The obvious answer to a low carbon electricity system – More Nuclear Power

I started writing this while sitting on the very long plane ride on my way to China. The Rio+20 conference had just started, the largest ever UN conference and yet it was receiving relatively little press. I remember the first Rio conference 20 years ago when there was so much hope for the environment and the conference was seen as an important beginning in addressing climate change. Now 20 years later, expectations were low and interest even lower. I guess it's not surprising. With economic crisis ongoing in Europe, a weak recovery in the US and a slowdown in China, environmental issues have fallen way down on many people's list of priorities.

In advance of this conference, the IEA recently issued its Energy Technology Perspectives Study (ETP 2012), where they make a passionate case in support of the environment and the need to develop a low carbon energy system. Love it or hate it, this study is a gold mine of interesting and useful information in its almost 700 pages. This study takes the 450 ppm scenario in the World Energy Outlook 2011 and extends it out to 2050, now calling it the 2 degree scenario (2DS). This is then compared to the status quo (6 degree scenario) with a 4 degree scenario in between. It then goes a step further to see if a zero emissions energy system is possible by 2075. It is just not possible to discuss the entire study in one short (actually not so short) blog post, so I will focus on a few key issues and will likely continue to use it as a valuable source of data in future postings.

The study makes the case that environment and energy development must go hand in hand. Here are some of the

findings:

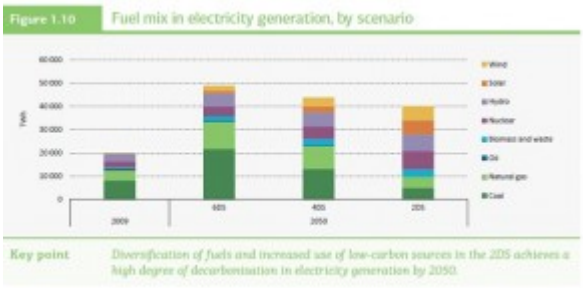
- **A sustainable energy system is still within reach and can bring broad benefits**
  - **Technologies can and must play an integral role in transforming the energy system.**
  - **Investing in clean energy makes economic sense – every additional dollar invested can generate three dollars in future fuel savings by 2050.**
  - **Energy security and climate change mitigation are allies.**
- **Despite technology's potential, progress in clean energy is too slow**
  - **Nine out of ten technologies that hold potential for energy and CO2 emissions savings are failing to meet the deployment objectives needed to achieve the necessary transition to a low-carbon future. Some of the technologies with the largest potential are showing the least progress.**
  - **The share of energy-related investment in public research, development and demonstration (RD&D) has fallen by two-thirds since the 1980s.**
  - **Fossil fuels remain dominant and demand continues to grow, locking in high-carbon infrastructure.**

It then goes on to focus on how energy policy must address the key issues and the role of government in making it all happen, finally concluding with recommendations to energy ministers (assuming these recommendations were to be considered at Rio+20).

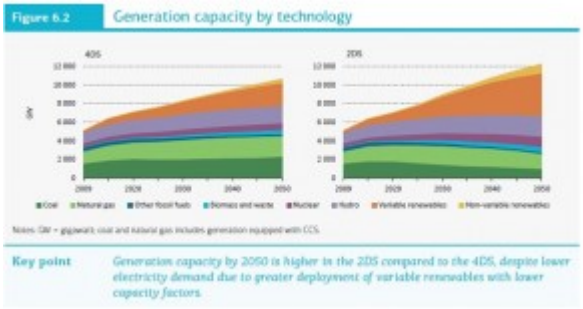
When considering "technologies" the focus is on renewable technologies such as wind and solar, energy efficiency technologies to reduce demand and carbon capture technologies to clean up the ever-expanding fossil infrastructure. Nuclear is also shown to be important although it role is somewhat less than the other technologies. It is these same technologies, primarily renewable and Carbon Capture and

Sequestration (CCS) they are talking about when they say “progress in clean energy is too slow”

Focusing on a few key issues, consider the following two figures. The first illustrates the change in electricity generation mix for each of the three scenarios. Improved energy efficiencies is the most important source of clean generation. The figure shows that in the 6DS there is almost 50,000 TWh of generation required dropping to about 40,000 TWh in the 2 DS. It can be seen that there is huge growth in renewable generation (wind, solar, hydro and biomass) and an increase in nuclear capacity. Most of the remaining fossil generation is assumed to have CCS installed.

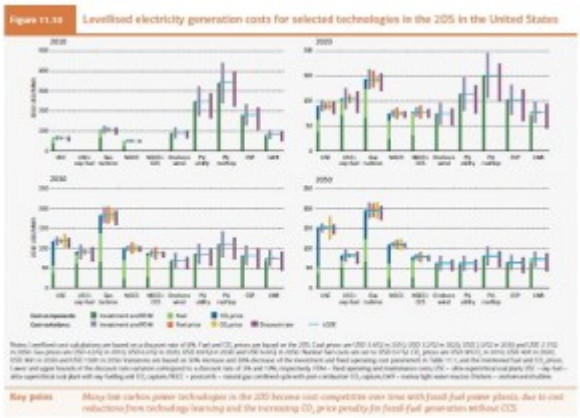


The next figure is somewhat more telling. It shows the needed capacity and illustrates that due to the variability and low capacity factors of renewables such as wind and solar, capacity must still increase even though total generation decreases by 20% (50,000 to 40,000 TWh Fig 1.10). This demonstrates the importance of nuclear as it has high efficiency relative to other forms of generation. With less than 5% of the generating capacity (about 550 GW), it produces close to 20% of the electricity! i.e. nuclear is an essential technology in a low carbon electricity system.



The main tool in achieving CO2 reduction targets for the 2DS is CO2 price, increasing from USD 40/tCO2 in 2020 to USD

150/tCO2 in 2050. This greatly increases the electricity generation costs of CO2-emitting technologies and thereby improves the relative cost-competitiveness of low-carbon power technologies. The following figure is a bit busy but important as it clearly shows how CO2 pricing is implemented to achieve this result.



The cost increase to effect change is one of the key points made in Jeff Rubin's new book "The end of Growth". In an excerpt published in the Globe and Mail on May 5, Jeff talks about the electricity and transport systems in Denmark. The Danes have achieved a heroic drop in carbon emissions of 13% over the past twenty years while those of us in North America have seen an increase in emissions of 30% in the same time period. Often praised for its commitment to renewable energy, now producing 20% of its electricity from wind power, what often goes unsaid is that the remaining 80% of its electricity is generated by coal.

So how is Denmark achieving this great carbon reduction? Simple – price. At $0.30/KWh, the price of electricity in Denmark is 2 to 3 times higher than in most jurisdictions in North America. And at this relatively high price has a significant impact on behaviour and usage drops dramatically.

This is absolutely consistent with the IEA report as it suggests the only way to achieve a low carbon world is to price carbon aggressively to force behavioural change; first by reducing demand and second through the implementation of

higher cost low carbon technologies.

Now while this may work in Denmark and in other countries where there is no choice but to implement higher prices to manage the transition such as in Japan and Germany (due to their need to replace idled nuclear), any politician who takes the position of significant increases in energy costs in North America will not keep his or her job for very long. In North America the population believes that cheap and abundant energy is a right and anyone who tries to say we need to do otherwise won't make it very far at voting time.

So what are we to do? I do believe that the IEA's ETP report has this answer as well. And for us in the nuclear industry it has always been quite clear. More nuclear power.

I have talked about the IEA's nuclear roadmap before. In effect, they prepared a number of "roadmap" reports for various technologies and this ETP report is where they bring them all together in a cohesive model of a clean energy system for the future. When it comes to nuclear the IEA continues to be positive and sees an increase in nuclear generation from about 14% of electricity supply to almost 20% in 2050. While the increase in nuclear capacity may appear to be modest, as stated earlier this modest capacity provides a significant portion of the needed electricity generation!

It should be noted that this target represents a decrease from their original target of 24% in their nuclear roadmap due to the impact of the Fukushima accident on public acceptance which has become the limiting issue. This is based on a 2011 post Fukushima survey in which support for nuclear power drops due to an increased concern about nuclear safety with more people now supporting nuclear shutdown due to its inherent dangers.

Of importance, the study continues to include a "high nuclear" sensitivity case for the 2DS scenario. In the 2DS-hiNuc case,

nuclear generation is increased to 34% in 2050. Compared with the base 2DS, nuclear replaces fossil power plants with CCS and renewables, whose share in 2050 falls: in the case of CCS from 15% to 7%, and in the case of renewables from 57% to 49%. This scenario reflects a world with greater public acceptance of nuclear power. On the technical side, the average construction rate for nuclear power plants in the period 2011 to 2050 rises from 27 GW/yr in the base 2DS to 50 GW/yr. The cumulative investment costs of this case are only USD 0.2 trillion higher than in the base 2DS and are more than offset by costs savings for fossil fuels in the order of USD 2 trillion (10 to 1).

Going back to the cost figure above, this is not surprising because nuclear is competitive with other forms of generation and can be built now without the need for high carbon costs to incentivise it. (I know in North America current low gas prices are challenging new nuclear and this was my topic last time – but keep in mind this study is looking at the bigger picture over a longer timeframe).

A system with about one third of the generation provided by nuclear seems very sensible and achievable so long as the industry can overcome the major issue of public acceptance. Therefore the challenge is clear. The industry should focus on the high nuclear scenario as our base case and work hard to regain public trust – no small task that will certainly require a long term sustained effort.

In the end, our world will become more electrified and we need to move forward with a cleaner, sustainable electricity system for our future. So what is harder for the public to accept – very high carbon costs and a very large increase in variable renewable generation or a bigger role from a relatively modest increase in the number of nuclear power plants??

Nuclear Power – The Dream lives on!

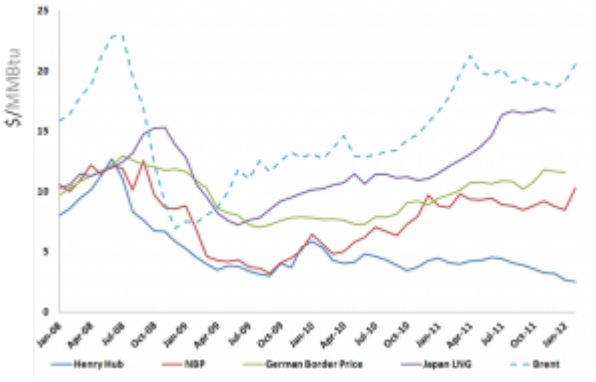
It seems as if a day doesn't go by when we don't hear about the low price of gas in North America and its impact on potential growth in the nuclear industry. In the past month, the price of gas actually dropped below $2 /million BTU; a price that was unimaginable just a few years ago. Back in September I wrote about this when John Rowe, then Chairman of Exelon, America's largest nuclear operator, said ""**Nuclear is a business, not a religion**". Mr. Rowe has been even more vocal about the impact of low gas prices on nuclear since his retirement.

Now it is clear that at $2 / million BTU, new build nuclear is not competitive. Not a big surprise. However it does need to be put in context and the time has come to make a few key points about the economic competitiveness of nuclear power on a global scale, not just in North America. This is especially important following the article in the Economist on the first anniversary of the Fukushima accident. With a cover that read "**Nuclear Energy – The Dream that Failed**", the Economist provided an analysis that was strong on data, but weak on insight resulting in understandable but still (in my view) wrong conclusions.

First let's talk about gas prices. Yes, gas prices are at a historical low in North America. But this is the exception, not the rule globally. In most markets as can be seen in the figure below, gas prices follow oil prices with Europe (UK's National Balance Point – NBP and German Border Price) and Asia experiencing gas prices 3 to 5 times those in North America (Henry Hub). It is easy to see the issue Japan is facing

where LNG and Oil (Brent) are high so that nuclear power remains very competitive and as such is a needed source of supply to prevent electrical utilities from going bankrupt.

Fuel Prices ($/million BTU)



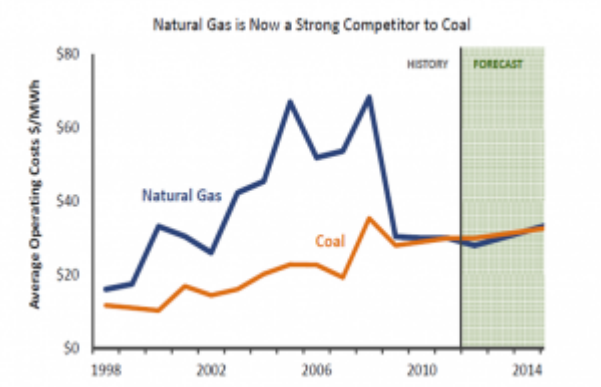
Source: Didier Houssin “International Energy Outlook” presented at the World Nuclear Fuel Conference, Helsinki April 2012

Second, the Energy Information Administration (EIA) in their 2012 Annual Energy Outlook Early Release continue to project gas prices below $5 million BTU for America until 2024 and thereafter rising to about $6.52 million BTU by 2035. While this is below the $7.78 million BTU used by the International Energy Agency (IEA) in its “Project Cost of Electricity Generation 2010” that shows nuclear being competitive in the US, prices in the mid to high $6 range are sufficient for nuclear to be competitive. (Note: nuclear was about 15% less costly than gas in the IEA report). And since most new plants will come in to service in the post 2023 time period, there is every likelihood that nuclear can be competitive in the US with gas in this crucial time period.

And finally, while the resource estimate for gas in the US continues to increase, there is rarely a discussion of price. Yet resources are related to price. The higher the price the more resource is exploitable and the lower the price, the less resource will come out of the ground. With gas there is a bit of unique situation where the price has become decoupled from

oil in the US and so for conventional gas, drilling will continue coincident with high oil prices. However will we see much drilling for new shale gas at these low prices? One thing the oil and gas industry knows how to do is make money and they are quick to walk away from projects that do not make economic sense.

In the short term, low gas prices in the US will likely reduce green house gas emissions as gas is used to replace coal. At current prices, gas has become competitive with coal and emits about half the carbon when compared to coal. But in the medium to long term, nuclear remains the only very low (essentially zero) carbon option for reliable base-load generation.



Source: TVA President's Report to the Board February 2012

Going back to the article in the Economist let's put some context on their conclusions related to nuclear competitiveness.

Economist: In liberalised energy markets, building nuclear power plants is no longer a commercially feasible option: they are simply too expensive.

What we think: New build nuclear has never been built into liberalized energy markets. The reasons are somewhat complex and go beyond the discussion in this blog post. The issues are more related to the fact that open markets work best with projects that can be built quickly with low capital costs.

And most markets have been designed with gas in mind. Gas prices set the market price so the risk for gas plants is very low. On the other hand, even when their energy cost are very competitive, nuclear plants have relatively high capital costs and long project schedules requiring predictable electricity prices into the future. So this is nothing new although the UK will be the first to build such plants by modifying the market to try and accommodate the issues related to nuclear. On the other hand, nuclear plants, once in operation, operate very successfully in liberalized markets due to their very low production costs.

Economist: Existing reactors can be run very profitably; their capacity can be upgraded and their lives extended.

What we think: Very true

Economist: But forecast reductions in the capital costs of new reactors in America and Europe have failed to materialise and construction periods have lengthened.

What we think: While the first new units in America and Europe have had challenges resulting in not meeting budgets or schedules, we cannot forget that in Asia where there are many plants under construction, the benefits of standardization and series construction have been and continue to be proven. With a small number of plants being built in the western world, now is the time to ensure that lessons learned in Asia are transferred to the west so that the same benefits are achieved.

Economist: Nobody will now build one without some form of subsidy to finance it or a promise of a favourable deal for selling the electricity.

What we think: The context of this statement is incorrect. Modern liberalized electricity markets work well for gas and sometimes coal, but for nothing else. Large complex projects such as nuclear and large hydro are not amenable to the

current market structures. The Economist does not mention that all wind and solar are heavily subsidized by governments around the world as they are not in any way currently economically competitive. Yet somehow this is acceptable. On the other hand, in most jurisdictions, nuclear is indeed competitive, but needs stability of electricity price to enable the large up front capital investment. So the issue in most cases is not requiring subsidy per se, but rather stability. Yes, in the US the first movers are offered some support to help overcome first of kind issues related to not building in over 30 years. But in the medium to long term, this support is expected to fall away whereas renewable support is expected to remain required for the foreseeable future.

Economist: And at the same time as the cost of new nuclear plants has become prohibitive in much of the world

What we think: As discussed above exactly the opposite is true. In most parts of the world where nuclear is being built it is very competitive. Higher gas prices and lower nuclear costs result in very economic new build plants in China and elsewhere. The experience in Europe and the US is primarily due to building after a very long hiatus and now it is up to the industry to demonstrate that the price can come down in line with other markets.

Economist: Nuclear is getting more expensive whereas renewables are getting cheaper

What we think: Again, in China, Korea, India and other locations nuclear is indeed coming down in price with series new build of standardized designs. As I discussed in my previous posting, the cost in the west is increasing due to the lack of new projects resulting in a lack of confidence. Each bad experience causes estimates to go up while in the east each new project results in lower costs than the preceding project. This is why the Asians are now becoming

nuclear exporters.

Economist: Nuclear power will continue to be a creature of politics not economics, with any growth a function of political will or a side-effect of protecting electrical utilities from open competition. This will limit the overall size of the industry.

What we think: Nuclear power will always be a creature of politics. However for success, it must also be economic. In most jurisdictions there will be very little political will to move forward with new nuclear and all of its associated issues unless the project can be shown to be economically attractive. China is building in large quantities because they need large scale base-load electricity and nuclear is very competitive with the alternatives. The same goes for Korea and other markets.

In summary, nuclear is not a dream that failed, but rather is one of the most extraordinary discoveries of the 21st century that can still realize its potential for supplying global electricity for millennia. The Asians see the benefits and are moving forward with nuclear power to meet their ever growing energy needs. The question is will the western world wake up and learn from this eastern success.

For fully global success, new build nuclear must demonstrate that it is competitive in an economic sense. The current state of gas prices and other issues will continue to present challenges to nuclear power but these can all be overcome in the longer term as standardization and series construction continues to demonstrate that it is the most economic, reliable and safe method of electricity generation. **The nuclear dream lives on**.

Climate change or peak oil – does it really matter?

Has it been that long since my last blog entry? Been extremely busy this winter and of course, busy is good! But on the other hand, I have a set of topics piling up that I would like to write about.

Earlier, I blogged when I read Jeff Rubin's book "How the World is going to get a Whole lot Smaller". When I posted the blog, I had good feedback. I was told that if I read this book, then I should definitely read "The Long Emergency" by Jeff Kunstler. Having been written in 2005 it is getting a bit dated. This makes it even more interesting because as you read, reality can be compared to the author's predictions over the last 5 years.

I really did enjoy the book. The concepts are similar and predate Jeff Rubin. In summary, Jeff Kunstler is convinced that the age of peak oil is upon us and that the world is going to be a very different place sooner rather than later. A number of his predictions have come to pass including the housing crisis and the very deep economic recession that we are just coming out of. Unfortunately the book then goes on to predict doom and gloom- basically the complete collapse of society as we know it. While he may be right, and I hope not, the trouble with this is that it discourages readers from paying attention to the main message. And this message is an important one now being put forward by Jeff Rubin as well.

I do believe him when he says that we are at or near peak oil. I also believe that there is no magic bullet to replace oil and that those who postpone decisions to adapt on the

basis that “technology will save us” tend to be somewhat deluded – or in reality are just avoiding the issue. On the other hand, I don’t believe that the world will come to an end and I do believe that there is technology that will help us delay the large scale effects to give us even more time to adapt. But remember, adapting means changing behaviour.

For example, look at one industry. Publishing. How much carbon is used in the manufacture and distribution of books, magazines and newspapers? Look at the business model. Books are published in a big print runs. They are then transported to book shops where they are to be sold, generally on consignment. If not sold, the books are returned (more transport) to be destroyed. While I don’t have the numbers I can assume the carbon costs to be significant. So why am I talking about this? Well, along comes technology – an e-reader or now an Apple IPad and what happens? Millions of books, magazines and newspapers no longer have to be distributed in hard copy, but can now be distributed electronically thus reducing the carbon footprint of this one industry by a huge amount. Now I don’t want to get into the discussion about the merits or e-readers here – and in fact I do want to blog about it at a later date – but just assume that it does come to pass. Then assume there are other industries that can also do the same. You see where I am going.

So now let’s bring climate change into the equation. I am one who certainly does believe that the carbon we are putting into the atmosphere is having an impact on our climate. But even if you don’t, then focus on peak oil. If we take action to curb climate change then we can put in place policies to reduce oil consumption before the natural economics affect us too drastically. i.e by implementing carbon reduction policies to reduce carbon, we must price it and thus try and reduce use. Bacuase as we all know from the recent events, nothing is as effective in changing behaviour than

changing costs. This artificially pushes us to the same situation that would come naturally once peak oil has come and oil becomes scarcer. Of course people like Jeff Kunstler believe we are already too late!

This is why Copenhagen was such a big disappointment, In a sense it re-enforces the views in the Long Emergency that our dependence on oil is so great that we just don't have the political will to go in the right direction. Very discouraging.

As we saw from this last recession, when demand drops so does the price of oil. In fact what we see is that it doesn't really take that much of change to impact the price quite dramatically. With the price risking to almost $150/bbl in early 2008, it dropped to less than $50 by the end of 2008 and has continued to rise modestly since then. Now at over $80, once again there is fear that high oil prices will impact the economic recovery! Therefore the only policy is to price carbon and keep the price of oil from dropping by adapting the carbon price as necessary. Anything else will just lead to short term change and then back to the status quo.

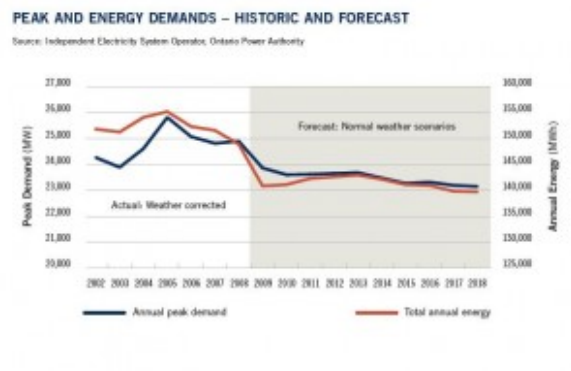
One thing is certain. Oil is a finite resource. Yes we may find more but yes it will be more expensive to exploit. At some point we are gong to have to accept that we need to start to shift to a less oil dependent economy. And given oil's uses outside of energy doesn't it make sense to use alternatives? So I will conclude by suggesting that climate change is our warning – start to act now to save the environment or wait until the oil is well past peak and have no plan to save society.

What do you think?

Lower demand and more renewables – is Surplus Base Load Generation here to stay?

Late in November I blogged about a recent phenomenon being experienced in some systems – Surplus Baseload Generation (SBG). This is being experienced in Ontario, Canada due to falling electricity demand and the increased use of variable renewable energy sources such as wind and solar.

At that time, I started a poll asking about the future of baseload power. Since then, the IESO in Ontario has published its latest Reliability Outlook. The numbers are striking. Demand was down 6.4% in 2009. The following graph shows that demand is not expected to reach pre-economic crisis peaks even by 2018.



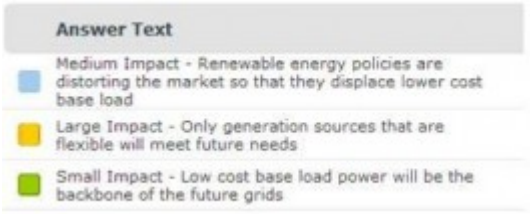
Ontario Demand Forecast

As of result the province continues to experience Surplus Baseload Generation (SBG). Forecasts of SBG are now made daily. With the growth of renewable generation SBG is expected to continue into the future. This will certainly impact any decision for building new nuclear, as nuclear plants are most suited to providing long term stable baseload power and energy.

The commitment to renewable energy continues to grow. Wind generation in Ontario rose by more than 60 per cent in 2009 over the previous year, to 2.3 TWh. Ontario has implemented the Green Energy Act, arguably making it one of the "greenest" jurisdictions in North America. Just this past week, government announced a $7 Billion deal for 2,500 MW of new renewable generation from a Korean consortium led by Samsung C&T. The deal includes the implementation of new manufacturing in the province for both wind and solar components.

While the above chart does not show baseload, with 1,000 MW of wind on the system and 11,500 MW of nuclear, this spring, Ontario started to experience SBG on a weekly basis. This resulted in nuclear unit reductions on 54 days, nuclear shutdowns on five days and water spillage at hydro facilities on 33 days. In the Reliability Outlook the projection is for 1600 MW of wind by 2013. With the Samsung deal and other FIT program renewables, we could be approaching 4,000 MW of wind and solar in the coming years while the overall demand is not expected to increase dramatically. Therefore, the baseload requirements will be further squeezed from the bottom as renewable generation has priority to the system when available. In other words, both renewables and nuclear are "non flexible" load i.e. not readily dispatchable. Clearly SBG will be an ongoing issue.

And now, for the results of my earlier poll. Although the number of votes was somewhat modest, the trend was clear.



While the comments suggested that baseload is important, only 10% of respondents thought that renewables will have a small

impact on the use of baseload. The most votes were for "Medium Impact" as it seems to be recognized that renewables are here to stay and that the nature of electric grids are going to be changed forever.

Happy New Year 2010!!

As usual at this time of year I find myself asking "Where did the time go?" Seems like just yesterday the year was beginning. And in this case, it was a very busy year. I am thankful to have been busy as we have been going through the worst economic times in recent history.

There have been a number of events that have defined the year in the nuclear sector. And it was a decision at the very end of the year that clearly demonstrated the nuclear industry strength moving from west to east. The announcement that the Koreans have won the bid for four new nuclear units in the UAE was HUGE. With an estimated value of $40 billion ($20 billion for construction of 4 units and $20 billion for their operation), this is an absolute "game changer" in the nuclear industry. The Koreans have now achieved their desire to become a global nuclear player exporting their domestic designed APR 1400. Of more importance it shows that commercial issues have won out over political strength in this case. The Korean bid was reported to be significantly less costly than the alternatives from Areva and GEH. So far I have not seen any mention of the commercial conditions, so I cannot comment on if or how much the actual commercial conditions (i.e. how much risk the Koreans were willing to take) impacted the decision.

Never under estimate the capability of Korea!! The nature of

international nuclear competition has changed! Of course, they still have to deliver. Given my own long experience in Korea, I would expect them to succeed.

This caps a year where nuclear growth in the east was substantial. Sticking with Korea for a moment, in addition to winning their first nuclear export, their new electricity plan calls for a large increase in nuclear capacity within the country to 2030. Korea also made a big investment in uranium as KEPCO purchased 17% of Denison Mines this year.

In China, nuclear growth exploded! With 11 units in operation, China now has 18 under construction. They have increased their target for 2020 from 20 GW to 60 GW or more and growing even faster after that. With construction under way for AP1000 units and EPR units as well as the existing CPR1000 units, their program is as broad as it is large. As domestication of the industry continues, the first CAP1400 – a Chinese derivation of the AP1000 was announced this year to be launched in 2013. China also continued its entry into international uranium development. CNNC bought Western Prospector with a property in Mongolia this past year and CGNPC bought a 70% interest in Energy Metals in Australia.

And of course, there is India. In 2009 India truly joined the international nuclear community. With just under 4,000 MW in operation, India is now on track to meet its target of 20,000 MW in service by 2020 and more than 60,000 MW by 2030. With new agreements from Russia for VVER units, agreements to build the EPR from France and new agreements anticipated to build US designed units, the PWR program is expanding quickly to supplement their home grown PHWR program.

Of more importance, India now has access to international supplies of uranium to meets its domestic fuel needs. So far there have been arrangements made with Russia, France and Kazakhstan to import uranium and agreements are in place to enable uranium importation from Mongolia and Namibia. Towards

the end of the year, India also concluded a Nuclear Cooperation Agreement with Canada opening the door for uranium imports. Cameco has opened an office in India and has big plans for this country.

With all this activity in Asia, how about the west? Well, while there was progress with projects in the USA and the UK program is continuing to develop, there have been no new firm commitments this year. Hopefully 2010 will see the continued growth with a new build project formally starting in the US. In the UK government suspport for new build nuclear has continued to grow while EDF concluded its purchase of British Energy. In the US, there was progress in a number of states. The DOE has announced that it will provide its first loan guarantee when a utility receives a COL from the NRC. Activity is increasing in both markets.

In Canada, the year started with a bang. Ontario looked to be leading North America with its international bidding process for new units. This fizzled later in the year when the project was suspended. The other three provinces with nuclear ambitions also had major decision points. In New Brunswick, the government is proposing to sell its utility NB Power to Hydro Quebec, Saskatchewan has decided against nuclear power in the short term and Alberta has stated that it is open to keeping nuclear as an option for implementation by the private sector.

Definitely a busy year for the nuclear industry. Of course, 2009 was also an important year for the climate change issue. I think that this posting is already long enough so I will comment on Copenhagen and the move to reduce green house gases in a subsequent posting. There were also many developments with renewables that deserve attention. More to come.

One thing is for sure, energy continues to be high on the agenda. With the economy starting to recover, energy issues are expected to continue to be of importance going into 2010.

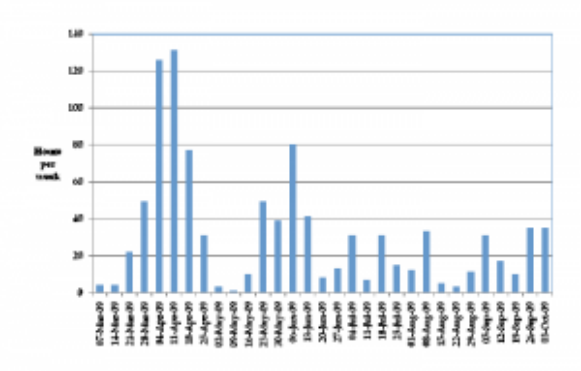
Is there a future for base load generation? Please respond to the poll?

System operators have recently seen something rather new – SBG – or "Surplus Baseload Generation". This is due to falling demand related to the current economic situation and a newer phenomenon; the displacement of base load by variable load renewable generation.

With governments everywhere and the public strongly supporting new renewable generation, primarily wind and solar; these forms of variable generation are displacing base load by being must run when the resource is available. So the question is "Is there a future for base load generation?". Please respond to the poll at the bottom of this blog entry

This issue was addressed at last week's Association of Power Producers of Ontario (APPrO) annual conference where a session was dedicated to this new phenomenon. The following shows the amount of time Ontario experienced SBG over the past 18 months. Excess generation of well over 1,000 MW was experienced! This resulted in shutting down low marginal cost nuclear plant as well as spilling water at hydro plants. The 18-month forecast by the IESO in Ontario expects SBG to continue to be an issue going forward.

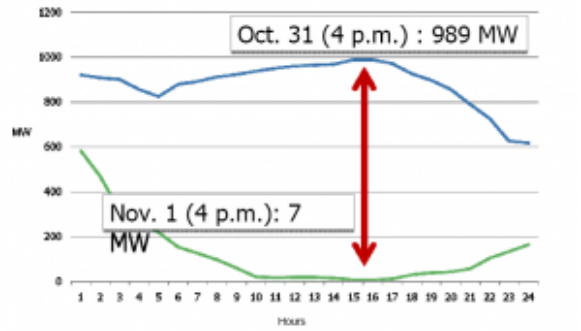
Surplus Base load Generation



IESO Presentation to APPrO
2009

The variability of the wind is shown in the following chart illustrating how two days in a row the wind at the same time varied from 989 MW to 7 MW on the following day.

Wind Capacity on Consecutive Days



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So what does this all mean? In the smart systems of the future is the concept of large scale base load generation doomed? Do you have to be able to manoeuvre to survive? Or will policies change to ensure that low cost base load generation is not displaced for higher cost alternatives?

This is just the beginning of the discussion for this subject. Please answer the following simple poll. I would like to get your views. More work is needed on this issue as we plan the systems of the future.

[polldaddy poll=2259325]

The precarious world of uranium supply and demand

Last month, the supply of uranium was severely interrupted when BHP declared force majeure on its deliveries of uranium as the main haulage system failed at Olympic Dam. Production has been reduced to about 20% of nominal and it is expected to take a number of months to repair and bring production back to its full output. Olympic Dam is a major producer of uranium, producing about 4,000 tonnes U per annum or just under 10% of global primary production. Therefore, losing the equivalent of 3,000 tonnes per year for six months or so (say 1,500 tonnes) represents a significant event in overall production that affects the delicate balance between uranium supply and demand.

Many people do not appreciate that the supply / demand situation for uranium is somewhat unique amongst commodities. I first gave a paper on this topic in 2007 to the Raymond James Uranium conference in New York (when the price of uranium was at its peak).

So what makes uranium so special in the world of commodities? A few things come to mind immediately. First, uranium is a single use commodity. Its demand is completely dependent upon how many nuclear power plants are in operation and how much fuel they need. In recent years, the global nuclear fleet has been consistently improving its operations but now has pretty much achieved it maximum. This means that demand cannot go up for the current fleet of nuclear power plants – there can only be negative shocks if a plant performs poorly. For example, following an earthquake in Japan, some plants were shut down for an extended period. This means that they are not using

fuel so demand decreases.

As for the future of demand, the forecasts are for a dramatic growth in new nuclear plants. The WNA is projecting growth of more than 50% in the number of GW in production over the next 20 years. This means a significant increase in demand that must be accommodated in future supply plans. However, it takes from 10 to 15 years to implement a new nuclear project from conception so there are really no surprises in demand in the short to medium term. We all know what plants are under construction so the projection for new demand is quite stable for the next 5 to 10 years with some uncertainty starting to appear at the 10 year mark.

So what does this mean? It means that demand increases in a predictable fashion and that the potential is always there for negative demand shocks if existing units perform poorly or are taken out of operation for any reason.

Now for supply. Similar to nuclear power plants, bringing new uranium mines into production takes quite some time and effort. Many projects are delayed as companies have been having difficulty in bring on new mines. Therefore, supply potential is also quite predictable for at least 5 years going forward. Again, as with nuclear power, the risk is that shocks affect the system negatively as there have been a number of events over the past few years that have halted production or delayed new mines.

And finally, as a fuel, uranium is also unique in that it is bought in batches. The volume of fuel required to operate a nuclear power plant is quite small so utilities can carry a significant inventory to reduce their risk. This means that buying and selling is not completely in step with usage. This is different from say, coal or gas that must be consistently delivered to keep fossil generating plants operating.

In the end, uranium prices have remained rather low over the

past 20 years with a short term blip in 2007. These prices remain low because in most scenarios, supply and demand are in balance making it difficult for price increases that are needed to encourage new supply. However, for utilities the risk remains. Therefore, the trend is now for utilities in the east (Japan, China, Korea and India) who are fast becoming the world's biggest users of fuel to invest in the resource itself to help them mitigate the risk. These countries also have little domestic supply so need to rely on supply from other countries.

Events like the one at Olympic Dam demonstrate how precarious supply can be. So we should expect countries with growing demand and little domestic supply to continue to step up their efforts to invest in global resources to reduce their overall supply risk.

Falling electricity demand and the impact on nuclear projects – An interesting article

Bruce Power officials say running at reduced capacity is the new reality for the nuclear plant for the foreseeable future

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Falling electricity demand and the impact on nuclear projects

During the summer I have been a slacker when it comes to contributing to my blog. It is a time for relaxation; a good time for reading and reflection.

As we all start the big climb out of the current economic crisis, it may be time to start thinking about what lies ahead and the legacy that this crisis will have left us. There has been an assessment by the IEA in May about the impact of the financial crisis on energy in general and a more detailed assessment of nuclear power in the USA by Moody's in June. So why am I thinking of talking about this now in August?

Well, this week OPG (Ontario Power Generation) announced their second quarter results here in Ontario Canada (home for me). They reported a 19% drop in electricity production for the second quarter. In part this is due to lower overall demand and also is related to production by others in the market. Now there are a number of reasons for this lower demand. First and foremost, this has been a mild summer so the air conditioning loads are down. Second the economy has had a big effect on industrial loads and finally, the success of the OPA conservation programs is starting to show benefits in the market.

This summer has seen some unusual things happen in the Ontario market. Nuclear plants have had to be shut down due to the lack of load. This is a result of low off peak demand and an increasing amount of renewables on the system that displace base load when the resource is available according to electricity market rules. Also this summer, the government of Ontario suspended its bidding process for a new build nuclear

plant. The reasons given were the high cost of the bid and the uncertainty over the future of AECL, the lead bidder. AECL's shareholder; the Government of Canada, is looking to partially privatize the national nuclear vendor. I would guess that the lower demand probably also had an impact. Hard to think about spending large amounts of capital when demand is shrinking.

In any case, reading about OPG made me think so I have had a look at the numbers. Demand has decreased in Ontario since 2005. Current projections by the IESO are for a 4% drop in demand this year and a further 0.35 drop next year. Wow! A far cry from even the modest 1% or so growth assumed in the current Integrated Power System Plan. This is consistent with the IEA forecasts. They are expecting a drop of 3.5% in 2009; the first drop in global electricity demand since the second world war!

The Moody's report is more focused and suggests that US utilities that are considering new nuclear plants are not doing what is necessary to strengthen their balance sheets to get ready for these large projects. Moody's claims that the size of these projects makes them "bet the farm" projects – a term I often use when teaching project structuring for the World Nuclear University. However, they also note on the positive side that there is a demand for new low carbon generation and that nuclear as an economic alternative can play a role.

So what does this mean for the future of nuclear in North America? The IEA is somewhat negative and states that the crisis may hold back some programs. It mentions South Africa as an example of one country that has delayed its new build projects for financial reasons. On the other hand, it also states that nuclear is probably the only large scale viable low carbon generation option and that its economics improve as carbon is priced. They also note that most programs that are in the advanced planning stages are continuing and once

operating nuclear plants are viewed favourably by the financial community.

To answer the question – the current economic climate may delay some new nuclear projects, however it is expected that most will continue and that they will be able to raise the necessary financing as the economy starts to improve. Most likely, investor-owned utilities in North America will look to strategic partnerships to share costs and risks. The lower demand may also buy the industry some time to ensure that it plans and executes new projects with the necessary diligence and oversight to ensure project success. Given the relatively high capital costs and long project schedules of a nuclear plant, projects currently in the preparation phase will be in service towards the end of the decade. And of course, continued focus on implementing new projects on budget and on schedule will be key to a successful future.

MIT Report Update "The Future of Nuclear Power"

This week MIT released an update to its 2003 report, "The Future of Nuclear Power". Back in 2003 this report brought the economics of nuclear power in the United States to the forefront. It supported new nuclear as a low carbon option for electricity generation and considered a scenario that would see the increase in capacity by a factor of 3 (meaning building about 200 new units) by the middle of this century. It is commonly accepted that this report was an important input into the policy that followed with respect to nuclear power including the nuclear power 2010 program and the Energy Policy Act of 2005.

This update looks at progress over the past 6 years and of most interest, updates the economics. The following table from the report shows the new versus old analysis.

Table 1: Costs of Electric Generation Alternatives

			LCOE		
	Overnight Cost	Fuel Cost	Base Case	w/ carbon charge $25/$tCO_2$	w/ same cost of capital
	$/kW	$/mmBtu	¢/kWh	¢/kWh	¢/kWh
	[A]	[B]	[C]	[D]	[E]
MIT (2003)					
$2002					
[1] Nuclear	2,000	0.47	6.7		5.5
[2] Coal	1,300	1.20	4.3	6.4	
[3] Gas	500	3.50	4.1	5.1	
Update					
$2007					
[4] Nuclear	4,000	0.67	8.4		6.6
[5] Coal	2,300	2.60	6.2	8.3	
[6] Gas	850	7.00	6.5	7.4	

Click on table to enlarge

As can be seen, the costs have increased significantly over this time period with the projected costs of nuclear increasing faster than the costs of the coal and gas alternatives. However, the authors draw the same conclusions as they did in 2003; that nuclear is competitive with the alternatives. The report continues to assume a higher project risk for nuclear than fossil. This translates into a higher cost of capital and the highest cost of electricity. Assuming the same cost of capital as the alternatives results in nuclear being extremely competitive.

I want to comment on the costs and assumptions. I have to admit, that back in 2003, when I worked for a nuclear vendor, I was not happy with this report assuming nuclear at $2,000 /kW. At that time we all believed that we were making strides to lower the cost of new plants and we wanted to see that reflected in the analysis. Well, I was wrong. Today the cost of nuclear power has increased and I do accept that $4,000 /kW is a reasonable assumption to make in today's world. Does that mean that I think that it is OK for nuclear plants to

cost $4,000 /kW? I definitely think that more work needs to be done to bring these costs down but that is the subject for another discussion.

On the other hand, things have evolved so that the other assumptions do need to be challenged. While it may have made sense to assume different costs of capital in 2003, this is no longer the case. The argument in the report is based on the industry's poor track record of building on time and on budget. It states that issues with new plants since that date confirm this and that the risk premium can only be eliminated with proven plant delivery performance. While I do agree that the industry needs to prove it can deliver a new fleet of plants to budget and schedule, things have changed since 2003.

In the current environment, the majority of new plants under consideration in the United States are with regulated utilities. These plants will be financed on balance sheet so they will be financed at the cost of capital of the utility itself, no different than if it were to build a coal or a gas plant. And now that the cost estimates have escalated significantly, it is reasonable to assume that part of this increase is due to utilities being more conservative and taking the risks into account in the cost estimates themselves.

Also, the risks of the alternatives have changed significantly. The risk of new climate change initiatives being put into place after the coal or gas plant is committed has increased. This means additional costs to the utilities to implement new carbon control requirements or charges due to additional costs for releasing carbon are likely. Is $25/t sufficient? At this stage nobody knows meaning higher risk.

And finally, it is interesting how the success of carbon capture and storage (CCS) is assumed, even though the technology has yet to be demonstrated while the success of building a new nuclear plant is consistently challenged. The

MIT study itself recognizes that CCS is not proven. The costs of CCS seem to go up every time a new estimate is made, yet they assume that nuclear has a higher risk profile and cost of capital than coal with a yet to be proven technology attached to it.

In the case of a merchant plant, should there be one; it will very likely only be implemented under the US government loan guarantee program. This means that they can achieve the 80/20 debt/equity ratio assumed for the other technologies with even a lower potential cost due to the benefit of the government guarantee.

All that being said, the timing of this update is useful. Their conclusion that more needs to be done is important. As stated ***"The sober warning is that if more is not done, nuclear power will diminish as a practical and timely option for deployment at a scale that would constitute a material contribution to climate change risk mitigation."*** It will be interesting to see how both government and industry respond.