Reliability means being connected – we need a strong integrated electricity system with nuclear generation as its workhorse

It was with great fanfare that Tesla launched its home battery recently. Headlines like "*Tesla launches Powerwall home battery with aim to revolutionize energy consumption*" were the norm as the public read about this revolutionary jump forward in energy storage. A recent article on where famed author Margaret Atwood is investing says it all …. "*if [Tesla CEO] Elon Musk was putting his Powerwall on the market, I would certainly buy a piece of that. My feeling is that, once that becomes affordable, everyone is going to do that. I think that's definitely the wave of the future*."

After all, this is the dream isn't it? We can all generate our own electricity with clean energy efficient solar panels and store enough on our home batteries to keep us going when the sun goes down. What can be better for our common future?

Well, in fact, just about everything.

It must be my age and my years in the energy industry that remind me of what are the real essential attributes of electricity supply. **Reliability and Economics**. Yes, that's right. For anyone who works in a modern electricity utility, that is what they focus on; delivering cost effective reliable electricity to users. And in today's energy intensive world where we need electricity for every aspect of our hyper active and energy intensive lives, this is even more critical. We have all experienced temporary blackouts and know well the

negative impact it has. The problem then with renewable energy generated at home is that, at least for now, it is neither reliable nor economic. Since the announcement from Tesla there have been a number of articles that explain this in detail, but of course supporters will just say that in time all problems will be solved. And frankly they may be right.

" Will I be able to have a night light if we switch to *solar power ?*

So let's step back and ask ourselves a more important question – are we trying to solve the right problem? Most people have no idea what it takes to generate and deliver the electricity (the so-called "grid") we take for granted in the modern world. In fact, many just think electricity is something that comes out of the wall outlet. What we all want is that when we turn on the switch, or plug in our phones, it just works. We are not in any way prepared for a world in which we say – oh, it's cloudy so we better not charge our iPhone today! I love the recent TV ads where BMW is explaining how they build their new I3 electric car in wind powered factories. Yet, do any of us really think that on days when it is not windy, these factories sit idle? No, of course not.

In most advanced economies around the globe we have achieved a high level of reliability in electricity supply. In fact this is one of the measures that makes an economy 'advanced'. **The problem is that much of our electricity is generated with fossil fuels; primarily coal.** (Coal continues to be the largest source of Germany's electricity where BMW has its factories, at nearly 50% of total supply). And along with this comes both pollution and a high level of carbon emissions. Therefore, the only way to address these environmental issues is to reduce the use of fossil fuels, not to eliminate an integrated grid.

Just like being connected to the internet improves our lives, so does being connected to a reliable electricity grid. Do we really want to live a life where if it is cloudy for a few days and our batteries run dry we do without? Of course not. Just imagine how much excess battery capacity we would each need to avoid this possibility. Even Elon Musk notes that his battery is currently for emergency backup – not for daily use – and yes it would be great to have some amount of reasonably economic backup for when we experience an outage. But as is starting to be seen in California where there are numerous discussions of the "duck curve", people want it all – they want to generate their own electricity when they can believing this is the best approach, but they also want the system to be there just in case they need it; and at a moment's notice. The result – higher costs all around. The less the grid system is used, the more it costs to keep the infrastructure in place to make up the shortfall when needed.

The answer is simple, let's take what works and make it even better. That is a large interconnected grid that includes large scale reliable economic generation based on nuclear power, and hydro where available, supplemented by wind and solar depending upon the local availability of these resources. To be reliable and cost effective, a system needs generation that can run all the time, not just when the wind

is blowing or the sun is shining. As storage technology improves, it can then contribute to both help manage the intermittency of renewable generation as well as flattening the demand curve to enable an even larger share of nuclear generation.

Remember, our economy, and in fact our very way of life, is completely dependent upon the availability of reliable, clean and economic electricity. So while we may dream of not needing the grid as we each generate our own electricity, what we really need is a strong well interconnected grid made up of reliable economic nuclear power as its work horse, with wind, solar and other forms of generation contributing when they can; all coupled with new forms of large scale storage to both even out demand and supply. Now this is more likely to be the system of the future.

It’s time to put nuclear on the offensive – and make it the low carbon energy generation option of choice

Have you ever seen something that just amazed you? We were wowed by a recent YouTube video showing what the Chinese have achieved in turning conventional high-rise construction on its head. A 57 story building was built in 19 days – yes – 19 days! Who would ever believe this could be possible? I live in Toronto, a city that has been undergoing a huge hi-rise building boom over the last few years and the time it takes to build these tall towers can be measured in months and years,

not days. This just shows what can be achieved when the imagination is let loose and innovation results in outcomes never before thought possible.

We first wrote about the importance of innovation in the nuclear sector last year. In its history nuclear power has shown incredible innovation, leading the way in a range of technologies especially with respect to delivering a level of safety and security not seen in any other industry. More recently there have been dramatic improvements in operations as the global fleet has reached a level of performance never even dreamed of in the early days of the industry. Current new build projects are using the most up to date methodology in modularization and other advanced construction techniques.

And yet when the IEA issued the 2015 version of its Energy Technology Perspectives (ETP 2105) report focusing on the need for energy technology innovation if the world is to address climate change; it doesn't mention this innovation, nor does it include discussion of potential future innovation with respect to the nuclear option.

As stated, *"Energy technology innovation is central to meeting climate mitigation goals while also supporting economic and energy security objectives. Ultimately, deploying proven, cost-effective technologies is what will make the energy system transformation possible. Continued dependence on fossil fuels and recent trends such as unexpected energy market fluctuations reinforce the role of governments, individually and collectively, to stimulate targeted action to ensure that resources are optimally aligned to accelerate progress. Establishing policy and market frameworks that support innovation and build investor confidence over the long term is a first-order task to deliver."*

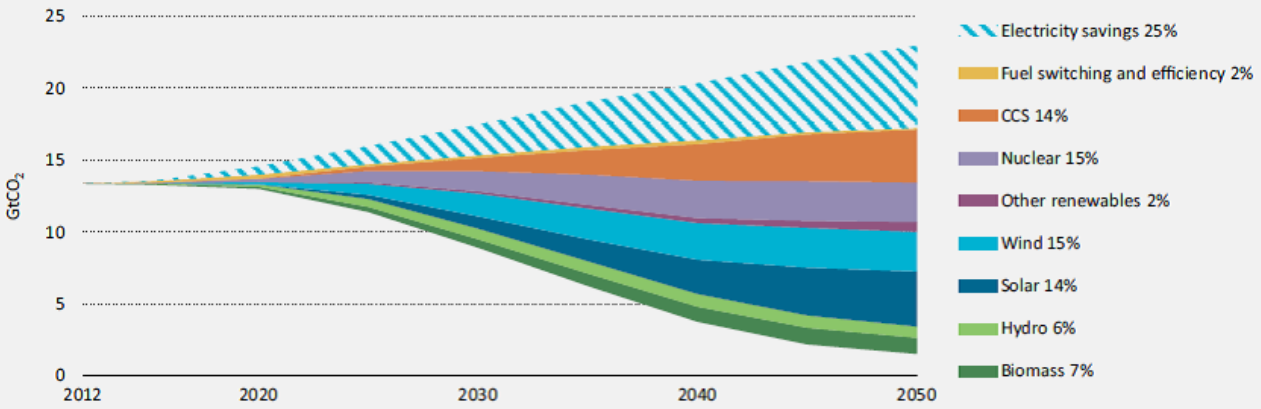
The report is clear when it says that "*Innovation support is crucial across the low-carbon technology spectrum".* The

discussion focuses on renewable technologies in the short term due their relative readiness and lack of a need for long term investment in development; and carbon capture (CCS) in the medium to longer term even though it requires substantive investment in development as it remains essential to address the large number of fossil plants being built and still in operation by 2050 that will require decarbonizing.

As usual, the same issues that have plagued nuclear for the last 30 years; primarily public acceptance issues, mute a positive discussion for the nuclear option. While recognizing its importance in achieving increased energy security, diversity of fuel supply and lower emissions, the report goes on to state "t*his awareness has yet to be translated into policy support for long-term operation of the existing fleet and construction of new plants" … "to recognize the vital contribution that nuclear energy can make."*

Yet the actual IEA scenarios have changed little from last year. As shown below, when considering technologies individually (rather than grouping into "renewables"), nuclear actually plays the largest role of any single technology in meeting carbon reduction targets showing that, even as it is stands today, the nuclear option is absolutely essential to moving to the IEA 2 Degree Scenario (2DS).

Figure 1.11 Key technologies to reduce power sector CO_2 emissions between 6DS and 2DS



Note: Percentage numbers refer to the contribution of the technology area to the cumulative CO_2 reduction between the 6DS and 2DS over the period 2012-50.

Key point *Electricity savings in the end-use sectors would stabilise power sector emissions at levels slightly above today's; a portfolio of low-carbon generation technologies is needed to sufficiently decarbonise electricity for 2DS targets.*

This can only be the case if nuclear is currently meeting its responsibility to be economic and reliable while being an essential large scale low carbon option. Given that we know the largest challenges in building new nuclear plants is related to their relatively high capital costs and long project schedules relative to other options; consider the role nuclear can play if improvements similar to those demonstrated in the Chinese YouTube video were implemented. Not marginal improvements, but mind blowing changes in approach that shake current thoughts about the costs and schedules of nuclear projects to their very core. This is the way forward. While discussion of next generation plants and SMRs is of interest, we need continued innovation that takes what we know now and improves it beyond what anyone can imagine.

The report shows that government investment in nuclear R&D has been dropping and in renewables has been increasing. This investment must be refocused on project improvement and innovation rather than the traditional areas of research such as safety and waste management where it has been spent for decades. While important for the nuclear industry, too much of

this spending is focused in these areas just to pander to the ongoing public beliefs that safety and waste issues remain unresolved. Rather, emphasis should be on continuing to improve new build project performance. Let’s think about new build nuclear in the same way we think about renewable technologies; that more investment and research will lead to shorter construction schedules and lower costs. It is time to let the innovation genie out of the bottle, stop being on the defensive and move forward with great things. With changes like this, the nuclear share will grow well beyond current expectations bringing a real solution to climate change while keeping electricity bills low and system reliability high.

So remember, nuclear power is essential in achieving increased energy security, diversity of fuel supply and lower emissions; and is already expected to have the largest impact on meeting climate goals of any other single technology. Today’s plants are economically competitive and provide safe and reliable electricity. Talking about investing in energy innovation without a discussion of investing in nuclear, when it’s currently the best option available, is absurd. Governments need to recognize the incredible innovation already achieved by the nuclear option, and unleash even greater potential by investing in this well proven technology.

A nuclear future means clean, reliable and economic electricity; yet fossil fuels

reign supreme

This past month, following the fourth anniversary of the Fukushima accident, it is good to see there is less emphasis on the nuclear accident and more discussion of the significant natural disaster – the tsunami and earthquake that killed some 20,000 and destroyed so much, leaving 300,000 homeless. It is now clear that the nuclear accident will not be a cause for radiation-induced cancer, food is not contaminated, and most people can return to their homes should they so desire. While there continues to be a big mess to clean up and many important lessons in managing nuclear accidents to learn, there is no disaster in terms of either immediate or long-term health impacts. Yet we still see news such as was reported this week- that Fukushima radiation has reached the west coast of Canada – one then has to read the report to find out it is so minute as to be a non-event.

So now 4 years on, if we look at China one could conclude the nuclear industry is booming. CGN reported 3 new units were connected to the grid in March, with 2 more expected to be connected within this year. Overall China now has 24 units in operation and another 25 under construction targeting 58 GW in service by 2020 and then accelerating from there to bringing as many as 10 units per year into service in the 2020s targeting about 130 GW by 2030. Two new reactors have just been approved in the first approvals for new units post Fukushima. In addition to this, China is now developing its Hualong One reactor for export as it strives to become a major player in the global nuclear market.

China Hongyanhe 3 completed

China’s commitment to nuclear power is strong and unwavering. An important reason for this rapid expansion is the need for clean air. Pollution in China is a real and everyday problem for its large population. The Chinese see nuclear power as path to ultimately reducing their need to burn coal and hence help the environment.

On the other hand, in Germany a decision to shut down some nuclear units in 2011 immediately following the Fukushima accident and to close the rest by 2022 has led to a large new build construction program of lignite-fired units to meet short term energy needs. With several under construction and some now in operation, coal is producing about half of Germany’s electricity. Keep in mind that these new plants will likely be in service until about 2050. This is while Germany supposedly is focusing its energy future on ensuring a cleaner environment using renewables. I would expect their goal would be easier to reach without a number of new coal-fired units going into operation to replace clean carbon free nuclear energy.

The lignite coal fired power plant Frimmersdorf

It is with these two extremes in mind that I noted when attending the Nuclear Power Asia conference in Kuala Lumpur this past January that while almost all South East Asian countries are planning to start nuclear power programs, they have had little success in getting them off the ground. Currently Vietnam is in the lead and countries such as Indonesia and Malaysia are continuing with their plans, but with little progress. For example, Indonesia has been talking about nuclear power for more than 30 years. With a need for 35 GW of new capacity in the next five years and an annual expected growth of 10 GW per year after 2022, it is easy to ask why a decision for new nuclear seems perpetually stalled while there has been no problem building new fossil plants.

While in Malaysia I couldn’t help but think – why is it so difficult to make a decision to invest in new nuclear plants, especially for first-time countries? Is it a fear of nuclear itself and the issues associated with public acceptance – or is it the commercial aspects whereby nuclear plants have relatively large capital expenditures up front raising

financing and risk issues? Or, more likely, a combination of the two.

At the same time as decisions on new nuclear seem to be so difficult to take, literally hundreds of coal plants and thousands of gas fired plants are being built around the world. If the environment is actually important, why is it so easy to invest in fossil stations and so hard to invest in nuclear? One simple answer is the size of the global fossil industry. Countries like Indonesia and Malaysia have huge industries with fossil fuel development being an essential part of their economies. The public is comfortable with this industry and many either work in, or profit from the industry in some way. The same is even true in Germany, where coal and lignite mining is entrenched. While committed to reducing hard coal use over time, once again this is an important industry in the short term.

For a country looking at nuclear for the first time, like those in South East Asia, there has to be a strong base of support to get the industry off the ground. They need to be serious about their consideration of the nuclear option, not just dabbling with little real interest. While these countries have modest research and other programs, there is simply not enough going on nor a strong belief that there are no alternatives to garner the political support to move forward. Starting a nuclear program is a large undertaking and the fear of securing public support and concerns about safety and financial ability to support the program are paramount. This makes it difficult for decisions to be taken. A strong and committed view from within government is needed and this can only be achieved with a strong need for energy and an even stronger belief that the public is on side.

China has passed this milestone and now has a large and vibrant domestic industry. Government support is assured so long as the industry continues to thrive. To the Chinese, the issue is clear. Nuclear plants are economic and their

environmental benefits are essential to helping solve their huge environmental issues. The Chinese have CONFIDENCE in their ability to deliver safe, economic and reliable nuclear power stations.

On the other hand, the Germans have decided their fear of nuclear is stronger and more urgent than their need to reduce their carbon emissions in the short term even though they had a large and strong domestic nuclear industry. In this case, Germany is an outlier and to this end they justify building new coal units even when their overriding goal is environmental improvement.

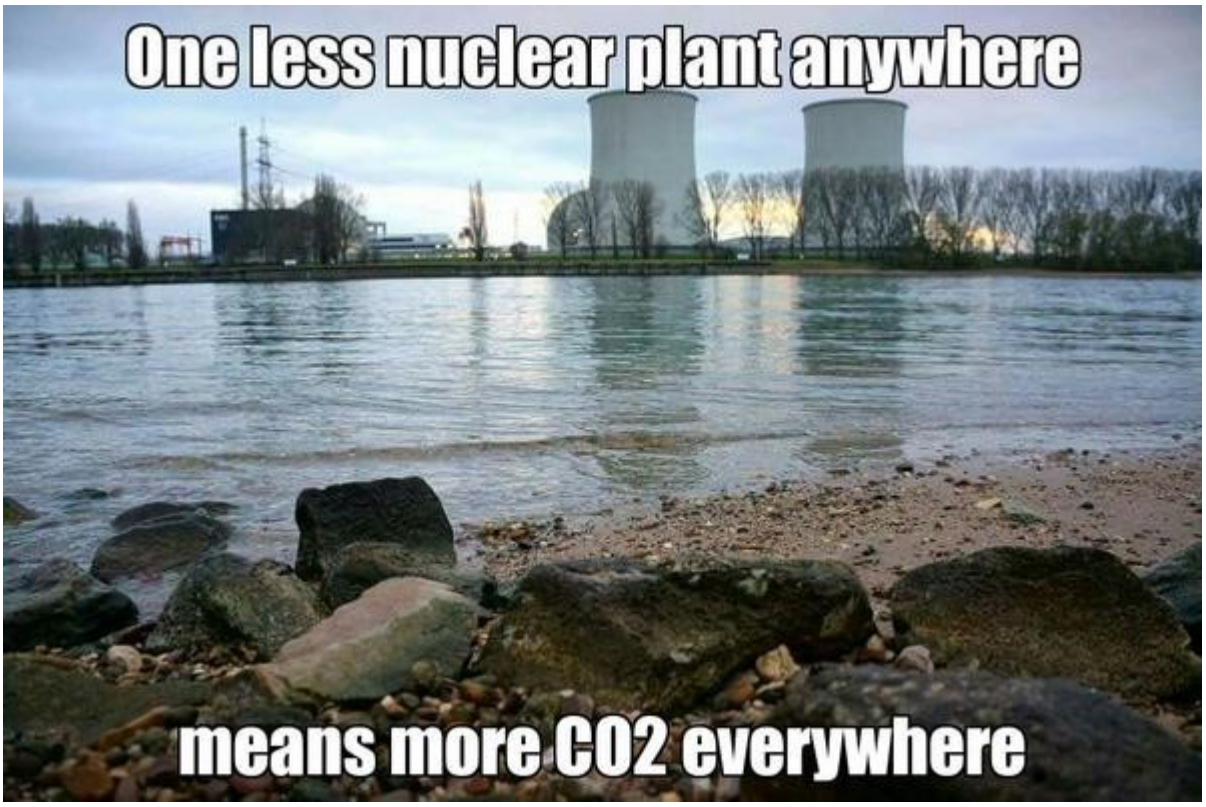
I am confident that nuclear plants will expand their already important role in the future electricity mix of the world and, as such, the industry needs to find new and innovative ways to make taking a nuclear decision easier. This includes ways to gain a higher level of public support, ensure that project risks are manageable and that costs can be kept under control. In some future posts, we will talk about some of these ideas and how we can unlock the global nuclear potential.

As 2014 comes to a close, nuclear power is at a crossroads – again!

The world needs nuclear power – so says the latest edition of the World Energy Outlook (WEO) issued in November. *"Nuclear power is one of the few options available at scale to reduce carbon-dioxide emissions while providing or displacing other forms of baseload generation. It has avoided the release of an estimated 56 gigatonnes of C02 since 1971, or almost two years*

of total global emissions at current rates."

Yet looking back at 2014, the industry has had its ups and downs. There were setbacks as France formalized its intention to reduce its reliance on nuclear going forward, Sweden pulled back after its most recent election, and in Finland the Olkiluoto 3 project was delayed once again. In the US, the most recent plant to be shutdown is the Vermont Yankee plant; shutdown after 42 years of operation as not being economic, yet its shutdown will definitely raise electricity costs for its consumers and impact the local economy as a result of its closure-related job losses.



Vermont Yankee shuts down

There was good news in Japan as the first units were approved for restart since the 2011 Fukushima accident, although the actual restarts are taking longer than expected. The re-election of the Abe government also bodes well for Japan's nuclear future. In the UK, there was a big win as Europe approved the project at Hinkley Point as not contravening state-aid rules; but once again progress is slower than most

would like.

And then there are places where nuclear power is booming. China brought new units into operations and approved numerous new units with a larger-than-life target for its nuclear share in 2020 and beyond. The Chinese also approved its first Hualong One reactor, the evolution and combining of designs from both CGNPC and CNNC, as they plan for future exports. Korea approved new units and its first new site in decades. Russia continues to grow both domestically and continues to be very aggressive in the export market.

Given the importance of nuclear power, it is the first time since 2006 the WEO includes a special chapter on nuclear – in fact this time 3 full chapters performing a detailed in-depth analysis of the nuclear option. It clearly demonstrates the benefits of nuclear power in addition to being one of the only generation options at scale available to reduce carbon emissions; it also plays an important role as a reliable source of baseload electricity that enhances energy security. Clearly the benefits and the need for more nuclear is becoming clearer than ever. So why is there this continuing imbalance as we look around the world at various counties' policies for nuclear power?

The WEO notes two significant issues holding back a large-scale nuclear renaissance. These are public concern and economics. Both are valid and need to be better addressed by the industry. We have written much over the past year or so on the importance of improving public attitudes and, in fact, in many countries we now see improvement. But we also acknowledge there is a long way to go to reduce public fear about nuclear power. For example, even though the main objective of Germany's Energiewende is to reduce carbon emissions; their even stronger emotional response against nuclear is causing a short term increase in carbon emissions .i.e. their fear of nuclear is stronger than their desire for a cleaner environment.

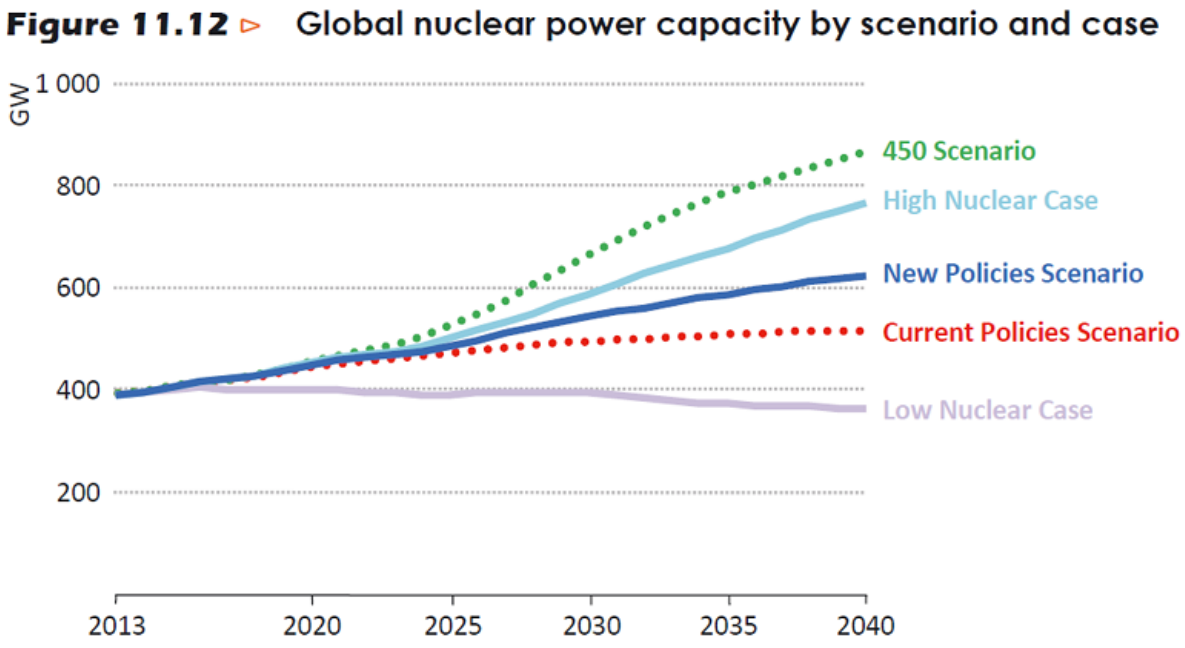
On the cost side, concerns about high capital costs and completing projects to cost and schedule are valid. The industry has more work to do on this issue as evidenced by some recent projects. At the same time we see that countries such as Korea and China, who are building series of plants in sequence and are achieving the benefits of replication and standardization resulting in lower costs and improved certainty, are completing projects to cost and schedule. Yes, it can be done. But even these countries are not immune to public concerns.

The real problem is that these concerns tend to overwhelm the discussion even amongst energy professionals. For example the summary in Chapter 12 of the WEO, "The Implications of Nuclear Power", starts "*Provided waste disposal and safety issues can be satisfactorily addressed, nuclear power's limited exposure to disruptions in international fuel markets and its role as a reliable source of baseload electricity can enhance energy security…..* ". Renewables are always addressed with hope and little concern for their very real issues while discussions about nuclear are most often focused on its challenges.

Yet even at Google, engineers have come to a conclusion that the challenges to achieving climate goals with renewables are very large. Two Google engineers assigned by the company to show how renewable energy can tackle climate change each came to a blunt conclusion: It can't be done. As stated, "*Trying to combat climate change exclusively with today's renewable energy technologies simply won't work; we need a fundamentally different approach*."

The following figure sums it up very clearly. In the case that doom and gloom overwhelms good policy and decision making, we may end up with the Low Nuclear Scenario. But this scenario has real implications – "*taken at the global level, a substantial shift away from nuclear power, as depicted in the Low Nuclear Case, has adverse implications for energy security, and economic and climate trends, with more severe*

consequences for import-dependent countries that had been planning to rely relatively heavily on nuclear power." Of more importance, at the other end of the spectrum is the 450 Scenario which the IEA believes we need to achieve to truly have an impact on climate change. And in this case, even more nuclear power than the so called "High Nuclear Case" Is needed.



So there it is, the best way to economically and efficiently address climate change is with a substantial contribution by nuclear power. This year's WEO lays out the challenge very clearly – once gain nuclear power is at a crossroads. The options range from a slow decline to a more than doubling of nuclear power in the next 25 years. Nuclear power must be an important part of any future low carbon energy system but there are beliefs that are very well entrenched in the minds of both the public and even many global energy professionals that must be addressed once and for all. It is our responsibility to take on these challenges for a brighter future. It's time to go big and work together to build a strong base of global support for nuclear power. Beliefs are hard to change, but change them we must if we are to have a sustainable, abundant and economic energy future for us all.

And as 2014 comes to a close, I want to thank all of you for continuing to read our blog and contribute to the discussion. Wishing you all a very happy, healthy and prosperous 2015!

The challenge of financing nuclear plants – financing energy requires huge investment

Quite often we hear about the problem of attracting financing to support new build nuclear projects. In fact financing will be a topic of major interest at a number of upcoming nuclear conferences. While it is easy to agree that financing nuclear projects is a big challenge, in my view difficulty securing financing is not the issue – rather it is a symptom of a number of other very important issues that are the root cause. Necessary conditions to secure financing for any project is first and foremost, an economically viable project. Next comes the project structure – or to state it more simply – ensuring the risks are managed in a way that can satisfy investors that they will receive an adequate return for their investment. These concepts will be discussed further in a future post.

For today, I will look at the $40 trillion energy industry and consider nuclear's share of the overall expenditure needed for energy over the next 20 years. I would like to put some context on the issues related to financing nuclear plants by looking at a recent IEA report called the "World Energy Investment Outlook" or WEIO. I found this report of interest

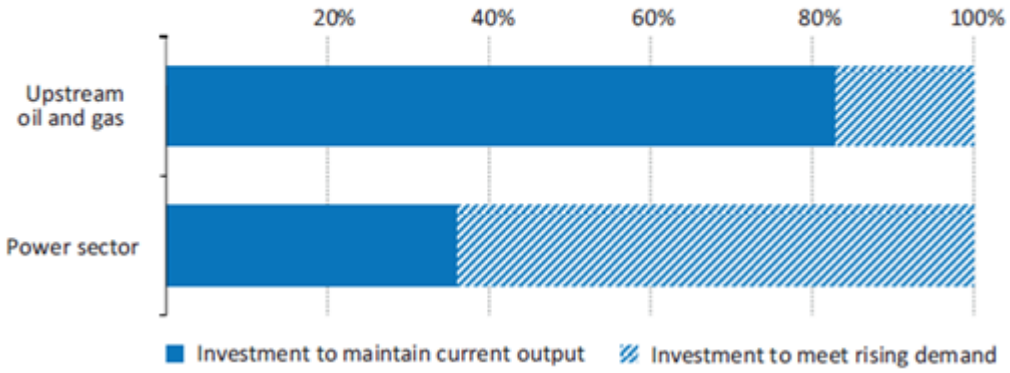
because it provides useful data on global funding required to support energy. Or as stated in the Forward to the report "…. *data on today's investment flows have not been readily available and projections and costs for tomorrow's investment needs are often absent from the debate about the future of the energy sector*."

We often talk about the large size of nuclear projects and how they require huge amounts of funds. Nuclear projects are very capital intensive and have relatively long project schedules; both important issues when trying to secure financing. When we talk about large, a good first step is to try and understand how much funding is required for nuclear projects relative to the rest of the energy industry. And for this we turn to the WEIO.

With annual spending in 2013 of $1.6 trillion rising to about $2.0 trillion by 2035, meeting global demand for energy requires an enormous amount of money. This excludes another $500 billion or so per year to be spent on energy efficiency to try and moderate this growing demand.

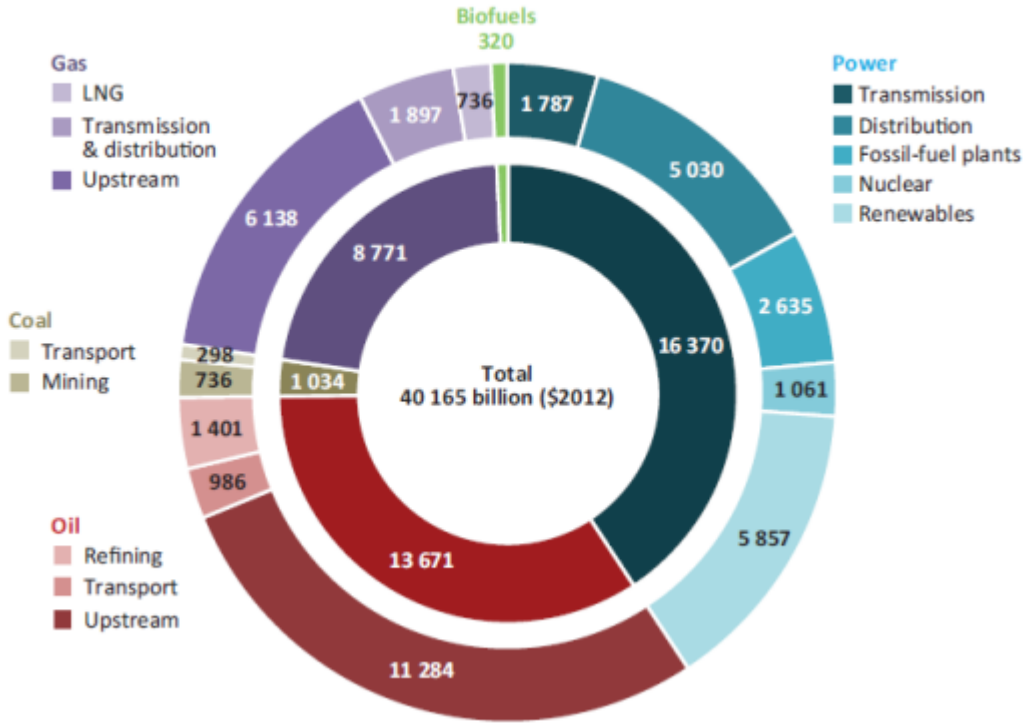
Of even more interest, the report specifies that less than half of the $40 trillion dollars required to meet energy demand between today and 2035 goes to meet demand growth; the larger share is required to offset declining production from existing oil and gas fields and to replace power plants and other assets that reach the end of their productive life.

Figure 1.5 ▷ Share of investment required to keep global output at current levels versus total investment required in the New Policies Scenario, 2014-2035



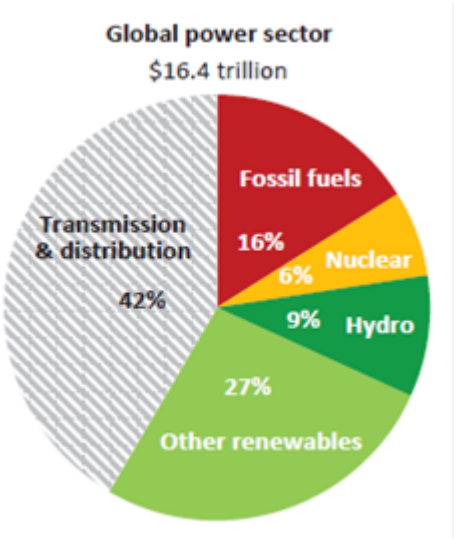
A staggering statistic – more than $20 trillion is required over the next 20 years just to stand still. And of course, most of this investment is in fossil fuels that continue to emit carbon as the world tries to find a way to turn the corner and find alternatives.

Figure 1.3 ▷ Cumulative global energy supply investment by type in the New Policies Scenario, 2014-2035



If we drill down and focus on the electricity sector, we can see that of the above $40 trillion about $16.4 trillion is investment in the electricity sector. The largest component of

this investment (about 40%) is in transmission and distribution. In the developed world this essential infrastructure is ageing and requires significant investment to meet growing needs. In the developing world, there is a huge need to build up the infrastructure for a population hungry to enjoy the benefits of using electricity.



Looking further we can see two important facts. First, nuclear power only needs about 6% of the funds for the electricity sector; this is assuming the very modest growth for nuclear in the WEO New Policy Scenario. The other is that renewables are demanding a very large share of the available funds as more and more markets turn to these forms of energy to meet their growing energy needs while trying to curb carbon emissions.

What can we learn from this high level look at the funding requirements for the energy industry? On the one hand, nuclear projects require only a very small portion of the total funds being invested today and for the next 20 years in energy. The main uses of funds are to replace existing depleted fossil fuel reserves – usually at a cost higher than the resources they replace; to invest in critical T&D infrastructure, in part due to the need to expand transmission to be able to accommodate renewable energy generation; and the investment in renewable energy generation itself, virtually all of this last

investment subsidized by governments to encourage growth.

On the one hand, there is tremendous competition for funds in the energy industry meaning nuclear projects need to be an attractive financial proposition to get its share of these funds. And on the other hand, much of the competing technologies are being supported by governments with subsidies based on policy decisions.

So what is it that makes nuclear plants so difficult to finance? As I said at the start of this post, there are a number of issues that need to be discussed. These include project economics, energy market structures, poor project construction performance in a number of markets; and of course, public perception that skews the risk profile of nuclear projects in a way not seen in other industries. But a discussion of these factors will have to wait until another time…….

Note: all figures above are from the IEA World Energy Investment Outlook.

As a solution for climate change – nuclear power is falling behind

Recently, the 2014 edition of the International Energy Agency's (IEA) Energy Technology Perspectives (ETP) was issued. The ETP is issued on a two year cycle; the current edition takes the World Energy Outlook 2013 forecasts and looks to the longer term out to 2050. With climate change now becoming even more pressing I thought it would be interesting

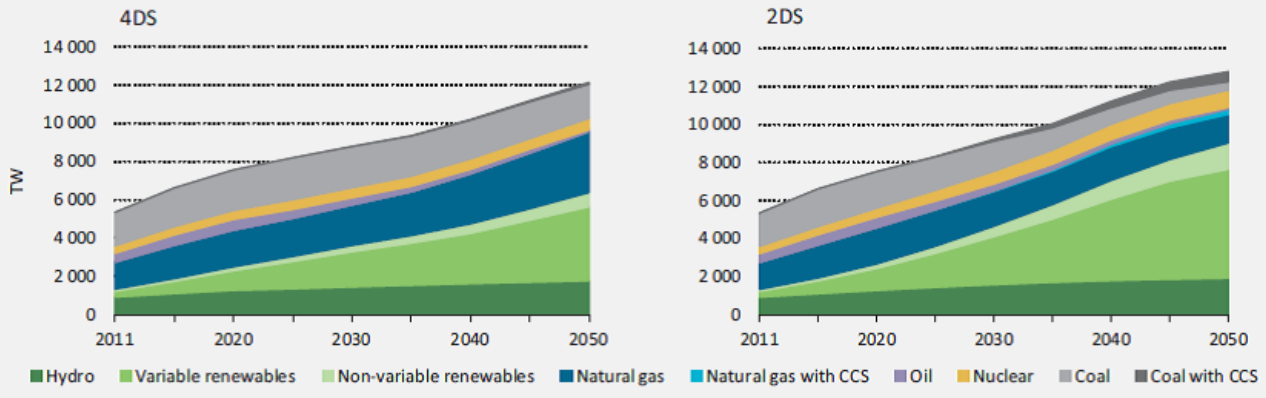
to see the progress over the last two years (I wrote about the 2012 edition back in June of that year). According to the report, as an important contributor to meeting climate requirements going forward, nuclear power is falling behind.

On the positive side, the IEA sees the opportunity by which "*policy and technology together become driving forces – rather than reactionary tools – in transforming the energy sector over the next 40 years.*" The report looks to balance energy security, costs and energy-related environmental impacts. But in the end it concludes that "*Radical action is needed to actively transform energy supply and end use*. "

Why is radical action required? Of all the technologies required to meet the 2D target (this scenario sets a target of only 2 degrees C change as compared to 6 degrees in the status quo scenario), the IEA suggests that only renewables are on track while pretty much every other clean technology is not moving fast enough. Two important technologies not meeting targets are Carbon Capture and Storage (CCS) and Nuclear Power. To no one's surprise, CCS has yet to be proven and become a viable commercial option to de-carbonize fossil fuel emissions. As for nuclear power; after the Fukushima accident, growth has been slower than previously predicted and is expected to be 5 to 25% below the level required by the 2D scenario in 2025.

This leaves much of the burden on renewables to meet the need for lower carbon emissions. Surprisingly, in the hi-renewables scenario, solar becomes the dominant source of electricity reaching 40% penetration by 2050. Realistic or pipe dream? I don't know. One thing is certain, (see chart below), with almost half of future electricity generation coming from variable renewables, compared to almost nothing today, the IEA is demonstrating the need for a huge technology transformation in how the world generates electricity.

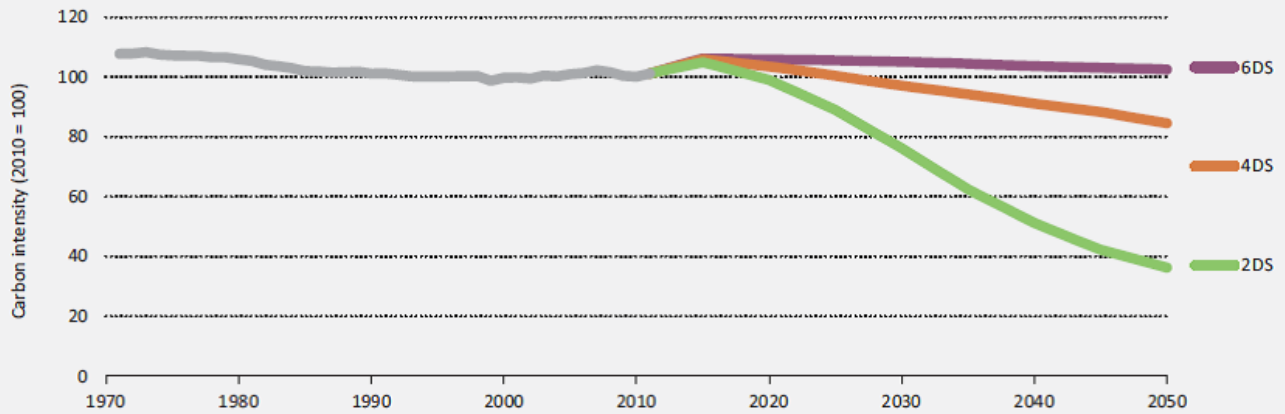
Figure 3.4 Global electricity generation capacity by technology



Note: TW = terawatts.

The following chart is the most telling of all. Over the past 40 years carbon intensity (the amount of carbon emitted per unit of energy supplied) has barely budged. Almost no change at all. Yet now we require the carbon intensity to be cut in half in the next 35 years (meaning less than half as much carbon produced per unit of energy supplied). This requires a complete change in how energy is delivered.

Figure 1.1 The Energy Sector Carbon Intensity Index (ESCII)



Notes: the ESCII illustrates the aggregate impact of technology shifts on carbon emissions in the energy sector. It measures how many tonnes of CO_2 are emitted for each unit of energy supplied. Under the ESCII, 100 represents CO_2 intensity in 2010, providing a base to measure progress. Unless otherwise indicated, all tables and figures in this chapter derive from International Energy Agency (IEA) data and analysis.

Key point *The carbon intensity of the global energy supply improved only slightly over the last 40 years, but with growing energy demand, annual emissions have increased by more than 17 gigatonnes (Gt) of CO_2 per year.*

The reason is simple. Fossil fuels still represent 80% of

global electricity generation and most of the energy used for transport. To disrupt the curve requires going off fossil fuels to cleaner alternatives. To achieve the 2D scenario, electrification is paramount given the option of generating electricity with clean alternatives. Fossil fuel use must then be cut in half to about 40% of electricity generation and much of the remainder makes use of CCS to reduce its carbon footprint. The report notes that gas must only be a bridging technology to support renewables in the short to medium term as gas still represents a major carbon source. So what's left? Solar and wind to replace fossil fuels and CCS to make them cleaner.

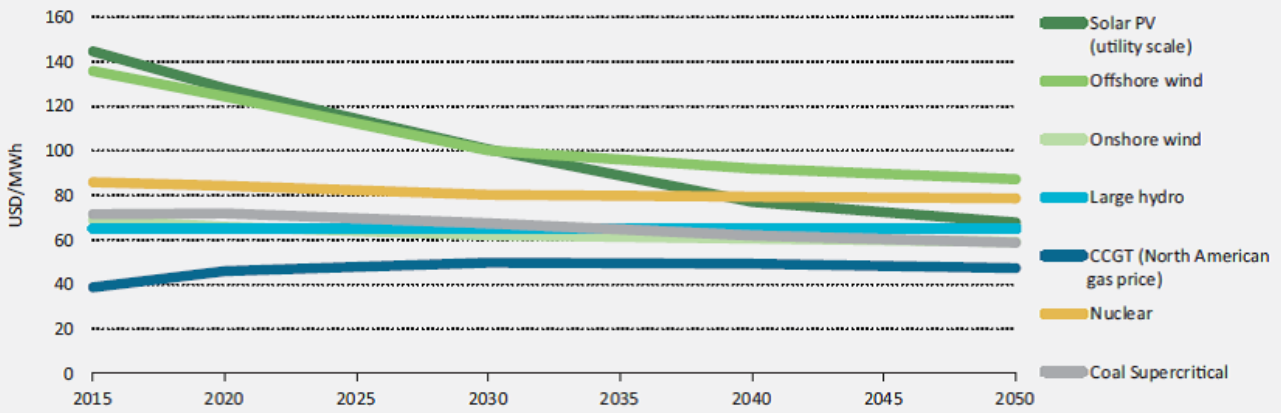
Of course nuclear power is an obvious candidate to make a larger contribution. It is a mature technology and already is an important source of low carbon energy. Given its energy intensity it is certainly feasible to implement more nuclear power on a very large scale. And even with recent set-backs, there are now clear signs of renewal as the industry puts the Fukushima accident behind it.

For example, China continues to expand nuclear power at an ever increasing pace. Japan has reconfirmed its commitment to nuclear although restarts are slower than anticipated and the ultimate level of nuclear in post-Fukushima Japan remains unknown. Russia is increasing its commitment to nuclear and, of most interest, is becoming a major exporter offering innovative risk and financing structures that have not been seen in the market to date. Other markets are also starting to move; the latest being Hungary which has just approved a new plant for the PAKS site. However some other important nuclear markets are having challenges. Korea has cut back its long term plans and France is looking to limit the contribution of nuclear power in the future.

While nuclear power has challenges with public acceptance, this report notes the commercial issues – economics and implementation risk. As can be seen in the following chart,

the IEA estimates nuclear to be the most expensive option after off-shore wind. I have not had time to delve into the details and review the numbers. However, taking this at face value, we know that some projects in the west are not doing as well as they should be. On the other hand, standardized series-build in countries like China and Russia are demonstrating a strong path to lower project costs and risks.

Figure 8.1 *ETP's LCOE excluding a carbon price*



Notes: unless otherwise noted, material in all figures and graphs in this chapter derive from IEA data and analysis. PV = photovoltaic. CCGT = combined-cycle gas turbine. MWh = megawatt hour. Figures and data that appear in this report can be downloaded from www.iea.org/etp2014.

Key point *Based on LCOE, low-carbon technologies remain more expensive than generation from fossil fuels over the transition period to the 2DS.*

There is no hi-nuclear scenario in this edition of the report. That is quite unfortunate as a strong renewed commitment to nuclear power is a very good way to help move this plan to achieve a 2D future become a reality. By stating that nuclear power is not meeting expectations, the report lays out a clear challenge. Now it's time to show the nuclear industry is up to it. If we really want to bend the carbon intensity curve, then more than ever, the world needs more nuclear power as an important part of a low carbon future.

The British are coming – new nuclear committed in the UK

After many years of effort, this month it finally happened. The UK government and EDF Energy, the French-owned UK integrated energy company, agreed to a strike price making the first new nuclear build in the UK in a generation, at Hinkley Point C, a reality.

It was a long hard road. New nuclear first came up about a decade ago when it became clear that Britain's nuclear fleet was aging and would soon need to be retired. At that time British Energy was advocating to replace the existing fleet with a new fleet over the coming two decades. Unfortunately the timing was not right. Late in 2002 British Energy got into severe financial trouble requiring a significant restructuring to keep it solvent and early in 2003 the British government declared war in Iraq. Both of these events made it difficult for the then Labour government to take on the issue of new build nuclear. So in 2003 the Energy White Paper issued by government focused on reducing carbon emissions primarily with renewables and nuclear was but a footnote as government declared its intention to "keep the nuclear option open".

What a difference a decade makes. Over the ensuing years as it became clear that renewables on their own would not be able to carry the load if carbon targets were to be met and concerns about security of supply as the UK became a net importer of energy (primarily Russian gas); once again government turned to nuclear energy. The history of events over this decade it too long to describe here although I think it would make an excellent business or public policy school case study.

Slowly the issues were tackled one by one through aggressive

policies that resulted in among other things: EDF Energy buying British Energy, the creation of a generic design approval process by the regulator, changes to the electricity market to support non carbon producing projects to be built; and most of all – continuing effort to support positive public opinion even after the Fukushima accident in Japan.

And this is all in the context of the UK slowly and deliberately dismantling its domestic nuclear industry. The UK was an early leader in the development of nuclear power in the 1950s. Over the next 40 years it developed a large domestic infrastructure culminating with the transition to PWR technology at Sizewell B to the extent that in the 1990s BNFL actually bought the Westinghouse nuclear business – Britain was back in the nuclear business as a vendor.

Yet over the past decade, Westinghouse was sold to Toshiba, British Energy was sold to EDF and British Nuclear fuels Limited (BNFL) was completely dismantled (all at great profit to government). The new UK nuclear industry is comprised of a domestic manufacturing and services sector using foreign technology with plants being built by new nuclear operators also owned by foreign companies.

After all the hard work, the agreement reached this week is of tremendous importance to the global nuclear industry for a number of reasons.

The UK is forging ahead with a strong nuclear program while others in Europe are going in the opposite direction. Germany is abandoning its nuclear industry and even France is looking to reduce its reliance on nuclear over time. The lesson learned here is that need trumps all else. The UK is strongly committed to reducing carbon emissions; recognize they can't do it with renewables alone and are not prepared to become overly dependent upon fossil fuel imports.

The project is being built in a liberalized (deregulated)

market. Although there is much discussion about subsidy being provided by government, this project will demonstrate that a new nuclear plant can be built with outside investment in a western open market. The CFD (contract for difference) model is necessary to provide the stability needed to invest the huge sum of money required (estimated at £14 billion) with a very long payback period. In Canada this model has been used successfully to refurbish the Bruce Units 1&2 reactors but this will be the first time it is used for a longer duration and higher cost new build project.

While some are critical of the price (€92.50 /MWh) it should be clearly noted that this price is below all other forms of carbon free electricity even if it is higher than imported gas at the moment. Just imagine trying to set a rate today for a project coming into service in 2023 and then lasting for 35 years. And most of all, it has been reported that EDF Energy is expecting about a 10% return on its investment – very reasonable given the expected risk profile of a large nuclear project, especially with the experience so far in Finland and in France with new build.

So why can EDF Energy take such a risk? Primarily because this will be the 5th and 6th EPR built and the third project in Europe after Finland and France. At this point, the design is well developed, the supply chain is in place and the costs are well understood. What is new is that it is to be done in the UK and there will be new local suppliers likely taking on a significant scope.

The UK government has accepted a significant Chinese investment in the project. CGNPC, the Chinese operator of a number of nuclear plants and the constructors of the two EPRs at Taishan and its Chinese partners will bring about 30 to 40% of the money needed for this project. This is huge! First of all it is a clear acceptance of the size and strength of the Chinese nuclear program – CGNPC has the most active nuclear

construction program anywhere. And it opens up the potential to ensure the expertise from the Taishan project, arguably the most successful EPR to date, will be available to support Hinkley Point C.

The public is supportive of this project. Public support for new nuclear in the UK has become somewhat more positive in recent years, with similar proportions of people now supporting (32%) and opposing (29%) the use of nuclear power, compared to 26% (supporting) and 37% (opposing) in 2005. And of more interest, a similar number of people want to continue nuclear at current levels or with expansion (43% in 2005, 46% in 2010 and 44% in 2013), while fewer people now want to see nuclear power phased out or shut down (50% in 2005, 47% in 2010 and 40% in 2013). This is a result of a number of factors. First, there is a need for energy and nothing drives support more than worrying if the lights will go out. Second, the environmental sector is behind nuclear. The British are very serious about their commitment to reducing carbon emissions. George Monbiot came out in favour of nuclear energy within a month of the Fukushima accident. Mark Lynas has become a strong supporter and has been profiled in the recent documentary “Pandora’s Promise”.

So what can we all learn from this process? First of all developing new nuclear takes time. With a decade of effort behind this agreement, the time it took to reach agreement is just as long as the anticipated time to build the plant. A decade to get ready and now a decade to get the project into service (scheduled for 2023). Amazing isn’t it?

So to all of our friends in the UK, you have reached a critical milestone on your journey. Keep up the good work and we wish you all the best as you move to the next phase of your new build programme.

Pricing carbon in North America

It was with great interest that most of us listened to President Obama put climate change back on the US agenda in his state of the union address this month.

"*After years of talking about it, we are finally poised to control our own energy future. We produce more oil at home than we have in 15 years. We have doubled the distance our cars will go on a gallon of gas, and the amount of renewable energy we generate from sources like wind and solar – with tens of thousands of good, American jobs to show for it. We produce more natural gas than ever before – and nearly everyone's energy bill is lower because of it. And over the last four years, our emissions of the dangerous carbon pollution that threatens our planet have actually fallen.*

But for the sake of our children and our future, we must do more to combat climate change. Yes, it's true that no single event makes a trend. But the fact is, the 12 hottest years on record have all come in the last 15. Heat waves, droughts, wildfires, and floods – all are now more frequent and intense. We can choose to believe that Superstorm Sandy, and the most severe drought in decades, and the worst wildfires some states have ever seen were all just a freak coincidence. Or we can choose to believe in the overwhelming judgment of science – and act before it's too late."

The real question is will there be policy to support acting before it's too late?

I think most would agree that any strategy that would change behaviour requires an economic impact – because we all respond

to prices. This means we need a price on carbon; either a carbon tax or a cap and trade program. In the past most jurisdictions in North America have favoured consideration of the cap and trade approach as new taxes (to nobody's surprise) are very difficult to implement. In North America (in contrast to Europe) we generally believe we have a right to low cost energy and there is genuine concern that higher energy prices further weaken the economy and negatively impact jobs. And with jobs being a huge priority, many have said that there will not be any price on carbon in the foreseeable future.

But for all of those who have said there will never be a price on carbon in America, I am sorry to say – YOU ARE WRONG. Today there is a price on carbon – the only problem is that it is negative. That's right – its negative. In other words, we have significant subsidies on oil and gas that encourage more production and consumption; whereas pricing carbon positively would encourage reduced oil demand and use of lower carbon alternatives.

The 2012 World Energy Outlook (WEO) shows ever-growing subsidies to fossil fuels. It only considers consumer and consumption subsidies, commonly applied in the developing world and in oil producing countries. In 2011, this subsidy amounted to almost $300 billion, far greater than any other form of energy.

In North America we do not provide consumer subsidies for oil but rather producer subsidies in the form of tax relief through various exemptions and special provisions in the tax code. Most talks by President Obama have quoted the cost of these subsidies at about $4 billion per annum federally (some estimates show that state subsidies are many times greater than the federal subsidy). In Canada, subsidies to the oil industry are estimated at about $2.8 billion per annum (both federally and provincially).

The argument in support of these subsidies is that they are generally intended to encourage drilling, agreeably a very risky endeavour. The arguments against fall into two categories: first there are many subsidies that have outlived their usefulness but somehow are never removed from the books; and second, that at a price of over $100/bbl, oil companies are making record profits (the three largest oil companies made profits of $80 billion or $200 Million/day in 2011) so they shouldn't need subsidies to encourage them to find more oil, i.e. the current price of oil is incentive enough.

Examining the subsidies a bit further, we can calculate the cost (if you see any errors in my calculations, please let me know). Using production data from the WEO 2012, we can take $4 billion and divide it by 8.1 mb/d in the US and take $2.8 billion and divide by 3.5 mb/d in Canada. The result is about $1.35/b in the US and $2.20/b in Canada. Assuming a carbon content of about .43 t/bbl would result in a subsidy cost per tonne of carbon of just over $3 in the US and about $5 in Canada. The US number is smaller because it is limited to federal subsidies while the Canadian number is for both federal and provincial subsidies. What this shows is that carbon indeed has a price and it is negative, i.e. it incents more fossil, rather than less or alternatives.

So let's take this one step further. Again going back to the WEO, they assume a carbon price reaching $45/t in the New Policies Scenario (base case – continue down the current path) rising to $120/t in the low carbon 450 ppm scenario. Or to put it more simply, a large positive price on carbon (equivalent to $20-50/b) rather than the current subsidy (i.e. negative price) is required to move the world to a low carbon scenario that will actually have an impact on climate change.

In summary, if a price on carbon is a key tool to help reduce fossil fuel use and combat climate change, then we are clearly going in the wrong direction. Because yes, today we do have a price on carbon in Canada and the United States – and it is

negative.

Note to readers – I did not comment on the benefits of nuclear in this blog as I was focused on making a point about the impact of subsidizing oil and gas prices. There have been a number of other blogs that have done a good job on this point. See Steve Alpin's blog showing how Ontario in Canada has drastically reduced its carbon emissions through increasing production from its nuclear fleet while reducing coal use. There is also the point to be made about how large a subsidy is required to implement renewables even with large carbon prices. And there is the pressure that most are expecting to come to Canada from the US in exchange for approval of the Keystone pipeline. But we will leave that for another day……

Nuclear competitiveness and the folly of forecasting

Hard to believe we have already come to the end of another year. It was a year with both highs and lows for the nuclear industry. I will talk about this more in the new year. But for today, I wanted to close out 2012 by writing about something that I have been thinking about since I first addressed it in September of 2011 – gas prices.

It was about a year and a half ago when the then president of Exelon gave a speech to the ANS noting that "Nuclear is a business, not a religion". The premise was that nuclear needs sustained high gas prices to be competitive. Since that time it has become a given that gas prices in North America are low and predicted to stay low for some time; the result being that

new build nuclear plants are not competitive in this environment. It is said in almost every article and discussion of the future of nuclear in North America. i.e. we love nuclear but low gas prices are making it impossible at the moment (albeit more in the US than in Canada).

And indeed, this was the year that gas prices seemed to go lower than anyone could have imagined. Earlier this year the price actually dropped below $2/mmBTU and has stayed roughly in the mid $3 range ever since.

But this is the point. Predictions are just that – predictions – and in most cases are notoriously wrong. Just look at the change in prices from 2008 until now. And I can assure you that in 2008 no one was predicting this to be the case.

I first cited Dan Gardner's book "Future Babble" in my post of August this year. I loved this book. It was good fun to read and I strongly recommend it. Basically the book explains why expert predictions fail and why we believe them anyway. It includes some fun anecdotal examples. "*In 1984, the Economist asked sixteen people to make ten-year forecasts of economic growth rates, inflation rates, exchange rates, oil prices, and other staples of economic prognostication. Four of the test subjects were former finance ministers, four were chairmen of multinational companies, four were economics students at Oxford University, and four were, to use the English vernacular, London dustmen. A decade later, the Economist reviewed the forecasts and discovered they were, on average, awful. But some were more awful than others: The dustmen tied the corporate chairmen for first place, while the finance ministers came last.*"

And while giving examples of where expert predictions are wrong is fun, Future Babble does actually quote a bone fide study on the issue. This study comes from Philip Tetlock who today, is a much-honoured psychologist at the University of

California's Haas School of Business. In 1984 Tetlock undertook a massive study on just this issue.

"Scouring his multidisciplinary networks, Tetlock recruited 284 experts – political scientists, economists, and journalists – whose jobs involve commenting or giving advice on political or economic trends. All were guaranteed anonymity because Tetlock didn't want anyone feeling pressure to conform or worrying about what their predictions would do to their reputations. With names unknown, all were free to judge as best they could.

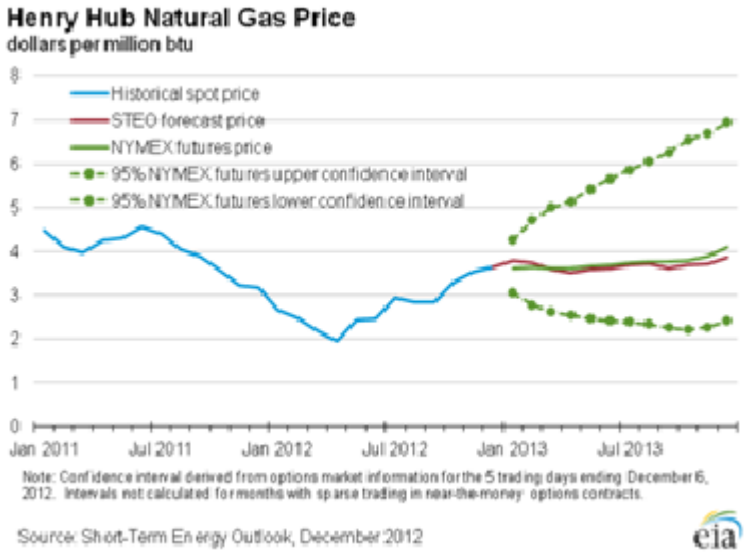
Then the predictions began. Over many years, Tetlock and his team peppered the experts with questions. In all, they collected an astonishing 27,450 judgements about the future. It was by far the biggest exercise of its kind ever, and the results were startlingly clear. The experts beat the chimp by a whisker. The simple and disturbing truth is that the experts' predictions were no more accurate than random guesses."

The reality of successful forecasting is captured in what I find to be a very funny current ad by Ally Bank in the US.

http://youtu.be/lu6MwbYsoxI

So what can we conclude from this discussion on the folly of predictions? What will gas prices be in a decade? Nobody knows. Period. Look at the history of gas prices. In the last twenty years about half the time prices have been below $5/mmBTU and about half the time above. The second graph is even more telling. Even with scores of predictions that prices will remain low for some time, forecasts by the EIA (US DOE) show that over the next six months or so there is a 95% confidence level that prices will be somewhere between $2 and $7/mmBTU, pretty much the same as they have been over the last twenty years with a few exceptions.

Source: DOE EIA



While this is all in good fun – after all, it is the holidays – why am I discussing this and what does it mean for the future of nuclear in North America? I guess I need to get a bit serious to close out the year and give you something to think about as we move into 2013.

So here are some truths:

- Most nuclear plants in operation today are competitive as they are the lowest marginal cost producers in almost every market (and they were all built in a lower gas price environment)

- New build nuclear is currently not competitive with $3/mmBTU gas
- In a previous post, I showed that new nuclear in the US does well against $7 gas in the OECD./NEA report issued in 2010. If we are able to reduce capital costs due to the benefits of series build (after FOAK projects), then new build nuclear should be able to compete with gas in the $5/mmBTU plus range.

The conclusion of this is that nuclear is competitive with gas over much of the range that gas prices are likely to be. It struggles at the bottom, but excels at the top. So a general conclusion is that a nuclear power is expected to be a competitive option for the future and as such, would be a reasonable part of any electricity supply system. This is the rationale for new plants currently being built in South Carolina and Georgia.

Now the real issue. Nuclear plants take about 8 to 10 years to implement. Do we have any idea what gas prices will be in a decade? No we do not. In fact we don't even know what gas prices will be next year. But we do know that overall, whatever they may be, nuclear plants will produce electricity at a cost that is within a reasonable range of gas and other alternatives. And hence the issue. If we can't predict electricity prices next week, how can we ever make the decision to build a plant that will come into service post 2020?

This is where we need to question the current structure of the competitive electricity markets (which I have long said are really gas markets) [Note: the UK is struggling with just this issue at the moment as they work to move forward with new nuclear]. While the lowest cost at any time is a commendable objective, we must also accept that we do not want an electricity system with only one form of generation – and it is a truth that, at any point in time, only one form of generation can be the least cost option. Add to this the fact

that it takes time to build electricity generation and we can easily see how it is so difficult to take investment decisions, especially for capital intensive long schedule options like nuclear power. The world is readily accepting that subsidies must be paid to encourage the use of renewables – and we certainly know that fossil fuels are heavily subsidized in many markets. So what about nuclear?

We also know that today in Germany and Japan (at least temporarily), where decisions to not operate nuclear plants have been taken, costs have gone up with a huge impact to the local economies. In fact high energy prices are becoming a very significant issue in Europe as recently reported in the NY Times.

So given we want an electricity generation system that is at least somewhat diversified and not totally dependent upon one form of generation, let's consider the long term benefits of nuclear power:

- Highly reliable and stable production
- Extremely energy dense producing huge amounts of energy from relatively small amounts of fuel.
- Relatively insensitive to uranium prices making the electricity costs very stable over the entire life of the plant.
- Very low carbon energy source

So do we want a low marginal cost, reliable, and of most importance – stable cost alternative as part of the mix? Well, given that we don't know what gas prices will be, we do know one thing – that fossil prices vary with time and hence no matter what, gas fired electricity prices will be volatile. So yes, I believe that having nuclear as part of the mix to help keep prices reasonable and stable is sensible and in the interest of consumers.

But all that being said, the future is up to us in the

industry. While we can't control the cost of gas, we must do our best to continue to reduce the cost of new nuclear as we gain the benefits of series build, including learning lessons from China and elsewhere where these benefits are being proven. And we must be able to demonstrate that we can build plants on time and on budget – and the rest will follow.

Wishing you all a very happy new year and thank you for reading my blog! Looking forward to more interesting discussion in 2013.

The changing face of global energy – Is nuclear power being left behind?

I have just done my first pass of the Word Energy Outlook 2012 issued by the IEA this November. Many of you will have seen some of the headlines – one of the most intriguing is that the US is expected to become the world's largest oil producer by 2017 exceeding the output of Saudi Arabia. With headlines like that how can you not want to read this report?

The trouble with trying to read and write about this report is that, as was the case with the Energy Technology Perspectives (which I talked about earlier this year), there is just so much in it to make you think that, agree or disagree, the report is full of interesting information that is worth discussing.

I have been a bit stuck on what perspective to take in this post. Ultimately I decided to focus on some general points this month (of course with the outlook on nuclear as the key

talking point) and then I will undoubtedly use the report for future discussions on more focused topics.

Reading the Executive Summary the report starts off with "***The global energy map is changing, with potentially far-reaching consequences for energy markets and trade. It is being redrawn by the resurgence in oil and gas production in the United States and could be further reshaped by a retreat from nuclear power in some countries, continued rapid growth in the use of wind and solar technologies and by the global spread of unconventional gas production***."

When it comes to global energy production, this short phrase pretty much sums it up. Strong North American oil production, more coal, less nuclear, more renewables and much more gas. And not surprisingly, this translates into more difficulty meeting climate change objectives. It continues, "***Taking all new developments and policies into account, the world is still failing to put the global energy system onto a more sustainable path***. ***Successive editions of this report have shown that the climate goal of limiting warming to 2 °C is becoming more difficult and more costly with each year that passes. Our 450 Scenario examines the actions necessary to achieve this goal and finds that almost four-fifths of the CO2 emissions allowable by 2035 are already locked-in by existing power plants, factories, buildings, etc. If action to reduce CO2 emissions is not taken before 2017, all the allowable CO2 emissions would be locked-in by energy infrastructure existing at that time."*** Another testament to the continuing lack of progress on meeting the world's climate change challenges.

And finally when it comes to the future of nuclear power it recognizes the changes in some countries to cut back while others continue to move forward.

"The anticipated role of nuclear power has been scaled back as countries have reviewed policies in the wake of the 2011 accident at the Fukushima Daiichi nuclear power station. Japan

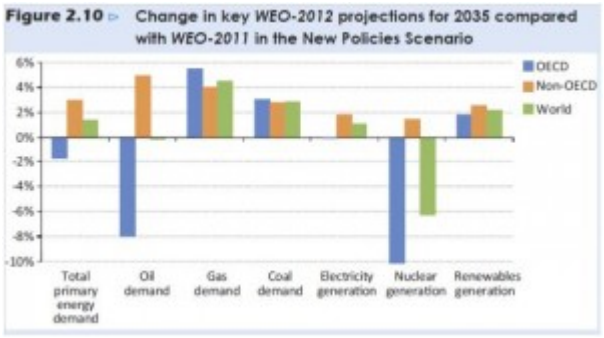
and France have recently joined the countries with intentions to reduce their use of nuclear power, while its competitiveness in the United States and Canada is being challenged by relatively cheap natural gas. Our projections for growth in installed nuclear capacity are lower than in last year's Outlook and, while nuclear output still grows in absolute terms (driven by expanded generation in China, Korea, India and Russia), its share in the global electricity mix falls slightly over time."

I am showing all of the above quotes because in a few words from the Executive Summary, the report says so much. The figure below shows the key changes in projected energy use from the 2011 WEO. In summary, as I read this report we can conclude that:

- Fossil fuel use is thriving. Clearly North American policies to increase both oil and gas production are very effective. Coal use is up again globally from the last WEO even with a larger increase in (mostly unconventional) gas use. Fossil fuel subsidies continue to be the largest of any energy source estimated at $523 billion, more than 6 times that for renewables and a 30% increase from 2010.
- Renewables use continues to grow without any real demonstration that increasing renewables to that extent is feasible. Subsidies are at $88 billion and rise to $240 billion in 2035
- Nuclear is being left behind as the 6% reduction in nuclear compared to 2011 is the largest single change in the new WEO New Policies Scenario.

And this path is taking us down the road to being unable to meet the 2 degree climate change scenario. After trying everything else in past reports, this year they try to demonstrate that increased efficiency is a potential path to delaying the inevitable and make time for more policy change to support the environment. This has the potential to extend

the 2017 date for lock-in to 2022. However we can also ask, without a real and substantive global commitment to reducing carbon emissions, what will these extra few years actually achieve? Most likely – nothing!

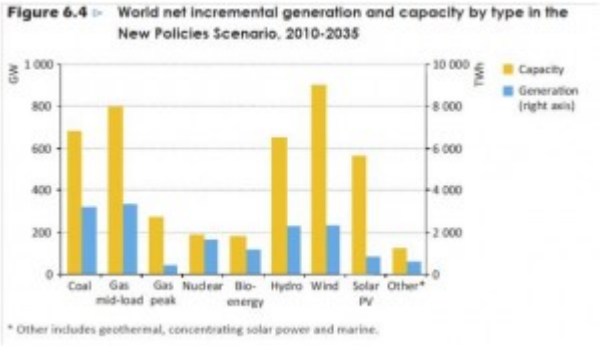


So let's look at the nuclear case in a bit more detail. Compared to the 2011 scenario, nuclear use is decreasing in those countries with the most to lose, Japan, Germany, Switzerland and even France, while being economically challenged in North America; and rising in the more rapidly growing economies of the east led by China. This leads to an important question. Is nuclear power becoming a transient technology that helps countries develop and then once there, can be phased out over time by a policy shift to renewables? This seems to be a possible theme going forward but in practice nothing can be further from the truth. It is interesting to note that this past week was the 70th anniversary of the first sustained criticality at CP-1 by Enrico Fermi. And here we are today with the countries named above all having substantial nuclear programs providing a large and important part of their electricity generation (Japan 30%, Germany 30%, Switzerland 40% and France 75%). Clearly, with this much nuclear, replacing it is not trivial and will have significant impacts. Even the WEO acknowledges that ***"shifting away from nuclear power can have significant implications for a country's spending on imports of fossil fuels, for electricity prices and for the level of effort needed to meet climate targets."***

And that is what we are seeing today as Germany and Japan

wrestle with these impacts as they try to reduce the use of nuclear very quickly. Based on hysteria following the Fukushima accident, the politicians in these countries (even France) seem to have forgotten what they have achieved since that famous date 70 years ago and why they built such large nuclear fleets in the first place. Building a successful nuclear program is a major undertaking requiring investment in regulation, infrastructure and industry. Germany, Japan and France have all benefited from this investment as they developed significant technology, know-how and industrial capability with the result being, in all cases, a very large portion of their electricity generation being economical, clean and reliable. Reducing its use as a result of a misguided view on nuclear safety will result in a large negative impact to industry and their economies. In Germany, utilities are suffering financially and in Japan, there is the risk of losing capability and business to the new nuclear powers of Korea and China while having staggering increases in imported fossil fuels and a devastating impact to the local economy.

In fact, looking at the following figure from the WEO shows the bigger story. Just compare the capacity bar with the energy bar in each case and one thing is clear. Nuclear power is a key workhorse of the global energy system. It is by far the most efficient investment as every GW of capacity produces more GWh of energy than every other type of electricity generation. As I stated in my earlier post on the ETP, one of the reasons for the enormous investment in renewables is that you have to build about three times as much capacity as nuclear to get anywhere near the same energy output – and of course even then this energy is not dispatchable. But even looking at the use of more tradition fossil fuels, because nuclear fuel costs are very small, they are dispatched before more expensive coal and gas plants and, as the figure shows, 3 times as much coal capacity and almost 4 times as much gas is projected to each only generate twice the energy as nuclear.



It is important to remember that the WEO is not a forecast per se; rather it is a projection of how government policies would look once implemented. And what we see is a world investing heavily in fossil fuels to protect the status quo while also investing in renewables as a token path to the future. The fall in nuclear power use in developed countries is an important testament to the ongoing impact of the Fukushima accident on government policies in the west.

While the 2012 projection is less than 2011, nuclear power does continue to grow and in 2035 it is projected to supply 12% of world electricity (13% in 2011 projection). Yes, it is being left behind relatively but, as I see it, this report clearly demonstrates the importance of nuclear power as a clean, efficient and reliable source of non carbon electricity going forward. Implementing policies that reduce its use is folly as it definitely will result in expanded fossil use, higher costs, trade imbalances and higher carbon emissions; all leading us down an unsustainable path.

Therefore the policy answer is not to limit and reduce the use of nuclear energy, but to expand its use because even a small expansion in capacity results in a relatively large increase in energy generated. And that means that we need to work harder to address the issues resulting from the Fukushima accident in the developed world and remind those governments who are reacting to short term pressures why they went nuclear in the first place; and of the consequences of reducing its use to their societies so they can rethink potential policies that may move them away from this very important part of our

global energy mix.