

# Open Research Online

---

The Open University's repository of research publications and other research outputs

## Symbolic power: the future of nuclear energy in Lithuania

### Journal Item

How to cite:

Elliott, Dave and Cook, Terry (2004). Symbolic power: the future of nuclear energy in Lithuania. *Science as Culture*, 13(3) pp. 373–400.

For guidance on citations see [FAQs](#).

© 2004 Process Press

Version: Accepted Manuscript

Link(s) to article on publisher's website:  
<http://dx.doi.org/doi:10.1080/0950543042000262431>

---

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

---

[oro.open.ac.uk](http://oro.open.ac.uk)

Elliott, D and Cook, T (2004) 'Symbolic Power: the future of nuclear energy in Lithuania' Science as Culture, Vol.13, No.3, Sept. pp 373-400 (80% co-authored)

## **Symbolic power: the future of nuclear energy in Lithuania**

**Dave Elliott and Terry Cook**

### **1. Introduction**

EU accession states may have thrown off their Soviet past in political terms, but abandoning some of the Soviet era technologies is proving to be harder. Civil nuclear power is on the way out in most of Europe, but for some ex-Soviet countries this may present serious problems of economic, social and cultural transformation -- especially in countries like Lithuania, where nuclear power supplies the bulk of the electricity.

The issue has come to a head given the EU's insistence that several ex-Soviet states must agree to close their nuclear plant as a condition of EU entry. Lithuania is the accession country most wedded to and certainly most reliant on nuclear power. It has a nuclear plant which uses a technology (the RBMK, Chernobyl-type reactor) which the EU has insisted should be closed rapidly on safety grounds. This has proved an unpopular requirement in Lithuania for a variety of reasons. There are problems with ensuring continued energy supplies and replacing the lost employment and earning power.

However Lithuania also has a more general commitment to this technology as a symbol of national prowess and independence. During and immediately after the struggle for national independence in 1991, the country had a mass anti-nuclear movement. This has been analysed as a covert expression of nationalist and anti-Soviet feeling, given that most opposition to nuclear power evaporated after independence (Dawson 1996). Subsequently the EU ruled that Lithuania's Ignalina nuclear plant should be closed. Yet now it is widely seen as a national asset, a view reinforced by resentment about the EU apparently imposing an unwarranted closure policy.

This article will analyse how public and policy views on nuclear power have changed over time in Lithuania and how its symbolic meaning has changed during different phases of transformation of the Lithuanian society.

### **2. The collapse of the nuclear dream**

Nuclear power has certainly been demoted as an energy option over the last three decades in the USA and most countries in Europe. Once seen as the 'high tech' way forward to cheap, safe and clean power, the collapse of support for nuclear power has been dramatic. The 1970's saw the first signs of change. Following the Three Miles Island accident in the USA in 1979, and the increasingly poor relative economics of nuclear power, no new nuclear plant orders were forthcoming in the US. Most of Europe subsequently backed away from nuclear, a process which accelerated after the Chernobyl disaster in the Ukraine in 1986, culminating in 1999 with Germany's decision to phase out its nineteen nuclear plants. Although France still had a major nuclear programme, supplying around

75% of the country's electricity, in 1997, the newly elected Socialist administration imposed a moratorium on new nuclear developments and shut down the Fast Breeder programme.

However the picture is not entirely one of disengagement. In the USA, in 2001, President Bush indicated support for restarting the US nuclear programme, as part of his push to reduce reliance on imported oil, although so far it is not clear if this programme will be taken up very enthusiastically by US companies. Nuclear programmes have kept going in Eastern and Central Europe, although progress on new plants has been slow, and, as we shall see, several older plants are being closed. Finland has broken ranks with most of the rest of western Europe and is planning a new 1.6GW nuclear plant, but otherwise, the main signs of expansion are in the East – notable in China, Japan and S. Korea.

Nevertheless, on current projections, unless policies change, as existing plants reach the end of their operating lives, and given the various phase-out programmes, globally, overall nuclear capacity seems likely to decline. Certainly on basis of then current plans, global nuclear capacity was seen by the Royal Society/Royal Academy of Engineering, as reaching a peak at around 2010 and then falling off dramatically. It noted that, unless policies changed, by 2060, all the worlds existing and currently planned plants will have closed (Royal Society 1999).

### **Nuclear Power- no thanks?**

Given this context, it is perhaps not surprising that for many casual observers, at least those in the West, the nuclear issue appears to be a dead one. Certainly, the powerful anti-nuclear movements that grew up in Europe and the USA in the 1970's and 1980's are no longer active- most of the campaigners have moved on to other issues, including, in the EU, the much more positive campaign for renewable energy.

The general public's view is evidently similar- for most Europeans, nuclear power is out of the picture. An opinion poll carried out for the European Commission in 2003 found that 67% of those asked supported renewables and only 3% supported nuclear power (EC 2003). The specific level of support varies from country to country and will of course also depend on exactly what question is asked. For example, in a UK poll carried out for the Royal Society for the Protection of Birds by the British Market Research Bureau in 2001, 68% of those interviewed agreed with the suggestion that nuclear power stations would not be built in Britain in the next ten years. A year later, in 2002, a MORI poll of the UK residents found that 72% of those asked favoured renewable energy rather than nuclear, while a National Opinion Poll carried out in the same year for the Energy Saving Trust found that 76% believed the Government should invest time and money developing new ways to reduce energy consumption, 85% wanted government investment in 'eco-friendly' renewable energy (solar, wind and water power) and only 10% said they favoured investing in nuclear power.

However, in some countries there is still overall support for nuclear power. For example, according to an IPSOS opinion poll, reported in the International Herald Tribune in Aug 2002, almost 70% of French adults have 'a good opinion' of nuclear power, although

56% also said, rather fatalistically, that they believed a Chernobyl type accident 'could happen in the country'. There will also sometimes be different responses depending on whether the topic is existing or new plants. For example, in Sweden, where the government is trying to phase out nuclear power, a poll in 2001 found that only 19% supported premature closure of the Barseback-2 nuclear plant, as planned by the government, while 37% favoured continued operation of all the country's 11 nuclear power units and a further 28% favoured this, plus their replacement in due course. But only 11% wanted to further develop nuclear power in Sweden.

Interestingly, the level of opposition in the USA, which typically has run at around 60%, initially decreased after the energy crisis in California in 2001, when it was claimed that power blackouts could be avoided in future by building more nuclear plants. However, this argument subsequently seemed to lose its force after the terrorist attacks on the USA in Sept 2001. A Gallup Poll showed support for nuclear power dropping from 48 % in May 2001 to 42 % in November 2001.

So although there are clearly exceptions, it does seem that, in general, with contemporary events sometimes increasing or decreasing the level of opposition or support, nuclear power is not popular with most people in the industrialised West. Certainly within Europe, there seems to be a general consensus amongst the majority of the population that nuclear power is not the way forward.

### **The ex-Soviet Reactors**

In the context of the downgrading of the nuclear option, the situation in the ex-Soviet states presents some major problems. The collapse of the USSR bequeathed Central and Eastern Europe with a nuclear legacy, including reactors of the RBMK type. RBMK is a Russian acronym for "Channelised Large Power Reactor"-this is the design that was used at Chernobyl.

Most of the former Soviet states tend to have a different view of nuclear power from the rest of Europe. In part this is for geopolitical reasons, in part for historical reasons. During the latter part of the Soviet era, Russia tended to reserve its vast oil and gas resources for export to Western Europe, in order to earn desperately needed foreign exchange. The construction of large nuclear plants in Lithuania, the Ukraine and in satellite countries like Hungary, Czechoslovakia, fitted in to this approach. Following the Chernobyl disaster, and then the collapse of the USSR, the help of the EU was enlisted to keep this policy going- by trying to patch up the ailing nuclear plants wherever possible. With North Sea oil and gas reserves beginning to reach their peak, the EU clearly wanted continued and indeed increased access to Russia's gas for the longer term. For its part, Russia, if anything, needed the foreign exchange from gas and oil sales even more. With there being little cash available for new energy plants, it also needed to keep its reactors going to provide heating. Many of the newly independent satellite countries faced a similar problem: even if they wanted to, there was no money to develop alternatives. The nuclear plants had to stay on-line.

However there was another problem: the EU could not support keeping the Chernobyl type RBMK reactors going, since, despite efforts to upgrade them, they were seen as falling below EU safety standards. Long negotiations ensued, but eventually a programme of closure of the Chernobyl RBMK reactors in the Ukraine was agreed, with money being promised to help with decommissioning, and also possibly to provide alternative sources of power. Similarly, the EU called for Lithuania's RBMK plant to be closed, this being made a condition of eligibility for the country's application to join the EU. With this closure agreed, and the EU accession date agreed for May 2004, EU funds have been provided to help with decommissioning and with the problems of transition. In the same way, with eligibility for EU accession being the driver, some other early soviet reactors in former soviet countries - for example non-RBMK reactors in Bulgaria and Slovakia.

This will not be easy. The DTI has allocated funds to help with the transition, but notes that *'securing closure of, or closure commitments for these reactors, has been a difficult task. One of the reasons for this is that the plants are located in isolated and otherwise economically limited areas of the Former Soviet Union (FSU) Countries of Central and Eastern Europe (CEE), where they are the only source of significant employment. There is thus considerable domestic opposition to closure - and workers or locals do not generally accept the safety argument for closure'*.

The DTI says its support programme is designed *'to try and ease the pain of closure and help tackle the potentially negative social and economic impacts that closure will bring to these areas, through efforts to promote economic diversification and regeneration. Such efforts can help to keep FSU states committed to closure programmes, and can generate significant goodwill.'* (DTI 2003)

### **3. The Lithuanian energy situation**

Lithuania faces significant problems, in terms of phasing out nuclear power, due to its heavy reliance on this source of energy. The Ignalina nuclear plant currently provides nearly 80% of the country's electricity which means that there is less need to rely on imported energy from Russia. Gas imports in particular have been a major bone of contention, given the past history of the two countries, and the continued potential for political manipulation of prices. The Ignalina reactor complex, with its two RBMK 1500 reactors is also a major source of employment - it employs some 5000 people directly and the resultant cash flows support many more indirectly.

However, as outlined in Lithuania's National Energy Strategy, agreed in 2002, the first reactor is scheduled to close in 2005 and the second in 2009, although the latter date has yet to be confirmed, with 2012 being considered as another possible date (NES 2003). The EU has offered to provide 40% of the expected Euro 1 million cost of decommissioning over the next 30 years and is also providing support to ease the transition problems, as is the DTI.

The long decommissioning programme should help provide continued employment for some of the staff for many decades into the future. The impact of closure of Ignalina may also be softened in energy terms by the fact that, since the collapse of the USSR and then independence, Lithuania's economy has shrunk dramatically and energy demand has fallen to about a third of its initial level. The result is that there should be no major energy balance problems when the first reactor is closed in 2005. In effect, the second reactor could meet all the country's electricity needs on its own. The only major difference could be that, whereas at present Lithuania exports increasing amounts of power, there might then be less available to export.

However, when the second reactor is closed there could be more serious energy availability problems. In 2001, fossil fuel fired plants (oil and gas) supplied around 17.6% of the country's electricity, and it also has some medium/large sized hydro plants, which supplied about a further 4.7%. This existing hydro and fossil-fuelled generating capacity, coupled possibly with some new or revamped fossil plants, should be able to cope initially, perhaps up to 2015, but as the economy grows, as is expected following EU Accession, problems could emerge from the increased energy demand. Demand for power within the country has already risen by 3% since 2000 and exports of power have also increased. Assuming current development patterns, the base energy scenario for Lithuania quoted in a recent IAEE review suggests that primary energy demand will increase by 30% between 2000-2020, with most of this being met by imported fossil fuel, chiefly gas. On this basis, it is predicted that the use of fossil fuels will increase by 1.9 times, from 5mtoe in 2000 to 9.4mtoe in 2020 (Vilemas & Miskinis, 2003).

### **Limits to the use of fossil fuel**

Expansion of fossil fuel use on this scale could meet constraints due to growing concerns about climate change and emissions of greenhouse gases. In 1998 Lithuania signed the Kyoto Climate Change accord, which requires the EU to work towards an 8% reduction (from 1990 levels) in greenhouse gas emissions, averaged across the EU, in the commitment period 2008-2012. Lithuania ratified it in 2002. It has thereby agreed to a 8% reduction on 1990 levels by 2010. This should not be onerous for Lithuania, at least not initially. Indeed it has significant 'headroom' for emission growth because of the dramatic reduction in economic activity after the collapse of the USSR – Lithuania's 1994 GDP was 56% of that in 1990, and that led to significantly reduced energy demand. Even after a slight retrenchment as the economy began to recover (e.g. with 3.3 % growth in 1995), in 2000 total primary energy supply was 45% of the 1990 level, a reduction which, incidentally, put the percentage contribution from Ignalina up from around 73% to 80% of the country's electricity. This reduction in energy use has meant that greenhouse gas emissions have fallen by 57% since 1990. They fell from 37.3 million tonnes of carbon equivalent in 1990 to 10.5 million tonnes in 1998 and have continued to decline despite continued growth in economic activity. Structural changes in the newly developing economy seemed to have helped Lithuania to reduce its carbon intensity (carbon emissions/ GDP) which has fallen from 1.16 kg/\$ in 1990 to 0.66kg/\$ in 2000 (Konstantinaviciute, 2003).

So Lithuania, like Russia, has a major advantage over many other industrial countries- its emissions are currently well below the 1990 baseline used in the Kyoto accord. How long this 'head room' will remain as the economy expands is unclear. Lithuania is currently experiencing very rapid economic growth, of around 6.7% in 2003. Even if Lithuania does manage to continue to improve its carbon intensity with Ignalina being phased out, in order to constrain emissions as the economy grows and energy demand increases new policies seems likely needed for energy . The two basic non – nuclear options are energy conservation, and new non-fossil capacity.

### **Sustainable Energy Options**

Lithuania's Soviet era housing and industrial infrastructure offers many opportunities for dramatic improvements in energy efficiency, an area which, until recently, seems to have only attracted limited attention. Given the generally low level of attention to energy efficiency in Lithuania (and indeed in many other countries) there are certainly many easy ,quick and relatively cheap options for reducing energy waste.

The options for new non-fossil plant are less straight forward and could take time to materialise. Compared with neighboring countries like Finland and Sweden (which in 1995 obtained around 23% and 25% respectively of their primary energy from renewable sources) Lithuania has not developed its renewable energy potential significantly - it only obtains around 9% of its total primary energy from renewable energy sources. Moreover, progress on installing new capacity is slow. Lithuania has only installed around 223MW of new renewable energy capacity since 1994, mostly involving small hydro schemes and wood chip combustion plants, producing in total around 3% of the country's electricity (DEA 2002).

However, Lithuania has a reasonable wind energy potential, estimated to be of the order of 500MW, according to a study completed by the European Bank of Reconstruction and Development. A 4MW demonstration wind farm is planned at Butinge, on the Baltic coast, and there are also reports that NEG Micon is planning to install 15MW of wind plant between Gargzdai and Vezaicai in the West of the country, at a cost of Euro 20m. In addition the Janava- based Achema Hidrostoys hydro power company is planning to branch out into wind power, and has talked of investment in up to 60MW of new wind capacity. The Lithuanian governments energy planners have however expressed some concerns about potential problems with grid management if substantial amounts of wind power were fed in, and a rather conservative limit of 170MW has been suggested (Juska 2003) .Although it has costs, grid strengthening would presumably help avoid this constraint. Certainly, Denmark has not had significant grid balancing problems with a very much larger contribution from wind (over 3000MW) supplying over 20% of the countries electricity.

There are also some good sites for further micro and mini hydro projects (possibly 200MW in all), and the biomass resource is very large -it is a heavily forested country like Finland and Sweden. At present most of the biomass used is for heating, but electricity production from biomass could be come a major new option, particularly in

Combined Heat and Power projects. Small to medium scale biomass and hydro projects, along with small solar and wind projects, could support local economic renewal. The EU has provided Euro 200m to support regional development work, to offset any dislocation caused by the closure of the nuclear plant, and some of this might be used to develop local renewable sources and create local employment.

As it stands, Lithuania's National Energy Strategy envisages a moderate expansion of new renewables, so that, on top of the existing 3%, they would supply 7% of the country's electricity by 2010. Adding in the heat suppliers (mainly biomass) that translates to a total of 12% of the country's primary energy by 2010 (compared to 9% in 2000), followed by a subsequent expansion to 14% by 2020. This primary energy percentage is in line with the overall EU 15 target, as outlined in the EC's Renewables Directive, of a 12% contribution by 2010, but the electricity target of 7% compares poorly with the EC suggested overall EU target of 22% of electricity by 2010, and the 2010 target for neighbouring Finland of 35%, although it is better than the UK's current target of 10% by 2010, one of the lowest in the EU. However, these renewable energy targets include existing large hydro, which is perhaps unfair to countries like Lithuania that do not have large hydro resources. The EU 15 electricity target for 2010 *without* large hydro is 12.5% , so that on this basis Lithuania is near the average for the EU 15, although the figure without large hydro for Finland is 21.7% by 2010.

The statistics for some fellow accession states are even more dramatic: in 1999, renewables (including hydro) supplied 42.3% of Latvia's electricity and the target is to expand this to 49.3% by 2010. Further afield, Slovakia hopes to expand its renewable contribution from 17.9% to 31% and Slovenia from 29.9% to 33.6% by 2010. Lithuania is actually near the bottom of the accession state league, only beating Cyprus at 6%, Malta at 5% and neighbour Estonia at 5.1% and Hungary at 3.6%. In addition, it is worth noting that Denmark *already* generates 21% of its electricity from wind plants, while Germany, which, as we have seen, is phasing out all its nuclear plants, has a very ambitious wind programme, with over 14GW of wind capacity so far installed. Clearly then, by comparison, Lithuania is not currently looking to renewables to expand very rapidly, so that they are not likely to be the main replacement for Ignalina in the short term.

In part this reticence seems to be because, in a country used to large-scale Soviet projects, small scale renewables are seen as unreliable and marginal. Certainly there has not been the decades long exposure to the debate about the prospects for a sustainable energy future and the role of renewables in achieving it that has occurred in Western Europe. Unlike its counterparts in, for example, Denmark and Sweden, the Lithuanian 'green' movement is still relatively small. In addition, there is very little practical experience of the 'new' renewables, with few companies being involved in the field. This presents a major potential problem since, given the national sensitivities that exist in Lithuania, there is some hostility to having to rely on imported technology. As was argued at a conference on the prospects for renewables in Vilnius in 2003, when German and Danish vendors were much in evidence, while overseas expertise and help was appreciated, the indigenous development of Lithuanian technology was preferred (Vilnius 2003)



To summarise the options, given the closure of Ignalina, if Lithuania is to meet its Kyoto obligations and balance its energy system, there will be a need for major programme of investment in new non-fossil plants, matched by a major programme of energy conservation and improved energy efficiency. In parallel, it could also invest in more conventional options, by building a series of new gas turbine combined cycle plants to generate electricity. Of course, that would mean relying heavily on Russian gas to fuel them- something Lithuania is loath to do for political and financial reasons. It would also undermine efforts to reduce emissions- although less so than using coal as a fuel. Perhaps less painful, would be buying in electricity from neighbouring countries, although that would involve spending hard earned foreign exchange. Another option is to seek to delay the closure of the second reactor, to allow time to develop the renewables more effectively.

#### **4. Phasing out Nuclear Power in Lithuania**

The success of the phase out programme will depend as much on the social as on the technical issues. Before looking at these issues and at how the problems that exist might be overcome, it is therefore useful to first look back briefly at the history of the Ignalina plant, since that has shaped current situation.

Unit 1 was commissioned in late 1983, Unit 2 in 1987. The Lithuanian project was part of an ambitious Soviet nuclear expansion programme, established not to meet Lithuania's energy needs, but as part of the Soviet Union's North-West Unified Power System, with the Lithuanian government having very little say in the programme-it was simply imposed, albeit with some concessions on technical grounds.. For example, there were originally plans for four RBMK 1500 units, with a total capacity of 6GW, but, although this was not made public until later, plans for the fourth reactor were dropped in 1984, after lobbying from the Lithuanian scientific establishment who were concerned that the nearby lake would not be sufficient to provide cooling water without significant local environmental impacts. Subsequently, following the accident at Chernobyl in 1986 and then the growth of a powerful grass-roots anti-nuclear movement, and the third plant was abandoned. But the second plant nevertheless went ahead, making the plant the USSR's largest nuclear project.

Even though in general, public opinion on nuclear power in the Soviet world tended to be muted, the Ignalina plants' location in a popular lakeside resort area raised hackles. The fact that most of its staff were Russian was even more provocative, given the growing nationalistic sensitivities in Lithuania. These local resentments were a starting point for the anti-nuclear movement that flourished during the 'perestrioka' years. Although use was made of more general anti-nuclear arguments e.g. on safety, resentments about Russia's imposition of this plant increasingly became a focus for the growing national movement for independence. The level of support for this movement grew dramatically. In 1988 Lithuania's environment NGOs established an umbrella organisation called the Lithuania Green Movement which, as noted above, successfully lobbied against the construction of a third RBMK-1500 unit at Ignalina. Public protests stopped work on the

third reactor in 1989, when Lithuania was still part of the Soviet Union. The campaign included a daring protests against the third reactor, with a human chain being formed round the plant to stop the work on the reactor.

Lithuania declared its independence in March 1990, but the Ignalina plant was guarded by Soviet troops and KGB operatives and remained in the jurisdiction of the Soviet Union until August 1991 when independence was achieved. After the political events of August 1991 (the formal collapse of the Soviet Union) the Ignalina plant finally came under the authority of the Lithuania Republic.

In 1993 it was decided to dismantle the partially completed third unit. Today the abandoned 20 metre concrete shell is a strange monument sitting next to the other two reactors. The structure, several stories of concrete slab floors with exposed metalwork, represents two year' work on the third reactor. It also acts as a monument to the end of the Soviet era.

However, not everyone in the country necessarily sees this outcome, or the EU's subsequent requirement that the two Ignalina reactors be closed, as positive. The nuclear programme had after all created a lot of jobs and economic security. In particular, the proposed full phase out is widely seen as a major problem for the region around the reactor complex. The Soviet Army had built Visaginas, a new town, to house the Ignalina staff about 8km west of the Ignalina plant . It is located in the isolated north east part of Lithuania , close to the borders of Belarus and Latvia. There are major social problems associated with the proposed closure of Ignalina centre, not least in trying to integrate the Russian speaking nuclear scientists and engineers into the Lithuanian labour market. Visaginas consists of 92% Russians and Russian speakers. Visaginas has around 33,800 inhabitants and 5100 employed directly at the plant. If the closure of the first unit goes ahead by 2005, up to 900 people will lose their jobs. More than 80% of incomes of the Ignalina district consists of incomes from the plant.

Due to restructuring at the plant, jobs have already begin to be lost, and the workforce's well educated community of nuclear scientists and engineers are becoming demoralised. For many there seems to be not much of a future.

### **Nuclear symbolism and value conflicts**

The social and economic situation in countries like Lithuania may clearly make a rapid nuclear phase out difficult and the various entrenched attitudes and commitments will certainly make it hard to carry out, although ,as we shall see, these are changing.

The Ignalina plant has clearly played a symbolic role - before independence it became a major symbol of Soviet dominance, and it, as well as plans for expansion, attracted large scale opposition. But once independence had been won, the once very influential anti-nuclear movement seems to have fade away. Dawson argues that the anti-nuclear cause was in fact mainly a surrogate for the emergent independence movement. She claims that this movement used the nuclear programme as a symbol of Russian power and of

Moscow's colonial treatment of Lithuania, even depicting the plant as a threat to Lithuania's survival as a nation. Thus Dawson notes during the spring and summer of 1988, the antinuclear activists argued that an accident at Ignalina could contaminate the entire country and force its residents to relocate in the USSR.

There were clearly those who saw the nuclear threat mainly in terms of the safety and environmental hazards. However, Dawson argues, given that, despite perestroika, direct opposition to Soviet rule might be unwise, many of the activists saw the anti-nuclear movement as 'a building ground for the creation of mobilisation networks and the resuscitation of a sense of Lithuanian national identity' (Dawson 1996).

Once independence was achieved the situation changed. Opposition to nuclear power evaporated, in part following the blockade of fuel supplies by Russia after Lithuania's unilateral Declaration of Independence in 1990. At the same time, operational problems with Ignalina led to fears of power shortages and highlighted the importance of the plant to the Lithuania economy.

Several key members of the anti-nuclear movement had joined the new government, but given the new situation, they were faced with contemplating a change in approach. There were even plans for nuclear expansion. However this was not to be, in part because the collapse of the national economy drastically reduced energy demand so there was no need for new generation capacity, and no funding for it in any case. Even so the pro-nuclear views seem to have remained widespread, even after exposure to the EU strictures about the need to phase out Ignalina as a requirement for EU accession. Thus a public opinion survey by Vilmorus in November 1998 found that 80% were in favour of Ignalina, compared to 68% who were reported (by the *Baltic Times*) to be in favour of EU accession (Huang, 1999).

The level of public (as well as governmental) commitment to Ignalina may have fallen since then, in growing recognition of the EU's insistence on its closure as a condition for accession, but support for nuclear power is still high. The bulk of the population seems to be either unconcerned about, or, rather, resigned to, the nuclear safety issue. An opinion survey carried out by Vilmorus in June 2001 found that 58% of those asked felt that a serious accident was 'likely', and 8% felt it was 'very likely'. Yet, overall, only 27% were opposed to the use of nuclear power to generate electricity, while 48% were in favour (Vilmorus 2001). Part of this response might be seen as being due to a remnant of the fatalistic acceptance of the status quo left over from the Soviet era, with many Lithuanians evidently treating the safety risk as something that has to be accepted, or, more likely, ignored. Certainly, there was a substantial proportion, 25%, who did not have an opinion on nuclear power, and for many people who do not feel that they are directly affected by the nuclear issue, this is probably the norm.

Amongst those that are directly affected by the proposed closure, views will of course be much stronger- and much more pro-nuclear. The employees will be more aware of major social costs that will be imposed locally by closure. Certainly, the impending closure of Ignalina, has created some major social stresses. One report suggested that the

uncertainty was one reason behind the increased level in suicides and drug abuse amongst the children of employees (LIU 2002).

While it might be expected that at least some nuclear workers would be thankful to escape the risks of employment in this industry, many nuclear workers in ex-Soviet countries like Lithuania will no doubt retain the fairly 'macho' attitude to safety risks that existed in the Soviet era, which insisted that radiation was something that workers could cope with (Read, 1993). This type of bravado seems to be the flip side of the wider fatalistic acceptance of the status quo mentioned earlier, and is reinforced by the employees' historical attachment to the industry, which has kept them in well paid jobs. Indeed, as has been found in other contexts (for example with the nuclear worker at Sellafield in the UK), the employers can usually rely on groups like this to be the most ardent defenders of nuclear power (Blowers & Elliott 2003).

In parallel with concerns about the impacts of the closure plan, and resignation to and defence of the status quo, there also seems to be a general sense of pride that Lithuania produces more power, in percentage terms, from nuclear energy than any other country in the world. There is also a sense of pride that Lithuanian scientists have responded to the challenge of taking over the plant from its Russian operators, and have introduced, as they see it, a more effective safety regime, along with a more open management style. As a result, those involved with this transition, evidently feel cheated by the closure plan: they were hoping to build on their efforts, and this view may also have wider support.

Certainly there is no shortage of rhetoric from the nuclear lobby about the desirability of remaining a major 'nuclear power state' (Sevaldin, 2002). Moreover, some Lithuanian political leaders clearly feel that there is no real reason to shut the plant, and there was an attempt to revise the National Energy Plan seeking to get the closure date for the second reactor being put back to 2017. In February 2002, in the run up to a presidential election, President Valdas Adamkus said in relation to the proposed closure of the second reactor: "*We shouldn't yield to any unilateral pressure of the European Union. We shouldn't commit ourselves on any dates of decommissioning of the Ignalina plant... I appreciate nuclear energy as a clean energy of the future and in this field Lithuania should have just the same opportunities to use it as other countries of the world*" (Adamkus 2002).

To the extent that this view, and the resentment it implies to EU pressure, are widely shared, the anti-nuclear consensus that exists in most of the rest of Europe may be seen as irrelevant, or as a luxury. Indeed, to some extent, given the depressed economic conditions in the country as a whole (the impact of the current boom has not as yet trickled down very far), the Ignalina plant may even be seen as a much needed symbol of national success, harping back to Soviet-era beliefs in nuclear power as a symbol of technological and social progress. So whereas before independence Ignalina was seen as a symbol of Soviet oppression, now it was a symbol of national independence and prosperity, with, for some, the EU being the new external threat.

To summarise, the situation is obviously in flux, but it seems that the bulk of the Lithuanian population would still like to continue with nuclear power- or can see no easy

alternative. In addition, some resent what they see as a policy imposed by the EU- after all, they have just escaped from having policies imposed by the Soviet Union and are very proud of their independence. But the Soviet era may have left its mark in more subtle ways. Some people in Lithuania will still probably share the general view that was evidently current in much of the Soviet world, that its technology was fine, and that criticisms were just from anti-Soviet sources (Read, 1993). In the updated version of this, the plant is seen by some as a national Lithuanian asset and possibly also as symbol of progress, to be defended against the EU.

### **Overcoming the Legacy of the Soviet Development Model**

As noted above, some of the opposition to the planned closure of Ignalina and the continued support for nuclear power in some sectors can be seen as reflecting the values and orthodoxies established and inculcated during the Soviet era. It is worth exploring some of the implications of this legacy in more detail.

The long history of Central state planning and ‘top-down’ management has made it hard for countries like Lithuania to transform their economic systems to a market basis for EU Accession. Under the Soviet system, managers and workers worked in a stable, predictable, and centrally planned environment, where roles were performed in an almost mechanistic manner. Since the state aimed at full employment many jobs were created, regardless of need. Nuclear projects were seminal examples of this approach, so that the closure plans have presented major problems, both social and technical. Little, if any, consideration had been given by the Soviet planners to future decommissioning or closure, since nuclear power seemed secure.

The post-Soviet environment is characterised by wide-scale organisational and cultural change. A cultural shift from collectivism towards individualistic and achievement oriented goals is taking place. Anyone over 35 years of age completed their education under the Soviet system. Although traditionally people went through a well developed and demanding system prior to beginning work, relatively little attention was paid to skills development once an employee had a job. More recently, the western notion of career has emerged as a concept which recognises the importance of personal development and individual values.

In the Lithuanian context, these changes are superimposed on a society in which nationalistic sentiments and political commitments to independence are highly visible and indeed are widely celebrated. Lithuania is proud of being the first of the Former Soviet Republics to have broken away from the Soviet Union. After more than 40 years of communism, independence is often referred to by Lithuanians as the “time of change”.

However, some of the changes are particularly painful. The potential for alienation associated with threats to people of workplace closures are always significant. However, in Lithuania, the closure plan presents special problems given that the Ignalina plant is in a region where the employees earn above average wages, do not speak the local language, and feel they will lose everything and gain nothing from joining the EU. At the same time, renewable energy is a new thing in Lithuania. As far as new energy sources were

concerned, nuclear was seen as the progressive option. As has been indicated, alternative views are now emerging, but it is a slow process – part of a process of rethinking attitudes to technology.

To summarise, the social conflicts brought about by the closure of the Ignalina nuclear plant are inextricably linked to issues emerging in transitional economies and political issues of EU accession. They reflect the dynamic relationships between individuals, organisations and society in a transitional country. It will take time for the conflicts to be resolved, for new attitudes to emerge and for new symbols of progress to emerge and be widely accepted.

## **5. Changing Views on Nuclear Power**

The ongoing social and cultural processes are important, and may in time lead to wider acceptance of alternatives to nuclear power, but given that at least some of the support for Ignalina is based on its alleged economic benefits, the issue may be resolved in the shorter term by economic considerations. After all, general perceptions about technology are usually shaped at least in part by more specific and concrete economic and technical issues and concerns.

Under Soviet conditions, economics was not the key factor, but as has become increasingly clear in the West, nuclear power is not economically competitive. Interestingly some commentators in Lithuania still claim that the Ignalina plant could generate economically. Of course this is only relative- given the high cost of importing fuel and the relatively inefficient fossil fuelled plants, electricity prices generally are quite high in Lithuania, the national current tariff being Euro 0.054/kWh (about 7.7p/kWh compared to around 6p/kWh for retail electricity in the UK). However, one report quoted the suggestion that Ignalina could generate at 6.56Ltc/kWh, or around 1.2p/kWh (Ryding, 2002). For comparisons, UK the average whole sale/generation price for electricity in 2004 was around 2p/kWh. Figures like this have evidently been used in the local media to claim that the reason why the EU wants Ignalina closed was because it was worried about competition from a cheap power source (Energy Start 2002). However, as with the figures for nuclear costs that used to emerge from state energy agencies in the UK, this seems to ignore or downplay sunk capital costs, waste treatment costs and decommissioning costs. Currently nuclear generation costs in the UK, on a full life cycle basis and under commercial conditions, have been put at 4-6p/kWh, compared to gas fired generation at around 2p/kWh or less. Even if new 'advanced passive' nuclear technology successfully emerges at some point, it is unlikely to generate at below 3p/kWh, whereas wind power has already achieved that in some locations (PIU 2002).

It is interesting in this context to see that the Finnish government's commitment to a new nuclear plant is based on the claim that it would be competitive in terms of price with all other alternatives, including combined-cycle gas turbines. However, this analysis was based on the assumption of a 50% rise in gas prices. This price rise may well happen over time, but then many other technologies would also be competitive. For the moment, it simply illustrates the fact that nuclear power is more expensive than conventional electricity.

Unfortunately, for the next few years, countries like Lithuania are faced with having to rely on what are these days labelled 'stranded assets'- expensive nuclear plants which have to be used. This has become particularly clear in the USA. Indeed, it has been argued that one of the reasons for the energy crisis in California in 2001, when blackouts had to be imposed after dramatic price rises failed to stem demand peaks, was that the energy companies were saddled with expensive nuclear plants which could not be run competitively in the newly deregulated market. The UK nuclear programme has also fallen foul of competitive pressures. In 2002 the government had to step in and provide £650m in loans to prop up British Energy, which was losing £4 on each MWh produced by its nuclear plants, which included the new PWR at Sizewell. For the longer term, the government has also provide £2billion to meet the cost of decommissioning and waste clean up. Given this situation, it is clear why the belief in the cheapness of nuclear power no longer hold much appeal.

It is also interesting in this context to look at the situation in France, given that France is often held up as a example of a country where nuclear power is economic. Certainly her major programme, based on serial production of standard reactors designs, had the benefit of economies of scale. However, this state-led construction programme was funded not by the charges made to consumers for their electricity, as in the UK and some other countries, but at least in part by borrowing on the international money markets. This led to low consumer prices ,but it also left France with a large outstanding debt to service. Unfortunately, demand did not rise as much as expected when the programme was planned in the 1960s, and France had to sell off its excess nuclear electricity at relatively low rates to other European countries. But given the low prices charged for this electricity, the interest on the initial capital borrowed still represents a sizeable proportion of the income generated. Indeed, it seems initially that the debt repayments were greater than the income raised (WNA 2001).

Of course, given the cost of closure, and the costs of importing Russian gas and oil, the Lithuanians may not be too concerned about the operating costs of their nuclear plant, at least in the short term. Indeed, it is sometimes argued that keeping it running will be cheaper than importing Russian oil and gas. So, given the requirement to close the plant, they will seek the maximum possible financial compensation to help make the technological transition. In parallel, they may seek to delay closure of the second reactor, perhaps to 2012 or even later, to give more time to develop alternatives. However, if a delay in closure of the second plant is condoned by the EU, then, not only will more money be lost through having to operate a relatively expensive plant, but the argument will be strengthened that these plants are not really that dangerous, and the anti nuclear position could gradually be eroded. In addition, the transition to a sustainable energy system would be delayed.

While economic and strategic issues like this are clearly important, for some opponents of nuclear power, the key issue is **safety**. Strenuous efforts have been made to improve safety since Chernobyl, but there remain some major operational issues for RMBK reactors. One relates to a design defect which means that the gaps between the fuel

channel and the graphite moderator rods gradually close. This can make it impossible for the control rods to be inserted or removed. The channels can be replaced, on a 15 year life cycle. However, in the summer 1998, measurements showed that the gaps in Ignalina Unit 1 were closing faster than expected. That, it seems, was one of the main reasons for the EU's insistence on its early closure. Given that rechanelling is expensive, it was also presumably why the Lithuanian government acceded- the EU was after all offering to pay at least part of the cost of decommissioning. But, the channel gaps in Unit 2 are not it seems closing rapidly, which is one reason why there is opposition to shutting this plant.

However, quite apart from the risks associated with operating RBMK reactors, there is the longer term issue of what to do with the wastes. The spent fuel from Ignalina, is currently stored on site in special 84tonne dry store container casks. So far there are 27 of them, but the existing site only has room for 72. The closure and decommissioning process will itself create a lot more waste- around 350 more casks will be needed. However, that still leaves the longer term disposal issue. The casks are only designed as interim storage, up to 50 years, and there are, as yet, no long term plans for the ultimate disposal of these wastes. The longer the reactors are run, the more waste will be produced, and the worse this problem becomes. Interestingly, the public opinion poll carried out in 2001 found that 47% of those asked did not feel that nuclear waste could be stored safely without damage to human life or the environment, while only 30% felt it could, with 23% saying they did not know (Vilmorus 2001).

### **The potential for change**

The economic and safety issue may feed into the wider process of change in attitudes underway in Lithuania. Like many other ex-Soviet states, it is undergoing a major economic, political and social transformation. Although, as we have seen, there are some residual orientations and practices left over in relation to nuclear power, Soviet orthodoxy and values are have in general been rejected and replaced by renewed national pride and enthusiasm for independence, coupled with the beginnings of Western style consumerism, fed by the economic boom and the growing tourist industry. It could be that western style environmentalism will also emerge on a wider scale, and along with it, concerns about nuclear power and a commitment to renewable energy.

None of this will be automatic or easy. For example, although some good progress has been made on moving in the direction of a sustainable energy future around Europe, it has not been that dramatic, and this is despite the existence of a quite well developed and supported environmental ideology. Given that the commitment to the newly emerging 'green energy' paradigm may not yet be very strong in Lithuania, whereas support for nuclear power remains quite strong, change may take time.

However this the situation is far from static. While, as noted earlier, a public opinion survey by Vilmorus in November 1998, found that 80% were in favour of Ignalia, in its 2001 opinion polls, Vilmorus found that support for nuclear power as a means of generating electricity had dropped to 48%. Moreover, in the 2001 survey, when the nuclear issue was set in the wider context as one possibility amongst other energy sources



including renewables, only 22% felt that electricity should be generated mostly by nuclear plants, while 47% felt that attention should be given to new sources like solar and wind power, and 16% favoured continued use of coal and hydro. Only 2% favoured imports. Perhaps unsurprisingly, when asked what they felt about having a new nuclear plant installed within 10-20km of their home, 75% were opposed and only 15% in favour, with only 10% saying they did not know.

As we have seen, for a range of local and national reasons, the continued use of the existing nuclear plant still has strong support in Lithuania, but otherwise, public opinion seems to be moving, albeit slowly, in roughly the same direction as that in much or the rest of Europe, with support for new nuclear plants being low and interest in renewables increasing.

## **6. Options for the Future**

There are a number of possible ways forward for the energy system in Lithuania. If the funding is available, in addition to proving energy and employment, the development of renewables offers a way to offset the residual commitment to nuclear power by providing a new symbol of progress. Moreover, a renewables energy based programme could also offer a more open and participative approach to energy system planning and development. Given that renewable energy technologies are generally smaller scale and more locally based than convention power plants, there could also be an opportunity for new locally owned projects and for local economic renewal.

Change is often traumatic and certainly there would be a need for careful and sensitive consultation on the development and deployment of the new technologies. That certainly has been the experience in some parts of the UK in relation to some wind farm projects. The lesson that emerges from this experience is that there is a need for careful local consultation and public engagement, and for a constructive process of social negotiation over which energy systems are chosen and how they are developed (Elliott 2003). However, acceptance of this type of change, and of the closure of Ignalina, would be enhanced if financial and technical support is available to help stimulate the development of viable alternative energy projects, and the associated employment .

If funding is not available to build a viable and visible alternative programme, then pushing for a delay in the closure of the second RBMK, so as to allow time for a crash programme of renewables and energy efficiency to get going, might be seen by some as an attractive option, especially given the problems with the main short term alternative-buying in power from outside. Buying in Russian gas would be politically unpopular and might create balance of payment problems. Some electricity could perhaps be bought in from other countries as in interim measure- it would probably be cheaper than continuing to run the Ignalina plant. But a delay might allow time to broker more coherent power trading arrangements with the other Baltic states, possibly setting up a regional energy exchange system, of the type that exists amongst the Scandinavian countries. Indeed, the Baltic states could possibly link up to this system- the so called Baltic Ring concept. Lithuania has a large biomass resource and, in time, it could again become a net exporter

of power- exchanged perhaps for power from hydro from Norway. As it stands, the power transmission lines that exist were all designed to link Lithuania to Russia, rather than Central Europe, but that could be changed, for example there are plans for a HVDC link to Poland and Finland, so that Lithuania could trade power with the rest of the EU. But it would be difficult to achieve this before the current closure dates for the Ignalina reactor complex.

A delay might also give time for Lithuania to adjust to the idea that renewable energy can become a major element in its energy mix , and to begin to build support for the new sustainable energy paradigm that is emerging elsewhere in Europe. To some extent, that is an education issue. In Denmark, the decision to avoid going nuclear was preceded in the 1970's by an extensive national programme of discussion, seminars and debates, with material of renewables and other alternatives being used prominently. Thirty years on, there are now many more examples of successful renewable energy programmes to point to, so perhaps bringing about this particular value change should not be too difficult, but it may still take time. A delay might thus be needed to allow time for cultural values within Lithuania to adjust to the new European realities, thus making the transition less fraught. In particular, a delay might allow the Lithuanians to see a range of EU countries start and go through their nuclear phase out programmes. Germany and Belgium have in fact adopted relatively leisurely phase out programmes , and Sweden is also taking it slowly, given concerns about possible energy shortfalls and dislocations. So a rapid phase out in Lithuania might be seen as unfair.

However, there are other views. The Lithuanian Green Movement have called for all talk of a delay to be resisted and for *'clarification of and official registration of the commitment to shut down Ignalina NPP and to make funds available for full and proper decommissioning.'* They also suggest that it is vital to address the *'social and environmental issues as adequately as technical issues'* and call for more funds to be provided for the social adjustment e.g. to help provide replacement employment . They conclude that *'in this manner, we suggest promoting the successful decommissioning of Ignalina NPP as an example for the entire region'* (LGM 2002)

In part the resistance to delay is based on the belief that, not only would it be unfortunate strategically, in terms of getting on with the transition to a sustainable energy future, but also because of concerns about safety, both in terms of plant operation and in terms of the storage of nuclear wastes. Moreover, safety and security issues has become even more urgent given current concerns about the risks of terrorist attack, and the illegal diversion of radioactive material for weapons use. Clearly for the anti-nuclear activists, nuclear power remains a symbol of all that needs to be avoided, so that the planned closure of Ignalina is seen as welcome and as prefiguring a more positive future.

On the other side, the concerns are often more pragmatic- can energy supplies be secured, can jobs be protected. But as we have seen, there are also those with strong nuclear commitments, some of whom might even support the construction of new nuclear plants. This is probably not a very realistic option in that the EU would be unlikely to help fund the construction of replacement nuclear plant, although it is not impossible: the Euratom

Treaty is still in operation. Certainly there are those within the EC who still support nuclear power, including EU energy commissioner Loyola de Palacio. For example while attending the Eighth International Energy Forum in Osaka in 2003 she commented “*Nuclear power is unavoidable in Europe if we wish to fulfill our commitments to the Kyoto Protocol.* It could be that, by forcing countries like Lithuania to close their old Soviet reactors, the EU could, consciously or unconsciously, be playing into the hands of the nuclear lobby, who would no doubt be delighted to offer replacements.

For the moment however, the main issues that are in dispute, at least in the Lithuanian context, are the time scale of the phase out of Ignalina and the level of external funding needed to ease the transition. It has been argued above that it may take time for the necessary cultural and value system changes to occur and be widely accepted- hence the interest in a delay. However it has also been argued that this sort of change can perhaps be speeded up if there is adequate financial support to ease the transition and to help make the development of viable alternatives easier.

## **7. Conclusions : changing symbols**

Nuclear power is being phased out in several countries in Europe, but Lithuania present special problems. Some are practical and technical -- for example, maintaining energy supplies and employment. Other problems relate to the symbolic meaning that the Ignalina plant now has for many people in Lithuania.

As we have seen, many Lithuanians still have a Soviet-era belief in nuclear power as a symbol of progress. In this context, the EU closure plan is seen by some Lithuanians as undermining Lithuania's reborn sense of national pride and its new-found sense of independent self-identity. It is difficult to challenge such 'nuclear-nationalism' because the anti-nuclear movement has declined since 1991. Instead, for some, the Ignalina plant has now become a symbol of national pride rather than Soviet dominance.

However attitudes are changing. Those directly affected by the closure plan are inevitably hostile to it, but there is a growing anti-nuclear sentiment amongst the general public. It is possible that the growth of a consumer society, and economic and political integration into the EU, may bring about further changes in popular attitudes in countries like Lithuania -- in a way similar to the rejection of nuclear power in most of the EU 15 member states. However, for this to occur there will be a need to ensure that the merits of the alternative renewable energy options, and particular their job-creation potential, are more widely appreciated and experienced. These technologies ought to become a new symbol of progress. Funding must be found to ensure that the new 'green energy' paradigm, already emerging elsewhere, is given sustenance by practical examples. And Lithuania is asking the EU for help. Failing that, the attempt to phase out nuclear power may be perceived as an unwarranted, unwelcome attack on national assets and even on national identity.

## **8. References**

- Adamkus, V ( 2002) statement at a press conference in Feb 2002, quoted in ‘Lithuanian NGOs’ Experiences on Decommissioning of Ignalina Nuclear Power Plant’ CEE Bankwatch, May 2002
- Blowers, A and Elliott (2003), D ‘Power in the Land’ in Bingham et al (eds ( Contested Environments’ Wiley/ Open University.
- Dawson, J ( 1996) ‘Eco-nationalism’ Duke University press, London
- DEA (2002) ‘Enhancement of Use of Local Renewable Energy Sources’ study financed by the Danish Energy Authority and contracted by Dansk Energi Management A/S <http://www.lei.lt/lith/renewable.htm>
- DTI (2003) Department of Trade and Industry Web site: Social and Economic Consequences of Nuclear Plant Closure  
<http://www.dti.gov.uk/energy/nuclear/fsu/scp.shtml>
- EC (2003) ‘Public Opinion on Energy: issues, opinions and Technologies’, European Commission.
- Energy Start ( 2002) see the list of ‘Ignalina myths’ and the refutations at <http://www.energystart.lt>
- Elliott. D ( 2003) ‘ Energy, Society and Environment’, Routledge, London.
- Huang, M. (1999) ‘Lithuania’s Nuclear Dilemma’, Central Europe Review Vol 1, No 9, 23 August ([http://www.ce-review.org/99/9/nuke\\_huang9.html](http://www.ce-review.org/99/9/nuke_huang9.html))
- Juska, F (2003) ‘Renewables and their use in Lithuania’ paper circulated at the conference on ‘Prospects for Wind Energy development in Lithuania’, Vilnius, Dec 2
- Konstantinaviciute, I ( 2003) ‘Climate Change Mitigation Policies in Lithuania’ Energy and Environment, Vol 14, No. 5, April.
- NES (2003) Lithuanian National Energy Strategy, see: <http://www.seimas.lt>
- Royal Society/Royal Academy of Engineering (1999) ‘Nuclear Energy; the future climate’, Royal Society/Royal Academy of Engineering, London
- Sevaldin, V. (2002) ‘Nuclear Power in Lithuania’ Energy News No.1 (24) , Lithuanian Energy Union, June, p9.

- LIU (2002) Comment at a session of the Public outreach Program on the Future of Visaginas, May 20, Energy News, No.1 (24), Lithuanian Energy Union, June 2002, p.25
- PIU (2002) 'The Energy Review' UK Cabinet Office, Performance and Innovation Unit <http://www.piu.gov.uk/2002/energy/report/index.htm>
- Read, P.R. (1993) 'Ablaze; the story of Chernobyl' Secker and Warburg
- Ryding, H (2002) "Progress on the Social Impact of Ignalina NPP Closure" Energy News, No.1 (24), Lithuanian Energy Union, June 2002, p.16
- LGM (2002) quoted in the NGOs Issue Paper 'Decommissioning of Ignalina Nuclear Power Plant' for the EBRD Annual Meeting, Bucharest, CEE Bankwatch Network, May 2002
- Vilemas, J and Miskinis, V (2003) 'Lithuanian Energy: On the Way to Integration into the European Union' International Association for Energy Economics Newsletter, Energy Economics Education Foundation, Inc., Third Quarter, pp18-21.
- Vilmorus (2001) Lithuanian Public Opinion Trends, Vilmorus Market and Opinion Research ([www.vilmorus.lt](http://www.vilmorus.lt)), as relayed by the Central European Opinion Research Group, Brussels.
- Vilnius (2003) 'Prospects for Wind Energy development in Lithuania', Vilnius Conference, Ministry of Economy of the Republic of Lithuania, Dec 2
- WNA (2001) The World-Nuclear Associations evidence to the PIU Energy Review <http://www.world-nuclear.org/wgs/wnasubs/energyreview/index.htm>