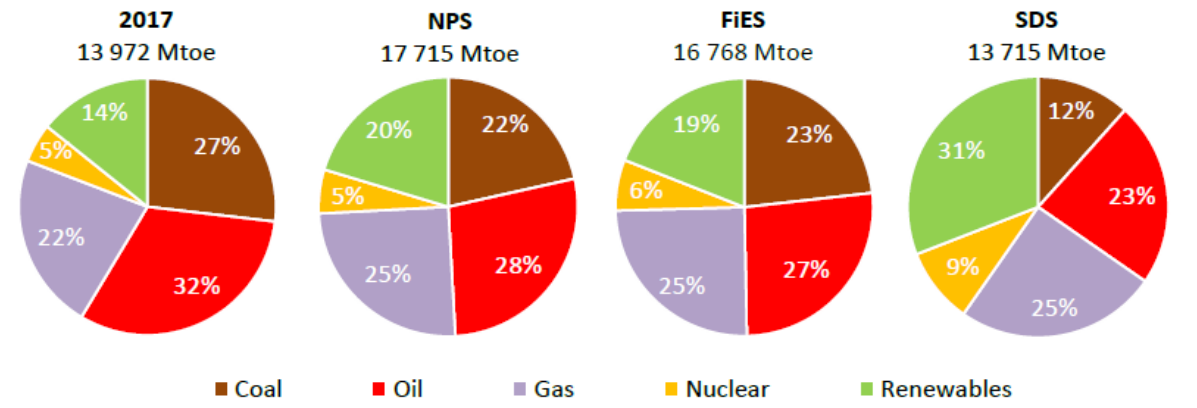
International Energy Agency (IEA) says we need nuclear

The International Energy Agency (IEA) plays an important role in looking at the global energy scene. Every year it publishes the World Energy Outlook (WEO) providing important information and analysis to countries to support their development of energy policy. Over the years, the focus of the WEO has been to consider alternative scenarios to business as usual to provide guidance on what is needed for the world to decarbonize. In various iterations of its report, it called this scenario the 2 Degree scenario, the 450 scenario (for 450 ppm) and now the Sustainable Development Scenario (SDS). Every year the IEA states the importance of decarbonizing our energy systems, and every year it laments how difficult this will be.

Yet, it rarely talks much about the role that nuclear power currently plays and must play in the future to achieve this decarbonization goal. Rather the analysis generally focuses its attention on massive increases in renewables which does reduce the fossil footprint but not nearly enough as fossil fuels remain more than half of global energy supply in 2040. The only path to meet its scenario emission targets then requires policies that reduce energy demand. Consider the following figure from the 2018 WEO that shows renewables doubling, coal being cut in half while gas retains its position as an important fuel in the SDS scenario – with the balance of the carbon reduction due to reduced demand in 2040 for this scenario

– 2% less than 2017 and much less than currently projected in the New Policy
Scenario (which projects a 26% increase to 17,715Mtoe). Do we really think that the world will use
less energy in 2040 than it does today?

Figure 10.15 ▷ Shares of fuels in world primary energy demand today and in 2040 by scenario



Promoting energy security is an important policy consideration; electrification, together with energy efficiency and other alternative fuels, can help achieve this goal

Note: NPS = New Policies Scenario; FiES = Future is Electric Scenario; SDS = Sustainable Development Scenario.

Source: World Energy Outlook 2018
But that was then, and this is now. At the Clean Energy Ministerial (CEM) meeting in Vancouver last month, the IEA issued a report "**Nuclear Power in a Clean Energy System**" and the message is unequivocal. The IEA is stating that to decarbonize our energy systems, WE NEED NUCLEAR!

The report notes that "*lifetime extensions of existing nuclear power plants are crucial to getting the energy transition back on track.*" And "*that without nuclear investment,*
achieving a sustainable energy system will be much harder."
In fact, "*a collapse in investment in*
existing and new nuclear plants in advanced economies would have implications
for emissions, costs and energy security."

Of more importance it says that "*achieving the clean energy*

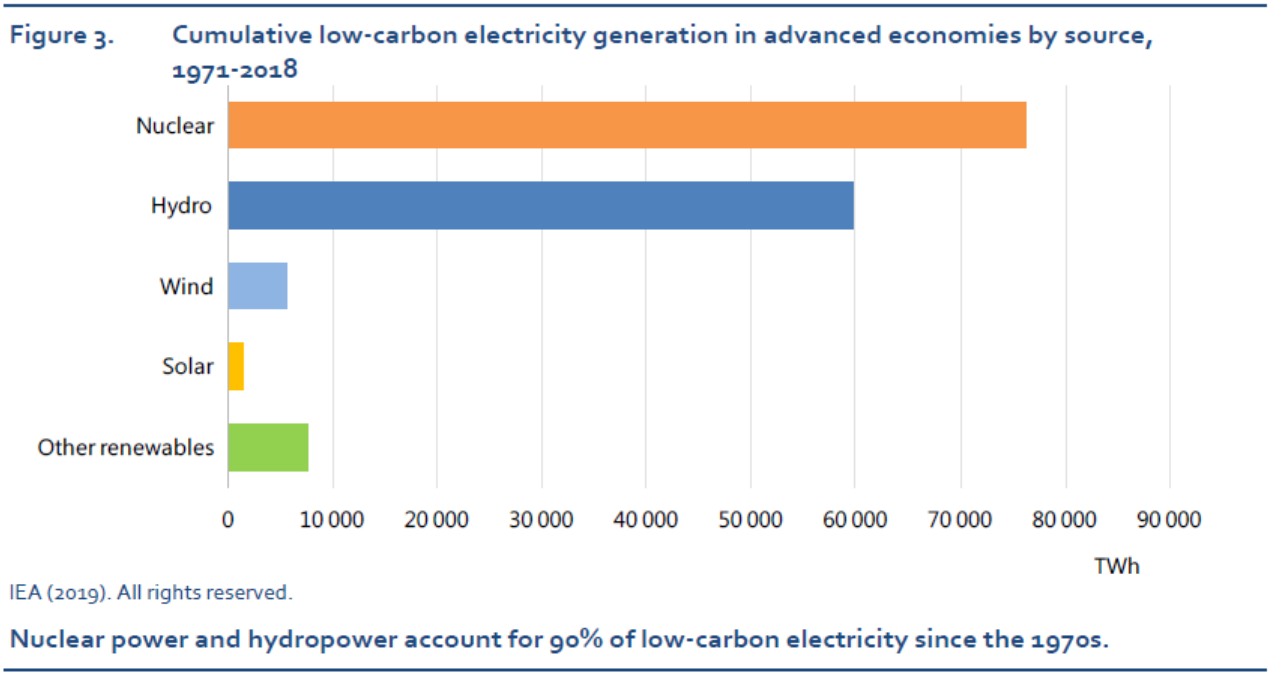
transition with less nuclear power is possible but would require an extraordinary effort." And even though it talks about the economic challenges facing nuclear power, both existing and new, it also notes that "*offsetting less nuclear power with more renewables would cost more*" and that "*taking nuclear out of the equation results in higher electricity prices for consumers*."

Finally, it concludes with a message to world governments, "*strong
policy support is needed to secure investment in existing and new nuclear plants*."

This is the strongest support given to nuclear power by the IEA in memory. Even back in 2014 when it had 3 chapters on nuclear in the WEO, it was a reluctant supporter. At that time it noted that "*Nuclear power is one of the few options available at scale to reduce carbon-dioxide emissions while providing or displacing other forms of baseload generation",* but also started its discussion with "*Provided waste disposal and safety issues can be satisfactorily addressed,"* while never discussing the challenges that other forms of energy face.

To their credit, in this new report, there is no discussion of these traditional nuclear bugaboos with the focus clearly on why nuclear is needed, why we are better off with nuclear in the system and then suggests policy options for government to make this happen going forward.

The report shows the role nuclear power plays in mitigating carbon emissions is nothing new as over the last 50 years it has displaced more carbon than any other electricity source. Yes, that's correct. No other electricity source has displaced as much carbon as nuclear. So, just imagine what can be achieved in the next 50 years.



Source: **N**uclear Power in a Clean Energy System . IEA 2019
This IEA report is a turning point in the global discussion. As one government official said, this is the kind of report that moves the world. I am not sure how far – but it is definitely a very important step in the right direction. Because one thing is now absolutely clear – if the world wants to decarbonize, the quickest and lowest cost option is to ensure an increasing role for nuclear energy.

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10 years of blogging…. Nuclear power is making progress, but it hasn't been easy

It's hard to believe, but this month it is 10 years since our first blog post in May of 2009. 10 years! And what a decade it has been for

the nuclear power industry. There were highs and lows, and most of all change…..

In 2009, there was still optimism about the nuclear renaissance, until the effects of a world financial crisis and the first downturn in global energy demand since World War 2 made it a difficult time to support large energy projects. Nevertheless, the first next generation EPR design in Finland was under construction, and the UAE would soon select the Koreans to build their new nuclear plant (based on their next generation APR1400), to become the first nuclear newcomer-country in many years.

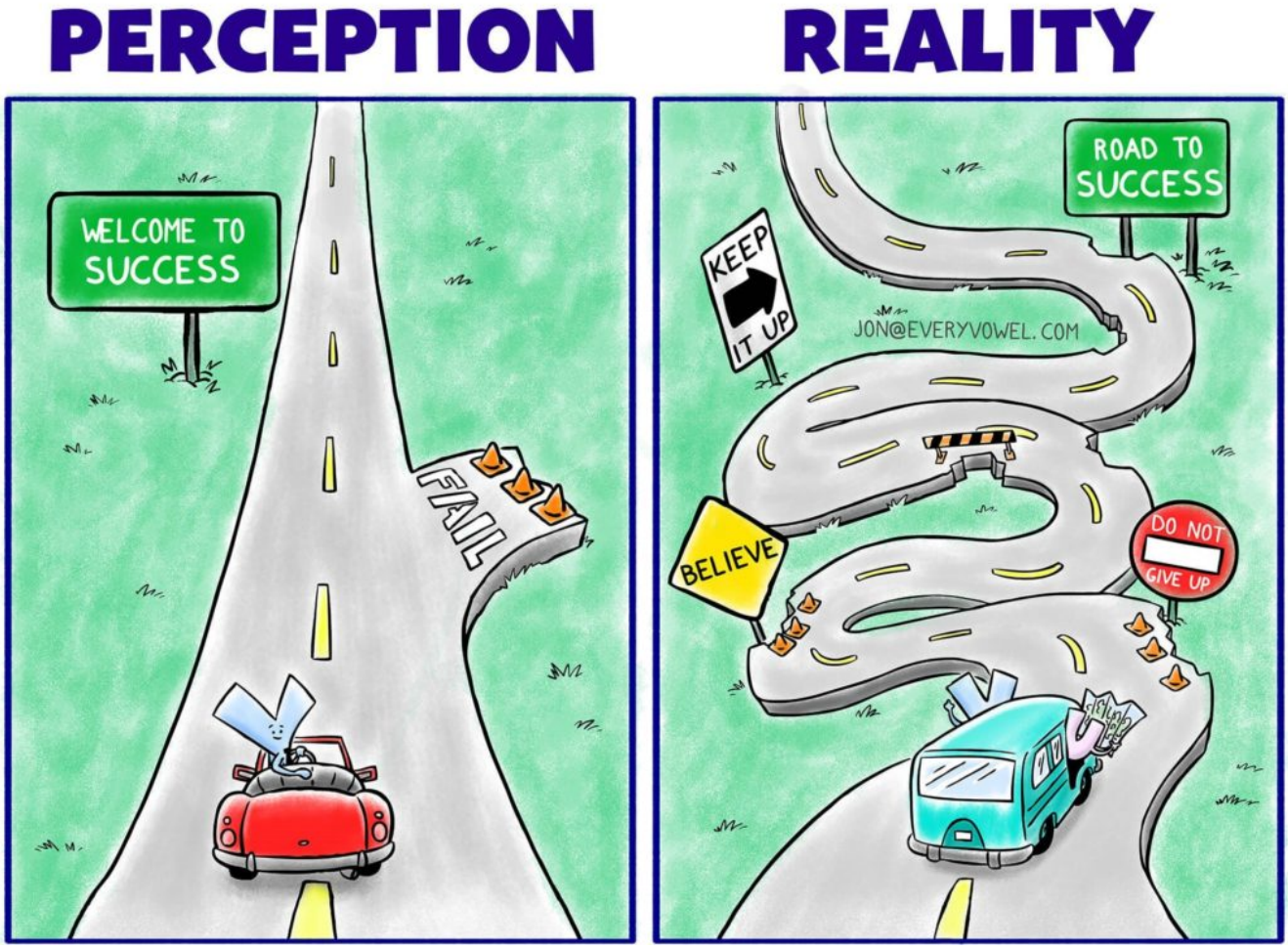
This was also the time the environmental movement started to consider the merits of nuclear power. It was 2009 when Stuart Brand published his book "Whole Earth Discipline: An Ecopragmatist Manifesto" in which he took on the environmental establishment with this statement that "***Cities are green. Nuclear energy is green. Genetic engineering is green.***" This was a turning point for some environmentalists as they started to question their life-long opposition to nuclear power.

It was looking like the industry would weather the financial storm, but then in 2011, the great Tohuku earthquake and the tsunami that followed devastated the coast of Japan resulting in a serious accident at the Fukushima Daichi nuclear power plant. While no one was killed, an event of this magnitude in an advanced country such as Japan heavily reliant on nuclear power caused a huge amount of global fear. To this day Japan only has 5 of its units in operation with some others permanently out of service as many more are working to meet new higher safety standards to enable them to restart. Some countries took a common-sense approach such as China, who stopped approving new builds until they could satisfy

themselves that all was in order. Others such as Germany decided to abandon the technology altogether.

There were some positives in this immediate post Fukushima accident period. In the US, two AP1000 projects were approved in 2012 at Vogtle and VC Summer. The UK continued to march forward with its commitment to new build although it took another year for the UK government to agree to a price of energy for the Hinkley Pt C project which is now under construction.

In 2015 Canada made a big re-commitment to nuclear power approving the refurbishment and life extension of 10 units at Bruce and Darlington, a commitment of $25 Billion over 15 years.
This clearly showed a strong commitment to nuclear as these plants will continue to be the backbone of the Ontario electricity system into the 2060s.



And there were many challenges. The world's two largest nuclear vendors,
Westinghouse and Areva, struggled financially as a result of difficult projects
that impacted their financial viability.
After taking a huge financial hit, the VC Summer project was cancelled,
and Toshiba sold the bankrupt Westinghouse to Brookfield.
Meanwhile In the US, hydraulic fracking
produced very cheap natural gas causing financial mayhem in those states with
de-regulated electricity markets resulting in some early nuclear plant closures
and more being considered for economic reasons.

In France, Areva was restructured into Framatome and Orano as the Olkiluoto project in Finland and the Flamanville project in France continued to be delayed. French government support

for nuclear weakened as it set out a policy to reduce its reliance on nuclear from 75% to 50% by 2025.

However, in the US today many states are pushing back and providing support to keep their plants operating as they acknowledge the benefits of nuclear power to grid reliability and their near zero carbon emissions. And in France, the current government has accepted the importance of nuclear power delaying the roll back to 50% to at least 2035 as they consider their future strategy.

While many countries in the west continued to experience challenges, the east is charging ahead. China has the world's most ambitious nuclear program having reached 45 units in operation and targeting to triple this by 2030. They are also starting to work their way into the export market with success in Pakistan and discussions ongoing with many countries. And Russia is having a big impact on the global industry as Rosatom has become a leading exporter of nuclear plants.

Concern about climate change has increased with the most recent agreement to reduce green house gases made in Paris in 2015. Following in the steps of Stuart Brand, more environmentalists now believe that nuclear power must be a part of the solution. The evidence from Germany and California demonstrate that a 100% renewable future is not in the cards as the challenges of managing a system based on an energy-diffuse, intermittent energy source becomes clear. To really decarbonize the world must use all the tools available to reduce emissions. This includes nuclear power. Many governments agree and at the Clean Energy Ministerial (CEM) meeting in Vancouver (just getting underway as we write this post), discussion will continue about the NICE initiative (Nuclear

Innovation – Clean Energy future (NICE)) advocating for all clean energy options to be on the table – and this includes nuclear power. During this meeting, the IEA is expected to release a report that supports the need for nuclear energy to meet climate goals.

There is also an active movement to develop the next generation of nuclear plants, so called SMRs (small modular reactors), that are to be smaller, more versatile and easier to build. The thought is to replace the economics of scale with the economics of numbers. The UK, Canada and the US are all promoting these options with a plethora of companies working on these novel designs.

While there have been challenges over the years, we have seen much progress. Every time negative emotions knock us down, facts and logic raise us up. Today we have the first AP1000s, EPRs, VVER1200s and APR1400s in operation, governments are talking about the role of nuclear power to decarbonize the world to combat climate change, a new generation of SMRs is under development, and environmentalists are seeing the possibility of using these plants going forward. This provides us with hope, but we always recognize that while hope is nice, it is not a strategy. There is much work to do in the next decade and the outcome is far from certain. But there is one thing we are certain of – the world needs lots of energy, clean, reliable and economic to power mankind – and nuclear power has what it takes to deliver.

As for our blog, over the last decade we have written about nuclear power's ups and downs, focused on various countries from China to Korea to Canada and the UK, talked about economics and how to make projects successful and the impact of the Fukushima accident on the psychology of the world.

What about the future?
While our audience has increased dramatically over the last 10 years, we are still talking mostly to ourselves – the nuclear industry – and while that may make us all feel good, it does not change minds. We plan to work hard to expand our reach and start a dialogue with those who are more skeptical of nuclear power and see where that takes us. And of course, we want to continue to talk about those things that are happening and what they mean for both the industry and the world at large.
Your thoughts and recommendations on future direction are welcome.

We thank you for reading our blog and hope you will continue.

Nuclear Power provides the performance we need

We often speak about the incredible energy density of

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

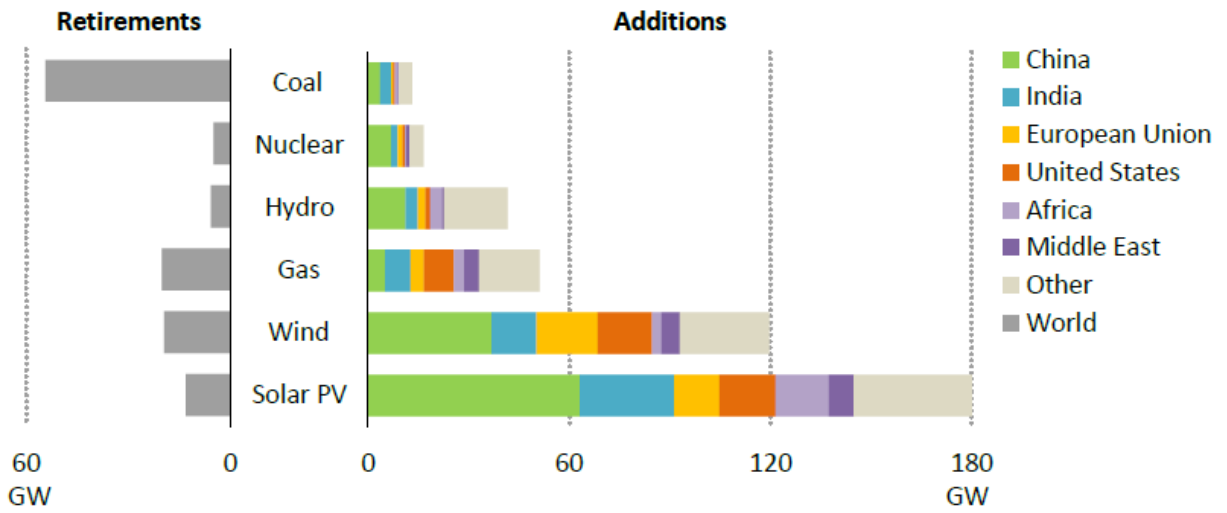
In fact, even as the global fleet ages, it just keeps on getting better. In 2018, the US fleet produced the most energy ever, exceeding the previous peak from 2010 even though 7 units have been retired and only two new ones have come on stream. The annual capacity factor in the US for 2018 was 92.3%. This should come as no surprise since the US fleet has operated around 90% CF for the past 20 years. This is a testament to the technology and its robustness. Not only does nuclear operate extremely well, it does so at all times during its very long life. It has no early life breaking in period and no end of life deterioration in its performance. It just continues to provide the energy we need day after day, year after year.

Let’s contrast this with the world’s most talked about generation sources, wind and solar. Not only are they intermittent, because the wind doesn’t always blow and

the sun doesn't
always shine, but on average they produce relatively small amounts of energy
from a given plant, i.e. a low capacity factor. Wind farms usually operate about 35% of the
time and solar only about 15% of the time.
Not only does each generator produce a relatively small amount of
energy, it can't be called upon to produce it when it is needed.

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

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



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

Source: IEA World Energy Outlook 2018
At first look, it seems like wind and solar are leading the

charge to decarbonize the world energy system – 180 GW of new solar, 120 GW of new wind and only 17 GW of new nuclear.

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

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

A successful narrative has been created that renewables are a good way to meet all our energy needs, but it is based on how they make us feel, not on science. Who doesn't like the sound of harnessing nature and getting our energy from the wind and the sun? In reality, we simply cannot make the wind blow or the sun shine. We cannot imagine

our way to a clean energy future with solutions that sound good but are incapable of giving us the result we so desperately need. In fact, the WEO bases its low carbon scenario on implementing large efficiency gains to reduce demand as a massive renewables new build program alone cannot meet the carbon reduction targets.

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

It's fear, not facts, that influence our attitudes and beliefs

"*We are the healthiest, wealthiest, and longest-lived people in history. And we are increasingly afraid. This is one of the great paradoxes of our time*." As said by Daniel Gardner in his book "The Science of Fear: How the Culture of Fear Manipulates Your Brain" more than a decade ago; fear can be all consuming and it is often hard to understand how we choose what to be afraid of and why.

8 years ago this month, Japan suffered the great Tohoku earthquake and tsunami that killed more than 20,000 people and caused US$300 billion of damage. Entire towns were wiped out when the wave hit on March 11, 2011. Farms, factories, roads, railways and electricity lines were destroyed, while almost half a million people were made homeless. Yet when you research this tragic event, the focus is more than likely to be on the resulting accident at the Fukushima Daichi nuclear power plant than on the natural disaster. The reality is that **no one died from the nuclear accident**, although some died indirectly as a result of the evacuation. No one was exposed to enough radiation to cause future concern for their health, but there are health impacts, all as a direct result of a tremendous fear of radiation and what people believe may be its potential impact on the population and their families. It is this same fear that is delaying the recovery of the nearby towns even though radiation levels are as low as other safe cities in the world like Hong Kong and London while the area's fruits and vegetables are fine to eat and so is the catch from the Fukushima fishing boats. When this tragedy is discussed, it is not fear of earthquakes and tsunamis that are talked about, it is an overwhelming fear of radiation.

Japan plans to lift the evacuation order for part of Okuma town on April 10

But it is not just radiation that we fear. For years, there has been a portion of the population that has feared vaccinations and as a result, have refused to immunize their children against preventable childhood diseases. Currently, we have an outbreak of measles in North America, a disease that should no longer exist given there is a very effective vaccine to prevent it. But over the past decades there has been a huge fear campaign by so called anti-vaxxers, causing many people to be wary of vaccinating their children and allowing the disease to flourish once again. The science clearly shows the risk is essentially zero for those getting the vaccine while the risk of complications from the disease are indeed real. Prior to the availability of a measles vaccine, 2.6 million children annually died of the childhood disease. Today, that number is 109,000 but it should be zero. The WHO (World Health Organization) has now declared “vaccine hesitancy” as one of the top ten health threats to the world in 2019. So why is it, when the science is clear, so many are so afraid of vaccines to the point that they are willing to put their children’s health at risk (although they believe

they are protecting them)?

This month we had a second tragic accident with the new Boeing 737 MAX as an Ethiopian Airlines plane crashed soon after take-off causing 157 deaths. This is the second crash of this new version of the popular airplane in 6 months; the first being a crash of a Lion Air flight in Indonesia last October, killing 189. Never before in the modern air travel age have we seen a new version of a plane come out and have two fatal crashes within 6 months of each other – and so soon after the plane first entered commercial operations. Yet it took days until the US and Canada grounded the plane for safety reasons as it became apparent there were similarities in the accidents. With more than 300 dead, all within the first few minutes of their flights, we just don't seem very worried about flying. Don't get me wrong, air travel is very safe – but this particular situation is troubling and there is a need to ensure the root cause of this failure is identified and addressed. Early reports state that a new system that may be implicated in the accidents was not properly rolled out to pilots in order to save airlines money. I travel a lot and I am very concerned about flying on this type of aircraft until a solution is identified that ensures this particular issue will never happen again. But somehow, when fears can in fact be justified, we find a way to manage them. In this case it is essential for Boeing and the industry to act decisively to not squander this very important public trust.

So, what is the point of this discussion? We know that fear can be a powerful driver in
our behaviours. What is not always clear
is why we choose to fear things to the point of trauma when they are proven
safe, yet don't get too worried about things that should actually be of concern. As a result, it is not enough to fight fear
with facts. Fear is a strong emotion. The

facts may be clear but all you need is just a bit of doubt and the fear
remains. And it is easy for those
opposed to something to cause doubt.

As asked in this interesting article on the measles issue, should we hijack the fear monger's method and use fear to push back on untrue claims? Clearly what is driving the strong push to finally silence anti-vaxxers is the resurgence of this disease and the potential impact to children and young adults who may get it. In other words, once we see the disease touching those close to us, a mostly forgotten childhood disease becomes real again and the option of vaccinating becomes less scary than the fear of getting sick. We see young adults getting vaccinated because they are worried about getting measles overcoming their parents' earlier concerns that caused them to withhold vaccination when they were children. Is it time to use frightening imagery to push the factual side of the argument? As stated in this article, "*A baby in the midst of a whooping cough (pertussis) fit will appear to cry without making a sound. Her mouth will be open as she tries to cough to clear the mucus from her narrowed airway, but if she's really struggling, nothing will happen. Her lips and tongue might turn blue. She could seize. When the fit is finally over, she'll vomit. It's absolutely terrifying to watch (and no doubt, to experience), and precisely the type of picture public health organizations need to paint to counter anti-vaccination propaganda*."

Getting back to the nuclear industry, it is time to accept that taking the high ground and fighting fear with facts alone is just not enough. We are in an industry where fear abounds. An article this week, on the 40th anniversary of the Three Mile Island accident looks at just how frightened we were at the time. While this may be historically interesting, the real question is why we think about this 40 years on when the accident turned out to have **no impact on public heath**. 40

years is a long time to focus on a non event. A new poll in the US shows the public evenly split on the issue of support for nuclear power (49% in favour, 49% opposed), but of more interest, is the fact that 49% are also concerned with nuclear safety, or in other words, it is fear that continues to drive opposition to the technology.

Even more so, the people in Germany today are investing hundreds of billions of dollars in decarbonizing the German economy through its Energiewende; yet they seem to be comfortable replacing low carbon nuclear plants with new coal plants greatly impacting their ability to achieve their climate goals. So, what does this say? Clearly Germans believe nuclear power is far more frightening than climate change. Again, this is not consistent with the facts, but the public remains supportive.

The reality is, if we are afraid of something, we need a strong reason to change our views. Just telling someone there is no need to be afraid by explaining the facts is going to fall on deaf ears. What is needed to revisit one's fear is understanding that there is a greater issue at hand, a bigger problem to solve. Only then may we be willing to reconsider our long-held beliefs. Not because we suddenly believe the facts, but rather because we finally feel a need to actually listen to them to solve a greater concern. It is easy to worry about vaccines when you've never heard of anyone getting measles, and for sure never dying of it. But when you see your neighbour's child seriously ill, it may be time to

reconsider.

https://www.youtube.com/watch?v=Z-MZjeBWilQ&feature=youtu.be
The wind blows and the lights come on
Over the last 40 years the nuclear industry has been worn down and tends to respond to criticism defensively. Well, maybe it is time to do something different and go on the offensive. Of course, as opposed to those on the other side, we should always tell the truth (although those against scientifically supported truths always have an easier time as they see no need to tell the truth, only to frighten). For example, it is not enough to say nuclear can help in the fight against climate change because the public already believes a viable solution is available with renewables. We also need to show that 100% renewables is simply not feasible. Only then can we get the attention required to consider alternatives. Here is a recent ad by citi bank about its support for clean energy – look at the last part where the lights all go on as a result of this new off shore wind farm.
Should we be making ads that show the lights going out when the wind stops blowing as it does two thirds of the time, showing the need for reliable 24/7 clean energy?

How do we decide what we are afraid of and what we are not? The time has come to divert some of the research money going into the continued improvement in nuclear safety to better understand the psychology of fear and how it impacts views on this clean safe energy source. Then we need to better address these concerns by showing how this technology can reduce societal fears making all our lives better. One thing is for

sure, the facts are on our side, but we need to understand that this is simply not enough. Only then can we really try and change attitudes.

Addendum (added April 7): See this video by BP that shows that gas is there to meet the need in the "*off chance the wind ever stops blowing here*" making it seem that wind is the primary source of energy. Of course we know that it is actually in the **absolute certainty** the wind doesn't blow more than half the time, gas will fill in the gaps.

https://youtu.be/C5Jj2wD3GjE

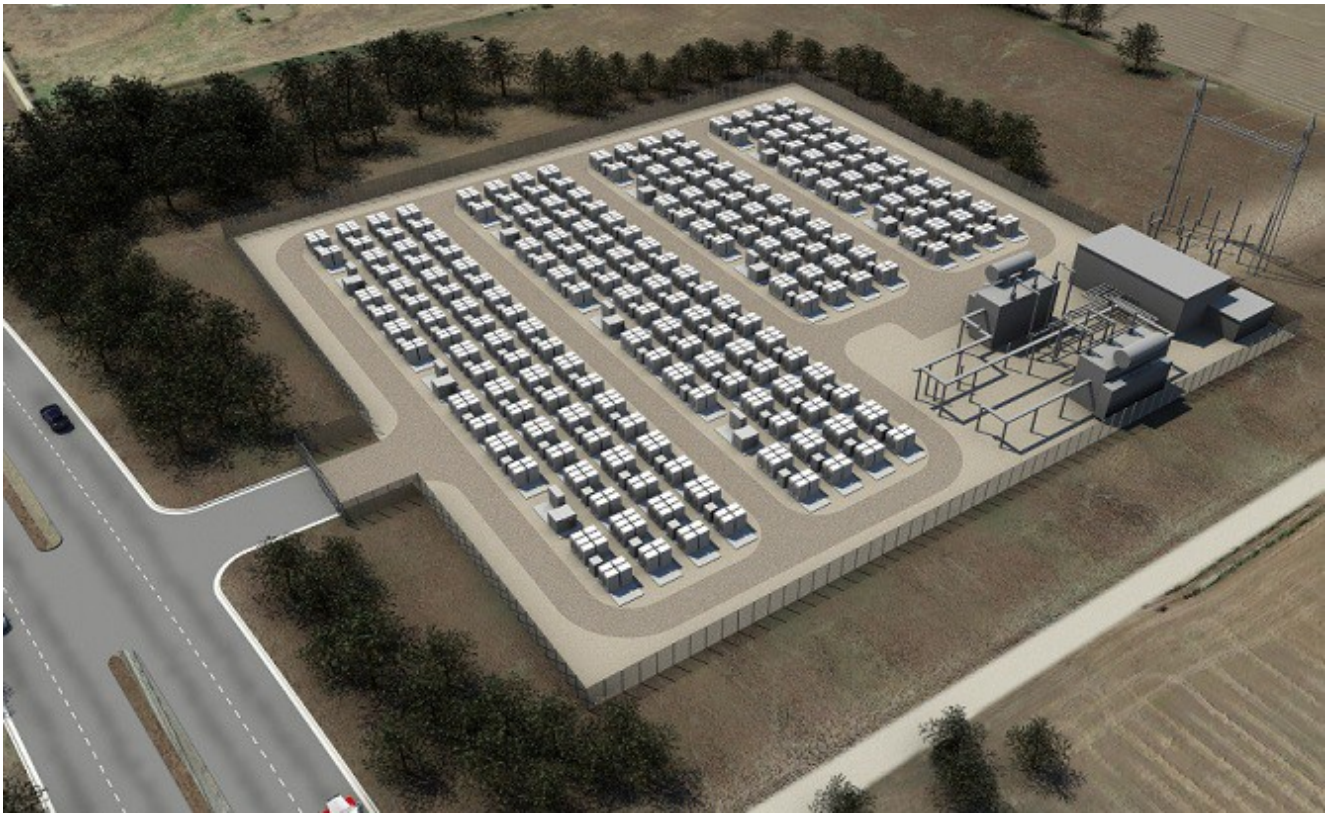
We already have the perfect energy storage – nuclear fuel

If decarbonizing global energy systems is a priority; it seems obvious that all low carbon options should be considered as part of the solution. Yet, a year and a half after 21 prominent scientists ***disproved*** the Jacobson paper that claimed a 100% renewables electricity system is feasible in the USA by 2050, it remains a challenge for many people to move on to more sensible solutions. Hence the Green New Deal that says this 100% renewable dream can not only be achieved, but in half the time. In reality, it still just won't work.

Imagine a world where the electricity system works like the battery in your cell phone. You depend on your phone and worry the battery will run out just as you need it most. To make things worse, even though there is an electrical outlet available, you can't charge your phone because these outlets don't work all the time. To keep your anxiety in check, you must always carry spare batteries with

you to make sure
your phone doesn’t die at the least opportune moment.
Assuming you make it through the day, you would
like to charge your phone while you sleep so it is fully charged when you wake
up ready for a new day. Unfortunately,
you can’t charge it at night because your charger only works during the day at
the same time you most use your phone. Planning to keep your phone charged becomes a
constant pre-occupation as you go about your daily business.

This is the challenge with an electricity system based on variable intermittent renewable energy sources.
We know that if we want to rely on wind and solar for all our electricity needs, that wind only produces about 30 to 40% of the time, and
that solar panels only produce about 15% of the time. After all, we can’t make the sun shine, or
the wind blow more than they do. Therefore,
we need to find a way to save the energy produced when it is available using
some type of storage – like the extra batteries for your cell phone – that will
allow it to be used later when it is needed.



Southern California Edison 20 MW battery storage project

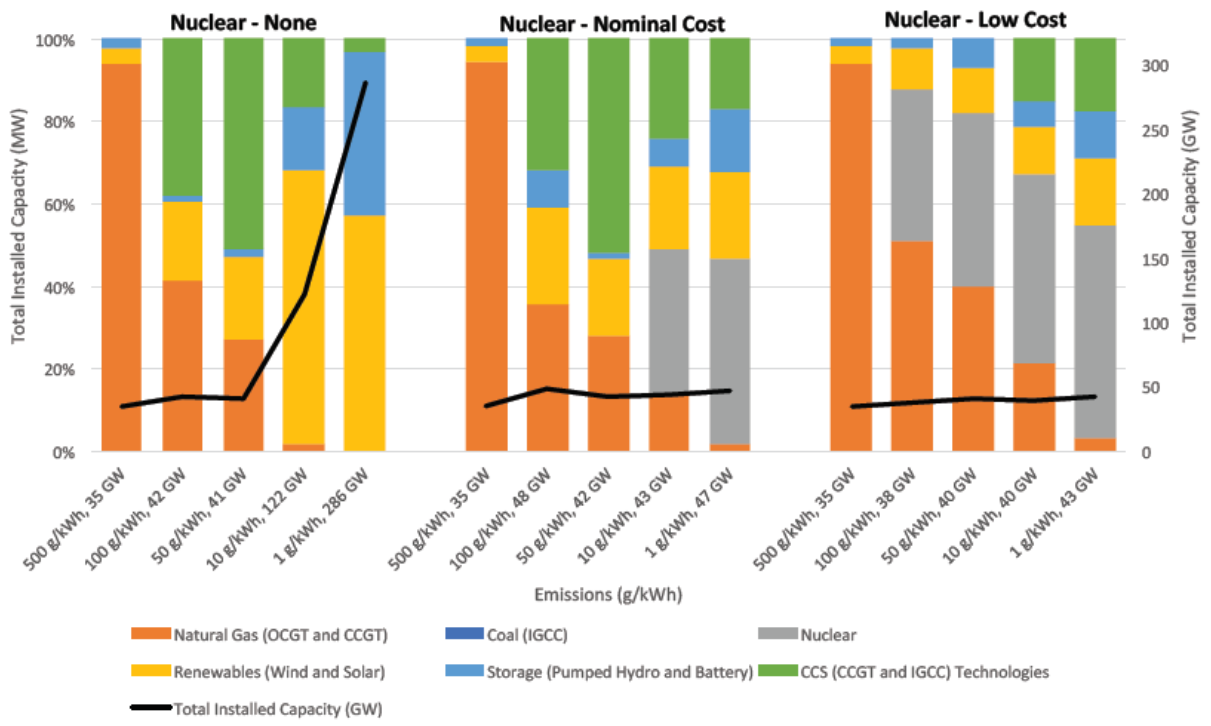
So how do you make sure you have enough energy to meet electricity demand reliably in this scenario? The only way would be to build lots and lots and lots of wind and solar, way more than you need at any given time and do your best to store this large amount of excess energy for later use. In other words, the intermittency of these resources means you have to build a HUGE amount of capacity coupled with a large amount of storage to get the same amount of energy you could otherwise get from a readily dispatchable resource that is available whenever you need it, (which is why the fossil industry loves this scenario because they know the most likely option is using gas plants to meet the demand when renewables cannot.)

An MIT study "*The Future of Nuclear Energy in a Carbon – Constrained World*" published last year looks at what is needed

to fully decarbonize a system both with and without nuclear energy. As can be seen below, replacing fossil fuels without nuclear means having to build a system that is an **ORDER OF MAGNITUDE** larger that what is currently in place. Yes, that is right. Without nuclear, you need to build a system of renewable energy and storage that is on the order of 10 times larger than what you have in place today to try and make sure you will always have enough energy available to meet demand. After all, it would be hard to imagine a future where our economies accept that it's OK to run out of energy until the next time the sun shines or the wind blows.

For example, as can be seen from the figure, to eliminate the emissions from a 500g/kWh system in New England without nuclear power would require increasing the size of the system from **35 GW** to **286 GW** to replace gas with renewables and storage. (*About 500 g/kWh is an average carbon emission for many systems around the globe today. This study looks at what it would take to bring that close to zero.*) The figure also shows that decarbonizing by replacing gas with a combination of nuclear and renewables (or "nuables") results in a system with little change in size to what is in place today, and at much lower cost. (For New England, the cost would be about half of a fully renewable system.) The MIT study looks at many regions. Achieving the same result for the UK means increasing the system size from **58** to **478 GW** while Zhejiang China would need to increase the size of its grid from **78** to **1515 GW** to get off fossil fuels without using nuclear power.

Figure 1.6: Optimal capacity mixes for New England



Source: MIT Study “The Future of Nuclear Energy in a Carbon – Constrained World”

We have seen this in action.

To date as part of the Energiewende, Germany has doubled its system capacity to replace some of its nuclear with a massive amount of renewables all to deliver the same amount of energy to consumers with almost no impact to its carbon footprint, and at higher cost; all while still relying on coal as its most important form of generation.

This also bursts the fantasy that a fully renewable system is local and environmentally friendly as the electricity system (the grid) needs a huge amount of investment to support ten times as much capacity, not to mention the very large amounts of land needed to place these wind and solar collectors, and the huge amount of materials like steel and

rare earths needed to
build them and then all the waste when it comes time to dispose of them at
their end of life.

As for storage, the task ahead is enormous. As stated in a recent article touting the benefits of battery storage from the IEA, "*Today, pumped hydro storage systems account for the majority of storage capacity (153 GW, equivalent to about **2% of total power capacity worldwide**, while battery storage systems total around 4 GW. However, while pumped hydro storage is projected to grow in the next decade, the technology deployment is largely constrained by the location of suitable sites.*" This article then goes on to say battery storage can reach 400 to 500 GW by 2040, but this is still a drop in the bucket compared to what would be required. With the storage requirements for New England alone being about 100 GW, the global requirement would be in the many thousands of GWs to reach the levels required by a fully renewable system. And let's not forget today's batteries provide only short-term storage with technologies for long term storage nowhere near ready to meet a challenge of this magnitude.

Energy is most efficiently stored in fuel, like coal, gas or uranium, and then burned exactly when it is needed. And which fuel stores the most energy?
Uranium. A single pellet of enriched
nuclear fuel about the size of the end of your little finger, has the same
amount of energy as one ton of coal. Or
to put it another way, uranium produces about 3 million times more energy from
a kg of U235 than coal does from a single kg of coal.

Uranium fuel pellet

Now that is what I call energy storage. This little bit of fuel can produce a huge amount of energy and it is accessible to us when we want it. If we need to decarbonize our energy systems, and we want to do it relatively quickly, what makes more sense? Building a system that is ten times larger than we currently have to produce the same amount of energy we produce today, with all the materials and land that goes along with that, or building nuclear plants that can produce huge amounts of energy from a small amount of resource? I know which option would let me sleep at night – and would give me the best chance my phone alarm would actually work in the morning.

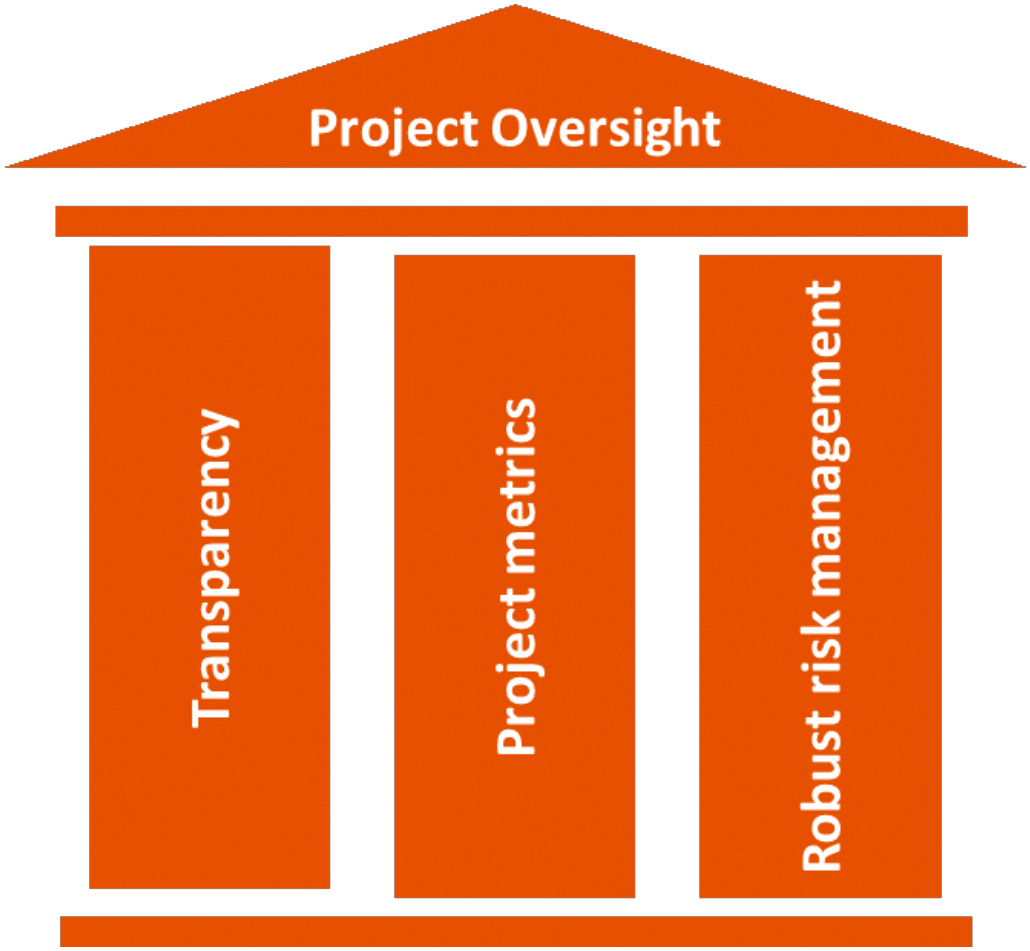
The importance of strong and effective project oversight to project success

Nuclear projects are large and large projects are hard. They are hard to organize, and they are hard to execute. We have seen what happens when we try and convince people they are easy – or that we can

make them easy
by shifting the risk onto the vendor/contractor – and then expect everything to
turn out all right. The outcome is either a project that is cancelled before it starts, or that runs over budget and over schedule.

Last year we did a three-part series on how to manage nuclear costs. We focused the discussion on how to build to cost and schedule, how to control the cost of capital and finally, how to control the capital cost. Today we are going to focus on an essential element of managing large projects to cost and schedule – project oversight. Project oversight can mean both the direct project management of a project, as well as the indirect and independent oversight that may be put in place by project investors or customers. In all cases, the need is the same. We must make sure projects are well managed and proper oversight plays an essential role in meeting this objective.

The purpose of project oversight is to ensure the project is proceeding on time and on budget – and of more importance, that problems are identified early so that corrective action may be taken while the cost to correct the issues are manageable. In our work on various nuclear projects we have identified a set of three pillars for successful project oversight:



Transparency – Transparency incentivizes good behaviour. The owner and other stakeholders must all have complete transparency through to every project detail. Once there is project transparency, it becomes clear that all project participants must line up with the same objective, completing the project successfully. Don't listen to contractors that say they are taking a firm price so you can't see the project details – no matter what the contractual model, there can be no secrets when it comes to project progress. This is the only way to see issues early and then take decisive action to resolve them quickly and efficiently. Otherwise, there will be delays as the contractor will only approach the owner for assistance after all other efforts have failed, greatly increasing the cost of correcting the

issue and adding
time that cannot be recovered.

**A strong set of
project metrics** – numbers don't lie, people do. The next step adding to transparency is to
base project reporting on a clear unambiguous set of project metrics. These metrics must be kept current and be
used to assess real project progress. If
there has been poor progress in the past period, the metrics will show it, but
more importantly, force a realistic recovery plan. We have all seen reports that say things were
slow last week but will be made up next week – but the numbers show that this
is not possible without adding resources i.e. to make up time, you need enough
people to do the planned work for the next period AND the additional work that
is behind. Metrics keep the project on
track and demonstrate where there are issues that need attention, and then whether
the attention is having the desired impact.

**A robust risk
management plan** – we don't create confidence by being told not to worry and
that everything is under control; rather we want to know the risks are well
understood and that a mitigation plan is in place should they be realized. Large projects will have things go
wrong. It is inevitable. It is what we do about it and how well
prepared we are that will make the difference on the project outcome.

All big projects are hard; nuclear projects are not unique. Clear precise reporting is an important

element to understand project status and take action for project improvement. We have all been on projects that have "what
I did on my summer vacation" type reporting telling us what has been achieved
in the last period without providing context.
This will not get the job done.
However, if a project has adequate oversight based on these three pillars,
it has the tools in place necessary for project success.
Remember, success means finding ways to manage
and mitigate risk, not pretending it doesn't exist because it has been passed
on to specific project participant making it their problem.
 As we have said many times, there are no
scenarios where your contractor fails, and you succeed.

Nuclear plants have an important role to play in our current and future energy mix. To properly play
its part requires projects to be economic with predictable outcomes. If we do our part to demonstrate we can
deliver on our commitments, we can then work to secure more support from our stakeholders,
and of most importance, the public.

The world needs more nuclear – and it needs it now

The world is burning – or it's about to – so says the Intergovernmental Panel on Climate Change (IPCC) in its special report considering the benefit to the planet if we manage to keep the increase in temperature to 1.5 C rather

than the target most often discussed of 2 C.

This report concludes, most often with high confidence, that the impact to the world will be considerably greater with only 0.5 degrees of difference in temperature.

It projects that by 2100:

- Global sea level rise would be 10cm lower with global warming of 1.5 C compared with 2 C.
- Extreme heatwaves will be experienced by 14% of the world's population at least once every five years at 1.5 C. But that figure rises to more than a third of the planet if temperatures rise 2 C
- Arctic sea ice would remain during most summers if warming is kept to 1.5 C. But at 2 C, ice free summers are 10 times more likely, leading to greater habitat losses for polar bears, whales, seals and sea birds.
- If warming is kept to 1.5 C, coral reefs will still decline by 70-90% but if temperatures rise to 2 C virtually all of the world's reefs would be lost.

Coal plant belching out pollution in Poland while climate is discussed at COP24

It also concludes that time is of the essence stating urgent and unprecedented changes are needed to reach the target, which it says is affordable and feasible. It notes that there must be dramatic change by 2030 (carbon reductions of 45% compared to 20% in the 2 C scenario) with carbon emissions eliminated completely by 2050.

Quite the message – and yet, the world has somehow become immune to this constant and ever-increasing threat. The sky is falling – yet many seem to not care.

There are those who choose to not believe it at all, and there are those who don't believe it is our fault. There are those that do believe it but also believe its consequences are too far in the future and the cost too high today politically to ask people to pay to resolve it. Well, if this report is correct, the future is now, and we must act. Yet at COP 24 in Poland this month, the best that could be achieved was to agree on the rules for measurement so that each country can report its Paris commitments in the same way.

One thing is for sure – the world needs energy, and lots of it. Yet getting the political support for meeting these needs while setting even more aggressive carbon targets seems impossible.

One of the reasons we don't see the progress we need is that the solutions are hard. The answer on the left is 100% renewables – which excludes a number of low carbon technologies; all while this option is being proven more and more to be an unfeasible solution. Looking at Germany we can see that huge investments in renewables have resulted in Germany still being the largest emitter in Europe as they remain a huge coal user. But the believers have no doubt that renewables are the solution and reject all other options.

The answer on the right is to downplay or in some cases ignore the problem and continue to push fossil fuels to maintain

important jobs that are critical to local economies. They abhor the idea of carbon pricing seeing it as a job-killing government tax grab. Of more importance as we have seen in France with the massive yellow jacket protests, the answer cannot be to place the burden of paying for change at the feet of the most vulnerable in society who don't have ready options to use non-carbon solutions when the price goes up for their core energy needs.

The reality is that both sides make good points, and in both cases, there is some progress. Renewables are starting to contribute to lowering carbon. Replacing coal with lower emitting natural gas has had a big impact. The rising cost of energy due to increased renewables penetration and carbon pricing in some jurisdictions may also be impacting the outcome by reducing demand, but the stress of higher prices on those that live pay cheque to pay cheque cannot be ignored.

These are the low hanging fruits and it is clearly not enough. In 2017 emissions increased and will do so again in 2018. So, what are we to do?

The reality is we have a solution available today that can work for everyone – nuclear power – recognized as necessary in the IPCC report, but there is hesitancy across the political spectrum.

Nuclear power solves the main concern of the left – it is a very low carbon emitter – but long entrenched anti-nuclear sentiment of many environmental groups is hard to overcome. It solves the concerns of the right – providing large quantities of reliable energy while creating lots of high-quality jobs that boost local economies, but there are valid concerns about large project costs getting out of control negatively impacting its economics. And both sides remain concerned about the one overriding issue when it comes to nuclear generation – fear of radiation.

The real strength of nuclear power lies in its energy density. It can be built at very large scale. After all, currently it powers 11 % of the world with only 450 plants as opposed to literally thousands of what we otherwise use. For example, in the US, 98 nuclear plants generate about 20% of its electricity while about 3,000 coal and gas plants generate just over 60%. Or, in other words, it takes 30 times as many plants to generate only 3 times as much energy as the nuclear fleet.

Nuclear power can be the solution we are all looking for. It is reliable, economic, low carbon and creates many high-quality high paying jobs while contributing to the tax base of its host community. Its massive energy density provides a lot of energy from a small amount of fuel – and a new generation of smaller more versatile plants (SMRs) are being developed to expand the market potential and address new energy needs in addition to traditional on-grid electricity such as high-quality process steam.

We don't see many governments championing nuclear as the solution. Korea and Germany, both with strong nuclear programs, have seen their leadership move away from the technology. France, as the world's most prolific nuclear country seems to think reducing reliance on nuclear is the way to go. Yet there are bright spots. In Canada, a decision was taken to life extend Ontario's nuclear fleet at a cost of $25 billion for 10 nuclear units (producing more than 60% of Ontario's electricity), and this is now the largest clean energy project in North America.

Change is in the air. More and more environmental groups are realizing that their environmental goals cannot be met without nuclear and are opening their minds to this solution. On the other side, there is an acknowledgement that nuclear projects are good for communities, good for the environment and good for producing large amounts of reliable electricity. And even though much of the press has talked about nuclear plants

closing in the US in 2018, it was a year of great progress globally. 15 GW of new nuclear were added to the global grid in 2018 and both the first EPR and AP1000 reactors have entered into service after substantial delays.

The public are moving forward as well. Sweden has stopped its nuclear phase out with support from its population. Switzerland voted to not accelerate the closure of its plants. In Korea, a citizen's jury, established by the current government to take a decision on whether or not to continue with two units under construction, strongly supported the project's continuation and polls show that in excess of 70% of the Korean public are supportive of continuing with its nuclear power program. To the government of Taiwan's surprise, a referendum on whether or not to continue with an early shutdown of its nuclear plants supported continued operation by a large margin.

And governments are starting to move in the right direction too. The NICE future (Nuclear Innovation: Clean Energy Future) which began as part of the Clean Energy Ministerial (CEM) recognizes that nuclear power has an important global role to play in meeting international climate objectives. The three founding members of NICE are Canada, the United States and Japan. Other participating members include the UAE, UK and Russia. Three non CEM countries are also participating (Argentina, Poland and Romania).

But as we enter 2019, we in the industry have much work to do. The challenges are many, but they must be overcome.

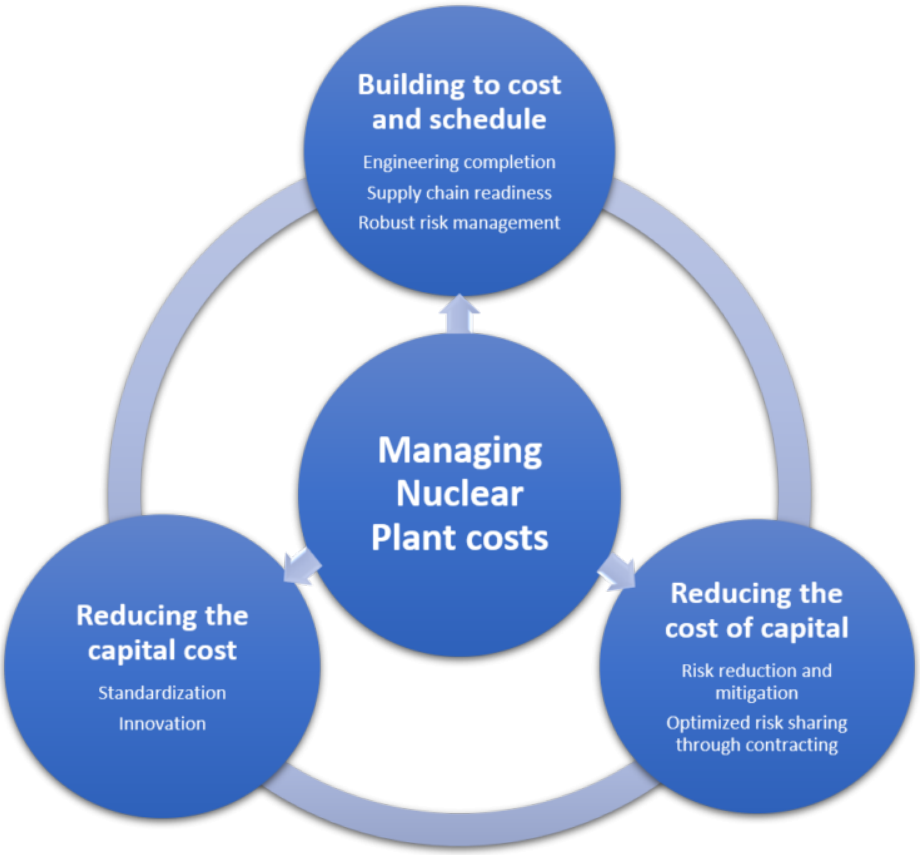
The sky is falling, and the world is in crisis. However, the public recognize the increased magnitude and frequency of extreme weather events such as storms and flooding. What they don't know is what we know – that nuclear power is an excellent solution to many of the energy issues we face as a planet. We know that we can build and operate them successfully. We must all work together and engage with our

communities to show people there is a viable solution out there that can be embraced by all.

Wishing you all a Happy Holiday Season and Healthy and Prosperous 2019. And thank you for reading our blog. We plan to keep on writing in 2019 and hope you keep on reading.

Making nuclear plants cost less – build and repeat, the benefit of standardization

When it comes to nuclear project implementation there is no greater challenge than getting the costs right. The industry can focus on improving public acceptance and demonstrating a need for low carbon generation, but only a cost competitive nuclear industry will really meet its full potential. This is the third part of our 3-part series on managing nuclear costs. The first part focused on the need to build to cost and schedule (March 2018) avoiding the severe overruns that have been experienced in the past. The second part considered how to bring down the cost of capital (July 2018), which can be shown to be the most sensitive parameter when considering the cost of energy from a nuclear plant. In this final part, we will focus on the very root of the nuclear cost structure, the capital cost of building a new plant and how to reduce it, primarily through standardization.



We need to look no further than nuclear construction in China and Korea to see how nuclear can be done right. Building a fleet of plants of the same design is paramount to reducing risk and managing cost. There is little doubt that standardizing plant designs and building the same plant over and over reduces both risk and cost. Risks are reduced by doing what has been done before and is well understood, and costs are reduced by learning by doing – or simply getting better at doing the same thing over and over again.

Often, we limit the definition of a standard plant to repeating the same design for a series of projects. However, to get the maximum benefit, it must be thought of in much broader terms. Any change, no matter how small introduces risk that can negatively impact the outcome. The ultimate in standard plant construction is when an exact replica is built on the same site as the previous project. This means using the same design and drawings, the same suppliers of both equipment and construction, the same commercial structure, the same project management approach, and most of all using the

very same people who did the work the last time, all in a time frame that maximizes the continuity of what was done before. This is no surprise. Keep in mind that success is all about people. We all know that when we want to do something at home, we have the world's best teacher in YouTube to show us how to do whatever we are doing. But we also know, that no matter how well we are instructed, we still do better when we do the job for the second time.

Barakah Nuclear Power Plant – United Arab Emirates

Evidence shows that huge gains can be made replicating at the same site. The ETI (Energy Technology Institute) report on nuclear cost drivers notes that early units have higher costs for the Barakah project and later units have significantly lower costs through both multi-unit efficiencies and learning effects (The final unit is about 40% less cost than the overall site average cost). However, once we leave a given site, replication benefits start to be reduced. In the same jurisdiction we are likely to closely replicate what has been done at one site to another although different site conditions will have to be considered. In a second jurisdiction, where there may be new project managers, new suppliers and new site conditions, more challenges arise. It is essential to maximize what is replicated and minimize what is not. Of course, moving around the world, we know the challenges. Re-localizing the same components and services for each new

market is a recipe for added risk. A model where we globalize supply would be much better so that the same suppliers can have the same scope in many different jurisdictions. However, political reality makes this difficult. The next best thing is to use the same design and then do our best as an industry to institutionalize the processes so that new suppliers and contractors can replicate what has been done by others with appropriate learning methods to ensure the benefits of replicating can be maximized.

Once we are focused on replicating standard plants, we can then further improve costs by innovating. It seems counter intuitive since innovation means change, and change means moving away from the standard. While true, the key to success is modest and managed change within the construct of a standard plant. As we learn, and new technologies become available, we can innovate through improved methods and smarter design.

A 2016 study by McKinsey found that productivity in the construction industry is poor compared to other industries for a range of reasons. One is the slow adoption of digital technologies into the field. Using technologies found in other industries to improve construction in general and nuclear project implementation specifically can make a huge difference. Anything that improves the cost and reduces time and risk is worth considering. This does not mean huge design changes but rather project management and construction improvements. Construction of large projects means managing large amounts of information and ensuring modern information management techniques are used by this industry will bring obvious benefits.

Design changes need to come as well but based on learnings from a series of plants. The big issue is whether or not we can achieve the volume of projects required to build a series, make changes and then implement an updated model for a new series of projects. This is what the French did in the past

and the Chinese are going down this path with their large domestic program. As seen above at Barakah, the Koreans have been masters at developing and implementing standard plants.

The bottom line is that lower costs are a key driver for future industry success with improvement not only being possible, but well within reach of the industry. If we pay attention to all three paths to cost reduction, i.e. ensure projects are built to cost and schedule, reduce the cost of capital through more realistic risk management, and reduce the cost of building plants through standardization with innovation in construction methods, the result will be significantly lower costs of energy (likely anywhere from 25 to 50%) than are being realized in western countries today. This would be a game changer.

As nuclear power becomes recognized as the only large-scale generation option that meets both environmental and reliability requirements for an energy hungry world, there is no better way to get the world to accept nuclear than bringing down the cost of energy.

South Korea has a strong vibrant nuclear industry – except it is not supported by its President

It is with great sadness that we see the Wolsong Unit 1 reactor start to defuel after being shut down prematurely as

part of the South Korean government's plan to reduce reliance on nuclear energy.

This is part of the South Korean government's commitment to replace nuclear and coal with renewables supported by gas, hopefully one day coming by pipeline from Russia through North Korea. (Today all gas in South Korea comes as LNG and even an optimist would see energy security issues with this pipeline plan.)

We have a long history in South Korea. We were very active in the development of the contracts for Wolsong Units 2, 3 and 4 back in the early 1990s and worked to secure collaboration between South Korea and Canada for most of the next decade. This first big project success in Korea holds a special place in our hearts. And of even more importance, the lessons learned in South Korea are the backbone of our approach to nuclear power projects today and going forward.

In 2017, South Korea elected Moon Jae-in its President. As part of his platform he committed to reducing the share of nuclear over time. "*So far, our country's energy policy has been focused on low price and efficiency only, thus neglecting the safety of the people or the sustainability of the natural environment*," he said last year when Kori 1, Korea's oldest reactor, was retired. "*The new government shall consider the nuclear safety issue as a national security agenda*," he said based on a fear of nuclear power following the accident at Fukushima in 2011 in neighbouring Japan.

Wolsong Nuclear Power Station, South Korea

Wolsong 1 is South Korea's second oldest reactor, so what's the big deal with retiring it? It is a CANDU and Korea has developed its own domesticated PWR as its main reactor type. Why should anyone care? First, its on-time construction as it went into operation in 1983 was a precursor of what was to come from this burgeoning technical and industrial powerhouse in the making. In the 1970s, four CANDU 6 type units were committed around the world. Two in Canada (in Quebec and in New Brunswick) and two abroad (Argentina and South Korea). Even though it was the last of the four committed, Wolsong 1 was the second to go into operation following a short 60-month construction schedule. This showed how Korea was developing its strong construction industry that focused on success. They also fully domesticated fuel production with only one CANDU unit in operation, another success story. It operated for 25 years at top capacity factors until it was shut down for refurbishment and life extension in 2009 returning to service in 2011.

Once again, it was the most successful CANDU refurbishment

project anywhere to date. And that is the rub. Although reported that it is South Korea's oldest operating reactor and only had a license until 2022, in reality, it was the newest of the units on the Wolsong site. A CANDU refurbishment is a complete overhaul of the reactor changing out the entire core so that the unit can operate another 30 years or more. This means that the Wolsong 1 reactor had the newest components when compared to Wolsong 2, 3 and 4 that came into service in 1997, 1998 and 1999 and should be operated into the 2040s.

In his recent article "Nuclear Energy Needs Truth, Not Truthiness" (truthiness is a term coined by comedian Stephen Colbert to describe the phenomenon – that basically one's desires, intuitions and fantasies are as true as reality and can substitute for them with no consequence), Jim Conca talks about the importance of the media being "*energetic advocates for, and defenders of, the actual, factual truth*" rather than succumbing to providing a "*false balance*" in their ongoing effort to report both sides of the story. Trying to match experts on one side with others who have no actual knowledge or expertise to support the other is foolish at best, and dangerous at worst. We need to listen to experts to know the actual truth.

Here is the truth about South Korea.

In 1960, a few years after the end of the Korean War, it was one of the poorest countries on earth. With a small population and little to no natural resources; even though a peninsula, it was more like an island with its unfriendly neighbour to the north. Based on sheer determination of its people, South Korea achieved an economic miracle, becoming an industrial giant, a software leader and an exporter of goods and services to the world. This was in part due to its ability to secure reliable and economic energy to fuel this development. Today, South Korea produces 70 percent of its electricity from 24 nuclear reactors (27 percent) and thermal coal plants (42 percent). Liquefied natural gas (LNG) accounts

for about 20 percent. Renewables are less than 10%. All its coal and gas are imported.

As for the nuclear sector, since it built Wolsong 1 on time and on budget three decades ago, Korea went on to develop a nuclear industry second to none. It fully domesticated its standard 1,000 MW design, the OPR1000 and then developed its larger standard APR1400 design on its own. In 2009, it became a full member of the tier one nuclear club with its first nuclear export to the UAE, a four-unit APR1400 project. Today the first of these units is complete and ready for operation with the remaining units on a path to completion on schedule. The UAE project is considered one of the major successes of the global nuclear industry in recent times, when other projects by more traditional vendors have not proved to be nearly as successful.

And what about the public? Last year, when President Moon proposed to stop construction of the in-progress Shin Kori units 5&6, he decided to make the decision with the help of a jury of the public to secure support for his energy plan. The Citizens' Jury announced on 20 October 2017 that it recommended construction of the two units should be resumed. The panel – comprising 471 randomly-selected citizens – voted 59.5% in favour of construction proceeding. More recently in August of this year, in a poll conducted by the Korean Nuclear Society, 71.6 percent of respondents supported the use of nuclear power in the country, far more than the 26 percent that said the country will be fine without it.

South Korea is a small country and so far, efforts to increase the renewable footprint has also had issues. Solar power plants installed on mountains are causing landslides. Korean Experts say that the government should slow down its transition to renewable energies due to both environmental concerns (such as the land slides) and energy inefficiencies. Nuclear remains the key low carbon energy source and with an electricity carbon intensity of about 540g/KWh due to its

significant fossil generation, South Korea will not succeed in decarbonizing by trying to replace its nuclear fleet with renewables. Replacing coal with even more nuclear would be a far better approach.

Even though the nuclear phase out is intended to be long and slow, it is having an immediate effect on the industry. As one of the world's most successful nuclear industries, the South Korean nuclear community is demoralized. It is a sad thing to see. New graduates are already avoiding an industry that doesn't appear to have a long-term future, and I would expect that some of Korea's best and brightest will be getting job offers from the global industry which will be Korea's loss. Of course, it is also difficult to export a technology when the strategy at home is to phase it out. While the term of a South Korean president is 5 years, this is long enough for a lot of damage to be done.

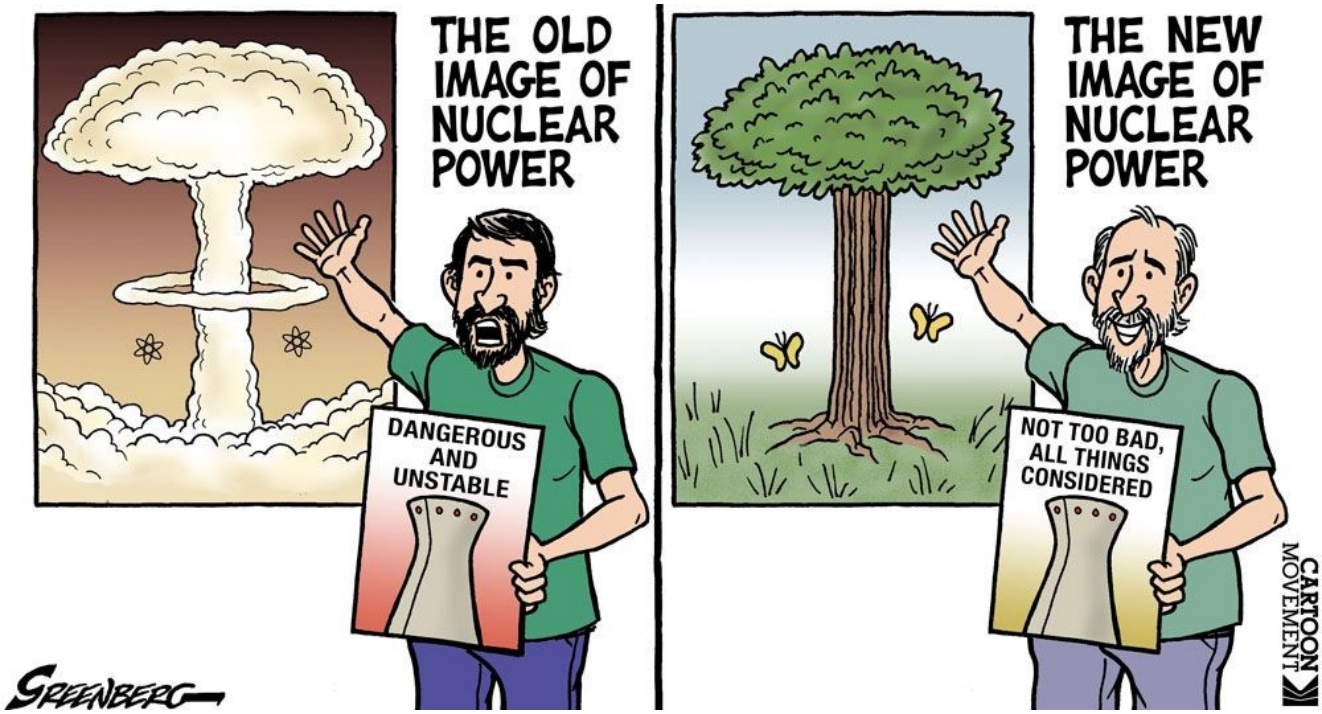
South Korea is truly an economic miracle and has developed one of the world's most successful nuclear industries. They have created a fleet of standardized plants that are built at low cost and to schedule. Their operating performance is excellent, and their people are among the world's best. This should be a point of great pride. It is hard to find any other country that has benefited from nuclear power more than South Korea. It is a shining example of what to do when building an industry. Even the Korean people see this to be true. Unfortunately, truthiness prevails as fear shapes the beliefs of its President. All we can say is ***President Moon, please listen to your nuclear experts. They are the very best there is***.

Let’s stop focusing on beliefs and really start communicating

How many discussions have you had today where either you or the other person thought carefully, and then said “here is what I believe….”? Believe is a strong word. It evokes personal values; and when something makes it to the level of a belief, it is often unshakeable.

There was a time when we didn’t talk like this. We gave our opinion, or our view on a topic. This was developed through learning, by listening to (hopefully) an expert or reading relevant information. An opinion meant this is what we think at the moment, and that should we learn more, we may change or evolve our position. Now our views on almost every topic need to be elevated to the level of “belief”. And as we know, we don’t change our beliefs easily.

In our world of nuclear power, we know that many have strong views on whether this technology is worthy of being a path to a better world with clean economic abundant energy, or as others believe, is a path to our eventual demise. We have written before about the need to ramp up our communications and work hard to increase support for nuclear power. The facts are on our side, but negative beliefs stand in our way. We are happy to see even more young people come out with supportive communications, from Jarret Adams, to Eric Meyer at Generation Atomic and Bret Kugelmass with his podcast series, Titans of Nuclear; each using their own unique method to promote a nuclear future.



As it is the middle of summer, this is when we love to be a bit more philosophical. It is a time to do some deep thinking while enjoying the sunshine and sharing some more esoteric views based on our reading list so far this year. I have read a few books that I think are useful to both better understand the current environment for communications and provide some useful insights on how to better communicate going forward.

You may think these three books have nothing in common, but I see a common thread that should contribute to our thinking as we move forward. They are "**The Death of Expertise**: **The Campaign Against Established Knowledge and Why it Matters**" by Tom Nichols, "**Is Gwyneth Paltrow wrong about everything**: **When Celebrity Culture and Science Clash**" by Timothy Caulfield and finally, "**If I understood you, would I have this look on my face?: My Adventures in the Art and Science of Relating and Communicating**" by Alan Alda.

The first two books provide us with two different but complementary views of the environment we live in. Tom Nichols, in his excellent book, makes the case that America has taken freedom and liberty to an unrealistic extreme – that there is a common belief that everyone is equal and thus, so

are their opinions. In fact, he goes so far as to suggest that it is cool to be ignorant. Experts are no longer respected and in fact, he states that "*we actively resent them, with many people assuming that experts are wrong simply by virtue of being an expert*."

He talks about the changes to higher education, where young people think they are customers buying a service rather than students given an opportunity to learn. He talks about the changing news media, from provider of unbiased news to "infotainment" and notes that too many people approach the news not to seek information but rather confirmation of what they already know, avoiding sources they disagree with because they believe they are mistaken or even lying ("fake news").

This book is a must read, with more good quotes than I can use in a short blog post. But if I can summarize in one quote, it would be as follows. "*The death of expertise, however, is a different problem than the historical fact of low levels of information among laypeople. The issue is not indifference to established knowledge; it's the emergence of a positive hostility to such knowledge. This is the new American culture, and it represents the aggressive replacement of expert views or established knowledge with the insistence that every opinion on any matter is as good as every other.* " For everyone in the nuclear industry – sound familiar?

If we don't listen to experts, then who do we listen to? That is answered in the next book. In his fascinating book on celebrity culture and how it influences us, Timothy Caulfield explores the massive power that celebrities have over our decisions and beliefs. This ranges from using beauty products endorsed by your favourite celebrity (costly but not likely harmful), to using their favourite health care products (costly and may be harmful), to taking bad decisions that can negatively impact the health of our children like avoiding vaccines (definitely harmful).

In summary, we have replaced “experts” who we no longer believe in, with celebrities, who are the ones we look up to. We long for fame rather than accomplishment and dream of achieving it without necessarily working to get there. Anything to be like our idols. Unfortunately, the outcome is often nothing more than an empty wallet and little in terms of being able to take decisions that positively impact our lives.

This takes me to the third book of the bunch, Alan Alda’s book on how to better communicate science. Of course, if we shouldn’t listen to celebrities, then why listen to Alan Alda? It tuns out that he has been involved in communicating science to laypeople for over 20 years, having hosted a show by Scientific American and then starting the Alan Alda Center for communicating science at Stony Brook University. So, what does this book have to say that you may not have heard before? It makes a strong case for communicating, which means having a conversation noting that “*real conversation can’t happen if listening is just my waiting for you to finish talking*.” It talks about the importance of having empathy for your audience, consistent with many who talk about better communications; but he goes further, saying empathy is not enough; we need to be able to “relate” to our audience. Only then are you really communicating. The book then makes the case for using theatrical improvisation techniques as a means to break down barriers to learn to relate to others.

What can we learn from these books that we can apply to the nuclear industry? Our objective is to change the paradigm on nuclear power and raise awareness of the many benefits it brings to society. To do that let’s first work to improve our approach to communicating. We need to avoid trying to change others’ deeply held beliefs nor try to impose our own beliefs on others. This is a path to nowhere.

Rather, we need to focus on communicating, i.e. having an open and productive conversation with others while working hard to keep open minds. It is a willingness to consider new

information that is important for life long learning. Go beyond empathy and truly try to relate. Developing a relationship is hard work but hopefully the outcome will be that we both understand each other better and learn something new.

Moving the needle on public opinion on nuclear power is important and also very challenging. Hopefully some of these perspectives will help us think of new and better ways to have the conversation.

Afterword

For those of you that are interested, the following are a few more quotes from The Death of Expertise. Powerful stuff.

"There is a cult of ignorance in the United States, and there always has been. The strain of anti-intellectualism has been a constant thread winding its way throughout political and cultural life, nurtured by the false notion that democracy means that "my ignorance is just as good as your knowledge.""

"These are dangerous times. Never have so many people had so much access to so much knowledge and yet have been so resistant to learning anything. In the United States and other developed nations, otherwise intelligent people denigrate intellectual achievement and reject the advice of experts. Not only do increasing numbers of laypeople lack basic knowledge, they reject fundamental rules of evidence and refuse to learn how to make a logical argument. In doing so, they risk throwing away centuries of accumulated knowledge and undermining the practices and habits that allow us to develop new knowledge."

"Rather, Americans now think of democracy as a state of actual equality, in which every opinion is as good as any other on almost any subject under the sun. Feelings are more important than facts: if people think vaccines are harmful, or if they believe that half of the US budget is going to foreign aid,

then it is “undemocratic” and “elitist” to contradict them.”