

In an era where facts no longer matter, consequences still do

Over the last few years, we have written extensively about the strength of peoples' beliefs and how difficult it is to change them. In spite of this, I thought we were making progress with a push to more evidence-based decision making. For something as polarizing as nuclear power, facts-based decision making is critical to increasing support. (I understand the paradigm of fear of radiation is more emotional than fact based and I agree that we need to appeal to emotions to create the change we need – but let's leave that to a future discussion. In any case it certainly doesn't hurt to have the facts on your side.)

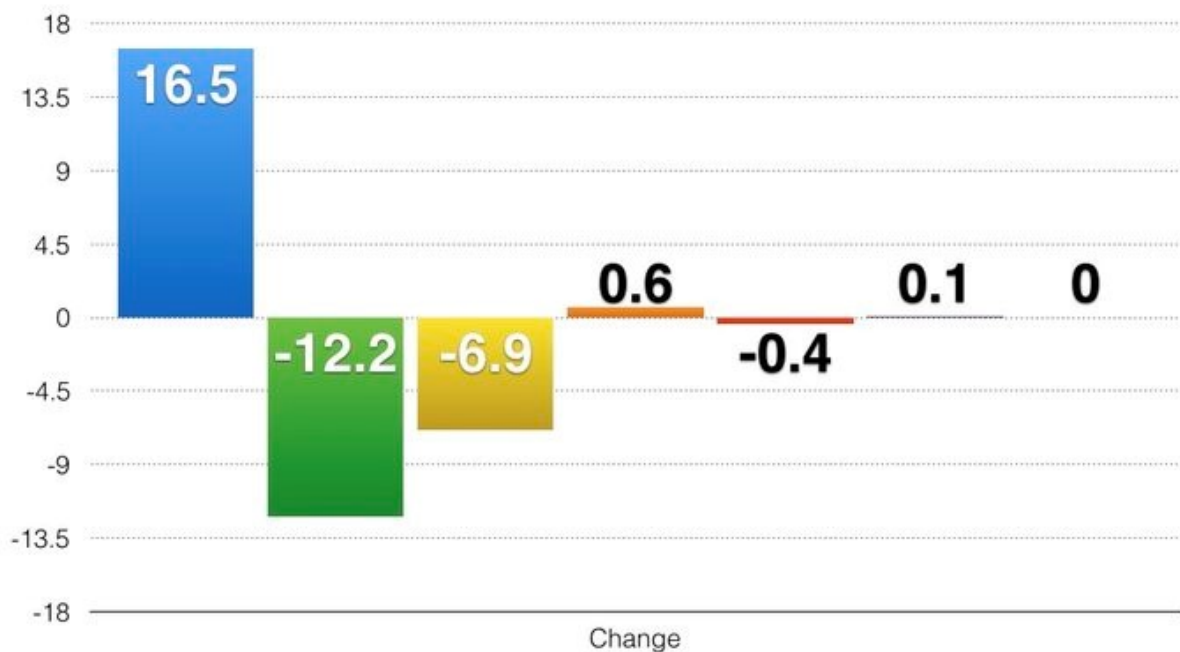
With the populist surge in 2016 we have seen an accompanying rise in complete disregard for facts; all the way to the propagation of absolute lies (or "alternative facts") to support peoples' beliefs. I don't want to get into a political discussion nor take sides on right versus left. What I do want to do in today's post is to discuss something more fundamental – i.e. that although we are free to believe what we want – that beliefs have consequences – and that consequences matter.

So, let's look at what happens when countries believe they can eliminate nuclear power from the mix and replace it with more wind and solar power. Of course, I am talking about Germany. Reducing carbon emissions is a reasonable goal as evidence (alternative facts notwithstanding) shows that climate change is impacting our environment and has long-term implications for our entire society. On the other hand, removing a low-cost low-carbon source of energy like nuclear power because of safety concerns is based on a strong element of fear rather

than evidence. In fact, Germany's nuclear plants are likely some of the safest in the world and there is no reason to suspect they will result in a catastrophic accident that means the end of Germany as we know it – yet that is what people fear.

So, what happens in a case like this? The results are in. Fossil fuel use is increasing in Germany, carbon emissions are going up and so is the cost of energy. The German people are paying more money for an outcome that does more damage to the environment and hence, their health. Frankly, it's a high price to pay for the piece of mind that comes from eliminating the perceived risk of nuclear. Or in other words, the extreme fear of nuclear is driving policy more than concern for either energy cost or the environment.

Closure of Nuclear Plant Wiped out Emissions Reductions from Less Coal Power



■ Natural Gas ■ Coal ■ Nuclear ■ Wind ■ Solar ■ Biomass ■ Hydro

Source: AG Energiebilanzen, 2017

As shown above, closure of another nuclear plant in 2015 resulted in increased emissions in 2016 (the first full year

it was out of service) even though there was a substantial substitution of gas to replace coal.

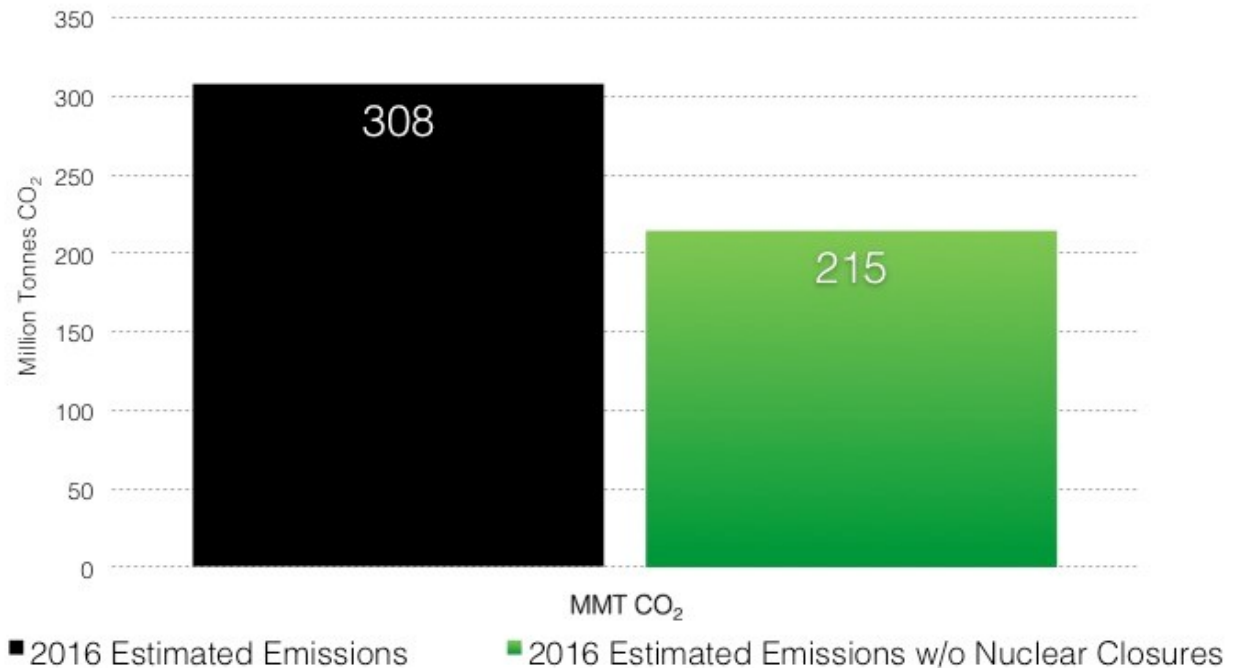
And after adding 10 percent more wind turbine capacity and 2.5 percent more solar panel capacity between 2015 and 2016, less than one percent more electricity from wind and one percent less electricity from solar was generated in 2016. So, not only did new solar and wind not make up for the lost nuclear, the percentage of time during 2016 that solar and wind produced electricity declined dramatically. And why was this the case? Very simply because Germany had significantly less sunshine and wind in 2016 than 2015.

This analysis was done by Environmental Progress and shows that the intermittency of these renewable sources of electricity both throughout the day and from year to year mean that even huge increases in capacity of these forms of generation will continue to require fossil backup in the absence of nuclear power making 100% renewables an unachievable goal. Another study shows that to achieve a 100% renewable system in Germany would require a back-up system capable of providing power at a level of 89% of peak load to address the intermittency.

Comparing Germany to France, France has more than double the share of low carbon energy sources and Germany has more than twice the cost of energy as France.

So, trying to decarbonize by also removing nuclear from the mix at the same time is simply too high a mountain to climb. The following shows that German emissions were 43% higher in 2016 without the nuclear plants that have been already shut down. Keep in mind that they still do have operating nuclear and with more plants to shut down, the future trend is not likely to change.

2016 Germany Electricity Emissions 43% Higher Without Electricity From Closed Nuclear Plants



Source: EP analysis using preliminary 2016 electricity production data from Fraunhofer ISE; nuclear production assumed to displace lignite, hard coal, and natural gas production proportionally to the share of each on the grid in 2016



It's not just about Germany. As Japan struggles to get its nuclear plants back on line after the 2011 Fukushima accident, its use of coal has skyrocketed. In 2015 its use of fossil fuels for electricity generation was 82% compared to 62% in 2010 when the nuclear plants were in operation. And now Japan plans to build 45 new coal plants (20 GW) over the next decade to meet its energy needs.

Finally, we can also look at South Australia, a nuclear free zone. Recent blackouts due in part to lower wind availability and the inability of thermal plants to make up the shortfall are also leading to questions on 'how much renewables is too much'.

So, we can all continue to hold our beliefs very dearly and only listen to those that support them, while vilifying those that do not. However, please keep in mind that in a world where the farcical becomes reality, results still matter. And

for now, the results are clear, taking nuclear power out of the mix in Germany is not achieving its political-planners' goals. Yet these results are also not likely to change any German minds when it comes to nuclear power. But hey, why worry about the outcome when you know you are right or as said by comedian Chico Marx in the famous Marx brothers movie Duck Soup "Who you gonna believe – me or your own eyes?"?

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

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

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

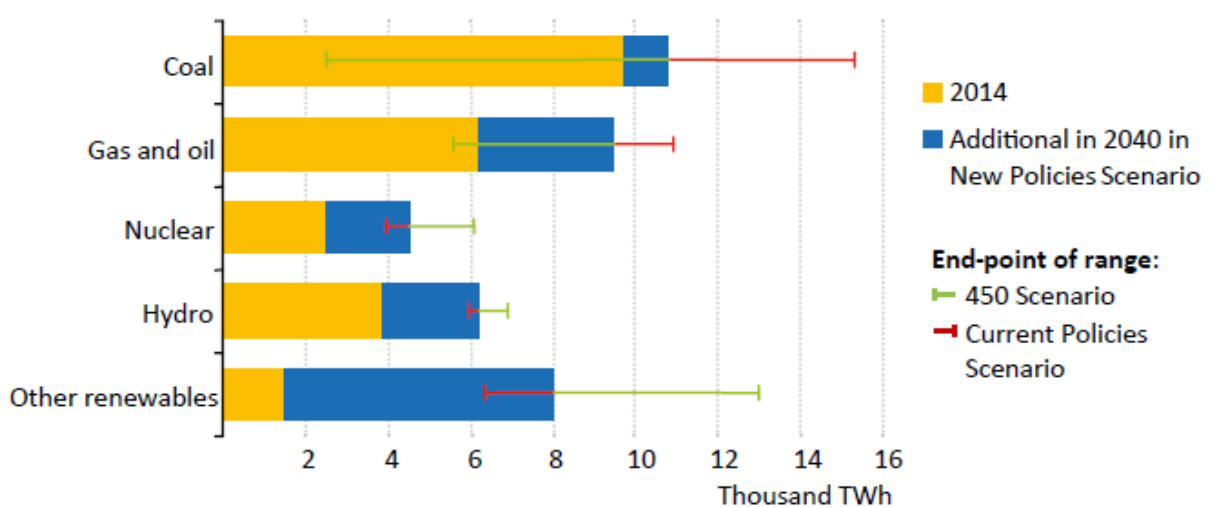
In other countries, Japan continues to struggle with bringing back its nuclear fleet in a timely manner; South Africa seems to have postponed the bulk of its nuclear plan; and Vietnam

cancelled their nuclear projects outright.

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

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

Figure 6.3 ▶ Global electricity generation by fuel and scenario



Source: World Energy Outlook 2016

While the press has been consumed with the challenges, there has been a string of good news for the sector this year. In Britain, there was a final commitment to the Hinkley Point C project and in Switzerland the early closure for their nuclear plants was strongly rejected in a referendum. In the United States, while the focus was on the plants that have closed and

that may be closing both Illinois and New York states have taken government action to keep their plants open recognizing their essential contribution to both the local economies and to their carbon emissions targets. Also in the US, Watts Bar 2 came into service as the country's first new nuclear plant in more than two decades. And so far, it looks like the incoming administration, while not necessarily on the side of combating climate change, will be supportive of nuclear energy going forward.

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

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

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

Want to minimize radiation from power generation – build

more nuclear

Yes, you read that right. For years, there have been efforts to demonstrate that people who live near nuclear plants or work at nuclear plants are getting sick from all that darn radiation they are receiving. Over the years these stories have been debunked as study after study has shown that there is no impact from radiation from living near or working at a nuclear plant.

But now a study has been done that shows that of most of the options to generate electricity, nuclear actually releases the least amount of radiation. This is documented in UNSCEAR's, the United Nations Scientific Committee on the Effects of Atomic Radiation, most recent report to the United Nations General Assembly, on its study to consider the amount of radiation released from the life cycle of different types of electricity generation.

The Committee conducted the comparative study by investigating sources of exposure related to radiation discharges from electricity-generating technologies based on nuclear power; the combustion of coal, natural gas, oil and biofuels; and geothermal, wind and solar power. The results may surprise some, especially those that strongly believe that nuclear pollutes the earth with radiation, coal with a range of air pollutants and carbon, and that solar and wind are environmentally wonderful.



Coal generation resulted in the highest collective doses to the public, both in total and per unit energy. Coal radiation emissions result from coal mining, combustion of coal at power plants and coal ash deposits. The study also considered occupational doses to workers. Here is the biggest surprise. As stated *"With regard to the construction phase of the electricity-generating technologies, by far the largest collective dose to workers per unit of electricity generated was found in the solar power cycle, followed by the wind power cycle. The reason for this is that these technologies require large amounts of rare earth metals, and the mining of low-grade ore exposes workers to natural radionuclides during mining."* It is important to note that in all cases these levels of exposure are relatively low and have little impact to public health.

This study only addresses normal discharges during the lifecycle of the station. Possible larger releases as a result of nuclear accidents are not considered and we recognize that many will argue it is accidents and their consequences that create the largest fear of nuclear power.

So why talk about this? The reality is that this information is not likely to change even one single mind on whether someone supports nuclear power or fears it. We live in a world where facts no longer matter – the only truth is the one that any one person believes. Well, we believe that scientific study remains the best way forward to establish

truth and that studies such as these are part of the path forward. No one electricity generation technology is perfect. Coal is cost effective and technically strong, but is also a strong emitter of a range of pollutants (including radiation); renewables such as solar and wind are clean but their resource is intermittent and they have issues with both their front end (mining of rare earths) and disposal at the end of their life cycle.

Nuclear power continues to have a good story to tell, with respect to its economics, reliability, environmental attributes and the many good jobs it creates for local economies. Concerns about nuclear relate mostly to one major issue – fear of radiation. And fear is a strong emotion that is not easily changed. But at least what we have here is another study to show that radiation emissions from normal operations of the nuclear fuel cycle is not something to fear – and in fact if you really want to minimize the collective dose to the public, nuclear power remains the option of choice.

Young people with passion – that is the future of nuclear power

We talk a lot about the merits of nuclear power in this blog. From economics and reliability to environment, we focus on why nuclear is now and should be an essential part of our future energy mix. But how do we get there? Again, we often talk about the challenges associated with public acceptance and how we can better position nuclear as the energy solution we all

know it is.

But today we want to focus on something different. People.

We have been privileged to work in this industry for more than 35 years. Often it's hard to believe that this much time has passed since we were so excited to start our first jobs as a young engineers working on nuclear safety. Over the years there have been many challenges as the industry slowed, in part due to the accident at Chernobyl, in part due to the slowdown in energy demand growth in many industrialized countries, to the challenges of building capital intensive large projects into deregulated markets. But one thing has not changed; our passion for the industry – our passion for making the world a better place with clean reliable economic nuclear power. And we are not alone.

At a recent industry event, I spoke to many of our colleagues, many of whom have come out of retirement again and again simply because their passion for nuclear power as a solution to meeting our ever growing energy needs is simply impossible to extinguish. Some are well into their 70s and their enthusiasm is as strong as when they were in their 30s.

With nuclear power growing once again, it is time to ensure its continuity by instilling this passion into a new generation of young people. It is the fuel that will ensure the industry continues to be innovative and reaches its full potential going forward. That being said it is important to focus on what is important to this new generation of engineers and scientists; what will keep them enthused and committed. It is hard to imagine millennials thinking of utilities or large industrial companies as the growth companies of the future. Rather they think of companies like Google, Facebook and Uber when it comes to large innovative exciting companies – or they believe in being entrepreneurs and starting their own tech start-up. This ad campaign by GE (one example below) is a brilliant one as it tries to show young people that it can indeed be exciting to be in this large industrial

company – that not everyone has to be coding and developing the next app that puts hats on cats – but that to truly change the world, it is the future of things like transportation and energy that really matters.

I love it (There are a series of these ads, just go to YouTube and you can see more).

In the nuclear industry we have the problem of a gap in age. There are many people in their 50s through to retirement age that have been in the industry for decades, and then there is a new cohort of young people who have joined the industry in the last 10 years or less. This new young cohort has different work expectations than the older group. They expect to be able to find a place and make a meaningful contribution in a relatively short time. They are impatient and expect to change jobs many times in their career. They do not expect to join one company and stay there until they retire.

Yet we are an industry that believes that it takes years to learn and become an expert. We need people with 10 years plus experience and we need experts who continue to grow as they gain the experience needed to make a difference.

Therefore, as industry leaders we need to understand and address the desires and concerns of those just starting out. We need to remember that 30 years ago when we were younger we quickly developed into experts as new techniques were established and we did not have the benefit of people like us to show us the ropes. We were at the leading edge and we loved working in this exciting young industry. We learned on the job. We were excited with every opportunity and put our best into developing a product that we strongly believed in. These are the conditions we need to replicate for this next generation. We need to ensure they are actively engaged, play a strong role in new projects and in innovating as the industry moves forward. We need to provide them with the

opportunities they crave to develop their passion for this exciting industry. Competition for these people will be fierce and we need to show that the nuclear industry is where they can truly make a difference in the world.

Sometimes as conservative engineers, or as some of the anti-nuclear activists may state – that it is not fair to leave problems for future generations to solve; we need to push back. As one quite learned colleague once said, why solve every issue – we need to leave some things for the bright young people following us to solve – because they will be smarter than we are and bring new thinking to old issues.

While many think the future of nuclear power depends on public acceptance, or solving the waste issue, or improving nuclear safety; it actually depends on building a passionate next generation of young people to take it in directions that none of us has even thought of yet. Life is about passion – so let's all work to bring out the passion in a new generation of nuclear people. The future is open to us – but only if we can attract the best and brightest people needed to make it happen.

If you are under 40 and have read this post – please comment explaining why you are passionate about working in the nuclear industry.

UK commits to nuclear new build – a critical decision

for the future of nuclear

More than a decade since then Prime Minister Tony Blair launched a review into UK energy policy, a positive decision has been taken to approve the construction of the first new nuclear station in the UK in a generation, Hinkley Point C.

Finally, after more twists and turns than a good British mystery novel, including: EDF's purchase of British Energy, the nuclear accident at Fukushima in Japan, agreement to an innovative Contract for Difference (CFD) type of contract to support the project, the introduction of a significant role for the Chinese, and most recently the Brexit vote; the UK decision shows that Europe remains a nuclear continent.



The project is not without its opponents; some of whom are supportive of nuclear new build in the UK, but do not support this particular project. Concerns range from the cost of energy to the inclusion of the Chinese. But following extensive review and assessment, the decision has been taken, and its importance goes well beyond just approving a single

new nuclear project in Britain.

Following the Fukushima accident in Japan, a number of European countries reconsidered their commitment to nuclear power, the most significant being Germany, who immediately shut down a number of their nuclear units and made a clear plan to retire the remainder. Many said nuclear in Europe, where there are the most nuclear units in the world, is a technology of the past. Renewables are the future. Even the French government, with the world's largest nuclear fleet in terms of share of electricity generated, said it would cut back on its use.

Through it all, the UK maintained its strong commitment to new nuclear. Its existing fleet is aging and with domestic gas waning and energy imports on the rise, it recognized that new nuclear is the best, and likely only way, to both achieve energy security and meet its carbon reduction goals.

While all the talk has been about delays in securing approvals for its new nuclear ambitions, EDF Energy, the operator of the current UK fleet, has been quietly going about its business and making game-changing improvements in its operations. On September 16, Heysham II was taken off line after 940 days of continuous operations, a new world record beating the record held by Pickering Unit 7 in Canada (894 days) for more than 20 years. *[As we all think about light water reactors (PWRs and BWRs) as the global standard, we often forget that these other reactor types, AGR in the case of Heysham and CANDU in the case of Pickering, have their own specific advantages.]* In addition, EDF has been able to extend the lives of the AGR fleet by an average of 8 years. This shows the strong capability of EDF Energy as an operating entity and bodes well for the next step; new build.

So why is the approval of Hinkley Point C so important to the nuclear industry? First of all, it is the first new build nuclear project in the UK since Sizewell B came into service

in 1995 and, even more importantly, is expected to be the start of a major ongoing new nuclear program. It is the base to rebuild the UK nuclear supply chain, once a world leader, and support the broader European nuclear supply chain. It is the first new unit to be built supported by a CFD type agreement and as stated by Duncan Hawthorne, CEO of Horizon Nuclear, likely the next to build in the UK, it “blazes the trail” for those that follow. The UK is taking an interesting approach to new nuclear going forward as there are multiple companies who are planning to build a multitude of designs (EDF Energy with the EPR, Horizon with the ABWR, NuGen with the AP1000 and CGN with its HPR1000). And finally, after years of cooperation in China, it entrenches EDFs global partnership with CGN and establishes China as a reputable exporter of nuclear power.

But most of all, it is further evidence that Europe remains a nuclear continent. While most articles on nuclear tend to say nuclear is languishing everywhere except for its saving grace – China – Europe is moving forward. Sweden is taking real steps to keep its fleet operating, France and Finland have new build underway albeit while experiencing First of a Kind (FOAK) issues, Finland now has a second new unit going ahead, Hungary is waiting for an imminent decision from Europe on state aid and is ready to start its a new station at Paks, with other countries continuing to plan for new nuclear plants. And now the UK starts a new program – one that will ultimately include a number of vendors and countries.

Of course the real challenge is just beginning – that is for EDF Energy to demonstrate that it can build Hinkley Point C on time and on budget – and as the 5th and 6th EPR units to be built, there is certainly a very good chance that they will.

Nuclear, a technology of the past in Europe – I don’t think so – in Europe nuclear power is a technology of the future.

Fighting for the environment – keep nuclear in the mix

Earlier this month I enjoyed a week of vacation sitting on the beach in front of a beautiful camp (or cottage, cabin or country house, depending on where you are from) staring at a stunning view of the north shore of Lake Superior, the world's largest fresh water lake. This is pretty far north (at the 49th parallel), and this year the summer has been very hot. Once again, July has been the hottest month ever recorded.



It's times like this of quiet reflection that the issue of environment comes to the forefront. Contrast this idyllic view to that of some of the world's cities where pollution is rampant and health is impacted every day. This is the short term need – make the air breathable for all those that are having their health impacted negatively by pollution primarily coming from burning coal to generate electricity and from

burning fossil fuels in cars each and every day. And then there is the issue of climate change. Harder for many to understand as the consequences are not as easy to see in the short term; but clearly the environmental issue of our time.

Let me start by saying that I am not one of those people that believe we should directly tie the future of nuclear power to climate change but rather that the case for nuclear needs to be made on its merits – reliability, economics, sustainability and yes, its environmental attributes. In fact, today environmental attributes of any generation technology should be the price of entry – low carbon and low polluting technologies are the ones that should make the list to be considered for deployment. However once on the list it is the other attributes that need to be considered when planning and implementing a robust electricity supply system.

Looking at this beautiful view, I find it hard to understand how so many are trying to disadvantage the environment by excluding nuclear power from the list of technologies that are environmentally friendly. And not just for new generation, but many are fighting to close existing plants that have been providing clean, economic and reliable electricity to the grid for decades. Examples abound.

In California, a decision was recently taken to shut down Diablo Canyon in 2025 rather than extend its life and replace it with renewables and demand management. This decision has recently been severely criticized by Dr. James Hansen, one of the world's most prominent climate scientists who has asked the Governor for a debate on the issue stating *"Retirement of the plant will make a mockery of California's decarbonization efforts. Diablo Canyon's yearly output of 17,600 gigawatt-hours supplies 9 percent of California's total in-state electricity generation and 21 percent of its low-carbon generation. If Diablo closes it will be replaced mainly by natural gas, and California's carbon dioxide emissions will rise..."* [Read the entire text of the letter [here](#)]

In New York state there has been an important victory as nuclear has been included in the clean energy standard as legislators have acknowledged the important role that nuclear plays in reducing carbon emissions; and in fact accepts that meeting carbon objectives is simply impossible without nuclear. However, this is just a first step. It protects existing nuclear but also maintains the future target of 50% renewables, making nuclear a bridge to the future. Well if existing nuclear is good, then so should new nuclear – but that fight is for another day.

Of course the battle to include nuclear as a low carbon energy option is not uniquely a US issue. A new study * by the University of Sussex and the Vienna School of International Studies suggests that *“a strong national commitment to nuclear energy goes hand in hand with weak performance on climate change targets”*. While the authors do note that *“it’s difficult to show a causal link”*, this does not stop them from suggesting it is likely there. It is easy to say that Germany has done a good job and reduced its carbon emissions by 14% since 2005. What is not said is that Germany’s carbon reduction efforts have really struggled since it closed a number of nuclear plants in 2011 after the Fukushima accident and has yet to get back on track; which was likely a key factor in Sweden where the Greens have accepted the need for continued nuclear operation to meet its climate goal.

Here in my home jurisdiction of Ontario Canada, we had the largest carbon reduction in all of North America as coal was removed from the generation mix in 2014. This was not done by replacing coal with renewables although renewable generation has increased, but was made possible by refurbishing and returning nuclear units into service.

I have written extensively about peoples’ belief systems over the years and this is what is standing between nuclear and success. Ask anyone in the street about clean electricity and you will hear that renewables, primarily wind and solar, are

what is needed to transform our energy systems. Ask about nuclear and the response is much more likely to be mixed.

It is great news that many environmentalists are now seeing the necessity of nuclear in the mix. As concluded by James Hansen in his letter” *It would be a tragedy if we were to allow irrational fear to harm the climate and endanger the future of our children and grandchildren.*” So if we are to avoid a tragedy, we in the nuclear industry have a lot of work to change the narrative and continue to increase public support. The agreement in New York is a good beginning but the hard work has only just begun.

*** The study referenced above was retracted by the authors on November 25, 2016 as they admitted mistakes in the analysis. The link to the retraction on Retraction Watch is here.**

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.

Let's create awareness for all the benefits that nuclear technology brings to mankind

When a report on the benefits of nuclear technology starts with *"The public are often unaware of the extent to which aspects of their everyday life involve products and processes originated from the application of nuclear technology via the nuclear industry"*, it tells me that the time has come to tell this story and increase public awareness.



I had the opportunity to attend the Nuclear Industry Summit in Washington last month and was privileged to participate in Working Group 3 which had the mandate to summarize the role of

the nuclear industry globally. The NIS was a very successful event. It was a companion event to the Nuclear Security Summit held by President Obama and provided an opportunity for the nuclear industry to interact and present its views to global leaders on the key issues of nuclear security and how the industry addresses it.

With the 5th anniversary of Fukushima having just passed last month and the 30th anniversary of Chernobyl this month, we have a steady reminder of the issues that never seem to go away for the nuclear industry. It is our nature. In his very enjoyable talk to the Canadian Nuclear Industry Conference in February, Malcolm Grimston asks the key question of why is it that the safest source of large scale electricity generation we have ever come up with is considered so dangerous by enough people that in a number of countries there is an effort to stop using nuclear energy? I have commented on Malcolm's presentations before and I really enjoy his perspective. We in the industry tend towards the problem being an irrational public – Malcolm insists the public are quite rational and that it is actually the industry that is providing much of the information that frames public views. An example is the constant talk by the industry about safety and how safety is the most important issue. While intended to provide comfort, it can achieve quite the opposite effect. If safety is even more important than generating electricity reliably and efficiently the answer is quite simple – shut down the plants and safety is assured. I won't go into more detail but I do recommend you watch Malcom's presentation when you have 25 minutes to spare.

Or as was so eloquently put by the CEO of Ontario Power Generation at the CNA conference when talking about the nuclear industry, *"we make sure to find the black cloud around every silver lining left to our own devices."* Yes, we in the industry often succumb to the narrative and as Malcom suggests, probably even feed the beast. (Aside: I also urge

you to watch Jeff Lyash's presentation when you have 20 minutes to spare. It is an excellent view of the industry going forward.)

So rather than talk about safety and nuclear waste as we tend to do over and over again; in this post I want to help increase awareness of the many benefits that nuclear technology brings to us all across a range of industries. The paper submitted by Working Group 3 led by Dr. John Barrett, President of the CNA is a must read. It is one of those papers that once read makes you wonder; why hasn't this paper been written this way before? So please read the paper – it is about 20 pages and well worth it.

But for those who may not get there quickly enough here is a summary of the benefits that nuclear technology brings to society each and every day. As stated in the paper, *"Nuclear technology is vital for more than just providing reliable, low-carbon energy. It also has life-saving medical application; improves manufacturing, mining, transport and agriculture; and help us discover more about the planet we live on and how we can sustainably live with it."*

So for example, did you know that

- nuclear technology saves lives through use of radioisotopes for screening, diagnosis and therapy of various medical conditions? According to the WNA, over 10,000 hospitals worldwide use radioisotopes. Radioisotopes are used in therapy to control and damage cancerous growths. Iodine-131 is used to treat thyroid cancer; Phosphorus-32 to treat leukemia. Nuclear techniques are used for neonatal screening for sickle cell disease, hypothyroidism and cystic fibrosis, as well as childhood cancers.
- radiation is used to preserve seeds and food products and breed disease-resistant plants. In plant breeding, some 1800 new crop varieties have been developed through

mutation induced by ionising radiation.

- irradiation technology is increasingly being used to preserve food – spices, grains, fruit, vegetables and meat. It avoids the use of potentially harmful chemical fumigants and insecticides
- use of the IAEA's Sterile Insect Technique irradiates the eggs of these insects to sterilise them before hatching. The IAEA estimates that, by suppressing insect pest populations with SIT, pesticide use worldwide has been reduced by 600,000 litres annually.
- in industrial radiography, nuclear substances are used for the non-destructive examination and testing of new materials. Radiation from the substances passes through the material and allows defects in welds or constituency to be recorded on film or a digital imager.

This list does not do justice to the report itself which I strongly suggest you read. It's time to stop being on the defensive and make sure that we no longer have to write reports that start with *"The public are often unaware of the extent to which aspects of their everyday life involve products and processes originated from the application of nuclear technology via the nuclear industry."* It is time to celebrate our successes and not just talk about where we need to improve. We are proud to be part of the nuclear industry and we are confident that we are making a difference that helps to make the world a better place.

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 Laureate 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 U308 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.