

A Competitive Fringe in the Shadow of a State Owned Incumbent: The Case of France

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We examine what kind of competitive fringe has been built in France around the State owned incumbent without destroying it or significantly weakening its dominant position; what impacts this particular reform process have on the market in which the incumbent monopolist is still overly dominant; and what more can be done to strengthen the opening of the market while staying in this typical French policy framework (no industrial restructuring and no forced divestiture by the monopolist). We wonder if a larger window of opportunity will open up at some later date for contesting the position of the monopolist, especially when investment in generation resumes.

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INTRODUCTION

The French electricity reform, framed by successive acts of legislation passed in February 2000, January 2003, and August 2004 implementing the European directives, is a typical case of reform without industrial restructuring of the dominant operator. France is not the only European country in which the legislation did not impose significant industrial restructuring on the dominant operators (cf. Sweden, Germany, Spain, Belgium, Portugal, etc.) alongside the few which partially or totally dismantled the state-owned incumbents' assets and privatised them (England and Italy). However, it is a rare instance of a "competitive" market having been created around a public monopoly that retained all of its industrial assets. What Sweden did was somewhat similar, but with a much smaller state-owned incumbent's market share (50%) (Bergman and von der Fehr, 1999). Consequently, the hallmark of the French reform is the development of a competitive fringe around an incumbent monopoly (Finon, 2003; Finon and Midttun 2004; Glachant, 2003).

This type of electricity reform must raise a number of questions, some of which are quite interesting. What kind of competitive fringe can be built around the monopoly without destroying it or significantly weakening its dominant position? What impacts can this reform process have on the market in which the incumbent monopolist is still overly dominant? Can more be done for this reform while respecting the framework of the French policy (no industrial restructuring and no forced divestiture by the monopolist)? Is this type of reform sustainable or transient? Will a larger window open up at some later date for contesting the position of the monopolist, especially when investment in generation resumes?

We will address these questions in five parts. In the first part, we will see whether foreign competition can, at least potentially, constitute a competitive fringe around the French monopoly. Is this monopoly vulnerable to competition from abroad? Does the French power

grid allow electricity generated in neighbouring countries to penetrate the domestic market? Does the French monopolist itself export to neighbouring countries? Is this potential for foreign competition enhanced by a context of excess generating capacity? Do short-term generation costs favour foreign or French producers? Having described the strengths and weaknesses of foreign competition vis-à-vis the French monopoly, in the second part we will turn to examining some competitive provisions imposed on the domestic market to reduce the monopolist's power. These are French and European initiatives, including direct measures affecting supply and demand and adjustments to market mechanisms and market access. In the third part we will examine whether these various measures of competitive encirclement of the monopoly has had a perceptible impact on the domestic market, in terms of volume or price. In the fourth part, we will examine a scenario in which competitive pressures increase on the monopoly at the time of resumption of investment, especially when the French nuclear generation capacity is due for renewal. When will investment in generation be relaunched in France, and how will the nuclear capacity be renewed? Who will invest, and where? Finally, after observing that no massive investment programs can be expected in France during the upcoming decade, and that its practical aspects remain very uncertain, we will devote the fifth (and last) part to answering the question of what might be done to bolster the competitive framework in the highly probable event that France's policies will remain unaltered (no main industrial restructuring or forced divestiture of generation and sales).

II. A quasi-monopoly in a transmission grid open to foreign competition

A domestic monopoly can be challenged from abroad if its transmission grid allows power to be imported from neighbouring countries or if it is, itself, exporting to those countries. This

competition from abroad is all the more intense when excess generation capacity exists and when short-term production costs favour foreign producers. These special conditions are only partly applicable to the situation of France's electricity monopoly. However, they suffice to create a potential for foreign competition.

France typifies the case of government monopolies. In the electricity sector, EDF possess over 90 per cent of generation capacity and 100 per cent of the transmission grid. EDF operates approximately 95 per cent of the distribution network (though these networks belong to local authorities) and supplies about 95 per cent of the clientele that is ineligible for competition (the other ineligible clients draw on local public distributors or non-governmental cooperatives: called DNN), (EDF, 2003 and 2004; RTE, 2000–2003). EDF is thus Europe's largest electricity utility, with nearly 500 TWh. Aside from EDF, there is only approximately 25 TWh of "free" generation, the remainder of independent output being either for in-house consumption or resold to EDF in the framework of "purchase obligations" associated with the "public service of generation" (especially in the case of cogeneration and renewables).

The electricity transmission grid remains an internal department of EDF, but its management and operation have been separated from EDF's chain of command and placed under the direct control of the independent regulator CRE (the Energy Regulatory Commission). The regulator monitors and guarantees the separation on the books and the transmitter's autonomy (including such elements as the investment program, financing, and prices). In practice, the French transmission grid has been essentially run as an independent firm, and there have been no complaints from large consumers or EDF competitors contesting its impartiality (CRE, 2003 and 2004).

Since the transmission system operator does not collude with the dominant generator, the output of EDF's quasi-monopoly feeds into a network that is open under the European

directives, and the generator is thus not protected against imports from abroad. On its four borders (Germany, Belgium, England, and Spain), where import capacity can be defined with the ETSO methodology, this capacity reaches a guaranteed 10,350 MW during the winter. As to the two borders (Switzerland and Italy) on which maximal import capacity cannot be defined with the same degree of precision, it may be said to approximately equal the export capacity (from France), particularly with over 2400 MW of import capacity guaranteed from Switzerland (IEA, 2004). With peak winter demand in France reaching about 80,000 MW (exports account for approximately 13 per cent of this), total guaranteed imports of around 14,000 MW thus equal about 20 per cent of mean domestic demand (70 GW). Since the size of the eligible market was approximately 1/3 of the French domestic market until 2004, and is over 2/3 as of July 1, 2004, France's guaranteed physical import capacity over passed 50 per cent of the eligible market before 2004 and is about 30 per cent since July 2004. This physical import capacity is all the more accessible to foreign initiatives since there is no (or nearly no) congestion to import in France. Furthermore, the portion of the French market open to foreign competition between 1999 and 2004 was industrial customers, who represent the demand that is most price sensitive and most liable to buy from foreign producers.

Table 1. The Opening up of the French Market

Apart from this, the French monopoly is also subject to competition from foreign generators in all markets into which EDF exports. These exports are considerable, since EDF is the leading European exporter with over 70 TWh (approximately 15 per cent of its generation). Overall, in light of its export activities and the openness of its transmission grid, EDF is today

a domestic monopoly that is subject to potential foreign competition for a large volume of provision (at least 150 TWh).

Table 2. French electricity imports and exports in 2001 (in GWh)

This situation of potential competition on the borders of the French monopoly is compounded by the existence of excess generation capacity in France and in most of the countries connected to France's transmission grid. Even during the peak demand in the winter of 2003–2004, five of these six border countries showed “real” excess capacity (power stations in operation) of at least 10 per cent or more above the 5 per cent reserves recommended by the UCTE [Platts, 2004].

According to studies by the French grid operator RTE, this excess capacity during the winter peak in continental Western Europe (estimated at 12 GW above the UCTE's 5 per cent reserves in 2004) could persist until 2008 (when it would decline to 7 GW) before disappearing in 2009 [RTE, 2004]. At the beginning of 2005, French TSO said that this over capacity could end one year in advance.

Nonetheless, even in times of excess capacity, potential competition from foreign producers does not pose a serious threat to French generation who obtain 90 to 95 per cent of their provision from nuclear and hydro. Of course, with nearly 80 per cent of its electricity being generated by nuclear reactors, the French nuclear system has not reached the limits of its capacity (less than 83 % at full output per year—average nuclear performance). But this does not materially affect its short-term costs (fuel plus operation & maintenance). French nuclear power can thus easily confront any “price war” launched by the traditional thermal power

capacity of foreign producers, in particular from Britain, Germany, and Spain. In May 2004, J. Bower estimated the short-term cost of traditional nuclear power in Great Britain at 2/3 that of the coal- and gas-fired and combined-cycle generation technology already in operation (Bower 2004). The French Ministry of Industry set it at only half (13 vs. 25 euros) in its 2007 scenario (DGEMP, 2003). And French nuclear variable short term costs are only at 8 euros then being strongly deterrent to any foreign thermal generator (IGF-CGM 2004). Since the French set of nuclear plants is managed to serve both the base load and the mid base load on a daily basis and operates in strong cooperation with hydro plants, the threat of the French short term costs on potential competitors is really strong. Only Swiss hydropower could easily penetrate the French market in terms of its short-term costs, but prefers to sell into much more lucrative markets (such as Italy).

To conclude, there does indeed exist a potential for foreign competition on France's borders, both because of France's sizable exports into neighbouring countries (over 70 TWh) and because its transmission grid is capable of importing a large proportion of eligible consumers' demand (between 1/3 and 1/2). However, to a large extent this competition remains limited to a potential, despite the excess capacity still in place, since the short-term costs of French nuclear power cannot be challenged by the short-term costs of foreign thermal generation.

III. Provisions for mitigating monopoly power on the French market

Since foreign competition on the borders of France's domestic market remains largely in the realm of the potential, we need to take a look at what competitive initiatives have been taken to mitigate monopoly power on this market, whether by direct action on supply or demand (divestiture of assets, electricity release, procurement auctioning, etc.) or on market

mechanisms and market access (power exchange, balancing mechanism, transmission capacity auctions, etc.).

The presence of a vertical and horizontal industrial monopoly does not leave much room for the introduction of competition. Nonetheless, several margins remained available in France outside of EDF. These margins were broadened by regulatory provisions (from both the French regulator and European Commission) and by private initiatives (such as the creation of the Powernext electricity exchange).

Table 3. Generation Shares of French Electricity Supply Companies, 2002

Several “independent generation” sources were progressively spun off from EDF and associated with foreign operators (Electrabel, Endesa). These are CNR (run-of-river hydro, 16 TWh), SNET (thermal, 8 TWh) and SHEM (reservoir hydro, 2 TWh). In 2004, Electrabel, which is principally active in Belgium (at whose border a guaranteed import capacity into France of nearly 3000 MW exists) was able to expand its participation in French hydro (CNR and SHEM) before negotiating an agreement to jointly operate power plants with EDF giving it access to nearly 1000 MW of nuclear power in France. Thus, Electrabel’s current stated goal is 10 per cent penetration into the eligible French market (30 TWh by 2007).

Also, remaining on the supply side, the European competition authority required that, in exchange for its acquisition of a stake in the German ENBW, EDF allows an electricity release, called VPP (Virtual Power Plants). These VPP, which cover a total of 6000 MW, entered into effect in January 2002 and will continue until at least the end of 2006, at which time the European Commission will decide whether they should be extended in light of the competitive situation of the French market. VPP are built around the auctioning of three

products: VPP baseload (8 euros per MWh withdrawn plus a fixed premium sold at auction); VPP Peak (23 to 26 euros per MWh withdrawn plus a fixed premium sold at auction); and PPA (basic supply between November 1 and March 31 sold at auction price). The durations of these products vary (between three months and three years), but the most common is annual (accounting for 2500 MWh sold). Since the intervention by the regulator in July 2002, the French exchange Powernext has directly managed the daily allotments of the suppliers' VPP to the transmitter RTE. The generator EDF is only informed of the total volume for each hour of these daily allotments.

On the demand side, the French regulator has increased competitive openness on the market of eligible clients by requiring that RTE replaces grid losses (13 TWh) by an auction mechanism open to all (producers and traders). Furthermore, in February 2003 more than one hundred French distributors independent of EDF (the DNNs) became eligible to make their own wholesale purchases of energy (totalling approximately one TWh). Aside from these two measures, all other major competitive changes to demand issue from the legislative schedule for expanding the eligible market (22 per cent of the domestic market in 1999 = 90 TWh; 30 per cent in 2000; 37 per cent in 2003; and 68 per cent in 2004 = 290 TWh). From July 2004 the distribution grid losses entered in the same auction mechanism like the transmission grid.

Besides these direct measures affecting supply and demand, other measures have organised or consolidated competitive market mechanisms and market access. The most important of these measures at the beginning of the reform was the French regulator's neutralization of the conduct of the transmitter RTE, which remained an internal department of EDF. The French regulator, created by legislation in February 2000, did not obtain full power over the transmitter. The transmitter's rates are proposed by the regulator and can be rejected, but not modified, by the minister (this led to a "cold war" over rates which lasted until July 2002). However, the regulator's power was adequate to ensure a true autonomy of the transmitter,

given the active support of its management (the Director of RTE is not nominated by the president of EDF and does not take orders from him).

Since the French grid features little congestion either at the incoming border or internally, access to it from foreign producers does not present major difficulties *a priori*. This is even more the case because the rate for access to the French transmission grid covers all network and systems expenses (fixed costs, losses, auxiliary services, internal congestion) with a single “postage stamp” paid entirely by consumers ($G = 0$; $L = 100\%$). Subsequent to the European agreement on the cross border fee, the French regulator incorporated it into the grid access postage stamp. Consequently, for foreign generators, access to the transmission network for importing into France is essentially open and free (aside from imbalances).

Imbalances settlement first occurred in the framework of a quasi-exclusive supply contract held by EDF that was priced at a fixed rate (for example, in summer negative imbalances at 23–26 euros and positive imbalances at 8 euros). The regulator required that this procedure be changed to an adjustment mechanism open to all offers (independent generators and cogenerators, foreign generators, consumers). This new mechanism is more competitive than the previous arrangement in France, even though it does not create an energy spot market. Since 2003 it has operated with two price differentials (one upward and another downward), each of which includes a 20 per cent penalty on top of the mean cost assumed by the transmitter. To assign a value to the imbalances that help the system operator (RTE) reach equilibrium, the French mechanism is to compensate them at the Day Ahead price from the Powernext electricity exchange.

This French electricity exchange was created in 2001 by the French-Belgian-Dutch financial market Euronext (1/3 of the capital) in cooperation with a consortium of three transmitters (French RTE, Belgian Elia, and Dutch Tennet: 18 per cent of the capital) and the participation

of five European energy suppliers including the electrical concerns EDF, Electrabel, and Endesa (20 per cent combined). Limited to Day Ahead for the first two and a half years, Powernext opened a futures market for monthly, quarterly, and annual (up to two years) trading in June 2004. This exchange has close links to the French transmitter, and the Chairman of the Board of Powernext is none other than the Director of the RTE's "power system department". In particular, the French transmitter guarantees that it will carry all Day Ahead and Futures transactions concluded on the exchange. Other technical and commercial links bind the transmitter to the exchange. These affect the allotment of the VPP, the allotment of other trades between operators for settling imbalances, and the establishment of the value of imbalances by the transmitter. All of these links are supported by the French regulator.

Also, the transmitter manages a mechanism for allotting transfers of Day Ahead "blocks" between operators on the OTC market. As of the end of 2002, the regulator required that a half dozen intraday windows for transferring blocks between operators on the OTC market be opened by the transmitter.

Finally, competitive mechanisms were established for allocating transmission capacity on the line connecting France and England. They cover all timeframes, from intraday to annual. Furthermore, the French and British transmitters can also trade reserves across this same power line, and they are working on opening it up to supplying each other's domestic imbalance adjustment mechanisms. This is the most competitive of France's international borders. On the other borders, the French transmitter prioritises France's exports (operators having used less than 75 per cent of retained capacity lose their priority status in the event of congestion). That rule obviously favours an incumbent exporter with an existing portfolio of stable export contracts [IGF-CGM 2004]. In the case of Italy, until 2004 a pro rata system allocated interconnection capacity quotas to eligible Italian clients on the basis of their

previous consumption. As to the interconnections with England, Belgium, and Italy, the French transmitter cooperates with its foreign counterparts to measure and allocate export capacity. On the Spanish, German, and Swiss borders this type of cooperation was rejected by the foreign partners or the regulatory authorities. However, the Spanish market OMEL and the Powernext exchange continue to work on linking their Day Ahead markets, including a mechanism for allocating interconnection capacity. Cooperation is growing among France, Belgium and Netherlands to establish an “harmonized” framework for the operation of their grids and PXs.

All of these provisions, aimed at surrounding the French monopoly with a “competitive circle”, can facilitate the exercise of foreign competition on the French market (notably access to the transmission grid and use of the interconnection capacity, the opening of an exchange, and a new balancing mechanism). However, these provisions cannot increase the competitive potential of foreign operators. Only the divestiture of generation facilities (CNR, SHEM, and SNET) and the VPP could bring additional competitive supply to stimulate the domestic market. Therefore what results have been obtained with this reform?

IV. The volume and price effects on the French market

Over five years after the beginning of the competitive reform in France, we should be able to identify the main impacts on volumes and prices. We specifically seek to evaluate whether the competitive fringe has truly caught on in France, and what impact it may have had in terms of volumes and prices on the “monopolistic heart” of the French market.

A. Volume effects

We can evaluate the French electricity reform on the basis of several volume effects. In the first instance, we are interested in the origin of the electricity resources of EDF competitors (independent production? imports? VPP?) and then in the use they make of them (sales to eligible clients or the transmission grid? re-export? or...resale to EDF?). We will subsequently examine the evolution of the share of the market of eligible clients for EDF and its competitors. We will finish with some measures of concentration in the different parts of the French market and of France's competitive fringe.

Table 4. French electricity imports and exports from 1999 to 2003 (in TWh)

The relative weight of independent generation, imports, and the VPP in competition with EDF can be identified using data published by the transmitter and the regulator. After the opening of the French market, between 1999 and 2003, potential foreign competition did not result in an overall increase of imports into France, nor did exports diminish to any great degree. During these first years, imports remained at between 0.75 and 1.5 per cent of total domestic consumption, which rose from 431 TWh (in 1999) to 467 TWh (in 2003), while the balance of French exports during 2000–2002 reached a historic high (75 to 80 TWh). However, from 2003 a substantial increase in imports (+3.2 TWh) and decrease in exports (-8 TWh) have been observed. A part of it could be attributable to exceptional climatic conditions that will not recur in 2004.

Data from the regulator is more precise (CRE, 2003 and 2004). They reveal that the resources used by all EDF competitors on French territory evolved from a total of 1800 GWh per month in September 2001 to 7200 GWh per month in March of 2004 (an increase of 400 per cent).

If we base our comparison on the same month, we see that between March 2003 and March 2004 independent generation contributed little to this increase in the volume of resources, while imports added between 500 GWh and 1000 GWh per month. Thus, during the first quarter of 2004, imports by competitors of EDF reached the highest level observed over the past three years. However, the bulk of their resources continue to be supplied by VPP, which contributed nearly 4000 GWh in March 2004 (approximately 55 per cent of total resources).

Use of these resources by EDF competitors has also featured several significant fluctuations. First, only in February 2003 did (direct and indirect) sales to eligible consumers exceed sales to the transmitter RTE (to cover grid losses) and re-exports to other countries. In March of 2004, these sales to eligible consumers reached a monthly record of 3000 GWh. However, as of October 2003, total sales for RTE losses and re-exports caught up with sales to eligible consumers and, in January 2004 and March 2004, also attained a record level of 3000 GWh per month. On the other hand, as of July 2003, total sales by EDF competitors fell substantially below their available resources, with a monthly gap ranging between 500 GWh and 1200 GWh.

Table 5. EDF competitors' business as seen by the grid operators (1st Quarter 2004)

Table 6. EDF competitors' resources as seen by the grid operators (1st Quarter 2004)

This gap reveals that EDF competitors don't sell all their resources to French domestic demand or export, and that they thus finally resell all their surpluses to EDF. If this trend from the second quarter of 2003 and the first quarter of 2004 is to persist, questions will arise concerning the effectiveness of the VPP for creating an alternative competitive supply on the French market; as said –for the first time- a French official report in Fall 2004 (IGF-CGM

2004). In March of 2004, re-sales to EDF reached 1200 GWh, or over 30 per cent of the month's VPP resources. Furthermore, informal "not to be quoted and thus anonymous" sources suggested that actual resale to EDF by the competitive fringe is underestimated by the French regulator statistics. The official report (IGF-CGM 2004) notes that EDF buys about 26 TWh on the French wholesale market (mainly on the OTC). Finally, the last of the major changes that characterised the first quarter of 2004 is that imports by EDF competitors reached the record level of 5 TWh per quarter, constituting 25 per cent of their total resources.

Another volume-based indicator of the French reform is the evolution of sales on the market of eligible clients. This is known as the "switching rate". Aside from auctions to cover grid losses, the penetration of EDF competitors that began in the autumn of 2001, when they skirted 10 per cent of the eligible market, surged to 16 per cent (in volume) in the spring of 2002. This level was not surpassed during the 12 subsequent months (April 2002 to March 2003). A new high was reached in the second quarter of 2003 when this market share attained nearly 19 per cent—followed by a decline to 16 per cent in January 2004. With the opening of the eligible market to all non-domestic consumers in July 2004, the market share of EDF competitors continued to fall to about 11% market share in late October 2004 (before taking into account the distribution grid losses auction), since the size of the eligible market rose from 173 TWh to 318 TWh. After six months of the new opening about 22,000 of the 3,500,000 new eligible consumers had changed supplier (1 to 2 TWh?).

Figure 1. Market Share gained by New Entrants in France (September 2001 to January 2004)

The final volume-based indicators that characterize the evolution of the French market and its competitive fringe represent concentration. The concentration of sales indices documented by

the French regulator (CRE, 2004) suggests that EDF's net activities neither draw power from the Powernext exchange nor cover the transmitter's losses or balancing entities on the OTC market. Unfortunately, the French regulator's statistics are special in defining what EDF is and isn't. They don't consider foreign subsidiaries of EDF as part of EDF itself, in particular EDF's trading arm named Louis Dreyfus. Nevertheless, these three activities are not very concentrated among EDF competitors and EDF foreign subsidiaries, either (HHI below 800). Conversely, on the eligible market, EDF-in-France's share remains above 80 per cent (but below 83 per cent), and, on the export market, near 79 per cent. EDF competitors and EDF foreign subsidiaries are quite highly concentrated within their own share of the "non-EDF" segment of the eligible market (HHI of 1618, with 90 per cent of sales going to the top five and approximately 35 per cent to the biggest, Electrabel?) However, their concentration rate is low in exports (HHI of 565).

The French regulator's indicators (CRE, 2004) of resource concentration reveal that EDF controls about 95 per cent of generation (including power purchase obligations), but less than 40 per cent of imports into France. EDF competitors are highly concentrated in their generation activities (non-EDF HHI of 4617) and very little concentrated in all other activities (HHI below 750 for purchases on the Powernext exchange and at VPP auctions, for imports, and for block purchases on the OTC market).

The parallelism of the indicators of concentration, sales, and resources suggests that competition with EDF on the eligible market owes more to independent generation in France than to VPP auctions or imports. The resources represented by VPP and imports remain dispersed among many small EDF competitors. Logically, this also relates to the dispersal of their sales on the Powernext exchange, on the market for grid losses, on the OTC market, and in exports. It is a dispersed "competitive fringe".

B. Price effects

Having established that foreign competition remains largely in the realm of the potential and that 75 per cent of the resources of EDF competitors are generated in France (independent and VPP), we can now turn to price effects. In an environment such as France, characterised by an open and highly interconnected transmission grid and excess generation capacity both in the interior and at the borders—but with a cost advantage for domestic production—a monopolist could allow foreign competitors to fix the price on the wholesale market and to eligible clients (to increase own earnings) or undercut the price to eligible clients so as to reduce the profitability of entrants. In parallel, this monopolist can impose a greater margin on its captive non eligible clientele. The late French official study (IGF-CGM 2004) defined the continental Europe present situation as a Cournot oligopoly and ran a basic model with both nuclear and fossil fuel generation. It shows that an unrestricted monopoly will sell at 9 euros above its long run nuclear costs while a concentrated oligopoly will put it at 3 to 5 euros above these nuclear costs. In this study the actual long term costs of the existing French nuclear plants are given at 30 euros / MWh in 2004 (including sales force cost). These simplistic scenarios of a “reasoned response to the opening of borders” can then be compared to price data.

Figure 2. Average base load OTC power prices on a monthly basis

Between the autumn of 2001 and the spring of 2004, wholesale prices for the French baseload indeed appear to coincide with German prices, and are sometimes lower (Figure 2). These French prices evolve mainly as if the short-term costs of French plants were very similar to

those in Germany. However, in a competitive scenario with excess generation capacity and congestion at the French border to enter Germany, French baseload prices should be much closer to the short-term costs of French nuclear power than to the short-term costs of German traditional thermal power. Indeed, EDF has conventional coal plants (with 20.5 TWh generated in 2003 by 10.5 GW of capacity after mothballing 5.5 GW) setting its marginal costs at about 25 Euros / MWh (a cost used to set the fixed term of the VPP “peak” auction). But this is true about 2000 hours a year. During most of the rest of the year, EDF’s marginal plants are hydro or nuclear with a nuclear short term cost at about 13 Euros / MWh (Fuel cost + marginal and fixed cost of O&M) (French Ministry of Industry data: DGEMP 2003) and a nuclear marginal cost of 8 euros (IGF-CGM 2004).

Wholesale prices at one-year maturity also reveal a strong parallel in levels and changes between France and Germany, with a slight falling off of French prices, especially during the period from 2001 to the first quarter of 2004 (Platts, June 2004). This suggests that the French dominant player found no incentive to play the tougher “price war” that lower nuclear marginal costs could permit. In the second half of 2003, a parallel price increase in Germany and France sent prices to a more profitable 35 euros per MWh, substantially above the French nuclear long term costs. Before July 2004, each one euro per MWh increase on the French wholesale market could yield about 170 million euros per year if it could be passed on to all of EDF’s eligible customers in France and abroad. In June 2004, the EDF’s Chairman stated that its company selling price was definitively going towards 35 euros/MWh.

Table 7. Electricity Consumer Prices in 6 European countries 1997-2003
(January Prices except July 2003; Euros / MWh)

In terms of consumer prices, if we rely on the European Commission's statistics for the group of six Western countries centred on France, French prices always ranked among the lowest two countries between 1999 and 2003 (Table 7). For the 24 GWh / year big industrial consumers, the French price has been less than or equal to 50 euros per MWh since 1999 and was the lowest during three of these five years. All this time, French prices were below German prices (by 13 euros from 1997 to 1999, by only 1 euro in 2000, and again by 15 euros in 2003). The French incumbent obviously did not exercise its price-setting power to wildly raise prices on the domestic market of large eligible clients. The same is true for the 50 MWh / year small professional customers eligible in France as of July 2004. The French price was the lowest among these six countries from 1997 to 2002 and the second lowest in 2003. For medium-sized domestic customers with 3.5 MWh / year, the French price was one of the two lowest from 1997 to 2003.

Table 8. EU Estimated breakdown of expected consumers prices 2004 (Euros / MWh)

Of course, a more thorough analysis of electricity prices requires separating power costs and grid costs, which are mixed in these European statistics. The 3d Benchmarking Report of the European Commission offers such a rough breakdown of electricity prices into their 3 major components: power costs (consisting of energy and capacity costs), grid costs, and supply margin. This data (Table 8) confirms that at the beginning of the year 2004 the underlying French power price is still lower than Germany's (by 7 to 10 euros / MWh) and seems to be the cheapest in this group of six countries for both the 24 GWh and the 50 MWh consumers. At a level of 28 to 30 euros per MWh, the underlying French power price is aligned with French official long term nuclear costs (DGEMP, 2003) and (IGF-CGM 2004) but doesn't

take into account the peak load energy cost nor the balancing cost. Nevertheless the supply margin itself seems to be comfortable at 10 euros / MWh (equal to 36 % of the power costs in the 24 GWh segment) while the cost of sales force with big industrial consumers is said to be about 1 Euro / MWh (IGF-CGM 2004).

Table 9. Margin between Domestic and Industrial Prices (in euros per MWh)

Such a breakdown is not available for domestic customers. We can only calculate a margin between the prices to large industrial consumers and to domestic consumers. In France, this margin is one of the two smallest of these six countries for all years (Table N°9). This suggests that the underlying power price paid by non eligible customers from 1999 to 2003 left little room for an aggressive cross-subsidization from domestic to industrial consumers. A further complication in calculating this margin comes from the fact that the French government can increase the cost of Public Service Obligations (from 1.3 billion euros in 2003 to 1.7 billion in 2004) while denying any change to the tariff charged to ineligible customers. This increase in obligations in 2004 amounts to 1 to 2 euros per MWh depending on how it is shared among customers.

Finally, looking beyond only consumer prices, we may ask about the existence of competitive links on the French domestic market between price and volume effects—especially of the ability of the French market to respond with short term volume changes to wholesale price differentials with neighbouring markets. This information is of particular interest in terms of the link with England, which is managed by the most competitive of any of France's interconnection arrangements. We do, in fact, observe this type of competitive effect in the short run, with flows and counter-flows reaching 12 and 37 GWh per day (the equivalent of 6

to 19 hours of daily use of this link's 2 GW capacity) (CRE, 2003). The cumulative effect of these variations in volume over the year 2003 is remarkable. The reduction in French exports reached 5.6 TWh over that year, while imports from England increased by 3.4 TWh, for a total annual change of 9 TWh in the balance of exchanges (equivalent to 4500 hours at this link's full capacity in one direction). On the contrary, the French - German interconnection is said to be run against any rational wholesale price arbitrage behaviour neither from France to Germany nor from Germany to France because of the method used to allocate its capacity (IGF-CGM 2004).

V. A Challenge to the monopoly when investment in generating capacity resumes in France?

Since foreign competition remains largely in the realm of the potential, and domestic competitors have not been able to penetrate very deeply into the French market, we must ask whether it is not the resumption of productive investment in France which may create a veritable challenge to the monopoly. This scenario of "an investment-driven challenge" implies a variety of aspects. We cannot address them all. First we will look at the timing and magnitude of this investment. Then we will ask who might do the investing, in what technology, and where.

These issues may be broached using the forecasts of the French TSO and statistics on nuclear power plants. The French transmitter foresees excess capacity in continental Western Europe lasting until 2008. As to the evolution of demand in France, the TSO proposes three scenarios in the most recent forecasted balance sheet for 2006–2015.

Table 10. French TSO scenarios 2010-2020

Under these scenarios, the French TSO concludes that, even with minimal investment in generation, the risk of a one-hour shortfall is only 1 to 3 per cent for the year 2006. In 2010, there is a 22 per cent risk of an 11-hour shortfall (thus, investment in 1.4 to 4 GW will be necessary before that date). Finally, the risk of an 87-hour shortfall in 2015 is 83 per cent (requiring an additional 5 GW between 2010 and 2015).

However, several of the TSO's other assumptions suggest that there will not be very much room for substantial investment before 2015. On the one hand, voluntary reductions in demand during the winter peak can be purchased from consumers (before the electricity reform there was a voluntary reduction of 3 GW during the peak load). On the other hand, EDF's exports could decline in lockstep with new investments abroad as the generation costs of marginal plants progressively converge across continental Europe. EDF could also reactivate old thermal plants that have been mothballed (approximately 5 GW). Moreover, U.S. nuclear operators have successfully increased the output of reactors that are similar to those used in France by five per cent, which would create an additional capacity in France equivalent to two or three reactors (3000 MW) before the nuclear plants are abandoned. Finally, a series of investments in renewable energy (2500–8000 MW by 2007) is provided for in a decree of the French government in 2003. It will be supplemented between 2010 and 2015 by a prototype of the new 1600-MW reactor EPR (proposed after the decree of 2003 and the construction of which in the west of France, between 2006 and 2011, was officially announced in October 2004).

Under these conditions, major investments in France would only begin after the closing of the current nuclear power capacity, i.e. after 2015. If the lifespan of nuclear power plants is assumed to be 40 years, EDF will shut down nearly 50 GW of capacity between 2017 and

2027 (CEA, 2003). But this scenario is far from certain. Many in the nuclear industry maintain that a 50-year lifespan is imminently reasonable, on condition that some secondary investments are made and, of course, that irreplaceable components (such as the reactor vessel) continue to meet safety requirements. Aside from any disaster scenarios, there is thus a range of uncertainty spanning at least a decade concerning the beginning of the closure of French nuclear power plants: 2017 or 2027?

Figure 3. French nuclear generation capacity from 2016 to 2039 assuming a 40 years lifespan (GW / Year)

A second series of unknowns relates to the practical aspects of this massive future reinvestment. Will each of the current 63 GW nuclear plants be replaced by new nuclear generating capacity? Knowing that mean French consumption in 2020 will be approximately 550 TWh, with a winter peak load below 90 GW and an annual demand growth rate well below one per cent? Moreover, if EDF maintains its existing sales in neighbouring countries (70 to 80 TWh annually), will the corresponding generation capacity be built in France or abroad? Will this be nuclear or traditional thermal? This represents at least 10 GW more or less in nuclear capacity. A third series of unknowns lies in the future investment behaviour of French nuclear enterprises. It is said certain that EDF and Areva (the French nuclear fuel processor and reprocessor) will be privatised in 2005 (between one-quarter and one-third). In 2010–2020, when nuclear reinvestment will really open, both companies could be more private than public. How will they behave then when facing a potential 100 billions euros nuclear investment (Glachant 2005)?

Finally, will this period of massive investment open a window for the entry of new operators, such as the former English “Dash for Gas”? Should we expect that future generating capacity

will essentially be vertically integrated with supply like seen in other countries (Newbery 2000; Joskow 2003)? and, in consequence, that investments will be made by suppliers already present on the French market? If this vertical integration scenario materializes, only a handful of foreign investors can be envisaged. Electrabel, which is targeting ten per cent of the French market (35 TWh to 50 TWh in the long term); Endesa, which may attain between one quarter and one half of Electrabel's goal (between 12 and 25 TWh), and Enel, which could enter the French market on the invitation of EDF (notably, by acquiring a share in French nuclear plants) in consideration of EDF's presence in Italy.

However, the main unknown in vertically integrated investment is not from foreign sources, but rather French: Gaz de France. This "national champion" of gas is the primary potential competitor to EDF, both in the commercial market (with 500,000 consumers) and in the domestic market (with 11 million consumers). It is particularly in the area of "Dual Fuel" (joint supply of gas and electricity) that Gaz de France has a competitive edge that would be difficult to overcome by any potential new entrant. Of course, Gaz de France cannot match the position of British Gas – Centrica, since the use of gas is less widespread in France than in England (half the consumption) and since EDF is a more solid brand nationally than Gaz de France. Nonetheless, as Gaz de France will probably never be merged with EDF by the French government, we can easily imagine that in time it could achieve at least half of penetration of British Gas – Centrica in electricity, or 10–12 per cent of the French market. When added to the market shares of foreign electricity concerns, this could put one fifth of the French market outside of EDF (100 TWh) and accounted for approximately 18 GW peak capacity. But how will all these new producers find the sites required for dozens of power plants in France, not to mention the fuel to operate them? and when? after 2010–15, when the success of the opening of the retail market (2007) and the opening of a new investment window have been established? or before 2010-15, and quite soon from now in a "Dash for

investment” scenario resulting in the voluntary addition of new capacity before the former overcapacity has entirely been exhausted?

VI. Other measures to mitigate the French monopoly?

Since a massive reinvestment is not to be expected in France over the next decade and the practical aspects of that reinvestment remain very uncertain, what can be done to bolster the competitive fringe in the very likely event that French policy will not change (no industrial restructuring and no divestiture of generation or sales imposed on the national champions) (Bouttes and Trochet, 2002 and 2004; Finon, 2003; Finon and Midttun 2004)?

Doubtlessly, steps could be taken toward unbundling the transmission grid (transforming it into an independent entity, owned by a neutral public entity like the Caisse des Dépôts) and toward converting the distribution network, which does not belong to EDF, into several publicly owned regional bodies (as was discussed in the “Upper French corridors” in the autumn of 2002). Regionalised unbundling of the distribution network could allow for improved control over the quality of service and economic performance by the network owners (local governments) and by the regulator. These various unbundling measures could facilitate the activities of the competitive fringe but not materially increase them.

Changes to demand should be anticipated. On one hand, all business customers became eligible in July of 2004, and this will be extended to include all residential consumers in July of 2007. On the other hand, all public bodies (government ministries, municipalities, schools and universities, hospitals, etc.) will eventually apply the rules of competitive bidding to obtaining their electricity supply, though they can avoid this until 2007, given the August 2004 law and its recent interpretation by the French Supreme Administrative Court (Conseil

d'Etat). In the coming years, this could broaden the scope of activity for all suppliers wishing to establish themselves in France. In this new environment, it is possible that one or two new entrant suppliers will grow (such as Poweo and Direct Energie) until their portfolios include 50,000 or 100,000 non-domestic clients (2.5–5 TWh) and eventually resell themselves as bridgeheads for larger operators (foreign, such as Endesa or Enel, or even French, such as Gaz de France). At the end of 2004 these two new entrants have gained about 20,000 customers.

On the supply side, the European Commission could maintain, or even expand, EDF's VPP program after 2006. EDF could accept such a measure as a demonstration of "European" good faith, especially if the framework of a unified market has not progressed enough on the continent. Some of these additional VPP could be relatively informal and consist of bilateral accords, such as the one making 1000 MW of EDF's nuclear power available to Electrabel, or like the agreements that EDF has discussed with ENEL on several occasions.

Also, on the supply side, domestic market structures could be shielded from any new concentration by the dominant operators. This is particularly relevant in the Dual Fuel (or bi-energy, gas plus electricity) market, in which no operator who is dominant in one energy form would be allowed to merge with or acquire an operator who is dominant in the other. A further variant, on the Italian model, would be a new anti-trust rule establishing a ceiling on market share for dual fuel: No operator could have more than x per cent of this new market until a proven competitive structure had emerged. The feasibility of this anti-trust rule could be ensured, *ex ante*, by a dismantling into regional subsidiaries of the dominant suppliers' operations. This would allow eventual divestiture of market shares with limited industrial or social disruption. Such divestitures would, moreover, be easier to implement between EDF and Gaz de France, which are both publicly owned and national institutions. Furthermore, all activities of all dominant actors, whether in their historical markets or in new ones, could be subjected to permanent oversight by a specialised branch of the Energy Regulatory

Commission (Glachant and Littlechild 2004) in conjunction with French and European anti-trust authorities which could back the French energy regulator as said by the official report (IGF-CGM 2004). A different approach could be to help Gaz de France enter more deeply into the generation of electricity by reselling EDF's mothballed plants. Ideally this 5 GW capacity should be auctioned off to any bidder, not only Gaz de France. But an open competitive auctioning of EDF plants could be politically unfeasible, at least under Chirac's presidency.

Partial privatisation of EDF and GDF was announced by the French government and arranged in the new law in the summer of 2004. It could be implemented in 2005 or 2006, covering a tenth to a quarter of their shares. As many details still have to be determined, it is too early to foresee all the effects of this new policy. Nevertheless, it is certain that this privatisation will be very smooth and kept under control by the government and the companies' managers (like ENEL's privatisation was managed in Italy). To comply with the policy, the two companies' management was shuffled in September 2004 and the new bosses will last at least until the end of President Chirac's term in 2007. Both new bosses are "insiders": EDF got the GDF Chairman and GDF the Prime Minister's assistant. This process of privatisation will bring at least more transparency and stability in the accounting rules practiced at EDF, after the many changes seen in the previous three years (up to 2 or 4 billions euros per year). Furthermore, EDF's balance sheet still needs to be stabilised and revamped, given the huge liabilities still to be addressed with only 20 billions in existing capital. Approximately 10 billion euros are needed for transferring EDF pensions into the French national pension system. More or less 10 billion euros in various debt and financial instruments are still held exclusively by EDF subsidiaries (notably in Germany and Italy). Some 5 billion euros of foreign investment could still have to be written off. Aside from these 25 billions in various liabilities, EDF accounts exhibit 24 billion euros in debt and 25 billions in nuclear liabilities (11 billions for plant

decommissioning and 14 for fuel reprocessing and storage). It explains why the official report to the Minister of Finance, Economy and the Industry (Roulet 2004) suggests that the actual EDF equity is either nil or negative.

Finally, French market and market access mechanisms could be reinforced or refined. The French balancing mechanism could be opened to operators from neighbouring countries, which is currently being prepared by the TSO and the French regulator. This mechanism could also be transformed into a true energy spot market, backed by competitive procedures for allocating interconnection capacity and coordinated with the TSOs in bordering countries. The Powernext Day Ahead exchange could be joined with adjoining exchanges and directly allots interconnection capacity, as is proposed in the project under discussion with Spain, Belgium and Netherlands. However, projects to expand linkages between the French and foreign markets have elicited less than enthusiastic responses in some of the neighbouring countries, where they have been primarily perceived as a new bridgehead for EDF's penetration of their market [Glachant, 2003].

VII. Conclusion

France undertook in 1999-2000 a unique electricity reform in which the state-owned monopoly was not privatised, demolished, or dismantled. Nonetheless, we observe the existence of a competitive fringe, foreign and domestic, surrounding the old monopoly and its ability to exercise market power. Despite the 63 GW of nuclear plants and their low short-run marginal cost of generation, French wholesale prices are aligned to those of the alternative generated abroad: German traditional thermal power. However, sales prices to large eligible French clients often appeared to be the lowest in Western Europe. In comparison, sales prices to ineligible domestic clients, which are fixed by the French government, could have

incorporated a higher margin—at least until 2003, when the Public Service Obligation increased and wasn't fully compensated.

These elements could coincide with the profile of a public generation monopoly hemmed in by a competitive fringe, but they do not portend any radical future competitive changes to the structure of the French market. Furthermore, as said by the official French report (IGF-CGM 2004) the same picture would perfectly fit with the outcome of a continental Europe generation oligopoly where a lonely nuclear generator is not submitted to any competitive threat from other nuclear competitors. Such oligopoly game might result in a substantial 5 euros / MWh margin above the long term nuclear costs of generation. If radical generation capacity realignment can only be expected at the time of the renewal of the French nuclear power capacity, it will be a long wait, since less than 4000 MW will be shut down before 2019...or even 2029 depending on the lifespan of these plants. And no new thermal plants will ever be able to oblige a lonely French nuclear generator to sell at its own generation costs (IGF-CGM 2004).

While awaiting any kind of distant future and in preparation for the opening of the market to domestic clients in 2007, a policy aimed at bolstering the competitive fringe could extend the provisions of the electricity release and arrange the length and variety of its products to the needs of new suppliers. Even though the VPP have not yet attracted any alternative operators of substance. Mergers between the dominant French gas and electricity concerns could be blocked so as to maintain the potential of competition between them, especially in the Dual Fuel market. An alternative way could be to resell or to auction off EDF's 5 GW mothballed plants to any buyer including GDF. The competitive mechanisms of the French market and access to this market could be reinforced and coordinated or aligned with the competitive provisions of neighbouring networks and markets. This would increase the openness and transparency of the French market and enhance the credibility of some competitive challenges

to the national monopoly from foreigners or new entrants. These steps, affecting market access and mechanisms, would also contribute to the construction of a wider European market on the continent.

However, a prolongation of the French policy of “competitive encirclement” of the national champion for more one or two decades raises serious issues of feasibility and effectiveness. Since it seeks to perpetuate the core of the French monopoly’s industrial structures in the face of expanding market forces, realisation of a policy of “encirclement by the borders and the fringe” also requires a good deal of cooperation from neighbouring countries and the European Commission. It is thus based on the premise that everyone wins playing that particular game. That is still to be demonstrated to all foreigners and the EU because it would open foreign power grids as much as the French grid, and foreign markets as much as the French market, while retaining the other structural asymmetries between the French and the foreign industry. Many French officials and a substantial part of the French elite would like to replay in Western Continental Europe the astute Swedish play to enter the Nordic electricity game. They still have to find their complacent “Norwegian” partners. The late French official report (IGF-CGM 2004) suggests that a rational continental generators’ oligopoly oughtn’t to be afraid of the French nuclear generator since it is not its interest neither to aggressively fight them.

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Table 1. The Opening up of the French Market

	Threshold	Number of eligibles	Market Share
February 1999:	40 GWh	450	22 %
February 2000:	16 GWh	1 400	30 %
February 2003	7 GWh	3 100	37 %
July 2004	All non-households	3 500 000	68 %

Table 2. French electricity imports and exports in 2001 (in GWh)

	<i>Exports</i>	<i>Imports</i>	<i>Net Exports</i>
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: IEA “France Report” (June 2004)

Table 3. Generation Shares of French Electricity Supply Companies, 2002

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

Source: IEA "France Report" (June 2004)

Table 4. French electricity imports and exports from 1999 to 2003 (in TWh)

	<i>Imports</i>	<i>Exports</i>	<i>Net Exports</i>
Year 1999	5	68	63
Year 2000	3.3	73	70
Year 2001	4.2	73	69
Year 2002	3.8	81	77
Year 2003	7	73	66
2003/2002 (%)	+90 %	-10%	-14%

Source: RTE (French grid)

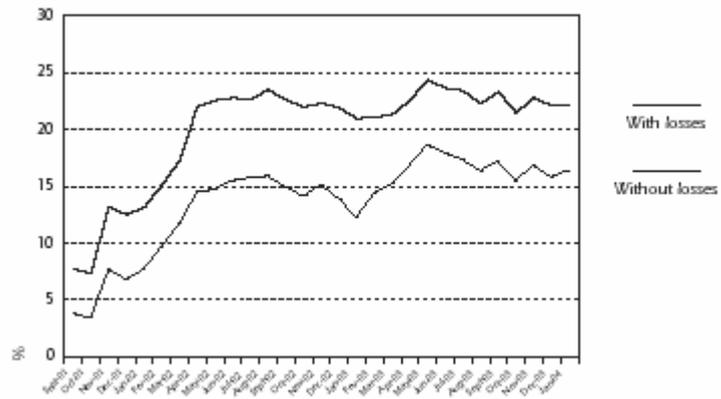
Table 5. EDF competitors' business as seen by the grid operators (1st Quarter 2004)

<i>(sold to >>)</i>	Eligible Customers	Grid Losses	Exports	EDF	Total
in GWh	8200	3500	5900	2700	20,300
in %	41 %	17 %	29 %	13 %	100 %

Table 6. EDF competitors' resources as seen by the grid operators (1st Quarter 2004)

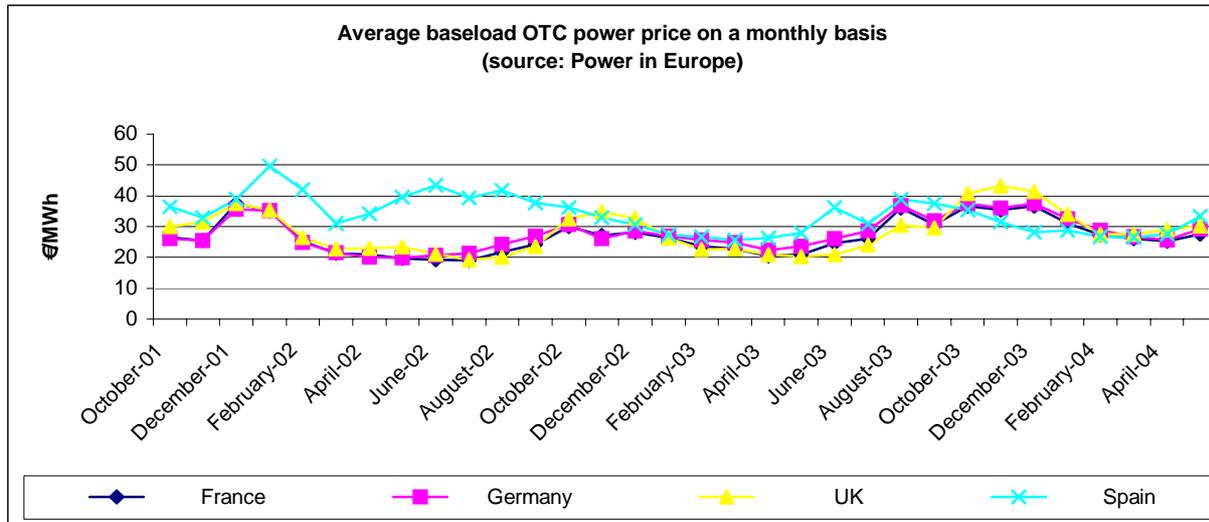
<i>(coming from >>)</i>	Independent Generation	VPP	Imports	//	Total
in TWh	3900	11,400	5000	//	20,300
in %	19 %	56 %	25 %	//	100 %

Source: Rough approximations deduced from data published by the French regulator (June 2004)

Figure 1. Market Share gained by New Entrants in France (September 2001 to January 2004)

Source: IEA France report (June 2004)

Figure 2. Average base load OTC power prices on a monthly basis



Source: Power in Europe, Platts

Table 7. Electricity Consumer Prices in 6 European countries 1997-2003
(January Prices except July 2003; Euros / MWh)

24 GWh - Industrial consumers / Eurostat category IG							
	1997	1998	1999	2000	2001	2002	2003
ITA	59	60	53	60	79	71	77
GER	68	66	63	50	53	53	60
BEL	58	56	55	55	57	58	56
SPA	59	52	53	54	49	47	48
FRA	55	52	50	49	48	49	45
U-K	60	54	59	54	51	47	43

50 MWh - Industrial consumers / Eurostat category IB							
	1997	1998	1999	2000	2001	2002	2003
GER	165	163	162	139	133	131	134
BEL	147	148	148	143	125	129	122
ITA	119	119	114	119	87	98	104
SPA	111	100	98	98	98	99	95
FRA	100	92	89	87	85	86	83
U-K	114	109	107	107	94	92	78

3.5 MWh - Domestic consumers / Eurostat category DC							
	1997	1998	1999	2000	2001	2002	2003
ITA	167	168	157	150	157	139	147
GER	127	126	128	119	122	126	125
BEL	119	119	118	117	118	114	112
U-K	108	105	102	99	96	97	95
FRA	101	96	95	93	91	92	89
SPA	105	95	93	90	86	86	87

Source: European Commission DG TREN, 3d Benchmarking Report (March 2004)

Table 8. EU Estimated breakdown of expected consumers prices 2004 (Euros / MWh)**(24GWH) Industrial consumers Eurostat category IG**

	Power	Grid Costs	Supply Margin	TOTAL
ITA	60	13	10	83 €
BEL	40	25	8	73 €
GER	35	25	10	70 €
FRA	28	15	10	53 €
SPA	38	10	5	53 €
U-K	30	15	5	50 €

(50MWH) Industrial consumers Eurostat category IB

	Power	Grid Costs	Supply Margin	TOTAL
GER	40	65	20	125 €
ITA	60	30	25	115 €
BEL	45	50	20	115 €
SPA	40	45	10	95 €
FRA	30	50	10	90 €
U-K	33	35	10	78 €

Source: European Commission DG TREN, 3d Benchmarking Report (March 2004)

Table 9. Margin between Domestic and Industrial Prices (in euros per MWh)

	Price (DC =3.5 MWh) - (IG=24GWh)						
	1997	1998	1999	2000	2001	2002	2003
ITA	108	108	104	90	78	68	70
GER	59	60	65	69	69	73	65
BEL	61	63	63	62	61	56	56
U-K	48	51	43	45	45	50	52
FRA	46	44	45	44	43	43	44
SPA	46	43	40	36	37	39	39

Source: Own calculation on EU data

Table 10. French TSO scenarios 2010-2020*French Consumption Growth Rate (Yearly %)*

<i>Until</i>	<i>2010</i>	<i>2010-2015</i>	<i>2015-2020</i>
<i>Scenario R1</i>	<i>1.4</i>	<i>0.9</i>	<i>0.6</i>
<i>Scenario R2</i>	<i>1.3</i>	<i>0.9</i>	<i>0.5</i>
<i>Scenario R3</i>	<i>1.1</i>	<i>0.6</i>	<i>0.3</i>

French Consumption (in TWh)

<i>Year</i>	<i>2010</i>	<i>2015</i>	<i>2020</i>
<i>Scenario R1</i>	<i>520</i>	<i>544</i>	<i>561</i>
<i>Scenario R2</i>	<i>513</i>	<i>536</i>	<i>550</i>
<i>Scenario R3</i>	<i>503</i>	<i>519</i>	<i>527</i>

Source: Bilan prévisionnel RTE (2006 – 2015)

Figure 3. French nuclear generation capacity from 2016 to 2039 assuming a 40 years lifespan (GW / Year)

Source: CEA (2003)

