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Nuclear Power in the OECD

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Introduction - Nuclear Power and the IEA

From its beginnings in 1974, the International Energy Agency (IEA) has emphasised three pillars of energy policy, what it called the three E's: energy security of supply, enhancing economic growth, and the protection of the environment. In this context, nuclear energy was recognised as an important element of an energy policy: it enhanced energy security by replacing power generation from oil; it was seen as an increasingly economic energy option with oil and gas prices expected to increase without end; and it did not have the air emissions associated with fossil fuel plants. Communiqués from the IEA Ministerial meetings from this period called for “a steady expansion of nuclear capacity” as a key element of achieving the IEA's objectives.

Over the years we have seen a change in tone of these communiqués with respect to nuclear power. By the early 1980s, Ministers were noting the slowdown in nuclear plant construction and the need to enhance the “public acceptance” of nuclear power. Beginning in 1987, communiqués no longer referred to the need for nuclear power to increase energy security, but rather emphasised that each country had to decide on the appropriate mix of fuels. To quote from the latest communiqué, “each country will choose that mix of fuels it considers most appropriate: oil, gas, coal, nuclear or renewables”.

This might appear to be a very modest reference for an energy source that has grown to account for nearly a quarter of Organisation for Economic Co-operation and Development (OECD) power generation (*Figure 1*). But is also the only major power source which faces political restrictions on its future development in 13 of the 30 OECD countries.

It is in this energy policy context that the IEA was asked to write a book about nuclear energy in OECD countries. The objective behind writing the book, **Nuclear Power in the OECD** [1], was to survey the current situation and outlook for nuclear power. This paper will discuss some of the findings of this book from the perspective of nuclear power's economics, its contribution to energy security, and its environmental issues. In addition, the questions of public trust and political opposition and of research and development in nuclear energy are also addressed.

Economics

From a commercial perspective, existing nuclear plants are generally in a sound economic position. Nuclear power's cost structure makes it suitable for baseload power generation, since it has a high fraction of fixed construction costs and a low fraction of variable operating costs. Moreover, performance has improved greatly over the past 20 years (*Figure 2*).

Well-run nuclear plants have operating costs similar to, or lower than, those of competing plants. The introduction of competitive electricity markets in most OECD countries is encouraging all operators to achieve improved plant performance and is leading to consolidation among nuclear generators and among suppliers of nuclear equipment, services and fuel. Proposals to extend the lifetime of older plants are becoming common.

By contrast, new nuclear power plants face challenging competitive conditions. Fossil-fuelled plants are expected to have a lower total cost of electricity than nuclear plants in most countries under the energy market conditions and fuel prices that have prevailed in recent years (*Figure 3*). In addition, market liberalisation is altering the conditions under which investments in new generating plants are made in the OECD. Table 1 shows the status of market reform in OECD countries with nuclear power plants:

Table 1: Status of Electricity Market Reform in OECD Countries with Nuclear Power Plants

Country	1999 Nuclear Generation Share (%)	Retail Market Opening (%)	
		2001	2003
Belgium	58	35	100
Canada	12	0-100*	0-100*
Czech Republic	21	0	40
Finland	33	100	100
France	75	33	35
Germany	31	100	100
Hungary	38	0	35**
Japan	36	30	30
Korea	43	0	24
Mexico	5	0	0
Netherlands	4	35	100
Slovakia	47	0	0
Spain	31	54	100
Sweden	47	100	100
Switzerland	36	0	***
United Kingdom	29	100	100
United States	20	0-100*	0-100*

* Wholesale markets are open. Retail market opening at provincial/state level varies from 0-100%.

** Proposed

*** Planned market opening over the period 2002-2007.

Sources: EU Commission and IEA.

The introduction of market liberalisation ensures that the financial risks of investments are incorporated into investment decision making. Nuclear power has the advantage of a relatively low operating cost compared to fossil fuel technologies. But in common with other capital-intensive power generating technologies, the high capital costs of nuclear power mean that financial risks assume a relatively greater importance. While some of these risks, e.g. changes in the cost of capital, are common to all technologies, some nuclear power projects have experienced problems, such as construction delays and changes in regulatory requirements, to a much greater extent than has been the case with other technologies. Moreover, nuclear power plants have had problems with operations and maintenance cost escalation, and with requirements for safety retrofits, while uncertainties in waste disposal and decommissioning costs can also add to the perceived risks. The nuclear industry has, of course, taken steps to improve its record through standardised “preapproved” designs and better construction methods, but it must be borne in mind that cost reductions in other technologies are also taking place.

In the IEA World Energy Outlook [2], this assessment translates into a boom for gas-fired power generation (*Figure 4*), a boom that is currently underway in much of the OECD despite spikes in the price of natural gas in some markets. Still, each US\$1 increase per GJ (or MMBTU) translates into roughly a US\$7/MWh increase in electricity costs for a gas-fired combined cycle plant.

While governments have played a pivotal role in securing the economic viability of nuclear power in the past, today the technology is mature. Private investors and commercial generators must bear most of the financial risks of new nuclear plants. Nuclear power must increasingly face the future on its economic merits and economic drawbacks as judged by the electricity markets.

The report suggests governments:

- Aim to ensure that the full, unsubsidised costs of all forms of generation are borne by the generators, including internalisation of external costs.

Energy Security

Energy security concerns were a major motivating factor for government support for nuclear power during the 1970s. France and Japan both rely on nuclear power to underpin their energy security because of their limited domestic energy sources. Energy security has also been a consideration for some of the countries that have developed nuclear fuel reprocessing facilities. Nuclear energy today displaces large amounts of energy that would otherwise have to be purchased outside the OECD.

However, energy security concerns, particularly in relation to power generation, have diminished in most OECD countries, particularly as oil has been largely phased out of the generating mix. Furthermore, the development of international markets for hard coal make it a secure energy alternative for power generation. Similarly, renewable resources, though more expensive than coal, can also enhance security of supply.

The report suggests that governments:

- Seek to better define the value of energy security and diversity benefits of nuclear power relative to other energy sources.

- Consider to what extent existing government policies such as strategic stockpiling already address energy security concerns.

Environment, Safety and Waste Disposal

Environmental issues are found throughout the nuclear fuel cycle – from mining and milling to processing to plant operation and finally to waste disposal. The report addresses all of these aspects, with a focus on reactor safety and on waste disposal.

The safety record of the nuclear industry is very good. Few serious reactor accidents have occurred in OECD nuclear power plants, and according to nuclear safety authorities, these have not resulted in significant public health consequences. The main high-level policy issue for nuclear safety is how to make it effective and more cost-efficient. The report recommends that governments need to:

- Ensure that regulation is independent and adequately resourced.
- Improve regulatory effectiveness through simplification, stable and predictable regulation and avoiding unnecessary retrofits of existing plants.

Waste disposal is widely seen as nuclear power's environmental weak point. There is a wide agreement among scientists that geological isolation is the best method to dispose of high-level and long-lived wastes. Most governments have adopted such an approach. Yet, progress on implementing these concepts remains slow. A lack of practical experience also makes the costs associated with the step more uncertain (Table 2).

Table 2: Cost Estimates for Encapsulation and Disposal of High-Level Waste

Country	Type of Waste	Total Cost	Cost per Unit Volume
		(million 1996 US\$)	(thousand US\$/m ³)
Belgium	reprocessing waste	900	270
Canada	spent fuel	9 786	101
Finland	spent fuel	855	326
France	reprocessing waste	7 087	506
Germany	spent fuel, reprocessing waste	5 174	108
United Kingdom	reprocessing waste	1 912	630
United States	spent fuel	110 249	124

The report suggests that governments:

- Make step-by-step progress to build confidence in waste management programmes.
- Programmes should deal with all levels of waste. A successful low-level waste management programme can build credibility.
- Consider making high level wastes retrievable.

Nuclear power does, however, offer some environmental benefits. Some of the environmental damage from nuclear power generation may be more limited than that arising from other energy sources. Perhaps most significantly, nuclear power emits no greenhouse gases from its operation.

Efforts to combat climate change could modify the perception of, and the prospects for, nuclear power. Electricity generation accounts for about one-third of emissions of man-made carbon dioxide. A strong commitment to reduce emissions of carbon dioxide could have a dramatic positive effect on the prospects for nuclear power over the coming decades. For example, a tax of US\$15 per tonne of carbon dioxide would raise the fuel cost of a combined cycle plant by US\$6/MWh and that of a conventional coal plant by US\$13/MWh. Moreover, a focus on nuclear power's potential benefits in relation to climate change could put concerns about nuclear plant safety and environmental protection in a different perspective.

In the World Energy Outlook, we looked at the emissions impacts if existing nuclear plants were assumed to continue operating beyond 40 years, instead of being retired. In this scenario, life extension decreased carbon dioxide emissions in the OECD by 2.5 per cent.

Actions for governments to consider include:

- Considering the contribution of nuclear power to reducing emissions of carbon dioxide.

Public Trust

It is impossible to discuss nuclear power or its environmental opposition without discussing the public trust issue. Mistrust of nuclear power has many origins, from “NIMBY” (“not in my back yard”), to nuclear power's heritage of military secrecy, to non-proliferation concerns, to simple economics.

Past efforts to gather public support for nuclear power have used analysis and intellectual approaches to assure the public that nuclear power is a beneficial energy option. However, this type of factual and technical communication has probably been over-emphasised. According to Paul Slovic, a noted researcher in this field, attitudes towards nuclear power (for or against) “will not be quickly or easily changed by improving ‘technological literacy’ or improving the communication of technical assessments showing the risks of nuclear power generation and nuclear waste disposal to be minuscule” [4]. At best the reliance on factual or “rational” communication is incomplete. The debate about nuclear power challenges underlying values and beliefs. Such issues can only be resolved in political context, not a technical one.

For governments wanting to preserve the nuclear option, the report suggests:

- Openness and transparency in nuclear decision making.
- Refraining from claims that nuclear power is “perfectly safe”.
- Being active in nonproliferation activities.

Aside from any economic hurdles, political opposition to nuclear power is widespread in the OECD. Opposition has translated into political restrictions on its future development in 13 out of 30 OECD countries, 5 with operating commercial nuclear power plants (*Figure 5*).

A few countries have adopted policies to phase out existing nuclear plants. The report suggests that countries phasing out nuclear power should:

- Assess the costs and benefits including the implications for the environment, the national energy balance and radioactive waste disposal.

Research and Development

Nuclear power has dominated government spending on energy research and development, accounting for over US\$159 billion between 1974 and 1998. Although its share has fallen, it still accounts for 51% of the OECD energy R&D budget (*Figure 6*).

Interestingly, government energy R&D spending as whole has correlated quite well with the changes in the price of oil. The strong rise in the price of oil over the last two years should therefore be good news for energy R&D.

Until recently, governments investing in nuclear research and development were devoting relatively little to innovative new designs. As international co-operation has been common in nuclear energy this is clearly an area for further co-operation. The report therefore suggests governments:

- Consider shifting nuclear R&D to new designs.
- Take greater advantage of international co-operation to maximise benefits from these expenditures.

Conclusions

The IEA report on nuclear power sought to identify clearly the challenges facing governments as they consider the role for nuclear power in the overall energy supply. Economics, energy policy and political opposition explain the current situation of nuclear power in the OECD and our expectations that it will grow little over the next 20 years.

However, energy policy priorities of energy security and environment are currently gathering more attention from OECD governments. This is leading a number of them to debate the future energy mix. In our view, nuclear power should not be excluded from this consideration of future energy supplies, but equally it cannot be considered indispensable.

REFERENCES

- [1] International Energy Agency, *Nuclear Power in the OECD*, Paris, France, 2001.
- [2] International Energy Agency, *World Energy Outlook 2000*, Paris, France, 2000.
- [3] Stevens, Geoffrey, *Nuclear Waste Management Funds, An International Overview*, Paper presented at the 10th Anniversary of the Finnish Nuclear Waste Management Fund, (3 March 1998, Helsinki, Finland).
- [4] Slovic, Paul, *Public Acceptance of Nuclear Power in Democratic Societies*, Proceedings of a Global Seminar on the Future of Nuclear Power, (Cannes 10-12 May 1998), Atlantic Council of the United States, 1998.

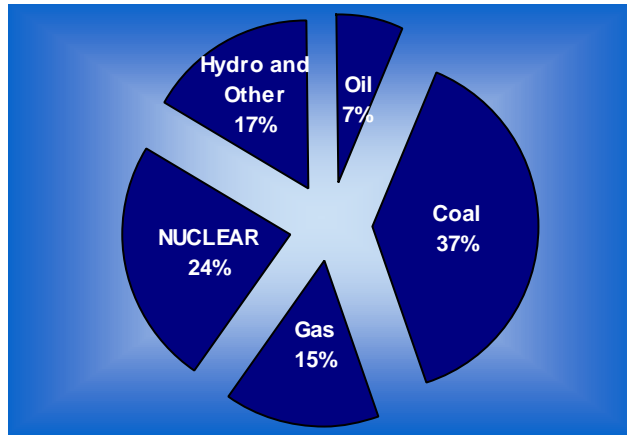


Figure 1: OECD energy sources for power generation 1999

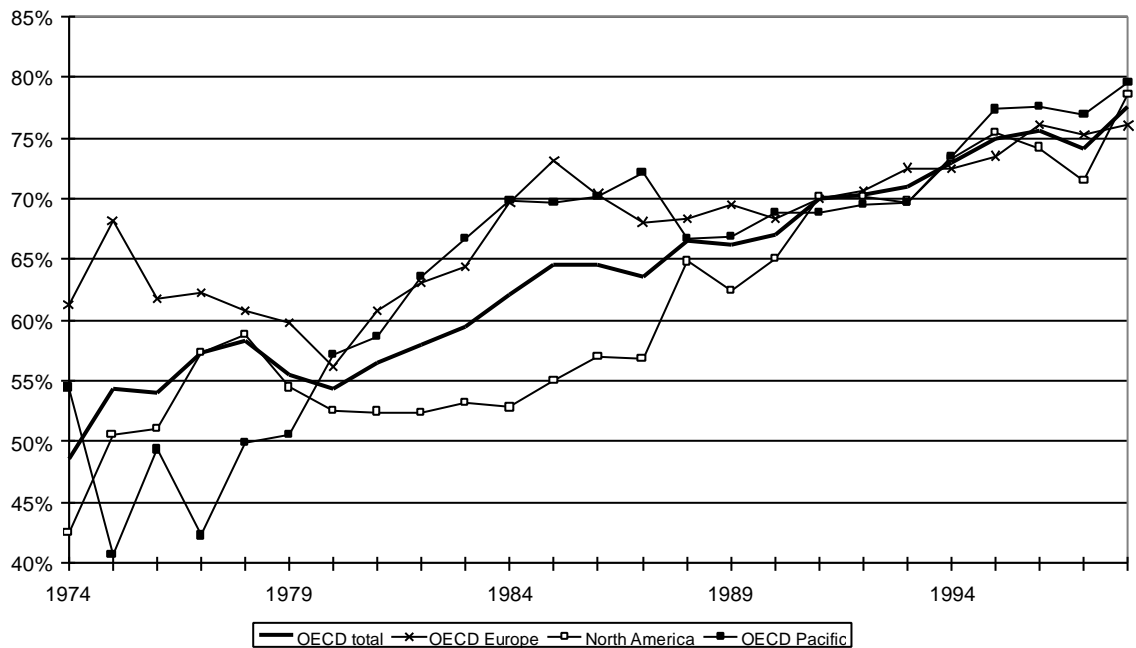


Figure 2: Nuclear plant gross capacity factors, OECD regions, 1974-1999

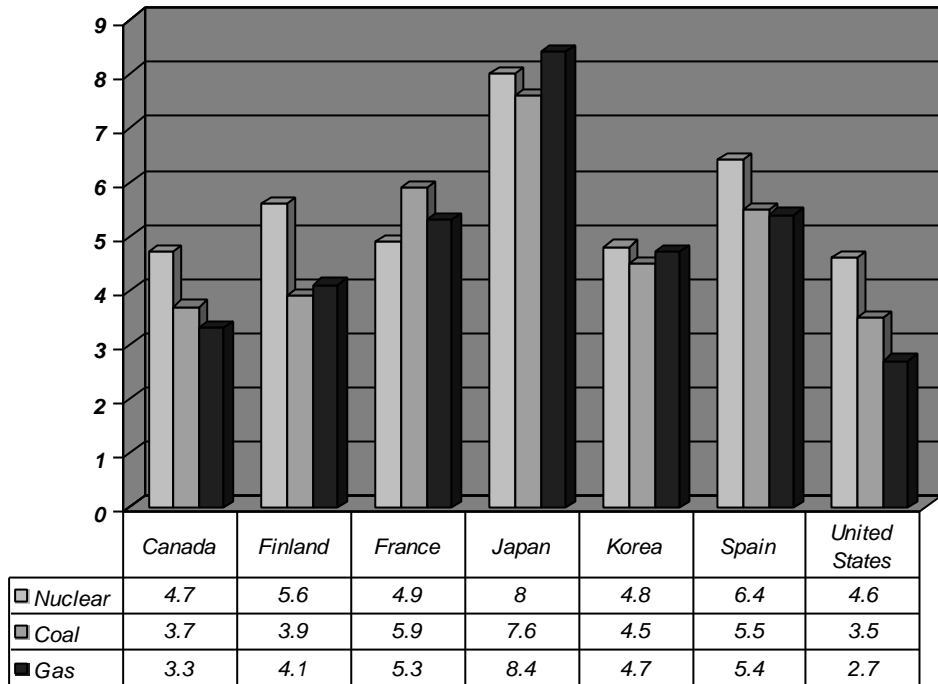


Figure 3: Projected costs of generating electricity in selected OECD countries at 10% discount rate (1996 US cents/kWh)

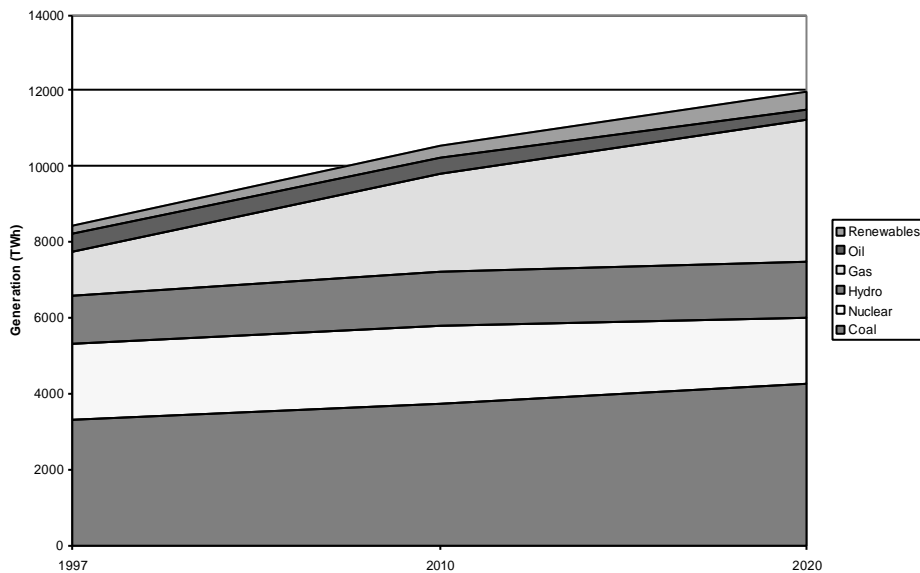


Figure 4: World energy outlook projections of sources for OECD power generation (1997-200)

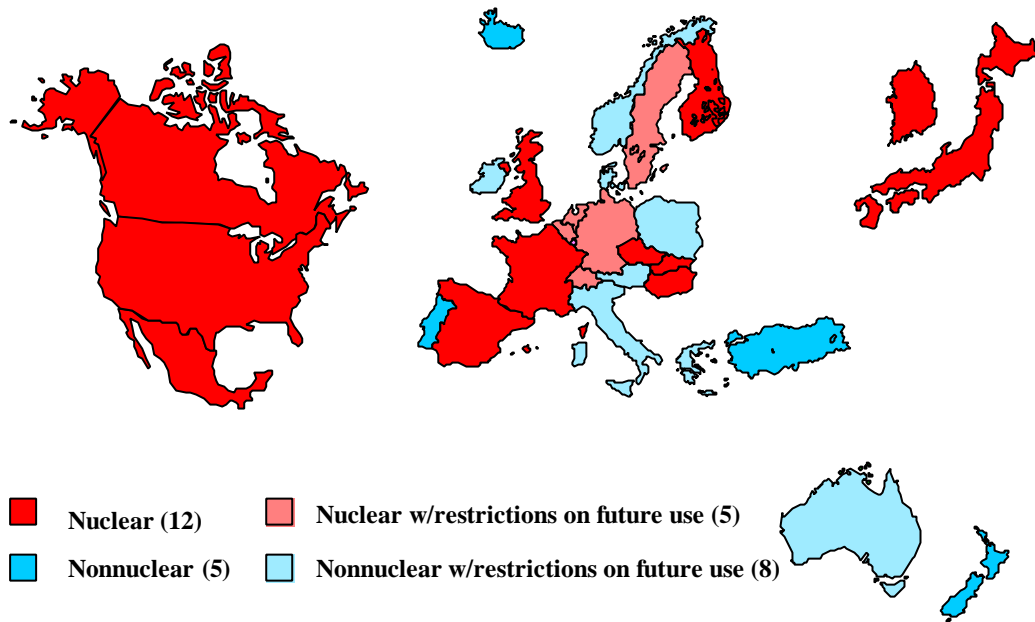


Figure 5: Political restrictions on future nuclear power development in OECD countries

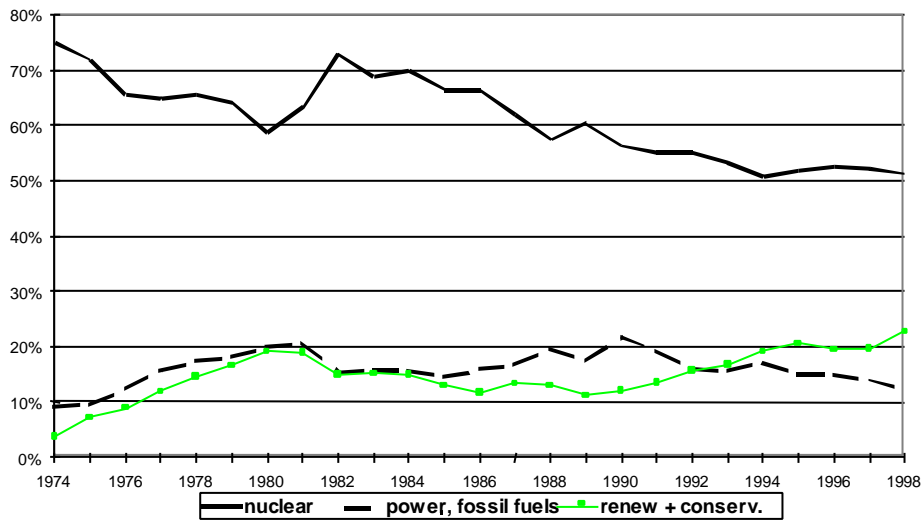


Figure 6: Shares of OECD Energy Research and Development Expenditure 1974-1998