# CHAPTER 4

# THE CREDIT CRUNCH AND NUCLEAR POWER

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Since the decline following nuclear power's golden era of the mid-70s, there have been frequent predictions of an imminent nuclear revival, but all came to nothing. The latest revival, widely known as the "nuclear renaissance" and dating from 2002-03, is being pursued with greater determination than its predecessors. However, after 5 years, the absence of any new orders in key markets like the United States and the United Kingdom (UK), and unresolved issues (for example, on finance) have led to increasing doubts—even before the extent of the impact of the "credit crunch" on the world economy was apparent—as to whether the renaissance will again be still-born. While the credit crunch will not be good for most large scale projects, will it be the last straw for the prospects of a nuclear renaissance?

## FINANCE

The most obvious place to start is at the heart of the credit crunch itself, the banking system, in particular, the ability of electric utilities to borrow the money needed to build nuclear plants. It is clear that one of the legacies of the credit crunch will be that banks will be more risk-averse and will also be more careful with their risk assessment procedures.

A nuclear power station is the most capital-intensive way to generate electricity and, based on its past

record, the most economically risky. So it is clear that unless ways can be found to insulate the banks from this risk, the impact on the prospects for the nuclear renaissance will be very severe. There are two main ways that banks can be insulated, at least in part, from this risk: by electricity consumers, or by government credit guarantees.

## DEREGULATION AND INVESTMENT RISK

In the past, while electricity was still a regulated monopoly, obtaining cheap finance to build nuclear power plants was made easier by the fact that consumers effectively guaranteed the loans. If costs escalated, performance was worse than expected, alternatives proved cheaper, or electricity demand had been overestimated, the plant owners simply increased electricity prices to recover the additional costs they had incurred. When this assurance broke down, either because competition had been introduced to electricity or, as in the United States in the late 1970s, because regulators were no longer prepared to make consumers pay for the errors of electric utilities, finance became a thorny issue. When regulators began to disallow part of the cost of imprudent investments, in short, utilities were made to pay for the plants from their profits, the ordering of new facilities ground to a halt, and many existing orders were cancelled.

Some have suggested that new nuclear units would most likely be built in states where the electricity industry is not deregulated and is still regulated under cost-of-service procedures. But this assumes that regulators will be willing to pass on whatever costs the utility incurs; a risky assumption to make.

The poor record of nuclear plants being built on time and on budget, and the mixed record of reliability has always made nuclear power a risky option, but now the risks are falling directly on the utility building the plant. If, as a result, the utility failed, financiers would not be repaid. This has been proved to be more than a theoretical risk more than once. In 2002, the privatized British nuclear generating company, British Energy, collapsed because its costs were higher than the wholesale electricity price of the electric power that it sold. In this case, the British government chose to rescue the company using taxpayer money and the banks did not lose, but this will not always be the case. The Olkiluoto project in Finland, the only Generation III+ design on which substantial construction work has been completed, is acknowledged to be 50 percent over budget and 3 years late after only 3 years of construction.[1] The owners, Teollisuuden Voima Oy (TVO), expect to be covered for the cost escalation by a turnkey construction contract. Whether this contract will stick is now far from clear.[2] But most of the costs of late completion—buying the replacement power from a potentially tight Nordic wholesale electricity market—will fall on the owners.

Negligible quantities of new power generation have been built since the Nordic market was created in the late 1990s, and already dry winters, which reduce the availability of hydro-power, have led to large increases (up to 6-fold) in the wholesale electricity price. So for the period 2009-12, when Olkiluoto should have been producing 12 terawatts (TWh) per year, the owners will have to buy that power from the wholesale market, assuming that amount of power is available. The economic studies on which Olkiluoto was based assumed the generation cost would be €24/megawatt

(MWh). If the Nord Pool price was three times that, far from unusual in recent years, the extra cost of purchasing this power from the market would be in the order of €2 billion over 3 years.

However, TVO is owned by its customers, energy intensive industries such as paper and chemicals, for which electricity purchase is likely to be one, if not the largest of their input costs. So passing these extra costs on to consumers has serious repercussions. While the owners of TVO would not want to cause its failure, their first priority must be to ensure that the cost of the power they buy is not so high as to make their products uncompetitive. It is not hard to imagine a utility with less financial and contractual back-up than TVO collapsing under the strain of the cost and time overruns suffered at Olkiluoto. If cost escalation at the site continues, perhaps even TVO will collapse, with a resulting long-lived impact on the financeability of nuclear projects.

## GOVERNMENT GUARANTEES

Even before the credit crunch, the risk premium involved in nuclear projects, as discussed above, was a severe barrier to new orders. At the top of the utilities' wish list for government support were credit guarantees, which shift this risk to taxpayers. One of the factors that made the Olkiluoto order financeable was export credit guarantees from the French and Swedish government. This made loans at only a 2.6 percent interest rate possible. At the time, the guarantees were shocking and looked extensive but in comparison with what U.S. utilities are asking for, they now seem small.

In the United States, Congress has made $18.5 billion in federal loan guarantees for new nuclear plants available for 2008-09.[3] This is part of the Bush Nuclear Power 2010 initiative, which was based on the premise that some federal subsidies and guarantees to a handful of new plants would overcome barriers to new ordering and lead to a flow of new, unsubsidized orders. The Department of Energy estimates that loan guarantees could reduce total generation cost by about 40 percent: "A new merchant nuclear power plant with 100 percent loan guarantee and 80/20 debt to equity ratio could realize up to a 39 percent savings in the levelized cost of electricity when compared to conventional financing with a 50-50 debt to equity ratio."[4]

There are restrictions on the type and number of plants that would be eligible for loan guarantees. The Congressional Budget Office stated:

> The Department of Energy has indicated that it will deny a utility's application for a loan guarantee if the project is not deemed to be both innovative (essentially, in the case of nuclear technology, a plant design that has not been built in the United States) and commercially viable, and that no more than three plants based on each advanced reactor design can be considered innovative.[5]

If three units of each of the five plant designs under consideration were built, 15 units would be built. But while utilities have been keen to stand in line for these handouts, with 30-40 plants now at various stages of planning, it seems increasingly likely that only plants with loan guarantees will be ordered. If the new U.S. administration really wants to get a significant proportion of the 30-40 reactors proposed built, the $18.5 billion will not go very far.

If we assume that a new plant will cost no more than $7-9 billion and that industry gets its wish that 80 percent of this cost is covered by federal loan guarantees, guarantees worth about $100 billion would be needed to build just the 15 innovative units. To build 35 units, guarantees of $230 billion would be needed. By October 2008, 17 power companies had already applied for $122 billion in federal loan guarantees.[6] If, as argued by Standard & Poor's,[7] skills and component bottlenecks mean that only a few units can be supplied per year to the U.S. market, the need for this very large number of guarantees may not arise.

There has also been speculation that the French and Japanese governments would offer loan guarantees for plants supplied by their national companies.[8] Areva NP is controlled by French interests, indeed, it is majority-owned by the French state, and the French government has already proved itself willing to offer loan guarantees, for example to Finland and South Africa.

The Japanese government is much less experienced with supporting Japanese vendors. Despite the extensive nuclear program in Japan as well as large exports of nuclear components, this is the first time Japanese vendors have tried to win foreign orders as a main contractor. Nevertheless, Japanese vendors are involved in four out of five of the designs being considered in the United States—the Franco-German engineering, procurement, and construction project, European Pressurized Water Reactor (EPR) is the fifth.

Mitsubishi has its own design, the U.S. Advanced Pressurized Water Reactor (US-APWR). Hitachi is collaborating with General Electric (GE) to offer the Economic Simplified Boiling Water Reactor (ESBWR) and, perhaps, the Advanced Boiling Water Reactor

(ABWR). Westinghouse, which is offering the AP-1000, although largely based in the United States, is now owned by Toshiba, which is also offering the ABWR. Standard & Poors believes the Japanese government will provide finance for orders from Japanese vendors through the Japan Bank for International Co-operation.

Providing guarantees for one order, like Olkiluoto, which was seen as opening up the market for French exports might be acceptable to French and Japanese taxpayers. However, if such guarantees are a condition for all orders to be placed, taxpayers will see this as a blank check and, especially if the Olkiluoto order does lead to a default, a highly risky one.

For U.S. orders, if public opinion remains that failures of the U.S. banking were at the root of the credit crunch, the idea of foreign banks supporting U.S. financial institutions to again make risky investments will be even more unpopular.

This is an issue that the new Obama administration will need to look at urgently. The U.S. Government seems to have three choices:

1. Abandon the program;
2. Build 3-4 totemic plants within an $18.5 billion budget; or
3. Cave in to the nuclear industry's demands for blank check support.

The first option is more feasible for a new administration at the start of its term and would be the logical choice if it was judged that orders without loan guarantees would not be feasible. It would face huge opposition from those who stood to gain from nuclear orders. The second option would be politically less

contentious by avoiding the opposition that abandoning the program would lead to, but would put $18.5 billion of public money at risk.

For other countries, especially the UK, the government has not faced up to the prospect that loan guarantees will be necessary if orders are to be placed. It is one thing for taxpayers to be forced to find this sort of sum to save the global banking system, it is a very different thing to volunteer this level of taxpayer money simply to get nuclear power plants built when there are non-nuclear alternatives that would not need this level of support. The public opposition to the U.S. Government $700 billion bail-out of the banking sector demonstrated that the public is not prepared to risk its money on what appear to be ill-thought-out policies.

## KEYNESIAN STIMULATION

With governments desperately looking for measures that will prevent their economies from slipping too deeply into recession, there is bound to be some pressure for Keynesian measures to stimulate the economy through government or government-inspired investment in infrastructure. Building nuclear power plants might seem to be a good way to do this. To some extent, any major infrastructure project will stimulate the economy because it will employ labor and use materials but that does not avoid the need for governments to choose projects that have long-term value to the economy so choices still have to be made. The other relevant issue is how quickly can the chosen project have an impact, and this is the major weakness for nuclear projects. Even in the countries where the process of restarting nuclear ordering is most advanced, notably the United States and the UK, no or-

ders can be realistically placed for 4-5 years.

If an immediate stimulus is needed in the energy sector, energy efficiency measures, which have a short lead-time, which employ a large number of workers with varying skills and which have a huge long-term welfare benefit would seem likely to be far more effective. It is therefore particularly surprising that the British government is cutting funding for its flagship energy efficiency program, Warmfront.[9]

## NUCLEAR CONSTRUCTION COSTS

### Cost Estimates.

One of the most bewildering aspects of the nuclear debate over the past few years has been the escalation in forecast nuclear costs, even before any new plants have been built. The figure of $1,000/kW (so that a 1,000 MW plant would cost $1 billion) was toted by the nuclear industry in the late 1990s as an achievable cost for the new Generation III+ nuclear plants then being designed. This figure was seen by many outside the industry as a target rather than a realistic forecast. So when the first order for a Generation III+ plant was placed for Olkiluoto in 2004, the size of the contracted cost, €3 billion or $3000/kW—three times the figure that the nuclear industry had forecast—was not a surprise to experienced industry watchers. It was seen as a loss-leader, although given that the vendors would have to pay for any cost overruns, there was an expectation that it was at least of the right order of magnitude.

It is now clear that construction at the Olkiluoto is going very badly, and that the project is 50 percent over budget and 3 years late, and additional cost increases are expected. Even companies as big as Areva

NP's owners (Areva and Siemens) cannot easily take losses on this scale without expecting serious repercussions from their shareholders.

How much of the cost overrun is the result of the problems at the site and how much is because the price was an underestimate will probably never be known. Areva, in its attempt to pass these costs on to TVO, will have a strong incentive to argue it is due to specific site problems.

However, prices continued to escalate rapidly even after the Olkiluoto price was announced. By 2008, the estimated construction cost from a range of sources for a Generation III+ unit seemed to be settling at around $4,000-6,000/kW, double the Olkiluoto price and often double the estimates made by the same utilities a year or two previously. These cost estimates are not extrapolations by anti-nuclear activists, they are from credible organizations with no apparent motive for overestimating costs such as experienced nuclear utilities and financial institutions like Standards & Poor's. The figures need to be treated with some care partly because the projects are still at an early stage of development and partly because it is not always clear what is included in the estimates. In particular, some estimates may include finance costs, while others, e.g., Duke Power, Progress, and Florida Power & Light, are overnight costs. See Figure 4-1.

| Organization | Plant | Estimate ($/kW) | Date |
|---|---|---|---|
| Duke Poweri | Lee (AP-1000) | 4700 | November 2008 |
| Progress Energy/Harrisii | Harris (AP-1000) | 4000 | October 2008 |
| Standard & Poorsiii | n/a | 3000-5000 | October 2008 |
| E.ONiv | n/a | 6000 | May 2008 |
| Florida Power & Lightv | Turkey Point | 5400-7900 | February 2008 |

Sources:

i. "Duke Doubles Cost Estimate for Nuclear Plant," The *Business Journal of the Greater Triad Area*, November 4, 2008.

ii. "Reactors Likely to Cost $9 Billion; Progress Energy Doubles Estimate," T*he News & Observer*, Raleigh, NC, October 17, 2008.

iii. "Construction Costs To Soar For New U.S. Nuclear Power Plants," *Standard & Poor's*, October 15, 2008.

iv. "Reactors Will Cost Twice Estimate, Says Chief," *The London Times*, May 5, 2008.

v. "FPL Says Cost of New Reactors at Turkey Point Could Top $24 Billion," *Nucleonics Week*, February 21, 2008.

**Figure 4-1. Recent Estimates of Nuclear Construction Costs.**

A variety of explanations can be suggested for this escalation.[10] These include:

- Rapidly rising commodity prices driven by China's demands for them which makes all power plants more expensive, but affects nuclear plants particularly severely because of their physical size;
- Lack of production facilities, which is means that utilities hoping to build nuclear plants are taking options on components like pressure vessels;
- Shortages of the necessary nuclear skills as the nuclear work force ages and is not replaced by younger specialists; and,

- Weakness of the U.S. dollar.

All of these deserve consideration in light of how the credit crunch will impact them.

**Commodity Prices.**

If the recession triggered by the credit crunch does bite hard, commodity prices (including fossil fuels) could drop steeply in the short-term and this might at least help check the growth in estimates for nuclear construction costs—it will also tend to reduce the price of other types of power plants, albeit to a lesser extent. In the longer term, whether lower prices can be maintained will depend on resource issues. If the price of commodities rose because of resource issues, e.g., the marginal reserves that were being exploited had much higher costs than the main resource base, prices will tend to remain high. Advocates of the peak oil theory would probably argue this was the case for oil.[11] If the high prices are simply the result of a short-term supply-demand imbalance, as new capacity is built, prices will drop back sharply. This may be the case for steel and concrete, where there does not appear to be any basic resource problem. Note that some of the escalation in commodity prices may also be due to the decline from the end of 2005 to mid-2008 of about a third in the value of the U.S. dollar. Much of this decline had been recovered by November 2008.

## COMPONENT BOTTLENECKS AND SKILLS SHORTAGES

Standard & Poor's[12] places great emphasis on the issue of shortage of component manufacturing facili-

ties. It identifies in particular pressure vessels, circulating water pumps and turbine forgings as particularly problematic. While a large demand for these products would undoubtedly lead to an increase in capacity, the certification requirements for nuclear components will make this a slower process than it would be for less demanding technologies and companies will be reluctant to commit the investment needed to build such production facilities until they see solid evidence of long-term demand. Standard & Poor's also notes skills shortages as a major constraint and, again, such skills shortages cannot quickly or easily be overcome.

## CURRENCY INSTABILITY

Currencies values have been particularly volatile in the past 2 years with the dollar hitting historic lows against European currencies. Between November 2005 and July 2008, the value of the dollar against the Euro had fallen from €1=$1.17 to €1=$1.57. Yet by November 2008, the dollar had recovered most of this ground to €1=$1.27. It seems likely that at least some of the cost escalation was related to the decline of the U.S. dollar making some inputs more expensive in dollar terms. For the future, this currency instability represents a particular risk to all sides. For example, a Japanese company selling plants or components for which the contract is denominated in dollars would lose substantial amounts of money if the value of the dollar was to fall back sharply again.

A fifth factor, greater awareness among utilities that if the estimates they make are not accurate that there will be serious financial consequences for them, which is difficult to quantify. Experience with Olkiluoto and awareness that regulators and the public

are likely to be much less indulgent to cost overruns than they were in the past will be a strong incentive for utilities to build in ample contingencies.

Given that the current costs estimates are based on minimal actual construction experience and that such estimates have, in the past, seriously underestimated actual costs, the figure of $6,000/kW may yet turn out to be grossly inaccurate.

## TURNKEY CONTRACTS

The financial assurance that a turnkey contract seemed to give was an important element in Areva NP winning the Olkiluoto contract and also for the French and Swedish governments to offer loan guarantees. However, it was surprising that Areva NP was so desperate for the order that it was prepared to take the massive financial risk a turnkey contract involves. There have been few (if any) genuine whole plant (as opposed to individual component) turnkey contracts since the notorious 12 turnkey orders that launched commercial ordering in the United States in 1964-66.[13] These lost the vendors massive amounts of money although they did achieve one of their aims, which was to convince utilities that nuclear power was little more challenging than, say, a coal-fired plant and could be ordered with confidence as a proven technology. Turnkey orders for nuclear plants are much more risky compared to other power plants because so much of the work in nuclear construction is on-site engineering and construction, a process that is notoriously difficult to control. It is also not easy for the vendor to control the quality of work because of the large number of contractors involved.

Standard & Poor's were clear in a recent report that turnkey contracts would not be offered. "We expect no EPC [engineering, procurement, and construction] contracts to be fully wrapped through a fixed-price, date certain mechanism."[14]

## COMPETITIVENESS AND DEMAND

Nuclear power is just one of many possible ways of meeting electricity demand and, if it is not competitive or demand does not justify it, in the long term plants will not be built. Going back 30 years, large numbers of U.S. orders were cancelled when it became clear that either demand did not warrant them or that the cost of meeting demand with nuclear plants would have been prohibitive.

### Competitiveness.

Even though estimated costs have escalated rapidly in the past 3 years, this seems to have had little impact on the enthusiasm of governments for nuclear power. One explanation for this was the rapid rise of fossil fuel prices and insecurity in their markets. As in 1975, after the first oil crisis, the notion that fossil fuels could ever be cheap again seemed unimaginable. But now, as then, while fossil fuel markets are far from perfect, they do respond and by autumn 2008, this response was already apparent. Sharp declines in electricity demand were also becoming apparent.

High oil prices led in the short term to recession, and the credit crunch is likely to deepen this recession. This will reduce energy demand in the short term because of the reduction in economic activity. In the longer term, there will be a more significant demand and

supply side response. This is clearly illustrated by the marketing of new cars, which for the first time in 30 years are being sold based on their fuel consumption. On the supply side, higher oil and gas recovery rates will be justified, exploration efforts redoubled and previously uncommercial reserves, especially for gas, will become more economically viable.

The competitiveness of renewables will be improved, but it might be energy efficiency that is the real winner. Fuel poverty, as defined in the UK as a household spending more than 10 percent of disposable income on energy, has become a major issue and the forecast indicates that by the end of 2008 a quarter or more of British households will be fuel poor. Building nuclear plants might help keep the lights on in the long term, but even its most committed advocates cannot claim it will reduce the price of power. Spending money on energy efficiency to reduce demand will not only keep the lights on and replace fossil fuels, it will also permanently lift households out of fuel poverty with huge health and welfare benefits as well as reducing the strain on the social security system. Few policies pay off so handsomely and in so many ways.

**Capacity Need.**

In the past when the economic case for nuclear power was not so strong, nuclear programs were justified by the nuclear industry on the basis of needed capacity. Without a nuclear power program, they argued, the lights will go off, a prediction usually based on a projection of high electricity demand growth. High energy prices and the credit crunch are likely to cause a recession and a strong demand side response on energy efficiency, so electricity demands will be much lower than earlier forecasts.

**Other Markets.**

While most eyes are on the U.S. and UK nuclear programs, other countries' programs are also being affected. South Africa has, for the past decade, been trying to commercialize Pebble Bed Modular Reactor technology, but progress has been slow and the publicly-owned South African utility, Eskom, is now prioritizing orders for conventional nuclear plants, either the Areva NP EPR or the Westinghouse AP-1000. It has a budget of R343 billion ($34 billion) to build 16GW of capacity from new coal and nuclear plants by 2017. In the longer term, it plans to build 20GW of nuclear plant capacity by 2025. But at $6000/kW, its budget would provide less than 6GW of new nuclear capacity. Eskom's credit rating is falling, in August 2008, Moody's reduced their rating to Baa2. It is also deeply unpopular because of numerous blackouts over the past 2 years so its priority must be to deal with power shortages and strengthen the grid in order to ensure that these blackouts are a thing of the past. New nuclear plants which, realistically, will not be on line before 2020 will do nothing to achieve this. So South Africa's ability to proceed with any nuclear program now looks questionable.[15]

Berlusconi has been vocal in his support for nuclear power and is trying to overturn the 1987 referendum verdict that required the phase-out of nuclear plants in Italy.[16] However, the practical difficulties of relaunching the program, such as rebuilding skills and capabilities, were always underestimated and the credit crunch may make finance, even for a utility of the size of ENEL, difficult, especially given the financial strain on ENEL from its purchase last year of over €40 billion of the Spanish utility, Endesa.

**Decommissioning Funds.**

While the credit crunch could have an immediate impact on the prospects for new nuclear orders because of its impact on finance, construction, demand, and competitiveness, it could also have a long-term impact on funding for decommissioning.

Under the polluter pays principle, the responsibilities for decommissioning should be clear. Those that consume the electricity should be responsible for paying for the clean-up of the site. The consensus now emerging is that this is best ensured by setting up segregated funds that are only invested in low risk investments. In practice, funds have not always been segregated and decommissioning cost estimates have been largely underestimated so funds have been lost or are inadequate. While for long-term investments, the return will fluctuate over time, the credit crunch may well lead to large shortfalls in these funds which will not be repaired simply by the next economic upswing. Only a few examples have surfaced so far, but if these prove to be the tip of an iceberg, more extensive ways of ensuring adequate funds are available when needed. The decommissioning fund of the Vermont Yankee plant was reported to have lost 10 percent of its value in a matter of weeks.[17] This plant is licensed until 2012 but the license may be extended for another 20 years, in which case, there will be time to make up the shortfall. Decommissioning of the Zion plant (already closed) had to be delayed because its fund also lost 10 percent of its value.[18] On average, U.S. decommissioning trusts are 60 percent equity and 40 percent debt (bonds). Given that indices like the S&P 500 lost more than a third of their value in 2008, it is not dif-

ficult to see how losses could be as high as 20 percent. If plants are reaching the end of their life with inadequate funds for decommissioning there may well be a need for further assurance mechanisms. For example, it could be required that utilities take out financial instruments (insurance policies) so that if there is a shortfall, it will be covered by the insurers.

## CONCLUSIONS

Even before the scale of the impact of the credit crunch began to be appreciated, the cracks in the Nuclear Renaissance were becoming clear. The designs were unproven; costs were escalating sharply; obtaining finance was problematic; and there were skills shortages and component supply bottle-necks. The credit crunch has done nothing to lessen these problems.

There are likely to be many unexpected developments before business-as-usual for the world economy resumes, but two changes are clear:

1. The scrutiny by banks of the projects that they lend money to will be far more rigorous in the future so that the mistakes that led to the credit crunch can never be repeated; and,

2. Public appreciation of risk will be sharpened, and where risk is being passed to taxpayers (or electricity consumers), government will need a strong case for such support to be obtained.

The implications for nuclear power concerning these changes are severe, and it is clear that governments and utilities will no longer be able so easily to pass the risk of nuclear programs on to taxpayers and electricity consumers. Nuclear power has demonstrat-

ed extraordinary resilience over the past 2 decades, still remaining on the policy agenda despite its failings. So it would be unrealistic to assume that in a decade that powerful interests will no longer be lobbying for more nuclear orders. But the current conditions may be the best and perhaps the last chance for the nuclear industry. The external factors, such as fossil fuel prices, the need to act on climate change and the geopolitical situation are as favorable as they are likely to get. So if the nuclear industry cannot take advantage of these, will it get another chance? The nuclear workforce is aging and is not being replaced, and if a whole generation of new designs, which in a decade will be looking a little dated, has remained largely on paper, will there really be the appetite among private companies to spend the money necessary to bring another generation of designs to the market? Olkiluoto will continue to be the marker for the industry. At best, if there are no more delays and cost overruns, it will be a warning to potential investors, but if things keep going wrong and TVO fails financially, the ability to finance any future nuclear project will be put in doubt.

## ENDNOTES - CHAPTER 4

1. **Finland's Olkiluoto Plant.** The Olkiluoto construction project in Finland has become an example of all that can go wrong in economic terms with a new nuclear plant build. It demonstrates the problems of construction delays, cost overruns, and hidden subsidies. A construction licence for Olkiluoto was issued in February 2005, and construction started that summer. As it was the first reactor ordered in a liberalized electricity market, it was seen as proof that nuclear power orders were feasible in these markets and as a demonstration of the improvements offered by the new designs. To reduce the risk to the buyer, Areva NP offered

the plant under "turnkey" terms, which means that the price paid by the utility (TVO) is fixed before construction starts, regardless of what actually happens to costs. The contract allows for fines on the contractors if the plant is late. The schedule allowed 48 months from pouring of first concrete to first criticality.

**Finance**. The European Renewable Energies Federation (EREF) and Greenpeace France made complaints to the European Commission in December 2004 that the financial arrangements contravened European State aid regulations. The Bayerische Landesbank (owned by the German state of Bavaria) led the syndicate that provided a loan of €1.95 billion, about 60 percent of the total cost, at an interest rate of 2.6 percent. France's Coface provided a €610 million export credit guarantee covering Areva NP's supplies, and the Swedish Export Agency SEK provided €110 million. In October 2006, the European Commission finally announced it would investigate the role of Coface. Subsequently, in what was seen as an eccentric judgement, it found that the guarantees did not represent unfair state aid. Regardless of this, it is clear that the arrangements for Olkiluoto are based on substantial state aid that will not be available to many plants. The interest rate on the loan is far below the levels that would be expected to apply for such an economically risky investment.

**Construction Problems**. In August 2005, the first concrete was poured. In September 2005 problems with the strength and porosity of the concrete delayed work. In February 2006, work was reported to be at least 6 months behind schedule, partly due to the concrete problems and partly to problems with qualifying pressure vessel welds and delays in detailed engineering design. In July 2006, TVO admitted the project was delayed by about a year and the Finnish regulator, STUK, published a report which uncovered quality control problems. In September 2006, the impact of the problems on Areva started to emerge. In its results for the first 6 months of 2006, Areva attributed a €300 million drop in first-half 2006 operating income of its nuclear operations to a provision to cover past and anticipated costs at Olkiluoto. The scale of penalties for late completion was also made public. The contractual penalty for Areva is 0.2 percent of the total contract value per week of delay (past May 1, 2009) for the first 26 weeks, and 0.1 percent each week beyond that. The contract limits the penalty to 10 percent, about €300 million. In December 2006, after only 16 months of construction, Areva announced the reactor was already 18 months behind schedule, which seems to assure that the full

penalty will be due. In late 2007, the cost overrun was reported to have increased to €1.5 billion and in October 2008, the estimated delay was increased to 3 years.

Relations between Areva NP and TVO are near a breaking point, with Areva NP now appearing to want to renege on the turnkey contract, claiming that TVO had not fulfilled its part of the deal. The turnkey contract is now in dispute and seems likely to be settled acrimoniously. In December 2008, Areva announced it had initiated a second arbitration against TVO to recover €1 billion in compensation for the delays, which it attributes to failings on the part of TVO, in particular, slowness in processing technical documentation. TVO countered in January 2009 by demanding €2.4 billion in compensation from Areva NP for delays in the project. These cases are likely to take several years to settle and will hang over both TVO and Areva NP until they are resolved.

**Implications**. The scale and immediacy of the problems at Olkiluoto has taken even sceptics by surprise. It remains to be seen how far these problems can be recovered, what the delays will be, and how far these problems will be reflected in higher costs (whether borne by Areva or TVO). However, a number of lessons do emerge:

- The contract value of €2000/kW, which was never a cost estimate due to the turnkey nature of the contract, now appears likely to be a significant underestimate.
- Turnkey contracts may well be required by competitive tenders in liberalized electricity markets. Or, regulators may impose caps on recoverable nuclear construction costs, which would have the same effect. The willingness of vendors to bear the risk of cost over-runs in the light of the Olkiluoto experience is open to serious question.
- The skills needed to successfully build a nuclear plant are considerable. Lack of recent experience of nuclear construction projects may mean this requirement is even more difficult to meet.
- There are serious challenges to both safety and economic regulatory bodies. The Finnish safety regulator had not assessed a new reactor order for more than 30 years and had no experience of dealing with a first-of-a-kind design.

2. "Target date for operating Olkiluoto-3 again delayed, this time until 2012," *Nucleonics Week*, October 23, 2008.

3. "Nuclear Energy Institute president says Congress needs to boost loan guarantees," *Platt's Global Power Report*, October 16, 2008.

4. Prepared remarks of Deputy Energy Secretary Dennis Spurgeon at the second annual "Nuclear Fuel Cycle Monitor Global Nuclear Renaissance Summit," Alexandria, Virginia, July 23, 2008.

5. "Nuclear Power's Role in Generating Electricity," Washington, DC: Congressional Budget Office, 2008, p. 33, available from *www.cbo.gov/ftpdocs/91xx/doc9133/05-02-Nuclear.pdf*.

6. Available from *www.lgprogram.energy.gov/press/100208.pdf*.

7. "Construction Costs To Soar For New U.S. Nuclear Power Plants," Standard & Poor's, 2008.

8. "US Working with Allies to Change Global Rules for Nuclear Financing," *Nucleonics Week*, October 23, 2008.

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