September 2002 ECN-C--02-0043

Shifting the focus from nuclear to renewable electricity in France

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Acknowledgement/Preface

This report provides selected background information to an investigation of the European renewable electricity market. The study focuses on trends with respect to energy policymaking, and, more particularly, it brings together insights gained about the current French situation. It aims at serving the European policymakers and any potential investor interested in the investigation of the current opportunities in the French renewable electricity sector. With the usual disclaimer on remaining errors, the author acknowledges the stimulating exchange of ideas with Maroeska Boots. The ECN project number is 7.7449.04.01, and the publication received the number ECN-C--02-043.

Abstract

The study analyses two related observations. France's nuclear solution is not technically perfect or widely accepted. And France could take better advantage of the plentiful renewable sources it owns. The main challenge of the essay is to discern a way from the currently nuclear-based energy system in the direction of a system with an increased participation of renewable energy.

The essay starts with an enumeration of typical aspects of the current organisation of the French energy sector. With a state-owned industry, a legal monopoly on imports and exports and a low speed to liberalise the sector, France considers being economically and socially efficient and guaranteeing safety, and therefore does not favour privatisation. In the meantime, the nuclear way is economically and politically less safe than it has been. France might have to cope with the technical limitations given by a too substantial share (77%) of nuclear power. There is a growing need for diversification with complementary sources.

Next, the current policy framework is evaluated in an energy-environmental context. France has a relatively good record on environmental issues, except for its share of renewable electricity production, which has actually decreased in recent years. However, interest in the development of renewable energy resources in France is certainly increasing. The release of the Cochet report in September 2001 seems to have been a turning point in French energy politics and has led to several structural measures such as feed-in tariffs to encourage the generation of renewable electricity.

These results are the starting point for analysing various renewable electricity technologies. One can see attractive developments in favour of most renewables. However, a number of counteracting forces is still present. Some market barriers are old, like subsidies for other energy sources including nuclear, and difficult to remove. Other barriers are new, like impeding regulations and administrative planning aspects, departmental compartmentalisation, etc. Such market distortions might terminate several promising market developments.

The conclusion finally sharpens up the findings about the organisation of the French energy sector and the investigated renewable technology options. It is expected that France might (further) shift its focus from nuclear towards renewable electricity by increasing its idiosyncratic, regulatory guidance instead of lessening it. It might be indeed attractive to develop renewable technology sub-industries and not only their output, renewable electricity. One cannot really imagine why a country with splendid renewable resources should not strive to kill two birds with one stone when this opportunity seems to come.

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1. INTRODUCTION

Although the French energy supply is dominated by oil (41% of the energy needs), The share of nuclear in total electricity production is 77%. The French Kyoto reduction commitment is 0% (stabilisation of its greenhouse gas emissions at 1990 levels), which follows the logic of already being a relatively low-emissions country. Carbon emissions are only slightly above the country's 1990 levels, but increased economic activity and energy consumption tend to increase France's carbon emissions. Mid-2000 France had an installed power capacity of 108 GW, while electricity generation amounted to 539 TWh (see table). Due to the low marginal production costs of nuclear and hydropower, France is a net exporter of electricity. In 2000, nuclear-based power exports amounted to 92 TWh, i.e. 17% of its production.

Figure I.1 *French electricity generation in 2000*

	[TWh]	[%]
Nuclear	415	77
Fossil fuels	50	9
of which gas-fuelled power		less than 1
Renewables	74	14
of which hydro power	72	13
Total electricity generation	539	100

Source: EdF/Observ'ER in '3ème inventaire de la production d'électricité renouvelable dans le monde', December 2001.

Apart from large hydropower, the role of (new) renewables in the French energy system is negligible. In this chapter, it will become clear that a turn-around in public and politic thinking is taking place that makes a more pronounced role for renewables plausible. The renewable electricity targets as established in French and European documents indicate a leap in renewable electricity capacity from 14% in 2000 to 21% of electricity generation in 2010. It may show to be difficult to realise this vast increase as large hydropower generation has come to saturation in France. Thus, the increase should come from other renewable technologies. However, the target is not perceived in France as an impossible mission. The progression will depend on the adaptation of the existing institutional, mainly nuclear-based, structures and not on the availability of resources or technologies. The main 'raisons d'être' justifying an upgraded role of renewables in the French energy system are the notions that:

- France's nuclear solution does not lead to a technically perfect or a widely accepted solution.
- France could take better advantage of available renewable sources it owns.

The two above-mentioned issues will be developed in the essay afterwards. Therefore, it is attractive to impart, beforehand, some past (often political) issues that have clearly moulded past energetic choices and the resulting developments. The essay starts with an enumeration of typical aspects of the current organisation of the French energy sector, aspects that obviously put France in a typical position. The main challenge is to discern a way (expected to be a narrow way) from the current nuclear-based energy system in the direction of a system with an increased participation of renewable energy. In order to explore this theme, the current policy framework has to be evaluated in the broader, energy-environmental context. This will be the starting point for focussing on the various technological options, as they are currently dealt with by the French law and government.

2. THE FRENCH ENERGETIC POLICY FRAMEWORK

2.1 Political background, liberalisation and privatisation

2.1.1 Political background

Three periods of 'cohabitation' (having Presidents and Parliaments from different 'colours') strikingly do not seem to have really affected the energy policy field. In fact, the French government has pursued a quite consistent energy policy in recent decades. Because of its limited domestic fossil energy resources, energy supply security and fluctuating world oil prices traditionally are major issues in France. However, France has strongly reduced its energy import dependence, from 81% in 1973 to 50% in 1999, largely by developing and expanding its domestic nuclear power program that is run by the government (IEA, 2000). This has also allowed the development of an innovative industrial sector with good performance in terms of nuclear expertise and maintenance of reactors. Because these outcomes have been cheering, one may expect France to continue its tradition of a strong role for the central government. Recent technological developments achieving 'recycling' (almost total recycling of used uranium is achieved) might give French citizens and their authorities the feeling that the sky is the limit. Most of the R&D efforts to achieve this particular position have been brought about under pre-competitive or generic research programs, although the results merely served Electricité de France (EdF). In addition, because France has a good nuclear safety record, nuclear energy technology has become a natural export market for France. As long as the US keep their share of nuclear at 20% of their electricity supply, and therefore, keep their R&D budget quite low, France will remain one of the leaders (together with Japan) in nuclear R&D. For the French citizen, EdF's export statement generally relates to the need to find a site to build, for example, a new type of reactor that would serve as a 'technological showcase' for potential foreign buyers. Not surprisingly, there has been growing reluctance in France towards this increasing export because it was felt that EdF did not even intend to satisfy local or national electricity needs. No other European state would be willing to develop nuclear energy on its territory merely to facilitate electricity export.

2.1.2 Liberalisation

In 2001, France had one of the most protectionist electricity regimes in Western Europe, with a state-owned industry, a legal monopoly on imports and exports and a low speed to liberalise the sector. In February 2000, a full year after the first EU deadline, France passed legislation that began the liberalisation of the electricity sector. Since that time, about 1200 sites (actually only 600 large industrial and commercial consumers) comprising about 30% of the market, have been able to choose their electricity supplier. Accordingly, while there is the possibility to exchange electricity at the Powernext since the end of 2001, this newly created spot market is only accessible to the 1200 sites that are liberalised. The up-to-date result is, however, that very few of these consumers actually have changed suppliers. Note that the EU Electricity Directive has been translated in French by 'Law relative to the modernisation and the development of the public service for electricity'. (They have simply banished the taboo terms of deregulation and of liberalisation.) The French government announced in Barcelona in April 2002 that it would go further than the Directive requires. This might decrease the criticism from the EU and some Member States grieving that the integration of the French power industry has only been weakly affected after the transcription of the Directive. In addition, while still 'protected' to a large extent by the large group of captive customers in the domestic market, EdF is taking advantage of its economies of scale to export electricity. EdF has come under harsh criticism from Member States for entering foreign electricity markets while a large part of the French market remains

closed to competition. France keeps its captive customers while most of the EU countries went further than the required rate of liberalisation. However, these captive customers are not feeling that much 'captive' in the sense that they still have the lowest electricity prices in Europe. Domestic customers pay around 5 to 8 €ct per kWh (night and day tariffs respectively). Clearly, the French government does not want to undermine an industrial organisation that it still considers being both economically and socially efficient. All this refers also to the public service character of the energy policy, a feature very specific again to the French energetic system. However, even in the context of the incorporation of social objectives in it, it might be costly overall for society to support low-income groups through direct person-oriented support rather than through low electricity prices.

2.1.3 Privatisation

In the second-largest electricity market in Europe, behind Germany, EdF still produces, transports, and distributes virtually all electricity. EdF is often spoken of as 'the last of the Mohicans'. And indeed, the French utility's technostructure relies on French 'Colbertinisme', a non-privatised organisation of the sector that draws up plans from a central position instead of decentralised positions. One of the noticeable outcomes of Colbertinisme in energy policy is that a central authority tries to conceive of all distinct energy supply and energy demand needs in order to build its energy infrastructure. The advantages are economies of scale in production and in learning and shorter communication and decision ways. The disadvantages are would-be losses due to the market power of the operator and to sizeable impact of unions affecting the operator. There is no government (the socialist or the newly formed government) to support serious privatisation measures of the energy sector. The former government excluded a reorganisation that would threaten jobs in EdF for fear of antagonising the unions, among other reasons. Moreover, any government would have to take into consideration that not only the political acceptability but also *societal acceptability* of nuclear stations privatisation is far from guaranteed, for reasons of national security. Clearly, flawless maintenance of nuclear installations should never depend on the thrills of the market and nuclear safety should never depend on those people holding their market stocks. Additionally, a simple comparison between the French and the US nuclear park tells that the best way to deliver long-term safe operation and maintenance *at a reasonable price* is to keep it centrally organised. What is clear is that the desire to protect and preserve long-term investments and improvements such as the nuclear programme has led to a hesitant approach to competition and privatisation in the French power industry.

2.2 A nuclear based power system

2.2.1 French political sensibilities

Although nuclear energy has helped to provide France with the energy independence the country desires, environmental objections to nuclear energy have increased in recent years. Germany's decision to phase out nuclear power started a public debate within France about the future of its own industry. Public opinion polls showed that a very small but growing percentage of the public favours an immediate end to nuclear power. However, in a public opinion survey on nuclear power, the share of French citizens who said that nuclear power was less harmful to the environment than other sources, stood at 33% in 2000, up slightly from 30% in 1992. EdF pointed to these results as evidence that public perception of nuclear power has improved. The French government had acknowledged the public sensibilities away from nuclear power when it decided in February 1998, that the 'fast breeder' reactor Super-Phénix, located at Creys-Malville in the Lyon area, would be shut down permanently. This statement, made without backtracking the rest of the nuclear program, was an attempt to reduce distance with new groups like 'Les Verts' (the green party) in the government since 1997. The Green Party had threatened to pull out of the coalition unless a kind of nuclear power phase out begins. Overall, the practice is that France is the world's largest nuclear power generator on a per capita basis. Currently,

around 78 % of French electricity come from France's 58 nuclear power plants. Previously, the government had planned to have nuclear power reach 100% of electricity generation, i.e. eventually replacing large hydropower. The number of 58 reactors has been established in 2000, as a kind of 'status quo'. But France also decided to replace obsolete nuclear plants with more modern nuclear plants, turning down everlasting speculations about phasing out nuclear power.

2.2.2 Marianne's choice (the emblem of France without monarchy)

The French energy choice is essentially political instead of essentially economic, based as it has been on energy independence. The Green Paper of November 2000, 'Towards a European strategy for the security of energy supply', stressed that EU must retain its leading position in the field of civil nuclear technology. However, it does not mean that the nuclear way is politically very safe. With an overall energy system heavily based on nuclear power, France might have to cope with the technical limitations given by a too substantial share of nuclear power in the future. Indeed, with nuclear reactors that are not quickly started or interrupted, the need for diversification with more compliant sources to generate electricity is expected to grow. Hydropower plays an important role here, as it is a flexible source. (Gas could have done the job but there is quasi-no gas-fuelled electricity generation in France). Moreover, a relatively high base load production with nuclear plants is maintained (around 130%) in order to compensate for the inflexibility. While this is expected to be an expensive solution, this has been easily compensated by various electricity export contracts. Neighbouring countries shut down their own generation installations overnight and import French electricity instead. Recently, however, in the context of a European over-capacity accompanied by increasingly green political positions, anti-nuclear sensitivities have come to the surface, which altogether might undermine the current stability of the French nuclear-based system. In fact, for France like for the EU as a whole, the best guarantee of security of energy supply would to maintain a diversity of energy sources and supplies. This would also mean that the segregated thinking (nuclear versus renewable) in the French energy scene is not wise. Segregated thinking about electricity generation might even depreciate other opportunities like the systematic equipment of the nuclear sites to install wind turbines. Many of the nuclear sites are indeed located in remote areas that are attractively windy.

The Charpin-Dessus-Pelat report

In order to understand better what really are the options in France for electricity generation in the intermediate future, Prime Minister Jospin asked three high-level civil servants to conduct an economic study of the nuclear chain. In June 2000, the three experts handed over the 'report Charpin-Dessus-Pelat' in which they compared the nuclear option with the 'mainly gas' and the 'renewable sources' options. They calculated that the costs of the French electricity supply in the period 2010-2050 would be more or less the same *irrespective* of the option chosen. However, they assumed stability of fuel prices, which is of course not guaranteed. Moreover, the gas dependence risk of the 'mainly gas' option is not attractive in the French political scene. They also corroborated the government's view that the nuclear option is unavoidable if France is to meet its international environmental obligations.

2.3 Towards a renewable electricity concept

2.3.1 Developing political alertness

France has a relatively good record on environmental issues and most current energy related environmental trends appear positive. With a share of 2.7% in total world energy consumption, France's energy related carbon emissions merely amount to 1.7% of total world carbon emissions. Significant efforts by the French government to improve energy efficiency and conserva-

tion have resulted in such relatively low energy intensity and energy-related emissions. On the other hand, urban air pollution, especially in Paris, remains a pertinent environmental issue. Even if it is of course brought about by automobile pollution, this partly explains the position in favour of nuclear energy. It does not pollute the same way as coal, oil or natural gas do. Air pollution contributes to the enhancement of consciousness about all environmental issues.

In January 2000, France unveiled an extensive and detailed plan to reduce carbon emissions in order to meet its Kyoto commitments. The French government, through its newly established Interdepartmental Greenhouse Effect Mission (MIES), released its plans to discourage consumption of fossil fuels while re-launching France's energy management policy. The MIES program (unanimously approved by the deputies) seeks to discourage consumption through the use of ecological tax measures, targeting corporations as well as individuals by taxing polluting behaviour while rewarding 'ecologically useful conduct' with reductions in the value added tax. In addition, the French government set guidelines for creating a market in carbon, involving industries that are large energy consumers and that sign a voluntary agreement to limit emissions of greenhouse gases.

Most interesting in this extensive ten-year plan is that the French government explicitly reiterates the need for renewable energy sources in order to maintain its level of energy self-sufficiency. The share of renewable electricity production in France actually decreased from 17.4% in 1994 to 13.8% in 2000. Responding to this downward trend, the French government announced the consolidation of the existing market share of wood (biomass) and hydro-electricity (3% respectively 96% of the renewable electricity production) to spur the growth of renewable energy. In addition, the MIES program included several structural measures to encourage the use of *new* renewable energy resources. However, a number of counteracting forces is still present. It is unlikely that renewable electricity use will see a real surge until the French government removes market barriers that have inhibited the use of renewable sources for electricity. Like in other Member States, known examples of 'market' barriers are subsidies (or tax cuts) for other energy sources including nuclear energy, and impeding regulations and administrative planning aspects. Moreover, the existing suspicion that a planned carbon tax would not apply to the nuclear industry would even encourage an increase in nuclear power. In 2002, the year of two important elections, the political aspiration to (further) 'green' the French tax system has just been put on the ice.

2.3.2 Renewable energy policy until recently

French renewable energy policy is the responsibility of the Ministry of Economy, Finance and Industry. Its 'Service des Energies Renouvelables et Utilisation Rationelle de l'Energie' (SERURE) formulates the propositions and controls the 'Agence de l'Environnement et de la Maîtrise de l'Energie' (ADEME) as well. Traditionally, the focus of ADEME has been mainly on energy saving; this is changing however. Interest in the development of renewable energies in France is certainly increasing. This has been one of the reasons to increase the annual budget of ADEME from 318 million Euro up to 412 million Euro from 2000 on. (Note that this still is merely a fraction of the yearly budget granted to the CEA, the French institute that does the research on nuclear electricity.) Moreover, half of the budget still deals with waste and 20% with transport, air pollution and noise. Only 18% are meant to pursue the energy saving objectives together with the deployment of renewable energies. Yet, this last category has evidently benefited most of the recent budget increase. One example of activities instigated by ADEME is a participation in the European initiative 'Campaign for take off for Renewable Energy Sources-Electricity', launched by the European Commission. Up to the end of 2006, thus over the Commission's ending date of 2003, ADEME executes 26 state-Region contracts fostering sustainable development with a significant augmentation of renewable energy. The main part of this programme is dedicated to the deployment of renewable energy technologies in the French overseas departments (DOM), the French territories (TOM) and Corsica. In these regions, the economical conditions for renewable sources are more favourable. Moreover, newly available

fiscal incentives are providing the other part of the motivation in the DOM-TOM. Besides this spatial choice, three important 'source' programmes aim at spurring wind energy, small hydropower and biogas installations. To implement these programmes, ADEME mobilises 530 million Euro for seven years, the regions 440 and the Structural Funds of the EU a total package of 273.

The French utility, as far as it concerns its activities with renewable energy development, seems also to have focused on the DOM-TOM-Corsica. EdF devotes a very small (but increasing) part of its turnover to develop renewable energies prominently in these regions. EdF primarily invested in wind and solar energy, or in a combination of those. Wind power installations actually might constitute the most important supplement for energy sources in DOM-TOM. Solar energy might be mainly used to power habitations that are too isolated to be connected to the electricity grid and as a non-negligible back-up energy source in DOM-TOM (when functioning with batteries). These regions are exceptional due to their growing electricity demand (with a continuously high average of around 8%), an increase that is even encouraged for development aims. Another typical feature is that their grid-connected electricity generation is at least twice as expensive as in metropolitan France. In DOM-TOM-Corsica, 'conventional' electricity generation can only be realised in small-sized thermal plants, which costs are higher than those of high-power installed plants in metropolitan France. The large number of isolated sites combined with their access problem, makes the installation of electric lines for powering them, complex and expensive.

In these circumstances, with high costs for conventional generation in DOM-TOM-Corsica, one would have expected prosperity for most renewable energy options there. This is not the case; the practice is disappointing. EdF and/or Independent Power Producers (IPPs) seem not 'motivated' enough to reduce as much as possible the above-mentioned losses and/or to seize opportunities. Compared to obvious resources and economical opportunities, it seems that EdF has even been reluctant to start renewable electricity projects. As a rule, the money proposed by EdF to the IPPs in these regions has often been too short for their projects to be profitable. The main reason for this disinterest lies probably in the principle of 'perequation de tarifs' (postage stamp) also known as 'continuite territoriale'. Defined as a public service, the electricity industry follows the principle of geographic uniformity of prices across the entire national territory, explicitly including the French overseas departments. Differences in powering metropolitan France and DOM-TOM-Corsica sites are paid for by all French citizens. As a result of this principle, EdF loses a lot of money each year (nearly 455 million Euro for 2000). This is not only due to its obligation to supply all citizens in the French territory, but also of course in combination with the social objectives to deliver electricity at low prices. Altogether, too few incentives to help new technological 'filieres' which costs, not surprisingly, surpass even those of expensive conventional, at least for the time being. In the new Electricity Law of February 2000, a new fund ('le fonds du service public de la production d'électricité', with a budget of 15 million Euro) has been created to deal with these exploitation losses.

In all, prevailing principles of social cohesion, like the 'perequation tarifaire' that fights against social exclusion by ensuring the right to electricity for everybody, tend to create (additional) distorted price signals for investments in new renewable technologies. Even a public utility, servant of the public service with among other objectives an optimal management of national resources, seems to react to short-term signals instead of taking more seriously into consideration long-term objectives like that of independence and of clean environment. Previously, EdF was free to negotiate the contract with each IPP, and the price EdF was willing to disburse for 'green' generation merely based on the inevitable measure of 'avoided cost'. Under current legislation however, EdF copes with a purchase obligation for all the power from renewable energy sources produced by IPPs, at least, up to 12 MW installed. For most technological sources, a legislative minimum price is even indicated (as indicated by recent Decrees). The development that has not come yet may appear soon, mainly in view of recently increased tax breaks for renewable energy investments. Moreover, favourable technological learning effects affect further

posterior investment decisions. All told, uncommon site circumstances and technology-specific factors will privilege the development of each form of renewable energies (solar, thermal, photovoltaic, wind, biomass, geothermal). This will happen initially in the French overseas departments, and in any metropolitan site with alike circumstances thereafter.

2.3.3 'En France on n'a pas de petrole, mais on a des idees'

Having been quite stunned by the first oil shock, the French government reacted to the second oil shock by propagating the slogan which translation is the following: 'in France we have no oil indeed, but happily, we have ideas'. Twenty years later in 2000, Prime Minister Jospin asked Yves Cochet, to give an account of the renewable energy situation in France. Cochet was also invited to work out concrete ideas and concrete recommendations for the government in order to implement further the EU Electricity Directive. The outcomes of the longed-for 'report Cochet' were very encouraging for all categories of French renewable electricity sources. Cochet himself was at that time green member of Parliament and vice-president of the National Assembly, became Minister of the Environment after the summer of 2001, and is since June 2002 in the Assembly for the Green Party in Paris.

Cochet's main message was that France should take all measures needed in order to save 40 TWh electricity in 2010 and at the same time generate 40 TWh new renewable electricity. This combination should lead to an increase from 14% renewable electricity production to 21% as required in the European RES-E Directive. Cochet pointed out that such a renewable boost also means decentralised and diversified electricity supply. This somehow collides with the French culture of 'centralisme' and 'productivisme'. Up till now, it seems that people interested in power generation just cannot count in terms of hundreds of kW but only in thousands of MW.

Most propositions in the report Cochet are of a fiscal or an economical sort, for example a reduction of the VAT and other taxes on renewables. Some of these measures have already been accepted and some of them even implemented, such as a series of feed-in tariffs for some renewable sectors (wind, solar). Many of Cochet's propositions are meant to address specific problems and impediments encountered by private investors in renewable energy projects. One of the propositions has been to modify the flexible depreciation of 100% in one year, a fiscal incentive administrated by the Minister of Finance. The Cochet report revealed that this 'incentive' was just inaccessible for a new investor in a RES project. Moreover, the incentive is often not attractive for investors with small-scaled project with accordingly expected small benefits. As an indication of many additional aberrations addressed in the report Cochet, note that the wind projects are required to be at least for 1,5 MW and more expensive than 1,5 million Euro. Once more, small is not considered beautiful. One striking feature for the basket of proposed measures is that different best practice and learning experiences abroad, a quite recent approach in French policy making, have inspired them. And indeed, the main advantage pursued by the work group has been to elaborate solutions and recommendations that would be more or less proven, both technically and legislatively. This additionally means that their recommendations might be implemented in the very short term.

3. THE RENEWABLE ELECTRICITY TECHNOLOGICAL OPTIONS

3.1 France puts most of its energy in wind

3.1.1 Disappointing results of EOLE

By the end of 2000, France had no more than 94 MW wind power installed (115 MW end 2001) and the EOLE-2005 program, which had set in 1995 a target of 500 MW for 2005, was heading for a fiasco (BTM consult). EOLE was one of several National Energy Plans, based on an agreement between EdF, various involved Ministries and ADEME. The implementation was in the hands of EdF, in charge of selecting the best projects. Like in Ireland and the UK, which are countries also using a tender system (NFFO) to stimulate and evaluate the RES projects, the obvious problem with EOLE was that it creates uncertainty for the investors. It leads to a permanent 'stop-and-go' regime; moreover, the French utility was said to implement EOLE in a capriciously way. However, the criteria used by EdF for the selection of the projects were not really arbitrary, since they are merely based on economical measures with the unit cost of electricity as criterion. The length of the contracts was often 25 years, which should have been seen as a positive element, but EOLE was commercially less attractive when looking at the price level. The EOLE tender contracts resulted in prices of circa 4.5 €ct/kWh, which appears to be the lowest granted to wind energy in Europe at that time. Under these circumstances, it was rather difficult to keep fighting against (too) long administrative burdens and planning procedures and other obstructions. Involved investors can tell about problems that emerged only after prices had been contracted. They appeared powerless to re-negotiate the very low prices formerly contracted through EdF's tender procedure.

So far, the results of EOLE are indeed very poor. France seems to have invented 'virtual wind energy' as five years after the start of EOLE-2005, only 10% of the generation contracted with EdF is effectively produced.

3.1.2 Redefining a target for wind

Stimulated by the January 2000 MIES plan, Prime Minister Jospin announced in May 2000 that the new national target for wind power would be 3,000 MW by 2010. However, in his famous report in September 2000, Cochet stressed that the newly upward revised 3,000 MW target was still too low and France should be aiming for 10,000 MW in 2010 in order to get 21% of its electricity from renewable sources by 2010. This would also help to reduce France's heavy reliance on nuclear power. Cochet suggested that France should opt for a feed-in system obliging all local utilities to take renewable electricity fed into their grids at a fixed premium price. In his conclusion, Cochet recommended a high wind tariff (of 7,6 €ct/kWh). Note that, up-to-date, only a few of all Cochet's recommendations have been completely followed.

As expected, the 'Commission de Regulation d'Electricite' (CRE, newly headed by the former nuclear mogul Jean Syrota) and some officials in the Ministry of Industry were against such 'compassionate' policy. They 'calculated' what the costs of the proposed feed-in tariffs would be for the 'Fond de Service publique de production d'electricite'. The total bill would be 909 millions Euro for the Fund and presumably 0.23 €ct/kW extra for the consumer (not everybody agrees with their computation). Finally, the French Secretary of State for Industry, Pierret, announced in December 2000 the choice for fixed premiums or 'Renewable Energy Feed-In Tariff' (REFIT) for sites up to 12 MW. He also announced a new official target of 5,000 MW by 2010. This strategy clearly intends to make wind energy profitable for (mostly small) investors

and to open this way a wide range of potential sites across France. The final choice for feed-in tariffs for projects up to 12 MW but retaining the tender system for projects over 12 MW is a well-conceived compromise. The Ministry of Industry, EdF, the 'Syndicat de Energies Renouvelables' (SER, the renewable energy producers umbrella group), the 'Association Francaise des Industriels de l'Eolien' (Afineole) and the French Wind Energy Association (FEE) obtained together this compromise. Eventually, after a long process of cryptic policy initiatives, France has boosted its wind target, and has got fixed prices and a long-term strategy.

3.1.3 REFIT particularities

The above-mentioned results and consequent developments have logically formed the basis of the long awaited decree, published in May 2001 by the Ministry of Industry. The decree specifies that the basis for determining a feed-in tariff can consist of a compensation for the investment cost, the avoided cost of electricity to the Supply Company and a supplementary remuneration for its environmental benefits. In June 2001 France passed an 'Arrêté' on the exact pricing of wind power. It specifies that all operators of wind farms under 12 MW will receive a feed-in tariff of 8 €ct/kWh for the first five years of operation. For the following ten years, the tariffs will vary between 3 €ct/kWh for wind sites with an average annual production of more than 3600 kWh/kW and 8 €ct/kWh for sites with an average annual production of less than 2,000 kWh/kW. The tariffs between 2,000 and 3,600 kWh/kW are obtained through interpolation. Furthermore, the tariffs vary slightly depending on the region where the wind farm is located. Averaging out the two tariffs, a French wind farm can expect to earn between 5 and 8 €ct/kWh over the 15 years of its contract. This is slightly higher than the average feed-in tariffs as practised by other Member States in 2001. Additionally, having considered that extra dynamism was needed, applications for the feed-in tariff up to the first 1500 MW will receive an even slightly higher tariff. The logic of this stimulation is disputable, as one may expect that the first projects will try to use the best sites. Lastly, note that offshore wind farms are not included in the current feed-in pricing system for wind energy.

As France finally chose for a combination of competitive tendering and fixed premium wind tariffs, the system presents, with mainly two particularities, a more complicated image than, for example, the German one.

First particularity

For smaller projects, REFIT will run for 15 years divided in two periods. The tariff will be reduced according to the productivity of the site as demonstrated in the initial five-year period. Such 'variable-fixed' tariff is applied to cater for the different wind speeds between the two main areas of activity: the windy Languedoc on the Mediterranean and the relatively less windy north-western Atlantic seashore. It seems too difficult to work with differentiated tariffs from the beginning, i.e. without acquaintance and data. Moreover, even regional tariffs are designed to cope with productivity differences. A variable-fixed tariff, it is believed, will prevent an exaggerated concentration of wind plants in just a few areas. The government fears that otherwise only the (economically) best wind sites will be developed (where they might situate) and that this will increase opposition from the population. Thus, the target is not to achieve 5,000 MW at the least costs for society, but landscape and acceptability are important too.

Second particularity

The second particularity lies in the fact that the type of contract will depend on the size of the plant. For projects over 12 MW, a tender system like the competitive bidding for contracts of the EOLE-2005 program is retained. The parties may 'agree' tariffs that are higher or lower than the fixed feed-in tariffs. Rather small actors on the wind generation market, but still above the 12 MW limit, may feel uncomfortable when having to deal with EdF's tenders. The issue is that the avoidance of dealing this way with the utility de facto means that these actors then remain rather small. Alternatively, this might lead to contortions in the investors' behaviour as the in-

volved investors supplicate for either under the 12 MW or above the 12 MW depending on their anticipations of the contracted price instead of technical data related to the site.

3.1.4 Expected impediments for new French wind

While the wind energy producers and developers have had a difficult time in France, the new wind program is expected to provide new impetus to the development of wind energy. Given the progress made in 2001 and given the fantastic number of MW claimed for the next decade, the wind industry and ADEME are still optimistically pushing their forecasts to even 12,000 MW by 2010. Examining the many projects in the pipeline, BTM Consult foresees a development pattern similar to that in Germany and Spain.

An increase of administrative planning burdens

The disappointing rate of completion of the current EOLE programme is indirectly a result of problems with obtaining the linked site-planning approvals. Numerous lead times and administrative burdens, much higher than those expected, had rendered the proposed projects unprofitable. The recently adopted feed-in pricing system is expected to create the necessary financial certainty for developers, mostly because it includes more costs than merely 'plant costs'. However, some investors still are afraid to meet with the phenomenon of 'virtual wind electricity'. Of course, with the increased guaranteed revenue, developers might put more effort in tackling the other, administrative issues. Policy decisions regarding land and urban planning are said to currently form the barrier to wind power deployment in France.

The issue about grid capacity

Although financial and economical circumstances are improved with the REFIT programme, it is not clear yet who is responsible for grid costs. Many wind investment projects raise problems with regard to grid connection and/or grid strengthening. The project investor seems to be required to pay at least for grid connection. In this case, he will accordingly minimise the distance of new installations from existing connections. Besides connection of the project to the grid, there is the issue of the transmission capacity. The current French transmission capacity has been explicitly designed for the distribution of electricity to every citizen, even those living in remote areas. A true change in the way of thinking is necessary. Up to now, EdF merely considered renewable energy in terms of expected advantages related to the reduction of peak demand or related to the increase of stand-alone generation capacity. Indeed, the existing renewable funds (spent for example on PV systems in rural areas) were aimed at substituting grid extensions or grid strengthening, not at all at expanding them. All things considered, EdF as an operator has made an historical case of building an energy distribution system, capable to distribute small amounts of kWh everywhere. There has been no special attention given to also collect the energy from wherever in the 'distribution' system. But what wind project developers ask the utility today is to collect *and* circulate thousands of kWh in the reversed direction.

Responsibility and solution

The grid issue is crucial and seems to divide the parties seriously. This is mainly because the best wind sites in terms of resources are often the most expensive for grid connection and strengthening. By now, part of this responsibility rests with RTE that will tell the operator how far it is expected to go with the integration of decentralised collection of electricity for each region, each city, etc. The issue becomes tricky when one realises that the above-mentioned decision to be taken by the RTE depends on the volume of claimed wind projects. The total will be determined by a very large number of small investors. But wind investors are de facto only potential investors from various nationalities having retained an option for a special site. As long as these potential investors are not certain about their grid (connection and/or strengthening) costs, they can not definitely apply. On the other hand, the RTE can not determine the true grid costs for each project without knowing about their total. Seen from this point of view, one can regret that the French system is a bottom-up approach instead of a top-down approach as fol-

lowed in Spain. Given a continuation of the bottom-up approach, the estimations for the French wind energy branch (well above 10,000 MW in 2010) might well turn out to be an overestimation both of the MW and of the speed at which they can be installed.

Last but not least in this exercise of weighting up, it is interesting to better examine the position of the French utility in this altered, still evolving circumstances. As known, EdF has disputed for a long time the height of the feed-in tariff, which would be a clear departure from the actual, lower costs. If it is the real case, then, one may expect EdF to become itself a very large wind project developer with as a strong motive to avoid disbursing 8 €ct/kWh. Moreover, EdF is well placed to know all about administrative burdens regarding land and urban planning, and it is also the market agent with the most information about grid accessibility and linked costs. For a matter of fact, EdF is one of the owners of SIIF Energies, which is increasingly active in the field of wind development in Metropolitan France and Corsica. Additionally, EdF has started up activities within its own departments that will contribute more directly to an assessment of the true opportunities.

3.2 Other renewable electricity options

3.2.1 Hydro as the leader of renewable electricity generation

Large, larger, largest

Thanks to very good use of hydropower technology and resources, even if these resources are not the best (think of Norway and Sweden), France is one of Europe's leading renewable energy producers. Hydro-electricity remains the sole renewable energy produced on a large scale in France. The 220 reservoirs (including dams) operated by EdF serve several goals. They are used as tourist attractions to promote regional development, and they are used for occasional irrigation of cultivated fields. Additionally they are valuable to increase river flows (to occasionally improve navigation) and for drinking water in the event of major droughts. Hydropower energy, in combination with nuclear energy, is largely responsible for France's autonomy in terms of energy. And both contribute to fight the greenhouse effect. The flexibility of hydropower is greatly acknowledged in the French electricity system as a whole. For example, it takes the Grand'Maison pumped storage plant in the Alps only two minutes to provide 1,800 MW of power. This flexibility makes it possible to accommodate abrupt variations in overall demand, for example during a cold snap. This permanent modulation makes it even possible to save on nuclear fuel and decrease maintenance costs of nuclear plants. It is reasonable to state that, without the highly developed hydropower electricity, nuclear energy could not have played the important role it plays in the French electricity system.

EdF's own hydro installations provide 23,300 MW of power, out of almost 25,000 MW in 2000, which is circa 25% of the total amount MW installed in France. The electricity production usually amounts 70 a 73 TWh (depending on rainfall), which is on average, 15% of domestic production. The huge reservoir hydro stations with high falls, mainly located in mountainous regions, are particularly used to regulate the seasonal production of electricity. On the contrary, the run-of-river power stations do not have reservoirs and their linked production advantages. All the same, operating with very low falls and powered uniquely by the flow of the river, they provide most of the hydropower production in France. Finally, French hydro capacity is completed by plenty of small and micro hydropower plants that have been relatively inexpensive and relatively easy to set up. The production share of these small (up to around 15 MW) installations is 10% of total hydropower (about 7.5 MWh). In Metropolitan France, EdF use small plants mainly to contribute to powering a general network interconnected with other plants. In the DOM-TOM, EDF and some Independent Power Producers use them in isolated networks to provide electricity to a village, an industrial site or agricultural complex. This explains that 1,300 of the nearly 3,000 small hydro plants generate less than 1 MW.

Small, smaller, smallest
Micro hydroelectricity (< 10 MW of unitary power capacity) is a proven technology that has now reached technical and economical maturity. In the context of these improved conditions, a recent (2001) study carried out by the ESHA (European Small Hydraulic Association) estimates for the EU the potential that is still available in terms of micro at 5,939 MW (including 1,110 MW of rehabilitation) (ESHA in Observ'er, 2002). This study, which takes some way environmental and economic constraints into consideration, found 1,300 MW for France (1,000 new installation and 300 rehabilitation). This is to be compared with the 2,018 MW installed in France by the end of 2000. (One should always take figures about micro hydropower with considerable caution, since the absence of regular updating of installations led the researchers (ESHA and Observ'er) to estimate part of the capacities.) As seen above, the combination of large and (very) small hydropower plants would suit even more the entire organisation of the French electricity sector. However, this current (misleading) stability is endangered. Recent developments show that the small hydropower sector has shrunk and that earlier investments are sometimes not profitable anymore. This had been the motivation for Cochet (even before the study by the ESHA) to ask the French government to augment the kWh price of all *current* hydro contracts. This should even be the case for those contracts agreed on an emancipated basis with EdF (often for a period of 15 years or longer). Cochet also proposed an *instant* 'bonification' of 10% for all existing contracted prices, as a rescuing manoeuvre. Cochet required the French government to commit itself for a target of 1,000 MW additional micro hydropower in 2010. This would be a nice contribution (27%) to the target of the European Commission: 14,000 MW installed micro in 2010 against the 9862 in 1999 and 10,260 MW in 2000 in the EU (Eurostat).

The French government granted in 2001 the required bonification of 10% to support firm hydropower suppliers, but only in the winter period. Cochet recommended a dual tariff, for projects up to 500 kW and for projects above 500 kW. Again, the government acted upon this recommendation by granting 6.5 €ct/kWh for less than 500 kW plants and a little bit less for larger micro plants. As required, the contract may even run for twenty years. However, the government did not take over the proposed target of 1,000 MW additional hydropower in 2010. It did not regard it as realistic. Anticipated unmanageable aspects, like regulatory and administrative burdens, are at the basis of this decision. Indeed, two decades long, France had put a clear, increasing priority on environmental issues such as environmental impact assessments, water management, coastal protection measures and river protection. The result is a jungle of legislative measures in these various, linked fields, and a jungle private investors in small hydro and wind have to cope with. For example, since a decree issued in October 1996, impact measures of small hydropower investment projects on rivers and fishing practices have to be developed in compliance with the increasingly severe legislation from the Ministry of the Environment. Current investment practice indicates that only very few small hydro projects are now being considered, as a logical result of this regulatory reversal.

3.2.2 Geothermal

Geothermal energy is composed of two sectors that are characterised by different technologies and applications. High and middle temperatures (between 200 and 350°C) are necessary to produce electricity, and low and very low (below 200° C) temperatures to produce heat. The rich volcanic resources of the French DOM-TOM are put to good use by producing high quality geothermal energy. Medium and low temperature geothermal energy is used to produce heat for e.g. fish farming or drying of agricultural products. With regard to electrical production, Bouillante (Guadeloupe) is the only geothermal plant of its kind in the Eastern Caribbean, a region scattered with volcanoes which geothermal potential is probably vast. Bouillante has been connected to the electricity network in 1996 and produces around the 22 GWh in the years 1998 to 2000, but an annual production of around 160 GWh is expected for the intermediate future (EdF, 2000). The experiments made in the Bouillante power station are not only worthwhile in

terms of their contribution to Guadeloupe's energy and economic well-being but also to be used as a reference to develop the use of geothermal energy in the rest of the Caribbean region. Metropolitan France does not truly possess potential resources in terms of high temperature (aquifers between 180 and 350 degrees) geothermal energy like Italy and Portugal do. It produced only 21 GWh electricity in 2000. However, the French government seeks to increase almost with a factor four its installed capacities in low temperature (up to 19 MW heat). This will be however difficult to materialise and to estimate as most installations are operationalised for very small-scale applications (diversified heating aims, etc.).

3.2.3 Tidal energy

Besides geothermal electricity, France utilises the tides in Brittany where they built an installation unique in the world since 1951. To date, the 'La Rance' plant in Brittany is the only one in the world capable of converting the power of the tide into electricity on an industrial scale (240 MW). Its annual production is 640 million kWh, representing 80% of Brittany's production and the equivalent of the annual consumption of the city of Rennes (EdF, 2000). The plant is build in a dike that is over 700 metres long, which runs through the La Rance bay, forming a basin of 22 square kilometres. The construction of La Rance plant also provided the opportunity to extent general infrastructure in the region, as there is a highway incorporated. After this experiment, France chose to wait whether other countries would develop the tidal technology to an acceptable price. Moreover, research in wave energy for France does not mean any more energy from the constant *horizontal* wave realignment, but instead energy from the irregular *vertical* wave move. This turn-around in technological focus has also been determined by the results of research on environmental impacts of tide (horizontal) energy. The impacts have been recently considered to be unacceptable for the environment (mainly, for the fish).

3.2.4 Solar electricity

In France like elsewhere, the high cost of photovoltaic electricity has hindered its development. However, thanks to increased performance and decreased costs, PV can now be used to efficiently power sites that are too isolated to be connected to the grid. In theory, the savings made on the costs of connection offset the kWh price. In DOM-TOM, EdF and ADEME have provided financial and technical support to equip over 3600 homes, sheepfolds, etc., with PV. In 1999, 1,000 houses were electrified with circa 1 MW installations and the estimated installations for the coming years concern 3,000 homes in Metropolitan France and over 7,000 in DOM-TOM-Corsica. However, the technological results of the French industry (France exports its off-grid PV technology) does not seem to help France really. Indeed, in terms of installed MW at the global scale, on-grid solutions are far more developed while the French industry has focused on off-grid solutions. In France, there is currently not more than the 'HELIOS Plus' programme, an amendment of the former HELIOS 2005, that should lead to 50,000 solar heating and 25,000 m^2 PV in seven years. One might expect an increasing number of micro-applications to add to the PV potential for the near future. However, these results will remain insignificant in terms of their contribution to avoid fuel consumption and emissions compared to the needs created by the official targets.

All considered, one might expect France to wait and see for large-scale PV implementation in other countries. Unexpected in the Cochet report is that there is no shocking, ambitious target required and there is no feed-in tariff requisite for PV. Even without these recommendations, a new electricity law appeared in March 2002. The law puts a purchase obligation for RES-E with a capacity of up to 12MW and specifies further the basis for determining a feed-in tariff, like a contract length of 20 years. The level of a feed-in tariff for photovoltaic electricity is 15 €ct/kWh for Metropolitan France and 30 €ct/kWh for DOM-TOM. Besides this moderate guarantee for generation income, there is also an investment subsidy of 4,6 €ct per installed Wc or even 6,1 €ct in case of supply secured through a battery system. This addition is thoughtful but

is not expect to fuel many project developments. Evidently, France is not prepared to disburse disproportionately high feed-in tariffs for PV, like those granted in Germany, the country that makes up for almost all growth in PV in Europe. France does not want to support seriously a renewable technology that is still far from commercial viability.

3.2.5 Biomass and biogas: bagasse and municipal waste

The experiments conducted in Reunion Island and in Guadeloupe with bagasse, a sugarcane by-product with very high calorific properties, are a showcase of French know-how that could be used in other sugar producing nations. An early French experience with biomass concerns combined bagasse and coal power plants. Charbonnages de France, in association with EdF, thought up some original solutions to produce energy in the overseas departments using *local* resources, as this might have been the first goal. For example, two power plants on Reunion Island run on bagasse during the sugar season and on coal during the rest of the year. Producing 2 million tons of sugar cane a year, Reunion Island has access to 640,000 tons of bagasse, which is the equivalent of 120,000 tons of coal. In 1992, the first mixed power plant of 60 MW was commissioned and bagasse provides 40% of production. A second plant came on line in 1995. The cost per kWh produced is competitive for an overseas department. The two plants together provide 44% of the electricity of the island. In 1999, a similar plant of 60 MW started in Guadeloupe. Besides these eloquent examples in DOM-TOM, Metropolitan France is mainly interested in the exploitation of wood energy, for which France is a leader in Europe. Even though thermal uses (heating and industrial boiler plants) represent the essential of primary wood energy production, there is also a sector of electrical production resulting from cogeneration. To go this course, it will be necessary to first solve the technical and (mainly) financial problems encountered by cogeneration as quickly as possible. The report Cochet required the urgent adoption of purchase prices for electricity of wood energy origin that are really motivating one.

Biogas refers to the gas produced in landfills by the fermentation of household waste. It is produced in any place containing household waste totally or partly deprived of continuous aeration, more particularly in household landfills and water purification stations. Biogas is essentially a mixture of methane (45% to 65%), and the installation of equipment to convert the methane into exploitable gas for electricity (or heat) is part of France's environmental commitments. France wants to follow the example of the UK that is the leader in biogas exploitation. The current French biogas energy policy is heavily affected by the decision to eliminate as soon as possible waste stations in France without methanisation units (although there is not yet a firm deadline). The harsh decision taken by the French government authorities is expected to bring some difficulties to the sector unless it quickly reacts. Up till then, municipal waste in France was just stored (space enough within the country) and biogas only was an evident potential to be better valorised. In 2000, biogas electricity has been produced up to 346 GWh, a large increase compared to 1999. From the 60 methanisation units in Europe in 2000, France has thus only very few. It might have the biggest one, located in Amiens and owned by EdF, but it is however devoted to the production of heat. The utility provides, through its specialised subsidiaries, municipalities with its experience and know-how in the elimination of household wastes. And it also announced that it would itself consider the recycling of waste, one of its development poles in the near future.

4. CONCLUSION AND OUTLOOK

The organisation of the French energy sector has changed over the past years, even if probably less than in most European countries. Prominent influences that have an impact on all Member States in the EU, like deregulation, privatisation and internationalisation, have an impact that is still unfolding in the French energy scene. Clearly, France refrains from fully contributing to these changes as the French government reckons that the outcomes of the current trends fall short of what an optimal state of energy industry would look like. As seen, historical background and particular circumstances led the country to develop the technically well functioning, nuclear-based electricity sector. The conclusion that is elaborated on in this final section sharpens up the content of the paper. It is expected that France might (further) shift its focus from nuclear towards renewable electricity by increasing its odd, strong, overall regulatory guidance instead of lessening it.

In France like in most Western countries, in the field of renewable energy technologies, most of the incentive mechanisms emanate from government policy measures. In the past, France has pursued, to some extent, a diversification target in its renewables portfolio. But one can notice France adjusting the relative importance of its policy measures between technologies, depending on the opportunities that the renewable technologies have to bring the country closer to the EU Directive target of 21% renewable electricity in 2010. Despite an enlivened commitment toward the greening of its electricity supply, there seems to be still quite a huge task. Like in other countries, any new energy option has to be assessed against the existing ones. Clearly, for France the hurdle is higher. The legitimisation process has to measure up with very large-scaled technologies, like large hydropower and nuclear power. Within the framework of the existing power balance (of course, once set up without counting with the greenness) renewable energy technologies had been deemed to be of no interest. (Until recently, the French energy policy scenarios were not designed with reference to France's commitments under the Kyoto Protocol and the resulting EU burden-sharing mechanism.) The resulting lock-in is part of a larger phenomenon related to norms and values in the society at large regarding existing energy technologies. Additionally, the ambiguous acting of the French utility and the departmental compartmentalisation (the lack of consistence between different Ministry's policies) has also blocked renewables market formation.

However, the above statements do not mean that there is no hope and even no good rationale for France to walk further on a sustainable energy path. France might be interested, as it generally is, to look both at the product renewable electricity and at the technologies that can produce it. In this sense, one better grasps why French actors speak easily about the 'technological filiere' and not merely about its output, renewable electricity. There are (mainly historical) reasons to expect that France will seize various opportunities it has to build and support (some way) renewable energy technological filieres. By embracing the whole technological system, the French government can enhance the legitimisation process that it, no matter how, needs to achieve its renewable electricity target. This is not to say that France should implement any measure of protectionism towards its own producers. Not only this would not suit the Community Guidelines on State aid and a number of European directives to achieve an internal market. Additionally, this would only be possible to a limited extent, as the incumbent renewable technology manufacturers, such as the German and Danish wind turbines producers, enjoy a good reputation and a great legitimacy. But one can not really imagine why a country with splendid renewable resources should not strive to kill two birds with one stone when this opportunity seems to come.

Once, the French vast, long-term nuclear programme seemed the optimal response to the combined objectives of low energy prices, security of supply and environmental protection. A

changeover is in the air. Another long-term, renewable energy programme might be developed even in the French context of close government surveillance or guidance of the markets. Wind and solar programmes are expected to yield far better energy/economy ratios than for example the fortunate French biofuel programme. Biofuel has, beyond an energy rationale, been more motivated by the desire to provide temporary relief from necessary adaptations in the agricultural sector. There will always be more rationales (mainly security of supply, environment and industrial policy) to support renewable energy (technologies). Meanwhile, in the process towards such renewable energy developments, France should at least eliminate some clumsy burdens related to the planning procedures and other transaction costs suffered by project developers. Otherwise, market distortions often set up by governmental administrations themselves, might terminate several promising renewables market developments. Renewable energy technologies are capital intensive, even compared to nuclear or combined-cycle natural gas. In deregulated electricity markets, investors need strong guarantee that capital costs will be recovered. If French and European regulation can be designed in such a way, French and foreign players on the French territory will change their actions into the desired, renewable direction.

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