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INDUSTRY | COMMENT

JUNE 17, 2011

Japan and Nuclear: Can't Live With it, Can't Live Without it

Examining the likelihood and ramifications of Japan Abandoning Nuclear Power

Event

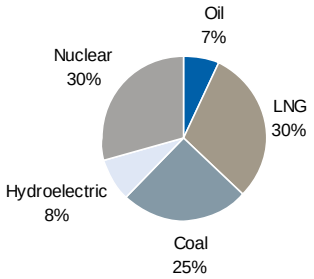
- Recent press reports say that Japan may be without any nuclear power come April 2012. The premise for this view is that local governments will not want nuclear generating stations restarted after routine maintenance. **While we think the potential for a complete nuclear shutdown is unlikely, such an event would undoubtedly have a significant impact on the uranium, thermal coal and LNG markets.**
- In 2009, nuclear power comprised 30% of Japan's electricity production, in line with natural gas (through LNG) and higher than coal at 25%. If Japan were to close its nuclear facilities, the first question that needs to be answered is: can Japan replace the lost generation with its existing fossil fuel fleet? We believe they can. **However, doing so would cost the country at least $30 to $38 billion more in fuel costs and would increase the country's CO_2 output substantially.**
- In Japan, reactors are required to be closed for inspection every 13 months and can only re-open once they have received approvals by Nuclear and Industrial Safety Agency (NISA) and with consultation with local governments. **We believe that the Japanese federal government will find it too costly and impractical to shut all of its nuclear plants and may be forced to re-open plants contrary to local government desires.**
- In this note, we highlight three industries that stand to be affected by any significant, long-term reduction of nuclear power generation. The **uranium market would most likely be the hardest hit** as it is already suffering from the nuclear disaster earlier this year. **Both thermal coal and LNG stand to benefit from increased demand from Japan**. Even if coal generation capacity utilization increased to 80%, gas plants would have to run at the limit of their effective capacity, implying an addition of around 10% of global LNG demand if nuclear plants were to be shut.
- Should Japan abandon nuclear, we would recommend investors look to **Cameco** for their uranium exposure given the company's extensive contract coverage. On the other hand, if Japan goes the other way, we would recommend **Uranium One** for upside leverage. For exposure to increased Coal and LNG consumption we recommend investors look to **Coal and Allied**, and **Royal Dutch Shell** and **Chevron**, respectively.

The news that Japan may have to shut all of its nuclear power facilities by April 2012 has raised more questions than the recent brief press coverage has answered.

The first question that has arisen is whether Japan has the generating capacity to make up for all reactors being taken offline. It would appear that the current installed base could make up for that loss, but it would require a very large increase in fossil fuel consumption.

2009 Actual Electricity Generation

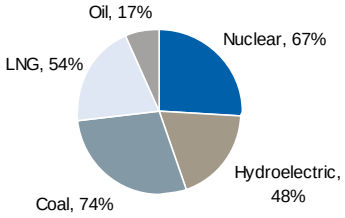
Exhibit 1. 2009 Japanese Power Output by Energy Source (proportional contribution)



Note: The FEPC is comprised of 10 power generating companies in Japan and accounts for ~90% of the country's power generation.

Source: The Federation of Electric Power Companies of Japan, RBC Capital Markets estimates

Exhibit 2. 2009 Japanese Power Output by Energy Source (Load Factor)



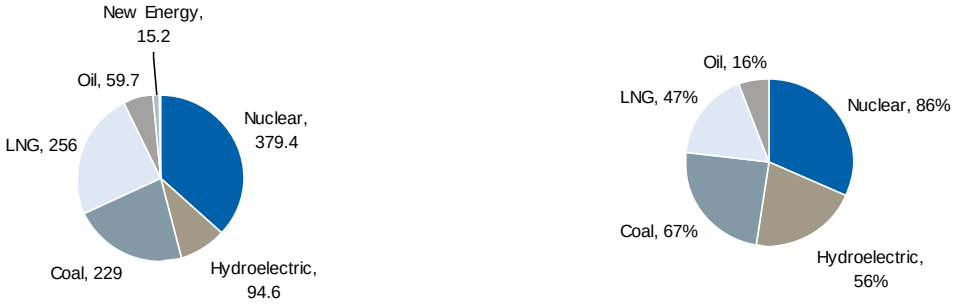
Source: The Federation of Electric Power Companies of Japan, RBC Capital Markets estimates

In 2009, nuclear accounted for approximately 30% of Japan's electricity generation; accomplished with a relatively low capacity utilization as a number of reactors were offline that year. Coal and LNG were the other biggest contributors.

Theoretical Generation by Installed Base

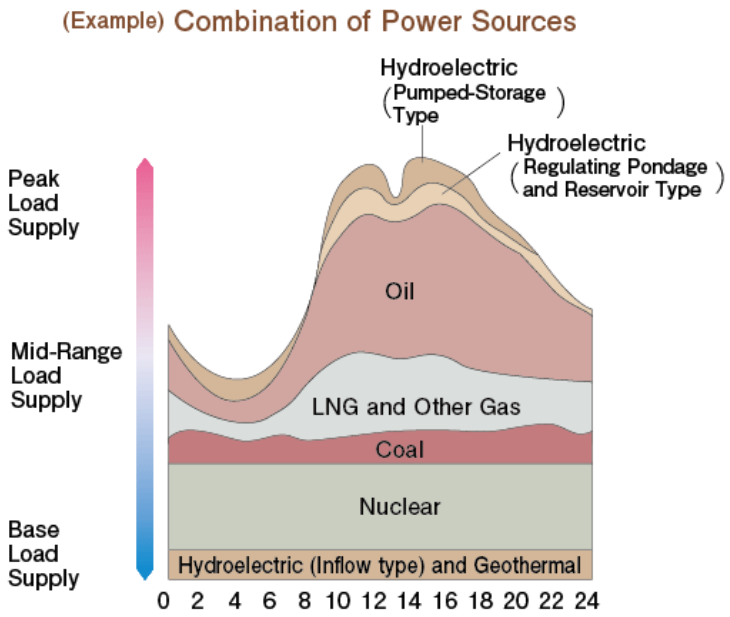
As described by the Federation of Electric Power Companies of Japan (FEPC), Japan has approximately 240GW of installed electricity generating capacity. We estimate that at reasonable capacity utilization levels, these could produce 1.42TWh of electricity. At the maximum output, nuclear's contribution would be reduced to 20% and the biggest increase would be from oil. Oil is currently used as a peak-load supply given its high fuel cost. We have assumed that hydroelectric is kept at the same capacity utilization as much of it is pumped storage.

Exhibit 3. 2014E Japanese Installed Base of Electricity Generation (Forecast, TWh Load Factor)



Source: The Federation of Electric Power Companies of Japan, RBC Capital Markets estimates

Exhibit 4. Japan's Electricity Supplies



Hydroelectric and nuclear power provides base load supply, while coal and LNG are major power sources for mid-range load supply. Oil-fired and pumped-storage hydroelectric power respond to peak demand fluctuation and contribute to consistent stable supply of electricity.

Source: The Federation of Electric Power Companies of Japan

Can Nuclear be Eliminated? Maybe.

If we assume that: coal and LNG plants can be run at 85% of their capacities; hydroelectric generation remains unchanged; and that oil generation is used as the swing production – Japan appears to have sufficient installed electricity generation to make up for the elimination of nuclear.

The assumptions above cannot be considered in a vacuum. We made the following assumptions in our calculations:

- the geographic location of the generating plants is aligned with Japan's electricity distribution network;
- the plants are able to attain higher utilization rates (some may need significant capital and time); and
- that Japan can secure sufficient sources of coal, oil and LNG.

Exhibit 5. Hypothetical Japanese Electricity Generation by Source with No Nuclear (Forecast, TWh Load Factor)

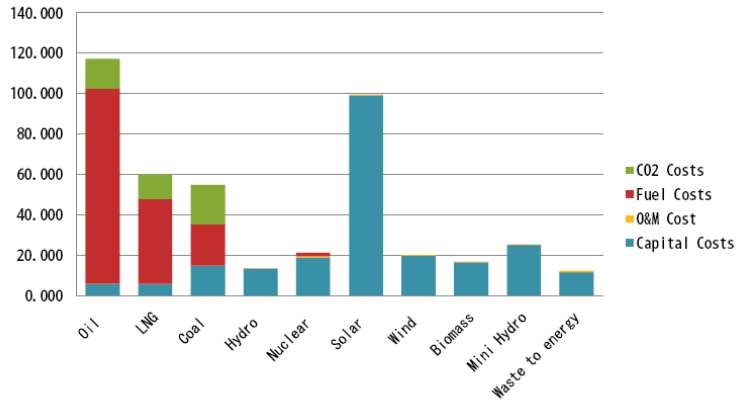
Source: The Federation if Electric Power Companies of Japan, RBC Capital Markets estimates

It's Possible - But VERY Costly

As noted in the recent press articles, the Japanese government estimates that it would cost between $30 and $38 billion annually in increased costs to cover the loss of all nuclear power plants. It is likely that these estimates were made using spot pricing and may be much higher in reality given the increased demand.

If Japan chooses to use LNG, oil and coal, clearly the incremental costs (excluding capital costs) would be very large. This is well illustrated in Exhibit 5.

Exhibit 6. Standard Break-Up of Generation Costs in Japan

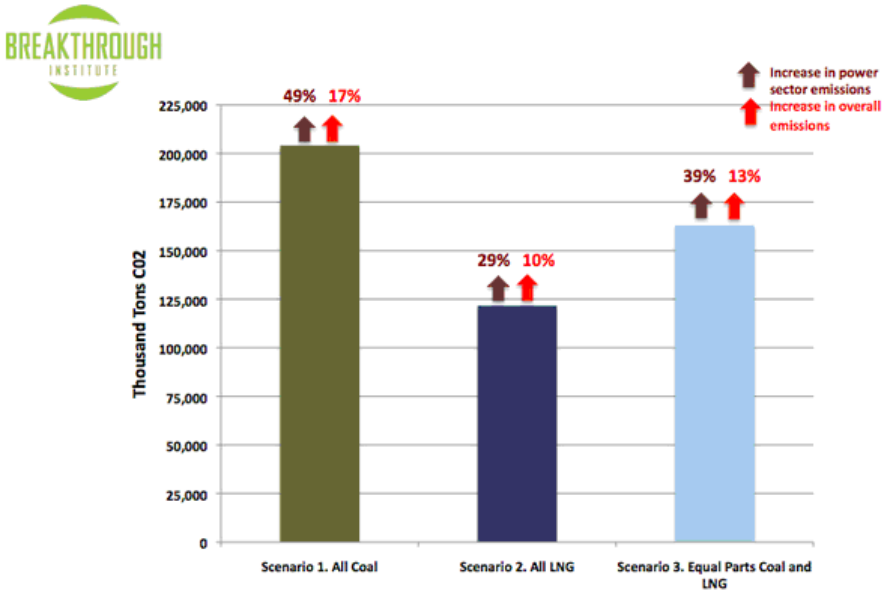


Note: The units were not described in the source document

Source: http://enviroscope.iges.or.jp/modules/envirolib/upload/3226/attach/unu-ias_seminar_series_2011.pdf

In addition to the financial cost of increasing fossil fuel usage, there is the environmental cost. According to the Breakthrough Institute, the increase in carbon emission would be quite substantial. With a mix of coal and LNG (as we outlined above), Breakthrough estimates carbon emissions would increase by 13% overall (39% for electricity generation).

Exhibit 7. Carbon Emission Increases Assuming Nuclear Replacement



Source: http://www.thebreakthrough.org/blog/2011/04/replacing_japans_nuclear_power.shtml

Keeping nuke plants running may be political suicide – then again… so is closing them

It is important to ask the question: for how long would nuclear plants be down if they are closed over the next year?

We think that the further closure of any nuclear reactors in Japan will only serve to make an already difficult situation worse. Even if fossil fuel facilities can make up for the loss of nuclear, it would likely take time, cost a great deal more money, pollute significantly and the design of Japan's grid may not be optimized for that change.

We think that when faced with the decision to close nuclear facilities, the Japanese federal government will be forced to ignore local opposition as the continued operation of the remaining nuclear facilities would be, in our view, in the best interest of the country as a whole. We think that there is the potential for some prolonged closures to carry out more thorough inspections or implement improved safety measures, but we think they will inevitably restart.

According to Japan's Ministry of Economy, Trade and Industry, there are no safety problems with restarting the nuclear reactors (except for Hamaoka) and that the federal government will need to bring local governments on side.

Impact on Thermal Coal Markets

A potential beneficiary from an elimination of nuclear capacity in Japan would be thermal coal. Based on our determined split of power generation in the absence of nuclear, coal fired power generation would lift approximately 20%. This would represent a 25 million tonne increase in demand for thermal coal, approximately 3% of the current global supply of 770 million tonnes.

There are, however, constraints to the potential growth in thermal power supply.

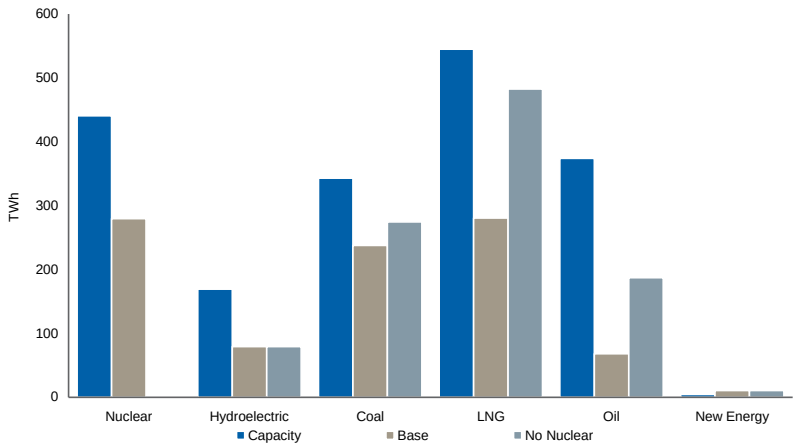
- **Lack of immediate spare capacity:** With the majority of Japan's coal fired power generation reported to have been running at close to capacity prior to the earthquake, we believe the potential for a ramp up of coal fired generation in the short term is limited. Additionally, new capacity may need to be built and that would require a minimum five year development timetable.
- **Damage to existing capacity:** There has also been substantial damage to existing thermal coal power plants. While reports suggest coal fired generators representing approximately 2.4GW of the impacted 10GW of coal fired power generation should be operational again in Q3 2011, there is at least 4GW of capacity unlikely to be operational until some point in 2012. Tohoku's 2GW Haramachi plant is expected to remain offline for up to another year, while Soma Joint Power's 2GW Shinchi operation will see 1GW of generation back on from early 2012, with the balance planned to be operational by mid-2012. In addition, Joban Joint Power's Nakoso 1.5GW plant has been severely impacted by damage to the Onahama port and will likely operate at reduced capacity until well into 2012. With planed fixes in place for damaged coal fired power generators, lack of supply from the existing thermal coal base is only a short term issue for now. But any sustained outage of existing thermal generation will need to be made up in addition to what would be needed to replace nuclear generation, further stretching the generation capabilities of the country.
- **Transmission complications:** The nature of Japan's grid is also problematic. The Tokyo/Tohuku/Hokkaido grid, serving the east coast regions most impacted by the earthquake, operates at 60HZ, while the rest of Japan operates at 50HZ. Even if thermal coal generation could be ramped up in other regions, the ability to transmit power into the areas where it is most needed is limited. This, however, is less of an issue for replacing nuclear generation outside of the earthquake impacted areas.

So while there are likely to be some benefits to thermal coal markets in the event Japan looks to abandon nuclear power, given restrictions on existing capacity, it is likely to be long dated. With greater spare capacity in oil and LNG power generation, we believe it is these sources that will be the focus for any replacement of nuclear power generation.

Impact on LNG Markets

Based on the analysis above, we believe that LNG would be essential to bridge the gap to allow Japan to eliminate nuclear through increased fossil fuels. Based on the relative input prices, we assume an increase in capacity utilizations for coal and oil to 80% and 50%, respectively, through to 2014, with LNG making up the "swing" capacity. This would imply a utilization rate rising from 54% in 2009 to 88.5% by 2014 for gas-fired power generation. We believe that this level of capacity would be at the limit of effective capacity for gas.

Exhibit 8. Capacity generation by power source, 2014 estimates



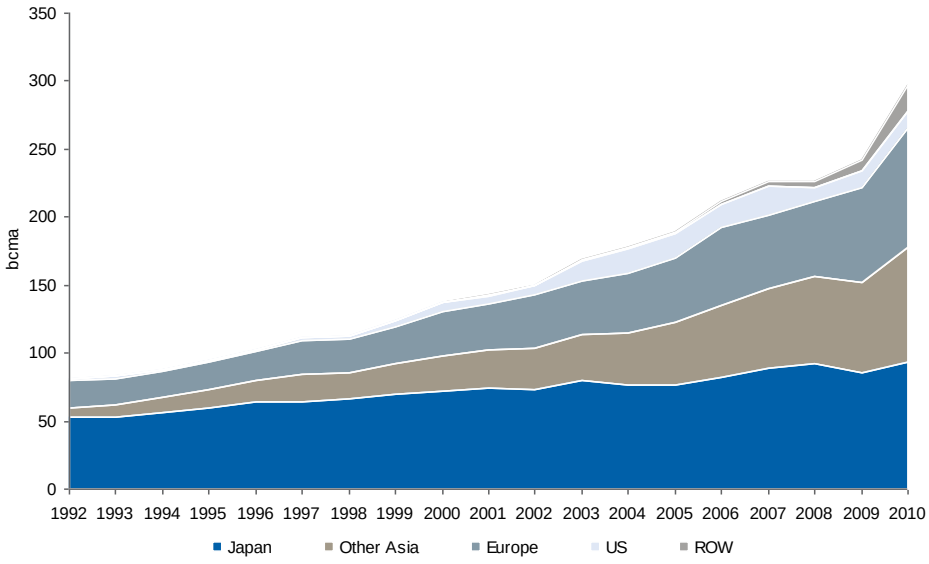
Source: Federation of Electric Power Companies of Japan, RBC Capital Market estimates

We estimate that this level of demand into power generation would translate to an incremental demand for LNG of between 17 and 26 million tonnes per annum (mtpa), based on 2009 data and 2014 forecasts. This equates to 23 to 36 billion cubic metres per annum (bcma) – compared to a market of approximately 93 bcma. Approximately 88 bcma and 81 bcma is believed to be available under contract for 2011 and 2012, respectively.

The forecast increase of 23 to 36 bcma equates to a 25% to 39% increase of Japanese demand and 8% to 12% higher globally. We believe this may be physically viable but would bring supply and demand closer to balance, and would rely on transforming trade from regional to global basis on a more permanent basis, with significant price pressure. We think that this leads to the conclusion that there would remain pressure on nuclear plants to remain open to mitigate severe additional costs for Japan and not just the switch to more expensive fuel at present prices, but the higher prices for LNG.

Industry consensus is that in practice the call on LNG will be mitigated by continued but lower reliance on nuclear capacity. BG has recently presented that the range of industry consultant views is for an incremental near term demand of 8-10mtpa (11-14bcma), around half the volume which would be required in our "no nuclear" scenario. For the longer term, to 2020, this consensus widens from 2-12mtpa (3-16bcma), suggesting a fuller return to nuclear generation.

Exhibit 9. Global LNG Volumes



Source: Company reports, RBC Capital Markets Estimates

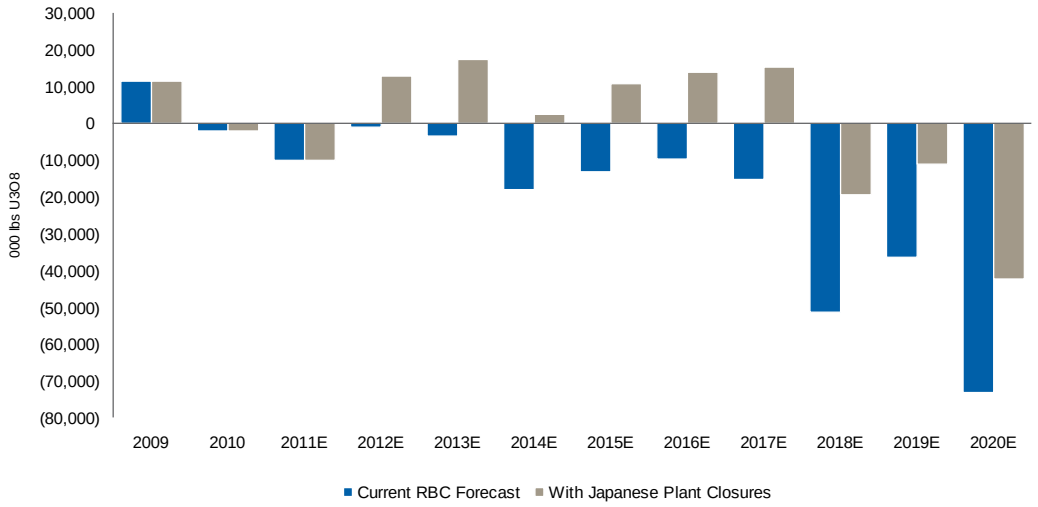
Impact on Uranium Supply – Demand

Should Japan decide to permanently abandon its nuclear facilities in 2012, the impact on the uranium market would be significant and negative.

We estimate that if the Japanese close all reactors after 2012, the uranium market's supply demand balance would immediately swing into surpluses until 2018. Additionally, we estimate that Japanese utilities own between 40 million and 85 million pounds of uranium as inventories – it is likely that this material would also find its way into the market.

While we think the chances of Japan abandoning its nuclear fleet are very low, if it does, we think the impact on the uranium market would be dramatic. Depending on how Japan would handle its inventories and how its unneeded fuel deliveries would be re-sold, we think the spot market would plummet to $40 per pound (or less). However, looking toward the end of the decade, the uranium market would still end up in a deficit - therefore, the depressed market would need to recover at some point between 2012 to 2014 to leave time for new mine development.

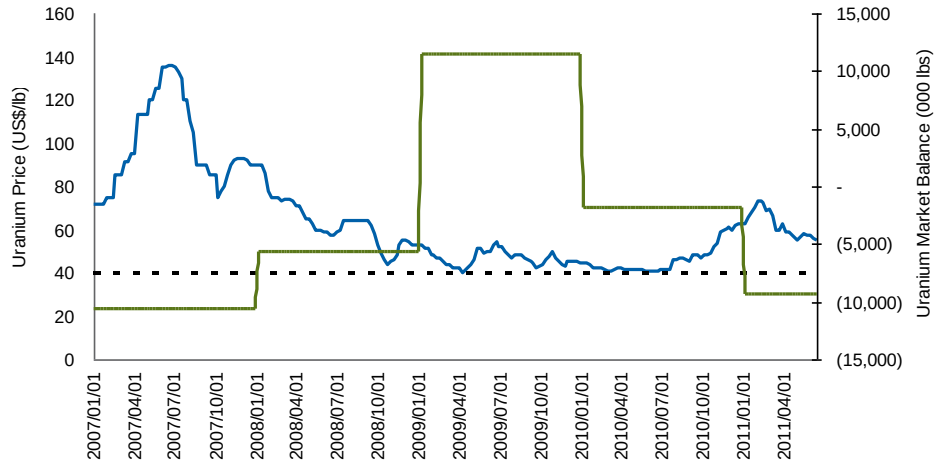
Exhibit 10. Uranium Supply Demand – Current RBC Forecast and No Japanese Nuclear Post-2012 Scenario



Source: Ux Consulting, RBC Capital Markets estimates

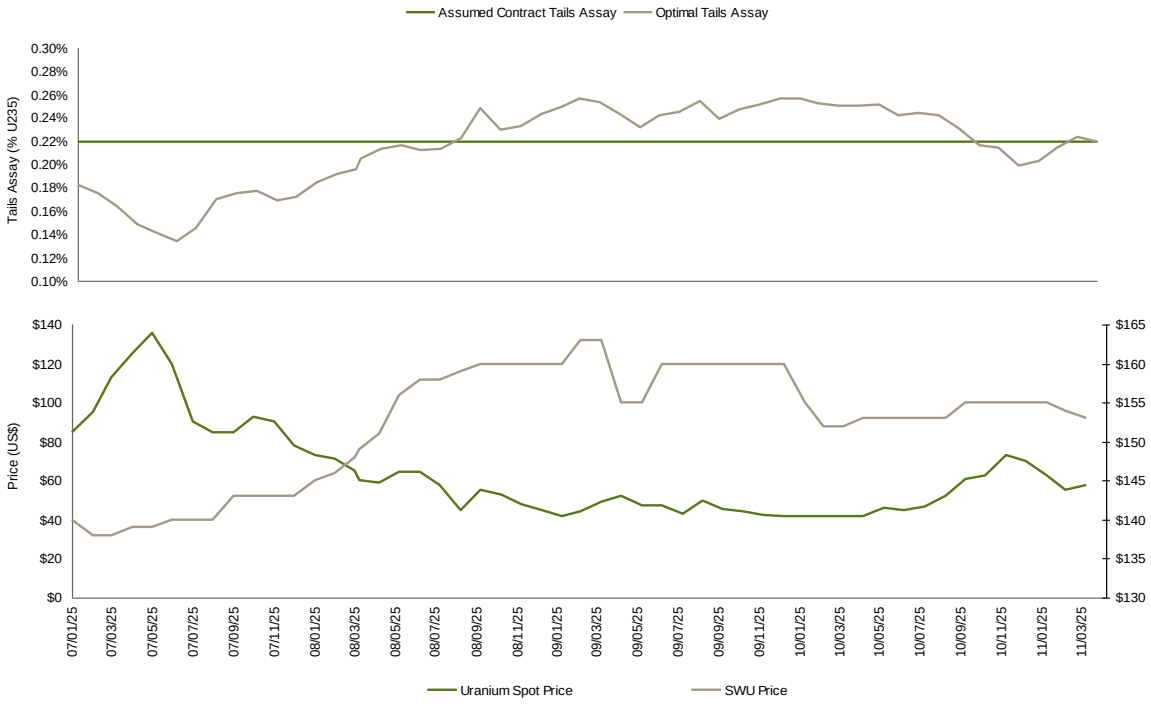
We think the floor price for uranium would be approximately $40 per pound. During 2009 and the first half of 2010, when the uranium market balance was in a significant surplus, the uranium spot price was range bound between $40 and $54 per pound. We believe the bottom of that range ($40 per pound) was supported by the upper end of the cost curve and the arbitrage opportunity that existed for enrichment companies between the SWU price (the measure of enrichment) and the uranium price. As illustrated in Exhibit 11, in theory, when the optimal tails assay is higher than the contracted tails assay assumption (0.22% U^{235} in this case), enrichment companies would purchase extra uranium and use less enrichment (if available) – this is known as overfeeding.

Exhibit 11. Uranium Price and Market Balance (January 2007 to June 2011)



Source: Ux Consulting, RBC Capital Markets estimates

Exhibit 12. Uranium Price, SWU Price, Optimal Tails Assay, Contract Tails Assay)



Source: Ux Consulting, RBC Capital Markets estimates

Equity Selections

Uranium: If investors believe there is a high probability that the Japanese make substantial or complete reductions to its nuclear generation, we recommend investors look to **Cameco** (TSX:CCO; C$23.91, Outperform, Above Average Risk) given its extensive contract portfolio and lower downside pricing risk. On the other hand, for investors who expect Japan to maintain its reactor fleet, we recommend investors look to **Uranium One** (TSX:UUU, C$2.87, Outperform, Above Average Risk) for its strong growth profile, low cash costs and high sensitivity to market pricing.

Thermal Coal: Our preferred thermal coal exposure is **Coal and Allied** (ASX:CNA, A$106.43, Sector Perform, Average Risk). Operating out of the Hunter Valley, NSW, Coal and Allied has a strong growth pipeline with attributable production set to steadily

ramp from 19Mt in 2010 to 35Mt from 2015. It has infrastructure access in place to match this growth profile. The assets are top tier, located in one of the world's premier coal mining districts – mines are large, long life and relatively low cost. Product is a high quality export thermal coal, with a semi-soft component of up to 25% of sales. The stock trades at the lower end of the valuation ranges for Australian listed coal stocks, and the company will continue to pay a 4% dividend yield.

LNG: For exposure the potential to higher LNG consumption in Japan, we recommend investors look to both **Royal Dutch Shell** (LSE:RDSB, 2,111.50GBp, Top Pick, Average Risk) and **Chevron** (NYSE:CVX, $99.43, Top Pick, Average Risk). These companies have large and growing positions in the Asian LNG markets.

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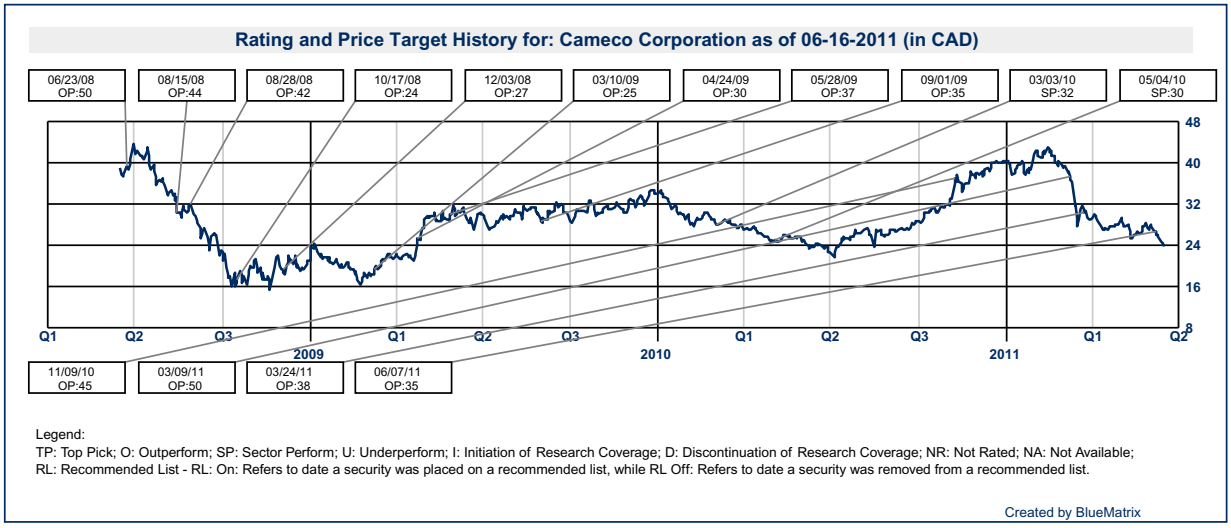

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Legend:
TP: Top Pick; O: Outperform; SP: Sector Perform; U: Underperform; I: Initiation of Research Coverage; D: Discontinuation of Research Coverage; NR: Not Rated; NA: Not Available;
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Rating and Price Target History for: Chevron Corporation as of 06-16-2011 (in USD)

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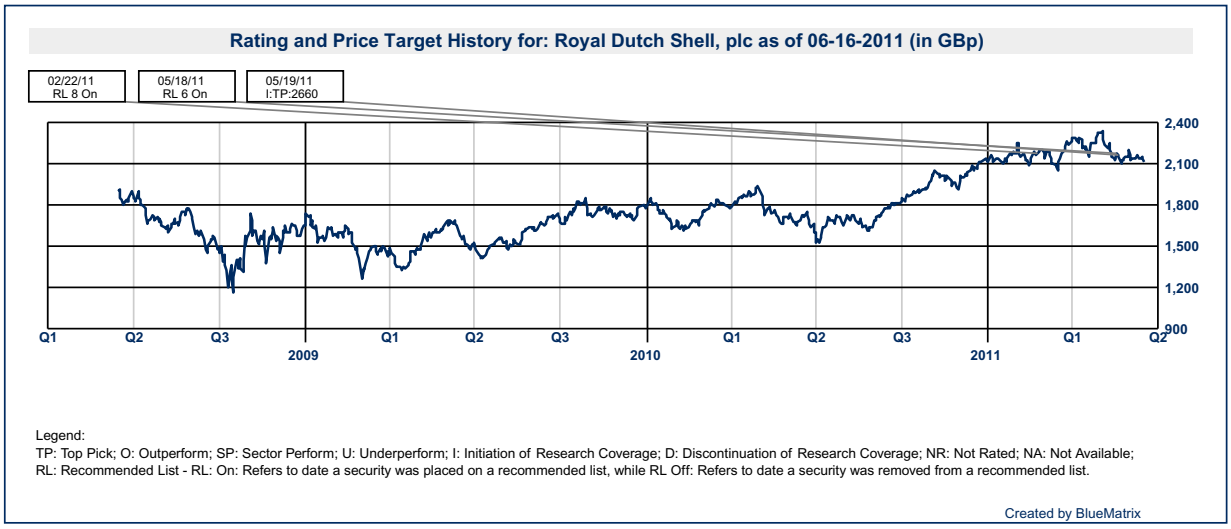

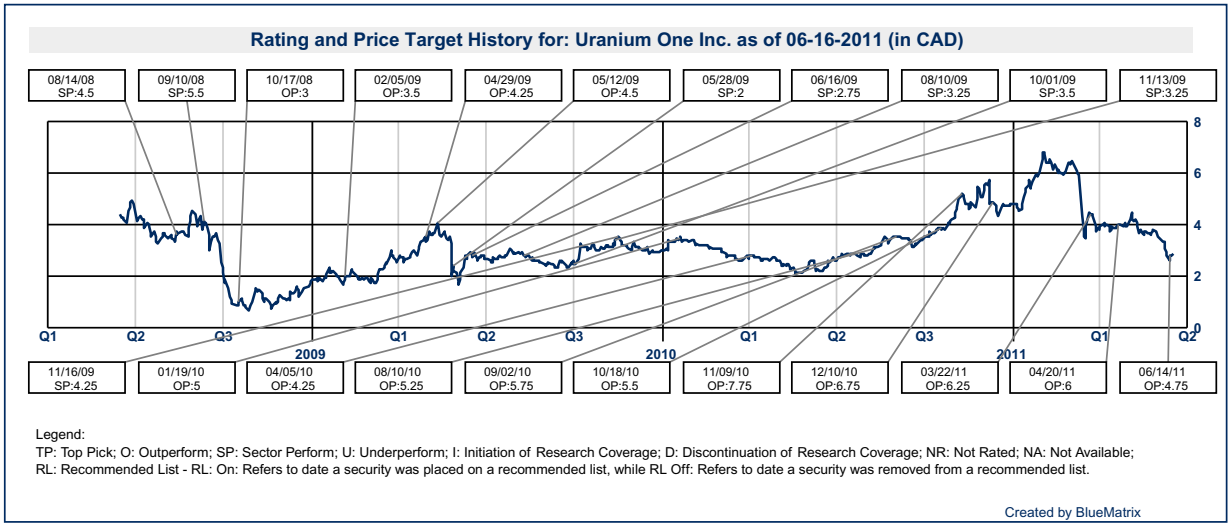

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