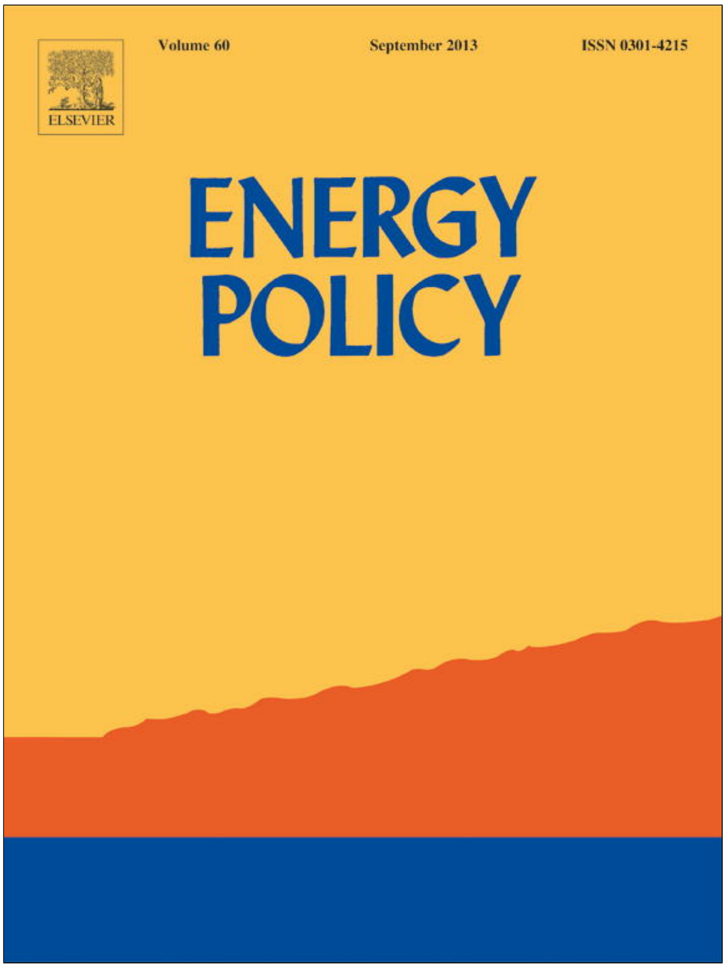
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Belgian nuclear power life extension and fuss about nuclear rents

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HIGHLIGHTS

- Nuclear phase-out is only successful when alternative supplies are deployed.
- Politicians cannot bind their successors by words or by lawgiving.
- The phase-out law exemplifies the disruption of a strong nuclear lock-in.
- Life extension exemplifies the disruption of the phase-out law.
- The impact of imprecise nuclear rents on life extension could not be tested.

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ABSTRACT

Nuclear decision-making is embedded in slowly evolving political, economic and financial institutions. Belgium houses extended nuclear activities, mostly under French control, for example: SUEZ-GDF and EDF own all Belgian nuclear power plants. But a 2003 law mandates the closure of Belgium's nuclear power plants at a service age of 40 years; only force majeure could lift the strict obligation. Opposition to the law argued with climate change danger, financial losses, and loss-of-load risks. The financial issue got interwoven with a fuzzy debate on the definition, height and appropriation of “nuclear rents”. As plausible hypothesis is adopted: the prospected transfer of hundreds millions of euro from power companies to the public interest will create public support for life extension. But the nuclear rents discussion had faded in July 2012 when the Belgian government admitted a 10-year life extension for TIHANGE I (962 MW) and imposed the closure of the 2 × 433 MW DOEL I and II. Loss-of-load risk was the government's only public argument. The opacity of the decision process and its “fifty–fifty” outcome do not allow proper testing of the hypothesis. The case illustrates that politicians cannot bind their followers except through the deployment of alternative power sources.

1. Introduction

In 2003 the Belgian parliament enacted a nuclear phase-out law imposing the closure at 40 years of operational service of power generation reactors sited in Belgium (www.ejustice.fgov.be). Ever since, the law and its implementation have been under debate. Studies were ordered to affirm the important role of nuclear power in Belgium (GEMIX, 2009). In Annex 8 of the GEMIX report, Percebois (2009) brought up the case of “nuclear rents”, what he also called: “windfall profits”, “fixed cost compensation”, and “scarcity rents”. The conspicuous cash flows are the result of operating largely depreciated nuclear plants, built at low historical outlays. He proposed the creation of a broad commission to assess the size of “nuclear rents”, and to decide on how collecting and on how allocating the money. But established public institutes (the federal regulator CREG, the study department of the National Bank of Belgium) delivered separate and deviating assessments of the rents volume and diverged in opinions about allocation.

The first goal of this article is informing an international readership about decision-making in Belgium on investing and de-investing in power plants, i.e., nuclear phase-out and nuclear plant life extension. As second goal I wanted to test the plausible hypothesis that (eventual) transfer of (voluminous) “nuclear rents” to the treasury or to electricity consumers would create a strong incentive for politicians and the public to approve life extension beyond 40 years operation. Investigating this hypothesis requires clear evidence about steps in the policy processes. However, in actual policy-making, many important issues are not publicly documented and the applied logic does not obey formal scientific rules. Processes are partly based on trust, rules

Abbreviations: CCEG, Control Committee for Electricity and Gas, 1955–2003; CGEE-BCEO, Managerial Board of the Electricity Companies; CREG, Commission for Regulating Electricity and Gas, since 2000; EDF, Electricité de France, French state power company; ELECTRABEL, Major power producer in Belgium; FANC, Federal Agency for Nuclear Control, since 1957 - reformed in 2007; GDF, Gaz de France; SPE, small public power producer in Belgium; SUEZ-GDF, French conglomerate, owning ELECTRABEL.

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and conventions are not detailed on paper, and interests exert hidden pressure, e.g., via almost invisible lobbying. Testing the hypothesis failed, excluding both its acceptance and rejection.

Ancillary findings emerged, meriting additional assessment. First, politicians cannot bind their followers by approving regulations, neither by enacting laws. Breaching predecessors' vows is partly related to partisan agendas. Changing course is, in principle, a valid practice because time-sequential decision-making includes regular evaluation of the past course, and re-optimizing the use of resources. Decision-making science recommends regular review above rigid obedience to inferior solutions decided in the past (Raiffa, 1970; Dixit and Pindyck, 1994). A nuclear phase-out decision is a breaching example in case, as is life extension breaching the phase-out decision. Second, the only guarantee for committing the future is the development and deployment of superior substitutes, creating a variety of lock-ins. Therefore, the article zooms in on two important failures of boosting power supply options as alternatives for nuclear power: independent cogeneration and renewable power.

There are six more sections after this introduction. Section 2 describes the evolving structure of the electricity sector in Belgium. Over time, the cooperation with France nuclear companies intensified, and is sealed by the take-over of the major Belgian power generators ELECTRABEL and SPE, including their nuclear plants, respectively by SUEZ-GDF since 1989 and by EDF in 2008. In Section 3 the growth and actual state of the nuclear power generation sector in Belgium is documented. More than half of power generated in Belgium over the last 25 years was nuclear. Resolving this dependency requires well conceived and managed alternatives, a course of deliberate policy, not evident in Belgium (Section 4). Building upon the previous sections, it is argued why life extension is the only option for commercial nuclear plants (Section 5). Section 6 sheds more light on profits in the Belgian electricity sector and on what "nuclear rents" could be. In 2010–2011 political parties, the federal regulator and the National Bank mulled the height and appropriation of "nuclear rents". It seemed the outcome of this debate could have a significant impact on the life extension chances of the eldest nuclear plants. However, the rents debate stranded in fuss and the interest in "nuclear rents" plunged before life extension was decided. The new Belgian government vested in December 2011, decided on extending the lifetime of TIHANGE I with 10 years beyond its 40 years operational life (Section 7). All public argument was based on concerns about the loss-of-load[1] risks in Belgium over the years 2012–2017, and the hypothesis could not be verified, a fortiori: not be accepted or rejected. Conclusions are summarized in Section 8.

2. Evolving structure of the electricity sector in Belgium

In the 1950–70s the Belgian super-holding Société Générale controls hundreds of industrial plants in all main sectors, most power generation plants, and the contracting-engineering firms Electrobel and Traction & Electricité, merged to TRACTEBEL in 1986 (Brion and Moreau, 1995). The latter design and supervise the managerial and physical structures of Belgium's post-war electricity sector. During the 1950/70s this means merging tens of small producers to three geographically franchised producers (EBES, INTERCOM, UNERG), unified to ELECTRABEL in 1990. Investment economies of scale at the plant, station, and system level are realized (Joskow and Schmalensee, 1985), while running costs are minimized by internal competition among the plants. Soaring productivity increases create high financial surpluses. The optimized structure of the Belgian power sector, and its direct links with banks via the mother holding, are the foundations for a successful nuclear construction program over the period 1965–1985.

Although the Société-Générale is sponging on the power sector, the holding crumbles during the 1980s. In 1989, the French holding SUEZ acquires 51% of the shares. The ultimate control over the private Belgian electricity and gas interests (mainly TRACTEBEL and ELECTRABEL and dependent companies such as FABRICOM) is moved to Paris. During the following 15 years the interesting parts – mostly the electricity supply activities – are step-by-step integrated.

The public producer SPE, structurally integrated with the private companies since 1981, generates about 8% of the national production. In 2005, CENTRICA (UK) and GDF (F) form a joint venture, acquiring 51% of SPE; in January 2009, GDF had to cede its part to CENTRICA; in May 2009, CENTRICA transferred its 51% share in SPE to EDF for acquiring a 20% interest in British Energy (UK nuclear power).

The control by French companies over Belgium's power generation is highly relevant for future nuclear activities in Belgium. Lacking suitable locations to install nuclear plants, and facing strong public opposition (Laes et al., 2007), Belgium will rather import nuclear power from France. When new plants would be constructed, they will be located in France rather than in Belgium, with the corollary that life extension is Belgium's only left over commercial nuclear option.

3. Nuclear power generation in Belgium

Except for a small but growing share of renewable power (wind, solar, hydro) all electricity generated in Belgium is thermal with 50–55% delivered by nuclear reactors since the mid 1980s. In the aftermath of World War II Belgium is treated as a privileged partner by the USA in return for Congolese uranium deliveries to the Manhattan project. In 1952, the nuclear research centre SCK-CEN in Mol is founded. During the 1950–60s Belgium covers the entire nuclear cycle from mining (Congo), fuel rod fabrication, reactor development (three research reactors, one being the first PWR in Europe), to waste treatment and reprocessing (EUROCHEMIC), and geological storage in clay seams (HADES) (Laes et al., 2007; Eggermont and Hugé, 2011).

Table 1 shows Belgium's involvement in atomic power, with several ties to France. CHOOZ A and TIHANGE I are joint venture power plants, as well as CHOOZ B1 and B2. TRICASTIN I–IV supplies power to enrichment activities. The breeder SUPERPHENIX was not a success, but neither was KALKAR (a common project with Germany and The Netherlands). Not shown are the links between France and Belgium in the nuclear fuel cycle such as enrichment, fuel rod fabrication and spent fuel reprocessing, substituting for the shut-down of Belgian industrial activities. The Paris-based corporations SUEZ-GDF and EDF control all nuclear power generation plants in Belgium.

Nuclear lock-in is strong by the long and deep involvement of the Belgian electricity sector in nuclear power. In the decades following World War II nuclear power enjoys the full support of private and public interests, industry, science, politics, mass media, the general public. The lion share of public funding on energy research is assigned to nuclear. Universities and research centers educate and train qualified professionals. Plant construction time and budget overruns stay within acceptable limits (Verbruggen et al., 1988), and operational availability is high. No major incidents or accidents occur. The sector runs mainly on self-control (La Revue Nouvelle, 1975).

But in 1986, TRANSNUCLEAR reveals irregularities in waste processing activities at SCK-CEN. Along the clean up of this waste

[1] Loss-of-load is faced in a power system when the available generation capacity supplying power to the grid falls short of the demand for power. Because electricity is not storable and is transported all over a continent in seconds of time, sufficient capacity is needed at every moment of the year. With probabilistic methods the risks of supply shortages are estimated. When the assessed risks are too high, the power system is said to be unreliable, and add or retain generation capacity is recommended.

Table 1
Nuclear power generation plants with Belgian involvement*.

Name	Location	Capacity (upgraded)		Lifetime	
		MWe	Belgian (%)	Start	Stop (planned)
BR3	Belgium	11	100	1962	1987
CHOOZ A	France	310	50	1967	1991
DOEL I	Belgium	392 (433)	100	1974	(2015)
DOEL II	Belgium	392 (433)	100	1975	(2015)
TIHANGE I	Belgium	931 (962)	66.4	1975	(2025)
TRICASTIN I	France	915	12.5	1980	?
TRICASTIN II	France	915	12.5	1980	?
TRICASTIN III	France	915	12.5	1981	?
TRICASTIN IV	France	915	12.5	1981	?
DOEL III	Belgium	970 (1006)	100	1982	(2022)
TIHANGE II	Belgium	930 (1008)	100	1983	(2023)
DOEL IV	Belgium	1001 (1039)	100	1985	(2025)
TIHANGE III	Belgium	1015	100	1986	(2025)
SUPERPHENIX	France	1200	2.4	1986	1998
KALKAR	Germany	282	15	Cancelled	–
CHOOZ B1	France	1455 (1500)	25	1996	?
CHOOZ B2	France	1455 (1500)	25	1997	?

* Since ELECTRABEL is taken over by GDF-SUEZ and SPE by EDF, all Belgian nuclear power plants are now controlled by French companies.

handling, and in the wake of the Chernobyl catastrophe, legislators impose more accountability on nuclear activities (Laes et al., 2007).

Nuclear issues remain within federal discretion, with as main platform FANC (Federal Agency for Nuclear Control). In 2007 FANC got a more transparent mission and structure, but is still directed by staff forthcoming from the nuclear sector. This extends nuclear self-control with lack of independent supervision.

Nuclear power is increasingly questioned since the 1970s, also in Belgium (Laes et al., 2007). In 1980, an important institutional reform law submits power generation expansion plans to a semi-overt hearing process (Belgium's Official Journal, August 15, 1980). In the submitted power generation expansion plans in 1981 and in 1982, CGEE-BCEO proposes the construction of two additional 1300 MW nuclear plants as first-comers in a series of one new plant every year as projected by an advisory commission in 1976 (Hoste and Jaumotte, 1976). Formal permission is denied, with little objection by the power sector, facing a slacking electricity demand and a 50% reserve margin in central power capacity. The 1983 CGEE-BCEO plan proposes the 25% participation in the French CHOOZ B1 and B2 1500 MW units, and the construction of a 1300 MW plant in Belgium (DOEL V, also called N8 – the eight nuclear plant) with an alluded 50% participation by the French state company EDF. In Paris, May 1984, Minister Eyskens signs the CHOOZ participation. The EDF interest in N8 (expressed "in mutual correspondence" (Senaat van België, 1987)) does not materialize, although the Belgian electricity sector executed preparatory investments in DOEL. Adding to the Chernobyl (April 1986) disaster, the already high share of nuclear capacity in the electricity system, the overcapacity in contracted natural gas imports, and the fast progress in gas turbine technology, indefinitely shelve new nuclear plant construction in Belgium. No permit for N8 is assigned in 1988 when CGEE-BCEO revived the demand. In the last plan before liberalization, CGEE-BCEO no longer proposes additional nuclear capacity, but keeps the nuclear option open because of "its specific economical and ecological advantages" (CGEE-BCEO, 1995).

Technically, the univocal choice for nuclear power after World War II and the extent of nuclear investments link Belgian electricity supply firmly to the nuclear path. This lock-in accords with CGEE-BCEO's master plan of an optimal power supply system: a three-fourth or higher nuclear share (buffed by pumped storage) and gas turbines for complementary and back-up power.

4. Policies on alternatives for nuclear power plants

Higher efficiency in using electricity and distributed power generation (cogeneration, renewable power) are the alternatives for nuclear power (Verbruggen, 2008b). Two crucial policy-making phases for their development are discussed, one related to independent cogeneration, the other to renewable power.

4.1. Cogeneration

In Belgium, many power plants in the years after World War II were on-site industrial units, several with cogeneration activity. The vertically integrated supply system substituted for on-site systems, opening the road to large-scale nuclear base-load units. The first oil crisis renewed the public interest in cogeneration (utility owned, related to e.g. district heating, and independent in industry and commercial facilities), demonstrated as viable in many other EU countries. Technical conditions and tariffs of grid access determine the financial feasibility of independent distributed sources. In 1988, CGEE-BCEO designed tariffs that nipped independent generation in the bud. Ph. Maystadt[2] (Minister Economic Affairs) required adapted tariffs. CGEE-BCEO deleted two-third of the impediments, but kept a skewed improper back-up tariff as lever to force a partnership on on-site generators (Verbruggen, 1990). Since 1994 several industrial sites have built cogeneration plants in partnership with ELECTRABEL. There has been no meaningful development of utility cogeneration and district heating.

4.2. Renewable electricity support

In 2001, Belgium's regions—Flanders, Wallonia, and Brussels—implemented the EU renewable energy directive. The state reform laws of 1980 and of 1988 assigned the political authorities on energy issues heterogeneously to the regional and federal levels (Verbruggen and Vanderstappen, 1999). For example: energy efficiency and renewable energy belong to the regions, but electricity pricing and taxing are decided at the federal level. Institutionally, the regions opted for tradable green certificate systems, in the year 2000 neoliberal mood of the EU Commission that the market would take care for public governance. Detailed analysis of the Flemish certificate system shows inferior results in comparison to the German feed-in mechanism, regarding effectiveness, efficiency, and equity (Verbruggen, 2009). A major share of the payments by electricity consumers ends as excess profits on the accounts of incumbent power companies. The poor development of renewable power strengthens the case of nuclear plant life extension. The institutional lock-in and the high profits for the suppliers (incumbents, but also new companies) result in a remarkable rigidity of the renewable energy support policies in Belgium. Here, the renewable energy alternative would be served better by dynamic and disruptive change.

5. Belgium's future nuclear option: life extension

The French–Belgian power sector acts for a nuclear renaissance. Climate change mitigation provides welcomed thrust for deploying old plans in new packages like GEN-III^{+}, GEN-IV, and GEN-V (Duffy, 2011; Kessides, 2012).

[2] Expert consult for his position was delivered by scientific know-how developed in Belgium's non-nuclear energy research programme (DPWB 1988). Over 1981–1985, Maystadt as Minister for Budget and Science Policy, fostered this programme. In 1987 it was canceled by his successor, Verhofstadt, depriving Belgium of public know-how on energy policy. This is an illustration of politicians unable to sustainably commit their followers.

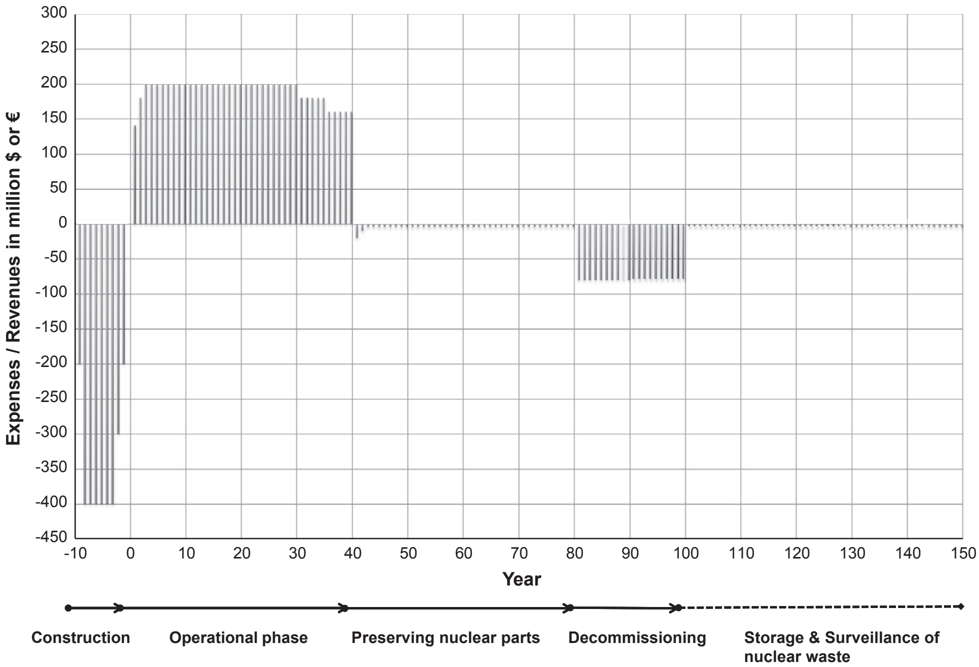

Fig. 1. Net expenses and net revenues related to a nuclear power plant (stylized representation excluding full risk coverage, major accidents and cost overruns).

Although technological success talk is part of the nuclear renaissance advocacy, the power sector is not ready to invest in, for example, a new breeder plant (GEN-IV). The sector is also reluctant to invest in GEN-III$^+$ nuclear plants, awaiting the full bill of construction time and budget overruns in Olkiluoto (Finland) and Flamanville (France) (Thomas, 2012). The preferred sector practice is extracting the maximum profit out of the existing plants, by extending lifetimes until marginal expenses of ongoing exploitation equal its marginal revenues.

Fig. 1 is a stylized representation of the time pattern of net expenses and net revenues related to a nuclear power plant excluding full risk coverage, major accidents, and cost overruns. About 10 years before operating a nuclear plant start expenses for design, licensing, construction, testing, etc. Because of this long period and the size of the investment, interest payments during construction are mostly capitalized. The operational lifetime is planned to be 40 years, period of positive net revenues when no major adverse events happen. Fig. 1 shows the case that depreciation is spread over 40 years. When depreciation is concentrated in the first 20 years (like done in Belgium), net cash flows during the operational period are shifted to its second 20 years. After the operational lifetime of the plant begins an indefinite eternity of costs and sorrows not compensated by any positive return: first taking out of operation and securing the high radioactive parts for cooling down during a few decades; then, decommissioning, and finally storing and caring about the waste – in particular the high radioactive parcels.

Fig. 1 illustrates the business case for life extension. First, the period for cashing net revenues is extended – they will decrease over time because of more maintenance but as long as being positive there is an incentive to keep the plant running. Life extension is accompanied by plant revamping, with replacement of steam generators significantly upgrading the capacity (Table 1). Plants selected for life extension have proved high capacity factors (the ratio of actual yearly output to the theoretical maximum of year-long full capacity production). High factors are crucial for the economics of nuclear power, but are incompatible with significant growth of renewable electricity generation (Verbruggen, 2008b).

The incentive for life extension is much stronger than the single cash flows reveal: running a plant longer means postponing the costing and sorrow-laden eternity of its aftercare. The business cohort that designed, built and operated the plants evades the responsibility and full liabilities of the aftercare, and loads it on future generations.

Also, in a densely populated country like Belgium, new locations for nuclear stations are not available, and naming locations has been a source of stiff opposition since the 1970s (Laes et al., 2007). In the 1980s, the eight nuclear plant N8 was conceived as DOEL V, at 18 km distance from the city centre of Antwerp across a maritime industrial zone of intense activity. Orderly evacuation of this area and of the city in case of an accident is beyond imagination (Ahlbrecht et al., 1997).

Life extension avoids focusing public attention on the dangers. The relevance of the Fukushima catastrophe for Europe is minimized. This attitude could be a source of more future danger (Kurokawa et al., 2012). Like in the USA, stress tests on nuclear plants help in finding out which plants may fail and cause collateral damage to other nuclear operators (ENSREG, 2012; Joskow and Parsons, 2012). When public authorities and independent groups share in the stress test processes and approve its outcomes, some responsibility for future nuclear accidents is implicitly footed to the entire society. Aging of plants adds risks to the exploitation of nuclear plants (World Nuclear Association, 2012).

6. Monopoly profits and rents in Belgium's electricity sector

Welfare economics and regulatory economics address monopoly power that companies own to increase their profits while causing societal welfare losses (Baldwin et al., 1998). Policy induced regulatory control and enhanced competition aim at containing and reducing monopoly power.

6.1. Profits in the Belgian electricity sector

Electric company's profits equal obtained revenues minus outlays. Revenues are the sum of applied power prices times sold quantities. Revenues can be raised by price discrimination (Phlips, 1983) and by prices exceeding Ramsey–Boiteux prices (Baumol and Bradford, 1970). Outlays are the sum of paid factor prices times used quantities. Production factors owned by the company will generally be rewarded at above market prices, e.g., TRACTEBEL charged 16% fees on engineering-contracting work for nuclear plants. Outlays are minimized by tax evasion and by unpaid social costs (adjournment of waste solution; uncovered risks).

The industrial reforms since 1955 and the decennial doubling of electricity sales created ample room for high profits in Belgium's vertically integrated electricity sector. The CCEG allowed high rewarding of the company's production factors, including high rates of return on capital invested in power supply, on top of yearly re-appraisals of sunk capital.

The height of the revenues largely depended on tariffs approved in the CCEG. Most income (for example 94% over the year 1997) was raised from sales to small and medium-sized consumers (households, SME, hospitals, schools, commercial facilities, etc.). Profits were cashed net of income taxes by sequentially applying two articles of fiscal law: first, a public company does not pay income taxes; second, an income flow can be submitted only once to the tax laws (Dister et al., 1987). For applying the first article, ELECTRABEL engaged in narrow cooperation with local governments sharing part of the profits as a compensation for using distribution monopoly rights.

The described system of high profit creation and sharing with local authorities survived the 1999 liberalization law and the abolition of the CCEG in 2003, but crumbled along ELECTRABEL's dwindling market share during last years, and takes an end in 2013. Along the drying of this important source of income, politicians searched for other canals for obtaining part of the revenues from electricity sales. Yearly lump sum transfers of nuclear rents payments were one.

The relations between ELECTRABEL and Belgian politicians have shifted since liberalization and unbundling. The ingenious profit sharing and tax evasion mechanisms are scrapped, being no longer compatible with new regulations, neither vital for ELECTRABEL. The latter moved its tax shelters from the local to the national and international level: notional interest cost deduction, fiscal coordination centers, and transfer opportunities within SUEZ-GDF, offer sufficient way-out to continue almost zero income tax payment. ELECTRABEL extracts profits in various ways, for example: (mostly small) consumer surplus skimming, income tax evasion, “windfalls” from the European Trading Scheme (Verbruggen, 2008a), over-subsidized green power projects (Verbruggen, 2009).

Press coverage arouses public animosity against the billion euro profits, followed by firm declarations about “making ELECTRABEL pay” on the lips of several politicians. After little successful endeavors to cash lump sum contributions by ELECTRABEL to the treasury, “nuclear rents” emerged as a fresh device.

6.2. Nuclear rents, causing fuss in Belgium

The federal regulator CREG, consumer organizations, politicians, media, etc. speak about “nuclear rents” as high profit margins on nuclear power generation because the plants are financially depreciated. From January 1st, 1982 onwards, accelerated depreciation of nuclear investments over a 20-year time-span started by a special CCEG tariff component charging the bill most on captive customers (Verbruggen et al., 1988), what seems a standard practice (Bradford, 2012). By 2006 the nuclear plants in Belgium were financially fully depreciated. The early and rapid depreciation of the nuclear plants applied since 1982 was part of an expansive nuclear strategy of building one new large-scale station every year in the future (Section 3). After Chernobyl (1986) this policy plan stranded, and CCEG could have canceled the accelerated depreciation practice, but it did not.

How can one identify part of the ELECTRABEL and SPE profits as nuclear rents? In the Belgian debate, “nuclear rent” was the term used for the difference between the sales value of nuclear power and the expenses made for its generation (in fully depreciated plants). Mainly the sales value is contentious, when it remains unclear how nuclear power is embedded in the integrated power systems (Verbruggen and Erreygers, 2011). Simple referring to price fixings at the power exchanges is contentious because the electricity reality is not identical to the textbook ideal market. Most power tariffs are still based on monthly or yearly average costs by category of customers. The largest share (around 80%) of electricity is sold via bilateral contracts with the residual (around 20%) via the power exchanges, which hourly spot prices reflect the short-run marginal costs of power systems, eventually enhanced by speculative margins.

CREG delivers the highest estimate of 1750–1950 million euro “nuclear rents” for a nuclear output of 46 TWh, i.e. on average €40/MWh generated in the year 2007. CREG defines “nuclear rent” as the electricity wholesale forward price at the power exchange minus the average expenses of nuclear generation (CREG, 2010). ELECTRABEL admitted a maximum 750 million euro margin on its nuclear generation accounts for 2007, referring to a higher average cost of the nuclear output and lower revenues from sales than posted by CREG. The National Bank estimates the height of the nuclear rents at 800–950 million euro (NBB, 2011).

Without full access to the detail of the calculations of the three contenders, it is difficult to point to the best estimate. My bet would be the range suggested by the National Bank, because it accords best with an independent assessment based on actual data and practices of electricity sales.

7. Nuclear power life extension or phase-out

Nuclear power phase-out is not a post-Fukushima idea. In 1978 Denmark rejected the deployment of nuclear power. In 1977–78 Austria decided not to load the finished 700 MW nuclear plant Zwentendorf, and banned nuclear power by law. Swedish Parliament decided in 1980 to phase out by 2010, but in 2010 allowed the replacement of the remaining 10 reactors in three stations. The Swiss government decided on 26 May 2011 that the country's five nuclear power stations would close gradually over the next 20 years (Mez, 2012). In Germany nuclear power versus energy efficiency and renewable power have been debated intensively since the 1970s. Local initiatives showed alternative approaches are feasible (Hennicke et al., 1985). In June 2011 Germany closed the oldest 8 reactors and decided on phasing out the remaining 9 by 2022, after an ethics commission attained a consensual advice (Töpfer et al., 2011).

Proposals and studies on phasing out nuclear power generation in Belgium following the Chernobyl disaster got little public or policy attention (Verbruggen et al., 1988). During their first (so far only) federal government participation (1999–2003) the Green Parties ECOLO and AGALEV were leading in passing the 2003 phase-out law: nuclear power plants on Belgian territory have to end generation at the age of 40 years. Article 9 of the law stipulates that in case of loss-of-load danger, the government can take “required measures”, but that only force majeure could affect the phase-out regulations of the preceding articles in the law. However, no clarity is added about how force majeure has to be “proved”.

The Belgian power sector acted as if the law was but a transient constraint. For example: a few large industrial companies (united as Blue Sky group) agreed with ELECTRABEL on delivery of low-priced nuclear power from the three eldest nuclear plants (World Nuclear News, 26 August 2011). FANC prepared more for life extension than for implementing decommissioning as the 2003 law schedules. Because in Belgium many (in particular topical) laws are changed rapidly and frequently, the nuclear industry expected abolishment or amendment of the phase-out law after 2003. The government established in 2008 did not mention the law in its vesting declaration, but H. Van Rompuy (interim prime minister during 30/12/2008–25/11/2009, then leaving for the EU presidency) announced the lifetime extension of nuclear power plants beyond 40 years and would adapt the law accordingly. However, before his intentions could be put in law, the government itself ended prematurely in April 2010. New elections took place in June 2010 but installing a new government lasted until December 2011. With the March 2011 Fukushima catastrophe, the new government (free of Green Parties) announced its intention to shut down the oldest plants as foreseen by the law, by a decision within six months. The Flemish nationalist party N-VA in opposition, and some coalition parties (Walloon liberals MR and Christian Democrats) speak in favor of life extension.

June 27th, 2012, the secretary of state responsible for energy, Mr. Wathelet, submitted a note to his colleagues in the government (Wathelet, 2012). The main argument is about reliability of power supply over the period 2012–2017, based on expected LOLE (Loss-of-Load Energy) assessed by the administration and the transport grid owner and operator ELIA.

July 4th, 2012, the government decided to extend the lifetime of 962 MW capacity of TIHANGE I with ten years. The closure in 2015 of 866 MW in DOEL (units I and II) is imposed, according the 2003 law. It means: capacity allowed life extension is higher than capacity closed.

For the own decision, the government did not refer explicitly to the force majeure foreseen in the 2003 phase-out law, escaping the inherent obligations of calling upon force majeure: providing extended and documented argumentation why alternatives for nuclear power had not been sufficiently developed over the last decade. On the contrary, the government announced to delete the force majeure article 9 in the 2003 law, for committing future politicians to respect the closure calendar. While the July 2012 decision is a neat example of preceding politicians unable to bind present colleagues, it used strong wording about guaranteed respect for the adapted closure calendar. Factually it is very unlikely that future politicians will feel committed by the July 2012 words; they rather will emulate the 2012 behavior after 2017. The power supply reliability will not improve without strong measures substituting electricity efficiency, renewable power and cogeneration for the nuclear output serving half of the present electric load in Belgium. Such a deliberate, full-scale transition program is not available and doubtful to be shaped and implemented in coming years in Belgium unless international pressures strengthen dramatically.

There was only marginal reference to “nuclear rents” in the life extension decision. A rather obscure part of Wathelet's note (p. 30) handles over the eventuality that the government would tender for generation capacity, and that above market costs could be compensated by income from “nuclear rents”.

The earlier debate about height and appropriation of “nuclear rents” had no identifiable overt impact on the 10-year life extension of TIHANGE I. The months ahead the July 2012 life extension decision brought no clarity about the height of the “nuclear rents”, or about the legal, financial and practical aspects of an eventual transfer by ELECTRABEL of such rents to the treasury or to the consumers. This is partly due to changing agendas of the politicians believing they addressed the nation's debt by other means and they addressed consumers' concerns by installment of a maximum electricity price from April 1st 2012 onwards. As a corollary the “nuclear rents” issue had no visible, and presumably little, impact on the life extension of the eldest nuclear plants. No proper test of the hypothesis is feasible, but most evidence points to small impact.

8. Conclusions

Belgium was in the immediate post World War II period an early adopter and developer of atomic power. After France, it owns the second most nuclear intensive power system in the world: over the last 25 years more than 50% of its power supplies is forthcoming from nuclear fission. Mastering the entire nuclear technology and fuel cycle failed due to the scale of the country. A tight relation with the French nuclear sector was developed, sealed by SUEZ-GDF and EDF taking ownership of the dominant share of Belgian electricity generation, including all nuclear plants. Like France, Belgium owns historical ties, customs, institutions, and interests strengthening the nuclear power lock in.

Amazingly, in 2003 Belgian Green parties tilted the political tide to enact a law for the phase-out of nuclear power generation plants in Belgium when passing 40 years operational life. But little work and resources were spent on conceiving, developing and implementing a full alternative for the nuclear plants. A country heavily tied to the nuclear path cannot be expected to change course overnight. The power companies, industrial circles, academics, officials, opposed the law, and continued business-as-usual. For abolishing or amending the 2003 law, they brought up mainly three arguments: addressing climate change (by being part of the “nuclear renaissance”), financial losses by premature closure, loss-of-load risks because no substitutes for nuclear are feasible, affordable, or ready.

Several groups rallied on “nuclear rents”. The accelerated financial depreciation of the nuclear plants over the period 1982–2005 was paid by regulated tariffs (mostly by small and medium-sized customers). After depreciation the owners cashed significant profits. Politicians voiced that “ELECTRABEL should pay” part of the country's budget deficit. But on the volume and transfer mechanisms of the money, no clarity was obtained. The regulator CREG and the National Bank published separate and conflicting numbers and opinions, shaming the country's public institutions and its political authorities.

In July 2012, the government based the allowance for 10 years life extension of 40-year old TIHANGE I (962 MW) nuclear plant on a power loss-of-load assessment over the period 2012–2017. This is not sufficient as proof of force majeure to break the phase-out law of 2003. While breaking the law made by preceding politicians, the present politicians strongly confirm phase-out to be respected by future politicians. This scenario is very unlikely when no comprehensive policy is implemented to bring in place the efficiency and renewable energy substitutes for nuclear power. The plausible hypothesis of nuclear rents favoring life extension could not be tested by lack of sufficient information. Most evidence suggests the impact is small.

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