THE ROLE OF NUCLEAR ENERGY IN WORLD ENERGY POLICIES

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Summary

Public opposition to nuclear power has grown and is now substantial in most countries. The industry denies that the arguments posed by nuclear opponents have much validity. The industry suffers from its military legacy but has gradually begun to shake this off, at least in the OECD countries. One beneficial effect today is that much ex-military uranium is now being recycled in civil reactors producing electricity.

Nuclear power now supplies 17% of world electricity, but its share has stalled in the 1990s. With reactor construction programs now insubstantial in all but a few East Asian countries, the nuclear share is set to fall over the next 20 years.

There are several important areas for debate about nuclear power, notably economics, radiation safety, waste management, non-proliferation, and prevention of greenhouse

gas emissions. Each of these areas includes important debates with different parties taking up radically opposing positions. Once the industry satisfies its opponents in one area, it is likely to be attacked in another. It is clear that with liberalized electricity markets gradually spreading around the world, nuclear electricity generation must certainly hit economic performance targets whilst satisfying public concerns.

Different scenarios can be posed for the future of nuclear power to 2020. A reference case would see only slow growth of nuclear capacity, below that of electricity supply in total. Only a more favorable operating environment is likely to lead to a rebirth of nuclear power.

1. Introduction

The generation of electricity through nuclear fission evokes strong responses from many people. Opposition to nuclear power is widespread in most countries of the world and has been frequently reflected in national policy-making. Being opposed to nuclear power is regarded as an "act of faith" within the environmental movement; removing it from the world is a common target amongst many divergent goals pursued by such groups.

On the other side, advocates of nuclear power, primarily but not exclusively from within the industry, claim that it is fundamentally misunderstood by the general public and that its strong opponents are irrational in their analyses. Proponents accept that they have been remarkably bad at putting their message across but nevertheless claim that it is, however, a benign technology that can provide the world with large quantities of cheap electricity at minimal environmental cost.

This continuous debate, which has raged since the beginning of the atomic era, shows few signs of resolution. It generates a huge amount of emotion, which it is necessary for the objective analyst to cut completely through. There are a huge number of well-founded and valid points to be made on both sides of the argument but these must be made fairly in order for each individual (and ultimately companies and governments) to make sounder judgments.

We may see that the anti-nuclear movement has perfectly respectable arguments in its favor, which raise its status above that of an anti-economic progress, environmentalist clique. Similarly, nuclear proponents are not merely an obscure, dying legacy of the past, reduced to the status, perhaps, of one of the crazier religious cults.

The approach taken here is to begin with a basic history of nuclear power, to allow understanding of why and how it reached its position today of supplying 17 percent of the world's electricity. Along the way, most of the arguments pro and con will be mentioned, and will be developed in more detail later; the resolution of these will determine the role of nuclear in future energy policies.

Plant safety, the risks of nuclear proliferation, waste disposal, transport, economics, global warming, and sustainable development are the major themes here. Finally, some possible scenarios for nuclear power in the twenty first century will be explored;

namely, will it die a slow, lingering death, or will there be a sudden, sharp revival? Can it ever again be regarded as an important source of energy in stimulating world economic development?

2. Some History

Although discoveries about the properties of uranium and other radioactive materials go back over 200 years, the possibility of generating electricity from uranium only became apparent after the discovery of nuclear fission in the late 1930s, just before the Second World War. Although it was the military motive, to make atomic bombs, which drove research funding in these early days, the eventually possibility of generating thermal electricity by the huge amounts of heat given off by the chain reactions was obvious.

This military legacy is one that has dogged the commercial nuclear power business since its eventual birth in the 1960s. Some industry advocates have tried to deny this legacy, attempting to draw sometimes imaginary lines between various activities, but it is ultimately foolish to deny the true past. The motivation for the early reactors was firstly to produce plutonium for bombs, with electricity essentially merely a convenient by-product.

The second military element was the development of nuclear propulsion for submarines, from which the most important reactor type (the light water reactor or LWR) in current commercial nuclear power was developed. The third was that most world uranium enrichment plants, in use today to enrich uranium for reactors used solely for generating electricity, were originally built for enriching uranium to rather higher levels in order to make nuclear bombs (a complementary route to that of producing plutonium via fission in a reactor).

The imagery of the mushroom cloud has been prominent in peoples' minds whenever and wherever the word nuclear has been mentioned since 1945. The military link today is insignificant so far as the commercial nuclear power business is concerned, but its existence is sufficient for many people to completely reject nuclear power as a result.

Today, stockpiles of nuclear weapons are being greatly reduced with arms control agreements and this is freeing up substantial quantities of uranium to be recycled into the civil fuel cycle. This "swords to ploughshares" situation is a notable improvement on the arms race, but still leaves many people with a sense of unease.

Much is to do with fear of radiation and the realization that our knowledge of its potential effects on the living world is far from perfect, indeed somewhat sketchy to be precise. Fear of the unseen and unknown permeates many of the anti-nuclear arguments highlighted below.

The generation of substantial amounts of electricity by controlled nuclear fission began in the late 1960s, and it is reasonable to separate this from military uranium uses from this point on, at least so far as the western world is concerned. In the Former Soviet Union and China, the separation of military uses from electricity generation for the masses came much later and is still being disentangled today. Large numbers of nuclear reactors were ordered in the west by electricity generators at this time, with a proliferation of designs.

In some countries, the state took a leading role in nuclear programs, particularly after the oil crises in the 1970s, which spurred energy-poor countries such as France and Japan to try to improve their energy-security. Elsewhere, where decisions to invest in nuclear plants were taken by electricity utilities, such as in the United States, this was only with the tacit approval of public authorities.

These moves were also defended by non-competitive electricity markets, whereby cost over-runs could usually be recouped through the rate-setting mechanism. It is therefore the case that the state has been a benevolent father to nuclear power, additionally so in relation to the generous amount of research funding available at this time.

During the 1970s, forecasts of the growth of nuclear power to the year 2000 were for over a thousand reactors to be in operation by then. It was believed that nuclear power would generate electricity very cheaply (hence the popularly reported claim of "too cheap to meter") and cause no severe environmental problems. The major problem on the horizon was believed to be an anticipated shortage of uranium.

It was therefore taken as given that it would be necessary to develop a new generation of "fast" nuclear reactors to economize on scarce uranium by utilizing plutonium separated from spent fuel. This move to a plutonium-based cycle has, however, become stalled for a variety of reasons. World uranium reserves have now been proven as substantially greater than was originally believed—price rises in the 1970s spurred much exploration and new discoveries were made.

Uranium is actually quite a common element in the Earth's crust, but few rich deposits have been found which can be exploited commercially with any ease. Second, nuclear power has not developed as rapidly as its proponents hoped, with only 430 reactors in use by 2000. This has been caused by a mixture of economic and political factors that can be explored. In particular, the accidents at Three Mile Island and Chernobyl cast a shadow over the industry. Third, many problems were found with developing fast reactors, so their deployment has now been put "on hold" until much later.

One legacy of the perceived shortage of uranium was the decision taken in several countries to reprocess spent fuel from reactors, separating out useful uranium and plutonium from waste products in an attempt to gain the maximum energy out of a given quantity of original uranium.

Other countries decided not to reprocess, but to simply store spent fuel in advance of disposal in a repository. What to do with spent fuel has perhaps become the industry's biggest Achilles heel; reprocessing generates lots of objections such as the possibility of plutonium being diverted to weapons and the risks of radioactive discharges from the reprocessing plants.

The concept of putting highly dangerous materials at the bottom of a hole in the ground, to lie there forever (hence the term final disposal) is also repugnant to many. The industry may argue that there are technical solutions available to all the objections, but it is far from easy to convince people of this fact (see Section 4.4 below).

Essentially two commercial nuclear fuel cycles have therefore developed, each of which is quite complex. In the more simple open cycle, uranium is converted, enriched, and fabricated into fuel which undergoes fission in the reactor until no longer effective, whereupon it is removed for cooling in storage, to be then disposed of in a repository.

In the closed cycle, the spent fuel is reprocessed and useable uranium and plutonium re-enters the cycle at appropriate points, the uranium as reprocessed uranium and the plutonium as MOX (mixed oxide) fuel.

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Biographical Sketch

Steve Kidd is Head of Strategy and Research at the World Nuclear Association, formerly the Uranium Institute, the international association for nuclear energy based in London, England. After a brief period as an economics tutor at Sheffield University, he followed a career as an industrial economist with leading UK companies from 1981–1990. These specialized in the raw materials and engineering sectors and included Rio Tinto and Rover Cars. His prime responsibility was the analysis of markets of interest to his employers, including possible business diversification. He practiced as an independent consultant covering similar areas from 1990 onwards and then joined the Uranium Institute as Senior Research Officer in 1995. He assumed his present position in 1998.