Net Zero needs more nuclear – it’s time to get on with it

Adopted in 2015, 196 countries signed the Paris Climate Agreement (to date 188 of them have ratified it) accepting global ambition to limit global warming to “well below” 2C and adding an aspirational goal of limiting warming to 1.5C. The Paris deal also commits signatories to balance greenhouse gas emissions and sinks in the second half of this century. This has become understood to mean “Net Zero” emissions.

By the end of August 2020, over 125 countries (including the European Union) had set or were actively considering long-term net-zero emissions targets by about 2050. As opposed to strategies to simply reduce emissions by 20 or 30%, a net zero target requires finding ways to totally eliminate fossil emissions and meet all of our energy needs with very low carbon options.

Source: istockphoto

The magnitude of the challenge is enormous, and more and more governments are realizing this means there is no single technology that can provide the complete solution. Rather, the time has come to stop thinking about competition between different energy sources and instead look at how they can best work together if there is to be a realistic chance of success.

In its current World Energy Outlook (WEO 2020), the International Energy Agency (IEA) recognized this push to net zero. In addition to its traditional Stated Policies Scenario (STEPS), based on today's policy settings and Sustainable Development Scenario (SDS) which examines what actions would be necessary to achieve 2030 climate goals; it created a new scenario, the Net Zero by 2050 (NZE2050) scenario to show a possible path for the world to reach net zero by 2050.

The NZE2050 scenario assumes large reductions in energy demand and massive increases in renewable generation, with a modest

increase in nuclear power, all to replace fossil fuels which show dramatic decline. This is a useful exercise. However, rather than provide a clear path to net zero, this scenario succeeds in demonstrating the sheer magnitude of the challenge ahead if we are to meet this ambitious goal.

For example, in this NZE2050 scenario primary energy demand falls by 17% between 2019 and 2030, to a level like 2006, even though the global economy is twice as large. This would be achieved through electrification, efficiency gains and behaviour changes. To put this in context, this same report estimates that energy demand will fall by about 5% in 2020 because of the global covid pandemic and the associated reduction in economic activity. It also points out there will be around 660 million people who will not have access to electricity and 2.4 billion who will not have access to clean cooking by 2030 globally if we stay on the stated policy scenario path. This makes it very hard to imagine achieving a demand reduction of 17% by 2030 with a fully recovered healthy global economy while trying to bring energy to those that are currently under served.

And yes, we certainly do agree that solar development has been nothing short of astounding and fully support continuing with this rapid growth. At the same time, it is hard to imagine the optimum solution to massive energy transformation requiring the large-scale replacement of much our energy infrastructure could be led by the electricity source (solar) that has the lowest energy density (requiring huge amounts of land) and that produces electricity only between about 13 and 23% of the time (when the sun shines). The WEO recognizes this large growth in variable renewables leads to issues related to system flexibility and creates further challenges requiring large investments in infrastructure including new sources of energy storage.

On the positive side, the IEA, as do many others, now clearly acknowledge that nuclear power is an important low carbon

source of energy and that it must play a role. In its analysis, nuclear and renewables grow while fossil use drops. The problem is that in this scenario, nuclear power only grows by about 36% to 2050. The result is the global share of nuclear hardly moves from today with renewables left to do the heavy lifting.

A larger nuclear share would provide energy security, reliability and be cost effective, mostly by reducing the large system (flexibility) costs required to implement such a large share of variable renewables all while reducing the pressure to reduce overall energy use. The IEA itself acknowledges that nuclear power plays a much larger role in many Intergovernmental Panel on Climate Change (IPCC) 1.5 °C scenarios, than in its NZE2050. (Half of IPCC 1.5 °C scenarios imply an increase in nuclear generation of 60% between 2019-30 compared with a 36% increase in the NZE2050).

The nuclear industry through the World Nuclear Association (WNA) has proposed its Harmony goal of 25% electricity generated from nuclear by 2050. This means about 1,000 GW (1000 large reactors) of new nuclear by then, which would be equivalent on an energy delivered basis to the growth assumed for solar adding a large amount of always on, 24/7 energy to the system. Achieving this goal requires strong commitments from governments and industry. This would complement the growth in renewables nicely and result in less pressure on demand reduction, less issues with flexibility requiring less infrastructure development and an overall lower cost energy system.

We are seeing exceptional innovation as vaccines for covid are being made available in time frames never before seen to address this pandemic. This shows what we can do as a society when we all work together to a common goal. As stated by Associate Deputy Minister of Natural Resources Canada Shawn Tupper in a web chat with OECD Nuclear Energy Agency Director-General William Magwood, “We’ve got to stop talking about

Utopia; we've got to stop just talking about what our targets are and actually articulate our plan starting tomorrow … what are the building blocks to getting there."

So, the time has come to talk less and do more to make sure nuclear can reach its full potential and set the world on a real path to net zero.

Nuclear Power provides the performance we need

We often speak about the incredible energy density of nuclear fuel; a pellet the size of the end of your finger can deliver as much energy as a ton of coal. In addition to producing a large amount of energy from a very small amount of resource, the plants themselves offer another important benefit, their exemplary operating performance. They operate at very high capacity factors (the amount of energy produced / the total energy that would be produced if the unit ran nonstop) meaning they provide us with a reliable 24/7 energy source to support our energy hungry economies.

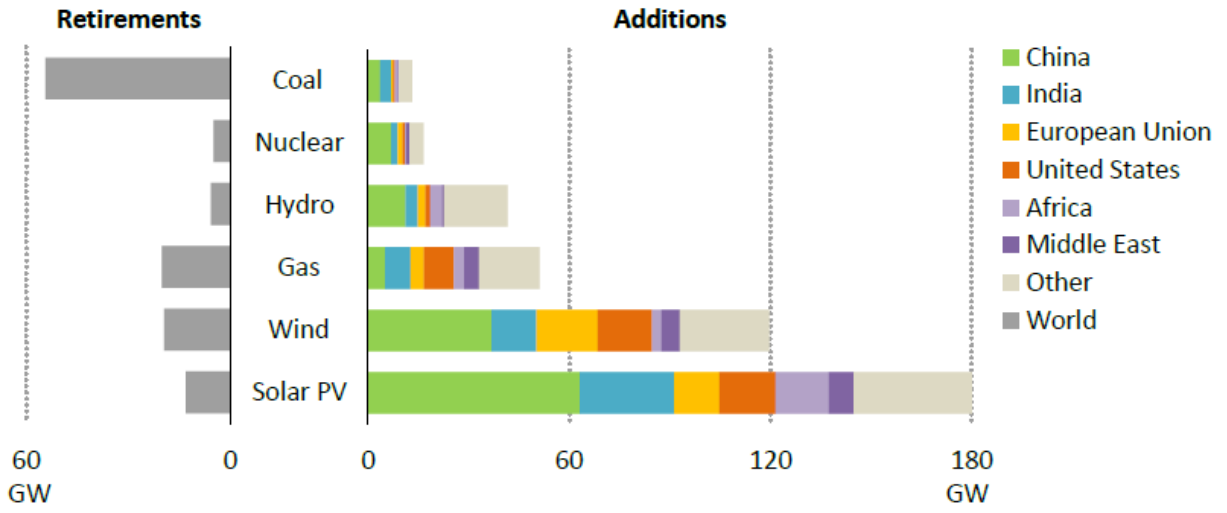
In fact, even as the global fleet ages, it just keeps on getting better. In 2018, the US fleet produced the most energy ever, exceeding the previous peak from 2010 even though 7 units have been retired and only two new ones have come on

stream. The annual capacity factor in the US for 2018 was 92.3%. This should come as no surprise since the US fleet has operated around 90% CF for the past 20 years. This is a testament to the technology and its robustness. Not only does nuclear operate extremely well, it does so at all times during its very long life. It has no early life breaking in period and no end of life deterioration in its performance. It just continues to provide the energy we need day after day, year after year.

Let's contrast this with the world's most talked about generation sources, wind and solar. Not only are they intermittent, because the wind doesn't always blow and the sun doesn't always shine, but on average they produce relatively small amounts of energy from a given plant, i.e. a low capacity factor. Wind farms usually operate about 35% of the time and solar only about 15% of the time. Not only does each generator produce a relatively small amount of energy, it can't be called upon to produce it when it is needed.

This is why it is frustrating and frankly, deceptive, when supporters tout how much capacity of new renewables is being added to the grid, without mentioning the inconvenient truth of how little energy they are really contributing. The following figure shows how much capacity is expected to be added to the global grid in the World Energy Outlook (WEO) 2018 Sustainable Development Scenario.

Figure 9.24 ▷ Global capacity additions and retirements by technology and region in the Sustainable Development Scenario, 2018-2040
(average annual)



Solar PV and wind provide the lion's share of new capacity, while coal sees the most retirements

Source: IEA World Energy Outlook 2018

At first look, it seems like wind and solar are leading the charge to decarbonize the world energy system – 180 GW of new solar, 120 GW of new wind and only 17 GW of new nuclear.

But now let's transform these capacities into energy. The WEO assumes that nuclear runs about 80% of the time, wind 30% and solar 15%. So, what does this mean? Building 10 times the amount of solar and about 7 times the amount of wind as nuclear results in only about TWICE as much energy being produced from these sources as from new nuclear. Yes, you heard that right. Building 180 GW of solar running 15% of the time produces only about double the energy in a year as building 17 GW of nuclear plant that runs 80% of the time.

And to top it off, the nuclear energy is also reliable and predictable. Of more importance, it also means that there

is a need for much more land to place all these wind and solar plants, a huge increase in the materials mined to manufacture them, a much larger and more complex transmission system, and a storage system that is not yet technologically feasible to accommodate their intermittency (or more likely gas generation to back them up); all leading to higher costs of energy, less system reliability and more carbon emissions.

A successful narrative has been created that renewables are a good way to meet all our energy needs, but it is based on how they make us feel, not on science. Who doesn't like the sound of harnessing nature and getting our energy from the wind and the sun? In reality, we simply cannot make the wind blow or the sun shine. We cannot imagine our way to a clean energy future with solutions that sound good but are incapable of giving us the result we so desperately need. In fact, the WEO bases its low carbon scenario on implementing large efficiency gains to reduce demand as a massive renewables new build program alone cannot meet the carbon reduction targets.

Looking at these numbers, should we be investing in these enormous quantities of renewables (and the back up / storage needed to accommodate their intermittency) or is there a better path to a lower cost decarbonized energy system. Nuclear power delivers what we need when we need it – large quantities of economic, reliable and low emission

energy.

2016 was a challenging year for nuclear power – or was It?

There is no shortage of people happy to see 2016 come to an end. It has been an extraordinary year characterized by strong popular revolt to the status quo resulting in unexpected government changes in places like Britain and Italy and a surprising result in the US election.

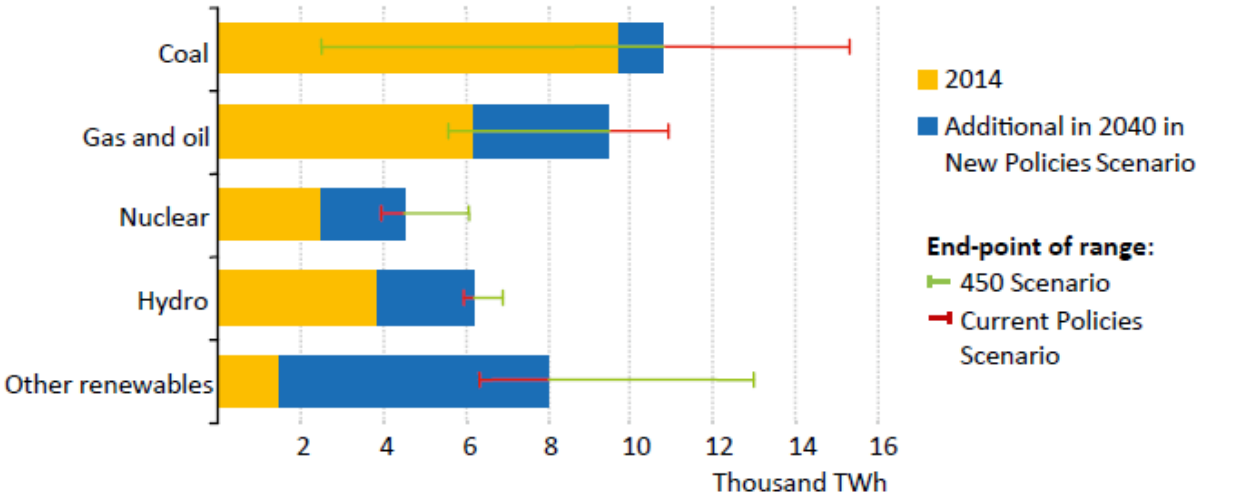
For those of us in the energy industry it has also been a challenging year. Oil prices have remained low depressing economies supported by oil. North American gas prices seem to have no bottom and these historic lows have led to dysfunction in electricity markets. This coupled with highly subsidized prices for renewables has resulted in tremendous economic pressure on American nuclear plants with a number of them closed and more slated for early closure. The most recent was just this month as Entergy announced that Pilgrim would be closed early in 2018.

In other countries, Japan continues to struggle with bringing back its nuclear fleet in a timely manner; South Africa seems to have postponed the bulk of its nuclear plan; and Vietnam cancelled their nuclear projects outright.

What makes these changes of more concern is that on the surface they are said to be a result of challenging nuclear economics rather than any specific anti-nuclear attitude.

But all this negative pressure also helped to put the need for nuclear in perspective. More and more countries have accepted that meeting climate goals will require continued use of nuclear power. Its 24/7 reliable low carbon generation can be the back bone for a healthy economic low carbon world. As shown by the IEA in their World Energy Outlook 2016 (WEO) in the figure below, there is strong growth expected for nuclear in the New Policy Scenario (base case) and that the number of nuclear plants will have to more than double for their 450 (low carbon) scenario.

Figure 6.3 ▷ Global electricity generation by fuel and scenario



Source: World Energy Outlook 2016

While the press has been consumed with the challenges, there has been a string of good news for the sector this year. In Britain, there was a final commitment to the Hinkley Point C project and in Switzerland the early closure for their nuclear plants was strongly rejected in a referendum. In the United States, while the focus was on the plants that have closed and that may be closing both Illinois and New York states have taken government action to keep their plants open recognizing their essential contribution to both the local economies and to their carbon emissions targets. Also in the US, Watts Bar 2 came into service as the country's first new nuclear plant in more than two decades. And so far, it looks like the

incoming administration, while not necessarily on the side of combating climate change, will be supportive of nuclear energy going forward.

Here we are; another year has come to an end and once again it has been a tumultuous year for nuclear. But overall, I believe it has been positive and we are well placed for 2017. There is a broad recognition of the importance of nuclear to meet climate change targets and there is a better understanding of the problems with market structures in supporting low carbon economic generation that is needed. All of this without even mentioning China which continues with its strong nuclear expansion.

One thing is clear. The world needs more nuclear if we are to have a reliable secure low carbon generating system. With the IEA forecasting a doubling of plants in the next 25 years, we had better get on with it…….

Thank you for continuing to read this blog – wishing you all a very happy, healthy and prosperous 2017.

When it comes to our need for electricity, reliability is essential.

As we come to the end of another year, it is not a nuclear issue that I want to discuss but rather the broader issue of our need for reliable electricity. Last month I started with a quote from the IEA's World Energy Outlook 2013 highlighting how important energy has become to our society – affecting the economics of nations and our environment as well as our daily

way of life.

Over this holiday season in North America the importance of electricity to our very survival has become more evident. On the Friday before Christmas the northeast United States and Canada were hit with a massive ice storm. Hundreds of thousands of people lost power. The cause was primarily due to power lines being affected both directly by intense icing as well as by debris from trees and other items that fell onto the lines as they became heavy with ice causing the lines to fall.

And here we are days after Christmas and while most households have had their power restored (many after more than 5 days without), thousands continue to wait. This is different from other extreme weather events such as hurricanes that have been responsible for mass destruction of homes and infrastructure. This ice storm, while also an extreme weather event, has only caused power loss as its lasting effect. The result is we are able to specifically see the importance of electricity to our

modern societies.

So what is the impact of a prolonged loss of electricity? Frankly it is very difficult for those without – especially for those most vulnerable – the elderly, the sick and those without friends or family nearby to take them in.

Living a large city in a cold climate, just imagine your home without heat in subfreezing weather, no power for the refrigerator or freezer (although outdoors can work), no water to flush the toilet or bathe or even more importantly drink; and you have the makings of a catastrophe – people freezing and hungry without the basics required for survival. And to make matters worse it is over the holiday season when most had plans to be with family. In some cases large family holiday meals were no longer possible as the emphasis was on finding ways to stay warm. The added downside of the season is that on Christmas almost everything is closed, no supermarkets, very few restaurants; no services of any type.

On the positive side, the number of people without power is now in the minority so there are many options for them to seek help and get warm. But others continue to struggle. The news has recently reported on police and fire departments having to visit large apartment buildings and take elderly sick residents down numerous flights of stairs to safety. These people have been stuck in their cold apartments for days without food or water. With no one to check on them, their lives were at risk.

As stated earlier, the cause of this mayhem is related to the transmission and distribution system failing in the weather, not generation. But the point to be made is that without electricity in our cities; it would only take days until the population would need to find ways to feed and warm themselves on mass.

So it is pretty obvious that we need to have reliable

electricity supply to keep society working. And reliable supply means robust generation and distribution. Our aging infrastructure can no longer be left to decay further so that with every extreme weather event, we take days or weeks to recover. After the major blackout in the North American northeast a decade ago, the focus was on ensuring system reliability. The rules changed and all North American utilities now adhere to these rules, making our system better. But here we are a decade later and the issue has changed. It is no longer about reliability in general, but the ability to withstand extreme weather events. And most of all our ability to recover when the system is damaged during such events.

And of course we have the issues associated with individuals that oppose what is necessary to keep our system running. For example, power lines have fallen when tree branches have damaged them. While simple measures like pruning may be the cost-effective way to protect power lines, it can carry a public-relations price. As stated by the CEO of Toronto Hydro "You can imagine … our arborists show up on the curb and knock on the door and say 'We're here to cut your branches down.' They're not necessarily a welcome news," he said. "So it's really finding that right balance." This shows that no matter what the issue, there are always those opposed (as with those opposed to nuclear power); but these are also usually the first to complain when they lose power and need their lines restored.

So while this is not directly about generation or nuclear power, it is important to remind ourselves of the importance of reliable supply as we continue the debate on how we want to generate our electricity going forward. Robust, reliable baseload electricity is important. And this is where nuclear power plays a very important role. We also talk about economics and environment. Both essential – so how can we meet the challenge of having reliable, economic and

environmentally benign electricity?

As we prepare to enter a new year, let’s remember that fossil fuels like coal and gas are reliable, can be economic, but impact our environment. Renewable sources like wind and solar are good for the environment but can be costly and unreliable. Nuclear Power is an important source of electricity that can provide large amounts of clean, reliable and economic electricity to keep our society moving.

I hope that all power is restored to those without as soon as possible so they can enjoy what is left of the holiday season.

Wishing you all a very happy and healthy 2014

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:

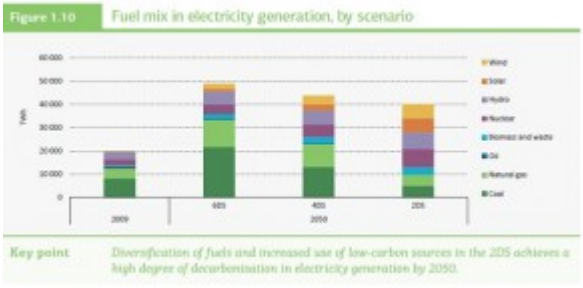
- **A sustainable energy system is still within reach and can bring broad benefits**
    - **Technologies can and must play an integral role in transforming the energy system.**
    - **Investing in clean energy makes economic sense – every additional dollar invested can generate three dollars in future 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.**

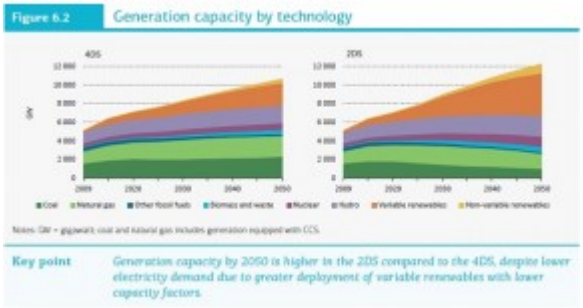
It then goes on to focus on how energy policy must address the key issues and the role of government in making it all happen, finally concluding with recommendations to energy ministers (assuming these recommendations were to be considered at Rio+20).

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"

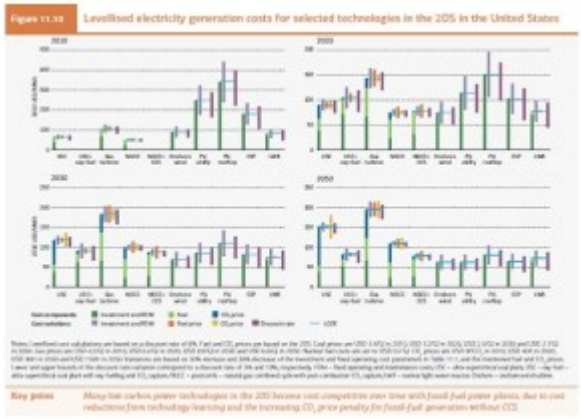
Focusing on a few key issues, consider the following two figures. The first illustrates the change in electricity generation mix for each of the three scenarios. Improved energy efficiencies is the most important source of clean generation. The figure shows that in the 6DS there is almost 50,000 TWh 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.

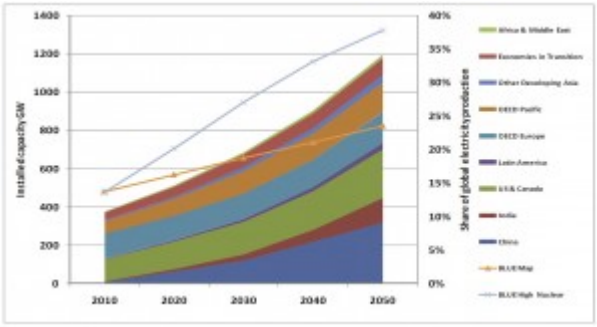
In the end, our world will become more electrified and we need to move forward with a cleaner, sustainable electricity system for our future. So what is harder for the public to accept – very high carbon costs and a very large increase in variable renewable generation or a bigger role from a relatively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

What a difference a year makes! With New Build taking hold in the west in 2012 now is the time to sell the benefits of nuclear power to overcome the Fukushima effect.

The good news is that as 2011 comes to a close, Fukushima has achieved cold shutdown and the recovery is moving to the next stage. The emphasis is now on decontamination and getting the

dislocated people back into their homes as soon as possible. Does this mean that nuclear will overcome the effects of Fukushima starting in 2012?

It was only a year ago that the International Energy Agency ("IEA") issued its Nuclear Roadmap 2010. This report clearly demonstrates the important role that nuclear power can play in meeting climate change targets. With a 50% CO_2 reduction targeted by 2050 in the so-called IEA Blue Map scenario, nuclear capacity triples and its share of electricity generation rises from 14% today to 24%, the largest of any generation technology. Under a postulated High Nuclear scenario, the nuclear share would reach as much as 38%!



IEA Nuclear Roadmap 2010 share of nuclear

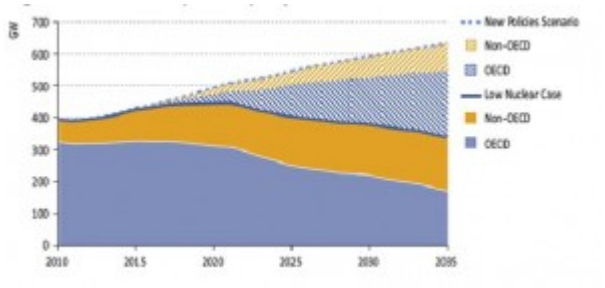
But that was then and this is now. On March 11, as we all know, a devastating earthquake and tsunami struck Japan with horrific consequences – killing more than 20,000 and causing a nuclear accident at the Fukushima Daiichi Nuclear Plant.

There was significant fuel melting in three units resulting in radioactive releases to the environment. Even though there have been no fatalities due to radiation and there is little risk of any future radiation health impacts, the global impact of this event to the nuclear industry was overwhelming. While many countries re-confirmed their commitment to nuclear power after reviewing plant safety and implementing lessons learned, some countries in Europe led by Germany have taken the decision to scale back or even move away from nuclear power.

In the IEA's World Energy Outlook 2011 released in early

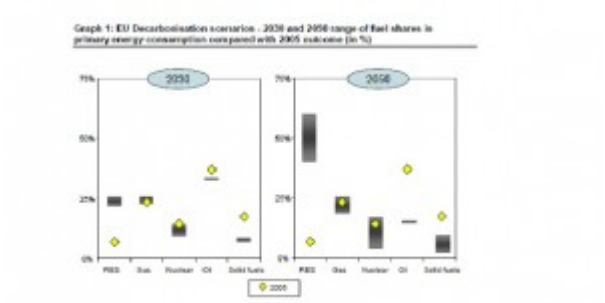
November they added a new scenario – Low Nuclear – to account for a possible post-Fukushima shift away from nuclear power in addition to the New Policies (reference) and Current Policies scenarios. In the reference case, global nuclear power is expected to rise 70% by 2035 with China, Korea and India leading the growth. This case is only slightly less than the projection last year. In the new Low Nuclear Case, the total amount of nuclear capacity actually falls from 393 GW at the end of 2010 to 335 GW in 2035. According to the IEA, this scenario has severe implications for energy security, diversity of the fuel mix, spending on energy imports and energy-related CO2 emissions.

In this low nuclear scenario, by 2035, coal demand increases to over twice the level of Australia's current steam coal exports. The increase in gas demand is equal to two-thirds of Russia's natural gas exports in 2010. The increase in renewables-based generation is equal to almost five-times the current generation from renewables in Germany. Energy-related CO2 emissions also rise with increased use of fossil fuels in the power sector. This clearly has significant implications for global energy supply making it extraordinarily difficult to meet carbon targets. As stated in the IEA's WEO report "*Following this trajectory would depend on heroic achievements in the deployment of emerging low-carbon technologies, which have yet to be proven. Countries that rely heavily on nuclear power would find it particularly challenging and significantly more costly to meet their targeted levels of emissions*."



WEO New Policies (Reference) and Low Nuclear Scenarios nuclear capacities

And now, Europe has issued its Energy Roadmap 2050 with the overall emphasis on renewables and energy efficiency; a policy document that has been clearly impacted by the post Fukushima shift in thinking in Europe. As illustrated in the chart below, even with five different scenarios, the one thing they all have in common is a large increase in renewable energy generation. No other form of generation increases anywhere near to that of renewables; and in fact most other forms decline over the plan period with only the size of the decline depending upon the specific scenario. But even with this emphasis on renewables, the report does make important positive points on the role of nuclear power noting that nuclear energy is an important contributor to meeting the roadmap objectives.



In fact the report notes that today nuclear energy is the decarbonisation option providing most of the low-carbon electricity consumed in the EU. It then goes on to note the post Fukushima reality. "*Some Member States consider the risks related to nuclear energy as unacceptable. Since the accident in Fukushima, public policy on nuclear energy has changed in some Member States while others continue to see nuclear energy as a secure, reliable and affordable source of low-carbon electricity generation*."

When it comes to cost, the impact is clear. Consistent with the IEA Nuclear Roadmap, this report states "*the scenario analysis shows that nuclear energy contributes to lower system costs and electricity prices. As a large scale low-carbon option, nuclear energy will remain in the EU power generation*

mix.”

This is critical since the average capital costs of the energy system will increase significantly due to investments in power plants and grids, industrial energy equipment, heating and cooling systems, smart meters, insulation material, more efficient and low carbon vehicles, devices for exploiting local renewable energy sources (solar heat and photovoltaic), durable energy consuming goods etc. And the reality is that renewables are expensive with the highest electricity costs in the “near 100% RES power” scenario which the RES power generation capacity in 2050 would be more than twice as high as today’s total power generation capacity from all sources (I am assuming primarily due to the low capacity factors of renewable generation). Other scenarios such as the High Energy Efficiency scenario and the Diversified Supply Technology scenario have the lowest electricity prices due to somewhat lower renewable penetration (60 to 65%) taking advantage of the lower costs of efficiency, gas and nuclear. The report notes that many renewable technologies need further development to bring down costs.

So as we enter 2012, where does this leave us? One lesson from Fukushima is that many in the world are still very afraid of nuclear power because of the huge fear of radiation. There was an interesting piece on this in a CNN Health article this past week which argues that public trust in nuclear energy should be built on the existing acceptance of medical radiation dose levels. The public welcome moderate medical radiation levels from both internal and external sources, for medical imaging (CT, PET, SPECT scans) yet fear the much smaller levels from nuclear plants. And as I stated in my last blog entry, as an industry our work is cut out for us in changing this thinking. Reducing the public fear of radiation is no small task and will take time and a carefully coordinated approach from us all. Professor Wade Allison argues that the ALARA principle has hurt us and increases this

fear of radiation and suggests that this policy should be replaced with “As High As Relatively Safe (AHARS)”, mindful of other dangers, local and global. An interesting approach indeed.

One thing is clear from the above IEA studies and the European Roadmap 2050. Reading between the lines nuclear power is essential to meeting long term carbon reduction goals. Relying too much on renewables is far too risky an approach and is more of a wishful thinking scenario than a realistic one. To achieve global carbon reduction objectives, it makes no sense to not take advantage of the one true large scale low carbon technology – nuclear power. It is here today – it is safe and in most jurisdictions it is economic.

So what about 2012? So far it looks like it can be a good year for nuclear power. Important progress in new build is being made in the UK; the US will see its first COLs enabling the first new builds to start construction in a generation; Canada may make a decision on its new build; and, of course China and others in Asia will continue to expand their programs.

Work in Japan will continue and will not be easy as the government works to decontaminate the area around Fukushima and hopefully many will get to return to their homes. Of importance we can expect to see many of the idled plants in Japan get approvals to restart easing the electricity shortage caused by these units not running. Again a recent Japanese study shows that nuclear remains the low cost option to 2030.

But of most importance, this is not time for industry complacency. This has to be the year where the industry marshals its forces to get the message out – in a thoughtful, clear, unambiguous way. The future is up to us so let’s get on with it and tell our story. Even though truth may be on our side, the path is going to be long and the work hard……..but in the end it is worth it for us all……

We offer a proven large scale clean, economic and, of utmost importance, safe option for electricity generation. As the only proven large scale low carbon option that can meet the world’s energy needs, nuclear power must continue to be an important part of the electricity generation mix now and into the future.