It is broken markets, not uneconomic plants that are putting nuclear plants at risk

A huge milestone has been achieved in the United States as Watts Bar Unit 2 produced its first electricity; becoming the first new nuclear plant in the US to start up in 20 years since Watts Bar Unit 1 came into service in 1996. Unfortunately, this good news was overshadowed by the announcement by Exelon that its Quad Cities and Clinton power stations in Illinois would close. This decision was the most recent but not the first, with headlines such as “Nuclear plants need boost to stay open, industry warns” or” Nuclear power plants warn of closure crisis” pointing to more nuclear plants that are at risk of premature closure because they are no longer economic in the competitive markets in which they operate.

Watts Bar – America's newest nuclear plant

There are many explanations as to the cause of this "crisis". Gas prices are currently very low, renewables are subsidized and the costs of some of the smaller oldest single unit nuclear plants in the country have been rising as they age. While all of these points are true, they are not in and of themselves, the direct cause of the problem. They are symptoms of deep structural issues in those parts of the country where electricity is bought and sold in so called open or deregulated markets.(Note: Watts Bar, owned by the Tennessee Valley Authority, is in a regulated market.)

This was the topic of a recent DOE summit on how to "save" the nuclear fleet ("*Summit on Improving the Economics of America's Nuclear Power Plants*") to address the crisis and take steps to avoid the unnecessary closing of a significant number of plants. So here we are and once again, we fall into the trap of incorrectly defining the problem as costly inefficient nuclear plants. After all the US summit is on how to **improve**

the economics of nuclear plants, not how to fix poorly structured markets – the real problem. (Note: In Europe there are similar issues driven by a high level of subsidized renewables rather than low gas prices. But the need to find a solution is the same. A European Commission official assured delegates at a recent nuclear financing conference held in Paris that the design of European wholesale electricity markets and the emissions trading system (EU ETS) will be improved to help – and no longer hinder – nuclear energy as a low-carbon source of electricity.)

In the guise of providing the lowest cost to ratepayers, most markets are completely focused on the short term. There is little consideration of risk built into the pricing mechanisms, only what is the lowest cost to generate electricity right now. This means that there is no value attributed to any of the other important operating attributes required for a reliable and secure electricity supply system such as fuel availability, maneuverability, flexibility and price volatility. On top of this, things like government environmental policies and subsidies further distort the markets to ensure that mandated renewables have a role in the system. (Of course nuclear has not benefited from such support even though it is a low carbon option.)

This may have all worked fine 25 years ago when markets were opened with the objective of creating efficiencies in the existing operating fleet –a time when many jurisdictions were in oversupply. But when it comes to adding capacity or making other substantive changes to the system, electricity markets are not nimble. While there may be a desire to respond to price signals in the short term, building new plant takes time. And one thing is for sure, no one will build new plant of any kind without some confidence that they will generate sufficient revenue to operate for their projected lives and earn a return on their investment. Or as stated in the OECD report Project Costs of Electricity, "*The structure of the*

electricity generation mix, as well as the electricity demand pattern, is quite inelastic in the short term: existing power plants have long lifetimes and building new capacity and transmission infrastructure may require a considerable lead time as well as significant upfront investments. In other terms, electricity systems are locked in with their existing generation mix and infrastructure, and cannot quickly adapt them to changing market conditions."

It is also important to understand that not all market participants are equal. In most markets gas is the price maker, not a price taker. So when gas prices are high, everybody else in the market makes money and when gas prices are low, everybody struggles. And yes, today gas prices are very very low. Yet gas operators are relatively indifferent as they are the risk free players in the market. Even in this enviable position, gas generators did not have sufficient incentive to build new plant, so many markets have responded with the development of capacity markets. These capacity payments then compensate gas plants for sitting idle – effectively removing the risk to gas generators of building new plants.

So you may ask, what's the problem with that as long as we have low energy prices?

If open markets are so efficient then we should expect that prices in these areas should be lower than in areas where regulated markets have remained. Not so, says an April 2015 study by the American Public Power Association. In fact, in 2014 prices in de-regulated markets were as much as 35% more than those in regulated states. (Note: this study has been done by an organization with an interest in the result and as such may contain bias.)

So let's go back to electricity system structuring. When it comes to managing risk, we know risk is generally reduced through a diverse portfolio of alternatives. The more

diverse, the more risk can be reduced. The current path will result in systems that are not diverse, but rather all gas, currently the most economic alternative. If markets do not adapt to better accommodate risk management into their pricing strategies, we face a future of volatile energy prices, possible energy shortages as new plant construction lags market needs and increases rather than decreases in carbon emissions; all in the guise of more efficient markets. Back to the decision in Illinois. As stated in the referenced article, not only are these two plants Exelon's best performers, they "*support approximately 4,200 direct and indirect jobs and produce more than $1.2 billion in economic activity annually. A state report found that closing the plants would increase wholesale energy costs for the region by $439 million to $645 million annually. The report also found that keeping the plants open would avoid $10 billion in economic damages associated with higher carbon emissions over 10 years*."

We only need one major market disruption to remind us all of the importance of truly reliable baseload power at a stable and economic price and how that protects us from the risk of higher prices and lower security of supply. And today, there is only one low carbon highly reliable baseload option, nuclear power.

So while a short term fix to keep operating nuclear plants open is required and more urgent than ever, let's stop talking about how plants are uneconomic and work to properly improve market structures to build and maintain the strong, reliable, economic and low carbon systems needed to power our modern economies.

It’s not about being “advanced”, it is ongoing innovation that will keep nuclear strong

This month in the United States, the Nuclear Energy Innovation Capabilities Act was passed to support federal research and development and stimulate private investment in advanced nuclear reactor technologies. All this good news about investment in the future made me think about how we use the words **advanced** and **innovation** in the nuclear industry. We first wrote about innovation in the nuclear sector two years ago. And what we said then still applies, in fact even more so, today.

When thinking about innovation in the nuclear industry, the discussion often centres around future reactor designs. However, this far too narrow focus tends to an argument that a so called **advanced** design is what is required to save the industry and implies that today’s designs are just not good enough. When we have a technology that produces abundant economic and reliable electricity with very low carbon, all while being one of the safest on earth; what we have today is something worth celebrating. Yet it is not unusual for some supporters of nuclear power to use the idea that new advanced designs are the magic sauce that will make nuclear great again.

Futuristic Thorium Plant from the Norwegian series “Occupied”

I was recently at a meeting where it was noted by someone who had recently visited Havana Cuba, that without access to newer technology, cars in Cuba are stuck in the past. The Cubans have found ways to keep these old cars running well past their original lives as they had no access to anything newer. And while we may find these relics fun to look at, we certainly don’t expect to be driving cars of this vintage. In fact, we know that while the cars of today basically look the same and operate in a similar manner to those of the 1950s, there is likely not one part that is the same as was made 50 years ago. Today’s car is made up of different materials, is computer controlled, is way more efficient and much much safer. This is all due to years and years of innovation. The same applies to nuclear plants. What would have happened if back in 1955 or so people only talked about and invested in what would replace cars for individual transport (i.e. “**advanced**” cars meaning electric vehicles or even flying cars) instead of how to make them better? The thought of it is just ridiculous. Yet that seems to be a common view of nuclear – that all we are doing is keeping old outdated plants (like 1950’s cars) operating until we get these shiny new plants of

the future ready for deployment. Nothing can be further from the truth.

While yes, it is important to research and develop new concepts based on specific needs, for example closing the fuel cycle or using new types of fuel such as thorium; it is not the case that this is what is required to continue to evolve safety, reliability and economics. For that we must continue to focus our efforts on improving what we have – innovating, taking the reactor designs available today – and making them better. Just like cars, there is abundant technology in any given nuclear plant that extends far beyond what kind of fuel we choose to burn. Implementing changes means using a large spectrum of new technologies that are being constantly developed as is necessary in every industry that wants to keep moving forward.

A great current example is the commitment in the US through the "*Delivering the Nuclear Promise: Advancing Safety, Reliability and Economic Performance*" initiative as the way forward to address falling prices of alternative generation options. As stated, this "*three-year program will identify efficiency measures and adopt best practices and technology solutions to improve operations, reduce generation cost and prevent premature reactor closure*." Now this is what drives innovation.

Extending the lives of current reactors through better understanding of how materials age, first to 60 years and next possibly to 80 years, use of remote tooling to reduce dose and shorten outages, use of new technology in controls to improve reliability; all of these things require innovation.

When it comes to new build, there is innovation in methods to reduce construction time and improve quality such as computer engineering tools, modularization and even simple things such as moving platforms to replace scaffolding and on and on and on. This is innovation. And let's not forget about

commercial innovation. Innovative business models such as those used in Canada for refurbishment and in the UK for new build are critical to future industry success. This even includes models from places like Russia where they are working with foreign customers in ways thought not possible in the past. Will this all work? Some things will and some things wont, but this is innovation. It is messy, it takes time – and it continues to move the industry forward. And most of this innovation will apply to all reactor types, todays and those of the future.

I support the development of future designs– just not at the expense of making the public think our current designs have hit their 'best before date'. I am concerned that the industry is risking too much on the importance of government money for advanced designs– i.e. here is a few hundred million dollars to study designs for the 2030s so shut up and focus on the future – then come back in 20 years or so when you have the next great thing. We cannot afford a mindset that says nuclear must stop until then as the world continues to build more and more gas plants and renewables. Every year these alternatives, wind and solar get better – and we need to do the same (and frankly we are).

The world needs abundant low carbon, economic and reliable electricity now if we are to replace coal and meet the needs of an energy hungry world. To meet the WNA target of 1,000 GW – 1000 new, 1000 MW nuclear plants by 2050 means we need to be building lots of new plants TODAY – not waiting until the next big thing comes around in a decade or two.

So, today's nuclear technology must continue to move forward and demonstrate it is a technology of the future and that improvements are continuing to come that make every project better than the last. We need to better celebrate our achievements and we need to continue to invest in further innovation because there is no choice but to continue to get better.

Our strength is through our performance. And our performance continues to get better through innovation, each and every day.

Canada makes big decisions to further strengthen its commitment to nuclear power

As Canadians, we were truly excited when this past fall, Arthur McDonald of Queens University in Canada was jointly awarded the Nobel Prize in Physics with Takaaki Kajita of Japan for discovering that neutrinos have mass. Dr. McDonald and his Canadian team captured neutrinos using a uniquely sensitive new detector 6800 feet below ground at the Sudbury Neutrino Observatory (SNO). SNO is a collaborative effort by six Canadian universities and the group were able to borrow $300 million worth of heavy water – used in the country's CANDU nuclear reactors- for 10 years for $1. Dr. McDonald began his career at the AECL Chalk River Nuclear Laboratory (now CNL) and is the 4th Nobel Laurate to have worked there.

When we think about nuclear power around the world these days, two things come to mind – the rapid growth in Asia led by China fueling the industry forward, and the challenges facing the industry in the west with some plants closing early in the USA and new build projects in Europe being delayed and over budget. With so much going on in the global nuclear industry – it's hard to find people talking about Canada and our home-grown CANDU reactors. In fact, in my very frequent travels, I often get asked if there is anything at all going on in the Canadian industry.

Well, we are here to tell you that nuclear power is indeed alive and well in Canada – and that 2015 was a bellwether year with hugely important decisions having been made by government that will set the stage for a strong nuclear industry for decades to come.

Canada is blessed with natural resources. When it comes to electricity, Canada has one of the lowest carbon and most economic generation anywhere. Most of the country is lucky to have large hydro resources, so much so that in Canada, we call electricity "hydro", not electricity. We pay the "hydro" bill

and worry when a storm knocks down “hydro wires”. Many of our electric companies have the word “Hydro” in their name. Yet what many people do not know is that in Ontario, Canada’s most populous province, about 60% of our electricity is generated by nuclear power. Yes, in Ontario more than half of our electricity comes from nuclear plants. And in New Brunswick, the only other province with an operating nuclear plant; the 630 MW Point Lepreau Generating Station is the workhorse of the electrical system, supplying a third of that province’s electricity.

Ontario’s nuclear electricity comes from three plants operated by two utilities. The Bruce Nuclear Power Station, again to many people’s surprise, is currently the world’s largest, generating 6,300 MW of electricity, and the Darlington Nuclear Generating Station and Pickering Nuclear Generating Station together add another 6,600 MW to the system. While these stations are generating most of Ontario’s electricity, these units are aging as are most nuclear power stations in the western world. CANDU type reactors can be refurbished to extend and effectively double their operating lives, but this requires significant investment and hence, a strong commitment to a nuclear future.

Over the past two months, decisions have been taken by the government of Ontario to refurbish both the remaining 6 units at Bruce (2 have already been refurbished) and the 4 units at Darlington. Together this represents a 15 year, $25 billion program of work that will have these nuclear units remain the backbone of the Ontario electricity system until the 2060s. Making things even more interesting, the Bruce refurbishment will be undertaken by Bruce Power, a private sector operator with private funds, through an agreement to buy electricity from the Ontario Independent Electricity System Operator (IESO) while the Darlington refurbishment will be undertaken by its public sector owner/operator, OPG on a regulated basis. To top it off, a decision was also taken to extend the

lives of the older Pickering units to 2024 before they are shut down at their end of life.

This is an exciting time for the nuclear industry in Canada. These refurbishment programs provide the industry with a stable work environment for the next 15 years, allowing it to hire and train a new generation of young engineers and trades people who can look forward to an exciting career in nuclear.

This alone would be exciting enough as Canada recommits to nuclear power for the long term, but that is not all. Canada has long been known for its excellence in nuclear research. The Chalk River Nuclear Laboratory has been an institution in nuclear research for 60 years. Today CNL has emerged from its restructuring as a government-owned, private-sector run world-class nuclear research centre.

And finally, we cannot talk about the nuclear industry in Canada without talking about uranium. Canada's Athabasca Basin is home to the world's highest grade uranium and is the world's second largest producer of uranium, fueling nuclear reactors around the world, helping countries lower their carbon emissions. This past year Cameco, the region's major producer, placed its newest uranium mine, Cigar Lake, into production producing about 10 million lbs of U3O8 and is on track to increase this production to 16 million lbs in 2016. They also signed a deal to provide India with uranium, the first since Canada and India signed a nuclear cooperation agreement in 2013, paving the way for renewed nuclear cooperation between these two countries.

As Canadians, we were extremely proud to see Dr. McDonald's work recognized with a Nobel prize. Canada has a great history of research and development in the nuclear industry, from fundamental nuclear physics to medical applications to power production. This is a pleasant reminder as to why we went into this challenging industry so many years ago. At that time, we had a vision – to make the world a better place through use of

clean, economic, safe and abundant nuclear energy. Now here we are 35 years later – a little grayer and with a little less hair – and with the decisions made this past year, we feel confident that Canadians will continue to reap the benefits of this industry for the foreseeable future.

Abundant and economic – Nuclear power delivers

The past few weeks have seen lots of excitement as the world reached agreement to tackle climate change in Paris. What is key to the Paris deal is a requirement that every nation (all 195 of them) take part. Ahead of the talks, governments of 186 nations put forth public plans detailing how they would cut carbon emissions over the next 10 to 15 years. However, these plans alone, should they come to fruition, will cut emissions by only half the levels required to meet the targets set out in the agreement. The plans vary significantly from country to country with some like China depending upon nuclear power as part of their plan – and others not. With no concrete plan to achieve the goals in the agreement, one thing is clear; that if there is any chance of meeting these ambitious goals, there will have to be a larger role for nuclear power.

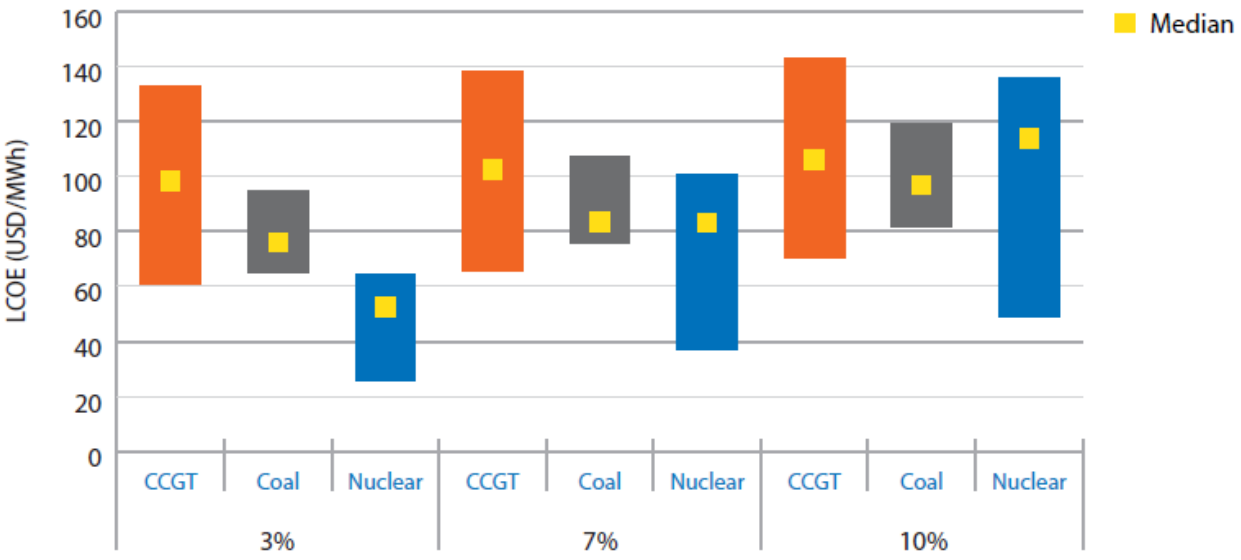
Critics of nuclear power generally focus on two main issues: safety, mostly concern that the consequences of a possible nuclear accident are not worth the risk; and cost, with many noting that nuclear is a high cost option that just diverts funds from the real environmental options for future generation, wind and solar. This month we will talk about cost

and how to ensure that nuclear is seen for what it is, a capital intensive yet highly economic option for reliable 24/7 generation. If nuclear is to play the role that it can, and must play in the future generation mix, it can only get there by being the economic option of choice.

In our last post we noted the updated version of "Project Costs of Electricity" has recently been published. This is an important report that is now in its 8th edition from the IEA and NEA looking at the costs of various forms of electricity generation.

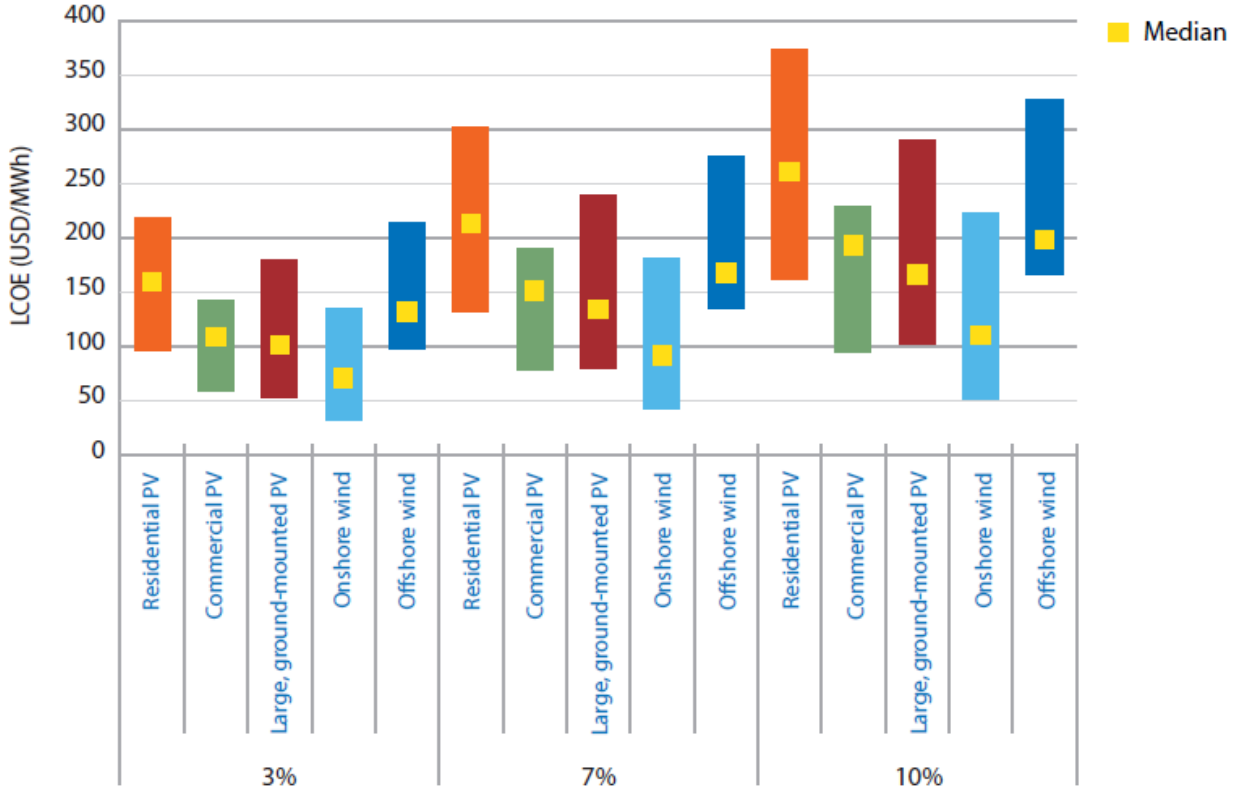
The results of this study are very clear. It shows that nuclear is a very competitive option on a Levelized Cost of Electricity (LCOE) basis.

Figure ES.1: LCOE ranges for baseload technologies (at each discount rate)



The ranges presented include results from all countries analysed in this study, and therefore obscure regional variations.

Figure ES.2: LCOE ranges for solar PV and wind technologies (at each discount rate)



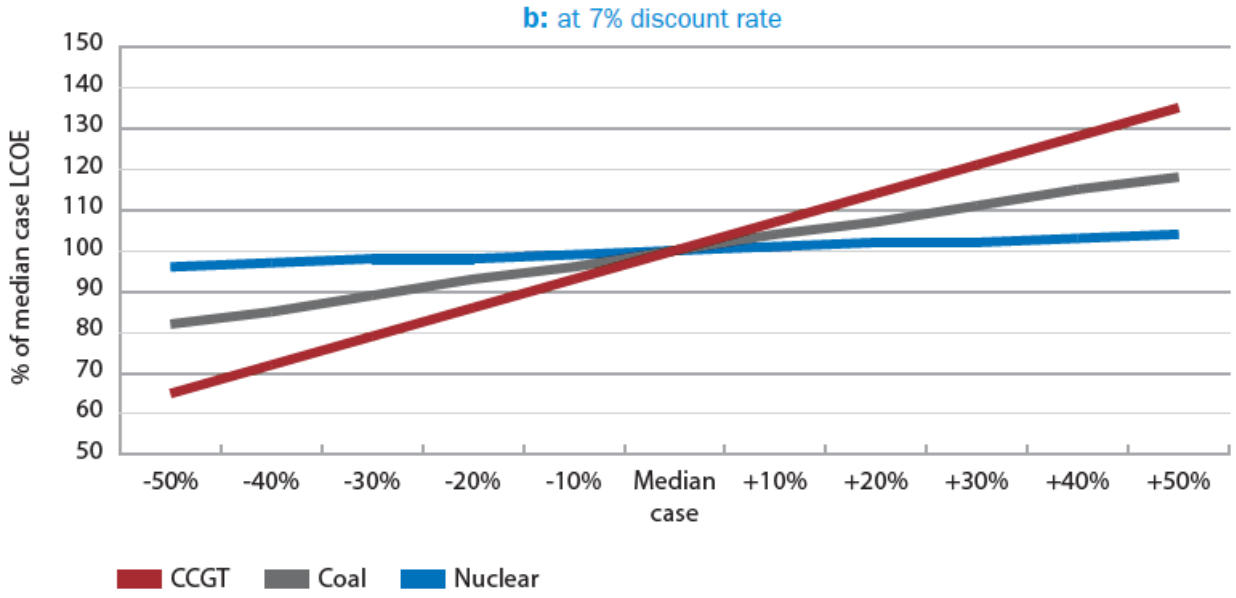
The ranges presented include results from all countries analysed in this study, and therefore obscure regional variations.

In fact, at low discount rates (3%), it is the clear winner among both traditional fossil technologies and the cost of renewables. While the report acknowledges the huge gains made by renewables in reducing their costs, it also notes the belief that nuclear costs continue to rise is false.

What is of interest is how the results are presented. The main comparisons in the executive summary are provided varying only one parameter, discount rates, that range from 3% to 10%. This represents a three-fold increase in the discount rate over the range. It is therefore not surprising that the technologies that are capital intensive, i.e. nuclear and renewables show the greatest sensitivity to this one parameter. This is one way to look at the comparative economics. On the other hand, generating stations powered by fuels like coal and gas are much more sensitive to fuel price. This sensitivity is only shown later on in the report in a sensitivity section.

Figure 7.12: LCOE as a

function of fuel cost



So for example, while gas plants (CCGT) vary little with discount rates due to their relatively low capital costs and higher fuel costs, their LCOE is very sensitive to fuel prices. In the chart above, the sensitivity only varies fuel prices by up to 50%; rather small in comparison to the three-fold change in discount rates in the earlier chart. Yet we all know that today's very low gas prices in North America are easily less than half as much as they were only a few years ago. Doubling gas prices or more would have a huge impact on electricity costs.

As would be expected, the economics also vary by region. It is no accident that China is building the most nuclear plants in the world. Even though they are also building many more coal plants to meet their ever increasing hunger for energy, nuclear plants provide clean reliable energy at about half the cost of coal in China making it an easy decision to move forward with new nuclear plants as quickly as they can. On the other hand, this past month we have once again heard about nuclear plants in the United States that are likely going to close prematurely due to poor economics. This results mostly from very low gas prices that impact the economics in those

parts of the country that have open competitive markets. The units that are most impacted are the older smaller single unit stations that are requiring capital investment at this stage of their life cycle. Without any acknowledgement of the low carbon characteristics of nuclear, or the reliability of fuel supply (gas plants generally are fed by pipelines that are at risk in cold winter months), these units are struggling. Yet the industry in the USA is not standing still. As reported in the December 10 Nucleonics Week, the US industry is targeting to reduce its costs for the existing fleet by 30%. Once achieved, this will ensure that once again nuclear will be the lowest cost generation on the system.

However, this is only the first step. Being a low carbon generator is only sufficient to ensure that nuclear remains an option. The key to long term success is the ability to reduce the capital costs of constructing the plant; producing low cost energy is what will really drive a strong new build program. This can be seen in countries such as China and Korea, where capital costs are relatively low, making nuclear by far the most economic option available. Lessons learned in these markets must be shared and implemented globally to bring down capital costs in other markets as well. China and Korea are showing the way. If the rest of the world follows, abundant nuclear power will play a large role in tackling climate change as the electrical grid workhorse of reliable low-carbon and mostly, economic generation, for decades to come.

Dreaming of a future with

abundant clean reliable energy – then dream about nuclear

When we look to the future, people the world over are hopeful for an era of abundant reliable electricity supplying all of our energy needs; all at a reasonable cost and with little to no impact to the environment. Unfortunately, in many western countries the politics of electricity planning has become largely a case of exploring the depths of our imagination with no real path to achieving this essential goal.

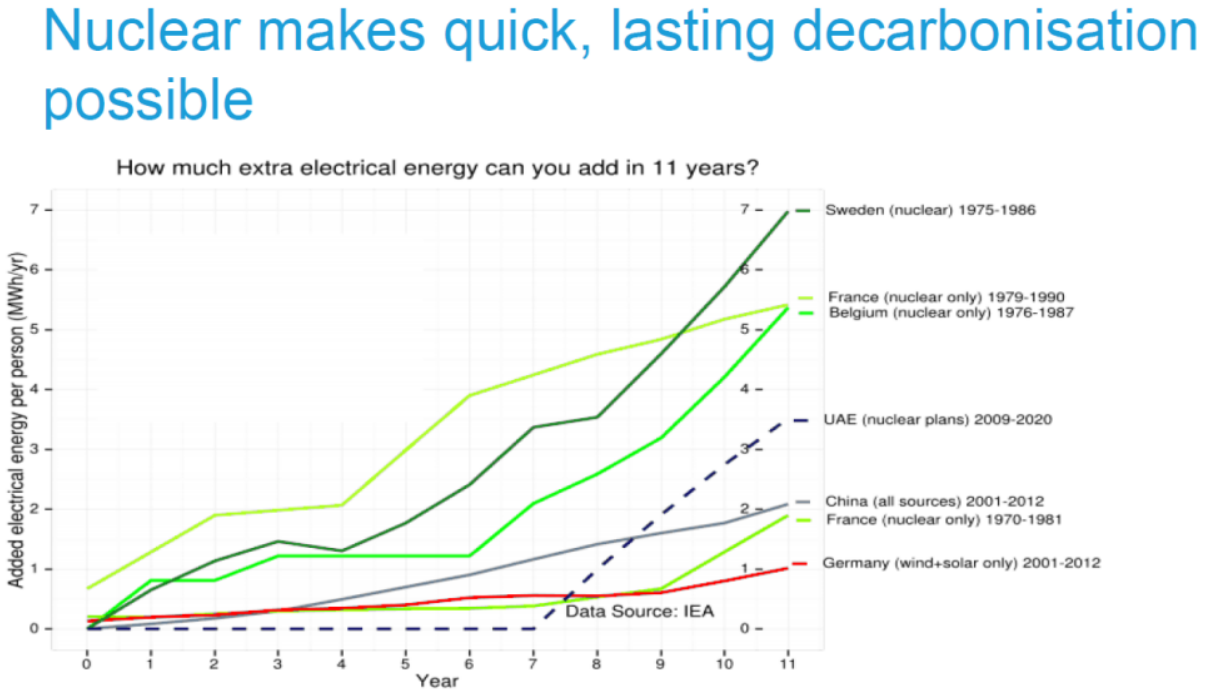
As stated by Malcolm Grimston at the World Nuclear Association (WNA) Annual Symposium last month in his brilliant talk "***Sclerosis at the heart of energy policy***" (in advance of a book he has coming out), we have become so accustomed to reliable and cost effective electricity supply that we can no longer ever consider a scenario where this can be at risk. He noted we even use the less than frightening phrase "keeping the lights on" when talking about reliability which greatly understates the importance of reliable electricity supply to our modern society. (As he said, he turns out his lights every night without concern – certainly a large scale disruption to our energy supplies would be much worse than having the lights go off.)

Given we can't imagine electricity reliability to be at risk; and given we have relatively slow growth in most western advanced economies there is a major reluctance to take decisions to protect and invest in our infrastructure for the future even while we want to work towards decarbonizing the system. Yes electricity demand growth is modest, but our lives depend more on reliable electricity supplies than ever before. Without electricity society quickly becomes paralyzed with no ability to communicate, travel, maintain our food supply,

sanitation, deliver health care and so on…in fact it is very difficult for us in all of our modern comfort to imagine how severe the consequences would be. Therefore in our great complacency we continue to do nothing because we all expect that the next great technological breakthrough is just around the corner. All we need to do is wait and advanced renewables will be available so we can have clean limitless energy forever. And so goes the narrative.

Ben Heard in his excellent WNA presentation "***World without Nuclear***" quotes Naomi Klein as she spoke to the media against the nuclear option in South Australia – "*What's exciting about this renewables revolution spreading around the world, is that it shows us that we can power our economies without the enormous risk that we have come to accept*". She said the latest research showed renewables could power 100 per cent of the world's economies. "*We can do it without those huge risks and costs associated with nuclear so why wouldn't we*?" she said.

But of course if it sounds too good to be true, it probably is. Ben's presentation goes on to review 20 studies that suggest that a world powered by 100% renewables can be a reality. However, in his review he rates most of these studies as poor. Overall he concludes that there is actually scant evidence for 100 % renewable feasibility while the literature affirms large dispatchable, i.e. guaranteed 24/7 supply is indispensable. His final conclusion is that global decarbonization requires a much faster-growing nuclear sector.



Source: Geoff Russell – nuclear has scaled far more rapidly than renewables

Reproduced from Agneta Rising Presentation at the WNA Annual Symposium 2015

But how can we have more nuclear when it has this perception of huge risks? We have written extensively on the issues associated with the perception of nuclear as a dangerous technology when in reality it has the best safety record of all technologies out there so we won't talk about that again now. In his presentation Malcolm Grimston places much of the responsibility for this public perception squarely on the nuclear industry noting that the industry "*spends half of its time implying that it is the new priesthood, with superhuman powers to guarantee safety; and the other half of its time behaving as if radiation is much much more dangerous than it actually is*." While it is hard to know what comes first, the fear or the industry reaction to it, we certainly agree that Malcolm makes a good point.

Then there are those that say nuclear power is way too expensive to be part of our future electricity system even though there is no doubt that wind and solar power are clearly the more expensive options. The most recent edition of

“Project Costs of Electricity”; an important report that is now in its 8th edition from the IEA and NEA looking at the costs of various forms of electricity generation has just been published. (This report is a must for anyone seriously looking at trends and costs of electricity generation around the globe.) While the report acknowledges the huge gains made by renewables in reducing their costs, it also demonstrates that nuclear power is one of the lowest cost options available depending upon the scenario. Of more importance, the report notes that the belief that nuclear costs continue to rise is false stating that, in general, baseload technologies are not increasing in costs and specifically “t*his is particularly notable in the case of nuclear technologies, which have costs that are roughly on a par with those reported in the prior study, thus undermining the growing narrative that nuclear costs continue to increase globally*”.

We will have more to say about this report in upcoming posts. But for now, let’s all do more than dream about a future of abundant, reliable, clean and yes, economic electricity; let’s make this dream a reality by making sure that the electricity system of the future includes highly reliable 24/7 nuclear power.

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*

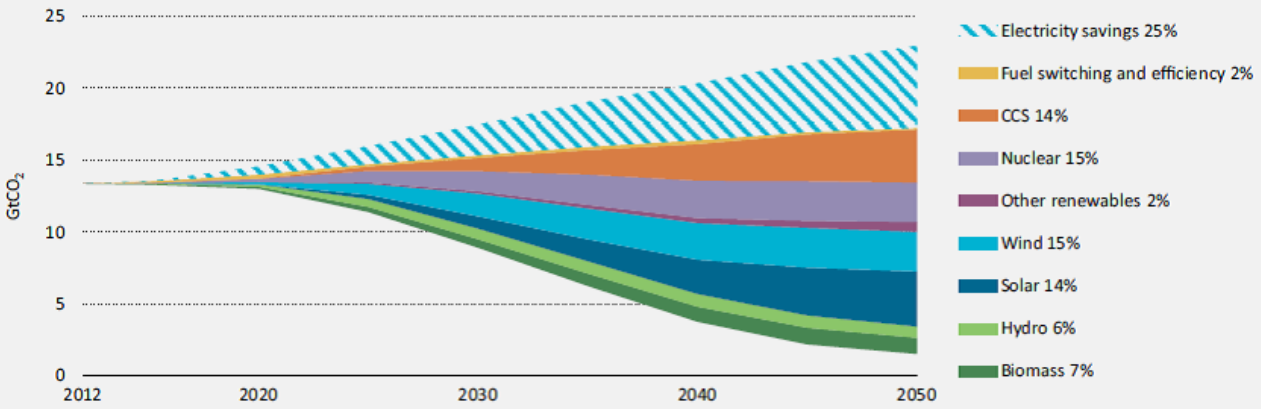
system transformation possible. Continued dependence on fossil fuels and recent trends such as unexpected energy market fluctuations reinforce the role of governments, individually and collectively, to stimulate targeted action to ensure that resources are optimally aligned to accelerate progress. Establishing 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.

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*."

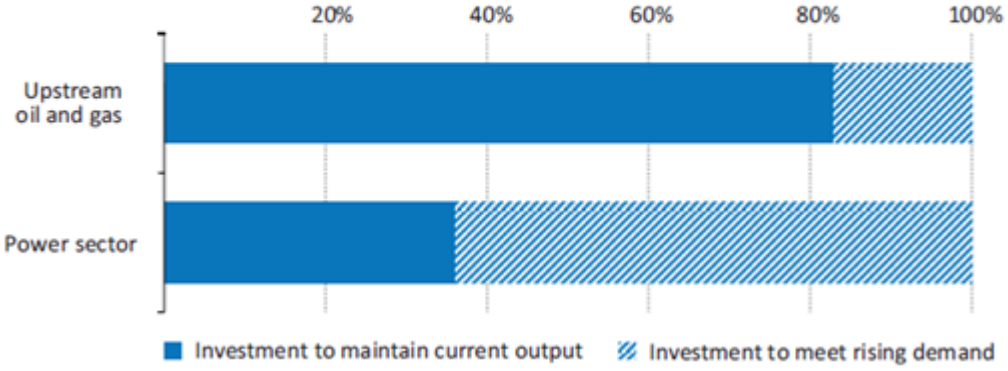
We often talk about the large size of nuclear projects and how they require huge amounts of funds. Nuclear projects are very capital intensive and have relatively long project schedules; both important issues when trying to secure financing. When we talk about large, a good first step is to try and understand 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.

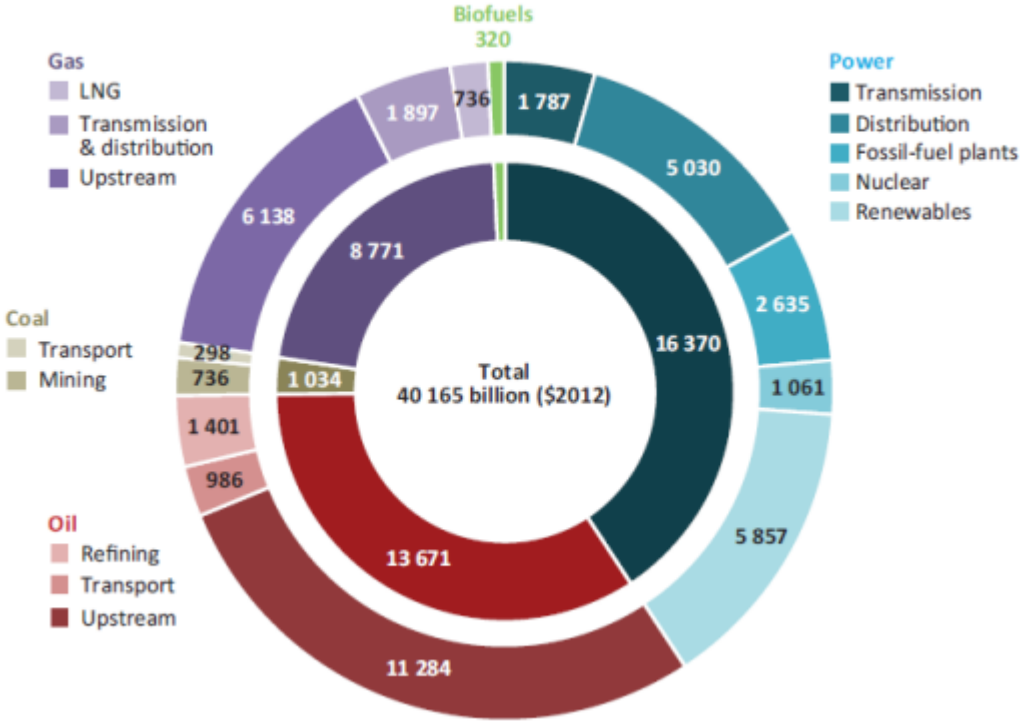
Of even more interest, the report specifies that less than half of the $40 trillion dollars required to meet energy demand between today and 2035 goes to meet demand growth; the larger share is required to offset declining production from existing oil and gas fields and to replace power plants and other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

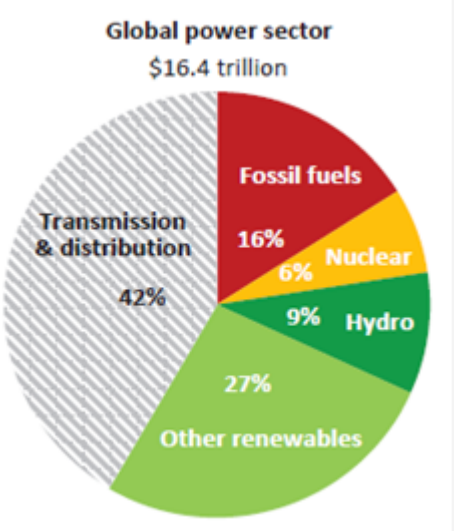


A staggering statistic – more than $20 trillion is required over the next 20 years just to stand still. And of course, most of this investment is in fossil fuels that continue to emit carbon as the world tries to find a way to turn the corner and find alternatives.

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.

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."

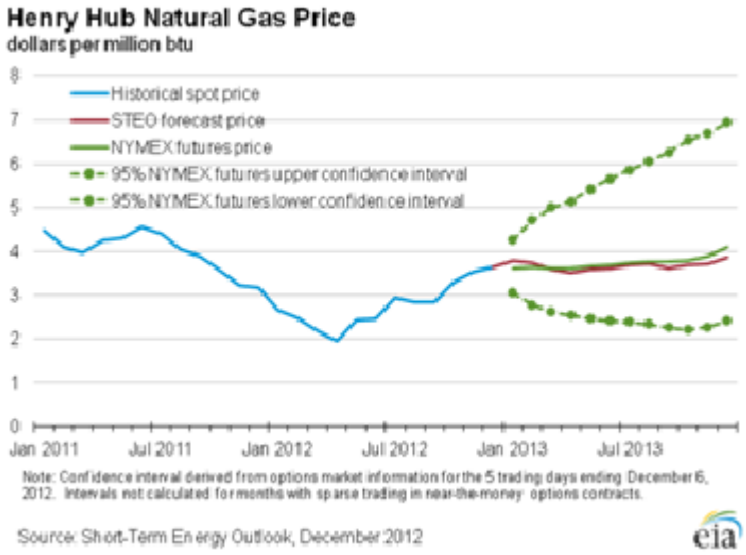
The reality of successful forecasting is captured in what I find to be a very funny current ad by Ally Bank in the US.

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.

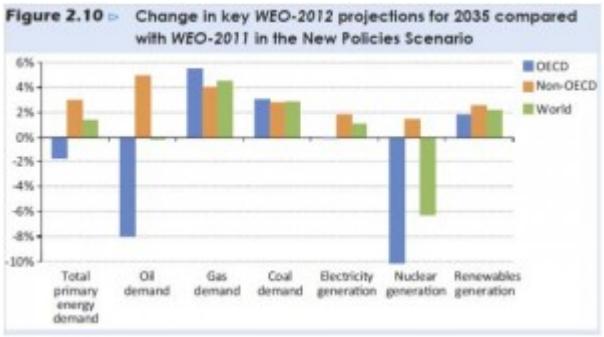
"The anticipated role of nuclear power has been scaled back as countries have reviewed policies in the wake of the 2011 accident at the Fukushima Daiichi nuclear power station. Japan and France have recently joined the countries with intentions to reduce their use of nuclear power, while its competitiveness 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!



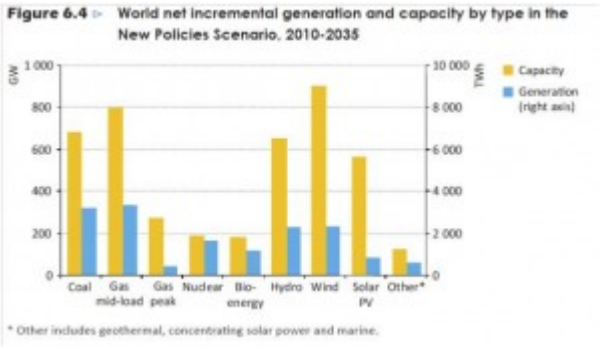
So let's look at the nuclear case in a bit more detail. Compared to the 2011 scenario, nuclear use is decreasing in those countries with the most to lose, Japan, Germany, Switzerland and even France, while being economically challenged in North America; and rising in the more rapidly growing economies 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.