the public.
- Gather the opinions and propositions of the public.
- To heighten public awareness of individual decisions regarding energy such as domestic use and transport.

As part of the longer-term energy plans, the government has suggested a target of cutting CO_2 emissions by 75% by 2050. This target has been termed "*Diviser par quatre*", or "Divide by four". Analytical work is currently being carried out on the appropriate means of achieving this target and the related costs to the energy sector and the economy as a whole. To date, publicly released government papers have examined which paths towards this end are promising, which are not viable, and prioritise the technical advances that would be necessary to reach the goal.

ENERGY POLICY INSTITUTIONS

MINISTRY OF ECONOMY, FINANCE AND INDUSTRY

The major policy-making responsibility in the energy field lies in the Ministry of Economy, Finance and Industry. Within the ministry, the Directorate-General for Energy and Raw Materials (*Direction générale de l'énergie et des matières premières,* DGEMP) defines and implements energy policy. The directorate's responsibilities include the opening of the gas and electricity markets, monitoring key energy sectors and supervision of state-owned energy companies. The directorate has some horizontal services and two sub-divisions. These horizontal services are in charge of international strategies and the observation and recording of energy flows and prices, among other tasks. The directorate for Energy and Mineral Resources (*Direction des ressources énergétiques et minérales,* DIREM) handles "upstream" energy issues, including hydrocarbon supply, the nuclear industry, and refining and other petroleum issues. The Directorate for Demand and Energy Markets (*Direction de la demande et des marchés énergétiques,* DIDEME) handles "downstream" issues, such as demand and energy efficiency, and the distribution of electricity, gas and fossil fuel.

COMMISSION OF ENERGY REGULATION

The Commission of Energy Regulation (*Commission de régulation de l'énergie,* CRE) is an independent regulator created in March 2000. This authority, although a state body, is independent from the government and has regulatory responsibility for the opening of the energy markets. While it originally dealt exclusively with electricity matters, at the beginning of 2003 it expanded its scope to include regulation of natural gas. It employs about 100 people. The CRE is responsible for ensuring open access to all transmission and distribution networks (for electricity and gas) for all eligible suppliers and customers. It ensures the independence of these networks from any historical or ownership influences. The CRE proposes transmission and distribution tariffs in both electricity and gas sectors to the government which then has the authority to accept or reject them.

AGENCY FOR THE ENVIRONMENT AND ENERGY EFFICIENCY

The Agency for the Environment and Energy Efficiency (*Agence de l'environnement et de la maîtrise de l'énergie,* ADEME) is a government establishment working under the ministries in charge of research, the environment and energy. It has over 850 employees with central departments at three sites (Paris, Angers and Valbonne) and 26 regional offices as well as three offices in the French overseas territories. ADEME implements French 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 energy efficiency in industry, transport and residences, while also promoting renewable energy technologies.

DIRECTORATE-GENERAL FOR NUCLEAR SAFETY AND RADIATION PROTECTION

The Directorate-General for Nuclear Safety and Radiation Protection (*Direction générale de la sûreté nucléaire et de la radioprotection,* DGSNR, also called *Autorité de sûreté nucléaire,* ASN) is the regulatory institution responsible for reactor safety and radiation protection.

COMMISSION FOR ATOMIC ENERGY

The Commission for Atomic Energy (*Commissariat à l'énergie atomique,* CEA) is a government agency specialising in development and innovation in the fields of energy, technologies for communications and health, and national defence. It has over 15 000 employees with an annual budget of €2.8 billion. In the energy field, CEA looks at ways to optimise France's nuclear park and find solutions for the treatment of radioactive waste. In addition to fission technology, CEA has programmes with hydrogen, photovoltaics, biomass and nuclear fusion.

INTER-MINISTERIAL MISSION ON THE GREENHOUSE EFFECT

The Inter-ministerial Mission on the Greenhouse Effect (*Mission interministérielle sur l'effet de serre,* MIES) was created in 1992. It is charged with co-ordinating French activity to combat greenhouse gas (GHG) emissions. It also represents France at European and other international forums.

FRENCH PETROLEUM INSTITUTE

The French Petroleum Institute (*Institut français du pétrole,* IFP) is a government-supported independent research and development organisation active in the fields of oil, natural gas and the automobile. With a staff of 1 860 people and a budget of nearly €300 million, IFP seeks to innovate and develop the knowledge and technologies that will enable the oil, gas and automobile industries and the wider community to achieve sustainable development.

REGIONAL DEPARTMENTS FOR INDUSTRY, RESEARCH AND THE ENVIRONMENT

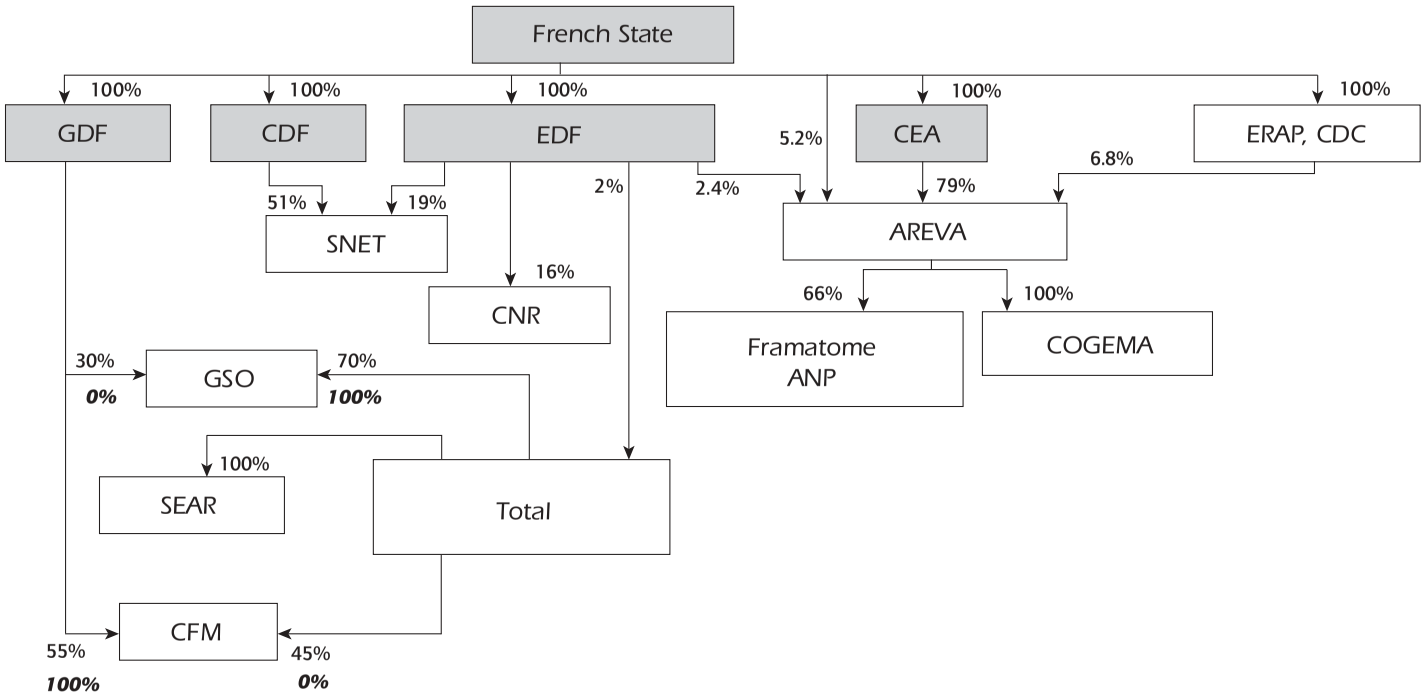
There are 24 Regional Departments for Industry, Research and the Environment (*Directions régionales de l'industrie, de la recherche et de l'environment,* DRIRE) around France, including in the overseas territories. These local organisations support regional economic development, prevent pollution and ensure the safety and reliability of infrastructure. In the energy field, the DRIREs promote the energy supply necessary for the economic development of the region. They also play a role in determining siting questions for energy-related infrastructure such as gas pipelines or electricity transmission lines.

ENERGY MARKET STRUCTURE

The French energy sector is characterised by extensive government ownership. While the oil industry has been completely privatised, the French government owns 100% of suppliers Electricité de France and Gaz de France. The electricity and gas sectors also have other players that are privately-owned. The previously state-owned global oil company, Total, was sold by the government to private investors in the late 1990s. AREVA, the primary manufacturer of nuclear power systems in France is still majority-owned by the State (primarily though the CEA) although private investors can now hold up to 4% of the capital but without the commensurate voting rights. Figure 6 shows the government shareholdings in the energy sector.

Figure 6

Government Shareholding in the Energy Sector



In accordance with an agreement signed between Total and GDF in November 2003

Source: Direction générale de l'énergie et des matières premières (DGEMP).

SECURITY OF ENERGY SUPPLY

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 its dependence with the result that France currently produces about 50% of its energy needs domestically. This has been achieved largely through the construction of a substantial nuclear park which today accounts for over 75% of French electricity generation. Energy imports fell from over 80% of French TPES in 1973 to less than 60% by 1984. Imports have accounted for less than 50% of TPES since 1993.

OIL AND OIL PRODUCTS

France has oil stockholding obligations for both the IEA and the EU. Legislative powers for oil supply security issues are under the Law no. 92-1443 of 31 December 1992. These stockholding requirements are partly met through agency-held stocks and partly by compulsory industry stocks. The law of 1992 introduced the present stockholding agency structure by creating the Professional Committee for Strategic Petroleum Stocks (CPSSP), which is supervised by the ministry. The CPSSP can directly manage strategic stocks or manage them through contracts with other bodies.

The law of 1992 also defines the obligation to hold emergency stocks for all operators. Ministerial Decree no. 93-131 of 29 January 1993 (modified in 2003) requires that each operator must hold oil stocks equivalent to 27% of the previous year's consumption (based on a 12-month moving average). As a result, French oil stocks are regularly above the IEA's minimum requirement of 90 days of net imports of the previous calendar year.

The Directorate for Energy and Mineral Resources requested a global review of the national strategic stockholding system in November 2003. A task force analysing the issue gave an overall positive assessment at the national level in their conclusions presented in March 2004. At the same time, the government has reported that it will continue its efforts to improve the transparency, management and efficiency of the strategic stockholding system.

France has well-developed demand restraint programmes and procedures as well as public campaigns. Moreover, under the law of 1992 and the law of October 1974 on energy conservation, France has sufficient legal authority to participate in an IEA co-ordinated oil emergency response, including the drawdown of stocks in both crisis and pre-crisis situations.

ELECTRICITY

France has developed substantial generating overcapacity in its electricity sector. In 2002, France had 63.3 GW of nuclear power capacity, 27.1 GW of thermal capacity and 25.2 GW of hydroelectric capacity for a total capacity of

115.6 GW. The highest demand ever recorded in France[2] was 79.4 GW, which implies a reserve margin of 46%. Projections[3] made by the *Réseau de transport d'électricité* (RTE), the transmission system operator, show that according to the baseline scenario, the reserve margin will stay above 33% through 2015 and in the extreme case (a one-in-ten possibility) would be 18% in 2015. A reserve margin is necessary since generating plants are subject to forced (and planned) outages and certain plants are not 100% reliable. Hydropower plants are reliant on rainfall and competition for water from other needs; wind plants are dependent on the weather; heavy fuel oil plants (while normally available) are costly and can be polluting; and co-genergation plants are run primarily during the winter. The reserve figures also refer to just meeting domestic demand without consideration for electricity exports. The projections assume that no new generation is built and that thermal capacity declines by 1.7 GW by 2015. Under these assumptions, and with France continuing to export electricity to its neighbours, the RTE report comes to the conclusion that 3 GW of new power is required by 2010 and 8.1 GW by 2015.

France has substantial electricity interconnections with other countries. In 2003, it had total export capacity of over 16 GW to six different countries and import capacity of 9 GW from four different countries in addition to what the RTE terms "unlimited" import capacity potential from both Switzerland and Italy. On a net basis, France currently uses these interconnections to export substantial amounts of electricity. In 2001, it exported 72.9 TWh, equivalent to approximately 13% of its total domestic generation.

In 2002, the government published a report on the Long-term Investment Programme for Electricity Production (*Programmation pluriannuelle des investissements de production électrique*, PPI). This report to Parliament projects a number of scenarios for energy futures and explores how the country can best meet its energy objectives. As a follow-up to the PPI, the government issued a decree on 7 March 2003 (*arrêté du 7 mars 2003*) which proposes a range of desired new build for different electric generating technologies and fuels. The decree establishes the following indicative levels of plant capacity additions to be put in place by 2007.

The PPI and the subsequent decree are not intended solely as energy forecast studies. If actual installed capacity of a certain generating technology exceeds the desired amounts specified in the decree, the government has the option to suspend authorisations (at least temporarily) for those types of plants, thereby preventing companies from building the type of plant they wish. 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.

2. Through 2003.
3. "Bilan prévisionnel, 2006-2015", 4 August 2003. The law requires that these projections be made every three years.

Table 1

Proposed Electricity Generating Additions by 2007

Technology	*Minimum (MW)*	*Maximum (MW)*
Renewable Energy	2 561	7 810
Of which: Biogas	*50*	*100*
Biomass	*200*	*400*
Waste	*100*	*200*
Wind Power	*2 000*	*6 000*
Geothermal	*10*	*60*
Hydropower	*200*	*1 000*
Solar and Others	*1*	*50*
Natural Gas	500	3 000
Coal	0	1 000
Nuclear Power		
Oil Products	0	2 000
Industrial By-product	0	1 000
Total	**3 061**	**14 810**

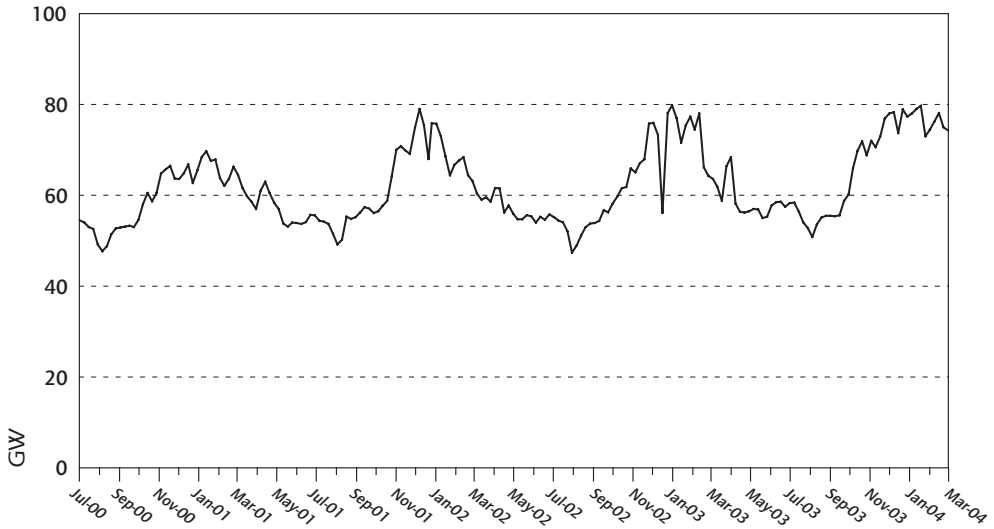
Source: *Arrêté du 7 mars 2003 relatif à la programmation pluriannuelle des investissements de production de l'électricité.*

In August 2003, France and most of the rest of Europe experienced an extreme heat wave, which strained the electricity system in two ways. First, demand rose as people used their air-conditioning to combat the heat. However, given the relatively low level of air-conditioning in France, this had only a moderate effect. The highest demand during the heat wave came on 6 August 2003 when demand reached 51.5 GW, but this was only 8.6% higher than the demand on the same day the previous year. The peak for the entire month of August 2003 (54.6 GW) was only 3.1% higher than the peak for the month of August 2002 (53.0 GW). For the entire month of August, electricity consumption was 4.2% higher in 2003 than in 2002. In addition, France is a winter peaking country (owing to higher penetration levels for electric heating than air-conditioning) and the peak in August is further subdued by people's vacation schedules and the fact that many industrial facilities are shut at that time. The highest peak demand ever reached in France occurred on 9 January 2003 at 19h00 when demand for electricity reached 79.4 GW. Weekly peak demand from July 2000 through February 2004 is shown in Figure 7. The first two weeks in August are traditionally the period of weakest demand throughout the whole year.

The second effect of the heat wave and lack of rainfall, the curtailment of the production capabilities of both hydroelectric plants and fossil and nuclear plants, was more pronounced. Hydroelectric production fell by 19% from normal levels during the period between 4 August and 24 August. In addition, the low flow of the rivers and high temperatures reduced the ability of thermal

Figure 7

Weekly Peak Electricity Demand, July 2000 to March 2004



Source: Réseau de Transport d'Electricité (RTE).

plants (both nuclear and fossil) to use the rivers for cooling, thus limiting their production capabilities. As a result, nuclear production fell by 4% from normal levels during the period from 4 August, and 24 August. A potential reduction in thermal capacity of 16 GW (or approximately 14% of total capacity) was identified for the week between 18 and 24 August.

Even with the high demand and the diminished production capability, French electricity infrastructure was adequate to meet demand, given that there is an installed capacity of 115.6 GW and the peak demand during the heat wave was 51.5 GW. Actual supply/demand margins did tighten, however, since EDF and other electricity generators in France had voluntarily taken generating plants off-line for planned maintenance or refuelling in anticipation of the normally low demand in August. In fact, the nuclear plants cooled by sea water and thus only negligibly affected by the heat had been taken off-line for maintenance while those cooled by river had been kept running to supply the country with power. Exacerbating the situation were similarly tight margins in other EU countries, especially Germany, caused partly from a fall in wind power owing to poor wind conditions at the time. RTE and EDF took steps to increase production and reduce demand, including by calling on citizens to consume less, asking that co-generators maximise their electricity production and getting special derogations from environmental laws that allowed thermal plants to discharge cooling waters into rivers at temperatures above the normally acceptable levels. It is worth noting that France continued

to export electricity throughout the heat wave. On 6 August, for example, it exported at levels ranging between 6 GW and 7 GW, or around 13% of the peak demand at that time.

On 28 November 2003, the French government, along with EDF and RTE, presented the Plan for the Uncertainties of Extreme Climate (*"Plan aléas climatiques extrêmes"*). This plan looked at various ways to ensure security of electricity supply given extreme climatic conditions, particularly heat waves of the type experienced that August. Among the suggestions for ameliorating security under such conditions were: *i)* a re-examination of the regulations and operating techniques of production companies, *ii)* more non-firm contracts to large suppliers, *iii)* co-operation between European TSOs, and *iv)* better co-operation between EDF and Météo-France to get more accurate, more timely meteorological information.

NATURAL GAS

In 2001, natural gas supplied 14% of French TPES. Domestic production accounted for 4% of supply although existing fields are expected to be shut down completely by 2010. France imports gas from a variety of different exporting countries. In 2002, Norway provided 28% of imports, Russia 24%, Algeria 24%, the Netherlands 12% and other countries the remaining 12%. Liquefied natural gas (LNG) makes up 23% of the country's gas supply. France has a substantial gas storage capability with 15 underground storage reservoirs and a total working capacity of 10.5 billion cubic metres (bcm), equivalent to 95 days of consumption.

Law 2003-8 passed on 3 January 2003 establishes the framework for a liberalised natural gas market in France, including a new gas security approach in a more market-oriented environment. In particular, the law establishes a regulatory framework that allows the government to continue to maintain diverse supply sources that are meeting French gas demand. Suppliers will be obliged to provide a provisional plan to the government which outlines what sources will be used to meet the demand they serve. The principle of continued assured supply to those clients not yet eligible for supplier choice was re-affirmed. In addition, the Parliament now requests an annual report from the government assessing the adequacy of investment in the gas sector in order to meet national demand. A decree on gas security is currently being prepared that will fix the obligations of various market operators in relation to their customers.

ENERGY FORECASTS

ASSUMPTIONS

The French government produces a number of forecast scenarios for the energy sector. Among them are the Long-term Investment Programme for

Electricity Production (*Programmation pluriannuelle des investissements de production électrique,* PPI) described above in the section on Security of Energy Supply in this chapter and the Reference Cost study of the projected costs of electricity-generating technologies, described in Chapter 8. In addition, the RTE also provides scenarios of future generation adequacy every three years, as described in the previous section of this chapter.

The Directorate-General for Energy and Raw Materials (DGEMP) also produces scenarios for various possible energy futures under different sets of assumptions. In early 2004, DGEMP produced a new set of business-as-usual scenarios[4] projecting energy supply and use until 2030. These scenarios assume only those policies which have already been put in place or those that are expected with certainty to be put in place very soon. As a result, not all the measures of the new Climate Plan have been included nor any other considerations regarding Kyoto Protocol obligations have been used.

Specific assumptions used in these projections include:

- Economic growth of 2.3% per year.
- Population growth of 0.3% per year, and 0.7% for the number of households and no growth of the working population.
- Parity in the exchange rate between the US dollar and the euro.
- Oil price (Brent) remaining equal to US$ 30 (in constant 2003 US$).
- International gas price of US$ 4.00 per MBtu, indexed with the price of crude oil.
- International price of coal between US$ 40 and US$ 50 per tonne.
- Discount rate of 8% (real).
- No carbon sequestration taken into account.
- No emission quota trading taken into account.
- France will reach its goal of having 21% of electricity generation coming from renewable energy by 2010 in accordance with EU Directive 2001/77, after which renewable energy production will evolve according to open market conditions.
- Cost of electricity generation technologies based on reference cost study released in 2003 (discussed in Chapter 8).
- Availability of nuclear power plants will be raised to 85% by 2010.

4. *"Scénario énergétique tendanciel à 2030",* DGEMP-OE (2004).

- All existing nuclear plants retired after 40 years of service, meaning the first retirement will occur in 2017 with the Fessenheim plant.

- A 1 600 MW "demonstration" EPR nuclear plant will come on line in 2013. A new generation of nuclear plants will begin coming on line in 2020, with 3 200 MW of new plant installed in 2020 and each year thereafter.

PRIMARY ENERGY

The forecasts indicate that French TPES will grow at an average rate of 0.7% per year from 2000 to 2030, although that growth will slow over that time. Up until 2010, growth is forecast at 1.0% per year; from 2010 to 2020 it is forecast at 0.7% per year; and from 2020 to 2030 growth is forecast at 0.5% per year. By way of comparison, French TPES grew at an average annual rate of 1.5% from 1990 to 2000.

Table 2

Projections of TPES by Fuel, 2000 to 2030

					Average Annual Growth	
Energy Source	*2000*	*2010*	*2020*	*2030*	*1990-2000*	*2000-2030*
Coal	14.2	10.3	11.6	21.4	–3.0%	1.4%
% share of total	*5.3%*	*3.4%*	*3.6%*	*6.3%*		
Oil	95.5	103.9	106.7	107.5	0.7%	0.4%
% share of total	*35.5%*	*34.7%*	*33.3%*	*31.8%*		
Natural Gas	37.3	47.3	59.0	69.9	3.5%	2.1%
% share of total	*13.9%*	*15.8%*	*18.4%*	*20.7%*		
Primary Electricity[1]	109.2	123.0	124.5	116.7	2.7%	0.2%
% share of total	*40.6%*	*41.1%*	*38.9%*	*34.5%*		
Thermal Renewable Energy[2]	12.8	14.7	18.5	22.5	0.6%	1.9%
% share of total	*4.8%*	*4.9%*	*5.8%*	*6.7%*		
Total	**269.1**	**299.3**	**320.3**	**338.0**	**1.5%**	**0.7%**

(1) Nuclear, hydroelectric, wind power and photovoltaics.
(2) Primarily biomass.

FINAL ENERGY

Final energy consumption is projected to grow at 0.9% per year from 2000 to 2030. By way of comparison, final energy consumption grew by 1.3% annually from 1982 to 2002.

Table 3

Projections of TFC by Fuel, 2000 to 2030

					Average Annual Growth	
Energy Source	*2000*	*2010*	*2020*	*2030*	*1990-2000*	*2000-2030*
Coal	7.6	7.2	6.9	7.2	–3.2%	–0.2%
% share of total	*4.3%*	*3.7%*	*3.2%*	*3.2%*		
Oil	89.1	95.1	97.3	97.8	0.9%	0.3%
% share of total	*50.9%*	*48.50%*	*45.62%*	*42.88%*		
Natural Gas	33.7	40.9	46.7	51.0	2.9%	1.4%
% share of total	*19.2%*	*20.86%*	*21.89%*	*22.36%*		
Electricity	34.0	39.0	46.3	52.5	2.5%	1.5%
% share of total	*19.4%*	*19.89%*	*21.71%*	*23.02%*		
Thermal Renewable Energy	10.8	13.9	16.1	19.6	–0.4%	2.0%
% share of total	*6.2%*	*7.1%*	*7.5%*	*8.6%*		
Total	**175.2**	**196.1**	**213.3**	**228.1**	**1.2%**	**0.9%**

French energy intensity is projected to decrease over the forecast period at rates significantly higher than seen from 1990 to 2000, as shown in the table below.

Table 4

Energy Intensity, 2000 to 2030

					Average Annual Growth	
Energy Source	*2000*	*2010*	*2020*	*2030*	*1990-2000*	*2000-2030*
GDP, billion 1995€	1 349	1 693	2 126	2 668	1.9%	2.3%
Primary Energy Intensity, TPES/GDP (index)	100	88.6	75.5	63.5	–0.3%	–1.5%
Final Energy Intensity, TFC/GDP (index)	100	89.7	78.3	66.9	–0.8%	–1.4%

CO_2 FORECASTS

Total carbon dioxide emissions solely related to the use of energy are expected to rise by 5% from 2000 to 2010 with significant higher growth in emissions thereafter. Emissions from the transport sector are expected to grow fastest,

followed by residential emissions. Emissions from electricity are shown to grow at a very high rate over the long term although this is contingent on the current nuclear park being replaced by fossil fuel generation. Industrial emissions are projected to continue their long-term decline.

Table 5

Energy-related CO_2 Emissions, 2000 to 2030 (MtC)

Sector	*2000*	*2010*	*2020*	*2030*
Transport	40.0	45.5	49.6	53.8
% change from 2000		*14%*	*24%*	*35%*
Residential	27.0	30.2	30.6	28.9
% change from 2000		*12%*	*13%*	*7%*
Industry	21.2	21.0	21.5	22.3
% change from 2000		*–1%*	*1%*	*5%*
Agriculture	2.2	2.4	2.4	2.4
% change from 2000		*9%*	*9%*	*9%*
Electricity	10.3	8.6	14.5	29.0
% change from 2000		*–17%*	*41%*	*182%*
Other	4.9	6.1	6.4	6.8
% change from 2000		*24%*	*31%*	*39%*
Total	**105.6**	**113.8**	**124.9**	**143.2**
% change from 2000		*8%*	*18%*	*36%*

ENERGY TAXATION

All products and services sold in France are subject to a value-added tax (VAT), set for most goods and services at 19.6%. The fixed component of all natural gas and electricity sales is subject to a reduced VAT of 5.5% while the variable component of these sales is taxed at the normal VAT level of 19.6%. In the case of wood, Article 20 of the finance law from 1997 lowered the VAT on wood from 20.6% to 5.5%. Note that VAT is levelled on the base price of the energy product plus any specific energy-related taxes, which are described below.

Coal is not subject to any specific taxation beyond the VAT. Specific taxation (excise duties) on petroleum products is termed TIPP (*taxe intérieure sur les produits pétroliers*) and a specific tax on natural gas is termed TICGN (*taxe intérieure sur la consommation de gaz naturel*). The table below shows the level of these taxes as of 1 January 2004.

Table 6

Taxation on Hydrocarbons (as of January 2004)

Product	*Units*	*TIPP or TICGN (€/unit)*
Gasoline	100 l	63.96
Unleaded Gasoline	100 l	58.92
Diesel	100 l	41.69
Aviation Gasoline	100 l	32.36
Residential Fuel Oil	100 l	5.66
Liquefied Petroleum Gas	100 l	5.99
Heavy Fuel Oil	Tonne	18.50
Natural Gas for Transport	100 m^3	8.47
Natural Gas for Residences	1 000 kWh	0.00
Natural Gas for Industry	1 000 kWh	1.19

Source: French government.

French energy taxes favour diesel fuel over gasoline with excise tax on gasoline approximately 50% greater than on diesel fuel. France has one of the highest gaps between gasoline and diesel taxes, approximately 25% above the EU average. This discrepancy is intended to encourage the use of diesel-fired automobiles, which are more energy-efficient and thus will reduce CO_2 emissions and oil imports. Partly owing to these tax policies, the use of diesel-fired cars has expanded considerably with 63% of new cars purchased in France in 2002 running on diesel fuel and 70% of all new vehicles (including trucks) using diesel. As of 2002, the vehicle fleet was made up of 48% vehicles running on diesel fuel. However, the government has recently decided to raise the tax on diesel fuel, effectively reducing the gap between the two fuels. In September 2003, the Prime Minister announced the first step in this plan with an increase in the diesel excise tax of 2.5 eurocents per litre[5], which took effect on 1 January 2004. However, this tax increase will not apply to the professional use of diesel, mostly in the trucking industry. The government expects this tax increase to bring an additional €500 to €800 million of tax revenues and has stated that it wishes this money to be dedicated to infrastructure development, which will reduce GHG emissions from vehicles.

Natural gas is favoured for tax purposes over petroleum products owing to its lower emissions. Residences face no taxation on natural gas and industry faces taxes that are less than equivalent oil products. The most common competitor for natural gas in industry is heavy fuel oil, which is taxed at a rate of €18.50 per tonne, or €.00166 per kWh. This is 39% higher than the tax rate for natural gas used in industrial processes.

5. This is equivalent to a 3 eurocent/litre rise when considering the VAT.

Electricity is subject to a number of taxes. The bulk of the taxation takes place at local rather than national level. The sum of all excise taxes (*i.e.* excluding VAT) is 0.45 eurocents per kWh for industry and 1.42 eurocents per kWh for households. One portion of the tax collected at the national level is the contribution to electricity public service (*contribution au service public de l'électricité,* CSPE). This fee is €4.50 per MWh and is paid by final customers with the exception of autoproducers who are only subject to this fee for electricity generation above 240 GWh per year. The money is used to purchase electricity from co-generation and renewable energy plants at above-market rates, provide service to zones not connected to metropolitan France (*e.g.* Corsica and the overseas territories), and to pay for energy services to consumers who could not otherwise afford them. The idea for such a tax was introduced with the passage of a law in February 2000. It was originally termed the Fund for Public Service for the Generation of Electricity (*Fonds du service public de la production d'électricité,* FSPPE) but changed to its current name on 1 January 2003. This tax did not represent any increase in total final price to consumers since it covers costs that were already paid for by electricity users and recovered through network charges and other tariff components in EDF billing. The idea was to make these costs explicit in line with a move towards a liberalised market. Therefore, these costs were simply shifted to this explicit tax recovery system and the tariffs themselves lowered by an equivalent amount.

Special tax reductions have been put in place to assist biofuels. Vehicle fuels containing a mix of regular gasoline and bioethanol (*ethyl tertiary butyl ether*, ETBE) receive a tax reduction of €38 per hundred litres from the normal gasoline tax. Pure ethanol receives a tax reduction of €37 per hundred litres. Vehicle fuels containing biodiesel (*ester méthylique d'huile végétale,* EMHV) receive a tax reduction of €35 per hundred litres from the normal diesel tax.

The General Tax on Polluting Activities (*taxe générale sur les activités polluantes,* TGAP) was introduced on 1 January 1999. It is based on a polluter-pays principle whereby sufficient funds are given to the State to fix the damage done by environmentally harmful activities. The TGAP did not represent an increase in tax levels but was rather a means of combining five existing taxes. It is principally levied against emissions of sulphur dioxide (SO_2) and nitrogen oxides (NO_x). An attempt was made to extend the TGAP to CO_2 emissions from industrial sources but this idea was ultimately rejected by the *Conseil Constitutionnel*. There are currently no plans and very limited political will to pursue CO_2 taxation of any sort.

CRITIQUE

The record of French energy policy over the past decades has been impressive. The country has largely succeeded in achieving the famous three E's of energy policy, namely energy security, economic efficiency and environmental protection. In

energy security, France's nuclear park has dramatically reduced its dependence on oil, and the national electric and gas utilities have a near-spotless record of providing uninterrupted service to their customers. Environmentally, France has one of the lowest carbon intensities of any OECD country, largely owing to the predominance of nuclear power plants in the electricity sector. The only concern in this regard is the long-term environmental liabilities associated with plant decommissioning and waste treatment. As for economic efficiency, French consumers consistently enjoy some of the lowest energy prices in industrialised countries for electricity, natural gas and petroleum products.

France has achieved these successes with a policy that stresses centralisation, a nation-based approach to energy and strong government involvement. However, the context in which French energy policy historically operated has changed dramatically in recent years, driven by two main forces. The first force is the introduction of competition in the electricity and gas sectors, precipitated largely by the European directives on market opening. This is leading to more market players who, unlike traditional utility monopolies, will focus exclusively on profit maximisation through individual strategic decisions on technologies, imports/exports and fuel. This freedom of choice – also to be exercised by eligible customers – will create energy supply and demand patterns that are more difficult for energy policy-makers to anticipate and control. The second major force is the move towards an internal energy market in Europe rather than a number of distinct nation-based markets. Energy trade within Europe has increased substantially and will continue to do so as more and more suppliers and consumers take a pan-European perspective. This trend can be seen as large companies use cheaper imported natural gas and electricity companies export power to countries with high power prices, as EDF currently does. Such integration will limit the effectiveness of any national energy policy that does not take into account the strong influences that neighbouring countries will increasingly have on one another.

The challenge for French energy policy-makers is to continue to succeed with the three E's while adapting to, and benefiting from, the changes brought about by competition and internationalisation. The large size and geographical position of France within Europe – and its many energy interconnections with neighbouring countries – make the development of the French energy sector particularly important for the European energy balance.

The government is working to adapt its security of supply strategies to the rise of competition and greater international trade. In a competitive market, individual companies will not concern themselves with the concept of national energy security. Consequently, the French government will no longer be able to dictate (through EDF) the amounts and types of installed electricity capacity. The French government has responded to this situation with the PPI which identifies a range of indicative targets for the types and amounts of new electricity capacity to be built in the coming years. It has the option to

withhold authorisations for technologies which have exceeded this range and the option to hold bid tenders for those technologies that have failed to reach the minimum desired levels.

The government's indicative targets for new plant to be built by 2007 range between 3.1 MW and 14.8 MW. While much of this plant would be renewable energy, it still represents substantial investment in a system which the RTE identifies as likely to have a reserve margin to meet domestic demand of between 30% and 49% in 2006 and between 23% and 41% in 2010, even if no plant is added. If the mid-point of the desired range is added (8.95 GW), the domestic reserve numbers would be between 40% and 61% in 2006 and between 33% and 52% in 2010. Such reserve margins could represent additional costs to French consumers with only a limited added security value although, as noted, many of the additions would be for renewable plant that is to be added also for environmental reasons and which may require its own thermal generation backup. However, calculations of reserve margins and the need for new capacity change when taking into account continuing electricity exports to neighbouring countries. RTE concludes that 3 GW of additional capacity would become necessary in 2010 and 8.1 GW in 2015.

The larger question is how such an approach would affect market operation. For example, if a company wants to build a new natural gas power plant because it believes the market would support such an investment, but France already has more than the 3 000 MW of new build specified in the decree of 7 March 2003, the government has the option to deny the authorisation for such plant. But it is difficult to see how preventing a new gas-fired power plant from being built could impact negatively on security, especially since gas would still be a very minor player in the electricity market (less than 10%) while nuclear would continue to dominate (over 70%).

The bid tenders the government has the option to launch if insufficient amounts of a certain technology are built could have more implications for the market. The offered contracts would be very desirable to potential investors and, since it is known that the government will issue such contracts if not enough plants are built, companies will refrain from building in order to precipitate the tenders. Thus, the programme could create some incentive not to build, thereby weakening the market's ability to supply secure energy sources. The government has noted that it will use these options to control the supply mix only as a last resort. While the government is ultimately responsible for the country's energy security (and this includes ensuring a reasonable diversity of fuels), care should be taken that market distortions are minimised.

Well-designed liberalised electricity markets have generally encouraged adequate investment to meet security requirements. Nevertheless, governments remain concerned about the performance of such markets and the reliance on often volatile electricity prices to induce required investment. While a market

unfettered by government involvement represents the ideal situation, a government concerned about security in the transitional phase towards liberalisation can rely on means that are decidedly less interventionist than what has been proposed in France. In New Zealand and Sweden, for example, the governments are paying for (or having consumers pay for) electricity peaking capacity. The Pennsylvania-New Jersey-Maryland (PJM) power pool in the United States requires suppliers to have or contract for sufficient capacity to meet their customers' need plus a reserve margin. Programmes pushing demand response may be the best way to strengthen supply security. While any government intervention can disrupt the market and discourage investors, the approaches such as those mentioned will give the market a better chance to provide needed investment without undue distortions. Market efficiency will be higher, costs to consumers will be less, and security is still guaranteed. France is encouraged to look at such tools as ways of providing security in a liberalised context.

France must also adapt its notion of energy security to the rising internationalism of energy markets. France's position as a large country in the centre of Europe and its role as the world's largest exporter of electricity make it well positioned to take advantage of this trend. International trade increases both efficiency and security for all countries involved. Governments should therefore increase the possibility for trade – both through enhanced infrastructure interconnections and establishment of regulations accommodating trade – to improve their countries' energy security. In this context, France should reduce the extent to which it regards energy security in a national rather than a regional context.

The tightening of the electricity supply-demand margin in August 2003 due to the heat wave does not represent structural inadequacies within the sector. With 116 GW of installed capacity and just 52 GW of peak demand, the country is equipped to handle even the most extreme summer weather conditions. There were no black- or brown-outs and the country's domestic producers honoured their commitments to export power. Nevertheless, the government, along with EDF and RTE, is rightly taking steps to avoid such a situation in the future. The market, while still in its nascent stages, worked effectively in that high prices increased supply and lowered demand. Full market opening and greater competition will make the sector better equipped for such conditions as both suppliers and consumers, driven by profit considerations, prepare for the likelihood of extreme weather and adjust their behaviour accordingly. Under such circumstances, the electricity sector should be able to meet demand during the period with the lowest consumption levels in the whole year.

Since the last in-depth review, significant progress on market reform has been made in France. Although the market opening still does not go beyond what is required by the European directives, the institutional market design has led to competition in the market segments that have been opened up. For instance, electricity sector unbundling has progressed commendably,

especially at the transmission level (RTE), and the regulator (CRE) has shown strength in making wise decisions about market structure. The creation of the Powernext electricity market and the fact that new market players have been able to take around 25% of eligible market away from the incumbent are encouraging signs of a developing dynamic in the market.

France is encouraged to continue its commendable strides towards market competition in three principal ways. First, the government should proceed with its already announced plans to change the legal status of EDF and GDF to *sociétés anonymes*. This is a key step in placing the companies on the same legal and regulatory basis as other market competitors. This change would also be necessary if the government decides in the future to open up the capital of the companies to private investors, but it is a useful step even if this path is not ultimately taken. Second, the full legal unbundling of accounts for EDF and GDF in their supply and distribution businesses should proceed without delay. Creating a clear separation between the competitive and still-regulated sections of the energy sector is necessary to prevent any possibility of cross-subsidisation or influence of one business segment upon another. This will also enhance the appearance of a level playing field for all companies and thus induce new competitors into the market. Third, the CRE should be given the right to set tariffs for the still regulated portions of the market (*e.g.* electricity transmission). The current system, whereby the CRE proposes tariffs that are then approved by the government, inhibits the strength the CRE needs to provide effective regulation.

As a more general point, the French government is advised to more clearly define its various roles in the energy sector. Currently, it is the exclusive shareholder to the dominant gas and electricity companies, the regulator, the law maker, and the financier and director of public energy research. It is also quite rightly responsible for ensuring energy security, transposing EU directives and meeting environmental targets. Thus, the government has a number of partly competing objectives corresponding to its different roles which may create conflicts. The government is advised to increase the transparency of government energy operations and better define which responsibilities lie with which entities. The *Débat national sur les énergies* has helped in explaining the energy sector and energy choices to the public, as well as the government's role in this sector.

The government is to be commended for the comprehensive long-term energy strategy it has laid out. In particular, it has established a number of ambitious goals to mitigate climate change, an issue best addressed in the long term. The *Livre Blanc* proposes a number of objectives, notably to limit energy consumption at 2003 levels by 2015 and to have 10 000 MW of installed wind power capacity by 2010. In addition, "*Diviser par quatre*" outlines different paths to cut CO_2 emissions by 75% by 2050. All these objectives would improve national environmental performance and augment energy

security. However, the reach of their ambition would necessitate tremendous effort and expense. In the case of energy consumption, French TFC grew at an average annual rate of 1.2% from 1990 to 2000 and is projected by the French government to grow by 0.9% annually until 2030 under business-as-usual conditions. If this happens, energy consumption will be more than 11% over 2003 levels by 2015. While avoiding increases in energy consumption to such a degree through government policies is possible, it will require a substantial commitment since no OECD country has held consumption steady over such a length of time. Attaining the wind power target in the *Livre Blanc* will also require tremendous government involvement. At the end of 2003, France had between 250 MW and 350 MW of wind power, with 100 MW having been added in 2003. To reach the goal, over 1.6 GW of wind power would need to be added annually. The government needs to continue conducting economic studies to examine the feasibility of these targets and the cost-effectiveness of the measures to reach such goals and to disseminate the results as widely as possible.

RECOMMENDATIONS

The government of France should:

- *Explore the benefits of adopting a more regional approach to energy security within the context of the evolving European policy framework. While maintaining the option for the government of influencing fuel mix (*e.g. *renewable energy), take into account the increasingly open European market where players make their own fuel choices, and thus any given energy mix cannot be guaranteed by government.*

- *Continue to monitor the supply-demand balance and investment trends of the energy supply sectors. Ensure that the manner of implementing the system of tendering for power plants will not send perverse incentives to market players.*

- *Further improve the design of market reform by completing full legal unbundling at both the transmission and distribution levels (in electricity and gas) and further strengthen the powers of the regulator by allowing it to fix the regulated tariffs.*

- *Move as quickly as possible to change the legal status of EDF and GDF to ordinary companies and, after this step has been taken, consider allowing "opening up" of their capital which is important to strengthen domestic competition in both the electricity and gas markets.*

- *Increase transparency in the energy field, especially by defining the different roles (and their limits) played by the government: as shareholder, law maker, regulator and financier of public research.*
- *Undertake additional economic studies on the feasibility of far-reaching climate change and efficiency targets and examine the cost-effectiveness of measures to reach them.*

INTRODUCTION

Environmental protection is one of the main objectives of France's energy policy. This objective is manifested through efforts towards sustainable development by conserving fossil and mineral resources, reducing greenhouse gas (GHG) emissions and guaranteeing the security of nuclear waste and installations

The 2003 *Livre Blanc sur les énergies* identifies climate change as one of the two main "new" challenges facing France's current energy policy[6]. The importance of preserving the environment was confirmed in the National Debate on Energy. It emerged from the public consultation as one of the four priority objectives for the development of France's energy policy. Consequently, the *Livre Blanc* (p. 35) states that it is desirable to put the energy policy at the service of combating climate change. It also states that, in parallel, it is advisable to ensure the appropriate management of nuclear risks[7] to avoid impacts on the environment.

CLIMATE CHANGE

FRANCE'S COMMITMENTS

Under the European Union (EU) burden-sharing agreement that sets the Kyoto Protocol target for each individual member State, France has the obligation to stabilise its GHG emissions at 1990 levels by the Kyoto Protocol's 2008 to 2012 commitment period. France, along with the European Union and the other member States, ratified the Kyoto Protocol in May 2002.

France is also looking beyond the Kyoto commitment period, thus responding to findings from the Intergovernmental Panel on Climate Change (IPCC)[8] Third Assessment Report that confirm the need to reduce global GHG emissions much further to stabilise global GHG concentrations in the

6. The other being the development of an energy policy that takes into account economic evolutions and realities, even tensions, which will occur at the global level.
7. Issues related to nuclear energy are discussed in Chapter 9.
8. The IPCC was set up jointly by the World Meteorological Organization and the United Nations Environment Programme to provide an authoritative international statement of scientific opinion on climate change.

atmosphere at acceptable levels. The government has announced an ambitious long-term target for 2050: a 75% reduction of GHG emissions (also called the "factor 4" target).

GREENHOUSE GAS EMISSIONS[9]

France's total GHG emissions (excluding land use, land-use change and forestry) reached 554 Mt CO_2e in 2002 (Table 7). France's GHG sinks amounted to 59 Mt CO_2e, resulting in France's net emissions (*i.e.* accounting for GHG sink enhancements as allowed under the Kyoto Protocol) amounting to 499 Mt CO_2e. As indicated in Table 7, carbon dioxide (CO_2) accounted for the largest share (*i.e.* 70%) of France's 2002 GHG emissions, followed by nitrous oxide (14%).

Table 7

Total Greenhouse Gas Emissions in France (metropolitan and overseas)

(Mt CO_2e)

	1990		*2002*		*1990-2002 (% change)*	
Gases	*Excluding LULUCF**	*Net***	*Excluding LULUCF**	*Net***	*Excluding LULUCF**	*Net***
CO_2	396	364	406	351	2.5	–3.6
CH_4	70	69	62	62	–11	–11
N_2O	89	89	72	72	–19	–19
HFC	3.6	3.6	9.9	9.9	174	174
PFC	3.5	3.5	1.6	1.6	–53	–53
SF_6	2.2	2.2	1.6	1.6	–29	–29
TOTAL	**565**	**533**	**554**	**499**	**–1.9**	**–6.4**

*land-use, land-use change, and forestry (LULUCF) activities, as allowed under the Kyoto Protocol.
**includes sink enhancement LULUCF activities.

Source: *Inventaire des émissions de gaz à effet de serre en France au titre de la Convention-cadre des Nations-Unies sur le changement climatique* (December 2003, p. 13)

In 2002, France's total GHG emissions were roughly equivalent to 1990 levels, and 6.4% below 1990 levels when accounting for sink enhancements. Carbon dioxide emissions increased by 2.5% during the

9. According to provisions related to the United Nations Framework Convention on Climate Change, countries must communicate information on six direct greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). These gases have different global warming potentials, but are all converted into the same measurement unit, *i.e.* CO_2-equivalent (CO_2e).

1990 to 2002 period, owing largely to energy sector trends (discussed below). Methane (CH_4) emissions decreased by 11% mainly as a result of increased landfill methane capture. Agriculture is the largest contributor (about three-quarters) to nitrous oxide (N_2O) emissions, but the significant drop in emissions (19%) was largely due to actions undertaken by chemical sector industries over the past few years. Hydrofluorocarbons (HFCs) emissions increased by 74% as their use increased in vehicle air-conditioning and refrigeration. Perfluorocarbons (PFCs) represent a small fraction of France's GHG emissions in 2002; they decreased by 53% compared to 1990 largely because of process changes in the production of aluminium. Finally, very small amounts of sulphur hexafluoride (SF_6) – used principally in electrical equipment, metal production and in the electronic industry – were emitted in 2002 and these were in decline compared to 1990.

According to France's national GHG inventory data, energy use (excluding biomass) typically represents between 68% and 72% of France's annual GHG emissions, but between 93% and 95% of its CO_2 emissions. The energy contribution to total GHG emissions is lower than most IEA countries, given France's significant reliance on non-GHG-emitting nuclear power as a principal source of electricity generation. Compared to all other IEA countries, France has the fourth-highest share (91%) of non-fossil fuel contribution to electricity output (after Norway, Sweden and Switzerland).

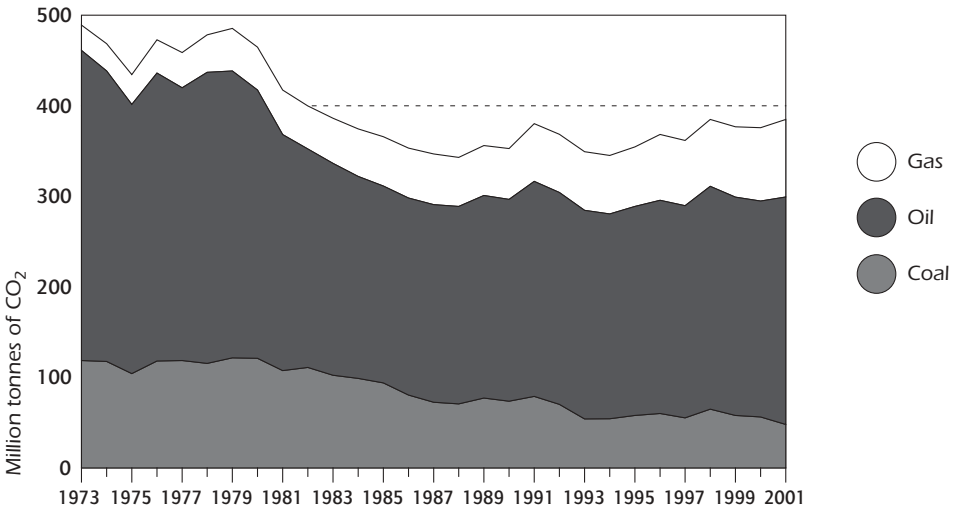
France's energy-related CO_2 emissions reached 384.9 Mt CO_2 in 2001, which is an increase of 9.1% above 1990 levels[10]. In relative terms, France's energy-related CO_2 emissions amounted to 6.32 tCO_2 per capita (only five other IEA countries have lower levels), increasing by 4.3% above 1990 levels. Its energy-related CO_2 emissions per gross domestic production (GDP), using exchange rates, declined by 12.5% compared to 1990 levels, reaching 0.21 kg CO_2 per 1995 US$ in 2001. According to IEA statistics, France's CO_2 intensity of GDP is the fifth-lowest among all IEA countries – with only Switzerland, Sweden, Japan and Norway having lower ratios.

10. Energy-related CO_2 emissions have been estimated using the IPCC Tier I Sectoral Approach. In accordance with 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 2001 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. Because of differences in methodology and definitions in estimating energy-related CO_2 emissions, the IEA statistics and the official French statistics submitted to the UNFCCC and elsewhere may differ. Unless otherwise stated, statistics in this book are taken from the IEA's statistics in *CO_2 Emissions from Fuel Combustion 1971-2001* (2003).

Oil is by far the fossil fuel contributing the most (65%) to France's energy-related CO_2 emissions. While its importance declined after the introduction of nuclear power in France's electricity mix in the early 1980s, it is now growing again as transportation needs increase (Figure 8). Coal-related emissions are steadily decreasing. Gas-related CO_2 emissions represent a small share of emissions but are increasing, especially as gas penetrates the heating market.

Figure 8

CO_2 Emissions by Fuel*, 1973 to 2001



* estimated using the IPCC Sectoral Approach.

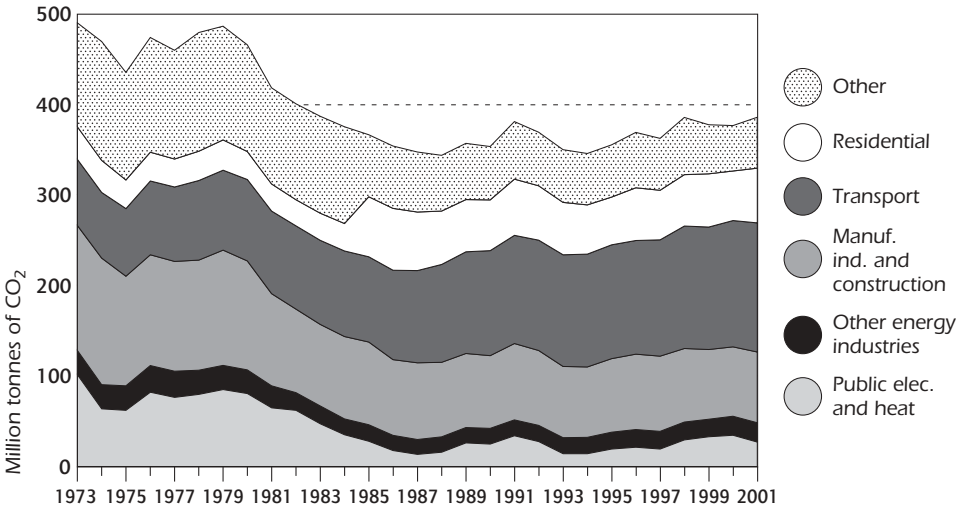
Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2003.

On a sector basis, the contribution of electricity and heat production to France's energy-related CO_2 emissions, while having increased by 9% in the period 1990 to 2001, is relatively small in absolute terms representing 9% of France's CO_2 emissions (see Figure 9). The average contribution from this sector for all IEA countries is 38%. This low figure in France is explained by the large use of emission-free nuclear and makes other sectors' contributions relatively larger than is the case in most other IEA countries. In particular, the transport sector was responsible for emitting 142 Mt CO_2 in 2001, representing 36% of France's energy-related CO_2 emissions. Transport-related CO_2 emissions are on an upward trend, having increased by 23 % since 1990 (Figure 9) following the steady increase of the French vehicle stock. Manufacturing industries and construction represented 20% of France's 2001 energy-related CO_2 emissions, but their trend has been declining slightly (-3% since 1990). The residential sector is the other major contributor to CO_2

emissions (16%), increasing by 8% since 1990. CO_2 emissions from other energy industries (largely comprised of emissions from petroleum refineries) only represent 6% of energy-related CO_2 emissions, but increased by 23% between 1990 and 2001.

Figure 9

CO_2 Emissions by Sector*, 1973 to 2001



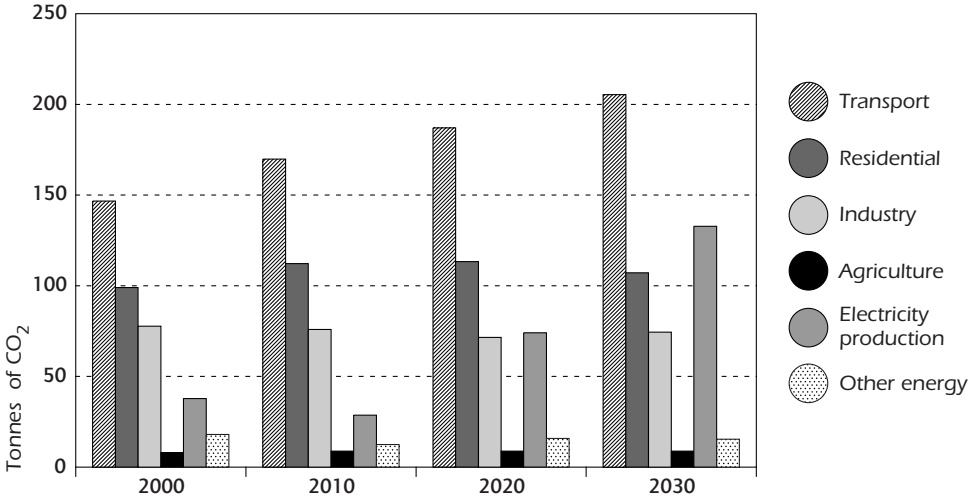
* estimated using the IPCC Sectoral Approach.
Source: *CO_2 Emissions from Fuel Combustion*, IEA/OECD Paris, 2003.

According to preliminary French government energy business-as-usual projections[11], energy-related CO_2 emissions are on an upward trend, projected to increase by 11.1% between 1990 and 2010 and by 40% between 1990 and 2030 under a business-as-usual scenario (see Figure 10). In 2030, the transport sector is still expected to dominate energy-related CO_2 emissions with close to 38% of the total. Other major contributors are projected to be electricity production (20% of 2030 CO_2 emissions) as a consequence of assumed greater gas-fired electricity in the future, and the residential sector (20% of 2030 CO_2 emissions). The electricity sector's contribution to energy-related CO_2 emissions is expected to experience the greatest increase from 1990 to 2030 (about 170%) given the assumed only partial replacement of nuclear facilities, reducing the current 63 GW of installed capacity to 51 GW in 2030 with natural gas-fired plants making up much of the difference.

11. *"Scénario énergétique tendanciel à 2030"*, DGEMP-OE (2004).

Figure 10

Projected* Energy-related CO_2 Emissions up to 2030



* This is a business-as-usual scenario; it includes only energy-related policies and measures that have been decided and those that are certain to be decided and implemented in the short term. It does not include measures being envisioned for France's Climate Plan to meet objectives under the Kyoto Protocol. The forecast methodology is generally simpler than that used for the UNFCCC.

Source: Direction générale de l'énergie et des matières premières (DGEMP), 2004.

POLICY AND MEASURES

France's response to its climate change obligation is co-ordinated through an inter-ministerial group, the *Mission interministérielle sur l'effet de serre* (MIES), which was created in 1992. While it was previously reporting to the Prime Minister, since May 2002, the MIES is operating under the authority of France's Minister for Ecology and Sustainable Development. The MIES consults and receives input from various ministries, including DGEMP.

The government has made it a policy objective that all measures necessary for meeting the Kyoto commitments should be implemented in a way that preserves the competitiveness of the French economy. To this end, the French authorities are favouring voluntary commitments and GHG emission trading over taxation on energy-intensive industries.

In 2000, France published its National Programme for Tackling Climate Change (PNLCC). The PNLCC, which aims to maintain France's "economic competitiveness and the overall ecological balance", includes almost 100 measures and actions in all sectors affecting GHG emissions (although most are energy-related). The measures and actions are intended to enable France to meet its emissions

target under the Kyoto Protocol. Implementation and monitoring of these measures were an integral part of this programme, but information on estimated costs was not included. The measures (see Table 8) were divided into the following three main categories:

- Measures relating to regulation, normalisation and labelling, including energy efficiency actions in all sectors of the economy.
- Economic instruments.
- Longer-term structural measures, in particular in the transport, buildings and energy sectors.

In November 2001, the publication of the PNLCC was followed by the publication of France's Third National Communication under the United Nations Framework Convention on Climate Change (UNFCCC).

The implementation of the PNLCC has been subject to a review of its effectiveness. The 2002 assessment of the PNLCC (*Programme national de lutte contre le changement climatique – 2ème bilan annuel et voies d'avenir,* November 2002) concluded that actions taken in the various sectors covered by the PNLCC 2000 had, after two years, more or less noticeable effects. GHG emissions dropped slightly in 2001, benefiting mainly from developments in the industrial sector. Changes in processes (*e.g.* adipic acid production and changes from thermal energy to electricity) started prior to the introduction of the PNLCC, led to a 19% emissions reduction compared to 1990 levels in that sector. However, increases in emissions in the residential-services sector and in the transport sector showed no sign of slowing down. These two sectors have significant inertia and while technical innovation allows reducing emissions from the new stock on a unitary basis, these gains tend to be largely compensated by emission increases owing to greater distances travelled for transport and to greater heated surface areas for residences. These increases could even lead to exceeding the business-as-usual GHG projections used for the PNLCC. The assessment also highlights the fact that a number of the PNLCC measures have not been implemented, or only incompletely. This is particularly the case for the following measures: *i)* GHG taxation (owing to the increase in 2000 of oil prices and international competitiveness considerations); *ii)* the increase in the share of rail freight; and *iii)* measures towards increasing energy efficiency (in both the transport and buildings sectors). The 2002 assessment of the PNLCC concludes that currently implemented measures will not be sufficient to meet France's stabilisation target at 1990 levels. While many efforts are needed, for example in education and research and development (R&D), it is unlikely that France's target could be reached in the absence of better results in terms of energy efficiency and demand-side management[12] both in buildings and transportation.

12. The description of energy efficiency policies and measures is included in Chapter 5.

Table 8

Overview of Key Measures* Included in France's 2000 National Programme for Tackling Climate Change

(estimated impact in Mt CO_2e)

	First Category Measures	*Economic Instruments*	*Long-term Measures*	*Entire Set of Measures*
INDUSTRY:	4.1	8.4		12.5
– CO_2, energy: targeted measures	0.4			0.4
ADEME + RCGF credits	1.8			1.8
– Energy consumption taxation	0	1.1		1.1
– PFC, SF_6 , etc.		7.3		7.3
TRANSPORT:	4.2	4.0	6.4	14.7
– Alternative vehicles	0.4			0.4
– Emissions connected to air transport	0.2			0.2
– Priority to public transit	0.07			0.07
– Traffic light regulation	0.4			0.4
– Reduction of train tariffs	0.5			0.5
– Taxation gap between fuels	1.7			1.7
– Management of evolution of urban space/urban tarification		3.7	1.5	5.2
– Carbon taxation, etc.		0.4		0.4
BUILDINGS	4.9	4.4	0.4	9.8
– Reinforced insulating glazing	0.8			0.8
– Insulation of existing building	0.7			0.7
– Collective wood energy	0.4	0.7		1.1
– Strengthening thermal regulations	1.1			1.1
– Action on public buildings	0.4			0.4
– Add. effect of ecotax on service sector	0	1.5	0.4	1.9
– Add. effect of ecotax on domestic sector, etc.		2.2		2.2
AGRICULTURE:	2.0	0.7	0	2.8
WASTE:	4.0			4.0
ENERGY :				
Total energy efficiency	2.2	0	0	2.2
Total production	0.5	5.5	1.5	7.4
Total electrical sector	2.7	5.5	1.5	9.6
– European directive on energy-saving equipment	1.3			1.3
– Reduction of VAT on energy-saving products	0.9			0.9
– Electricity savings in new buildings				
– Electricity savings in old buildings				
– Ecotax effect				
– Replacement of existing thermal energy base: gas combined cycle and co-generation		5.5		5.5
– Wind electricity generation			1.5	1.5
– Overseas renewable energy programme, etc.	0.5			0.5
REFRIGERANT GASES	3.9	4.1	0	5.3
OVERALL TOTAL	**25.8**	**24.6**	**8.3**	**58.7**

* Full listing of measures can be found in the National Programme for Tackling Climate Change 2000/2010 (2000).

At the request of the Prime Minister, the MIES has been charged with the task of co-ordinating the strengthening of national actions, drawing lessons from experience to date and elaborating a Climate Action Plan. The aim was to develop a plan that would become an operational and pragmatic tool to allow the following:

- Reaching France's Kyoto target (this target being a minimum for 2010).
- The anticipation of the necessary acceleration of emission reductions to go towards a 75% reduction of GHG emissions by 2050.
- The stabilisation, in the short term, followed by a reduction of emissions from the transport sector; changing the direction of the trend for the residential-services sector.

Eight working groups were set up in February 2003 to analyse different factors (legal, economic and technical) that would improve the effectiveness of the initial measures and to identify new measures. The adoption of the Climate Plan was scheduled for November 2003. After several postponements, at the time of finalising the drafting of this in-depth review (April 2004), France's Climate Plan had still not been released.

In the meantime, there have been other significant developments. In 2002, following national consultations with industry representatives, the government approved voluntary agreements to reduce GHG emissions with twenty companies and three professional associations which were grouped under the *Association des entreprises pour la réduction de l'effet de serre* (AERES). The voluntary agreements stipulate that in addition to internal investments to reduce emissions, emission trading and project-based credits will also be recognised. These voluntary agreements represent an important consideration in the determination of France's National Allocation Plan for the EU Emission Trading Scheme (see below).

In October 2003, the European Parliament and the Council adopted a directive establishing an EU-wide scheme for GHG allowance trading, which could have important implications for the energy sector (Directive 2003/87/EC). The EU trading scheme is to cover a large share of installations in the energy and energy-intensive sectors, including combustion installations with a rated thermal input exceeding 20 MW, mineral oil refineries, iron and steel producing installations, cement producing installations, and pulp and paper installations. The directive is to lead to a first trading phase from 2005 to 2007 and then a second phase corresponding to the Kyoto Protocol 2008 to 2012 commitment period, with subsequent five-year trading periods. The directive also stipulates that each member State shall develop a national plan stating the total quantity of allowances that it intends to allocate for each trading period (the emissions cap), according to a set of criteria. Member States were given a 31 March 2004 deadline to submit their first National Allocation Plans to the European Commission. The Ministry of Ecology and Sustainable Development is leading

the process for determining France's National Allocation Plan, which includes consultations with industry and environmental non-governmental organisations. Along with several other member States, France missed the 31 March deadline.

A directive to amend the EU Greenhouse Gas Trading Directive is being finalised that would allow linking the EU emission trading scheme to the Kyoto Protocol's project-based mechanisms, *i.e.* Joint Implementation (JI) and the Clean Development Mechanisms (CDM). This draft "linking" directive would thus allow entities with installations covered under the GHG Trading Scheme greater flexibility and compliance options to meet their targets. In January 2004, the EU Parliament's Committee on the Environment, Public Health and Consumer Policy (CEPC) recommended that such linking with JI and CDM be possible with or without the entry into force of the Kyoto Protocol. Adoption of the "linking" directive took place in April 2004.

Some elements of energy taxation in France include a consideration of the associated environmental externality. For example, the fiscal treatment of natural gas in France favours its use, as it is the least polluting fossil fuel. On the other hand, hydroelectricity is taxed relatively high, even though it is a renewable energy and does not emit GHG emissions. In 2003, it was decided to reduce the taxation differential between gasoline and diesel by increasing the diesel excise tax. However, this differential was included as one of the transport-sector measures in the PNLCC: low diesel taxes were expected to increase the market share of more efficient diesel vehicles, those reducing emissions. This change in taxation could have implications for GHG emissions from the transport sector if significant substitution between diesel and gasoline occurs. However, it might lead to reductions in local air-polluting particles which are greater for diesel.

Policies related to energy efficiency (in particular the new policy to implement energy efficiency white certificates), renewable energy and research and development all have a link with meeting France's GHG objectives, in both the short and long term. These are further discussed in Chapters 6 and 10.

Analytical work has been done by the government to better assess the implications of reaching France's long-term objective of reducing GHG emissions by 75% by 2050. The MIES published a paper[13] describing possible strategies without being exclusive. It quantifies emission levels in 2050 and presents, through a scenario analysis, the technical conditions to achieve GHG reductions by a factor of four, and the possible pathways as well as dead-ends, along with the likely critical choices. The DGEMP is also undertaking analytical work on this subject with results to be released by the end of June 2004.

13. Radanne, Pierre (March 2004): *Reducing CO_2 Emissions Fourfold in France – Introduction to the debate* (http://www.effet-de-serre.gouv.fr/main.cfm?page=/fr/etudes/etudes.htm).

OTHER ENERGY AND ENVIRONMENT ISSUES

The 1996 law on air and rational use of energy has been an important development for several regulation texts on pollution.

France transposed into French law the 1999 EU directive which decreased (in 2003) the maximum sulphur content in heavy fuels to the lower of 1% (compared to the actual average content in France of 2%), or to equivalent SO_2 emissions for installations consuming non-desulphurised fuel. This directive also lowered the sulphur content limit for domestic fuel to 0.1% by 2008. Additional investments in refineries will be demanded and the use of sulphurised heavy fuels will be limited to installations allowing smoke desulphurisation and to cement plants.

The transposition into French law of the Directive 98/70 stemming from the "Auto Oil" programme, covering new vehicles and light utility vehicles, tightens limits on motor discharges of carbon monoxide, hydrocarbons, nitrogen oxides and particles. It also makes more stringent fuel requirements with respect to benzene, sulphur, etc. Since January 2000, new types of vehicles must respect these requirements. More severe limitations are to take effect in 2005. The directive and its transposition into French law also led to the introduction of the first steps in equipment of on-board diagnostic (OBD) systems starting in 2000 to 2001 for gasoline vehicles and starting in 2003 for new types of private diesel vehicles (and in 2004 for all new vehicles).

With respect to non-GHG issues related to the electricity sector, in January 2002, the Minister for "*l'aménagement du territoire et l'environnement*" made an agreement with the Secretary of State for Industry, EDF and RTE on "electricity grids and the environment". The agreement includes commitments for a better integration of electricity grids and the environment. It also aims to combine concerns over the integration of the electricity grids in the environment with the need for increased security of these grids with respect to exceptional climatic events.

CRITIQUE

One of the four general objectives of France's energy policy is the respect of the environment. As per the energy policy objectives resulting from the *Débat national sur les énergies* and proposed in the *Livre Blanc* – and consistent with the IEA *Shared Goals* – it is important that France's energy policy developments seek to achieve the environmentally sustainable provision and use of energy. This means seeking to minimise the adverse environmental impacts of energy activities. In the French context, this largely means reducing GHG emissions from the production and use of energy to mitigate climate change risks, and, in parallel, managing appropriately the risks associated with nuclear energy to avoid negative impacts on the environment.

Under the EU burden-sharing agreement, France has the obligation to stabilise its GHG emissions at their 1990 levels by the Kyoto Protocol's 2008 to 2012 commitment period. The government has also started to consider the post-2012 period and has announced an ambitious long-term target of reducing GHG emissions fourfold by 2050. While France managed to maintain its 2001 GHG emissions at 1990 levels, energy-related CO_2 emissions have risen over that time and reversing this trend is the greatest environmental challenge to French energy policy. Business-as-usual projections indicate that by 2010 energy-related CO_2 emissions will grow to levels 8.6% greater than those in 1990, with an acceleration of emissions thereafter.

In particular, it is a challenge that France has limited opportunities to reduce GHG emissions in the electricity sector compared with other IEA countries. France's policy to develop and use nuclear power – a GHG-free source of energy – as a principal source of energy has been a key contributor to France's relatively low GHG levels. France is one of the IEA countries with the lowest GHG emissions per capita and per GDP. However, this means that, unlike many countries, France's electricity sector contributes only a small percentage of the country's overall GHG emissions. The electricity sector represented only 9% (36 Mt CO_2) of the country's overall energy-related CO_2 emissions in 2001. The extent to which gas or coal replaces nuclear in the electricity mix, if at all, will have a profound impact on the country's long-term emissions trends. GHG reductions/limitations might still be possible through greater energy efficiency in the sector and the substitution of GHG-emitting power plants with plants using renewable energies, for example, especially with respect to business-as-usual projections that include greater use of natural gas-fired power plants in the future. While such mitigation actions should be considered, the electricity sector in France offers significantly less mitigation opportunities than other countries where the electricity sector can generate large reductions through switching from coal to gas.

The government is finalising a second major Climate Plan to meet its stabilisation target. It is a challenging task because some measures proposed in the PNLCC in 2000 could not be introduced. The process to develop the plan has involved stakeholders and included an examination of potential measures in different sectors along with their estimated costs. The plan's release has been postponed several times. The 2002 assessment of the first (2000) climate plan showed that the measures being implemented are insufficient to meet the country's targets. In accordance with the energy policy at that time, the first climate plan included only measures to reduce emissions domestically. Current policy plans to make use of international mechanisms. Many emissions reduction measures, particularly in the energy sector and energy-intensive industries, take time to have a GHG impact and as many investments with significant GHG implications have long economic lives, it is imperative that the government takes the necessary steps to finalise and publish the new Climate Plan as soon as possible.

In doing so, it is crucial to integrate the consideration of cost-effectiveness and flexibility to minimise adverse economic and competitiveness impact. Noting the challenging situation in reversing GHG emissions, this is particularly important with a view to ensuring the sustainability of France's GHG emission mitigation strategy. Unlike the PNLCC which did not include the estimated costs of various policies and measures, the new Climate Plan needs to be backed by thorough and solid analysis on cost-effectiveness. In this context, it is encouraged to examine the cost implications and feasibilities of the ambitious targets set out in the *Livre Blanc*, including those for limiting energy consumption at 2003 level by 2015 and having 10 000 MW of installed wind power capacity by 2010, which are likely to constitute major parts in the new plan. The results of such cost-effectiveness analysis should be widely shared among all the stakeholders. Once the plan comes into effect, it would be important that the government be engaged in the regular monitoring and assessment of the effectiveness of the plan's policies and measures.

The government has set the ambitious target of "factor 4" to 2050. While it is to be commended for the scope and vision displayed in responding to the longer-term challenge of climate change illustrated in the IPCC report, the team notes that such an ambitious programme would represent tremendous challenges, particularly in light of the GHG emissions projections on a business-as-usual basis and the expected increase of energy-related CO_2 emissions in the electricity sector to 2030. Its fulfillment would require much stronger policies and measures, which could have substantial implications for the energy sector in particular and the economy in general. The government will need strong efforts to analyse the scenarios, the technical conditions and the possible pathways with solid cost analysis. In this context, it is commendable that the government has started the analytical work to provide an introduction to the public debate. All the information on the possible scenarios, including all costs and benefits of each approach, should be made transparent in the whole process of public debate.

Another important piece in the government's strategy to address climate change is the implementation of the EU directive establishing an EU-wide Emission Trading Scheme. Like many other EU member countries, France did not meet the 31 March 2004 deadline to submit its National Allocation Plan for the first 2005 to 2007 period to the EU Commission. As a market-based instrument, the emission trading scheme can help increase the cost-effectiveness and flexibility of meeting France's GHG commitments. However, it is very important that the details of the implementation of the scheme, and particularly the overall sectoral allocation and then the installation-level allocation, be clarified as soon as possible for the first trading phase that will begin in 2005. Engaging in regular discussions with other EU countries on the allocation process should help work towards a level playing field for French companies covered by the EU Trading Scheme. Early and clear signals should be given to market players to allow them to better plan their activities and to minimise the costs of meeting

their individual GHG targets. In this context, early clarification of signals for the trading scheme's phase II (2008 to 2012), which corresponds to France's overall Kyoto commitment, should also be a priority.

The review team was informed that the government's intention is to meet the 2008 to 2012 target through domestic action, although international credits would be purchased if France fell short of its commitment. Achieving the target domestically is legitimate; yet, given the projected gap in 2012 and in seeking to maximise cost-effectiveness and flexibility, the government should clarify early which body would be responsible for the purchase of international emission units should France's domestic action not deliver sufficient emission reductions by 2012. As a hedging strategy, this body should be tasked with the continuous monitoring of the international emissions market and have the opportunity to buy emission units at low prices. This would give France greater flexibility in meeting its target at lower costs, and thereby avoid the risk of needing to purchase emission units at the end of the commitment period when prices could be higher.

The recently finalised EU directive to link the EU Trading Scheme with the Kyoto Protocol's JI and CDM should provide firms whose installations are covered by the EU Trading Scheme greater compliance options and potentially lower overall compliance costs. To allow French firms to better assess the possibilities offered by this directive and allow them to take advantage of it, the government should ensure that relevant information is made available to the firms. To inform and facilitate actions by French firms interested in lowering their compliance costs via reductions achieved through the CDM, an important step would be for France to designate its National Authority for the CDM, which is a prerequisite to participate in the scheme under the Kyoto Protocol (*Annex decision* 17/CP.7).

It is important to note that significant progress has been achieved in reducing non-CO_2 emissions and in particular reductions in N_2O emissions from the industrial sector. The persistent trend towards an increase in emissions from the buildings/service energy sectors, and above all in the transport sector, forms the crux of France's energy and GHG challenge for the 2008 to 2012 period.

Indeed, the transport sector represents the largest share (37%) of the country's 2001 energy-related CO_2 emissions and its emissions are projected to continue increasing steadily. As is the case in many other IEA countries, curbing transport-related emissions is a major challenge for France, and particularly given that significant measures have already been taken, such as substantial public transit in cities and high-speed trains. Careful consideration of least-cost measures is needed in the short term, including information to the general public on ways to meet their mobility needs through less GHG-intensive means. With a view to ensuring the credibility of the challenging GHG emissions mitigation targets, more and stronger measures, including

road pricing, would merit consideration. Research and development to move towards low-GHG-emitting vehicles in the future – especially in light of France's 2050 target – should be established as a key research area.

The residential and services sector is the other large contributor to the country's GHG emissions, and assessments suggest a potential for greater energy efficiency with associated GHG emission reductions, which should be exploited. Working towards achieving greater energy efficiency in buildings, particularly in the existing building stock, should be a priority. The energy savings certificates (discussed in detail in Chapter 5) could be an efficient market-based instrument, as long as savings are truly achieved and administration costs are kept low. Effective monitoring will be needed.

RECOMMENDATIONS

The government of France should:

- *Finalise and publish, as soon as possible, the government's plan to meet the GHG stabilisation target, including the contribution sought by different actors of the economy, to send clear signals for investments by market players.*
- *Seek to maximise cost-effectiveness and flexibility in the development of the government's strategy to meet GHG objectives. Carefully assess and regularly monitor the costs and impacts of the climate change policies and measures. Share the results with the stakeholders.*
- *Undertake additional economic studies on the cost-effectiveness of climate change mitigation policies and measures, particularly with respect to meeting France's GHG target for 2050. Disseminate the results as widely as possible, with a focus on benefits of such a strategy and the possible implications for the energy and energy-intensive sectors.*
- *Carefully monitor the emissions market and develop its strategy with respect to purchases in order to take advantage of periods of low emission prices to avoid the potential risk of needing to buy during a price spike.*
- *Expedite discussions on the national allocation plan for installations covered by Phase I (2005-2007) of the European Union Emission Trading Scheme (EU-ETS), with the objective of ensuring that a timely, appropriate and clear signal is sent to the market, while also looking forward to Phase II (2008-2012) of the EU-ETS. Work with other EU countries to ensure a level playing field in the EU-ETS.*

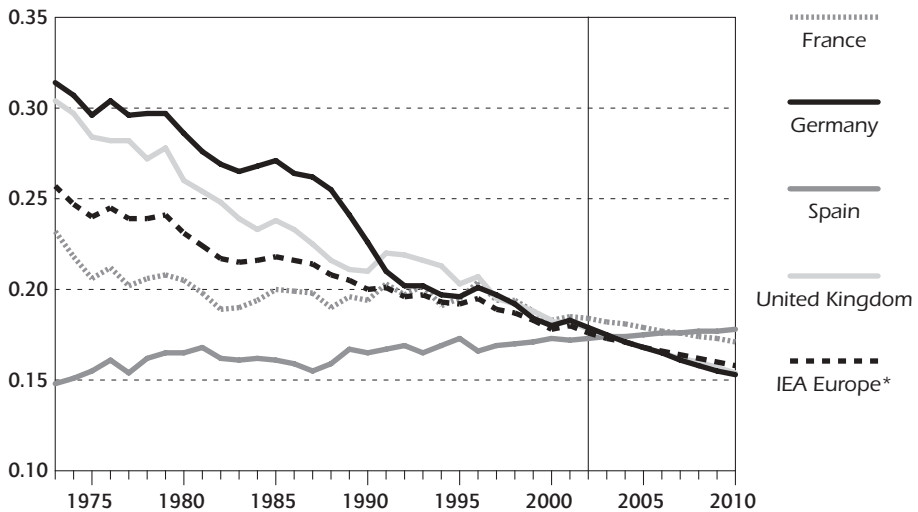
ENERGY INTENSITY MEASURES

In 2001, French aggregate energy intensity, as measured by a ratio of the country's TPES in tonnes of oil equivalent (toe) over its national GDP (in thousands of 1995 US$ PPP), was 0.19 toe per US$ 1 000. This was 6% higher than the average for IEA European countries. In 2001, France's TFC/GDP was 0.12, or 4% below the IEA European average, and its TPES per capita was 4.4, or 22% higher then the IEA European average. Figure 11 compares French national energy intensity to the IEA European average as well as to other similar countries.

Figure 11

Energy Intensity in France and in Other Selected IEA Countries, 1973 to 2010

(toe per thousand US$ at 1995 prices and purchasing power parities)



* excluding Norway from 2002 to 2010.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2003; *National Accounts of OECD Countries*, OECD Paris, 2003; and country submissions.

In recent years, France's aggregate energy intensity figures have improved in line with the rest of the IEA European countries. From 1990 to 2001, French TPES/GDP decreased by 9%, compared to an IEA average of 9% and an IEA Europe average of 10%. Over the same period, French TFC/GDP declined by 9% while the average decrease in the IEA as a whole and in IEA Europe was 10%.

French energy intensity as measured by TFC/GDP fell by 33% from 1973 to 2001, just one percentage point less than the 34% improvement seen in IEA European countries as a whole. France's energy intensity as measured by TPES/GDP has not improved over the long term as rapidly as other IEA European countries. From 1973 to 2001, French TPES/GDP fell by 20% compared to a 30% fall for the IEA European countries as a whole. This discrepancy is largely due to France's introduction of most of its nuclear park from the late 1970s to the early 1990s which had two effects. The first was the encouragement of electricity use by EDF as a way of creating demand from their numerous nuclear generating stations. Electricity use was also bolstered by low prices for large customers which encouraged the development of electricity-intensive industries. The second effect is statistical. In many cases, electricity from nuclear power replaced direct on-site energy use, particularly on-site oil combustion. For statistical purposes, nuclear is treated as being 33% efficient, so three units are added to national TPES for every unit of useful electricity generated. On-site oil combustion is statistically more efficient, particularly for space heating. So the replacement of oil by nuclear electricity had the effect of increasing TPES without actually increasing TFC. The effects of the introduction of nuclear in the country were a one-off occurrence that will not be repeated.

When considering the intensity of the French economy by sector, it is clear that transport efficiency is falling the least. From 1975 to 2001, French energy use for transport as a percentage of GDP actually rose by 5%, with road transport rising by 2%. The residential and commercial sector saw a 21% decrease in energy intensity as a percentage of GDP over the same period, agriculture fell by 37% and industry by 43%.

GOVERNMENT ENERGY EFFICIENCY PROGRAMMES BY SECTOR

French energy efficiency policy is intended to limit the country's energy dependence, keep the country's options open regarding future energy choices and limit GHG emissions. In this context, policy programmes are structured towards achieving four main objectives: *i)* raising the awareness of the industrial and agricultural sectors with regard to the greenhouse effect, *ii)* encouraging better decision-making by energy consumers, *iii)* supporting the most innovative energy options, and *iv)* assisting the development of new energy technologies through R&D.

The legislative base for energy efficiency policy remains the December 1996 law on air and the rational use of energy. Eight different decrees based on this law have followed, issued between November 1998 and December 2002. These decrees lay out more detailed regulations on issues ranging from the electricity consumption of domestic refrigerators and freezers to the renewal of the government transport fleet, to information requirements on gas usage for new vehicles.

ADEME is the major government body that develops and implements energy efficiency policies, although it is not responsible for targets and goals which are established by the Ministry of Economy, Finance and Industry or at the Parliamentary level. Between 1998 and 2002, the energy activity at ADEME (which includes support for renewable energy) had 200 new employment posts added and the budget expanded considerably. In 2002, ADEME had a budget of nearly €40 million to be used for energy efficiency programmes.

INDUSTRIAL ENERGY CONSUMPTION

In the last 30 years, French industrial energy consumption has been marked by three trends. One, the energy intensity in general has fallen (with services assuming a greater amount of sector added value); two, the energy performance of equipment and overall operations has risen; and three, the reorganisation of the industrial sector has resulted in the closure of old obsolete sites and a greater concentration of manufacturing facilities. In 2003, there were 22 000 industrial companies with 20 employees or more. Together these enterprises consumed 35 Mtoe, of which 11 Mtoe came in the form of electricity. An ADEME study (from 1998) identified 4 Mtoe (or 11% of the total) as being economically viable to reduce.

In 1998, France launched a large programme aimed at helping companies make energy-related decisions, most commonly by publicising the advantages of energy efficiency investments and practices. This programme has targeted small and medium-sized businesses with the intention of assisting them with "decision-support" studies. The goal is to have 7 000 such studies completed between 2000 and 2006 (or 1 000 studies per year). ADEME also organises and undertakes demonstration projects to illustrate energy efficiency technologies or techniques. It has the goal of 280 such operations between 2000 and 2006 (40 per year). Table 9 shows the numbers and costs for decision-support studies and demonstration projects for the last three years.

Table 9

Decision-support Studies and Demonstration Projects for Industry, 2000 to 2002

	Decision-support Studies		*Demonstration Projects*	
	Number	*Cost to ADEME*	*Number*	*Cost to ADEME*
2000	700	2.2 M€	38	2.59 M€
2001	600	2.3 M€	48	2.60 M€
2002	636	2.2 M€	47	1.60 M€

Source: ADEME.

In addition to these decision-support and demonstration projects, the government has taken steps to provide funding for companies wishing to make energy efficient investments. Towards this end, the Investment Fund for the Environment and Energy Efficiency (*Fonds d'intervention pour l'environnement et la maîtrise de l'énergie,* FIDEME) was launched by ADEME in 2002. Subscription to the fund by the banking sector (with guarantees from ADEME) closed in December 2002. Total funding was €45.7 million. FIDEME extends loans, rather than subsidies, to companies making efficiency investments

A dialogue was begun in December 2001 between the Ministries of Industry and Environment, and the major large energy consumers. In July 2002, the government approved a plan on voluntary agreements presented by two industry associations. As a result of this plan, the Association of Companies for the Reduction of the Greenhouse Effect (*Association des entreprises pour la réduction de l'effet de serre*, AERES) was formed in September 2002. The association currently includes 33 companies and four professional federations as members. As of the end of July 2003, 24 agreements had been approved by AERES, representing 56% of GHG emissions from industry (or 19% of the national total). These agreements target a reduction in GHG emissions by the signatories of 14% from 1990 levels by 2007, which corresponds to a total of 20 Mt CO_2.

Tax regulations allow for accelerated depreciation of any investment that saves energy or produces energy via co-generation. Such investments can be depreciated over a 12-month period from the day they are put into service. This special depreciation treatment has been in place since January 1991 and will run until December 2006.

RESIDENTIAL/COMMERCIAL ENERGY CONSUMPTION

In the residential housing sector, France has 30 million individual lodgings with a total of two million square metres to be heated; 57% of these lodgings (17 million) are individual homes and 53% (16 million) were constructed after 1975. Heating accounts for 70% of total residential energy use with electricity providing 30% of heating, natural gas 36%, heavy fuel oil 20% and others (mostly biomass) 14%. Hot water accounts for 10.5% of residential energy use with electricity supplying 43% of water heating, natural gas 36%, heavy fuel oil 12% and others 9%. In the commercial sector, there are 814 million square metres to heat, requiring 21.7 Mtoe per year. Heating is supplied from electricity (40%), natural gas (32%) and heavy fuel oil (21%). For residential space heating, France consumes approximately 224 kWh/m^2.

Since 1973, a number of factors have influenced energy use for space heating. The area to be heated has risen by 41% from 1973 to 2001, driven by population growth and an increase in average dwelling and commercial spaces. People are now demanding greater comfort levels. Central heating has

risen from 50% of the market in 1973 to 92% in 2001. New regulations pertaining to insulation standards have influenced new buildings and also led to the rehabilitation of older buildings. In addition, there have been a number of national public campaigns designed to encourage consumers to heat more efficiently. While overall heating needs (residential and commercial) have risen by 25% from 1973 to 2001 (a 0.8% annual increase), the heating requirements on a per square metre basis have fallen by 35%, from 372 kWh per m^2 to 242 kWh per m^2.

Energy regulations for new buildings were updated in 2001 as part of the "RT 2000" initiative[14]. In the residential sector, energy consumption in new buildings is to be reduced by 7% with respect to 1989 regulations and in the commercial sector energy consumption is expected to be reduced by 25% with respect to the 1989 regulations. The new rules constitute a general objective for energy performance and do not apply to any particular characteristic such as thermal insulation, thermal bridges, infiltration, etc. The optimal combination of techniques and technologies can be chosen by building designers and constructors from among all possible solutions.

ADEME supports energy efficiency in the buildings sector through both decision-support services and demonstration operations. Decision-support aid comes in the form of consultancy, pre-diagnostic and diagnostic tools, and feasibility studies. Information on the number of these programmes carried out is included in Table 10.

Table 10

Decision-support Studies and Demonstration Projects for Buildings, 1999 to 2003

	Decision-support Studies		*Demonstration Projects*	
	Number	*Cost to ADEME*	*Number*	*Cost to ADEME*
1999	846	2.0 M€	n/a	n/a
2000	5 067	3.6 M€	110	1.4 M€
2001	3 090	2.2 M€	44	1.3 M€
2002	11 235	4.1 M€	78	n/a
2003	5 149	2.2 M€	n/a	n/a

Source: ADEME.

France has introduced mandatory energy labelling for domestic appliances, including refrigerators, freezers, washing machines and dryers, dishwashers, light bulbs and ovens. Labelling on air-conditioners and water-heaters is

14. RT: *réglementation thermique.*

pending. France has also introduced energy efficiency standards on boilers, ballast for fluorescent tubes, refrigerators and freezers, all imposed through some specific European directives. In instituting this labelling and standards, France is complying with EU legislation in this area.

TRANSPORT ENERGY CONSUMPTION

France has 34 million light vehicles, of which 15 million (44%) are diesel-powered. There are 640 000 heavy vehicles the large majority of which run on diesel fuel. Of the 40 000 transport companies, the large majority (32 000) have less than five employees while less than ten companies could be considered large national or international shipping concerns. 65% of oil final consumption comes from the transport sector, 35% of national CO_2 emissions and 70% of NO_x emissions.

France also has significant local and national public transportation systems. The state-owned national rail company has seen an increase in passengers of 10.7% from 2000 to 2002 (3.5% annually). The high-speed train (*train à grande vitesse*, TGV) has seen passenger travel increase by 6.4% in 2002 alone. Local commuter rail and urban metro systems have seen passenger trips increase at a slower rate: 2.5% annually from 2000 to 2002 in the Paris region and 1.2% in other parts of the country.

French energy efficiency policy in the transport sector has three main objectives: *i)* minimise the effect of transport on GHG emissions, *ii)* reduce the national dependence on imports of oil and oil products, and *iii)* improve local air quality. To achieve these ends, the government targets both urban and long-haul transportation with four actions:

- Improve vehicular fuel efficiency.
- Encourage more efficient transport behaviour.
- Increase use of public transportation.
- Bring long-term transport needs under control.

Taxation plays an important role in meeting energy efficiency transport goals. As of the third quarter 2003, the French tax on diesel fuel (excluding VAT) was 39.16 eurocents per litre, or the ninth-highest tax level in the OECD[15], 21% above the average of OECD countries. Gasoline was taxed at 58.92 eurocents per litre, eighth-highest among OECD countries and 36% above the average found in OECD countries.

In addition to being above the OECD average levels, the French system heavily favours diesel fuel over gasoline with one of the highest gaps between the

15. Excepting Canada and Korea.

two taxes in the OECD, approximately 25% above the average such gap found in the EU countries. This discrepancy is intended to encourage the use of diesel-powered automobiles which are more energy-efficient and thus will reduce CO_2 emissions and oil imports. Partly owing to these tax policies, the use of diesel-powered cars has expanded considerably with 63% of new cars purchased in France in 2002 running on diesel fuel, compared to 41% in the EU as a whole.

Recently, however, the government has decided to raise the tax on diesel fuel, effectively reducing the gap between the two fuels. In September 2003, the Prime Minister announced the first step in this plan with an increase in the diesel excise tax of 2.5 eurocents per litre, which took effect on 1 January 2004. The government expects this tax increase to bring an additional €500 million to €800 million of tax revenue. Since dieselisation has been a major driver for fuel efficiency gains in France in recent years, this shift indicates that the government will likely need to look elsewhere for efficiency gains, such as encouraging the purchase of the most efficient gasoline vehicles, or promoting gasoline-electric hybrids.

Other measures to increase transport energy efficiency include:

- A decree issued in December 2003 states that information on the consumption of motor fuels and the related emissions of CO_2 for each vehicle offered for sale should be available at all times of the sales process.
- A decree issued in 1998 states that all public transport fleets are obliged to make 20% of their vehicles run either by electricity, natural gas or propane gas, although this requirement can be met over time with the natural turnover of vehicle stock. A May 2001 study by ADEME looking at 400 such fleets found that only 18% of the fleets had the minimum 20% or more of clean energy vehicles and 37% had no clean energy vehicles at all.
- Clean energy vehicles and all equipment for their maintenance and upkeep are granted accelerated depreciation schedules.
- Taxes on natural gas and on mixes of butane and propane used for vehicles have been reduced to the minimum levels allowed in the EU.

COMBINED HEAT AND POWER

Combined heat and power (CHP) generation is less widespread in France than in other European countries. The EU reports[16] that in 2000, 3.0% of French electricity production came from co-generation. This was the third-lowest figure in the EU, after Greece and Ireland, and considerably less than the

16. "EU Energy and Transport in Figures, Statistical Pocketbook 2002", European Commission. The definitions used to define co-generation capacity for this yearbook were not rigidly defined and subject to variance from country to country. The EU is in the process of tightening these definitions.

9.8% average for the entire EU. However, the French government reports that between 4 and 6% of electricity came from CHP plants by 2003[17].

At the end of 1997, France made a concerted policy decision to support CHP use through various support schemes. These include 12-month depreciation for segments of any CHP investment, tax reductions and exoneration from taxes on natural gas and fuel oil used in CHP facilities. In addition to these advantages, EDF was required to offer long-term contracts for the purchase of all electricity coming from CHP plants. The terms of these contracts have evolved over time, but as of the latest decree on the subject (31 July 2001), the contracts must be 12 years in length with a price ranging from 6.1 eurocents to 9.15 eurocents per kWh, depending on the price of natural gas, commercial operation date for the plant and the size of the plant. These initiatives increased the capacity of CHP equipment by 54% from 1998 to 2000.

In July 2002, the European Commission published a proposition for a directive intended to promote CHP. A compromise text was proposed to the Council in May 2003 and Directive 2004/08/EC of the European Parliament and of the Council was approved on 11 February 2004. France worked actively on the compromise language for this directive, specifically reiterating its opposition to any type of quantitative targets for increased CHP capacity or usage. France considers such quantitative objectives for the energy mix to be a potential distortion of the markets and contrary to the goal of establishing security of supply at the European level.

CONSUMPTION STABILISATION TARGET BY 2015

One of the three major axes of the *Livre Blanc* on energy released in November 2003 was an increased push for greater energy efficiency in France. In particular, the government paper called for French final energy consumption to be held stable at 2003 levels by the year 2015, assuming an annual economic growth of 2%. Achieving this goal would represent a reversal of past trends. In all OECD countries (excluding those whose economies suffered with the demise of the Soviet Union), the annual average growth in TFC from 1973 to 2001 has been 1.1%. The TFC increase has been more pronounced in recent years: from 1989 to 2001, the growth rate has been 1.5% per year. French TFC growth has been comparable though slightly higher than the average over the same periods, growing by 0.9% annually from 1973 to 2001 and by 1.8% annually from 1989 to 2001. The French government projects that under business-as-usual conditions, energy consumption will grow by 0.9% annually from 2000 to 2030. If this were to happen, energy consumption will be more than 11% over 2003 levels by 2015 to reach the target in the *Livre Blanc*.

17. These figures use the definition of co-generation given in the French legal decree of 3 July 2001.

The *Livre Blanc* notes that from 1973 to 1986, French energy efficiency policy has realised energy savings of approximately 30 Mtoe annually[18]. However, from 1986 to 1999, efficiency improvements achieved only 3 Mtoe of savings annually. This slow-down in energy savings is consistent with what has been found in other IEA countries. According to a recent IEA publication[19], energy savings rates across all sectors and in almost all countries have slowed since the late 1980s. In essence, the oil price shocks in the 1970s and the resulting energy policies did considerably more to control growth in energy demand than did the policies of the 1990s, despite increased attention to the dangers of CO_2 and other GHG emissions.

The major new policy tool proposed by the *Livre Blanc* to help France reach its consumption stabilisation target is the use of energy efficiency certificates, also termed "white certificates". The idea behind this system is to target the diffuse energy consumption of the many different actors who could make energy savings. Under such a certificate system, major energy suppliers (electricity, gas, fuel oil and motor fuels) would be obliged to realise an amount of energy savings equal to a certain percentage of the energy they supplied. These savings could be achieved in one of three ways: *i)* directly realising savings in their own operations, *ii)* helping their clients realise savings, or *iii)* buying energy efficiency certificates, or white certificates, from unrelated parties who have realised savings. The idea behind the last option is that savings would be realised where they are least costly within the economy.

The programme is expected to begin in 2005. The first period for the programme is projected to last three years during which electricity suppliers would be obliged to realise 34 TWh of savings, gas suppliers 10.5 TWh, heat providers 1.5 TWh and heavy fuel oil suppliers 7.5 TWh, for total savings of 54.5 TWh realised over the three years or 19 TWh per year[20]. This is equivalent to saving 1.54 Mtoe per year, or 0.9% of French TFC in 2001.

The government proposes to introduce penalties for those companies not meeting their savings obligation targets. This will act as a *de facto* price cap. These penalties would cap the price of the certificates at €0.01 per kWh. At the same time, the programme will limit the effect of the certificates system on the price of the goods provided (*e.g.* electricity) to a 0.5% rise from the original price without the certificate system. The *Livre Blanc* contrasts the €0.01 per kWh with the estimated €0.035 per kWh subsidy paid to electricity generated from wind power. It is estimated that some 20 persons will be needed to run the system in France.

18. The oil price shocks of that period also had a profound effect in reducing energy consumption. It is difficult to discern which of those two factors – the price shocks or efficiency policies – was primarily responsible for reduced energy over those years.
19. "Oil Crises & Climate Challenges – 30 Years of Energy Use in IEA Countries", 2003.
20. Saving obligations for motor fuel suppliers will be discussed and decided upon later.

French national energy intensity is comparable to IEA averages and to other similar IEA countries. This shows that exogenous factors to energy intensity such as an economy-wide shift from manufacturing to services and more efficient means of production combined with energy efficiency policy have worked to maintain adequate efficiency levels. France's TFC per unit of GDP has improved in line with European averages. France's slower level of improvement of its TPES per unit of GDP can be attributed to the statistical effect from the introduction of nuclear which is described in the text. These effects will not be repeated and will thus not hamper the country's improved energy intensity in the future.

Energy use in the transport sector offers the biggest challenge to curbing energy demand. Transport is the largest energy-consuming sector and oil (mostly used in road transport) is the country's dominant fuel. Transport was the only sector in the last 25 years where energy use has risen per unit of GDP. Curbing transport demand and its effects on energy security and the environment is made especially difficult by the lack of ready alternatives to oil. While natural gas and other hydrocarbons as well as biofuels can be and are used in transport, they do not constitute the types of ready economically competitive alternatives that can be found for electricity and heating.

France uses relatively high motor fuel taxes and a large tax discrepancy favouring diesel fuel over gasoline as tools to curb demand. This has encouraged the use of more efficient diesel-fired engines with 63% of vehicles purchased in 2002 being diesel-fired. The current plan to decrease this discrepancy by raising diesel tax may lower the diesel market share. This development has a positive aspect in the sense that, despite recent technological advances, diesel engines still emit more harmful pollutants, such as particles and non-methane volatile organic compounds (NMVOCs) than do gasoline-fired engines. Taxation could be reviewed with a view to these negative externalities for diesel fuel and with due consideration for the availability of new diesel technologies. However, from an energy efficiency standpoint, reducing the share of diesel engines in the national fleet will, all things being equal, lead to less efficiency and more fuel use. If this proves to be the case as the tax discrepancy between the two fuels is lowered, other measures should be introduced in the transport sector to offset such an impact.

Public transportation is a key component of French transport. Further expanding its use would help diminish the energy security and environmental questions surrounding oil use. This is particularly true in France. Since the large majority of both local and national rail systems run on electricity and nearly 80% of French electricity is emission-free nuclear or hydropower, this would reduce emissions given that the amount of travel does not expand too much as a result.

Energy use in industry has fallen more than in any other sector. This trend mirrors similar developments in other countries as developed economies shift from manufacturing to less energy-intensive services and as producers develop more efficient equipment and means of production. In addition, industrial energy-users are often more efficiency-conscious than individuals given their high consumption levels and the effect of energy costs on profitability. In general, French industrial efficiency policies have a sound basis. The decision-support studies are helpful since information on and awareness of efficiency issues are often lacking. In addition, the tax advantages offered will certainly encourage efficient investment and help to reflect the positive externalities that efficiency represents in energy security and emissions. While funding for efficiency investments is a crucial issue, it is unclear whether ADEME's administration of the FIDEME or the guarantees it provides represent a sound role for government. While the government can encourage such activities as necessary, industry has demonstrated in other countries that it is fully capable and efficient when raising and investing funds for energy efficiency projects. Care should also be taken that this funding system would not support free-riders, such as investments which would have occurred even without this system.

The level and scope of existing energy policy programmes will be insufficient to meet the government's highly ambitious goal of stabilising energy demand at 2003 levels by 2015. If French demand rises at the long-term trend rate (0.9% annually), this will mean a more than 11% rise in demand between 2003 and 2015. If French demand in the next 12 years rises at the rate seen in the previous 12 years (1.8%), 2015 demand will be almost 24% above 2003 levels under business-as-usual conditions.

The existing efficiency programmes are not designed to achieve this level of demand reduction. The last major law on energy efficiency came in 1996 and was not intended as a tool to meet such bold goals. A new system of policies with the scope to achieve such unprecedented levels of demand reduction must be developed and the costs associated with them fully explored. The top-down approach with which the demand stabilisation target was introduced can be effective in setting long-term energy direction, but it now needs to be supplemented by a more hands-on analysis to assess the feasibility and the costs of meeting such a goal.

In this light, the proposed white certificates scheme is a commendable and welcome development. It should mobilise private-sector actors that are knowledgeable and competent in energy use and saving. As with the EU emission trading scheme, the process of trading certificates would concentrate resources and efforts to those areas where they would be the most effective.

The government is now working to resolve a number of crucial administrative questions concerning the certificates programme. These include determining which operators will be given demand reduction obligations and the process

by which the reduction levels will be set. In addition, the baseline against which energy savings will be measured is being explored. This could come in the form of benchmarking or the averaging of actual results across relevant energy-users. Treatment of new entrants must be resolved as well as the interaction between the white certificates scheme and EU emission trading. The government is encouraged to continue developing the administrative and regulatory framework for this innovative and promising programme. Emphasis should be based on simplicity in order to minimise the government resources to administer the programme and the transaction costs for the participants.

It is unclear what effect the price cap on the certificates (€0.01 per kWh) and the 0.5% limit on energy price increases resulting from the obligations will have on the system. If the market values the certificates at below this level, there is no problem, but if the certificates are valued above the price cap, the system breaks down because major energy suppliers will simply pay the penalty instead of fulfilling their obligations. In that case, either the reduction targets are too ambitious or the cap has been set too low. As with the quota system with tradable green certificates in other countries, firmness of the penalties for non-compliance is a prerequisite for success. Since it is currently impossible to know where the market price of certificates will fall, the government should consider raising the price caps and limits. In this way, the targets are more likely to be achieved and policy-makers can ascertain the true costs of meeting the targets they set. Even if the price cap is doubled to €0.02 per kWh, the price for supporting energy efficiency will still be below the price French citizens are paying to support renewable energy production which gives many of the same benefits of environmental protection and energy security. The government could conduct test programmes of the certificates system to gain a better understanding of how the certificates will be valued.

RECOMMENDATIONS

The government of France should:

- *Continue to make efficiency activities in the transport sector a priority.*
- *Evaluate the feasibility and economic costs of stabilising energy consumption at 2003 levels by 2015.*
- *Develop the administrative framework of the "white certificates" programme, including standardised and clear methods for the issuance of energy efficiency certificates and a follow-up function to monitor the results.*

CURRENT AND HISTORICAL PRODUCTION

France has substantial natural resources conducive to renewable energy production, including the largest forest in continental Europe, a strong potential for hydroelectricity and a number of sites with characteristics supporting geothermal energy. The government estimates that France has the second-highest potential for wind power generation in Europe (behind the UK). France also has the only major tide-powered electricity generating station in the world, the 240-MW La Rance plant in Brittany.

In 2001, France produced 18.6 Mtoe of renewable energy. While this was the largest renewable production of any EU country, it accounted for only 7% of the national TPES, slightly above the European average and below the 11.5% average for all IEA countries. Renewables' percentage share of French TPES has been relatively steady since the late 1980s. From 1988 (when its share was 6.8%) to 2001, renewable energy's contribution to TPES has ranged between a high of 7.8% (in 1992) and a low of 6.7% (in 1998).

Biomass and hydropower dominate renewable energy production in France. In 2001, biomass accounted for 64% of all renewable production, followed by hydropower (34%), geothermal (0.75%), tidal energy (0.25%), solar thermal (0.14%) and wind power (0.06%). Although still a very minor part of the French energy picture (0.006% of TPES in 2001), wind power has seen the greatest increase in production in recent years. From 1997 to 2001, the generation of electricity from wind power rose by 525%. Over the same period, solar thermal production rose by 57%, hydro generation 17% and biomass production 8%. In 2001, renewable energy accounted for 14.3% of total electricity generation, dominated by hydropower (13.6%), then biomass (0.6%), then solar and wind (0.1% combined). Table 11 highlights French renewable production in 2001.

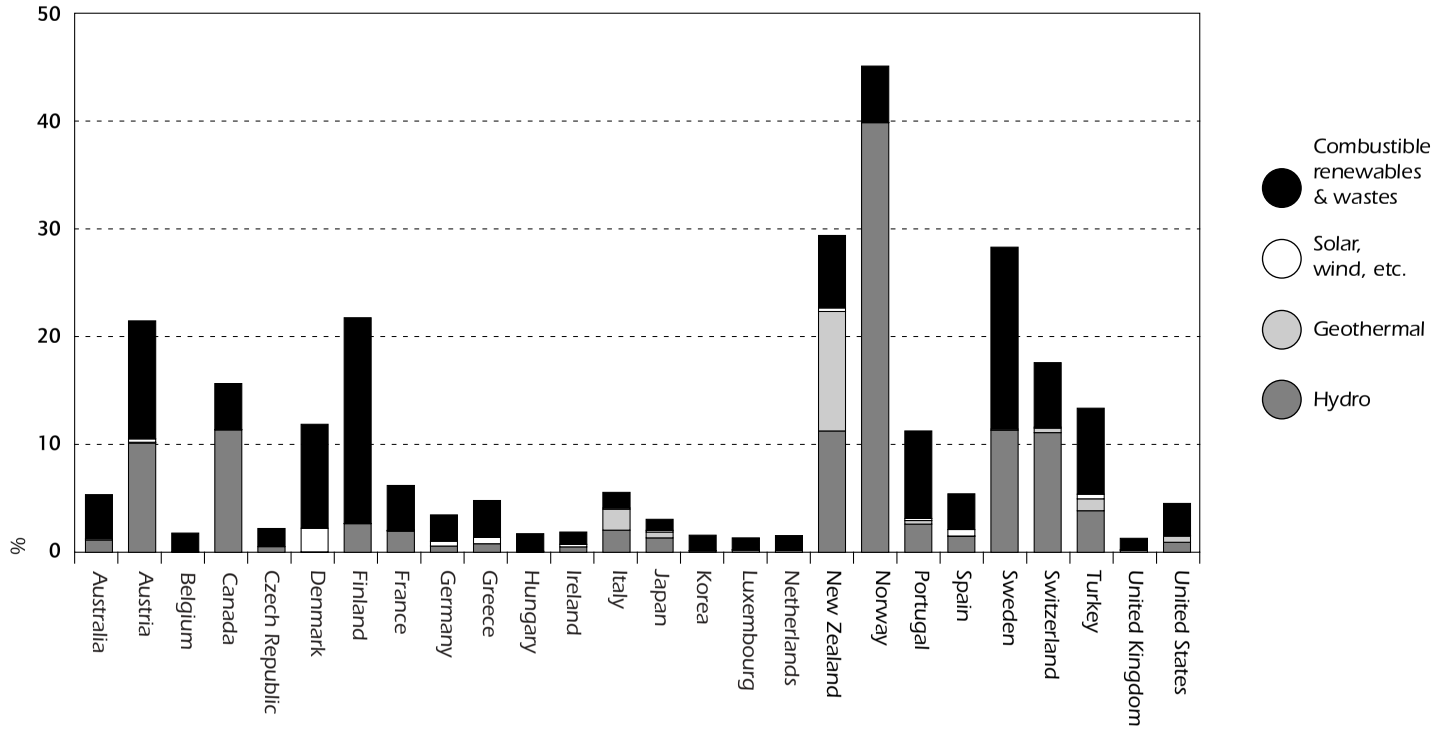
GOVERNMENT POLICY AND SUPPORT MECHANISMS

French renewable energy policy rests on the following three principal axes:

- France will not support all renewable energy technologies equally without regard for costs to the public. It recognises that certain technologies are far from being competitive with more traditional energy sources.

Figure 12

Renewable Energy as a Percentage of Total Primary Energy Supply in IEA Countries, 2002



Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2003.

Table 11

Energy Production by Renewable Resources[1], 2001

Technology	*Electricity Generated (GWh)*	*Thermal Energy (ttoe)*
Hydroelectric	**80 068**	**–**
Wind Power	**141**	**–**
Grid-connected	140	–
Not grid-connected	1	–
Solar Power	**13**	**–**
Grid-connected	1	–
Not grid-connected	12	–
Solar Thermal	**–**	**25**
Heat Pumps	**–**	**257**
Industrial Usage	–	36
Residential	–	221
Geothermal	**20**	**117**
Electricity	20	–
Heating	–	112
Agriculture	–	5
Solid Waste	**2 332**	**617**
Electricity Only	1 232	–
Heat Only	–	125
Co-generation	1 100	493
Solid Biomass	**1 273**	**8 809**
Residences	–	7 620
Heating	–	130
Industry (exc. black liquor)	449	537
Black Liquor	824	482
Agriculture	–	40
Harvest Residue	**360**	**189**
Biogas	**349**	**58**
Landfill Gas	253	6
Refining	90	32
Agriculture	–	5
Industrial Agriculture	6	15
Biofuels	**–**	**327**
Biogas	–	58
Biodiesel	–	270
TOTAL	**84 556**	**10 398**

[1] Figures in this table refer to renewable production in both metropolitan France and overseas.

Source: Observatoire de l'Energie.

- France supports renewable energies which have an application that makes them competitive (or which soon will make them competitive) with alternative energy sources.
- Renewable industries that are considered far from competitive receive government R&D support to reduce the technologies' generation costs.

The government has announced plans to increase the contribution the country receives from renewable energy. As a basis for setting targets for new renewable energy power generation, the *Livre Blanc* states France's intention to be in line with the EU directive of 27 September 2001 which sets an indicative target for France to have 21% of its electricity consumption produced by renewable resources by 2010. In particular, the government will strive to add the following electricity capacity levels by 2010:

- Biogas: between 100 and 500 MW.
- Biomass: between 300 and 1 000 MW.
- Solid waste: between 200 and 700 MW.
- Wind power: between 7 000 and 10 000 MW (of which at least 500 MW to 1 500 MW offshore).
- Geothermal: between 20 and 120 MW.
- Hydropower: between 400 and 2 000 MW.
- Solar and other renewables: between 1 and 150 MW.

FEED-IN TARIFF

One means the government uses to support and encourage investment in new renewable generating capacity is the feed-in tariff system. Law 2000-108 of 10 February 2000 obliges EDF and the local distribution companies (see Chapter 8) to purchase electricity generated by certain types of renewable technologies at the tariffs and other terms prescribed by law and shown in Table 12. Only generating stations[21] with less than or equal to 12 MW of capacity are eligible to receive the feed-in tariffs.

CALL FOR TENDERS

In addition to feed-in tariffs for plants not exceeding 12 MW of capacity, the government has instituted a series of tender offers (*appels d'offre*) for larger renewable plants from 2004. Under this system, the government publicly launches a request for bids from renewable plant developers. Bids are

21. The 12 MW limit applies to the entire capacity of a facility, not individual units, such as wind turbines.

Table 12

Feed-in Tariffs for Renewable Electricity[1], 2004

Technology	*Decree Date*	*Contract Length*	*Tariffs (eurocents/kWh)*
Wind Power	8 June 2001	15 years	8.38 for the first five years, then 3.05 to 8.38 for ten years, depending on site
Hydroelectric	25 June 2001	20 years	5.49 to 6.1 according to capacity plus 0 to 1.52 in winter according to regularity of production
Co-generation	31 July 2001	12 years	6.1 to 9.15 depending on gas price, length of service and capacity
Solid Waste	2 October 2001	15 years	4.5 to 5.0 plus 0 to 0.3 bonus for improved efficiency
Landfill Gas	3 October 2001	15 years	4.5 to 5.72 according to capacity plus 0 to 0.3 bonus for efficiency improvements
Geothermal	13 March 2002	15 years	7.62 plus 0 to 0.3 bonus for efficiency improvements
Photovoltaic	13 March 2002	20 years	15.25 in continental France and 30.5 in Corsica and overseas territories
Animal Waste	13 March 2002	15 years	4.5 to 5.0 plus 0 to 0.3 bonus for improved efficiency
Methane Gas	16 April 2002	15 years	4.6 plus 0 to 1.2 bonus for efficiency improvements
Solid Biomass	16 April 2002	15 years	4.9 plus 0 to 1.2 bonus for efficiency improvements

[1] Applies only to facilities equal to or less than 12 MW.

Source: French government.

submitted that include key parameters on the prospective projects, including technology type and size, location of plant, and financial and other information on the project sponsor. The government selects the winning bid or bids based on a variety of criteria and offers the winners long-term contracts for the purchase of electricity at the price specified in the bid. Three sets of offers are planned for 2004:

- 200 MW for biomass and 50 MW for biogas.
- 500 MW for offshore wind plants.
- Two separate offers each for 500 MW of onshore wind power.

GREEN CERTIFICATES PROGRAMME

While the *Livre Blanc* concentrates on both the feed-in tariffs and the call for tenders as a means of encouraging renewable energy that would not otherwise be supported by the market, it also entertains the possibility of using a quota system with a green certificates programme in the future. Such a programme will be more seriously considered if the feed-in tariffs and the calls for tenders do not yield sufficient new renewable capacity.

POSSIBLE CURTAILMENT OF WATER RIGHTS FOR HYDROELECTRIC PLANTS

Many of the concessions for water use granted to hydroelectricity plants in France will be coming up for renewal in the next two to five years. There is a great demand for this water from other sectors, including fishermen, the tourism industry and agricultural concerns. Water demand, as well as the value of the water in question, has risen substantially since the original concessions were issued. One factor in this debate is the Fishing Law of 1984 (*loi Pêche de 1984*, codified in article L. 332-5 of the environmental code), which in 1994 raised the minimum water flow in French rivers to one-fourtieth of the average multi-year flow rates. This resulted in a loss of 1.2 TWh of generating capacity for the hydroelectric plants, or 1.8% of that year's hydro production. The same law envisions a further increase in minimum river flows to one-tenth the average flows, a condition to be instated as concessions are renewed. If this were to happen, the government estimates that hydroelectric production capability would fall by a further net of 4 TWh, or 2.7% of the 2001 hydroelectric production. The debate over the water rights continues but it appears likely that at least some hydroelectric plants will lose a percentage of their production capabilities owing to decreased water availability.

WIND POWER DEVELOPMENT

Despite its large size and solid wind power resources, France has yet to develop substantial levels of wind power capacity. As of June 2003, France had only the ninth-largest wind power park in the EU with 220 MW. By way of comparison, Germany had 12 836 MW, Spain 5 060 MW, Denmark 2 916 MW, the Netherlands 803 MW and Italy 800 MW. Three factors that contribute to the relatively sparse French wind power production are local opposition to wind power plants, difficulties connecting new wind power capacity to the grid and the limit on the feed-in tariffs to projects with less than 12 MW total capacity. The local opposition in France can come in the form of difficulties in receiving permits from the *préfecture* and the regional environmental agencies, AREN/DIREN. This has led to high administrative costs for the

developers. Treatment of wind plants varies significantly from region to region. A number of developers have stated that the process for connecting to the grid is not transparent despite clearly defined marginal cost calculation methodologies. There have also been delays in providing these estimates and physically connecting new capacity to the grid which have led to high administrative costs. The government is taking steps to address these concerns. The CRE is engaged in modifying the procedure of handling demands by wind developers to link to the national transport grid and DGEMP is clarifying the methods for billing.

THERMAL ENERGY FROM RENEWABLE RESOURCES

The government has also established targets for increasing production in thermal energy from renewable resources. Overall, it plans to increase thermal renewable production from 11 Mtoe to 16 Mtoe by 2015. Particular objectives include:

- **Biomass development:** The *Livre Blanc* calls for an increase in biomass thermal energy of 2.9 Mtoe by 2015. This would come mostly from co-generation facilities and would, in this way, also contribute to reaching objectives of electricity coming from renewables. The government would like to install 1 500 MW of new biomass-fired co-generation capacity by 2015.
- **Accelerated penetration of solar thermal energy:** The *Livre Blanc* calls for 250 000 individual solar hot water heaters to be installed annually by 2010 (equivalent to approximately one million m^2 of solar panels). In addition, the target for collective solar hot water heaters is an annual installation rate of 300 000 m^2 by 2010 and a solar space heating annual installation rate of 150 000 m^2. These installations would provide 0.4 Mtoe annually.
- **Geothermal heat pumps:** The government wishes to have 250 000 individual or collective heat pumps installed by 2015 for a total annual production of 0.2 Mtoe.

Both government and industry have traditionally concentrated on electricity rather than thermal production from renewable resources. As such, new support methods will be needed to achieve the goals in this sector. In particular, the government plans to use fiscal measures and regulations for urban planning and residences, the energy efficiency system to be introduced and financial aid delivered by ADEME. Specific proposals at this time include the following:

- The tax credit for solar collectors will be increased from 15% to 25%.
- A feasibility study on all energy solutions, particularly from thermal renewable resources, will be required for all new constructions.
- Local authorities will be allowed to require new construction to meet certain minimum guidelines for the use of solar energy.

BIOFUELS

France seeks to increase biofuel use by blending them with petroleum-derived motor fuels or heavy fuel oil such that they can be used in conventional engines without modifications. Agricultural ethanol is blended with gasoline (ethyl tertiary butyl ether, ETBE) and vegetable oils are blended with diesel fuel (ester méthylique d'huile végétale, EMHV). The combustion and other characteristics of the blended products is sufficiently close to the original products that the blends can be used as direct substitutes. France has the highest absolute biofuel use in the EU. In 2002, EMHV production rose to 351 470 m^3 and ETBE production rose to 113 941 m^3. Targets for expanding this production will be fixed by decree after government consultation with industry. The EU has a target to expand biofuels use to 5.75% of total motor fuels by 2010. The figure for the entire EU is about 0.1%. In France, EMHV represents slightly less than 1% of total diesel fuel use and ethanol represents around 0.6% of total gasoline usage.

The French government supports biofuels through tax reductions. In 2002, fuels blended with ETBE received a tax reduction of €0.38 per litre and fuels blended with EMHV received a tax reduction of €0.35 per litre. These tax incentives continue and were added to on 1 January 2004 when pure ethanol destined for use in motor vehicles was granted a tax reduction of €0.37 per litre.

CRITIQUE

France's large renewable energy production contributes to the environmental performance of the energy sector and the country's energy diversity and security. 98% of the country's renewable energy comes from either hydropower or biomass, resources that were primarily developed because of their cost advantages over competing fuels and not for the environmental or security benefits they represent. Policy-driven support for renewable energy in France has thus far not resulted in substantial installations of new renewable energy capacity, at least when seen in relation to other European countries. For example, despite its large size and enviable wind resources, as of June 2003, France had only the ninth-largest wind power park in the EU with 220 MW. By way of comparison, Germany had 12 836 MW, Spain 5 060 MW, Denmark 2 916 MW, the Netherlands 803 MW and Italy 800 MW[22]. In general, delays in receiving local siting permits for renewable plants, difficulties in getting timely and transparent access to the grid, and the 12 MW upper limit on the plants that can receive the feed-in tariffs have inhibited renewables development.

22. All wind power capacity figures from the European Wind Energy Association (EWEA).

The government would like to be more active in supporting new renewable capacity. Meeting the EU indicative target of 21% of electricity consumption coming from renewables by 2010 will require a major acceleration in the installation rate of such capacity. To reach the 10 000 MW upper target set for wind power, for example, France would have to add approximately 1 400 MW of wind capacity each year when, by way of comparison, only about 100 MW were added in 2003. France has the opportunity to study and gain from the experiences of other countries in determining which policies are best suited to encourage large levels of new renewable energy. The country is encouraged to do so, particularly in assessing the total costs involved with achieving the renewable levels it seeks and disseminating those costs to the general public as widely as possible. The analysis supporting the Long-term Investment Programme as well as the Reference Cost study for different generation technologies could provide a sound basis for such an assessment. The government's basic principle not to support all renewables technologies equally without regard for costs to the public is sound and should be adhered to.

The call for tenders system that France will use to support renewable generators with more than 12 MW of capacity has had a mixed record in other countries. The UK had a similar system called the Non-Fossil Fuel Obligation (NFFO). However, of the 3 639 MW worth of contracts the UK government has given through the NFFO system, only 1 104 MW of capacity has been installed[23]. While some of the contracts may still lead to actual plants, the success rate of the programme on the whole has been disappointing. The UK has abandoned this system and replaced it with the Renewables Obligation (RO) programme, a certificate trading system, which is too new to have demonstrated its ability to consistently induce new renewable capacity. Ireland also uses a call for tender system to support renewable energy plants but they too have seen only modest new build from the contracts the government has thus far issued. Ireland is continuing the programme, but in a slightly modified form. Companies now bidding for contracts must already have the requisite planning consents from the local governments. In addition, the government will issue contracts for more capacity than it actually intends to support, assuming that a certain percentage of capacity will never be developed.

The problems experienced with call for tender systems can come from two types of difficulties. One, plants that receive contracts are subsequently unable to obtain siting permission or, two, plants are unable to receive financing despite the long-term contract to sell their electricity output. The inability to obtain financing is inherently linked to the bidding structure of the tender system: the winning bidders will have submitted the lowest tariffs and thus have the most difficulty operating a financially viable and credible project. France should conduct the bids in a way that minimises the effects of

23. Data from "NFFO Fact Sheet 11: Renewable Obligation Status Update as of 30 September 2003", revised January 2004 (Department of Trade and Industry).

these two types of problems. Certainly a minimum level of planning and siting work should be a prerequisite for any bidder as should be a financial plan that demonstrates the project's economic viability. If the bidding system is still unable to deliver the rates of capacity needed to achieve the country's targets, the government should consider either raising the 12-MW limit for feed-in tariffs or employing another means of supporting renewables, such as a quota obligation with certificate trading scheme, with firm penalties for non-compliance.

Feed-in tariffs have proven to be an effective means of encouraging renewable generation. This method has been used in Germany and Spain to create the two largest national wind parks in the EU. On the other hand, there is some room for watchfulness in the implementation of the feed-in tariff scheme. Under feed-in tariffs, depending on the design, the incentives for cost reduction may not be strong and it may be the producers, not the consumers, who enjoy the benefit of any cost reductions, unless benefits are passed through as a result of competitive pressures. It is not certain to what extent the current feed-in tariff scheme has a strong incentive for cost reduction. Introduction of a mechanism for reducing feed-in tariffs over time needs to be considered. While guaranteeing predictable tariffs for the planning horizon of projects, it is necessary to lower tariffs from year to year as costs come down, noting that the learning curves of renewable energy, for example offshore wind, are quite steep. In this way, the feed-in tariffs will both respond to and encourage cost reductions and efficiency improvements for the respective technologies. Furthermore, the current system with widely different feed-in tariffs for different technologies should be reviewed in light of the principle not to support all the renewable technologies equally without regard to the cost.

If a quota obligation with certificates is considered, it should be noted that its effectiveness will depend on the firmness of the targets, including the level of obligation and the penalties for non-compliance. The level of the penalty needs to be high enough to induce the achievement of the target. Because this system has been introduced only recently in other countries, its effectiveness needs to be thoroughly examined from their experiences.

Achieving the ambitious renewable targets will require more than marshalling the political and public will to pay for new renewable capacity, however. Another important challenge will be siting these plants throughout France, particularly wind power facilities. A number of local communities have objected to wind plants in their regions and developers have encountered costs and delays in this process. While local communities have a legitimate basis for deciding not to have wind turbine installations, such development difficulties may hamper the ability to reach the national renewable objectives. Co-ordination between national policy-makers setting the targets and the local groups and politicians making permitting decisions will be necessary to assure that all sides are satisfied. Where possible, the authorisation process should be streamlined. This effort will require strong government leadership.

Natural river water flow is a precious commodity so it is understandable that many actors compete to use it. If the Fishing Law of 1984 further increases minimum river flow as it did in 1994, some hydroelectric generation will be lost. Government energy policy-makers should enter the debate on water rights and explain the many national advantages of hydroelectric power. Debate participants should keep in mind the government's position in the summer of 2003, when it risked environmental harm to rivers by allowing nuclear plants to discharge cooling water above the normally accepted temperature limits. At the same time, the government should estimate as closely and as realistically as possible the amounts of hydroelectric generation likely to be lost and make plans accordingly.

The competing advantages of renewable generation and energy efficiency should always be kept in mind when formulating and implementing policy. Both energy tools address energy demand, dramatically lower GHG emissions and improve energy security. At the same time, the two options are very different with regard to how they relate to consumers. While direct head-to-head comparisons between the two approaches are not always straightforward, efforts should nevertheless be made to assess how limited funds can be dispersed among the tools available in these two fields to maximise results. France is undertaking ambitious efforts to reach challenging goals in both energy efficiency and renewable energy. This provides an excellent opportunity to construct a unified approach in both areas in order to achieve the joint goals of reduced emissions and enhanced security in the most cost-effective manner. Given the institutional division of responsibilities between efficiency and renewables activities, such an approach would have to originate at a fairly high level within the government.

RECOMMENDATIONS

The government of France should:

- *Assess the most effective policies for achieving renewable energy goals, evaluating and disseminating information on the costs and benefits involved in meeting such ambitious targets. Draw upon experiences of other countries.*
- *Ensure that the tender offers system results in substantial timely installed renewable capacity; while allowing significant time for the system to work and to give investors confidence, do not exclude the possibility of other market-based options if results are not satisfactory.*
- *Co-ordinate between the relevant authorities to ensure that the siting of wind plants and associated transmission lines can proceed without undue delay to achieve national objectives while still taking into account local concerns.*

- *Resolve the pending debate on water rights and hydroelectric plants to determine how much, if any, hydroelectric capacity will be lost and make plans accordingly.*
- *Adopt a unified approach to the renewable energy programme (both electricity and thermal) and those other programmes that could confer similar advantages, notably energy efficiency.*

NATURAL GAS

SUPPLY AND DEMAND

In 2001, gas accounted for 13.8% of national TPES, up slightly from 11.5% in 1990 but still well below the IEA European average of 23%. In 2001, France produced 1.5 Mtoe of gas and had net imports of 34.1 Mtoe. Production levels have fallen steadily since 1973 when there was 6.3 Mtoe of domestic production (nearly 50% of gas supply). The government forecasts that all domestic production will cease by 2010. Table 13 shows the import sources for France in recent years.

Table 13

Imports of Natural Gas

(million cubic metres)

From	*2000*	*2001*	*2002*
Norway	12 070	11 730	12 433
Former USSR	12 229	10 550	10 893
Algeria	9 950	9 560	10 329
Netherlands	6 020	6 000	6 272
Nigeria	2 538	2 342	3 625
United Kingdom	52	1 208	1 198
Other	–	1 022	–
Total Imports	**42 850**	**42 412**	**44 750**

Source: IEA.

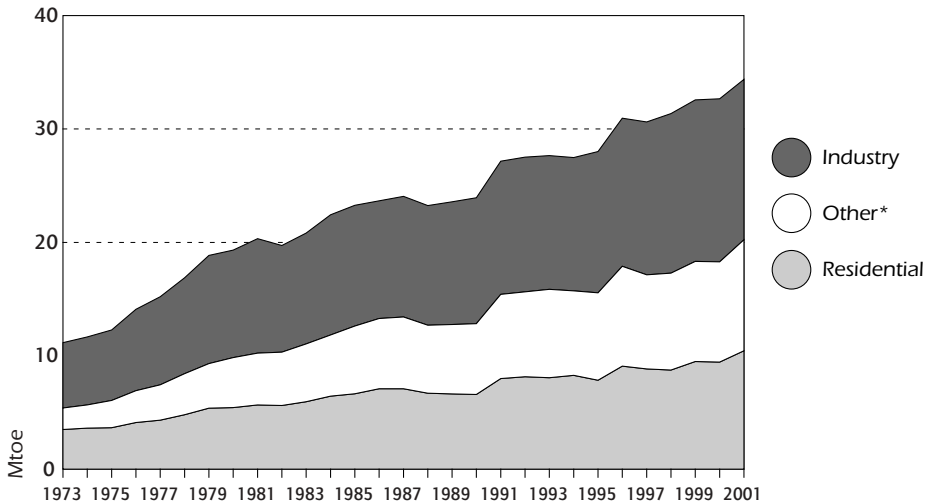
The state-owned gas utility, Gaz de France (GDF, described further below) had historically been granted a monopoly by the State to conduct all imports and exports but this was removed on 3 January 2003. GDF's supply comes mainly from long-term, take-or-pay contracts. While these contracts normally have built-in flexibility mechanisms that give GDF the ability to deviate up to 10% above or below the contracted supply levels, there is nevertheless a strong incentive to take possession of the gas regardless of immediate need. The average remaining life of these contracts is slightly less than 15 years. In addition, GDF has recently signed two new long-term contracts with Egypt and the Netherlands and has also extended its largest commitment to purchase Russian gas to 2015.

In 2001, France consumed 34.4 Mtoe of natural gas. This represents 19.8% of national total final consumption (TFC), slightly below the IEA European average of 21.8%. Gas consumption has risen by an average of 4.2% per year since 1973, compared to a 1.2% annual gas demand growth for all IEA countries and an average annual growth of 0.8% for French TFC for all fuels. More recently, French gas consumption rose at an annual average rate of 2.2% from 1997 to 2001, compared to 1.2% for combined TFC for all energy sources. Unlike many European countries, there are no power-only plants fired by natural gas in France. The gas used to fire CHP plants accounted for 3.1% of total electricity generation in 2001. Since residential and commercial sectors hold a major share of natural gas consumption, French seasonal demand profiles vary dramatically by season. For example, gas demand in August 2002 was only 17% of gas demand in January 2003. Such wide variations illustrate the wide use of gas for heating.

In 2001, industry accounted for 41.1% of gas consumption, residential accounted for 30.4%, commercial and public uses accounted for 27.5% and other sectors, including agriculture and transport, accounted for 1.1%. Figure 13 shows the historical and forecasted progression of French natural gas consumption by sector.

Figure 13

Final Consumption of Natural Gas by Sector, 1973 to 2001



* includes commercial, public service and agricultural sectors.
Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2003.

INSTITUTIONAL STRUCTURE

The natural gas sector in France is dominated by Gaz de France (GDF), the 100% state-owned vertically integrated natural gas supply, transportation and distribution company. GDF has divisions and activities in exploration and production; supply and trading; transmission; distribution; and services. GDF has 25 000 employees and owns and operates 96% of distribution lines, 100% of entry points to the country, 75% of the high-pressure transmission system[24], and 83% of storage. As of late 2003, GDF supplied about 83% of gas sales (by volume) in the country. Like EDF, GDF is currently an *établissement public industriel et commercial* (EPIC) under French law, although the government has stated its intention to change GDF's status to a *société anonyme* (SA) in 2004. EPICs are state-owned companies serving the public with special rights and privileges under French law. An SA designation is used for any company – public or private – that does not have this designation. The State may continue to be the 100% owner of GDF after the transformation of its statute. This change in statute would be a necessary first step to opening up a percentage of the capital of the company to private investment. It is also envisaged that GDF would form a subsidiary (in the form of an SA company) that would handle all gas transport.

Other players in the natural gas sector include:

- *Gaz du Sud-Ouest* (GSO) is a supply and transport company with 4 200 km of pipelines in the south-west of the country against the border with Spain. While GSO had been 70% owned by Total and 30% owned by GDF, the two companies agreed to a swap of assets between GSO and CFM (see directly below). Total will now hold 100% of GSO assets and operations.
- *Compagnie française du méthane* (CFM) is a supply and transport company with 6 700 km of pipelines in the central-western part of the country. CFM had been 55% owned by GDF and 45% by Total but following the above-mentioned asset swap, CFM will now be owned 100% by GDF.
- While GDF owns the majority of distribution lines, there are 22 non-nationalised distributors (*distributeurs non nationalisés*, DNNs), which, as local distribution companies (LDCs) distribute gas in their respective cities. Gaz de Bordeaux, Gaz de Grenoble and Gaz de Strasbourg are among the largest. These DNNs are primarily municipally-owned although other actors also own shares: GDF and Total each own 16% of Gaz de Bordeaux and 24.9% of Gaz de Strasbourg. In addition, since the passage of a 1998 law opening gas distribution to competition, there have been a number of private gas distribution companies such as Primagaz and Antagaz.

24. All high-pressure transmission lines (including entry points) have been separated operationally from other GDF activities although ownership remains with the same parent company. This arrangement is explained further below.

- A number of foreign supply companies have entered France to compete for eligible customers in the newly liberalised market. These include Distrigaz, BP, Ruhrgas and Norsk Hydro.

TRANSPORTATION NETWORK

Three-quarters of imported natural gas comes from entry points in north-eastern France. These entries and their respective capacities are Taisnieres (26.1 Mtoe per year), Dunkerque (14.0 Mtoe per year) and Obergailbach (12.4 Mtoe per year). The remaining gas enters through two LNG terminals, Montoir on the Atlantic coast with a capacity of 10 Gm^3 (9.5 Mtoe) per year and Fos on the Mediterranean with a capacity of 4.5 Gm^3 (4.3 Mtoe) per year. The transmission system owned by GDF has been carved from the body of the group to form GDF Transport which now operates independently although ownership remains with the parent company. No information on gas flow by third parties gained by GDF Transport is to be transmitted to the parent company.

The capacity of the transmission system varies significantly throughout France. In general, the north-eastern part of the country has a sufficient network to serve the customer base with excess capacity in many areas. The north-east is also where many of the large industrial gas users are located. In the south-west, the network is generally sufficient although there is very little excess capacity, and bottlenecks do exist especially in areas connecting the south-west with the north-east. The ownership and operation of the transmission grid is divided between the two main transmission companies (GDF and Total) according to geographic location, as shown in Figure 14. More detailed information is provided in Table 14.

Table 14

Length and Ownership of Gas Network

Company	*Transmission (km)*	*Distribution (km)*
GDF	32 064	164 290
GSO	4 200	–
CFM	6 700	–
Total Transport Gaz de France	690	–
DNNs	–	7 032
Total	**43 654**	**171 322**

The high-pressure gas network in Italy is 17 000 km, or less than 40% that of France. However, the Italian distribution system is 182 000 km long, which is comparable or slightly higher than that found in France. Germany has

Figure 14

French Natural Gas Transmission System with Entry Points

Source: *Commission de régulation de l'énergie,* Activity Report, June 2003, Paris.

96 000 km of high-pressure lines[25], over twice that of France and about 270 000 km of low-pressure distribution lines, also substantially higher than in France. The French high-pressure system is larger than that found in the UK, while the low-pressure system is considerably smaller. This reflects the role of France (and Germany) as important transit areas for the European gas markets.

STORAGE

France also has a substantial gas storage system with 15 underground storage facilities and a working capacity of 11 bcm, equivalent to 95 days of consumption. GDF owns 13 of these facilities with 83% of the storage capacity and Total owns the other 2 facilities.

GAS PRICES

Gas prices for French industrial and household consumers are shown in Figures 15 and 16.

LIBERALISATION OF THE SECTOR

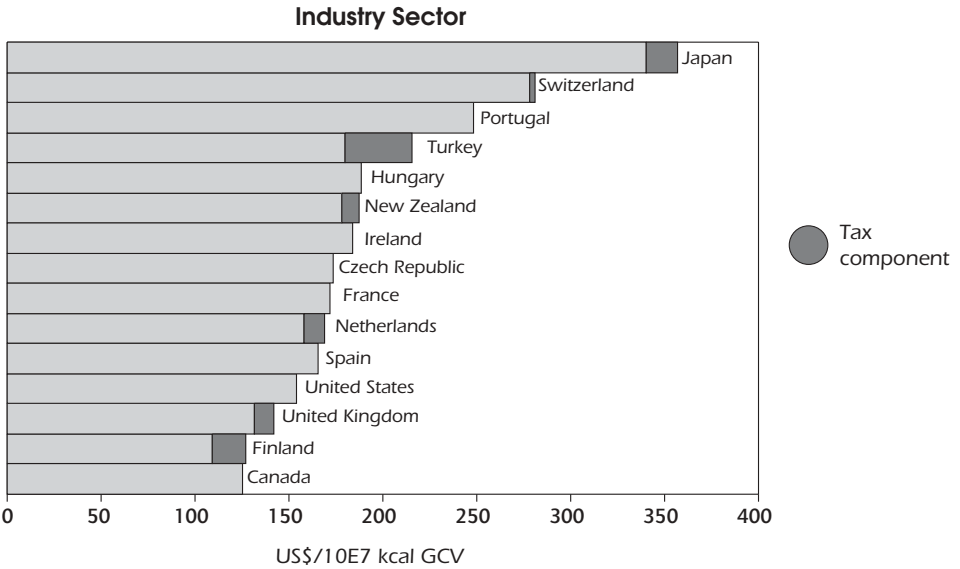
The law of 3 January 2003 implementing the EU Directive 98/30/EC gave all "eligible" gas customers the right to choose their supplier. All customers with annual natural gas consumption above 237 GWh (809 000 MBtu) were free to choose their supplier. This represented 150 industrial customers, or 20% of the national market by volume. On 10 August 2003, the government lowered the threshold to 83 GWh (283 000 MBtu). This added another 450 eligible customers and increased the legal rate of liberalisation to 37% by volume, putting France in compliance with the EU Directive 98/30/CE on the internal gas market which required a minimum market opening of 28% by volume. In addition to the customers that are eligible because of the large size of their consumption, all co-generators and all the non-nationalised distribution companies were also given the right of supplier choice.

As of October 2003, nearly one-half of eligible consumers (by volume) have taken advantage of the market opening with the rest continuing to get service from GDF at the regulated tariffs. The smaller eligible companies were least likely to switch or renegotiate their supply. Almost 80 sites representing 50 TWh (171 MBtu) of annual gas consumption had renegotiated their contracts at more favourable rates with their previous suppliers. About 30 sites representing around 35 TWh (119 000 MBtu) had changed suppliers. Therefore, the change rate to new suppliers, measured by the number of sites, stood at that time at 7%, which is between the 5% and 10% bracket seen commonly in continental Europe. It is

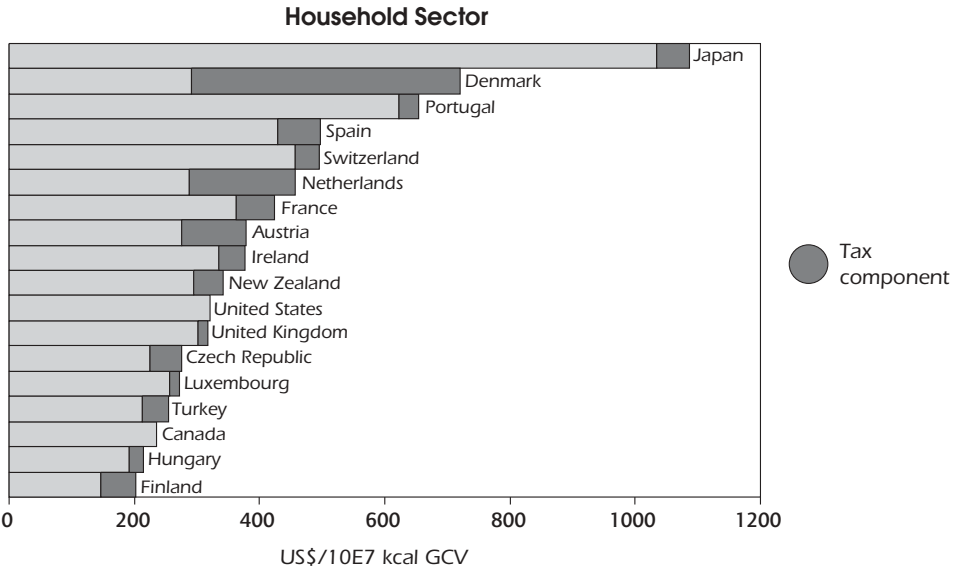
25. Includes lines designed for and routinely operated at pressures over 1 bar.

Figure 15

Gas Prices in IEA Countries, 2002



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

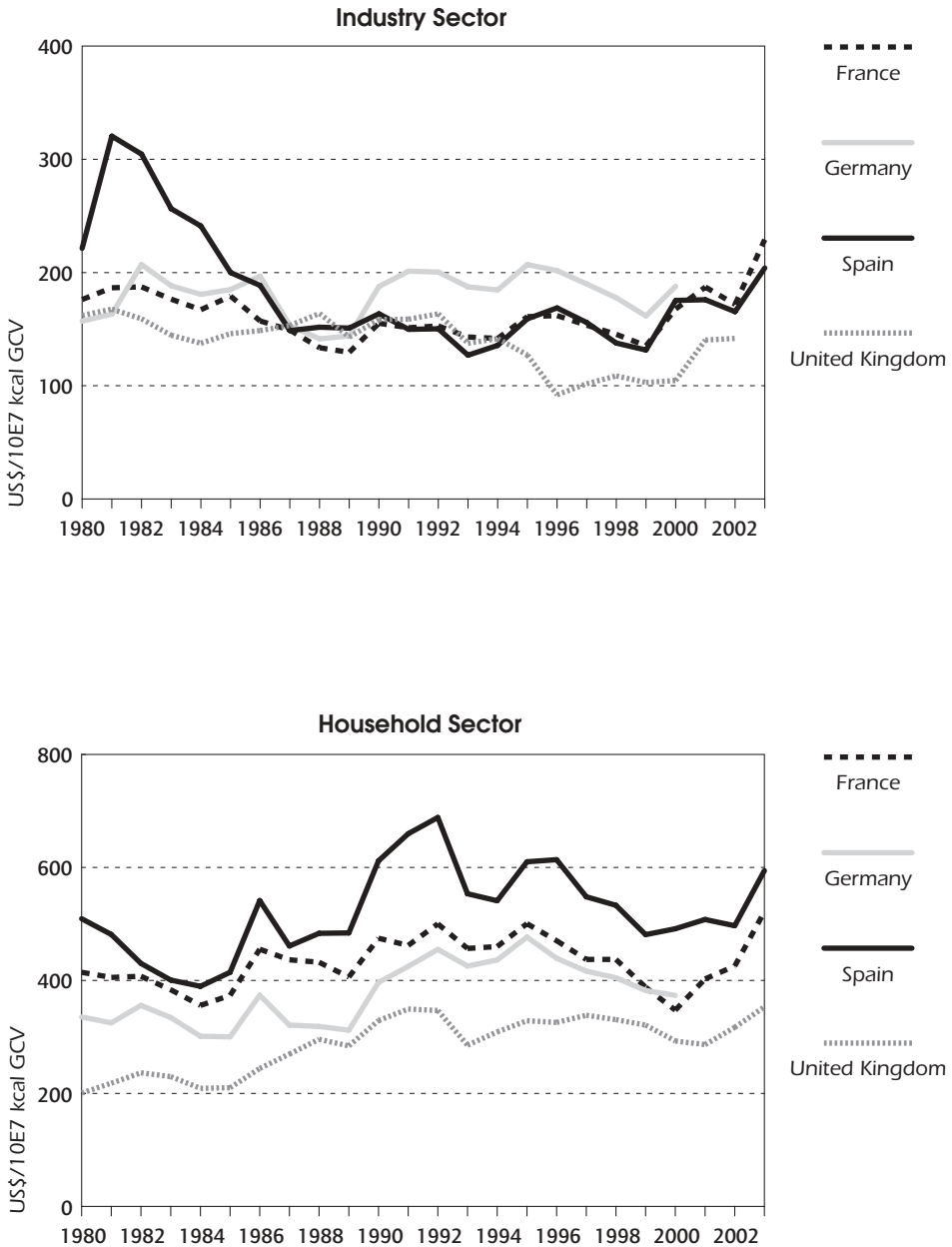


Note: Tax information not available for Canada and the United States. Data not available for Australia, Belgium, Germany, Greece, Italy, Korea, Norway and Sweden.

Source: *Energy Prices and Taxes,* IEA/OECD Paris, 2003.

Figure 16

Gas Prices in France and in Other Selected IEA Countries, 1980 to 2003



Source: *Energy Prices and Taxes,* IEA/OECD Paris, 2003.

worth noting that the largest of the eligible customers were those most likely to switch suppliers, followed by the slightly smaller customer base which renegotiated contracts with the incumbent supplier. In July 2004, all commercial and industrial customers will be eligible to change suppliers (representing approximately 70% of the market by volume) and all customers regardless of size will be free to do so in July 2007, according to EU Directive 2003/55/EC.

In addition to establishing the framework for expanding customer choice, the law of 3 January 2003 also created the following conditions of the liberalised market:

- All grid operators must offer open access to their transportation and distribution infrastructures, as well as LNG installations. The terms and tariffs for use of the network are fully regulated. For refusals to provide access on technical grounds, such as insufficient available capacity, the regulator (CRE) may give the operator formal notice to carry out the necessary expansion investments. For refusals to provide access on contractual ground, such as the capacity having already been contracted for, the operator may request an exemption to the open access requirement of no more than one year.
- Tariffs to non-eligible customers and tariffs for use of the network grid are determined and set by the Ministry of Economy, Finance and Industry, following an opinion issued by the regulator.
- Vertically-integrated companies must unbundle their accounts for different activities such as transportation, storage, supply, production and activities strictly outside the gas domain.
- The domain of the regulator (CRE) is expanded to include jurisdiction over the gas as well as the electricity sectors.

The open-access tariff system for the transmission network is based on the entry-exit system, in compliance with the recommendations of the Madrid Forum. Eight zones have been established in France (four corresponding to GDF's normal transmission lines, one for GDF's network for lower heating value gas, two for CFM's system and one for GSO's system). The zone for lower heating value gas is independent from the other zones as the gas from the two systems do not normally mix. Each operator has its own tariff which is based on the regulated asset base in that zone, depreciation methods (50 year straight-line for pipelines and 30 year straight-line for compression stations) and operating costs taken from the newly unbundled accounts.

The regulator has stated its dissatisfaction with the transparency regarding the availability of pipelines operated by GDF Transport. According to the regulations, all players should have access to sufficient information to secure pipeline capacity on equal footing. However, the CRE[26] notes that "the data [on the GDF Transport website] are insufficient either to enable the regulator

26. "Activity Report, June 2003". *Commission de régulation de l'énergie*.

to check that available capacities are indeed being managed in accordance with the desired transparency criteria, or to assure the historical operator's competitors that they can use infrastructures as efficiently as possible. A more detailed analysis of capacities is therefore required, so that market players may access available capacities with knowledge of existing and forecast technical problems."

Under the new legislation, storage facilities must first and foremost be used to maintain the balance of the transportation system and meet public service obligations. Suppliers may access available capacities depending on their respective public service obligations, particularly if they are distributors themselves or directly supply gas to distributors. New entrants and other competitors can have a form of access to GDF's and others' storage capabilities in the form of load balancing services offered by these incumbent operators. These services enable users to adjust their gas flow profiles at the intake and offtake ports. The service is negotiated on the basis of indicative tariffs published on the operators' websites.

Despite the switching and renegotiating of significant portions of eligible customers and the rules establishing open access on the networks, a number of new entrants looking to compete in the market have expressed frustration at getting access to the network system, especially in the south-west of the country where the pipelines are physically more constrained. To address this constraint, CRE has agreed, through a consultation on 18 March 2004, to assure the developers and owners of a new pipeline linking France with Spain a rate of return of 12% in real terms for the first five years and potentially longer if certain conditions are met.

To address this problem of constraints on third-party network access in the south, the regulator (CRE) proposed a gas release programme concerning both GDF and GSO (Total) although the exact parameters have yet to be finalised. According to CRE, the purpose of this programme is to "permit the entry of new suppliers into the south of France where there is no competition today." Beginning on 1 January 2005, the companies will offer gas for sale equal to 3.5% of their annual sales. GDF will offer 15 TWh (1.3 Mtoe or around 4 400 mcm) per year. This will be broken down and sold in lots through both auction and on a lot-by-lot negotiated basis. GSO will offer 1.1 TWh (0.09 Mtoe or around 320 mcm) per year, also divided into smaller lots. Bidders will be limited in the amount of each offering they can acquire, with the limits to be determined by CRE at a later date.

COAL

In 2001, coal accounted for 12.7 Mtoe of primary energy supply, or 4.8% of national TPES. This percentage share has been declining steadily over both the long term and the short term. Coal's highest share of TPES since

1973 was in 1977 when it accounted for 17.8% of national TPES. More recently, coal's share of TPES has fallen from 6.8% in 1998. While net imports of coal to France have been relatively stable since 1973, domestic production fell substantially, from 18.0 Mtoe in 1973 to 1.6 Mtoe in 2001. Coal production in France has now ceased entirely with the closure of the La Houve mine in March 2004. In 2002, South Africa represented the biggest coal importing country with 25% of the import market, followed by Australia (22%), the United States (10%) and other smaller importers.

In 2001, final consumption of coal was 3.5 Mtoe. The difference between the 12.7 Mtoe supply of coal and the smaller consumption figure is based largely on coal use for electricity production. Coal final consumption has fallen in both the long and short term, declining by over 75% from 1973 to 2001 and by nearly 35% from 1997 to 2001; 84% of coal final demand comes from industry and 16% from residences.

The costs of extracting hard coal in France have risen substantially in recent years. In 1995, the cost was €107 per tonne whereas by 2002, that figure had risen to €223 per tonne. Resulting losses from each tonne of coal extracted rose from €63 per tonne in 1995 to €173 per tonne in 2002. Hard coal production in France is concentrated in the hands of state-owned Charbonnages de France (CDF). Under the terms of the National Coal Pact (*le pacte charbonnier*), signed in October 1994 as an agreement between the government, CDF and the social partners (primarily the workers), all coal extraction was scheduled to cease in 2004. In fact, CDF is ahead of schedule in that regard and the final tonne of coal was extracted from the La Houve mine in March 2004. At the same time, the pact ensures the social welfare of all current miners, either in the field of coal extraction or other industrial areas. The number of workers at CDF has fallen considerably. From a high of 369 581 workers in 1947, the figure fell to 22 673 in 1990 and 4 200 at the end of 2003.

CDF has already closed a number of coal mines: Carmaux, La Mure and Forbach in 1997; Decazeville, Alès, Blanzy and Aumance in 2001; Gardanne and Merlebach in 2003 and La Houve in the first half of 2004. For up to two years after each mine closure, significant manpower and expertise is required to secure the site and rehabilitate it.

CDF receives significant support from the government geared towards terminating all production by 2005 as anticipated in the pact of 1994. This aid comes in two major forms. The first is social payments for the workforce, primarily benefits to the workers to pay for heating and lodging, and payments on debt that CDF was forced to take on from 1997 to 1999. The second is direct payments by the government to the CDF balance sheet. Recent government support to CDF is shown in Table 15.

Table 15

Subsidies by the State to Charbonnnages de France (CDF), 2000 to 2002 (millions of euros)

	2000	*2001*	*2002*
Capital Grants	548.8	487.8	487.8
Social Well-being of Workers	429.9	422	415
Interest on Loans	32	32	32
Total	**1 010.7**	**941.8**	**934.8**

Following a law of 3 February 2004, the government will create an agency on 1 January 2005 dedicated to guaranteeing the rights of the former and retired miners. These rights are principally financial ones and include state benefits for heating and housing. Representatives of the unions of the former miners will be members of the board of this agency.

OIL

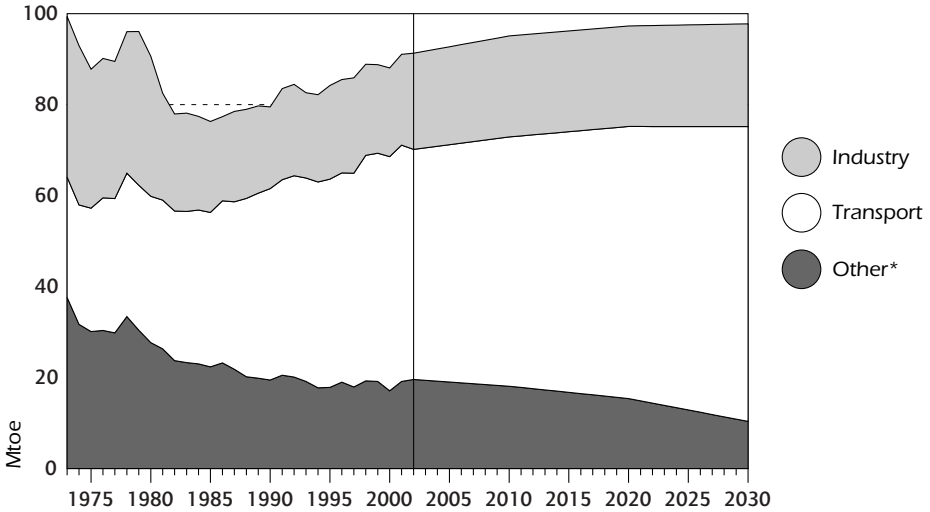
SUPPLY AND DEMAND

In 2001, oil and oil products accounted for 35% of French TPES. In the same year, oil and oil products accounted for 40% of TPES for IEA Europe and 41% of TPES for the IEA as a whole. Oil's percentage share of French TPES has been relatively stable since the early 1990s, but represents a major drop from the 1970s. In 1973, oil accounted for 70% of TPES. Its relative decline in use can be traced to the government's initiative to replace oil use with nuclear power following that period's oil shocks. France does not have substantial domestic oil production. In 2001, domestic production was just 1.8 Mtoe, or 1.9% of oil supply, 60% derived from the Paris region and 40% from the Aquitaine region. It is estimated that existing reserves would guarantee 15 years of production at current levels although government efforts are being made to stimulate production in this area which could extend economically viable domestic production. In 2002, Norway was the largest exporter to the French market, accounting for 20.3% of the total, followed by Saudi Arabia (13.2%), Russia (13.1%), the United Kingdom (11.4%) and Iraq 5.5%, with other (mostly non-OECD countries) making up the remainder (36.4%).

In 2001, transport accounted for 57% of oil TFC, followed by industry (17%) and residential (12%). Road transport uses 85% of oil final consumption in the transport sector. Transport continues to increase its share of oil TFC, rising from 55% in 1997 and, over the long term, from 31% in 1973. At the same time, the share of oil use for home heating and in industry has fallen in both

Figure 17

Final Consumption of Oil by Sector, 1973 to 2030



* includes commercial, residential, public service and agricultural sectors.
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2003; and country submission.

absolute terms and as a percentage of oil TFC. The most significant long-term drop in oil use, however, has been in power generation. In 1973, oil produced 40% of all French electricity whereas by 1990, it had fallen to 2.1% and in 2001, was 1.0%.

France has 13 refineries in metropolitan France plus several overseas, including a major facility in Martinique. Capacity and ownership of these refineries is shown in Table 16.

Table 16

Refining Capacity in Metropolitan France, 2002

Owner	*Facilities*	*Total Capacity (Mt/year)*	*2002 Total Throughput (Mt)*
Total	6	53.7	44.3
Exxon Mobil	3	16.4	15.1
Shell	2	13.3	10.5
BP	1	10.2	7.8
Reichstett	1	4.0	3.9
Total	**13**	**97.9**	**81.6**

Source: *Union française des industries pétrolières.*

The utilisation rates of the French refineries were 83.3% in 2002, below the average level owing to lack of economic growth and general overcapacity. There are significant discrepancies between French refining capabilities and French demand when considered on a product-by-product basis, as shown in Table 17.

Table 17

Refining Capacity vs. Demand by Product, 2002

Product	*Production Capacity, Mt*	*Domestic Demand, Mt*	*Capacity as % of Domestic Demand*
Gasoline	15.1	13.1	115%
Diesel Fuel	21.8	29.9	73%
Jet Fuel	5.1	5.8	88%
Heavy Fuel Oil	10	5	200%
Total	**52**	**53.8**	**97%**

Source: Ministry of Economy, Finance and Industry.

The discrepancy between the production capabilities of the French refining sector and the domestic demand can be traced to the 1970s and 1980s when considerable new refining capacity was installed. At that time, gasoline demand relative to diesel demand was considerably higher and refining investment decisions were based on industry forecasts of that period which showed such a demand profile continuing into the foreseeable future. In the 1980s, however, the country introduced a taxation scheme that favoured diesel fuel over gasoline and the fleet has become increasingly diesel-powered. In 2002, 63% of all new cars and 70% of all new vehicles (including trucks) were diesel-powered, bringing the total percentage of the fleet that is diesel-fired up to 48%. The resulting growth in diesel demand and relative drop in gasoline demand has created the mismatch between domestic refining capability. This mismatch may decrease in the coming years as France raises diesel taxes towards the level of gasoline taxes (see Chapter 3) and as the refining industry replaces existing plants and installs new capacity, albeit slowly. The present discrepancy between refining capacity and domestic consumption results in middle distillate imports and gasoline exports, mainly to the US market.

RETAIL MARKETS AND PRICES

The French retail market for motor fuels is highly competitive. This competition and the resulting decrease in retail price margins have forced the closure of numerous motor fuel outlets. In 1980, there were 41 500 such outlets in France, while in 2002, there were only 14 918 outlets. This rise in competition coincided with the expansion of the hypermarkets[27] into motor fuels retailing.

27. Hypermarkets are large retail stores selling a wide variety of products from food to electronics to clothes. They are generally located in suburban areas.

While oil companies lost nearly 30 000 retail outlets from 1980 to 2002, the number of hypermarkets selling motor fuels rose by 3 070, nearly tripling their numbers over that time. Since hypermarkets tend to have greater volume than other outlets, their increase in market share by volume of products sold has been even more pronounced. In 1980, they held about 10% of the market by volume, while in 2002, that figure had risen to 56%. While the oil companies' retail outlets did not at first attempt to compete on price with the hypermarkets, they have begun to do so in recent years in an attempt to stem their loss of market share. This strategy has produced some results in maintaining the oil companies' market share. In fact, the oil companies increased their market share against the hypermarkets from 43.4% in 2001 to 44.2% in 2002.

The government has been concerned about how the reduction in the number of service stations is affecting rural areas where a scarcity of motor fuel retailers could exist. This issue, coupled with concerns that some retailers are selling below cost, prompted the government to pass Law 96-588 on 1 July 1996. The law authorises the Experts Committee on Motor Fuels Distribution (*Comité professionel de la distribution des carburants,* CPDC) to work towards development of the retail network, improvement of its productivity and maintaining minimum service levels throughout the entire country.

Towards these ends, the CPDC can dispense three types of financial assistance to selected service stations: *i)* development aid to modernise facilities, *ii)* environmental aid to assist bringing stations up to standards, and *iii)* social aid in the case of the closure of a service station. The aid given by the CDPC in recent years is shown in Table 18.

Table 18

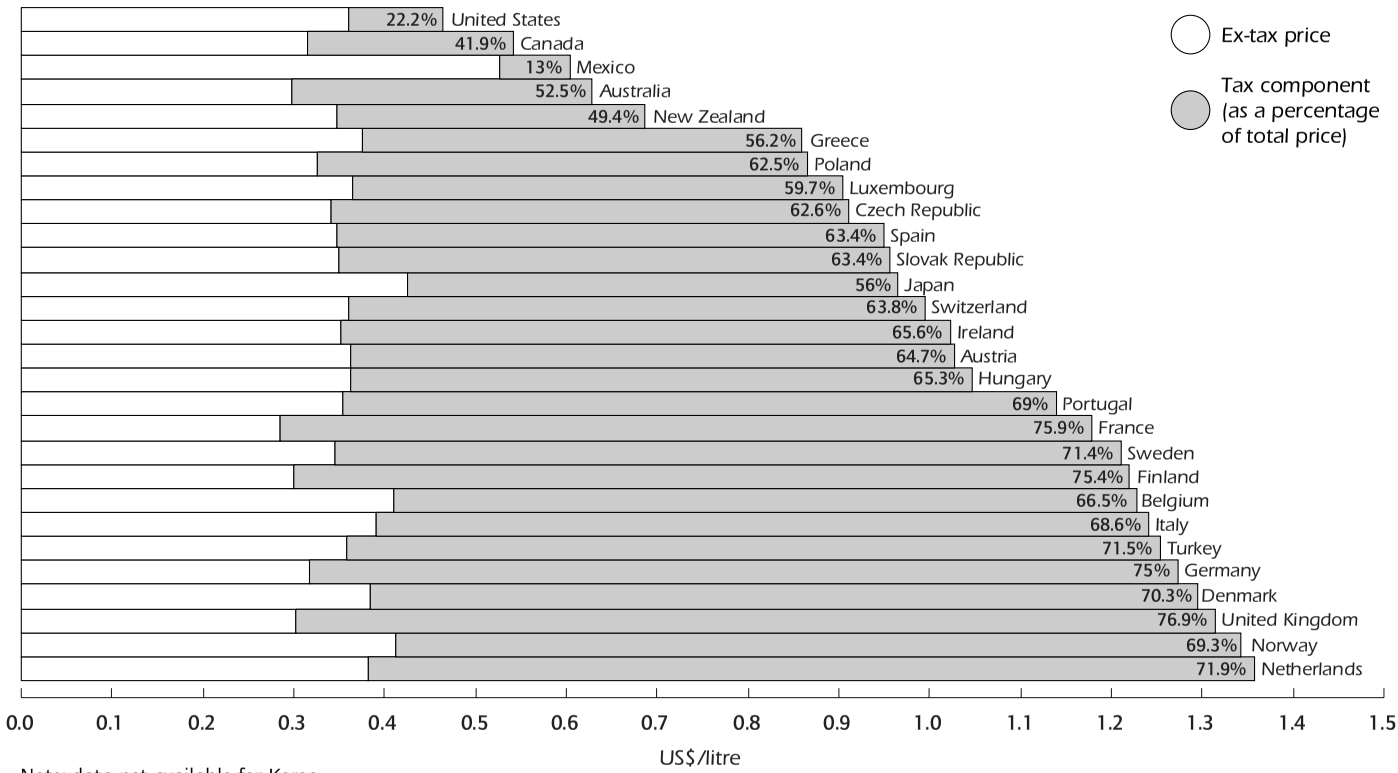
Aid Given by CPDC

	Stations Given Aid				*CDPC Contributions (M €)*			
	1999	*2000*	*2001*	*2002*	*1999*	*2000*	*2001*	*2002*
Environment Aid	363	405	405	427	3.57	3.37	4.13	4.02
in %	*38*	*36*	*43*	*38*	*36*	*31*	*39*	*34*
Development Aid	445	575	393	514	4.60	5.93	4.56	5.40
in %	*46*	*52*	*42*	*45*	*46*	*54*	*43*	*46*
Social Aid	150	135	140	192	1.75	1.68	1.83	2.31
in %	*16*	*12*	*15*	*17*	*18*	*15*	*18*	*20*
TOTAL	**958**	**1 115**	**938**	**1 133**	**9.92**	**10.98**	**10.52**	**11.73**

As a result of the high levels of competition in the French market, the country has some of the lowest pre-tax motor fuel prices in the OECD as shown in Figures 18 and 19.

Figure 18

OECD Unleaded Gasoline Prices and Taxes, Fourth Quarter 2003

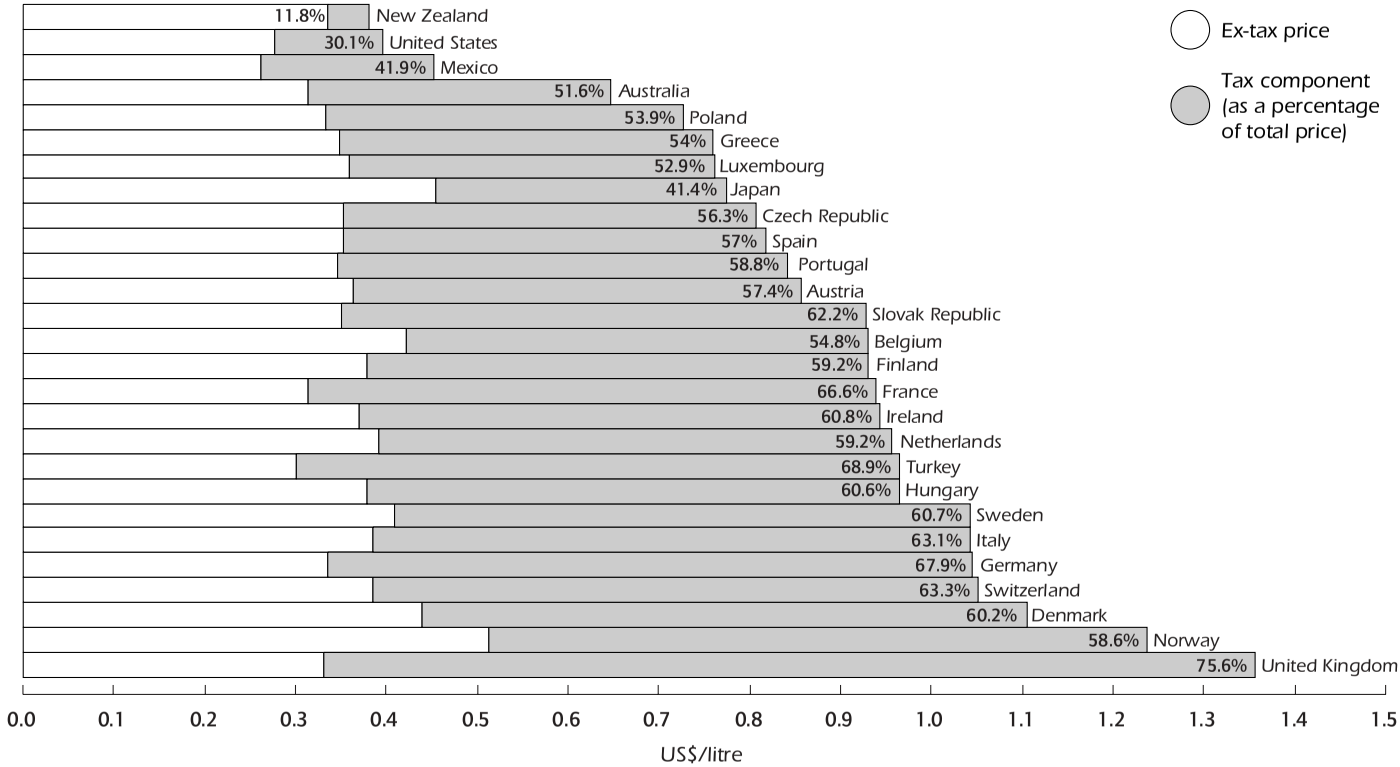


Note: data not available for Korea.

Source: *Energy Prices and Taxes,* IEA/OECD Paris, 2003.

Figure 19

OECD Automotive Diesel Prices and Taxes, Fourth Quarter 2003



Note: data not available for Canada and Korea.
Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2003.

EMERGENCY POLICIES AND PREPAREDNESS

As early as the 1920s, France developed an administrative and legal structure for oil issues to cope with the increasing use of oil in transportation and for national defence. The Directorate for Energy and Mineral Resources within the Ministry of Economy and Finance is the direct heir to the structure and is responsible for all issues of oil supply, including oil supply security. Legislative powers for oil supply security issues are under the Law 92-1443 of 31 December 1992.

France has oil stockholding obligations for both the IEA and the EU. These stockholding requirements are met in part through agency held stocks and in part by compulsory industry stocks. The law of 1992 introduced the present stockholding agency structure by creating, under the supervision of the ministry, the Experts Committee on Strategic Petroleum Stocks (CPSSP) which can either directly manage strategic stocks or manage them through contracts with other bodies.

The law of 1992 also defines the obligation to hold emergency stocks for all operators. Ministerial Decree 93-131 of 29 January 1993 (modified in 2003) requires that each operator must hold oil stocks equivalent to 27% of the previous year's consumption (based on a 12-month moving average). As a result, French oil stocks are regularly above the IEA's minimum requirement of 90 days of net imports of the previous calendar year.

In the continuing interest of improving the transparency, control and efficient management of strategic stocks in times of crisis, and as a means of assessing the emergency response system ten years after the liberalisation of the oil market, the Directorate for Energy and Mineral Resources requested a global review of the national strategic stockholding system on November 2003.

A task force comprised of senior ministry officials analysed the strengths and the weakness of the present system and gave an overall positive assessment at the national level in its conclusions which were made in March 2004. At the same time, even with this positive evaluation, the government has reported that it will continue its efforts to improve the transparency, management and efficiency of the strategic stockholding system.

France also has well developed demand restraint programmes and procedures as well as public campaigns. Moreover, under the law of 1992 and the law of October 1974 on energy conservation, France has sufficient legal authority to participate in an IEA co-ordinated oil emergency response, including the drawdown of stocks in both crisis and pre-crisis situations.

CRITIQUE

Natural gas now accounts for nearly 20% of French TFC and 14% of TPES and its importance will continue to grow. In addition to the traditional French gas markets

of the industrial, residential and commercial sectors, gas has the opportunity to expand dramatically if natural gas-fired power plants are built in France at the same high rates that they have been built in a number of other IEA countries.

The growing significance of natural gas makes the proper transition to a liberalised market especially important. The government is to be commended for the sound structure it has introduced. There is open access to the network, account unbundling, the creation of a separate operating entity for transmission in GDF Transport and an experienced, knowledgeable independent regulator in the CRE. (As stated in Chapter 3, the CRE only recommends tariffs to the government. Allowing it to set tariffs directly would strengthen its abilities.) These factors bode well for the success of the competitive market, as does France's geographic position which gives it access to gas from Europe, North Africa and Russia. In addition, its two major LNG receiving terminals give it access to the growing global LNG market. This diversity of supply should increase the potential benefits from the liberalisation in comparison to many IEA countries which have more limited supply options to compete with one another.

At the same time, certain conditions could impede the successful transition to competition and should be addressed. Primary among these are problems with non-discriminatory access to the grid network, including entry points in the north-east, storage facilities and the LNG facilities along the coasts. This problem is especially acute in the south and appears to be derived from both a physical constraint on the system and the insufficiency of the open-access regulatory framework to ensure non-discriminatory use of the system by new entrants. In order to best promote competition, the government should take steps to encourage infrastructure development to eliminate physical bottlenecks where they occur and where such investments are economically justified. The recent CRE announcement granting an attractive financial return (12% in real terms) on a new pipeline in south-west France is an important step towards improving the financial viability of these types of pipeline projects. Work on streamlining licensing and addressing local concerns over siting would also be helpful in this regard.

In addition, further separation in the form of legal unbundling of regulated and non-regulated activities as mandated by the EU Directive 2003/55/EC should be implemented as a means of eliminating any incentive for, or appearance of, the transport operators favouring the supply company with which they share a common owner. The appropriate level of unbundling should be discussed in light of the difficulties the regulator has encountered getting access to solid information on the GDF website.

Noting that GDF operates 13 of the 15 storage sites with 83% of the capacity, non-discriminatory open access to existing gas storage facilities should be continued to promote competition. Such access is currently granted in the form of modulation services offered by GDF on a negotiated case-by-case basis. The seasonal variation of demand in France makes it very difficult for

companies to match customers load profiles without access to storage capabilities at reasonable terms. While the variability of demand is less of an issue with the currently eligible larger customers who have a steady need for gas year-round, it will become increasingly important as smaller customers are given supplier choice, both for commercial customers in July 2004 and residential customers in July 2007. The country already has sufficient storage capability so while the government should not discourage the construction of more, it does not necessarily need to encourage it. The most efficient approach, therefore, would be to monitor the dominant position of existing storage owners (primarily GDF) to ensure they do not enjoy any undue advantages over new entrants.

French coal production had become increasingly non-competitive and the government is rightly terminating support for Charbonnages de France operations, a development which led to last tonne of French coal being mined in March 2004. The international coal market remains stable with numerous secure suppliers, so French coal users (*i.e.* power plants, industry and residences) will continue to have access to a steady supply of coal. The government is to be commended for the long-term planning and effective implementation they have displayed in stopping operating subsidy payments to a non-competitive industry.

The French oil and oil products market is characterised by two main features: *i)* a discrepancy between refining capacity and demand on a product-by-product basis, and *ii)* a highly competitive retail market which has led to low prices and the closure of many retail outlets. Regarding the mismatch in refining capacity versus demands for products, it is not the government's responsibility to manipulate demand through tax or other policy to meet industry's current refining capacity. The highly fluid market in Europe allows for trade to export excess product and import needed product. The government's plans to raise diesel tax, in effect narrowing the spread between diesel and gasoline taxes, should decrease the relative growth of the diesel fleet. At the same time, stability in policies that might influence demand is helpful both to the supply industry and drivers themselves in making investment decision. The government should send clear signals and stick with them as much as possible in this regard.

RECOMMENDATIONS

The government of France should:

- *Promote the development of cost-effective gas transport infrastructure to better accommodate competition in the gas sector through appropriate tariff structures.*

- *Maintain regulatory oversight of GDF's and Total's dominant gas storage position until sufficient alternative capacity becomes available.*
- *Implement the EU directive to expedite legal unbundling of a network transport operator with strong regulatory oversight to ensure equal access to the gas market for all market players.*
- *Send a clear signal on future excise tax differential for diesel and gasoline to allow industry and consumers to take appropriate investment decisions.*

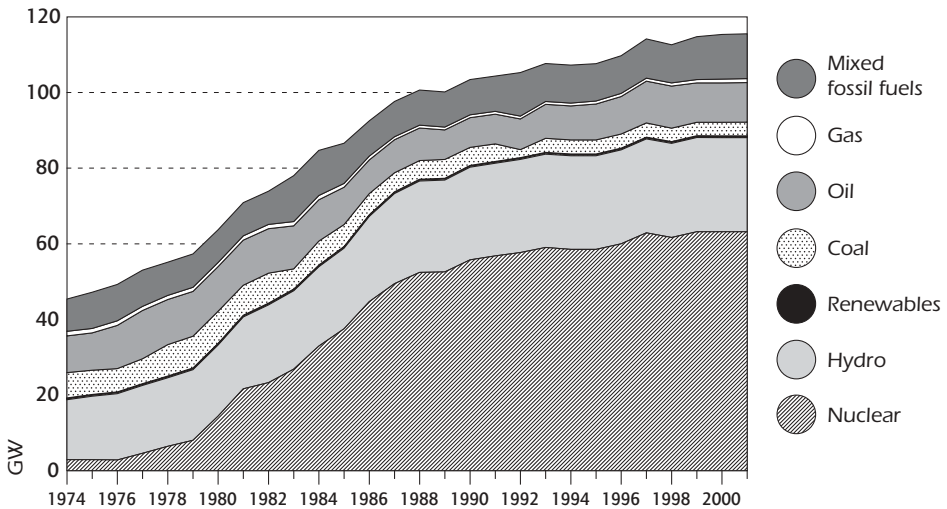
ELECTRICITY SUPPLY AND DEMAND

SUPPLY

French electricity capacity is dominated by nuclear power. Of the country's 115 GW installed capacity at year-end 2001, 55% was nuclear, followed by hydropower (22%), mixed fossil fuel plants (10%), oil (9%), coal (4%), natural gas (0.5%) and renewables (0.3%). There have been very few major capacity additions in France since the last nuclear power plant came on line in 1999. Figure 20 shows the trend in capacity for the last 30 years.

Figure 20

Electricity Generating Capacity, 1974 to 2001



Source: *Electricity Information*, IEA/OECD Paris, 2003.

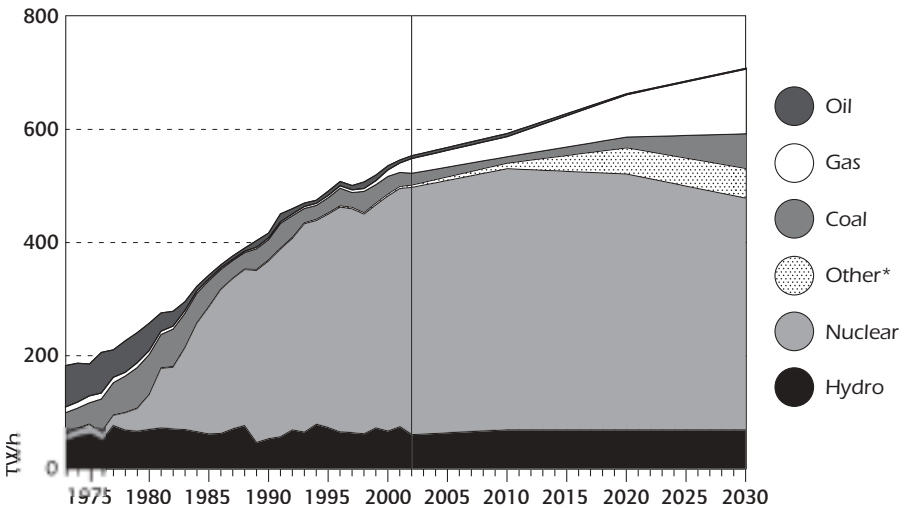
Nuclear plays an even more important role when considering French electricity generation. In 2001, nuclear accounted for 77% of total electric generation. This figure has been greater than 70% since 1986 and has ranged between 75% and 80% since 1993. France has the second-highest nuclear percentage contribution in the world[28]. The average for all OECD countries is 21%,

28. Lithuania has the highest.

and the country with the second-highest nuclear contribution is Belgium with 57%, followed by the Slovak Republic with 54%. The second-highest contributor to French electricity generation in 2001 was hydropower at 14% of the total, followed by coal (4.5%), natural gas (3.1%), oil (1.0%) and non-hydro renewables (0.7%). Nearly all of France's fossil fuel generation is based on simple steam turbines. It has some simple-cycle combustion turbines and some internal combustion capacity, but no major combined-cycle power plants.

Figure 21

Electricity Generation by Source, 1973 to 2030



* includes solar, wind, combustible renewables and wastes.

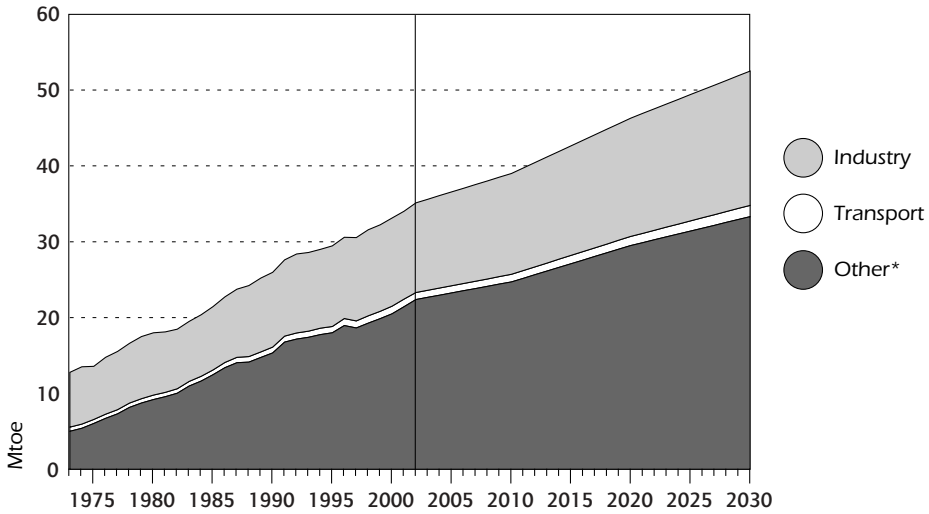
Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2003; and country submission.

DEMAND

French electricity demand has grown more quickly than overall energy consumption. From 1997 to 2001, electricity demand grew at an average annual rate of 2.2% compared to an average annual rate of 1.2% for TFC as a whole. Since 1973, electricity demand has grown at 3.6% annually compared to 0.9% annually for TFC as a whole. Electricity was encouraged by EDF from the late 1970s to the early 1990s as a means of creating demand from their numerous nuclear generating stations. Electricity use was also bolstered by low prices for large customers, which encouraged the development of electricity-intensive industries. Annual average electricity growth from 1973 to 2001 for all IEA countries was 2.6%.

Figure 22

Final Consumption of Electricity by Sector, 1973 to 2030



* includes commercial, residential, public service and agricultural sectors.

Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2003; and country submission.

EXPORTS AND IMPORTS

France is by far the largest electricity exporter in the OECD. In 2001, France exported nearly 73 TWh of electricity, equal to 18.4% of its domestic consumption. Electricity imports in the same year were 4.5 TWh for net exports of 68.4 TWh or 17.3% of electricity TFC. From 1990 to 2001, net exports have increased by over 30%. Figure 23 shows the long-term trend in French electricity trade and Table 19 shows the trading partners for 2001.

Table 19

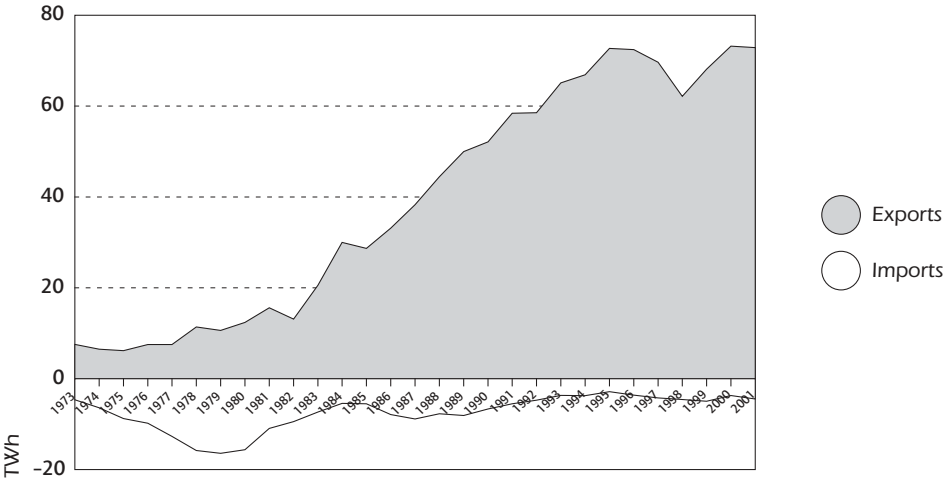
Electricity Trades and Trading Partners, 2001 (GWh)

	Exports	*Imports*	*Net Exports*
Belgium	11 651	204	11 447
Germany	14 924	542	14 382
Italy	18 030	459	17 571
Spain	6 768	1 242	5 526
Switzerland	9 839	1 816	8 023
United Kingdom	11 522	208	11 314
Others	127	–	127
Total	**72 861**	**4 471**	**68 390**

Source: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2003.

Figure 23

Electricity Trade, 1973 to 2001



Sources: *Energy Balances of OECD Countries*, IEA/OECD Paris, 2003; and country submission.

INDUSTRY STRUCTURE

GENERATION

The electricity sector in France is dominated by Electricité de France (EDF), the 100% state-owned vertically-integrated electricity company. EDF has generation, transmission and distribution operations around the world with total employment of 167 300, of which 110 000 work in France. It owns approximately 91% of the electric generating capacity in France, the high-voltage transmission system and most of the local distribution system. While EDF is currently an *établissement public industriel et commercial* (EPIC) under French law, the government has stated its intention to change EDF's status to a *société anonyme* (SA) in 2004. EPICs are state-owned companies serving the public with special rights and privileges under French law. An SA designation is used for any company – public or private – that does not have this designation. This change in statute would be a necessary first step to opening up a percentage of the capital of the company to private investment.

Other generators in France include:

- **Autoproducers:** French industrial sites often have their own co-generation facilities on site to serve their heat and electricity demands. Collectively, these plants constitute the second-largest electricity source in France.

- ***Compagnie nationale du Rhône* (CNR):** CNR is a joint stock company which has been given a government concession to develop and operate the Rhône River. It acts as an independent electricity generator with 19 hydroelectric plants. Electrabel holds nearly 48% of CNR with the remainder held by various public bodies.
- ***Société nationale d'électricité et de thermique* (SNET):** SNET was founded in 1995 from the electricity activities of Charbonnages de France (CDF, see Chapter 7). It has four main coal-fired power plants in France as well as generation assets in Poland and Germany. It is active in the liberalised market place, having acquired 70 eligible customers since market opening. As of 31 December 2003, SNET was owned by CDF (51%), Spanish utility ENDESA (30%) and EDF (19%). ENDESA will increase its share of SNET by purchasing a further 35% of the company from the other owners, pending approval by French privatisation authorities.

EDF regularly generates between 85% and 95% of the country's electricity. Variations depend on levels of hydroelectric generation and availability of nuclear power stations. In 2001, EDF plants in France generated about 16% of total generation in IEA Europe, while total EDF plants throughout Europe accounted for 19% of total generation. Table 20 shows the generation shares in France in 2002.

Table 20

Generation Shares of French Electricity Supply Companies, 2002

Company	*Market Share*	*Technology Type(s)*
EDF	91%	Nuclear, hydropower, coal, HFO, other technologies
Autoproducers	3.0%	Mostly gas co-generators
CNR	2.8%	Hydropower
SNET, Soprolif, Sodelif	1.2%	Coal
SHEM	0.3%	Hydropower
Small hydro producers	0.6%	Hydropower
Others	1.1%	Diverse technologies
Total	**100%**	

Source: Country submission.

TRANSMISSION

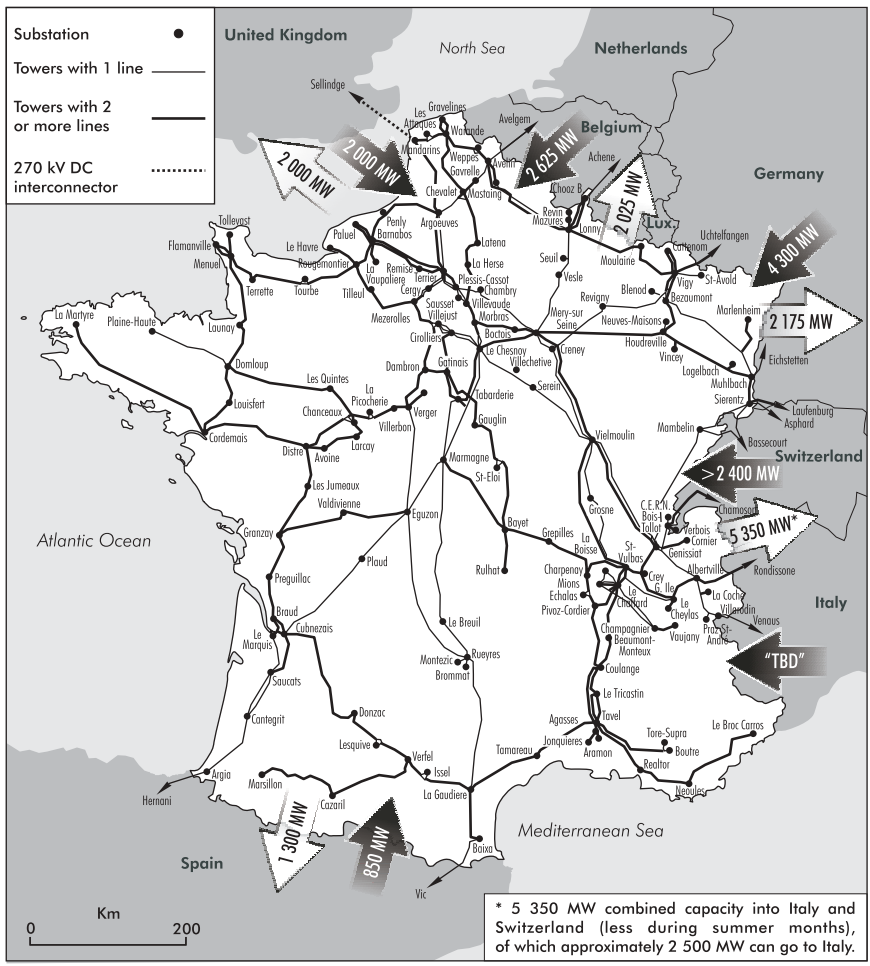
The Réseau de transport de l'électricité (RTE) manages and operates the high-voltage transmission lines owned by EDF. RTE was created in July 2000 by separating the transmission assets and operations of EDF. EDF remains 100% owner of the line but operations are completely separate. RTE's role is to ensure the continuity and quality of the national transmission service and to ensure that all eligible users have equal, non-discriminatory access to the

network. RTE runs a national control centre and seven regional centres which dispatch necessary plant to meet demand and ensure the technical viability of the system at all times. It has a staff of 8 100.

The network consists of 78 000 km of lines, 2 440 substations and 1 538 transformers. Figure 24 shows the high-voltage (400 kV) lines in France as well as the interconnection capacities with neighbouring countries.

Figure 24

High-voltage Transmission System with Interconnections(1)



(1) Interconnections refer to Net Transfer Capacity (NTC) as defined by the European Transmission System Operators (ETSO) and are an average of summer and winter capacities.

Note: TBD = to be discussed.

Source: Réseau de transport d'électricité.

RTE determines the use of international connections in different ways for each connected country as described briefly below:

- **France-England Interconnection[29] (IFA):** Export and import capacities are allocated via a system of auctions co-ordinated with the UK National Grid Company (NGC), the transmission system operator in England and Wales, according to the IFA Access Rules.
- **France-Italy Interconnection:** Export capacities are allocated in co-ordination with the Italian transmission system operator GRTN, with allocations in proportion to users' requests.
- **France-Belgium Interconnection:** Export capacities are allocated monthly, in co-ordination with the Belgian transmission system operator ELIA, according to a priority list system for monthly transactions.

For the interconnection with Germany, Belgium and Spain, the following rules apply. In order to declare an export from France, a user must hold export transactions characterised by a destination transmission system operator (TSO) and a maximum power level. The maximum power of export transactions is 25 MW. Every three months, RTE calculates a rate of use for export transactions. For the transactions of a user towards a given country A, RTE takes into account exports nominated by this user towards that country A, minus its imports from country A.

In order for the priority range to be carried over to the following period, the rate of use must be greater than or equal to 75%. RTE classifies export transactions by taking into account, first, the date and time at which it receives the request for new export transactions and then the rate of use of export transactions. RTE thus manages a list of priorities for export transactions on each border. RTE allocates capacities on D-1 for day D, depending on the list of priorities of transactions.

For imports from these countries, RTE accepts nominations for capacity use, which must be made before 14h00 on D-1. In rare cases where the sum of nominations exceeds available capacity, RTE accepts the programmes nominated by reducing them in proportion to requests.

DISTRIBUTION AND SUPPLY

Approximately 90% to 95% of local distribution lines are operated by EDF. They serve 31.3 million customer sites and have 1.2 million km of distribution networks. The EDF distribution business has approximately 51 000 employees. The remaining distribution lines are owned and operated either by local municipalities or agricultural or consumer co-operatives.

29. Interconnexion France-Angleterre (IFA).

Customer billing is handled in conjunction with Gaz de France (GDF). Customers receive one bill that covers both their electricity and natural gas consumption. EDF and GDF work jointly in maintaining and reading meters in customers' homes.

POWERNEXT WHOLESALE ELECTRICITY EXCHANGE

Powernext operates as France's electricity exchange. The company was incorporated in July 2001 with the launch of the first day-ahead product in November 2001. Its capital is divided up among some of Europe's major electricity and financial market participants, including RTE, Euronext Paris, BNP Paribas and EDF. Its main objectives are: *i)* to create an indisputable reference price in France, *ii)* to be a player in the "rationalisation" of European electricity markets by providing a spot market of European scope (block products, clearing of bilateral contracts, indices, opening up to other hubs) and *iii)* to be a major player in the construction of a unified financial power market in Europe and launch a range of hedging products for all power-related risk. Powernext currently offers hourly day-ahead contracts for electricity but plans to introduce electricity options, as well as products dealing with the weather, natural gas and CO_2. In June 2004, Powernext will launch futures. As of 15 March 2004, Powernext had 41 members, of which 38 actively trade on the system. Daily trading volume on Powernext has risen substantially and steadily since the market was launched. From around 300 000 MWh in November 2002, trade levels have risen to one million MWh in February 2004. If Powernext were to continue its monthly volume from February over a 12-month period, it would account for approximately 2.2% of the total generation in France and, since 37% of the market is open to competition (see below), it would account for approximately 5.9% of the eligible market.

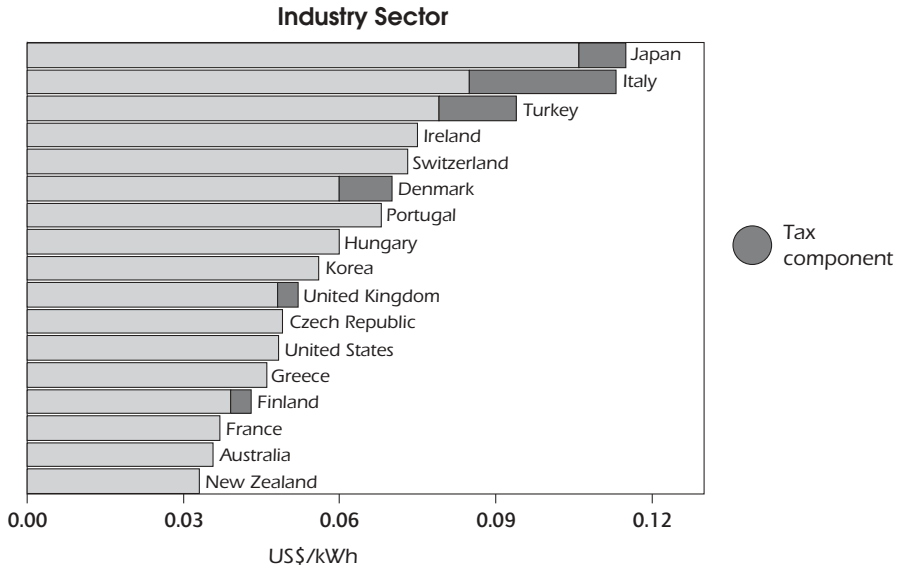
ELECTRICITY PRICES

Regulated electricity prices in France are lower than the IEA average electricity prices and those of neighbouring countries. In 2001, the average ex-tax price of regulated electricity for industry in France was US$ 35 per MWh. This is the fifth-lowest among IEA countries and 33% below the US$ 52.4 per MWh[30] average for IEA countries as a whole. For household customers, French prices tend to be closer to the IEA average. In 2002, French households paid an average ex-tax price of US$ 82 per MWh compared to the average for all IEA countries of US$ 86.5 per MWh.

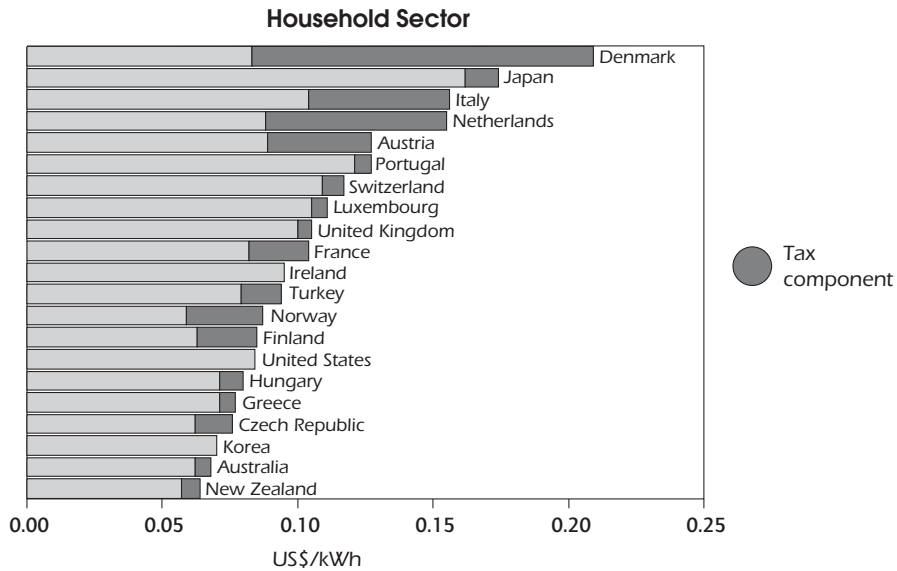
30. IEA data exclude Austria, Belgium, Luxembourg and Sweden.

Figure 25

Electricity Prices in IEA Countries, 2002



Note: Price excluding tax for Australia and the United States. Data not available for Austria, Belgium, Canada, Germany, Luxembourg, the Netherlands, Norway, Spain and Sweden.



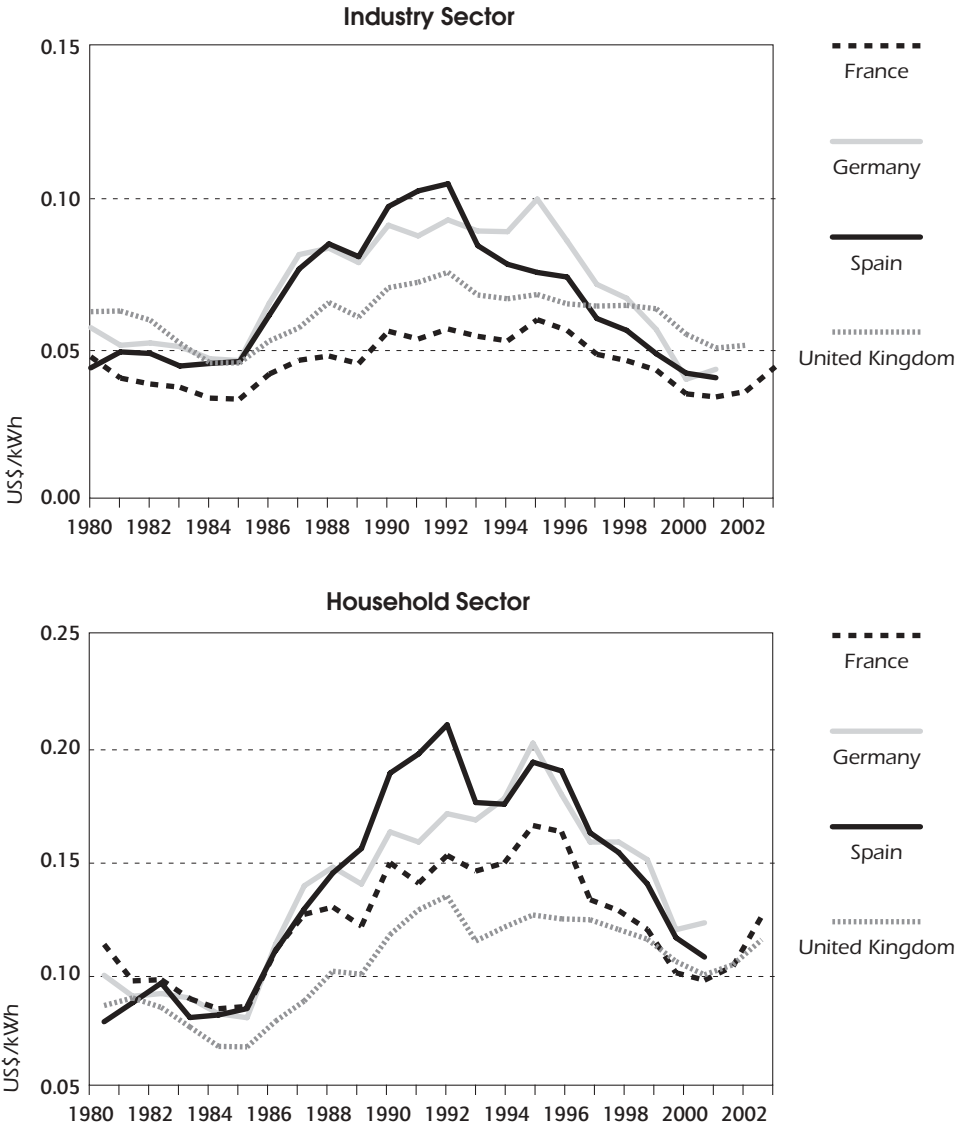
Note: Price excluding tax for the United States. Data not available for Belgium, Canada, Germany, Spain and Sweden.

Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2003.

French consumers have enjoyed relatively low electricity prices for some time, as shown in Figure 26.

Figure 26

Electricity Prices in France and in Other Selected IEA Countries, 1980 to 2003



Source: *Energy Prices and Taxes*, IEA/OECD Paris, 2003.

In addition to the low regulated prices for households and industry in France, the wholesale prices and prices offered to eligible customers in France are generally below those of other countries in continental Europe such as Germany, Spain and the Netherlands, although this can vary depending on the season or particular circumstances in the given markets. Wholesale prices offered to eligible customers have been rising steadily over the past year throughout Europe, including in France.

REFERENCE COST STUDY

In December 2003, DGEMP – DIDEME within the Ministry of Economy, Finance and Industry released a study on the costs of the generation of electricity from different generating technologies, *"Coûts de référence de la production électrique"*. The objective of this study is to clarify investment decisions for new means of electricity generation as they become necessary and also to inform national choices on the long-term generation decisions.

The study looked at a range of different generating technologies, including nuclear, gas-fired combined cycle, coal plants, and gas- and oil-fired simple cycle plants. Renewable energies will be addressed later in 2004. The report uses many assumptions in deriving its results, as well as extensive sensitivity analyses to ascertain the robustness of the results if the assumptions change. Several of the key assumptions are listed below.

- Interest rate: 8%.
- Exchange rate: US$ 1 per euro.
- Nuclear capital cost[31] in 2015: €1 663 (2001 euro) per kW.
- Combined-cycle capital costs in 2007: €559 (2001 euro) per kW.
- Combined-cycle capital costs in 2015: €569 (2001 euro) per kW.
- Natural gas price: €3.3 per MBtu.
- Coal (fluidised bed) capital cost in 2007: €1 437 (2001 euro) per kW.
- Coal (fluidised bed) capital cost in 2015: €1 276 (2001 euro) per kW.
- Coal cost: €30 per tonne.
- Brent oil cost: 2001 US$ 23 per bbl.
- Unlike an emission trading scheme, the analysis does not include explicit CO_2 costs in its baseline figures. However, it does add the cost effect of existing French taxes on fossil fuels in final generation costs.

31. This and all capital cost assumptions include equipment, construction, design, development and interest during construction.

The report considered a variety of different plant types at two different time frames: 2007 and 2015. The report did not consider nuclear plants for the 2007 time frame, judging it unlikely that such a plant would or could be built by that time. No operating costs are supplied for nuclear plants running less than 5 000 hours per year since the technology is not considered technically or economically appropriate for such operation. Total costs for the different plant types operating and three capacity factors for the two different time frames are shown in the tables below.

Table 21

Reference Cost Study Results for 2007 Plant Operation

Operating Hours	*Generation Costs (2001€/MWh)*			
	Gas-fired Combined Cycle	*Coal (Fluidised Bed)*	*Gas-fired Simple Cycle*	*Fuel Oil-fired Simple Cycle*
8 000	39.2	40.1	n/a	n/a
5 000	45	52.6	n/a	n/a
2 000	72.1	102.6	75.7	103.9

Table 22

Reference Cost Study Results for 2015 Plant Operation

Operating Hours	*Generation Costs (2001€/MWh)*				
	Nuclear	*Gas-fired Combined Cycle*	*Coal (Fluidised Bed)*	*Gas-fired Simple Cycle*	*Fuel Oil-fired Simple Cycle*
8 000	30.4	36.5	35.2	n/a	n/a
5 000	44.1	44.2	45.5	n/a	n/a
2 000	n/a	72.2	98.9	70.3	96.7

Source: *"Coûts de référence de la production électrique"*, Ministry of Economy, Finance and Industry, December 2003.

MARKET LIBERALISATION

France began liberalisation of its electricity market to competition through the "Act relating to the Modernisation and the Development of the Public Service of Electricity" (*Loi de modernisation et de développement du service public de l'électricité no. 2000-108*) of 10 February 2000, as required under the EU Electricity Directive[32]. Since it was adopted, more than 30 pieces of

32. Council and Parliament Directive 96/92/EC of 19 December 1996 *concerning common rules for the internal market in electricity*.

secondary legislation were issued as required under the law to determine the detailed functioning of the market, including the establishment of the Commission of Energy Regulation (CRE) and the creation of the RTE (transmission system operator). The government is working to maintain its idea of *service public*[33] within a liberalised context. A box describing this process is included below.

Market opening began by giving consumers with greater than 16 GWh annual consumption the right to choose their supplier (*i.e.* other than EDF). This threshold was lowered to 7 GWh on 15 February 2003. With the new threshold, approximately 3 100 customers were given the right to choose supplier, equal to approximately 37% of the market by volume. On 1 July 2004, all commercial and industrial customers will be extended the right of supplier choice and on 1 July 2007 all customers, regardless of size, will be free to choose their suppliers. The market openings in 2004 and 2007 conform to requirements included in the new EU directive[34].

A number of new companies have entered the market to compete with EDF for the eligible customers. According to the CRE, as of June 2003, there were 17 new entrants supplying eligible customers directly, 20 competing to supply the power required for compensating technical losses on the transmission system, and 40 that are active in the import and export markets.

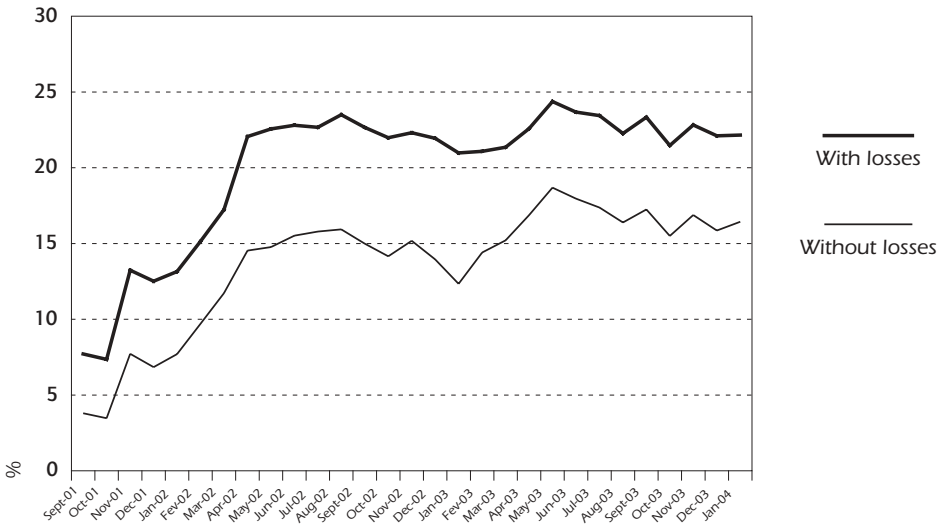
EDF has clearly lost market share among the eligible customer class. When considering simply the provision of electricity to final customers, new entrants have gained between 15% and 18% of the eligible market. When including the provision of balancing power, also open to competition, new entrants have gained between 20% and 25% of the market. These percentages have remained fairly constant since April 2002. Figure 27 shows the evolution of new entrants' market share from September 2001 to January 2004.

New entrants can source their electricity to supply customers in three different ways. First, they can have their own plants. The two companies with the most generating capacity in France are the *Compagnie nationale du Rhône* (CNR) and the *Société nationale d'électricité et de thermique* (SNET) (described above). Autoproducers primarily generate to meet their own needs or, assuming they have co-generation facilities, sell directly to EDF under the favourable tariffs established to support combined heat and power plants. Secondly, suppliers can import power from other countries to sell to French customers. This approach implies dealing with transmission interconnections and the markets

33. There is no defintive translation of *service public* into English. It can be roughly translated as "public service" but could be more accurately characterised as "services in the interest of the public good".
34. The relevant European Union Directive (2003/54/EC concerning common rules for the internal market in electricity and repealing Directive 96/92/EC) defines commercial customers as "non-household customers" or "any natural or legal persons purchasing electricity which is not for their own household use and shall include producers and wholesale customers."

Figure 27

Market Share Gained by New Entrants, September 2001 to January 2004



Note: These figures constitute an estimate because the volume of electricity consumed by all eligible customers in a given month is unknown. An approximation has been made by multiplying the total volume of the French consumption in the month being considered by the rate of market opening (by volume, currently 37%).

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

Public Service

The French electricity system, as well as many other parts of the French economy, works within the framework of public service ideals. Public service goals and objectives are stated in many of the government's position papers and in the laws themselves. In the electricity sector, public service was established in the law of 10 February 2000 and constitutes three primary manifestations. One is that electricity is made available to all citizens, even those with insufficient resources to pay for it at the standard rate. In this case, electricity is considered a "product of the first necessity" (*produit de première nécessité*) to which all citizens are entitled. The second is that all regions in France, even the overseas territories and isolated regions, are given access to the same level of electricity service at the same tariffs as found in continental metropolitan France. The third is that EDF is obliged to purchase electricity from certain generation types which normally would not be supported owing to high costs. These so-called obligatory purchases come primarily from

co-generation stations and certain types of renewable energy and are intended to aid the environment and increase the country's energy efficiency.

Prior to the introduction of liberalisation, the costs incurred to achieve those goals were lumped in with EDF's total costs and recovered directly from the customers as an implicit, though not stated, part of the tariff. With liberalisation, these costs are being made explicit since it would be unfair for EDF to bear them while competing suppliers would not. Towards this end, the costs of meeting the public service goals have been stripped from the EDF regulated tariff but still included as a separate add-on to all electricity bills. Eligible customers who have switched suppliers are subject to the same public service charges as customers who have remained with EDF.

The original method of separating out and recovering the public services costs was the Fund for Public Service for the Generation of Electricity (*fonds du service public de la production d'électricité*, FSPPE). This was changed to the Contribution to Electricity Public Service (*Contribution au service public de production d'électricité,* CSPE) on 1 January 2003. This fee was €3.3 per MWh in 2003 and is €4.50 per MWh in 2004. It is paid by final customers with the exception of autoproducers who are only subject to this fee for electricity generation above 240 GWh per year. In addition, there is a ceiling of €500 000 on annual CSPE payments by each customer site. CRE estimates that this ceiling – which was not taken into account when calculating the 2003 CSPE per unit cost – would have increased these payments from €3.3 per MWh to €3.85 per MWh. The costs and means of providing electricity to the impoverished have yet to be established and thus the recovery of these costs is not part of the current CSPE mechanism.

The final costs for meeting the 2003 public service obligations are still being calculated. However, initial indications show that total public service costs in 2003 were €1 461million, of which the cost for supplying service to the isolated and overseas regions was €398 million (*i.e.* €730 million in costs less €332 million in revenues) and the cost for obligatory purchases by EDF and local distribution companies was €1 052 million (*i.e.* €1 658 million paid for the purchases less €606 million in avoided costs) and €11 million (€27 million paid for the purchases less €16 million in avoided costs). Since the means of securing electricity for the impoverished have not yet been established, the costs for this aspect of public service have yet to be quantified. The €1 461 million of public service costs incurred in 2003 was 12% higher than the €1 306 million incurred in 2002.

The public service costs may continue to rise substantially. The cost for servicing overseas and isolated regions will rise in proportion to the demand for energy in those regions and the prices for providing that energy. Costs for EDF's obligatory purchases will probably rise much faster. France will need to spend considerable sums to meet its ambitious targets to increase renewable energy. Including energy services to the impoverished in the CSPE would also raise costs, although these will most likely be less than the other two aspects of the public service.

(continued)

The CRE estimates that by 2007, the total costs of meeting public service commitments would be between €2 000 million and €2 800 million. This would correspond to a per unit payment of between €4.7 per MWh and €7.2 per MWh, or the equivalent to an average of 5% of a residential customer's bill and 12% of an eligible industrial customer's bill (not taking into account the 240 GWh exemption or the €500 000 ceiling).

of other countries where prices are generally higher than in France (with the UK being the most frequent exception to this).

The third way companies can obtain electricity with which to compete for customers is through the Virtual Independent Power Plant (VIPP) system. Under this system, EDF offers the use of capacity from its own plants up for auction. The company bidding the highest price for a particular tranche of capacity is given the right to use the electricity generated from that capacity for a specified time. In addition to paying a fixed component for the right to use the capacity (in euros per MW/year), they pay an additional variable component when the electricity is actually used. In all, 6 000 MW have been auctioned off and this level is expected to stay in place through the end of 2005. This is approximately 5% of total French electricity capacity. There are three types of capacity being offered: *i)* baseload, which offers a variable component of €8 per MWh, *ii)* peaking plant, which offers a variable component between €23 and €26 per MWh, and *iii)* the re-sale of power purchase agreements (PPAs). The last type of VIPP auction (PPAs) entitles the user to the electricity that EDF is obliged to purchase from co-generators. They act as baseload products from November through March and in the summer the price for electricity is based on the price of natural gas.

As of March 2003, around 15% of non-EDF electricity came from generation in France, around 20% came from imported power and around 65% came from the VIPP tendering system.

CAPACITY ADDITIONS IN A LIBERALISED MARKET

In the developing liberalised market, all companies are free to build new power plants provided local siting permits are obtained. Electricity can be sold into the wholesale market, either through bilateral trades or the Powernext exchange, directly to eligible customers or exported. Nevertheless, the government influences the amount and type of potential additions to the French electricity capacity in three different ways.

The first is with feed-in tariffs and the tender offers through which EDF is obliged to purchase electricity from co-generation units and renewable energy

plants at prices above the wholesale market and above the cost at which electricity could be generated through other technology types. This system is discussed in the Chapter 6. The second means is through the Long-term Investment Programme for Electricity Production (*Programmation pluriannuelle des investissements de production électrique,* PPI). This programme, discussed fully in Chapter 3, projects the government's concept of a range of desirable capacity additions and gives the government the option of issuing a call for tenders if the amounts of each technology are not built. The government also influences the new build through its support of the new generation of European pressurised water reactor (EPR) nuclear plants which are discussed in detail in Chapter 9.

CRITIQUE

French electricity policy has traditionally been centralised and characterised by significant government control. This approach led to the creation of EDF, a 100% state-owned, horizontally and vertically-integrated utility. It also led to the creation of the substantial nuclear park that now dominates French electricity generation. In general, this approach has been successful to date. There is a high level of security together with substantially lower GHG emissions compared with other European countries. Electricity prices are below those found in most European countries and these low prices and abundance of generating capacity allow France to export substantial amounts of electricity to neighbouring countries. The country has been able to meet its public service obligations, an aspect of the policy that is taken very seriously and which infuses all electricity-related matters. However, the ongoing liberalisation and internationalisation of the sector will necessitate changes to the system.

The government is to be commended for the steps taken towards a liberalised electricity market. France has established sound legal and regulatory framework for a liberalised market. It has created an independent transmission operator that, while still owned by the vertically-integrated incumbent (EDF), has shown signs of true independence. All suppliers and eligible suppliers have been granted non-discriminatory access to the grid. There have been no significant complaints by new entrants that the system favours EDF. The Powernext electricity exchange is well-designed and operated and, although volumes are still modest, they grow at a steady, impressive rate. In addition, the regulator (CRE) has been established with adequate resources, experienced leadership and personnel, and significant independence from the government. The only area where CRE could and should have more independence is in the setting of tariffs. As stated in Chapter 3, the CRE only recommends tariffs to the government. Allowing it to set tariffs directly would stengthen its ability to conduct effective regulation.

These developments represent commendable advances towards a liberalised market. Further addressing some of the remaining issues will facilitate more successful competition in the French market. One important step will be transforming EDF from an *établissement public industriel et commercial* (EPIC) into a *societé anonyme* (SA). The government has correctly called for this transformation in 2004, and is encouraged to carry it out as scheduled to put EDF on a more equal footing with new entrant competitors. The transformation would also allow the company to be opened to private capital if the government decides to take that step at a later date. It would also allow EDF and GDF to compete in each other's markets (*i.e.* EDF selling gas and GDF selling electricity) which they are prevented from doing under their current statutes. Another structural issue that should be addressed is the relationship between EDF and gas utility GDF in regard to billing practices. Joint billing of gas and electricity represents a convenience to the customer that gives EDF a competitive advantage against competition. The government should consider ways to make billing practices consistent between EDF and other companies.

While the transparency of the system is quite good in regard to open access to the network, there are still problems with electricity generation. In a liberalised market, full knowledge of capacities and operation of all generators is needed to create an unbiased market. This is particularly the case regarding the planned and forced outages of power plants. During the heat wave of August 2003 and resulting tightening of supply-demand, EDF did not release the availability of its plants and how they were being affected by the weather in a systematic or standardised fashion that could be clearly understood by all players. This gives them an undue advantage in controlling the market and discourages other players to enter because of the difficulties in projecting supply and hence wholesale prices. As the market develops, the government should take steps to create a transparency for the generation operations for all players, including expected availabilities and planned outage schedules. Such developments would be the responsibility of the national regulatory body and should be considered at the European level within the scope of the achievement of a single European market.

The generating costs presented in the Reference Cost Study appear reasonable and take into account all of the factors related to electricity generation, although all assumptions in reports of this type are debatable, especially when projecting into the future. Notwithstanding the accuracy of the numerous individual assumptions and calculations in the cost study, such an analysis should not be used as a tool to justify government support of one technology over another. The structure of the French generation portfolio has been characterised by a large nuclear power park and significant over-capacity. Nuclear accounted for 77% of total generation in 2001. Since nuclear operates best (both technically and economically) in baseload, this means the country has not achieved the ideal generation mix with regard to economic efficiency in serving domestic demand. A greater proportion of

"cycling" plants which are designed to serve intermediate load (*e.g.* gas-fired combined cycle generators) would be more economically efficient. In addition, the overcapacity, while it does guarantee security of supply, further hampers the economic efficiency of the generating portfolio, resulting in additional costs to consumers. The heavy reliance on one technology type (*i.e.* nuclear) is not ideal for the most secure market. At the same time, given the growing trade of electricity between European countries, countries should increasingly assess the "adequacy" of the mix and size of their generating portfolio in a regional context. In general, the market can best determine the most efficient mix of generating types.

The feed-in tariffs to support renewable energy and co-generation are motivated primarily by environmental concerns and EU directives. The two other influences on the electricity generating mix – the PPI and the government's strong position in favour of EDF building a "demonstration" nuclear power plant – appear motivated by energy security concerns and an attempt to shape the energy supply mix. While the government should occupy itself with these two issues, the manner in which this is currently done could potentially undermine the workings of a liberalised market, thus reducing its effectiveness. Care should be taken to ensure that any such government policies does not result in market distortions which could decrease the economic efficiency of the system as a whole. The government is encouraged to look at less intrusive means of accomplishing the same ends. Such consideration should try to view the market in a regional rather than a French context whenever possible.

All future considerations of the "ideal" generating portfolio (both in terms of reserve margin and technology mix) must take into account the growing electricity trade in Europe, in particular the exports from France. The large increase in power exports from France has benefited EDF (and by extension the French economy) by supplying profitable revenue for assets (*i.e.* nuclear plants) that would have otherwise been idle owing to a lack of domestic demand. As domestic electricity consumption increases, the ability of France to export will become less if no new capacity is put in place. Additional nuclear plants could make sense financially if they could successfully target the export markets, especially those where new plants have been difficult to construct (*e.g.* Italy) or those with planned nuclear phase-out programmes (*e.g.* Germany). Nevertheless, the market rather than the government remains the best player to make informed investment decisions of this sort.

The government and the CRE are to be commended for making explicit the costs associated with public service in the electricity sector. Public service goals are not incompatible with a liberalised market, but explicitly defining them as France has done is essential. The government should continue to monitor how the costs associated with public service might affect competition. As the contribution to the public service of electricity (CSPE) rises, the percentage of each customer's bill that is open to competition (*i.e.* the

supply of electricity) will become smaller and thus, offers from companies that can provide a lower-cost electricity supply will appear less attractive on a percentage basis. While this situation warrants monitoring, the current level of CSPE payments is sufficiently small so as not to constitute a grave threat to customer switching. The government is encouraged to look at ways of limiting the growth of the CSPE payments or in some way preventing them from becoming an impediment to customer switching. In this light, the ceiling placed on CSPE payment by large industrial energy consumers poses a problem. If these customers pay less of the public service costs, the other smaller customers will pay more and, in general, it is the smaller rather than the larger customers that are more reluctant to switch suppliers.

One potentially problematic element of the public service activities is the geographic uniformity of tariffs, especially in the overseas *départements*. The previous in-depth review (2000) expressed concerns that such an approach could distort energy markets through substantial cross-subsidisation among captive consumers. It should be carefully examined whether the requirement of the geographic uniformity of tariffs is the best way to address the social policy objectives. In general, such policy objectives could be addressed more efficiently through direct support programme to the regions. Another problem of geographic uniformity of tariffs is that they could hamper the niche market for renewables. In overseas territories and isolated regions, certain types of renewables could be competitive if the electricity prices reflect real costs. However, if electricity prices are set below costs through geographic uniformity of tariffs, this could discourage the development of such a niche market. Consequently, the economy might need to bear a larger amount of costs to promote renewables.

Perhaps the greatest impediment to an effective market is the continued market power that EDF holds. Not only does the company consistently generate more than 90% of the country's electricity, much of its nuclear and other capacity has been largely depreciated, giving it access to inexpensive electricity in comparison with potential new entrants. In this way, EDF could undercut the prices offered by competitors, thus discouraging new entrants. While EDF has lost market share to new entrants, its percentage of eligible customers is still greater than 80% and has not declined appreciably for two years. At the same time, EDF market power would allow it to raise wholesale prices above competitive levels. A number of different means could be used to diminish market concentration. The first is to allow competitors access to EDF generation. This could be accomplished through a system such as the current VIPP (virtual independant power plant) programme which has been successful and could be effectively expanded. The second means of diminishing EDF market power is through the construction of new power plants by other companies. However, the current overcapacity in the French market would probably make such plants uncompetitive and thus significant new build is unlikely in the near and mid term. Alternatively, the government can simply

decree that the incumbent must reduce its market share to a certain amount for a certain amount of time, as Italy has done. A third way to diminish EDF market share is by expanding the relevant market from a French to a European level. EDF accounts for less than 20% of generation in Europe as a whole, although such a figure has little relevance today owing to difficulties and constraints with cross-border trade. Steps should be taken to expand interconnections with other countries. Impediments to such developments come largely from local and environmental opposition. While such voices must be respected, continued efforts are encouraged. Harmonising regulations and operations of electricity markets throughout Europe would further encourage electricity trade and, in this way, provide a means to effectively reduce EDF market share.

Demand response offers a promising means of mitigating the effects of peak demand periods. Giving consumers access to information on real-time prices and encouraging both technologies and contractual arrangements that allow customer load shifting when prices mount would be very effective in reducing the ability of supply-side actors in raising prices. France has already done substantial work through metering and available tariff schedules that could work in this regard. Such efforts would also raise the economic efficiency and environmental performance of the whole system by reducing the need for peak power which tends to be both expensive since it is so rarely used and heavily emitting.

RECOMMENDATIONS

The government of France should:

- *Monitor potential obstacles to the development of competition, including fair access to all networks and existence of market power; consider all options to remove such barriers.*
- *Ensure that government policies have minimal market distortions by using market forces as much as possible to determine the choice of power sources in line with traditional cost-benefit analysis and within the framework of policies for renewable energy, CHP, etc., thus boosting market confidence and opportunities for new entrants.*
- *Continue to integrate the idea of* service public *into the liberalised market, taking steps to avoid its becoming a barrier to entry.*
- *Facilitate further cost-effective investments in interconnections and thus continue to develop an EU-wide electricity market,* e.g. *by addressing local siting concerns wherever possible.*
- *Consider the use of existing and future demand-response mechanisms as a way to mitigate the effects of peak demand periods.*

OVERVIEW

GENERAL OVERVIEW

France currently has 58 commercial nuclear power units and is the second in the world after the United States which has 103 reactors. All the units are of the same generic design, the pressurised water reactor. France also has the fast reactor Phenix which was re-started in 2003 following renovation work. This reactor is used for transmutation studies as part of the waste management research and development (R&D) programme (based on the law of 30 December 1991). In 2003, nuclear electricity accounted for 77.6% of the total electricity generated in France (419.8 TWh of 540.7 TWh total). In 2002, nuclear power accounted for more than 78.0% of total electricity generation and, owing to high electricity exports, French nuclear plants alone generated an amount of electricity equal to 92% of the electricity the country required for domestic purposes. Table 23 details nuclear capacity in France.

Table 23

Nuclear Power Generating Capacity in France

Number of Units	*Type*	*Capacity per Unit (approx.)*	*Commissioned*
34	PWR	900 MWe	1977-1987
20	PWR	1 300 MWe	1984-1993
4	PWR (N4)	1 500 MWe	1996-2002
1	Metal cooled fast reactor	230 MWe	1973
59		**63 100 MWe**	

Source: NEA.

In constructing a large nuclear park to meet electricity policy objectives (*i.e.* security of supply, minimum environmental impact and minimum costs) France has developed a strong capability to design, construct and operate nuclear power plants and to conduct the nuclear fuel cycle activities necessary to support them. The current energy policy in regard to nuclear power, as described in the *Livre Blanc*, is to maintain this indigenous capability to pursue nuclear development as a favoured option up to and through the time when the existing plants must be replaced.

KEY NUCLEAR ORGANISATIONS

France's key nuclear organisations are:

- *Electricité de France* (EDF), the national electricity utility, is the majority[35] owner and operator of all the commercial nuclear power plants in France.
- *AREVA* is a world leader in nuclear energy. The company in its present form resulted from the consolidation of five main companies: COGEMA, Framatome ANP, Technicatome, AREVA T&D (transmission and distribution), and FCI (connectors).
  - Framatome ANP is the world leader in the design and construction of nuclear power plants, engineering, instrumentation and control, modernisation, maintenance and repair services, components manufacture and supply of nuclear fuel. 34% of the shares are owned by Siemens.
  - COGEMA provides nuclear fuel services from uranium mining, conversion and enrichment through spent fuel reprocessing and recycling as well as supply of mixed oxide fuel (MOX).
  - Technicatome offers engineering and related services in the fields of energy and propulsion as well as transport, environment and industry.
- The *Commissariat à l'énergie atomique* (CEA) is a key player in research, development and innovation in the fields of energy, defence, information technologies, communication and health. The CEA played a crucial role in developing the nuclear reactor design in France. It owns and operates the Phenix fast reactor.
- The *Agence nationale pour la gestion des déchets radioactifs* (ANDRA) is the national organisation for the disposal of all radioactive waste.
- The *Direction générale de la sûreté nucléaire et de la radioprotection* (DGSNR, also called *Autorité de sûreté nucléaire,* ASN) is the regulatory institution responsible for reactor safety and radiation protection.
- The *Institut de radioprotection et de sûreté nucléaire* (IRSN) provides technical support to the DGSNR.

INDUSTRY DEVELOPMENT

The public ownership of the French nuclear industry has been reorganised since the previous review. The structure was simplified by grouping all the commercial nuclear plant and component companies under one holding company, AREVA. This new company has activities in all sectors of the nuclear fuel cycle.

35. Certain foreign utilities such as Electrabel in Belgium own minority shares of some of the EDF nuclear power plants.

The European pressurised water reactor (EPR) has been developed by Framatome ANP with the aim to replace the retiring units starting between 2015 and 2020. EDF and the major German electrical utilities also participated in the development project. At the same time, the safety authorities of the two countries worked together to harmonise the regulations that would apply to the new PWR plants.

The EPR design is based on the French (N4) and the German (Konvoi) reactors, which are the latest models built in these countries. The aim has been to make full use of the operating experience of these earlier plants and to incorporate the latest developments.

In December 2003, the consortium of Framatome ANP and Siemens won a contract to construct an EPR unit in Finland. The nuclear island for the turnkey project will be supplied by Framatome ANP, the turbine island by Siemens. The 1.6 GW_e plant will require a €3 billion investment. Full construction is scheduled to start in early 2005 with the project beginning commercial operation in 2009.

One interesting market for French nuclear companies is China which has very ambitious plans to construct more nuclear power plants. In 2003, the government of China gave a preliminary approval for construction of four new PWR units. These units will be subject to an open bidding process with contracts being awarded in 2005.

FUTURE NUCLEAR PLANTS

The analysis and conclusions presented in the *Livre Blanc* are based on the assumptions that the lifetime of current units is 40 years although longer lifetimes are probably achievable, especially for more recent units. According to the 40-year lifetime assumption, the first units will be placed out of service in 2015 to 2020. The technology expected to be available at that time will be based on so-called Generation III+ concepts, such as EPR.

Between 1977 and 1990, around 50 GW_e of nuclear capacity was commissioned in France. The government policy is to avoid a similar period of concentrated plant construction when the current plants will be decommissioned. The aim is to spread the replacement over the 20 to 30 years to alleviate the financial burden. This approach would also allow a diversification of the types of production capacity installed.

The *Livre Blanc* describes four scenarios to replace the current nuclear fleet. The first three scenarios are based on the assumption that plant replacement would take place with proven technology (*e.g.* Generation III+ concepts). The first option is to start with an industrial demonstration unit of EPR to be commissioned in 2010 followed by more plants around 2020, depending on

needs. In the second option, construction of EPRs is delayed until 2015 to 2020. The third option is to use foreign technology in case AREVA would have lost its competence to construct new nuclear units. The fourth scenario is to use current fleet at least 55 years and replace the fleet between 2035 and 2055. At that time, the next generation of reactors, the so-called Generation IV, might be available. Today these technologies are still on the level of concepts. The *Livre Blanc* favours the first nuclear scenario, in which a "demonstration" EPR plant is built and commissioned in 2010[36].

France is an active participant in the Generation IV International Forum (GIF) initiative launched by the US Department of Energy (DOE). GIF groups together ten countries plus Euratom, all willing to foster collaborative R&D aimed at developing future-generation nuclear energy systems that offer advantages in the areas of sustainability, economics, safety and reliability, proliferation resistance and physical protection, to be developed commercially by 2030.

ECONOMIC PERFORMANCE OF NUCLEAR POWER

The government estimates[37] that for baseload operations, nuclear is the most economic option with discount rates of either 5% or 8%. These cost estimates show that nuclear is more economical when operated for more than between 5 500 and 6 000 hours annually. Since the mid-1990s, these cost estimates show increasing competitiveness of combined-cycle gas turbines in the French market in intermediate load. The government expects CCGTs will play an important role in the future.

The positive economic outlook for nuclear is even more true for existing nuclear plants. The electricity industry and in particular the nuclear industry have evolved as state-owned monopolies in France. This has allowed the establishment of the nuclear industry, including the whole supply chain for plant equipment as well as for the fuel cycle in a co-ordinated manner, and thus the exploitation of economies of scale to a large degree.

When the reactors approach the end of their depreciation period, this picture will even improve. EDF has prolonged this period and currently the capital costs are amortised over a period of 40 years. Plants of the same genus in other countries have sound prospects for extending operating lives to 50 years and possibly beyond. French plants, the average age of which is around 18 years, could have similar prospects. The DGSNR will ultimately decide the lifetime of the plants.

36. More recent government statements have placed the commercial operation of such a plant at a later date, in the neighbourhood of 2013.
37. "Coûts de référence de la production électrique", Décembre 2003; DGEMP–DIDEME, described in further detail in Chapter 8.

The high capital intensity of nuclear technology is complemented by low operating costs consisting mainly of plant operations and maintenance plus fuel. As a result, increasing generation from existing plants is economically very attractive. The specific options include enhancing plant capacity factor, extending plant life and/or increasing plant capacity. All three are pertinent in France.

The standardisation of the nuclear plants in almost identical series allowed capital costs and design complications to be minimised. It also allows experience on design and operation to be shared among all the plants. However, the consequent lack of technical diversity in the nuclear generation portfolio means that type faults (*e.g.* vessel head cracking) or systematic failures have the potential to threaten the security of electricity supply in France. This concern appears to be well recognised, however, and actions in mitigation have been taken in the following four areas:

- Considerable technical expertise and infrastructure have been retained to support all nuclear operations.
- Considerable capacity of alternative, mainly fossil, generation plant is retained but little used in the course of normal operations.
- Large import capacity in the event of plant outages.
- The regulator DGSNR is particularly vigilant to detect possible generic safety risks.

Nuclear power plants have experienced comparatively low capacity factors as a consequence of the rapid build-up of the vast nuclear programme in the 1980s. Currently, improvements in plant availability and plant capacity factor are being sought by EDF as a specific objective, moving towards best world standards in plant operation. Availability of the nuclear plants has increased during recent years from 79.3% in 1999 to 82.0% in 2002.

In the US, the reactor power of nuclear plants with similar designs has been uprated by approximately 5%. A similar operation to uprate existing French plants would correspond to an increase in production capacity of two to three new units. Modernisation of other parts, such as turbine or heavy electrical components, could improve the production capacity by an additional several tens of megawatts per unit. If similar uprates and modernisations are realised in the older units, overall capacity for these plants would increase by one extra unit.

THE NUCLEAR FUEL CYCLE

Services to support nuclear power plant operations are currently mainly indigenous in France. The exception is the supply of the primary fuel, uranium ore, which is not sufficiently or economically available in France; it is procured

on world markets where supplies are well diversified and controlled by French interests. The uranium market is depressed at present and has been so for more than ten years.

France had previously chosen a nuclear programme which included fast breeder reactors. This involved reprocessing of irradiated fuel. The fast breeder part of this programme was abandoned, but reprocessing continues for both French and foreign nuclear power plants.

In the absence of a programme of fast breeder reactors which are fuelled by the separated plutonium from pressurised water reactors, a decision has been taken to recycle the separated plutonium in existing plants as mixed oxide fuel (MOX). Currently 20 reactors are loaded with up to one-third of this fuel. The outcome of this action is that stocks of separated civil plutonium will be maintained at a lower level than would otherwise be the case.

COGEMA and URENCO have signed a contract for working together in the field of centrifuge technology for uranium enrichment. COGEMA has decided to use this technology to replace in the future the current gas diffusion enrichment plant. A 50-50 joint venture is envisaged that would cover the design and construction of centrifuge equipment and installations to produce enriched uranium. The two companies will continue competing in the production and marketing of enriched uranium. This co-operation will become effective as soon as corresponding international agreements between the URENCO countries (Germany, the Netherlands and the United Kingdom) and France enter into force.

WASTE DISPOSAL AND NUCLEAR SAFETY

RADIOACTIVE WASTE DISPOSAL

France currently operates a repository at the *Centre de l'Aube* for the disposal of short-lived low-level and intermediate-level waste.

Very low-level waste is currently stored on production sites. Efforts are being made to rationalise its management. The final solutions for this waste are dedicated repositories and recycling of certain types of materials. A dedicated repository is starting to be operated near the *Centre de l'Aube*.

Disposal options for high-level and long-lived intermediate-level waste, currently stored in La Hague after a short cooling period on the plant sites, are sought along the lines specified by the law passed on 30 December 1991. Three different research directions are implemented, namely solutions to separate and transmute long-life radionuclides, retrievable and non-retrievable disposal in deep geological formations, and conditioning and long-term surface storage.

On 7 August 2000, the government authorised ANDRA to construct at the Bure site an underground laboratory to study deep geological formations, where high-level waste and long-lived waste could be disposed of. The government planned to select another site for a second underground laboratory, but this process has been temporarily postponed owing to strong local opposition.

Concerning the research on separation and transmutation, the Phenix fast reactor is used to conduct irradiation experiments and test new matrices for plutonium burning and actinide transmutation.

In 2000, the government approved a plan of the CEA to initiate basic design studies on surface and sub-surface long-term storage facilities.

The Parliament intends to take a decision on disposal of currently stored categories of waste in 2006, as stated in the framework law mentioned above.

The report of the government to Parliament will be based on multi-criteria analysis (economical, technical, societal) identifying also the research topics still to be performed. The government will also prepare a national waste management plan. As a next step, a new framework law is expected to be prepared to define how the high-level and long-life wastes will be managed as well as the organisational aspects. Public relations, such as dialogue with stakeholders, information for the general public and local economical development projects, will be continued.

NUCLEAR SAFETY AND REGULATION

The aim of the nuclear safety reform started in December 1998 is to simplify the safety regulation structures, to reinforce the relationship between nuclear safety and radiation protection and to clearly separate the roles of operator and regulator. The new regulatory organisation (DGSNR or ASN) was founded in February 2002 by merging the former nuclear safety organisation (DSIN) and the radiation protection authority (part of the *Office de protection contre les rayonnements ionisants,* OPRI).

As part of the reform, the principal technical support organisation of the regulator was separated from CEA and an autonomous public organisation IRSN (*Institut de radioprotection et de sûreté nucléaire*) was created.

In the near future, the government also plans to present a new law to Parliament to define principles of transparency and specific measures in the availability of the information for stakeholders and for the general public.

The exceptional heat wave of summer 2003 together with low precipitation increased the water temperatures and decreased the flow rates in rivers. As a result, several thermal power plants, both fossil-fired and nuclear, were forced to limit their production. In order to assure the security of supply, the

government authorised certain plants to exceed temporarily the temperature limit defined in their environmental permit. Although the temperatures inside some containment buildings also rose to near the authorised limit, none of the units was forced to limit production or to shut down as a result.

CRITIQUE

The proportion of nuclear in power generation is very high (about 80%). Diversity in terms of primary fuel for electricity production and technology is weak, but this is well recognised. France has taken steps to reduce this strong dependence on nuclear power and on the limited number of nuclear plant designs and technology currently in use. Opportunities also exist to increase generation from the current 58 commercial nuclear units by improving plant availability and production capacity via modernisations.

Plant lifetime assumptions appear modest. The economical and emissions saving opportunities due to life extension are considerable for France. Work must be done to establish credible estimates of working lifetimes for all plant types and determine which steps would economically extend the lifetimes.

Government policy to keep the nuclear option open up to and through the time when currently operating plants have to be replaced appears sound for France. One efficient way to maintain engineering and project skills is through French industrial participation in either domestic or foreign construction projects. AREVA's project in Finland is an excellent opportunity and the company is actively pursuing projects in other countries.

The construction of a "demonstration" project in France to be commissioned in 2010 is not the only means of keeping the nuclear option open. This nuclear capability can be maintained in a number of ways. For example, the leading French nuclear company, AREVA, has recently sold a 1.6 GW, €3 billion plant with European pressurised water reactor (EPR) technology in Finland to come on line in 2009. In addition, according to IEA data, the French government has spent an average of €445 million per year from 1992 to 2001 on research and development (R&D) in nuclear fission technology. The government has recently proposed a "demonstration unit" for the European pressurised water reactor technology to be completed around 2012. Maintaining the nuclear option by sustaining the country's technological resources is sound policy. Regarding the "demonstration unit", the government should ensure that any such plant would be built under market conditions whereby companies invest in the plant solely as a profitable venture in a liberalised market.

The importance of safety remains paramount. The high nuclear safety standards under the DGSNR control are commendable. The draft law on the transparency and accountability of regulatory activities would improve the picture *vis-à-vis* the general public.

Predictability of the regulatory framework is an important aspect of maintaining the competitiveness of nuclear power plants in open market conditions. In some countries, as part of a more general effort to improve the efficiency of the regulation, the nuclear regulator has started to improve the transparency of the licensing procedures *vis-à-vis* operators, for example by offering estimates of the time needed to assess the application documents and to issue the licence. In this light, DGRSN's recent actions to clarify and simplify some of the processes, such as the licensing process for test facility design changes or decommissioning of nuclear power units, are commendable.

The radioactive waste management policy covers all waste categories. Operational disposal facilities currently exist for radioactive waste other than high-level and long-life intermediate-level wastes. The government has recognised the strategic importance of the remaining waste management issues and Parliament is expected to take a decision on high-level waste disposal in 2006. This would be a welcome step and the Parliament is encouraged to honour that schedule.

Participation in the development of a new generation of nuclear energy systems is well in line with the government's policy to keep the nuclear energy option open in the future.

RECOMMENDATIONS

The government of France should:

- *Favour maintaining nuclear power as an option by authorising the building of a demonstration unit in an open market situation.*
- *Explore all possibilities of lifetime extension, power uprates and improved availability to increase the production capacity taking into account the climate policy and safety standards.*
- *Continue developing high-level radioactive waste management solutions, respecting the time schedule defined in 1991 and ensure that the entire waste management and decommissioning system is fully funded by the waste producers.*
- *Continue efforts in international co-operation in developing new nuclear power systems as part of diversification of energy sources and long-term actions to limit GHG emissions.*

ENERGY RESEARCH AND DEVELOPMENT

GENERAL POLICY STRUCTURE

The three primary bodies responsible for allocating the public budget for research and development (R&D) in the energy field are the Ministry in charge of industry, the Ministry in charge of environment and the Ministry of Research (*Ministère délégué à la recherche*). The Agency for the Environment and Energy Efficiency (*Agence de l'environnement et de la maîtrise de l'énergie*, ADEME) is an agency to which the government delegates funds on the civilian budget for R&D.

Energy efficiency and energy diversification are the central foci for the Department of Energy, Transport, Environment and Natural Resources in the Ministry of Research. In order to meet energy demand while respecting the environment, it is necessary to make advances in production technologies, in the rational use of energy and in optimising storage and transport technologies. Security of supply requires maintaining a diversity of supply from fossil fuels, nuclear power and renewable energies. Respect for the environment includes reduction of GHG and pollutants in general.

The future of nuclear energy and nuclear waste is a major preoccupation of the government. Public research in this field is sponsored by the government and the companies producing nuclear waste. This requires a concerted research effort to develop solutions to the question of radioactive waste.

ADEME's mission to steer and co-ordinate technological research is structured around three major issues, namely climate change, health and quality-of-life concerns, and waste management. Of these, only the first has a major impact on the energy sector. Among other areas, ADEME supports research in transport technology, renewable energy production technologies (*e.g.* biomass, biogas/methanisation, solar heating and geothermal energy), efficient energy use, fuel cells and the capture and sequestration of CO_2.

CEA is a key player in research, development and innovation in the field of energy, defence, information technologies and health. CEA has a budget of €2.7 billion euros (all provided by the French government), of which approximately €1.1 billion is devoted to defence and the remainder to civilian research. Of the €1.6 billion devoted to research, approximately one billion euros is spent in the nuclear field with the rest going to information technologies, health and theoretical physics. CEA has over 15 000 employees and nine research centres. In the energy field, CEA pursues technologies that are competitive, secure and clean, especially those that do not emit greenhouse gases (GHG). While nuclear fission energy constitutes the bulk of its focus, CEA also supports research into hydrogen, photovoltaics, biomass and nuclear fusion

energy. In support of industry, CEA seeks to optimise the current nuclear park as well as looking for solutions for the treatment of nuclear waste.

While the Directorate-General for Energy and Raw Materials (*Direction générale de l'énergie et des matières premières*, DGEMP) within the Ministry of Economy, Finance and Industry does not provide a substantial impact to the planning or the implementation of the energy R&D activities, it does have an impact in this area through its supervision of IFP (see below) and its co-supervision of CEA, ADEME and the *Bureau de recherches géologiques et minières* (BRGM).

Two other prominent energy R&D organisations are the French Petroleum Institute (*Institut français du pétrole*, IFP) and *Electricité de France* (EDF). IFP is an independent research and industrial development, education and training, and information centre specialised in the fields of oil, natural gas and the automobile. IFP's mission is to innovate and develop the knowledge and technologies that will enable the oil, gas and automobile industries to achieve sustainable development. In 2003, IFP had 1 860 employees and a budget of €296 million of which about 70% is provided by the French State with the remainder coming from the oil and automobile industries. Approximately 75% of the IFP budget is devoted to R&D. IFP's research activity is carried out in four different business units: Exploration-Reservoir Engineering, Drilling-Production, Refining-Petrochemicals and Engines-Energy. IFP maintains close ties with industry, including nearly 30 oil and gas companies, 40 oil services and supply companies, 10 car makers and 10 auto-parts manufacturers.

EDF is a 100% state-owned vertically and horizontally-integrated electricity company (see Chapter 8 for more information). EDF devotes €424 million to R&D activities and has 2 400 employees working in the field. EDF R&D has three main objectives: *i)* developing products that will appeal to its customers, *ii)* building smart energy networks, and *iii)* designing and improving more reliable, competitive, environment-friendly energy production technologies. GDF, the incumbent state-owned gas utility (see Chapter 7 for more information), has R&D activities in the gas sector with approximately 650 working in this field.

COMPARATIVE INTERNATIONAL SPENDING LEVELS

In 2001, the French government spent €441 million[38] on energy-related research and development, equivalent to approximately 0.3% of the country's

38. The €441 million cited here comes from French government submissions to the IEA. However, it is considerably less than the approximately one billion euros that CEA spends every year on energy (mostly nuclear) research. This type of discrepancy underlines the difficulties the review team had in finding consistent, reliable data on spending, an issue elaborated on in the Critique. This may be a problem with categorisation of R&D expenses. For example, in the past, France has not directly counted as R&D selected taxes which went directly to a research institute to be spent on nuclear decommissioning.

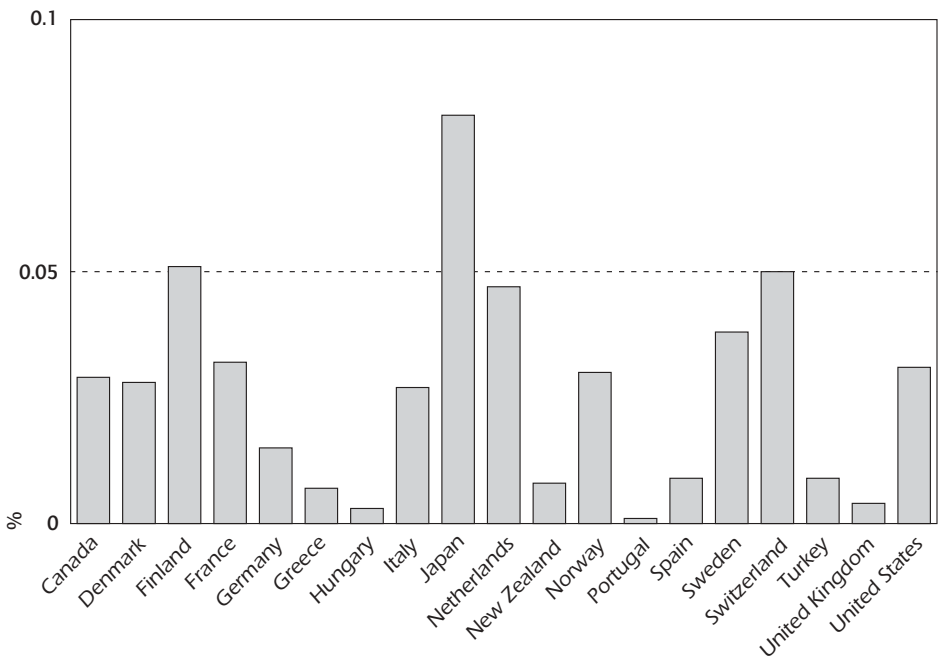
GDP. This spending has declined in recent years from €617 million in 1999 to €587 million in 2000. The average annual spending level over the 17 years from 1985 to 2001 for which reliable records exist was €506 million. The 2001 R&D spending as a percentage of GDP (0.03%) is the lowest it has been over the same 17 years during which the average was 0.042%. R&D spending in 2001 was the second-lowest figure in absolute terms behind the €424 million spent in 1994.

Compared with other IEA countries, France spends more on a per-GDP basis than most of its peers, even after the decrease in funding seen in recent years. In 2001, the average government-sponsored R&D spending as a percentage of GDP for all the IEA countries shown in Figure 28 was 0.024% compared to France's 0.030%.

As of May 2004, France was a member of 16 out of the 41 IEA Implementing Agreements.

Figure 28

R&D Budget as a Percentage of GDP in IEA Countries, 2001



Note: data not available for Australia, Austria, Belgium, the Czech Republic, Ireland, Korea and Luxembourg.

Source: Country submissions.

SPENDING BY CATEGORY

Over 83% of French R&D spending goes to the nuclear field. This figure is actually lower than the average over the previous sixteen years when nearly 89% of R&D funding on average was devoted to nuclear technology. The two fields seeing the biggest gains in spending in recent years are conservation and renewable energy. Conservation spending rose by 177% from a recent low of €4.25 million in 1997. Funding for renewable energy rose by 37% from 2000 to 2001 and has grown by over 500% from the recent low of €2.8 million in 1997. Nevertheless, the combined spending in these two fields in 2001 still accounted for less than 7% of the total. Table 24 below shows the breakdown of spending by category for 2001 and Figure 29 shows the historical spending trends by category.

Table 24

Government Spending on Energy R&D, 2001 (1)

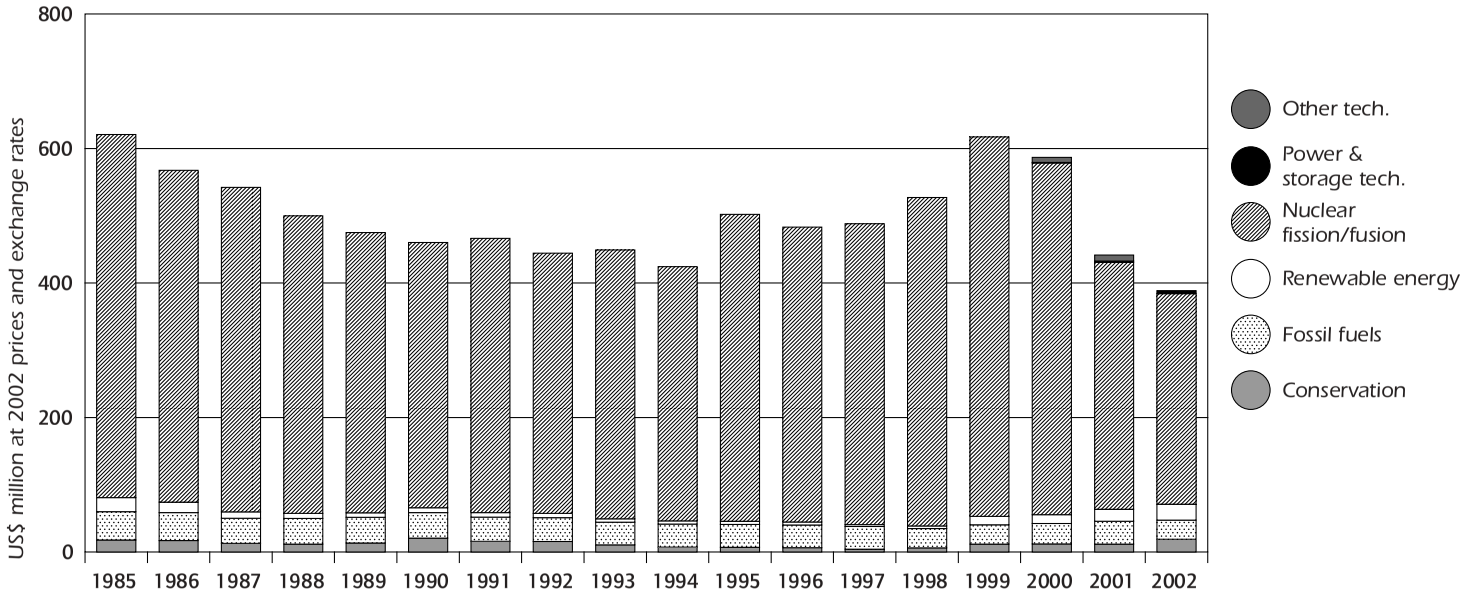
Research Areas	*Amount (€ million)*	*% of Total*
Total Conservation	**11.8**	**2.7%**
Industry	2.1	
Residential	1.5	
Transport	4.4	
Other	3.8	
Total Fossil Fuels	**33.8**	**7.7%**
Coal	33.8	
Total Renewables	**18**	**4.1%**
Biomass	2.4	
Geothermal	3.8	
Wind	2.5	
Solar	9.2	
Hydro	0.1	
Total Nuclear Power	**367**	**83.1%**
Light-water Reactor (LWR)	44	
Fuel Cycle	171	
Nuclear Supporting Technology	120	
Nuclear Fusion	32	
Total Power & Storage Technology	**2**	**0.5%**
Total Other Energy	**9**	**2.0%**
TOTAL ENERGY R&D	**441.6**	

(1) These figures should be considered preliminary and partial until the government finalises its work recategorising its R&D expenditures.

Source: IEA.

Figure 29

Energy R&D Budget by Field, 1985 to 2002



Source: Country submission.

ENERGY EFFICIENCY

ADEME is responsible for co-ordinating and implementing research activity in the energy efficiency area, including switching between fossil fuels for environmental or productivity gains. In 2002, ADEME's R&D budget in this area was €25 million, compared to €20 million in 1999.

The Scientific Centre for Building Technology (*Centre scientifique et technique du bâtiment*, CSTB) participates in energy efficiency research for buildings, as does the National Centre for Scientific Research (*Centre national de la recherche scientifique*, CNRS), particularly through their multi-disciplinary programme, ECODEV, led jointly with ADEME and related industrial concerns. Created in 1997, ECODEV was a university-oriented programme with three major energy-related themes: *i)* energy systems and sustainable development (fossil fuel energy cycles and impacts on the environment), *ii)* industrial technologies for sustainable development (clean energy processes), and *iii)* lifestyles for sustainable development (transport, lodging, residences and energy networks). The ECODEV programme has now been completed. In 2002, CNRS created the *Programme Energie*.

TRANSPORT AND FOSSIL FUEL

With the co-ordination of the Ministries of Research, Industry, Environment and Transport, and ADEME's support, the Predit 3 programme was launched, to be run from 2002 to 2006. This programme constitutes an effort on the transport of goods as well as on energy and environmental questions, GHGs and research on energy security. Funding is provided by the Ministry of Research and the Ministry of Equipment and Transport as well as by ADEME. It has been granted €300 million over its lifetime with activities organised in eleven groups. Two of these groups are particularly concerned with the energy and environmental performance of vehicles: Group Seven on "environmental and energy impacts" and Group Eight on "clean and efficient vehicles". Group Seven is predominantly focused on GHG emissions and dependence on oil and oil products. Among the issues addressed are determinants of emissions and impacts of different technologies "from well-head to exhaust pipe". Group Eight focuses on reducing consumption from motors (fuelled by both oil products and biofuels) and on electric and hybrid vehicles.

The government has also established a research network for fuel cells in order to encourage technical advances in this area in partnership with industry. This network has approved 51 projects, supplying €25.8 million of aid towards the total projects' costs of €74.9 million.

IFP plays a central role in research into fossil fuel technologies. This concerns primarily the oil sector in the fields of exploration and production (simulators,

transmission of seismic data), refining, engines (filtration and motor fuels). IFP also conducts some research on the treatment and liquefaction of natural gas, biomass (primarily biofuels and gasification) and on CO_2 capture and sequestration.

RENEWABLE ENERGY

ADEME is the main agency in charge of the implementation and allocation of financing for renewable energy R&D. It establishes multi-year contracts with research organisations. In 2002, ADEME's R&D budget for renewable energy was €14.4 million versus €13.3 million in 1999 and €3.8 million in 1998. Some of the major companies and groups receiving ADEME funding to support their renewable energy research are Photowatt, Total Energie, Apex, Transenergie and CEAC.

The Office of Geological and Mining Research (*Bureau de recherches géologiques et minières*) also manages research in the renewable energy field, particularly concerning geothermal energy. Its R&D programme on hot dry rocks at a site in Soultz is a European programme begun in 2001 as a scientific pilot. The next phase, as a pre-industrial pilot, is scheduled to commence in 2004.

NUCLEAR FISSION TECHNOLOGY

Nuclear fission research is led by the CEA, in collaboration with EDF and industrial companies such as Framatome. French research groups in this field contribute actively to the R&D Framework Programmes at Euratom, the organisation within the EU dealing with nuclear power.

Concerning the development of new reactor technology, one important objective for the French nuclear research programme is to improve the competitiveness of nuclear electricity. Two principal paths are followed to reach this goal: *i)* the prolongation of the economic lifetimes of existing nuclear power plants, and *ii)* the growth in efficient use of nuclear fuel.

For the last fifteen years, the European Pressurised Water Reactor (EPR) has been the subject of substantial European co-operation and spending, at both the industrial level (with French Framatome and German Siemens) and at the level of state regulatory authorities. The EPR project resulted from a desire to optimise pressurised water reactors. It was launched with the three following goals in mind:

- **Upgrading security:** Dividing by ten the risk of core meltdown, mitigating consequences for the surrounding population and areas resulting from a serious accident.
- **Enhancing technical performance:** Extending lifetimes and optimising fuel use.

- **Improving economic performance:** Reducing the cost of each kWh produced by 10%.

Working on the hypothesis that the existing plants will be limited to 40-year lifetimes and thus anticipating a need to at least partially replace the nuclear park in the coming years, the government believes that a decision on building an EPR "demonstration" unit to come on line in 2011 to 2012 should be taken shortly. This would give it three years of operational service before commencing on the construction of the next set of EPR plants to come on line around 2020. AREVA, the leading industrial company developing this technology, has just sold a 1.6 GW EPR nuclear power plant to an electricity co-operative in Finland to come on line in 2009.

NUCLEAR FUSION

French nuclear fusion technology is closely associated with the Euratom programme and takes place at the CEA research centre at Cadarache. Under the rubric of Euratom, France announced on 30 January 2003 that it would bid to have the experimental ITER reactor located at its Cadarache site. The ITER experiment is designed to demonstrate the scientific and technological feasibility of fusion energy. Following from today's largest fusion experiments worldwide, ITER aims to provide the know-how to build the first electricity-generating power station based on magnetic confinement of high-temperature plasma. ITER will test all the main new features needed for that device, namely high-temperature-tolerant components, large-scale reliable superconducting magnets, fuel-breeding blankets using high temperature coolants suitable for efficient electricity generation, and safe remote handling and disposal of all irradiated components. The project is expected to cost around $10 billion over its lifetime which should begin in 2014 and last twenty years.

Also bidding to host the ITER reactor site were Vandellos in Spain, Clarington in Canada, and Rokkasho-Mura in Japan. In November 2003, the EU decided it would support only one site which would be Cadarache, and the Spanish option was dropped. By December 2003, the Canadian site had also been dropped from contention. On 20 December 2003, the ministers representing the participants in negotiations over ITER construction – China, Europe, Japan, South Korea, the Russian Federation and the United States of America – met in Washington and announced their inability to decide on any of the two remaining choices, France or Japan. Meetings thus far in 2004 have not yet led to a decision.

CRITIQUE

France has a tradition of contributing substantially to energy technology and R&D. In 2001, the country contributed more funds in this area than any other

European country, spending more than Germany, Spain and the United Kingdom combined. As a percentage of national GDP, the figures are less exceptional although still impressive and demonstrate France's appreciation for the long-term benefits of technology development and the government's role in such development. The fruits of French energy R&D spending extend beyond France and have had a positive external effect for all IEA countries, particularly in the nuclear field.

Despite the comparatively high level of R&D spending seen in 2001, this figure has dropped substantially in recent years. For example, 2001 expenditures are nearly 30% below 1999 levels. While R&D spending can be rather cyclical, it is hoped that this decrease does not represent a long-term downward trend in spending. It is also worth noting that expenditures for government R&D are in the process of being recategorised, so any conclusions on spending trends would need to be revisited.

While this report commends France's proactive support of energy R&D, it also notes the problems faced in obtaining consistent, reliable information on government activities in this sector. Among the difficulties encountered were inconsistent reports on the amount of money being spent, particularly with regard to contributions to and from academia and industry; lack of clarity on which administrative and political processes are used to set priorities; how these priorities are linked to energy policy; how government R&D is being linked to R&D in the industrial sector; and lack of measures to assess the cost-effectiveness of the expenditures. While R&D is by its very nature long-term with diffuse benefits inherently difficult to quantify, the French government is strongly encouraged to develop a more comprehensive picture of the allocation of its energy R&D funds, their positive effects and how they complement other energy policy tools.

These problems could be at least partly ameliorated though improved co-ordination among the relevant government bodies, the Ministry of Research and New Technologies, ADEME and CEA. For example, all of these bodies are engaged in technologies related to nuclear, energy efficiency and renewables, and their division of responsibilities is not necessarily clear. This could stem from a lack of coherent national strategy on energy R&D and could result in inefficient use of financial resources. It appears that the Ministry of Research plays a central role in energy R&D policy-making, which is understandable considering the need for linkage between universities, research institutes and industry. However, as suggested by the *Livre Blanc*, the role of energy R&D should be defined in the broader portfolio of sustainable energy policies. In this context, a coherent national energy R&D strategy should be worked out with a stronger role for DGEMP so that energy R&D programmes can more effectively contribute to the long-term energy policy objectives.

One aspect of incorporating R&D spending allocation within the wider energy policy perspective is analysing the efficacy of monies spent in different areas.

For example, in the field of renewable energy, electricity consumers are bearing the cost of supporting renewable energy through the feed-in tariffs. In addition, taxpayers support renewable energy through R&D funding. Bringing R&D into the wider energy policy strategy would lead to an analysis of how these tools are achieving their objectives. While feed-in tariffs and R&D have their own separate goals, they also share a common goal of realising the environmental and security benefits of renewable energy. While application of R&D policies and market deployment policies could depend on the development stage of each technology, such a comparison would warrant the achievement of policy goals at the lowest cost.

The review team understands France's priority for nuclear energy. The *Livre Blanc* foresees a lasting role for nuclear energy in the country and the French knowledge base is assumed to be excellent and worth preserving. Since the transport sector is the biggest challenge to sustainable energy consumption, it too should receive a high priority although the team did not find such argumentations. In addition, given the ambitious policy targets for renewable energy and energy efficiency established in the *Livre Blanc*, greater expenditures in these areas would seem to make sense. The 7% of funding devoted to renewable energy and energy efficiency would seem not to reflect the energy paths the government has recently laid out.

Independent companies such as EDF also spend impressive amounts of money on R&D. They appear to have a clear vision on what they do, how much they do and why they do it. Owing to the introduction of competition in the gas and electricity markets, industrial energy R&D will probably decrease in the coming years. This trend has been seen in the public and private energy R&D budgets of other countries. If this coincides with increased efficiency of expenditure, there are no problems. However, France is an active partner in the Lisbon Process aiming at an overall R&D share (public plus private) of 3% of GNP. Therefore, industrial R&D has to be monitored carefully by the government and the possibility of more intense partnerships should be considered, of course in accordance with EU regulation.

RECOMMENDATIONS

The government of France should:

- *Clarify the allocation method (how, how much, in which fields, and to which institutions) for public spending on energy R&D.*
- *Define a clear energy R&D policy that supports government long-term energy objectives, particularly in the fields of transport, energy efficiency and renewable energy.*

- *Assess the effectiveness of R&D programmes in a broader concept of energy policy, for example in comparison with the effectiveness of public budget allocated to market introduction of renewable energy.*
- *Monitor R&D expenditure in the industrial sector.*

ENERGY BALANCES AND KEY STATISTICAL DATA

Unit: Mtoe

SUPPLY

		1973	1990	2001	2002P	2010	2020	2030
TOTAL PRODUCTION		**36.1**	**111.7**	**133.2**	**134.4**	**142.0**	**146.0**	**138.7**
Coal[1]		18.0	8.2	1.6	1.2	0.5	0.4	–
Oil		2.1	3.5	1.8	1.7	–	–	–
Gas		6.3	2.5	1.5	1.4	–	–	–
Comb. Renewables & Wastes[2]		1.7	10.9	11.9	11.0	14.7	18.5	22.5
Nuclear		3.8	81.9	109.7	113.8	120.3	117.8	106.6
Hydro		4.1	4.6	6.4	5.2	5.9	5.9	5.9
Geothermal		–	0.1	0.1	0.1	..	..	..
Solar/Wind/Other[3]		0.0	0.1	0.1	0.1	0.6	3.3	3.7
TOTAL NET IMPORTS[4]		**142.8**	**117.1**	**130.8**	**135.5**	**156.8**	**173.9**	**198.9**
Coal[1]	Exports	1.3	0.6	0.5	0.4	–	–	–
	Imports	10.8	13.7	11.6	12.2	9.8	11.2	21.4
	Net Imports	9.5	13.0	11.2	11.8	9.8	11.2	21.4
Oil	Exports	13.7	14.8	21.1	18.7	13.3	14.6	16.1
	Imports	145.1	100.9	115.2	114.3	120.3	124.3	126.6
	Bunkers	5.3	2.5	2.7	2.5	3.0	3.0	3.0
	Net Imports	126.0	83.6	91.4	93.1	104.0	106.7	107.5
Gas	Exports	0.1	0.3	0.8	0.8	–	–	–
	Imports	7.6	24.7	34.9	38.0	47.3	59.0	70.0
	Net Imports	7.6	24.4	34.1	37.2	47.3	59.0	70.0
Electricity	Exports	0.6	4.5	6.3	6.9	4.3	3.0	–
	Imports	0.4	0.6	0.4	0.3	–	–	–
	Net Imports	–0.2	–3.9	–5.9	–6.6	–4.3	–3.0	–
TOTAL STOCK CHANGES		**–2.4**	**–1.7**	**1.6**	**–2.1**	**–**	**–**	**–**
TOTAL SUPPLY (TPES)		**176.6**	**227.1**	**265.6**	**267.9**	**298.8**	**319.9**	**337.6**
Coal[1]		29.2	20.2	12.7	12.5	10.3	11.6	21.4
Oil		124.3	87.3	93.8	94.3	104.0	106.7	107.5
Gas		13.6	26.0	36.7	37.4	47.3	59.0	70.0
Comb. Renewables & Wastes[2]		1.7	10.9	12.0	11.0	14.7	18.5	22.5
Nuclear		3.8	81.9	109.7	113.8	120.3	117.8	106.6
Hydro		4.1	4.6	6.4	5.2	5.9	5.9	5.9
Geothermal		–	0.1	0.1	0.1	..	..	..
Solar/Wind/Other[3]		0.0	0.1	0.1	0.1	0.6	3.3	3.7
Electricity Trade[5]		–0.2	–3.9	–5.9	–6.6	–4.3	–3.0	–
Shares (%)								
Coal		*16.6*	*8.9*	*4.8*	*4.7*	*3.4*	*3.6*	*6.3*
Oil		*70.4*	*38.4*	*35.3*	*35.2*	*34.8*	*33.4*	*31.8*
Gas		*7.7*	*11.5*	*13.8*	*14.0*	*15.8*	*18.4*	*20.7*
Comb. Renewables & Wastes		*1.0*	*4.8*	*4.5*	*4.1*	*4.9*	*5.8*	*6.7*
Nuclear		*2.2*	*36.0*	*41.3*	*42.5*	*40.3*	*36.8*	*31.6*
Hydro		*2.3*	*2.0*	*2.4*	*1.9*	*2.0*	*1.9*	*1.8*
Geothermal		–	–	*0.1*	–	..	..	..
Solar/Wind/Other		–	–	–	–	*0.2*	*1.0*	*1.1*
Electricity Trade		*–0.1*	*–1.7*	*–2.2*	*–2.5*	*–1.4*	*–0.9*	–

0 is negligible, – is nil, .. is not available.
Forecast data for Solar/Wind/Other include Geothermal.

Unit: Mtoe

DEMAND

FINAL CONSUMPTION BY SECTOR

	1973	1990	2001	2002P	2010	2020	2030
TFC	**138.1**	**147.4**	**173.8**	**178.2**	**196.1**	**213.3**	**228.2**
Coal[1]	13.1	7.5	3.5	7.1	7.2	6.9	7.2
Oil	99.4	79.5	91.1	91.3	95.1	97.3	97.8
Gas	11.2	23.9	34.4	35.5	40.9	46.7	51.1
Comb. Renewables & Wastes[2]	1.7	9.6	10.0	9.1	13.9	16.1	19.6
Geothermal	–	0.1	0.1	0.1	..	..	..
Solar/Wind/Other	–	0.0	0.0	0.0	–	–	–
Electricity	12.8	26.0	34.0	35.1	39.0	46.3	52.5
Heat	–	0.7	0.6	..	..	..	..
Shares (%)							
Coal	*9.5*	*5.1*	*2.0*	*4.0*	*3.7*	*3.2*	*3.2*
Oil	*72.0*	*53.9*	*52.4*	*51.2*	*48.5*	*45.6*	*42.8*
Gas	*8.1*	*16.2*	*19.8*	*19.9*	*20.9*	*21.9*	*22.4*
Comb. Renewables & Wastes	*1.2*	*6.5*	*5.8*	*5.1*	*7.1*	*7.6*	*8.6*
Geothermal	–	*0.1*	*0.1*	*0.1*	..	..	..
Solar/Wind/Other	–	–	–	–	–	–	–
Electricity	*9.3*	*17.6*	*19.6*	*19.7*	*19.9*	*21.7*	*23.0*
Heat	–	*0.5*	*0.4*	..	..	..	..
TOTAL INDUSTRY[6]	**55.7**	**46.3**	**50.4**	**54.5**	**62.2**	**67.3**	**71.8**
Coal[1]	7.2	5.9	3.0	6.5	5.6	5.1	5.0
Oil	35.3	18.0	19.9	21.1	22.2	22.1	22.6
Gas	5.8	11.1	14.1	13.6	16.3	18.5	20.0
Comb. Renewables & Wastes[2]	0.2	1.5	1.7	1.5	4.8	6.0	6.5
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	–	–	–	–	–	–	–
Electricity	7.2	9.9	11.6	11.8	13.3	15.6	17.7
Heat	–	–	–	–	–	–	–
Shares (%)							
Coal	*12.9*	*12.7*	*5.9*	*11.9*	*9.0*	*7.6*	*7.0*
Oil	*63.4*	*38.8*	*39.6*	*38.8*	*35.7*	*32.9*	*31.5*
Gas	*10.4*	*24.0*	*28.1*	*24.9*	*26.2*	*27.5*	*27.9*
Comb. Renewables & Wastes	*0.4*	*3.3*	*3.5*	*2.7*	*7.7*	*8.9*	*9.1*
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	–	–	–	–	–	–	–
Electricity	*13.0*	*21.3*	*23.0*	*21.7*	*21.4*	*23.2*	*24.7*
Heat	–	–	–	–	–	–	–
TRANSPORT[7]	**27.1**	**42.8**	**53.3**	**51.8**	**56.4**	**62.2**	**68.3**
TOTAL OTHER SECTORS[8]	**55.4**	**58.2**	**70.2**	**71.9**	**77.5**	**83.9**	**88.1**
Coal[1]	5.8	1.7	0.6	0.6	1.6	1.8	2.2
Oil	37.6	19.5	19.1	19.6	18.1	15.4	10.4
Gas	5.4	12.8	20.2	21.9	24.6	28.2	31.1
Comb. Renewables & Wastes[2]	1.5	8.1	8.0	7.3	8.5	9.0	11.1
Geothermal	–	0.1	0.1	0.1	..	..	..
Solar/Wind/Other	–	0.0	0.0	0.0	–	–	–
Electricity	5.0	15.3	21.4	22.4	24.7	29.5	33.3
Heat	–	0.7	0.6	..	..	..	..
Shares (%)							
Coal	*10.5*	*2.9*	*0.8*	*0.9*	*2.1*	*2.1*	*2.5*
Oil	*68.0*	*33.4*	*27.3*	*27.3*	*23.4*	*18.4*	*11.8*
Gas	*9.7*	*22.0*	*28.8*	*30.5*	*31.7*	*33.6*	*35.3*
Comb. Renewables & Wastes	*2.7*	*13.9*	*11.4*	*10.1*	*11.0*	*10.7*	*12.6*
Geothermal	–	*0.2*	*0.2*	*0.1*	..	..	..
Solar/Wind/Other	–	–	–	–	–	–	–
Electricity	*9.0*	*26.3*	*30.5*	*31.1*	*31.9*	*35.2*	*37.8*
Heat	–	*1.2*	*0.9*	..	..	..	..

Unit: Mtoe

DEMAND

ENERGY TRANSFORMATION AND LOSSES

	1973	1990	2001	2002P	2010	2020	2030
ELECTRICITY GENERATION[9]							
INPUT (Mtoe)	**35.9**	**98.3**	**127.5**	**131.7**	**138.3**	**147.9**	**153.2**
OUTPUT (Mtoe)	**15.7**	**35.8**	**47.0**	**47.6**	**51.0**	**57.0**	**60.9**
(TWh gross)	182.5	416.8	546.0	553.5	593.0	663.2	708.3
Output Shares (%)							
Coal	*19.4*	*8.5*	*4.5*	*3.8*	*1.9*	*2.8*	*8.7*
Oil	*40.2*	*2.1*	*1.0*	*0.9*	*0.9*	*0.3*	*0.2*
Gas	*5.5*	*0.7*	*3.1*	*4.7*	*6.0*	*11.3*	*16.2*
Comb. Renewables & Wastes	*0.4*	*0.4*	*0.6*	*0.6*	*0.5*	*1.2*	*1.4*
Nuclear	*8.1*	*75.4*	*77.1*	*78.9*	*77.8*	*68.1*	*57.8*
Hydro	*26.1*	*12.8*	*13.6*	*10.9*	*11.6*	*10.4*	*9.8*
Geothermal	–	–	–	–	–	–	–
Solar/Wind/Other	*0.3*	*0.1*	*0.1*	*0.1*	*1.2*	*5.8*	*6.1*
TOTAL LOSSES	**37.6**	**75.2**	**95.6**	**95.3**	**102.7**	**106.5**	**109.4**
of which:							
Electricity and Heat Generation[10]	20.2	61.8	79.9	84.0	87.3	90.9	92.3
Other Transformation	5.4	1.6	2.1	0.1	0.3	0.4	0.4
Own Use and Losses[11]	12.0	11.8	13.6	11.1	15.1	15.2	16.7
Statistical Differences	**0.9**	**4.5**	**–3.8**	**–5.6**	**–**	**–**	**–**

INDICATORS

	1973	1990	2001	2002P	2010	2020	2030
GDP (billion 1995 US$)	961.43	1473.22	1809.68	1831.52	2196.93	2757.86	3462.02
Population (millions)	53.30	58.17	60.91	61.23	61.70	63.50	65.35e
TPES/GDP[12]	0.18	0.15	0.15	0.15	0.14	0.12	0.10
Energy Production/TPES	0.20	0.49	0.50	0.50	0.48	0.46	0.41
Per Capita TPES[13]	3.31	3.90	4.36	4.37	4.84	5.04	5.17
Oil Supply/GDP[12]	0.13	0.06	0.05	0.05	0.05	0.04	0.03
TFC/GDP[12]	0.14	0.10	0.10	0.10	0.09	0.08	0.07
Per Capita TFC[13]	2.59	2.53	2.85	2.91	3.18	3.36	3.49
Energy-related CO_2 Emissions (Mt CO_2)[14]	489.0	352.7	384.9	..	416.7	456.6	521.9
CO_2 Emissions from Bunkers (Mt CO_2)	22.7	17.7	22.7	..	23.7	23.7	23.7

GROWTH RATES (% per year)

	73–79	79–90	90–01	01–02	02–10	10–20	20–30
TPES	1.0	1.8	1.4	0.9	1.4	0.7	0.5
Coal	1.7	–4.2	–4.1	–1.2	–2.4	1.2	6.3
Oil	–1.4	–2.4	0.7	0.6	1.2	0.3	0.1
Gas	7.4	2.0	3.2	2.0	3.0	2.2	1.7
Comb. Renewables & Wastes	7.6	13.8	0.8	–8.1	3.7	2.3	2.0
Nuclear	18.1	20.6	2.7	3.7	0.7	–0.2	–1.0
Hydro	5.7	–2.0	3.1	–18.6	1.6	0.0	–
Geothermal	–	–	2.2	–23.0	..	..	..
Solar/Wind/Other	–1.8	3.2	2.8	6.0	27.5	18.3	1.2
TFC	0.7	0.2	1.5	2.5	1.2	0.8	0.7
Electricity Consumption	5.4	3.7	2.5	3.3	1.3	1.7	1.3
Energy Production	2.1	9.5	1.6	0.9	0.7	0.3	–0.5
Net Oil Imports	–1.4	–2.9	0.8	1.8	1.4	0.3	0.1
GDP	2.8	2.4	1.9	1.2	2.3	2.3	2.3e
Growth in the TPES/GDP Ratio	–1.8	–0.6	–0.4	–0.3	–0.9	–1.6	–1.7
Growth in the TFC/GDP Ratio	–2.1	–2.1	–0.4	1.3	–1.1	–1.4	–1.6

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

FOOTNOTES TO ENERGY BALANCES AND KEY STATISTICAL DATA

1. Includes lignite.
2. Comprises solid biomass, liquid biomass, biogas and municipal waste. Data are often based on partial surveys and may not be comparable between countries.
3. Other includes tide and wave.
4. Total net imports include combustible renewables and waste.
5. Total supply of electricity represents net trade. A negative number indicates that exports are greater than imports.
6. Includes non-energy use.
7. Includes less than 1% non-oil fuels.
8. Includes residential, commercial, public service and agricultural sectors.
9. Inputs to electricity generation include inputs to electricity, CHP and heat plants. Output refers only to electricity generation.
10. Losses arising in the production of electricity and heat at public utilities and autoproducers. For non-fossil-fuel electricity generation, theoretical losses are shown based on plant efficiencies of 33% for nuclear and 100% for hydro.
11. 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.
12. Toe per thousand US dollars at 1995 prices and exchange rates.
13. Toe per person.
14. "Energy-related CO_2 emissions" specifically means CO_2 from the combustion of the fossil fuel components of TPES (*i.e.* coal and coal products, peat, crude oil and derived products and natural gas), while CO_2 emissions from the remaining components of TPES (*i.e.* electricity from hydro, other renewables and nuclear) are zero. Emissions from the combustion of biomass-derived fuels are not included, in accordance with the IPCC greenhouse gas inventory methodology. Also 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 2001 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 the conditions in which the energy sectors of their economies can make the fullest possible contribution to sustainable economic development and 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 they 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** is 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 where practicable have regard to the Polluter Pays Principle.

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 members wish to retain and improve the nuclear option for the

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

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

ADEME	Agence de l'environnement et de la maîtrise de l'énergie (Agency for the Environment and Energy Management)
AERES	Association des entreprises pour la réduction de l'effet de serre (Association of Companies for the Reduction of the Greenhouse Effect)
AFH_2	Association française de l'hydrogène (The French Association for Hydrogen)
ANDRA	Agence nationale pour la gestion des déchets radioactifs (National Agency for Radioactive Waste Management)
ASN	Autorité de sûreté nucléaire (Nuclear Safety Authority)
bcm	billion cubic metres
b/d	barrels per day
CCGT	combined-cycle gas turbine
CDF	Charbonnages de France
CDM	clean development mechanisms
CEA	Commissariat à l'énergie atomique (Atomic Energy Commission)
CERT	Committee on Energy Research and Technology of the IEA
CFCs	chlorofluorocarbons
CFM	Compagnie française du méthane
CH_4	méthane
CHP	combined production of heat and power
CNG	compressed natural gas

CNR	Compagnie nationale du Rhône
CNRS	Centre national de la recherche scientifique (National Centre for Scientific Research)
CO_2	carbon dioxide
CPDC	Comité professionel de la distribution des carburants (Experts Committee on Motor Fuels Distribution)
CPSSP	Professional Committee on Strategic Petroleum Stocks
CRE	Commission de régulation de l'électricité (Regulatory Commission for Electricity)
CSPE	contribution au service public de l'électricité (contribution to the public service of electricity)
DC	direct current
DGEMP	Direction générale de l'énergie et des matières premières (Directorate-General for Energy and Raw Materials)
DGSNR	Direction générale de la sûreté nucléaire et de la radioprotection (Directorate-General for Nuclear Safety and Radiation Protection)
DH	district heating
DIDEME	Direction de la demande et des marchés énergétiques (Directorate for Demand and Energy Markets)
DIREM	Direction des ressources énergétiques et minérales (Directorate for Energy and Mineral Resources)
DOM	départements d'outre mer (French overseas territories enjoying the same administrative status as regions in metropolitan France)
DRIRE	Direction(s) régionale(s) de l'industrie, de la recherche et de l'environnement (Regional Directorate(s) for Industry, Research and the Environment)
DSIN	Direction de la sûreté des installations nucléaires (Directorate for the Safety of Nuclear Installations)
EDF	Electricité de France
EMHV	ester méthylique d'huile végétale
EPIC	établissement public industriel et commercial
EPR	European pressurised water reactor

ETBE	ethyl tertiary butyl ether
ETSO	Association of European Transmission System Operators
EU	The European Union
EU-ETS	European Union Emission Trading Scheme
Euro	European currency (€).
FIDEME	Fonds d'intervention pour l'environnement et la maîtrise de l'énergie (Investment Fund for the Environment and Energy Efficiency)
FSU	former Soviet Union
FSPPE	Fonds du service public de la production d'électricité (Fund for Public Service for the Generation of Electricity)
GDF	Gaz de France
GDP	gross domestic product
GHG	greenhouse gases (see note 9)
GIF	Generation IV International Forum
GJ	gigajoule, or one joule $\times 10^9$
GSO	Gaz du Sud-Ouest
GW	gigawatt, or one watt $\times 10^9$
GWh	gigawatt $\times$ one hour, or one watt $\times$ one hour $\times 10^9$
HFC	hydrofluorocarbon
IEA	International Energy Agency
IFA	Interconnexion France-Angleterre
IFP	Institut français du pétrole (French Petroleum Institute)
IGCC	integrated coal gasification combined cycle plant
IPCC	Intergovernmental Panel on Climate Change
IRSN	Institut de radioprotection et de sûreté nucléaire
J	joule; a joule is the work done when the point of application of a force of one newton is displaced through a distance of one metre in the direction of the force

JI	joint implementation
kV	kilovolt, or one volt × 10^3
kWh	kilowatt-hour, or one kilowatt × one hour, or one watt × one hour × 10^3
LDC	local distribution company (natural gas)
LNG	liquefied natural gas
mcm	million cubic metres
MEDEF	Mouvement des entreprises de France (Association of French Business)
MIES	Mission interministérielle sur l'effet de serre (Inter-ministerial Mission on Climate Change)
MINEFI	Ministère de l'Economie, des Finances et de l'Industrie (Ministry of Economy, Finance and Industry)
MOX	mixed oxide fuel
Mt	million tonnes
Mtoe	million tonnes of oil equivalent; see toe
MW	megawatt of energy, or one watt × 10^6
MWh	megawatt-hour = one megawatt × one hour, or one watt × one hour × 10^6
NEA	the Nuclear Energy Agency of the OECD
NFFO	Non-Fossil Fuel Obligation
NGV	natural gas vehicles
N_2O	nitrous oxide
NO_x	nitrogen oxides
OECD	Organisation for Economic Co-operation and Development
OPRI	Office de protection contre les rayonnements ionisants
PFC	perfluorocarbon
PJ	petajoule, or one Joule × 10^{15}

PJM	Pennsylvania-New Jersey-Maryland power pool
PNLCC	Programme national de luttre contre le changement climatique (National Programme for Tackling Climate Change)
PPA	power purchase agreement
PPI	Programmation pluriannuelle des investissements de production électrique (Long-term Investment Programme for Electricity Production)
ppm	parts per million
PPP	purchasing power parity: the rate of currency conversion that equalises the purchasing power of different currencies
PWR	pressurised water reactor
R&D	research and development, especially in energy technology; may include the demonstration and dissemination phases as well
RO	Renewables Obligation
RT	réglementation thermique
RTE	Réseau de transport d'électricité (the transmission system operator)
SA	société anonyme
SEAR	Société Elf Aquitaine de réseau
SER	Syndicat des énergies renouvelable (Renewable Energy Association)
SF_6	sulphur hexafluoride
SLT	Standing Group on Long-Term Co-operation of the IEA
SNCF	Société nationale des chemins de fer
SNET	Société nationale d'électricité et de thermique
SO_2	sulphur dioxide
TFC	total final consumption
TFE	TotalFinaElf
TGAP	taxe générale sur les activités polluantes (general tax on polluting activities)
TICGN	taxe intérieure sur la consommation de gaz naturel (tax on the comsumption of natural gas)

TIPP	taxe intérieure sur les produits pétroliers (tax on petroleum products)
toe	tonne of oil equivalent, defined as 10^7 kcal
TOM	territoires d'outre mer (French overseas territories)
TPA	third-party access
TPES	total primary energy supply
TSO	transmission system operator
TW	terawatt, or one watt $\times$ 10^{12}
TWh	terawatt $\times$ one hour, or one watt $\times$ one hour $\times$ 10^{12}
UFIP	Union française des industries pétrolières (French Petroleum Industry Association)
UNFCCC	United Nation Framework Convention on Climate Change
VAT	value-added tax
VIPP	virtual independent power plant
VOCs	volatile organic compounds

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