EPRG WORKING PAPER

UNIVERSITY OF CAMBRIDGE

Electricity Policy Research Group

Nuclear Energy in the Enlarged European Union

EPRG Working Paper 0904

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Keywords Nuclear Energy, European Enlargement, Energy Security

JEL Classification O13

Contact wjn21@cam.ac.uk
Publication January 2009
Financial Support CESSA (EC FP6 044383)

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Nuclear Energy in the Enlarged European Union

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EPRG Working Paper

Abstract:
The paper considers the European balance of opinion and experience of nuclear energy and notes that it has shifted significantly as the European Union has grown from 15 member states to 27. The proportion of member states with nuclear energy experience has increased markedly. Also, as a result of changes affecting the main drivers of energy policy, the balance of policy enthusiasm in most EU-27 member states has shifted with time in favour of nuclear power. Two contrasting examples of nuclear experience from new member states are presented. These examples are of possible benefit to those considering new nuclear build projects, for instance in the EU-15 states. Thus far much policy attention has been devoted to developments in Finland, France and the UK. This work has been made possible by the EC FP-6 project "CESSA". The CESSA project is conscious of much useful energy security experience in the countries of central and Eastern Europe and this paper is, in part, a reflection of that sentiment.

1. Introduction - 50 Years of Nuclear Power in the EU:

Nuclear energy has a special place in the history of the European Union. Concerns for European collaboration on nuclear energy matters was one of the founding motivations of the European project. Specifically, In April 1956, following the 1954 failure of the European Defence Community, an international committee, under the Presidency of P.H. Spaak, the Belgian Minister for Foreign Affairs proposed:

- the creation of a general common market;
- the creation of an atomic energy community.

These in turn became the two "Treaties of Rome" signed in March 1957.

The first Treaty established the European Economic Community (EEC) and the second the European Atomic Energy Community, better known as “Euratom”. These two Treaties entered into force on 1 January 1958[1]. The EEC Treaty has been modified numerous times most recently with the proposed Lisbon Treaty currently awaiting ratification by the 27 member states of what is today known as the European Union (EU).

The absence of amendments to the Euratom Treaty, in contrast to the decades of haggling and deal-making surrounding the EEC amending treaties, should not be taken as an indication that all EU member states have a common opinion on nuclear energy matters. While the EEC treaty, and its amending treaties, have moved incrementally towards the aim of “ever closer union”, the Euratom framework has moved forward much more slowly. The individual member states, rather than agreeing on all things nuclear, have taken a broad range of occasionally almost irreconcilable positions on what has become a most politically contentious energy technology. One area of progress, however, has been in the area of nuclear installation safety and radioactive waste management. Fernando de Esteban has explained:

> *“When the authors of the European Atomic Energy Community drafted the EURATOM Treaty, thoughts of nuclear installation safety and radioactive waste were not uppermost in their minds. For several years there was no Community activity directly dealing with nuclear installation safety. It was not until 1975 that the Community woke up to the seriousness of the issue. By then, nuclear power programmes in its then Member States had progressed and diverged along very different routes. Moreover, not only were many of the installations very different, but the national systems regulating them were also very different.”*

and

> *“… as a result of co-operation between the main actors in the EU since the*

[1] For further information on the underlying treaties of the European Union see: http://europa.eu/scadplus/treaties/eec_en.htm

1970s, there is a 'non-binding acquis' that is built on fundamental common principles. These form the basis of all the EU national nuclear safety regulations" (de Esteban, 2002)

This paper explores issues of nuclear energy policy in the particular context of EU enlargement.

Climate change is a global threat. The bulk of its impacts occur outside the EU and the EU is only partly responsible for the anthropogenic harm caused by greenhouse gas emissions. Also, the whole European Union faces growing fossil fuel import dependency and near total uranium import dependency. Both these major drivers of energy policy affect the EU as a whole and involve important factors external to the EU. Given the external nature of the issues, it might seem sensible for the EU to seek to shape the fuel mix at a European level. Such a policy would improve economies of scale in research and deployment of new technologies, reduce the need for duplicative and wasteful policy development at the member state level and ease the development of a single European market in energy products and services. There is no prospect however that this will happen and the reasons are political. Notwithstanding notions of a liberal European electricity market, the fuel mix remains a sovereign matter reserved for each member state to develop as it sees fit, subject only to the constraint that it should be respectful of the concerns of neighbouring states. Arguably recent European binding commitments on renewable energy and biofuels erode the notion that the fuel mix is a national concern, but it is for the issue of nuclear energy where the desire to protect national discretion is most strongly expressed. Interestingly, and perhaps even somewhat paradoxically, those states (e.g. Germany) which are usually most strongly Euro-Federalist on other aspects of policy are among the first to defend notions of "subsidiarity" on matters relating to nuclear power and the fuel mix for electricity (European Energy Forum, 2006).

Table 1 summarises the current situation for those EU member states that have ever operated a commercial nuclear power station[2]. Only one country (Italy) has actually eliminated nuclear energy from its electricity system, although several have at various times put forward policies for a nuclear power moratorium or phase-out (e.g. Belgium, Germany, the Netherlands, Spain, and Sweden) (de Esteban, 2002). Recently with the return to power of Silvio Berlusconi, Italy has renewed its interest in nuclear energy.

2 Small research reactors are neglected. Some European countries, e.g. Portugal (see: e.g. the Sacavem reactor – http://www.itn.pt/uk/uk_main.htm) and Greece (see: http://ipta.demokritos.gr/Documents/MOISSIS.pdf) have operated such reactors while never having operated a nuclear power station.

Country	Power Reactors Operating May 2008[2]	Power Reactors Building & Planned May 2008[2]	Closed by end 2007[3]	First kWh[1]	GWh 2007[2]	% of electricity generation 2007[2]
Belgium	7	0	1	1962	46	54
Bulgaria	2	2	2	1980[3]	13.7	32
Czech	6	0	0	1985	24.6	30.3
Finland	4	1	0	1977	22.5	29
France	59	1	11	1959	420.1	77
Germany	17	0	17	1961	133.2	26
Hungary	4	0	0	1982	13.9	37
Italy	0	0	4	1963	0	0
Lithuania	1	0	1	1983	9.1	64.4
Netherlands	1	0	1	1968	4.0	4.1
Romania	2	2	0	1996[3]	7.1	13
Slovakia	5	2	1	1972	14.2	54
Slovenia	1	0	0	1981	5.4	42
Spain	8	0	1	1968	52.7	17.4
Sweden	10	0	3	1964	64.3	46
UK	19	0	25	1957	57.5	15

Table 1. Nuclear Stations in EU-27, [sources: 1. Anthony Froggatt[3], *Nuclear Power the European Dimension,* in *Nuclear or Not?,* edited by D. Elliot, Palgrave(2006) except Bulgaria and Romania; 2. World Nuclear Association http://www.world-nuclear.org/info/reactors.html and 3 except Italy; 3. Relevant WNA country briefings: http://www.world-nuclear.org/info/info.html#countries]

2. Nuclear Power in the EU-15

It is not the purpose of this paper to seek to review the entire history of nuclear energy in the European Union, nor is it appropriate to attempt to address all of the drivers of past and present European energy policy. Rather it is perhaps sufficient to mention:

- The UK and France were the first countries to develop civil nuclear energy in Europe building upon their separate experiences with gas cooled reactors devoted to military plutonium production. In the 1960s France altered its technology policy to favour Pressurised Water Reactors while the UK did not make an equivalent policy choice until 1979 with policy implementation spanning the 1980s. France and the UK are the only EU-15 countries ever to have been nuclear weapons states and both states continue to maintain nuclear weapons capacity.
- In the 1970s issues of nuclear waste became prominent and in some EU-15 states (notably the UK and Germany) policy progress on the

3 Note Froggatt reports for Germany: 19 plants shut by 2005 rather than the 17 shown in Table 1, and for Spain 2 plants shut and not the 1 shown in the table.

expansion of nuclear energy became linked to a perceived need to resolve the waste question[4]. Waste then assumed a special significance in the wider policy debate surrounding nuclear energy.

- Following the severe accident at the Three Mile Island Plant, Harrisburg PA, USA in 1979 and the disaster in Chernobyl Ukraine in 1986 some European countries including Germany, Sweden and Italy established policies for nuclear phase-out, although only in the Italian case was this policy taken to completion. Sweden is uprating nuclear power plants at Ringhals and Oskarshamn and this will offset the loss of capacity caused by the closure and decommissioning of Barseback units 1 and 2 (WNA-Sweden). There is much political discussion in Germany concerning life extensions of existing nuclear power plants.
- Some countries, such as Ireland, having had initial ambitions for nuclear power, have since moved to exclude the option formally from policy consideration[5]. In Ireland (in 2008) the relevant Minister is required to approve all new power stations under the Electricity Regulation Act of 1999, but he or she is barred by statute from granting such permission to a nuclear fission-based power plant (Ireland, 1999).
- Finland, is unusual among the EU-15 in having spent the Cold War looking both west and east seeking to maintain balanced relations with both sides. Austria arguably adopted a similar approach although its western leanings were more obvious. While Austria resolutely avoided nuclear energy, Finland adopted nuclear power using technologies drawn from the west (i.e. Sweden and deployed at Olkiluoto) and the east (i.e the USSR and deployed at Loviisa).
- In the 1970s the UK and the Netherlands developed indigenous offshore natural gas resources whereas in contrast France lacks significant fossil fuel assets. Partly as a consequence of the oil shocks of the early 1970s France moved heavily into nuclear energy such that today roughly three quarters of France's electricity is supplied from nuclear energy with the balance mostly being supplied from hydroelectricity sourced in mountainous regions.

2.1 Balance of EU-15 national opinion

These differing national experiences across the EU-15 states resulted in a remarkably balanced range of national opinions on nuclear energy ranging from the enthusiastic (e.g. France) to the clearly hostile (e.g. Austria). This balance of opinion is summarised in table 2, as assessed by the author. Noting significant movement towards nuclear energy in the last two years, table 2 is perhaps best regarded as presenting the situation pertaining in the year 2006. Key criteria used to establish a given member state's position in the table include formal current government policy, extent to which policy is a consensus across major political parties, the level of acquiescence and public acceptance of policy and the scale of operating infrastructures such as: power plants and/or research reactors.

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4 See, for instance, UK Royal Commission on Environmental Pollution, sixth report, 1976, *Nuclear power and the Environment*, “The Flowers Report”

5 Note 1970s aborted plans for a nuclear power plant at Carnsore Point, County Wexford.

Strongly Positive	Weakly Positive	Neutral	Weakly Negative	Strongly Negative
Finland	UK	Luxembourg	Italy	Ireland
France	Netherlands	Denmark	Germany	Austria
	Spain		Sweden	
	Portugal		Belgium	
			Greece	

Table 2. EU-15 member state opinion concerning nuclear energy in 2006 – author's assessment

Table 2 confirms the impression that in 2006 the EU-15 states were almost exactly balanced in their opinion of nuclear energy. One must concede that since 2006 some countries have become more pro-nuclear e.g. Italy and the UK, but generally opinion is still finely balanced in 2008 with roughly half the EU-15 states uncomfortable with the prospect of nuclear new build.

3. Nuclear energy in the new member states

Elsewhere in the CESSA working paper series we explore the range of energy security issues facing EU member states in the early twenty-first century. While there are numerous points of comfort concerning EU energy security as a whole, there are notable differences between, on the one hand: Western Europe and the other: Central and Eastern Europe. Perhaps simplistically, one might argue that energy security is best assured by those energy systems that make use of a wide diversity of fuel types, drawn from a wide diversity of sources, via diverse transit routes and open to a plurality of trading opportunities. While fuels and electricity in western European countries, such as the UK, tend to measure up well, most central and eastern European countries have weaker grounds for comfort. In time the energy security jeopardy faced by these countries can be alleviated via the improvement of transmission infrastructures. However, at present the logistics of the energy supply chain is far from ideal and there is much reliance, and even more perceived reliance, on natural gas effectively controlled by Russian state-controlled corporations. The end of the Cold War in 199l, less than 20 years ago, motivates a high level of distrust of Russia in several of the new EU member states and the 2006 gas crisis in Ukraine and the 2008 Georgia crisis have done nothing to improve trust of the Russian Federation. These factors coupled with high global fossil fuel prices, increasing concern for global climate change (with its associated and trade-able EU greenhouse gas emission reduction targets) and strong electricity demand growth have in several cases motivated significant interest in an expansion of nuclear energy.

Table 3 presents an impression of policy opinion in the 12 newest members of the European Union as assessed by the author using the same criteria developed for Table 2.

Strongly Positive	**Weakly Positive**	**Neutral**	**Weakly Negative**	**Strongly Negative**
Lithuania	Poland	Malta		
Romania	Latvia	Cyprus		
Bulgaria	Estonia			
Czech Republic	Slovenia			
Hungary				
Slovakia				

Table 3. EU 12 newest member states' opinions concerning nuclear energy – author's own analysis. As with the countries listed in table 2 opinion is moving towards nuclear energy with time among the most recent 12 members of the EU.

Comparing table 3 and table 2 it becomes clear that the balance of opinion within the EU towards nuclear has now shifted dramatically. Furthermore in order to understand the position of nuclear energy within the EU it is essential to consider the experience and opinions of member states in central and eastern Europe at least as much those in western Europe and perhaps even, in some respects, more so.

Rather than seek to consider nuclear energy policy in each of the twelve most recent members of the EU we shall devote the rest of this paper to consider two specific examples, Romania and Lithuania, which between them illustrate some of the most resonant and provocative policy insights.

These case studies draw upon insights gained from CESSA-funded research visits to Romania (June 2008) and the Krynica Economic Forum in Poland in (September 2008). This paper represents merely the first in a planned series of research publications relating to nuclear energy in this most interesting of regions. In time it is hoped that it might be possible to complement the Romania research visit with a similar visit to Lithuania. In the absence of such experience, the Lithuanian case has been informed by numerous helpful interactions with colleagues from the Lithuanian nuclear industry.

4. Extended Case Studies:

In this section we consider in greater detail two topical case studies concerning nuclear power in recent member states of the European Union. The examples are chosen in part because they represent extremes concerning the relationship with Russia during the Cold War. The first example considered is Romania, which as we shall see, pursued a policy of national independence including significant distance from the policies of its ally - the Soviet Union. The other example will be the Baltic States with particular emphasis on Lithuania. The Baltic States are noteworthy because they are the sole examples of former territories of the Soviet Union now in membership of the EU. These differing histories concerning the relationships of Lithuania and Romania with Russia yield today (September 2008) very different nuclear infrastructures and also continue to shape both current and future energy policy choices.

4.1 Romania

Romania occupies a special place in twentieth century European history. The early twentieth century was characterised by shifts of geopolitical allegiance and territorial gains and losses. At the close of World War II Romania fell under the influence of the Soviet Union. However by 1958 the departure of Soviet troops had been agreed and the country had a new leader Nicolae Ceauşescu. Preserving communism he ushered in an extended period of national independence verging on autarky. The Ceauşescu regime relied on a Stalinist authoritarianism for power, although it must be acknowledged that some of the worst human rights abuses occurred in the immediate post war years before Ceauşescu's rule. Through the 1970s and 1980s authoritarianism became blended with a growing cult of personality reminiscent of that in North Korea for Kim Il Sung. Ceauşescu knew and admired North Korea having visited in June 1971. The influence of the North Korean conception of socialism on Ceauşescu and his policies for Romania has been summarised and explored by Adam Tolnay (Tolnay, 2002). Through the 1980s the economy deteriorated, partly as a consequence of Ceauşescu's isolationist drive to repay international debt (Turnock, 2007, p.33). In 1989, communist regimes fell across central and eastern Europe. At the very end of the year political tensions boiled over in Romania and a violent revolution occurred culminating in the execution of Ceauşescu and his prominent, and widely disliked, wife Elena. While characterised as a popular revolution, it is noteworthy that in the years since the revolution of 1989 Romanian politics has repeatedly featured the figure of Ion Iliescu, once a close colleague of Ceauşescu and one of the small group that travelled to North Korea in the summer of 1971 (Tolnay, 2002). Key to Iliescu's position was the use of miners to break up anti government protests, particularly in 1990. These aggressive interventions known as 'mineriads' remain controversial to this day. Nevertheless in the twenty-first century Romania has emerged as a functioning democracy. Iliescu was defeated in genuine elections in 1996 returning to power in the elections of 2000. Today (September 2008) Romania is a full member of both the European Union and NATO. Since December 2004[6] Romania has been led by anti-communist former mayor of Bucharest Traian Băsescu.

Ceauşescu's grandiose and foolhardy ambitions left Romania with an unbalanced legacy of industrial infrastructure. David Turnock notes of the1980s:

"*Economic policies became more irrational through the "gigantism" of excessive capacities in oil refining, petrochemistry and steel production based on raw material imports(…)that were not recouped through the value of exports."* (Turnock, 2007, p. 33)

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[6] With a brief hiatus in the spring of 2007 while impeachment proceedings went to a national referendum in which the proposal was rejected by the people.

In electricity coal was favoured, especially lignite. Some regional use was made of natural gas while oil was prioritised for petrochemicals (Turnock, 2007, p. 59). At the time of the fall of communism electricity distribution in Romania was very poor, with 50% losses reported (Turnock, 2007, p. 107). Blackouts were a significant feature of Romanian life in the 1980s.

Today (September 2008) Romania is a net exporter of electricity with an overcapacity in transmission (Diaconu et al. 2008). Roughly two thirds of Romanian electricity is carried on the national grid operated by Transelectrica which operates to good standards of reliability (ibid).

Ceauşescu's desire for autarky was realised in the national vision for nuclear energy. On nuclear matters, as with much else, Romania sought to increase its distance from the Soviet Union in the 1960s (Turnock, 2007, p.59). Romania chose to partner with Atomic Energy Canada Ltd and develop a fleet of CANDU-6 natural uranium fuelled heavy water cooled and moderated reactors at Cernavoda in the south-east of the country roughly 50km from the Black Sea port of Constanţa. The choice of CANDU-6 nuclear power technology suited the development of a wholly indigenous nuclear fuel cycle. The chosen approach involved uranium mining at a range of sites around the country. Today (September 2008) Romania continues to mine uranium through the activities of Uranium National Company s.a. (UNC) at Crucea and Botusana in the north of the country[7]. Together these mines comprise UNC's Suceava centre. At present these activities are undergoing modernisation. Uranium milling and processing is undertaken at UNC's Feldioara Branch in the centre of the country. This facility yields sinterable UO_2 powder. It is worth stressing that the CANDU-6 nuclear power system does not require enriched fuel and so enrichment activities do not form part of the Romanian nuclear fuel cycle. Sintered UO_2 fuel pellets are produced in Pitesti, 80km northwest of Bucharest, at the Fabrica de Combustibil Nuclear (FCN) [Nuclear Fuel Factory] part of Nuclearelectrica a majority government-owned nuclear energy company[8]. Also in Pitesti is the headquarters of the Sucursala Cercetari Nucleare (SCN) [Institute for Nuclear Research][9]. SCN has a large range of research and production facilities including research reactors and hot cells. The Pitesti facilities of Nuclearelectrica and SCN produce qualified CANDU-6 fuel ready for use in the power stations at Cernavoda.

As part of the Ceauşescu' s vision of self-reliance, Romania also developed perhaps the most technologically demanding aspect of a CANDU-6 fuel cycle: the production of heavy water for reactor moderation and cooling. This activity is undertaken by the Romag-Prod facility in the south west of the country. The Romag prod facility is a key part of the Regia Autonoma Pentru Activitati Nucleare (RAAN) [Romanian Authority for Nuclear Activities] of the Ministry

[7] See: http://www.cnu.ro/en/about.html
[8] See: http://www.nuclearelectrica.ro/?
[9] See: http://www.nuclear.ro/index_en.html

of Economy and Finance[10].

Heavy water is barely consumed during the operation of CANDU-6 reactors. Once produced in sufficient quantities for each power station, little or no additional heavy water will ever be required. It is expected that Romag-Prod will soon have produced enough heavy water for the four CANDU-6 plants expected to comprise the completed Cernavoda project. Once this task is done this aging and expensive-to-operate infrastructure will be closed and decommissioned (Bucur, 2008). While most of the heavy water has already been produced for plants Cernavoda 3 and 4 (plants 1 and 2 are already operating) it might be preferable to shut the Romag-Prod facility early and to obtain the balance of heavy water required internationally (Sandulescu, 2008).

While the CANDU-6 fuel cycle is relatively simple, in that it does not require uranium enrichment, it suffers from the production of relatively large volumes of spent fuel waste. At present no final decision concerning long-term spent fuel management has been made. In particular no final decision has been made concerning the site and specification of a radioactive waste repository. This situation is typical within Europe with only a very few countries having made concrete progress on this issue. Reprocessing is not on the Romanian agenda although it is worth noting the Romania could, in future, enter into a reprocessing based fuel cycle via the use of international reprocessing contracts, without needing to invest in domestic infrastructures (Sandulescu, 2008).

Concerning Ceauşescu's conception of the nuclear fuel cycle it is worth noting reports that prior to 1990 Romania did undertake some, at the time undeclared, research into plutonium separation, producing minute quantities of this nuclear weapons proliferation sensitive material. Romania, however, never developed a nuclear weapon and it is a signatory of the Nuclear Non-Proliferation Treaty (FAS. 2008).

At the heart of Romania’s nuclear energy activities is the Cernavoda power plant complex operated by Nuclearelectrica. In the 1980s it was planned that there would be five plants Cernavoda 1-5 to be built concurrently. Unit 5 was something of an after thought rumoured to have been forced onto the agenda by Ceauşescu himself despite the site being poorly suited for a fifth plant. While the locations for units 1-4 form a neat line beside the Danube River the site of the fifth (part-built) plant is slightly out of line because of insufficient solid limestone foundation at that end of the Cernavoda site. To compensate for this geological difficulty very large amounts of concrete were injected to form a solid foundation for the Cernavoda-5 plant. Of the four plants part-built at the time of the 1989 revolution the fifth plant was the least complete (at only roughly 4%). Given these circumstances it is now expected that Cernavoda-5 will never be finished and the Cernavoda site when complete will comprise just four CANDU-6 reactors (Mihai, 2008).

During the 1990s Romania faced significant economic challenges and the

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10 See: http://www.raan.ro/en/index.html

decision was made to progress the Cernavoda project in a phased way completing the Cernavoda-1 station in 1996. It is not the purpose of this paper to consider the financing of nuclear energy projects, and it is hoped that it will be possible to describe Romanian experience in this regard in a separate paper. Suffice it to say that the loans associated with unit 1 were repaid by 2006 and this existing asset was useful in collateralising the costs of unit 2, completed in 2007. Loans relating to unit-2 are scheduled to be repaid by 2020 (Bucur, 2008).

In 2008 the topical issue in Romanian nuclear energy policy relates to the completion of mothballed part-built units Cernavoda-3 (17% complete) and Cernavoda-4 (15% complete) (Bucur, 2008). There is significant public and private sector interest in financing these plants and again this will be discussed in a later paper. At this stage it is sufficient to state that there is no shortage of investment funding available to complete these two units (Bucur, 2008 and Sandulescu, 2008). The process has not been without some turbulence with government late in the day increasing its stake to a controlling interest of 51% much to the consternation of the private sector investors who were keen to have larger stakes in the enterprise than will be possible in the 51% state-owned model.

Nuclearelectrica s.a. is 90.28% owned by the Romanian government and it reports to the Societatea Nationala Nuclearelectrica [National Nuclear Corporation] headquartered in Bucharest. The Cernavoda project has involved numerous collaborations with international companies, most notably: Atomic Energy Canada Ltd. (AECL) designers of the CANDU-6 power plant. The Cernavoda 1 and 2 projects were delivered by AECL in collaboration with the Italian engineering firm Ansaldo. During the construction period the management team comprised representatives from SNN, AECL and Ansaldo (Mihai, 2008).

Once complete in 2015, the four reactor Cernavoda complex will produce 2600 MWe of baseload nuclear electricity (WNA-Romania, 2008), sufficient for roughly 40% of Romania’s electricity needs. While in 2008 the Romanian electricity market remains 70% regulated and 30% liberalised, by 2015 it is planned that the entire market will have been liberalised. As such, it seems probable that Cernavoda 3 and 4 will spend their entire operating lives in entirely liberalised electricity markets (Bucur, 2008).

In addition to the Cernavoda nuclear power plant, south-eastern Romania and the Danube delta has a wider significance in the Romanian electricity system. The region, including offshore sites in the Black Sea, has a large (3GWe) renewable wind energy potential (Leahu, 2008). The growth in renewables and nuclear power in this corner of Romania prompts investment for grid reinforcement in this region including 400kV lines for the Cernavoda area (Sandulescu, 2008).

Notions of self-sufficiency remain powerful in Romanian energy politics but the Romanian government’s conception of how to achieve such aims is radically different than the energy independence vision of the Ceauşescu era.

The government's view is that European and wider energy markets are beneficial for energy security and not a threat to it. Sufficiency is compatible with trade and the intention is that imports of primary fuels can be balanced by the export of electricity. While an exact balance will be difficult to achieve, an net balance is a policy goal for the country (Sandulescu, 2008). Such a strategy is well suited to Romania's position in southeast Europe. The region has a long history of international electricity trade. For many years Bulgaria was a net electricity exporter for the region. With investment in generation and grid reinforcement, particularly in Cernavoda and the Danube Delta, Romania will be well-positioned to be south-eastern Europe's electricity hub (Sandulescu, 2008). It is noteworthy that Bulgaria's position as a regional power exporter was badly weakened by the imposed EU accession requirement to close down Kozloduy 3 and 4 Russian designed VVER-230 pressurised water reactor plants near the Danube River border with Romania (WNA-Bulgaria, 2008).

Generally energy policy for EU member states comprises a balance of economic, environmental and security of supply concerns. While all these factors are of great importance to Romania the issue of greatest influence is the question of nuclear power is its possible contribution to electricity security of supply (Sandulescu, 2008). Romania faces the prospect of a dependence on Russian gas. Only 10% of Romania's electricity is generated from gas and the country's plan is to maintain, or possibly reduce, that proportion. Reductions will be difficult and may even be undesirable given that gas-fired electricity is associated with district heating and co-generation (Sandulescu, 2008). In 2008 70% of Romanian natural gas demand is still satisfied from domestic sources. However a previous government leased those assets for ten years to a foreign company, OMV of Austria, and this means that today profits associated with high fossil fuel prices are leaving the country.

The combined influences of rising fossil fuel prices, increased natural gas dependence on Russia and the challenge of global climate change, and an accepting regional and national public attitude to nuclear energy all lead Romania towards an expansion of nuclear power beyond the Cernavoda project. Preparatory studies for new build on a new site have been undertaken concerning location, site geology, seismology, cooling water supply and electricity network capacity (Sandulescu, 2008). This is to be followed by a feasibility study to provide clear answers concerning power plant scale and the technology choice. It is expected that the preferred technology will be a new and evolved technology (Sandulescu, 2008). It is unlikely to be the generation-II technology CANDU-6.

As regards European Union energy policy goals, Romania is in a comfortable position. Emerging from the burden sharing of the European Union's "20:20:20 by 2020" goals[11]. While, for instance, the United Kingdom must increase its share of renewables in total energy from 3% to 15% Romania's task is easier needing only to increase from 19% to 24%. Furthermore while the UK must decrease its greenhouse gas emission by 16%, Romania has the right to increase its emissions by 19%. Given that these EU targets may be achieved by

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11 See: http://news.bbc.co.uk/1/hi/world/europe/7296564.stm

trading between EU member states it seems highly likely that there will be wealth transfers from the EU-15 to Romania as states in western Europe struggle to achieve their binding quotas. Such wealth transfers are not necessarily undesirable, given Romania's need for modernisation and infrastructure renewal in order to reach EU norms.

4.2 The Baltic States

Until the completion of the 350MW Estlink[12] electricity interconnector between Estonia and Finland in December 2006 the Baltic States formed an "electricity exclave" or "island" disconnected from the rest of the European Union and unable to benefit from European electricity market integration in the bulk of the EU. Within the Baltic region very significant electricity trading occurs. In 2007, the country with the largest electricity generation capacity, Lithuania[13], traded the following amounts of electricity with neighbouring states:

> Lithuania exported 3.2 TWh to Latvia and imported 1.4 TWh
> Lithuania exported 1.1 TWh to Russia (Kaliningrad)
> Lithuania exported 2.0 TWh to Belarus and imported 3.6 TWh
> (Lietuvos Energija, 2007, p.12)

The Baltic States remain connected with the old USSR power grid, both directly to Russia and via Belarus. Reflecting changing geopolitical alignments these states now seek greater westward connection particularly to Poland and hence to Western Europe.

From 1940 until 1991[14] the Baltic states of Latvia, Lithuania and Estonia were constituent republics of the Soviet Union. As such, and in contrast to the Romanian experience, they fell completely under the centralised industrial policy of the communist government in Moscow. These command and control policies favoured large-scale industrial investments capable of serving the needs of the Soviet Union as a whole, with little sympathy for local circumstances. In electricity such planning left the newly independent Baltic States with a difficult legacy which still causes concern today (September 2008). Central to that legacy are the Ignalina nuclear power reactors in Visaginas, eastern Lithuania near the border with Belarus. At the time of independence the power station comprised two RBMK-1500 units each with a capacity of 1360MWe. The two units Ignalina-1 and Ignalina-2 came on-line in

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12 See: http://www.nordicenergylink.com/index.php?id=29

13 Juska and Miskinis, 2007 page 15, table 9: Data of the Baltic States 2005-2006:
Gross production 2006 (GWh):
Estonia: 9731
Latvia: 4891
Lithuania: 12482 of which 8651 from Ignalina-2 NPP

14 On 6 September 1991 the Soviet Union recognised the independence of the three Baltic States. Only a few weeks later the Soviet Union itself ceased to exist with the dissolution of the Supreme Soviet on 26 December 1991.

1983 and 1987 respectively. The RBMK design is a light-water-cooled graphite-moderated boiling water reactor, a type made infamous by the Chernobyl disaster of April 1986.

The Chernobyl disaster prompted the government of the then Lithuanian Republic to ask the government of the USSR that the construction of the planned unit 3 RBMK plant be abandoned. This request was accepted and construction of unit 3 was completely abandoned in 1989 (INPP, 2008).

In the 1990s there was much concern in western Europe regarding the presence of Chernobyl type (RBMK) reactors in the EU and the status of the Ignalina plant became *"one of the main issues in the Lithuanian accession negotiations"* (Euro.Lt, 2008)). The fourth protocol of Lithuania's treaty of accession to the European Union[15] states in Article 1:

"*Acknowledging the readiness of the Union to provide adequate additional Community assistance to the efforts by Lithuania to decommission the Ignalina Nuclear Power Plant and highlighting this expression of solidarity, Lithuania commits to the closure of Unit 1 of the Ignalina Nuclear Power Plant before 2005 and of Unit 2 of this plant by 31 December 2009 at the latest and to the subsequent decommissioning of these units."*(Eur-Lex, 2003)

Article 4 of the same protocol is however noteworthy:

"Without any prejudice to the provisions of Article 1, the general safeguard clause referred to in Article 37 of the Act of Accession shall apply until 31 December 2012 if energy supply is disrupted in Lithuania."

Article 37 of the Act of Accession states:

"*1. If, […] difficulties arise which are serious and liable to persist in any sector of the economy or which could bring about serious deterioration in the economic situation of a given area, a new Member State may apply for authorisation to take protective measures in order to rectify the situation and adjust the sector concerned to the economy of the common market.*

2. Upon request by the state concerned the Commission shall, by emergency procedure, determine the protective measures that it considers necessary, specifying the conditions and modalities in which they are to be put into effect. […]

3. The measures authorised under paragraph 2 may involve derogations from the rules of the EC Treaty and from this Act to such an extent and for such periods as are strictly necessary in order to attain the objectives referred to in paragraph 1. priority shall be given to measures as will least disturb the functioning of the common market."(Eur_Lex, 2003b)

The terms of Lithuania's EU accession are noteworthy in two important

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15 Lithuania's accession to the European Union was implemented via the 2003 *Treaty for the Accession of the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia and Slovakia.* See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:236:0017:0032:EN:PDF

respects. First Article 4 of the Fourth Protocol provides Lithuania with more than ten years of protection under Article 37 of the Act of Accession rather than the usual three, for the specific issue of energy supply disruption. Article 37 permits, at the Commission’s discretion, substantial measures up to, and including, derogations from the EC Treaty and the Act of Accession. However, and most importantly, such powers cannot permit a life extension for Ignalina-2 beyond 31 December 2009. That is, such measures are not in the gift of the Commission and would require a higher level reform of the Treaty and Act of Accession itself, and as such would require the agreement of all EU member states.

Life extension for the Ignalina-2 plant is a matter of great concern in 2008 as it is widely believed that closure by then end of 2009 will place Lithuania, and perhaps even the wider Baltic region in a position of dependence on Russia for electricity security. Given the worsening relations between Russia and the west in the period 2004-2008 and the role of energy in these geopolitical tensions such a position of energy dependence causes much nervousness.

The 2007 Lithuanian National Energy Strategy document notes:

“There exist serious problems in the field of energy security, which it would be highly complicated or nearly impossible for Lithuania to deal with on its own. Key problems include the long-term reliability of natural gas supply, construction of the prospective new nuclear power plant and integration of the electricity system into EU systems. Implementation of these strategic tasks could be facilitated only by close cooperation with other Baltic countries – Estonia, Latvia and Poland.” (Miskinis et al, 2008, page 9)

The perceived jeopardy is not open-ended but merely would exist until sufficient alternative electrical generation capacity had been installed. Given the now imminent approach of the Ignalina-2 closure deadline, it seems impossible that sufficient capacity can be installed by the closure date and as such some period of jeopardy seems inevitable. It might be argued that this situation would not have arisen if the Baltic States, knowing for many years of Lithuania's Ignalina closure obligation, had made proper compensatory arrangements much earlier. In response to this however it might be argued that the current reality of a frosty EU-Russia relationship could not have been expected only a few years ago.

Lithuania’s Prime Minister Gediminas Kirkilas is quoted as having said:

"We shall follow our commitments and we shall close the plant, but we would extend its operations for the particular period when we do not have other capacities," (EUBusiness, 2008).

He went on to caution that Lithuania could be "*completely dependant on a well-known neighbouring country (Russia), for either gas or energy imports*". He added: *"Our plan is very simple - to hand [all the arguments] to the European Commission, which is responsible for energy security of all the member states and we hope it will be taken into account".*

Lithuania's Vice-Minister of the Economy, Vytautas Nauduzas, points out that the situation faced by Lithuania at the end of the first decade of the twenty-first century was not anticipated at the time of the accession negotiations. The types of energy crisis that Lithuania could face represent a sort of *force-majeure* (Nauduzas, 2008).

In April 2008 the Lithuanian Government attempted to open negotiations with the European Commission (Lithuania, 2008). This against a background of popular support organised by Lithuanian trades unions (Rosatom, 2008).

Lithuania’s suggestions of a life extension for the Ignalina-2 reactor have been met with official silence from the Commission and Energy Commissioner Pielbag’s lack of a statement has been described as “stonewalling” (Collier, 2008). It is clear that while some EU Member States may be sympathetic to Lithuania’s proposal, a number of states would appear to be implacably opposed. As the shutdown deadline approaches, there are hints that Lithuania is resigning itself to compliance with its accession treaty obligations. With Lithuania planning for a new nuclear power plant for 2020 onwards it seems probable that the country will face 10 years without domestic nuclear electricity[16]. Jurgis Vilemas of the Lithuanian Energy Institute notes that the country will benefit from new investments in combined heat and power, new combined cycle gas turbines (450MWe in Lithuania and Latvia) and new investments in renewable energy prompted by the EU 2020 targets (Vilemas, 2008). It is important to remember that nuclear energy is one of only one aspect of Lithuanian infrastructure in need of updating. Arguably the most substantial challenge will be the €13Bn refurbishment of 30,000 blocks of flats in which standards of energy efficiency are currently poor (Nauduzas, 2008).

Lithuania with its large and amortised nuclear power plant enjoys very low domestic electricity prices. These prices must surely rise. First as the country covers the generation gap that will arise with the closure of Ignalina 2 and second to cover the costs of a replacement nuclear power station. That station will incur costs substantially higher than were incurred in building the original RBMK reactors in the days of the Soviet Union. The 2007 Lithuanian National Energy Strategy considered future price scenarios in some detail:

“In 2005, around 70% of the total domestic electricity production was generated by the Ignalina NPP (about 21% - by thermal power plants). In 2005, the average electricity generation cost was about 8.44 Lithuanian cent/KWh (taking into account the public interest component), and the average electricity price for the final consumer – about 23 Lithuanian cent/kWh. Taking into account the decommissioning of Unit 2 of the Ignalina NPP and the forecasted rise in the natural gas price, the average electricity generation cost in 2010 could stand at 16 Lithuanian cent/kWh, and the price for the final consumer could go up by 39% to 32 Lithuanian cent/kWh. A price should remain at similar levels until the planned construction of a new nuclear power plant in 2015. In the current and coming periods, the electricity price should also depend on the establishment of new electricity interconnections with Western European and Scandinavian countries and the level of electricity

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[16] 2020 would appear to be a plausible estimate

prices in these markets, as well as on the scope of the use of renewable energy resources in Lithuania. The evaluation of all the circumstances allows making forecasts that the electricity price in Lithuania should be somewhat lower than that in the markets of Western European or Scandinavian countries." (Miskinis et al, 2008, pages 34 and 35)

Lithuania has well developed plans for the construction of a new 3200 MWe nuclear power station to be located adjacent to the existing Ignalina RBMK installation (Nauduzas, 2008). As the majority state-owned electricity transmission operator Lietuvos Energija reports:

"On 28 June 2007, the Seimas (Parliament) of the Republic of Lithuania passed the Law on the Nuclear Power Plant, the validity of which was promulgated by the President on 4 July 2007. By order of this document the Seimas gave its approval for construction of a new nuclear power plant and designated Lietuvos Energija, which had expressed a private initiative to invest in the project, to act as the national investor." (Lietuvos Energija, 2007, p.25)

This new capacity together with a new1000 MW *power-bridge* to Poland entering into service in 2016 or 2017 and plans for a similar link to Sweden should ensure Lithuania's electricity security in the 2020s (Nauduzas, 2008). The 2007 National Energy Strategy warns in a list of threats, however:

"3) if the necessary competitive electricity-generating sources are not constructed and the reliability measures of the energy supply network, especially system interconnections with Poland and Sweden, are not implemented in proper time, the decommissioning of the Ignalina NPP and dismantling of reactors thereof, could pose a grave threat to the stable supply of electricity, while increased energy prices could become a heavy burden for consumers and the country's economy." (Miskinis et al, 2008, page 17)

Despite this warning electricity supply security is not inevitably compromised in the event of the closure of the Ignalina-2 plant because of the existence of the fossil-fuelled 1800MW (2006) Lithuanian Power Plant:

"The total installed electricity-generating capacity (nuclear and non-nuclear) amounts to nearly 5 000MW and exceeds the present domestic needs of Lithuania by more than two times, while the main source of electricity in the country is the Ignalina NPP which generates cheaper electricity than thermal power plants using fossil fuel. After the decommissioning of of Unit 2 of the Ignalina NPP at the end of 2009, the current generating capacities, including small capacity CHP plants that are planned to be constructed, will be sufficient to meet the national demand until 2013 in all cases of the growth in national economic needs and supply with systemic services necessary for the functioning of the system, but the Lithuanian Power Plant and the existing CHP plants with the lowest electricity generating cost during the heating season should be modernised. After the decommissioning of Unit 2 of the Ignalina NPP, the Lithuanian Power Plant will become the major electricity generating source until the construction of a new nuclear power plant, hence, it is required to carry out the necessary testing and adjustments of the power plant equipment and to ensure its reliable operation with a capacity of at least 1500MW from

the beginning of 2010." (Miskinis et al, 2008, page 36).

In addition the National Energy Strategy notes:

"With the final shutdown of Unit 2 of the Ignalina NPP at the end of 2009 and without constructing a new nuclear power plant, demand for primary energy resources would increase only by approximately 25% during the period until 2025 according to the basic scenario, however total demand for fossil fuel would increase almost 1.7 times within 20 years, i.e. from 6 million toe in 2005 to 10.5 million toe in 2025. Natural gas demand would double – from 2.4 million toe to 4.8 million toe in 2025, and the share of natural gas in the national balance of primary energy resources would increase form 28.4% to 45% during the forecasting period. The forecasts predict that the share of indigenous (excluding indigenous oil) and renewable energy resources in the total balance of primary energy resources would grow by up to 20% in 2025, while the share of petroleum products, including orimulsion, would constitute about 35%. Having constructed a new nuclear power plant, primary energy demand would be higher due to poorer energy conversion properties of the nuclear power plant but demand for natural gas and petroleum products would decline and the diversity of primary energy resources would increase. In this case, the share of natural gas in the fuel balance could remain almost steady, i.e. close to 30%." (Miskinis et al, 2008, page 33).

However, despite these sources of comfort regarding the ability of Lithuania to cover its energy needs, the national Energy Strategy cautions :

"In the event of failure to construct necessary interconnections in time, it may be required to co-ordinate the reservation of large capacity units in the joint power system of Russia." (Miskinis et al, 2008, page 38).

The new Ignalina-3 plant will be an entirely new plant based on western Generation-3 technology. Lietuvos Energija reports that *"Between November and December [2007], meetings were held with the suppliers of modern technologies for nuclear reactors: General Electric – Hitachi (GEH), AREVA NP, Westinghouse Electric Company LLC and Atomic Energy of Canada Ltd (AECL) with the aim of gaining knowledge about reactor technologies available on the global market, and in preparation for the tender on procurement of technology for the new nuclear power plant."* (Lietuvos Energija, 2007, p.26)

Ignalina-3 will be a "commercial" plant based upon an innovative international approach. In 2007 Lithuania, Latvia and Estonia agreed to the construction of a new nuclear power plant to serve customers across the Baltics and their main electricity companies contracted to collaborate on the project. Poland joined the consortium one year later. The three biggest Lithuanian energy companies have agreed to invest with the Lithuanian state will have a 51% share. It is perhaps relevant that Lithuania has the most liberalised electricity industry of the four partners. The planned power bridges to Sweden and Poland this will further increase the commercial attractiveness of the new nuclear power plant (New

NPP) project (Kirkilas, 2007). The original 2006 cost estimate for New NPP was €1600/kWe a figure that now (2008) seems to have been impossibly optimistic. A more realistic figure would probably be €3000/kWe (Vilemas, 2008). Vilemas has highlighted four interesting aspects of the Ignalina-3 project. Here we present his ideas as interpreted by this author:

- Economic assessments of the New NPP project suggest that in order for the project to be successful the plant must operate with a very high load factor of approximately 8000 hours per year.
- Placing a very large nuclear power plant in a small electricity system raises issues of the system capacity margin. The system must be able to draw upon alternative electricity sources up to at least the generation capacity of the large nuclear power plant. This need for a large capacity margin can undermine the case for the new nuclear power plant.
- It is not yet clear how waste spent fuel would be handled for a project established to serve the needs of one country. Should the four partner countries agree to share the waste burden? Or perhaps the waste burden should fall to the country hosting the plant – Lithuania.
- In contrast to the Romanian experience, none of the four partner countries associated with the Ignalina-3 project has ever built a nuclear power plant before, nor have they engaged the services of a western reactor vendor in such an endeavour. The Ignalina 1 and 2 plants, as products of the Soviet Union, were built by engineers from across the USSR. That said, Lithuania is blessed with significant nuclear operational, engineering, management competence and a world-class nuclear research centre the Lithuanian Energy Institute. These capacities might be regarded as a legacy of the rigorous Soviet approach to the physical sciences and engineering, despite the fact that prior to independence Lithuania had no independent regulatory institutions.

The 2007 Lithuanian Energy Strategy observes that the pressures of Lithuanian electricity security in the coming years are such that the new nuclear power plant must enter service by *“2015 at the latest”* (Miskinis et al, 2008, page 41). As the reactor type has not yet been selected, and some financial issues still remain unresolved, this author is skeptical that this requirement will indeed be met in time, in which case there is presumably the risk of a serious electricity security threat looming for Lithuania in the second half of the coming decade.

The opportunity to gain experience of nuclear power plant construction is arguably one of the main motivations for Poland's participation in the New NPP plan. This project allows Poland to build engineering knowledge and capacity through which it can create an option for a later nuclear energy programme in Poland.

5. Conclusions

The EC Framework Programme project “CESSA” is led by universities in western Europe (France, the UK, Germany, Italy and Spain) albeit with extensive participation from colleagues from across the EU as a whole. From the outset CESSA considered it essential to understand better issues of energy security pertaining to the newest accession states. Of relevance to future EU policy is not just the data concerning issues of import dependency and fuel mix diversity but also the politics of energy security which are driven as much by perceptions and emotion as by evidence and data. This paper is deliberately not empirical in its approach, rather it seeks to distil factors of importance concerning the interplay of nuclear energy policy in the European Union and enlargement of the European Union.

One simple message is that readers must not forget that much of the European nuclear renaissance will occur in the "New Europe". Experiences gained there will be every bit as valid as those gained in Finland, France and the UK and in some cases my act as better pointers to the future than the more often studied western examples.

CESSA accepts that there is no chance of a single European voice on new nuclear build. Rather there is a consensus that the generation mix for electricity is a matter for each member state individually. That will represent the framework for nuclear energy developments for some time to come. Nevertheless the Lithuanian New NPP project presents a very powerful example to those smaller western European countries contemplating the construction of a generation III nuclear power plant of sizeable output (e.g. 1100-1700MWe). Might for instance the experience of Lithuania and the Baltics have lessons to offer the Netherlands and the other Benelux states?

Concerning The Netherlands example: In September 2006 the environment and economics ministers submitted a paper to the Dutch parliament entitled, *Conditions for New Nuclear Power Plants* (WNA-Netherlands, 2008).

The Netherlands has since resolved that any new reactor must be a Generation III model with levels of safety being equivalent to those of Areva's EPR, and that any such plant should be constructed at a coastal site with operations planned for 2016 at the latest (ibid).

Furthermore in March 2008 the main advisory body of the Dutch government on national and international social and economic policy - the Social and Economic Council (SER) - said that the government should *"consider expanding nuclear energy in two years when it is due to evaluate its climate policies."* (ibid).

This scenario prompts the question of whether an EPR reactor of approximately 1700MWe can realistically be regarded as a project serving just Dutch consumers or whether the involvement of neighbouring member states should be made more formal and explicit as the Lithuanians have done in the case of the plans for Ignalina-3.

As progress is made on building a single European electricity market international electricity systems are being created (e.g. Nordpool in Scandinavia and SEMO on the island of Ireland). These developments will eventually run up against the notion that nuclear energy is a national matter subject only to sensitivity to neighbours concerning environmental and safety risks. Increasingly European neighbours will become aware of the benefits of nuclear power investments in neighbouring EU member states and in this way it is hoped by this author that there can a further Europeanisation of policy for nuclear energy to complement top down moves from the RTD and TREN Directorates General of the European Commission. The eastern European experience reminds us that it is possible to complete a nuclear power plant project straighforwardly (Cernavoda-2, Romania) and for different countries to come together to address their common concerns through a single nuclear power plant project (Ignalina-3, Lithuania). The experiences of Romania and Lithuania show us that the nuclear renaissance is clearly achievable, it may even be achievable in Western Europe.

Acknowledgements

The author is most grateful to all those that have provided insights and advice including: Ionel Bucur, Cristian Busu, Olivia Comsa, Raphael Heffron, Christian Kirschsteiger, Cristna Leahu, Vaclovas Miskinis, Alexandru Sandulescu, Derek Taylor, Simon Taylor, Sami Tulonen and Jurgis Vilemas. The opinions expressed in this paper are not necessarily shared by those that have provided assistance and all responsibility for errors and omissions rests with the author. The author is most grateful to the European Commission Sixth Framework programme project CESSA - Co-ordinating Energy Security in Supply Activities - EC DG Research contract number 044383 for financial support. The author also acknowledges the assistance of the ESRC Electricity Policy Research Group.

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