Industry

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New Nuclear – The Economics Say No

Equity ☑

UK Green Lights New Nuclear – Or Does It?

- **Green lighting new nuclear?** — The UK government today announced a fast-track planning process for new nuclear power stations. 10 sites have been approved for possible development. The government is presenting today's announcement as providing the green light for a major new nuclear programme, which it says is needed to meet climate change and security of supply targets.
- **But no financial support has been offered** — The government has not announced any direct financial support for new nuclear. The government still seems to expect the private sector to take an unacceptable level of risk, in our view.
- **The five big risks** — Nuclear power station developers face five big risks: Planning, Construction, Power Price, Operational, and Decommissioning. The government today has sought to limit the Planning risk. While important for encouraging developers to bring forward projects, this is the least important risk financially.
- **The three Corporate Killers** — Three of the risks faced by developers — Construction, Power Price, and Operational — are so large and variable that individually they could each bring even the largest utility company to its knees financially. This makes new nuclear a unique investment proposition for utility companies.
- **No where else in the world** — Government policy remains that the private sector takes full exposure to the three main risks; Construction, Power Price and Operational. Nowhere in the world have nuclear power stations been built on this basis.
- **Nor will they be built in the UK** — We see little if any prospect that new nuclear stations will be built in the UK by the private sector unless developers can lay off substantial elements of the three major risks. Financing guarantees, minimum power prices, and / or government-backed power off-take agreements may all be needed if stations are to be built.

Peter Atherton
+44-20-7986-3912
peter.atherton@citi.com

Andrew M Simms
+44-20-7986-4371
andrew.simms@citi.com

Sofia Savvantidou
+44-20-7986-3932
sofia.savvantidou@citi.com

Stephen B Hunt
+44-20-7986-6974
stephen.hunt@citi.com

See Appendix A-1 for Analyst Certification and important disclosures.

New Nuclear Development – Corporate Risks

The UK government today launched a fast-track planning process for a new generation of nuclear power plants in the UK. The government has selected 10 sites that will be taken forward by the new Infrastructure Planning Commission for approval. Planning inquiries will still be required but will deal with local issues only.

The UK government has presented this today as effectively "green lighting" the build of new nuclear stations. However, this is in fact far from the case.

The Five Risks

There are five substantial areas of risk faced by developers of new nuclear power stations. Three of those risk areas are so big and significant that if they go wrong, the developer (even the biggest utilities) could be financially damaged beyond repair. These risks can be classed as Corporate Killers. The government today announced measures to limit Planning risk, which while important in encouraging developers to bring forward projects, is actually the least significant risk financially. The government is still asking the utility companies to take on the three major risks — Construction, Power Price, and Operational. Indeed, at no time, anywhere in the world, has a utility built a new nuclear power station and taken the full Construction, Power Price, and Operational Risk.

The five risk areas are:

Planning is the least risky element from a financial perspective

1. **Planning**: Nuclear power remains controversial and opposition to new developments often results in extended planning procedures. In a lot of countries, planning can take five years or more. The UK government's action today is designed to limit this time frame, reducing the risk faced by developers. However, while an expiated planning process is essential in encouraging developers to bring forward projects, it is in fact the least risky element in the development process from a financial perspective. Developers will have spent some money acquiring a site (which could probably be used to build a conventional power station if planning consent for a new nuclear plant is refused) and will commit time and a few £10m's to the planning process. While annoying for the developers if this turns out to be wasted time and money, in no way would a failed planning application threaten the financial integrity of a utility company.

We see very little prospect of construction costs falling and every likelihood of them rising further.

2. **Construction:** Below we give the latest data on the current and future costs of building a new nuclear power station. The latest evidence suggests a cost range of €2,500/kW to €3,500/Kw. For a 1,600MW unit, that means a construction cost of up to €5.6bn. We see very little prospect of these costs falling and every likelihood of them rising further. The cost of the TVO plant in Finland has increased from €3.0bn to €5.3bn since construction started. It has also proven to be very difficult to predict how long a new plant will take to build. The TVO plant is also running three years late. Cost overruns and time slippages of even a fraction seen by TVO would be more than enough to destroy the equity value (and more) of a developer's investment unless these costs can be passed through somehow. Given the scale of these costs, a construction programme that goes badly wrong could seriously damage the finances of even the largest utility companies.

We calculate that a new nuclear station will require €65/MWh (£58.5/MWh) in real terms year in year out to hit its breakeven hurdle rate.

3. **Power Price**: Nuclear power stations have very high fixed costs and relatively low variable costs. Their cash flows and profitability are therefore particularly sensitive to the price that they sell their power. As we show later, even at the low end of the build cost estimates, we calculate that a new nuclear station will require €65/MWh (£58.5/MWh) in real terms year in/year out to hit its breakeven hurdle rate. As we show in Figure 5, the UK has only seen prices at that level on a sustained basis for 20 months of the last 115 months. It was a sudden drop in power prices that drove British Energy to the brink of bankruptcy in 2003. No nuclear power station has ever been built to our knowledge where the developer takes the power price risk.

4. **Operational**: Because of their high fixed cost base, nuclear stations are also very vulnerable to shortfalls in output due to operational unreliability. A six-month breakdown can cost £100m's in direct costs and lost output, particularly if the output has been pre-sold. This risk is too great for a single project to bear, in our view, and at the very least needs to be spread across a portfolio of assets.

5. **Decommissioning / Waste**: Nuclear plant operators set aside money in order to pay for decommissioning and the disposal of waste. Estimates of these costs can jump around by many £bn's depending on what discount rates are used, etc. The UK government is proposing adopting the "pay as you go" approach used successfully in the USA amongst other countries. Basically a tax will be paid on each MWh produced (probably as little as £1/MWh). This would effectively limit the risk faced by the developers.

The returns for new nuclear development will need to be underpinned by the government and the risks shared with the taxpayer / consumer.

In our view, it is extremely unlikely that private sector developers will be willing or able to take on the Construction, Power Price, and Operational risks of new nuclear stations. The returns would need to be underpinned by the government and the risks shared with the taxpayer / consumer. Minimum power prices (perhaps through capacity payments), support for financing, and government-backed off-take agreements may all be needed to make new nuclear viable.

Update on Cost Estimates

Construction costs are very difficult to quantify, but are a key factor in new nuclear affordability economics. Third-generation plants are meant to provide better performance with lower initial capital costs. However, as we noted in our previous note on European Nuclear Generation (see https://www.citigroupgeo.com/pdf/SEU20085.pdf), we believe that construction delays and cost overruns could sharply increase the quoted capital costs for new nuclear and lead to value destruction and lower returns to equity investors.

Evidence to date suggests time delays in new nuclear construction can be significant

Both Westinghouse and Areva claim to be able to construct a new third-generation plant (AP-1000 and EPR, respectively) in 3 years from first pouring of concrete. However, evidence to date suggests this is not necessarily the case, as Olkiluoto and Flamanville projects have both suffered delays, while the first AP-1000 unit under construction, in SanMen China, is running significantly over its $1,000/KW construction cost target and is expected to be over $3,500/KW target on current estimates.

Georgia Power stated in mid 2008 that two 1100MW reactors would cost up to $14 billion, depending on financing terms. This gives significantly high cost assumptions of $6,360 per kilowatt.

In November 2008, Tennessee Valley Authority updated its estimates for Bellefonte units 3 & 4 relating to two AP1000 reactors of 2234MW combined. It said that overnight capital cost estimates ranged from $2,516 to $4,649/kW for a combined construction cost of $5.6 to $10.4 billion.

Towards the end of 2008, at its investor day, EdF increased its cost assumptions for the Flamanville 3 EPR, raising them to €4 billion/$5.6 billion or €2,434/kW or $3,400/kW in real money terms. These costs were confirmed in mid 2009, when EdF had already spent nearly €2billion.

Another estimate from Nuclear Innovation North America, in June 2009, said that the cost of two 1350 MW GE ABWR units at the South Texas Project near Houston would be about $10 billion, including financing costs. This would be a merchant plant, not a regulated one, operating on cost plus basis with the first unit expected on line in 2016. This equates to $3,700/KW.

Construction delays and planning problems have led to a 77% increase in construction costs at the Olkiluoto site.

The Finnish EPR at Olkiluoto has been plagued by many delays during construction and is currently 3 years behind schedule, having originally targeted commissioning in 2009. The original cost estimate for Olkiluoto was €3bn. However, due to delays, planning problems (construction started in 2005), and issues with materials, Areva's latest estimate (August 2009) is that costs have risen by €2.3bn and could increase further depending on the outcome of negotiations between the owner, TVO, and Areva on the timeline for completion. Therefore at a running total of €5.3bn, costs stand at €3,300/kw ($4,785/KW) and although this is the first EPR project, and teething troubles ought to be expected, it is still indicative of the risks that we think equity investors should be concerned about.

Also, in May 2009, MIT published an update of its 2003 study into construction costs of large-scale engineering projects. The report stated that "since 2003 construction costs for all types of large-scale engineered projects have escalated dramatically." In addition, according to the report, the estimated cost of constructing a nuclear power plant has increased at a rate of 15% per year heading into the current economic downturn. This is based both on the cost of actual builds in Japan and Korea and on the projected cost of new plants planned for in the United States. The overnight capital cost was given as $4,000/kW, in 2007 money.

In a purely merchant market (such as the UK) where wholesale power prices need to cover construction costs over the life of the project, there is no active way for a developer to recover cost overruns.

This vast range of figures for new nuclear construction costs suggests that there is a high degree of uncertainty and therefore risk in this part of the project. In a regulated framework this is less of an issue for economic viability (but still a political and social issue) as construction costs can be recovered through higher regulated tariffs. However, in a purely merchant market (such as the UK) where wholesale power prices need to cover construction costs over the life of the project, there is no active way for a developer to recover cost overruns. It is this scenario that we believe threatens value and returns to equity investors.

As we have stated previously, there is a possibility that governments intervene in the wholesale markets to ensure power prices remain sufficient to reward new investment, but at this stage it is unclear whether this would be the case and how such intervention would work.

The Energy Bill recently passed by the US Congress recognises such risks and provides production credits of 1.8 cents per KWh for the first 3 years of operation, equivalent to the subsidy provided to the wind generation segment.

Debt & Equity Financing Environment Improving

The recent stabilisation in economic data and recovery in the equity and debt markets has had a positive effect on the financing environment, as CDS have contracted and appetite for corporate debt has increased, bringing yields down.

Figure 1 shows the IBOXX Utilities Bond price index since 2004. Although still some way below the peak in late 2005, the recovery over the past year shows that credit costs for utilities should have eased, although we would point out that the high capital risks associated with new nuclear construction may lead to higher cost of debt than other conventional power plant projects.

Figure 1. IBOXX Utilities Bond Price Index

Source: DataStream

The risks are significantly higher for equity rather than debt investors, with leverage likely in these projects at least 50:50%.

Due to the uncertainties on timing and cost, we believe nuclear projects should have a higher ERP than the overall market.

Figure 2 shows the trend in overall market equity risk premium (ERP) over the past 5 years. Although off its highs, the ERP is still high compared to 2006-7 and contributes significantly to higher WACC in new projects. Due to the uncertainties on timing and cost, we believe nuclear projects should have a higher ERP than the overall market.

Figure 2. Equity Risk Premium 2004-2009 (%)

Source: Citi Investment Research and Analysis

On the back of our observations on the trading levels of the debt and equity markets and our assessment of the risks involved, we believe a 4.5% post-tax cost of debt and a 12.5% cost of equity on a 50:50% gearing are appropriate, which provide an 8.5% post-tax WACC for the project.

Moody's has issued a statement saying that it is considering taking a more cautious view toward issuers that are actively pursuing new nuclear generation.

Moody's has recently issued a statement saying that it is considering taking a more cautious view toward issuers that are actively pursuing new nuclear generation, as history gives reason to be concerned about possible balance sheet challenges and the substantial execution risk. "In order to defend existing ratings, or to limit negative rating actions, we will look for investor-owned utilities to create strategic partnerships, to share costs and risks, and to increase reliance on equity as a component to financing plans. We would also expect them to moderate their dividend policies to retain cash flows".

Inherent risk in new nuclear development causes credit investors to seek increased funding from the equity side

We believe new nuclear is a classic example of divergent interests between credit and equity investors that also create a vicious circle. The inherent risk causes credit investors to seek increased funding from the equity side. However, with cost of capital the major determinant of break-even prices, an increased equity injection increases the power price required, therefore increasing the risk of failure, hence increasing the credit market's aversion for such projects. We expect utilities to try to seek support and assurances from involved governments, however we continue to argue that the risk/reward without such explicit support is skewed against equity investors.

Load Factors Not To Be Taken For Granted

A key aspect of the economics of new nuclear plants is the assumed and achieved load factors that a plant is expected to reach. EDF is targeting an availability factor of 85% for its existing operational nuclear plants.

In Figure 3, we show EDF's reported operational factors and our estimates to 2012E. We note that EDF in the past 5 years has consistently reported load factors below 80%.

Figure 3. EDF – Load Factors and Availability Factors, Reported (2004-8) and Estimated (2009E-2012E)

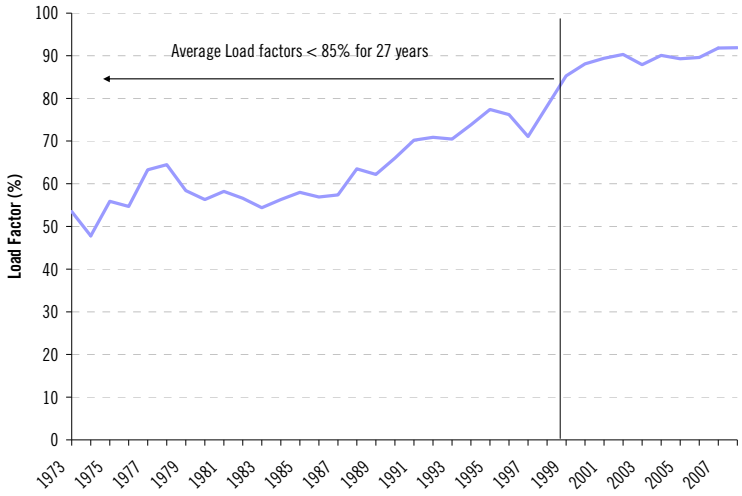
	2004	2005	2006	2007	2008	2009E	2010E	2011E	2012E
Load factor (%)	77.2%	77.6%	77.4%	75.6%	75.5%	74.6%	78.0%	80.8%	81.6%
Availability (%)	82.8%	83.2%	83.6%	80.2%	79.2%	78.5%	83.0%	85.0%	85.0%

Source: Company Reports and CIRA Estimates

US utilities recognised that the plants were not economically viable without increasing the load factors and therefore undertook programs to boost utilisation

In the US in the 1970s and 1980s, when previous generations of nuclear plants were built, load factors were consistently below 70%. This perhaps reflects the inexperience of dealing with new nuclear reactor technology at that time, a factor that could well impact new third-generation plants in future years. Figure 4 shows the load factors of the US reactors between 1973 and 2008 and the increasing trend towards 90%. The main reason for this is that the US utilities recognised that the plants were not economically viable without increasing the load factors and therefore undertook programs to boost utilisation. However, a plant built in 1990, with a useful life of 40 years, would have been operating at below 80% load factor for the first 8 years of its life, a scenario that threatens the economic viability of new nuclear plants.

Figure 4. US Load Factors (%) – 1973-2008



Source: EIA

With the recent experiences of the UK nuclear plants as well, we do not believe equity investors should take design specifications as 100%-proof, at least from year 1.

Bottlenecks in Construction a Rising Obstacle

India and China are both targeting huge increases in nuclear generation over the next couple of decades.

On 7th September, Japan Steel Works, the sole maker of certain atomic reactor parts, more than doubled its forecasts for China's nuclear plant construction. It now sees scope for China to have built 22 reactors by end 2010 and 132 reactors thereafter, compared to an original estimate from last year for a total of 60 reactors. We remind readers that the Chinese government has given approval for 25.4GW of new nuclear capacity, with 9.1GW currently on operation. Japan Steel Works is in the process of expanding its capacity from 5.5 units equivalent p.a. to 12 by March 2012 at a cost of ~$900m. This expected growth in China is very important for the ambitions of utilities on new nuclear in Europe. China's central planning of the projects, government support and rising GDP are likely to make this a priority market for constructors.

Later in September, the Indian Prime Minister, Manmohan Singh, predicted that India could produce 470 gigawatts of nuclear power, making India the largest nuclear energy producer in the world. India's 17 reactors currently produce 3.8 gigawatts of power and while the contribution of nuclear energy is expected to rise from just 3 percent to 6 percent of India's total needs over the next decade, it is expected to increase to between a third and a half of the country's energy needs by 2050, according to the new forecast announced by Singh. The ability to execute this will be highly dependent on the availability of nuclear developers, materials and experienced labour, and could create bottlenecks in construction, pushing back development timelines by several years, a factor that would severely hinder the prospect of a new nuclear project providing adequate returns to equity holders.

With significant bottlenecks, not least because of Japan Steel Works' paramount position in the parts chain, European plants could well fall behind. We continue to argue that unless we see strong government commitment on new nuclear projects in Europe, they are unlikely to come on line according to existing timetables.

Licensing

Neither the UK nor the US have yet approved any designs and although it will be a lengthy process anyway, amendments and additional configurations for each country's demands could be highly problematic.

The new nuclear program in the UK is likely to be delayed as the UK Nuclear Installations Inspectorate (NII) published a statement (April 2009) saying it has serious reservations about the safety of Areva's EPR reactor design. The NII has written to EDF and Areva highlighting concerns around the control and instrumentation systems in the design. The NII said the EPR technology was compromised due to interconnections between systems that should be independent.

Neither the UK nor the US have yet approved any designs and although it will be a lengthy process anyway, amendments and additional configurations for each country's demands could be highly problematic. This also remains an issue for other regions where each individual government may request additional design modifications to grant the licence, something that would greatly add to cost and remove one of the supposed construction efficiency advantages of having a standardised design across territories. Additionally, even with government intervention on power pricing, we would be surprised if governments allow a return to be made not only on the theoretical investment but also on the budget and time overruns, effectively burdening the consumer with the cost of any inefficiencies in the planning system or actual execution by the utilities

The NII called on the companies to submit an initial response by May 22, and then a full answer by the end of August 2009, although the HSE has not yet published a statement saying it has received the necessary responses. The recent HSE update report states that the target for completion of design assessment is 2Q 2011, in line with previous estimates. We do see scope, though, that due to licensing issues and regionally-customised design specifications, new nuclear power plants could take longer to be built than the timeframe planned and therefore cost more.

Grid and Back-up Capacity Costs

The UK has already provided some cost budgeting work, with National Grid estimating that should all existing nuclear power plants be replaced an extra £1.4b of spend would be required to reinforce the transmission network.

Taking the UK as an example of commitment to new nuclear generation, we look at the ability of the grid system to cope with such increases in generation from single sources. With the potential for 4-8 new plants to be built in the UK over the next 20 years, the current maximum grid connection of 1320MW and in the absence of simultaneous switch off of existing nuclear facilities, significant grid upgrades may be required to avoid overload in the event of the Areva EPR becoming the chosen standard for new nuclear build in the UK. The only reactor in the UK currently in operation with a power rating over 1000MW is Sizewell B with a power rating of c. 1250MW. The Areva EPR and other advanced PWRs have power ratings in the region of 1000-1700MW. Similar issues would be faced in other countries and anecdotal evidence has suggested that the preference of the smaller reactors over the EPR in China related partly to the reduced impact on the network.

The UK has already provided some cost budgeting work, with National Grid estimating that, should all existing nuclear power plants be replaced, an extra £1.4bn of spend would be required to reinforce the transmission network. Additional spinning reserve costs would have to be considered ,with PB Power quoted as saying that for every new EPR build in the UK, an additional 260MW of spinning reserve would be required at £1.3-2.1/MWh.

This also raises issues in the areas of planning for new substations, overhead power lines, site connection and gaining public approval for this infrastructure. In some cases, public opposition is significantly higher in regards to high-voltage power lines than for the nuclear plants that generate the electricity.

Dale Klein, chairman of the US NRC, has stated previously that necessary grid extensions and upgrades could lead to further delays of nuclear projects and indicated that he was surprised to learn that "it may take as long to site, permit, and build a transmission line for a new plant as to site, license, and build the plant itself."

Land Costs

The auction for three UK sites for possible development for new nuclear is reported to have netted the UK government £387m. The RWE / E.ON consortium acquired two sites, Wlyfa in North Wales and Oldbury in South West England. Edf acquired the third site, Bradwell in England. No breakdown of the prices paid for the three sites has been released yet, so is it unclear whether or not the payments will be made immediately or at least partly deferred to when construction begins. The RWE / E.ON consortium confirmed that is intends to build up to 6,000MW of new nuclear in the UK.

What it all means for shareholders

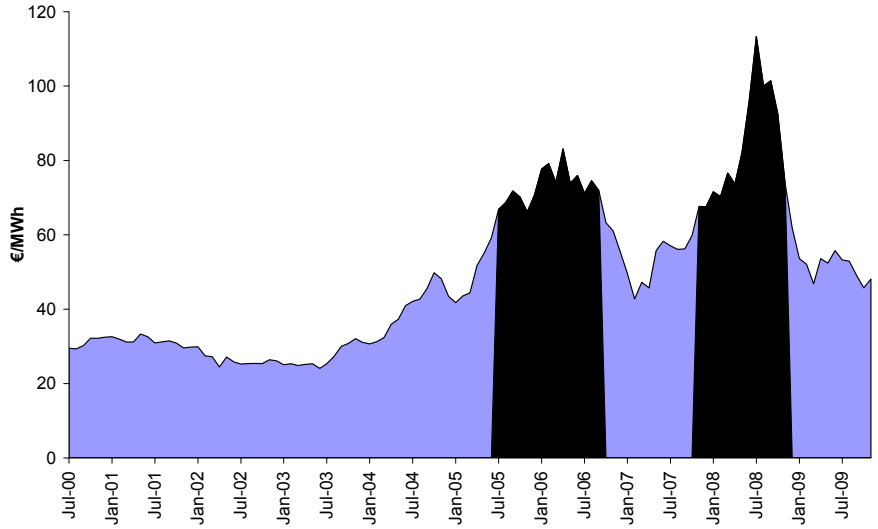
Scenario 1: Plant built on time and on budget

On the assumption that the total cost, inclusive of construction, financing, development and land purchase, of a 1600MW nuclear plant will be at €5bn, i.e. €3,125/KW, and that within 5 years the nuclear plants reach their maximum availability potential, we estimate that power prices need to be at €65/MWh for investors to earn a reasonable positive return (100bps over cost of capital).

Scenario 2: Plant built with delays

On the assumption of a 20% cost overrun (i.e. €3,580/KW) and 2-year time delay in construction and achievement of peak load factors, we estimate that power prices need to be at €70/MWh for investors to earn a similarly competitive positive return.

Figure 5. Periods (in dark black) in history during which new nuclear plants would generate competitive returns to equity investors in the UK



Source: Platts, CIRA Estimates

Government support still necessary

It is clear from the graph above that were power plants of today's specifications operating during the past decade, they would have only generated a competitive return to equity investors for a period of only 20 months in the last 115.

In recent months, several industry players, including Vincent de Rivaz (EDF Energy CEO), have commented on the need for the UK government to provide some formal support to the projects to build new nuclear power stations in the UK given the low power prices and weak economics of the projects at current price levels.

We believe that if governments want new nuclear to be part of their energy policy, they will need to provide some support as either these plants will not be built or once they are, won't be economically viable. Such steps could include a regulated CO2 price or a fixed-price off-take contract for the output of the plants or guarantees/subsidies on the financing side.

Appendix A-1

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