

A war raises fears about nuclear plant safety

As the 11th anniversary of the Fukushima accident passed in March, there were none of the regular articles that we see in the press every year to remind us how scary that event was. Often these articles have focused more on the nuclear accident and barely mentioned the catastrophic impact to Japan of the Great Tohoku earthquake, the cause of both the nuclear accident and more than 20,000 deaths.

This year the news was all about the shocking events in Ukraine, where it was reported that Russia occupied and attacked two nuclear sites; the Chernobyl site, home to the worst civil nuclear accident in history (1986), and the Zaporizhzhya plant – which is Europe's largest operating nuclear power station. This created a new level of fear for what may happen in the event these plants are damaged due to a planned attack.



Source: Pexels.com

The war in Ukraine is causing untold horror and suffering to its people. However, excessive worry about an event at a nuclear plant greatly increasing the devastation is misplaced. There could be military reasons to occupy a power plant such as the desire to control critical infrastructure. There is also the view that setting up a base at a nuclear plant would deter defensive attacks to avoid damaging the plant. Whatever the reason, the likelihood of actually trying to damage the plant and release large amounts of radiation to the environment is small. There have been many articles on why these nuclear plants are safe. Here is one to provide some context.

First of all, nuclear plants are extremely hardened against attack. The fire power needed to do damage that would result in large releases is substantial. It would be far easier to damage the switch-yard or transmission lines to stop energy from flowing. And when it comes to dramatic consequences, there are many easier industrial targets that would inflict more damage.

As of the most recent report from the IAEA on April 28, *"Regarding the country's 15 operational reactors at four nuclear power plants, Ukraine said seven are currently connected to the grid, including two at the Russian-controlled Zaporizhzhya NPP, two at the Rivne NPP, two at the South Ukraine NPP, and one at the Khmelnytsky NPP. The eight other reactors are shut down for regular maintenance or held in reserve. Safety systems remain operational at the four NPPs, and they also continue to have off-site power available, Ukraine said."*

There is also little to gain and much to lose from damaging a nuclear plant. Russia is on the border with Ukraine and would be at risk of radiation affecting its own territory. Prior to the war, Russia was the most prolific exporter of nuclear plants around the world with a reported project backlog in excess of \$100 Billion. This export market will certainly be impacted by this war. Russia would not want to demonstrate their plants are not safe and that they are readily subject to catastrophe.

This is not the first time fear of what may happen at a nuclear plant has exceeded the fear of the initiating event. In each case, the nuclear industry responded by making improvements at nuclear plants to reduce the risk. Following 9/11 in 2001, fear of a terrorist attack on nuclear plants resulted in much hardening of plants to withstand such an attack. Following Fukushima, all the plants in the world made changes to better withstand the impact of natural disasters such as earthquakes and tsunamis. And now, the fear of what

may happen at a nuclear plant seems to be even greater than other consequences of war.

This all comes down to the narrative that nuclear plants are just a whole different level of risk compared to the many other things that can cause serious consequences. Nothing can be further from the truth. In reality, people don't die from nuclear plant accidents. They do die from plane crashes, bombings, exploding gas from leaks and natural disasters. To date, many thousands have perished during this terrible war. Yet fear is greatest when thinking about what may happen should a nuclear plant have an accident. That being said, of course there can be consequences from attacking a nuclear plant and it is important that the plants in Ukraine are maintained and operated safely. But one thing is for sure, we need not be afraid of nuclear plants. We do need to be concerned about terrorism, natural disasters and of course, the horrific consequences of war.

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 health**. 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>

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.)

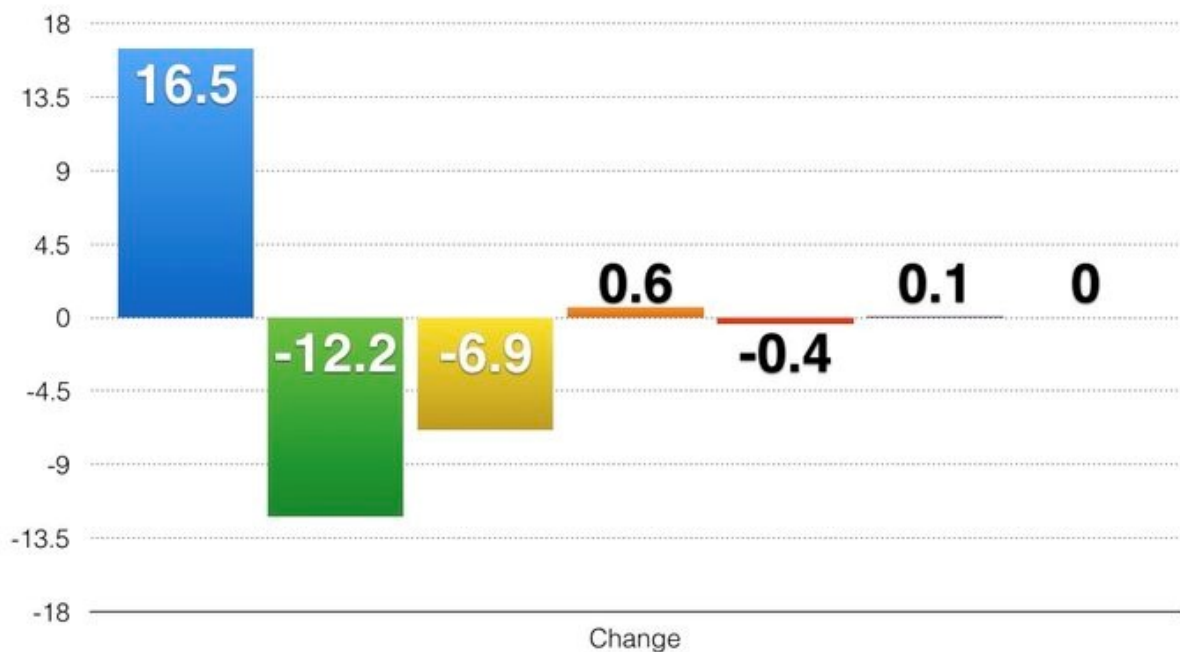
With the populist surge in 2016 we have seen an accompanying rise in complete disregard for facts; all the way to the propagation of absolute lies (or "alternative facts") to support peoples' beliefs. I don't want to get into a political discussion nor take sides on right versus left. What I do want 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.

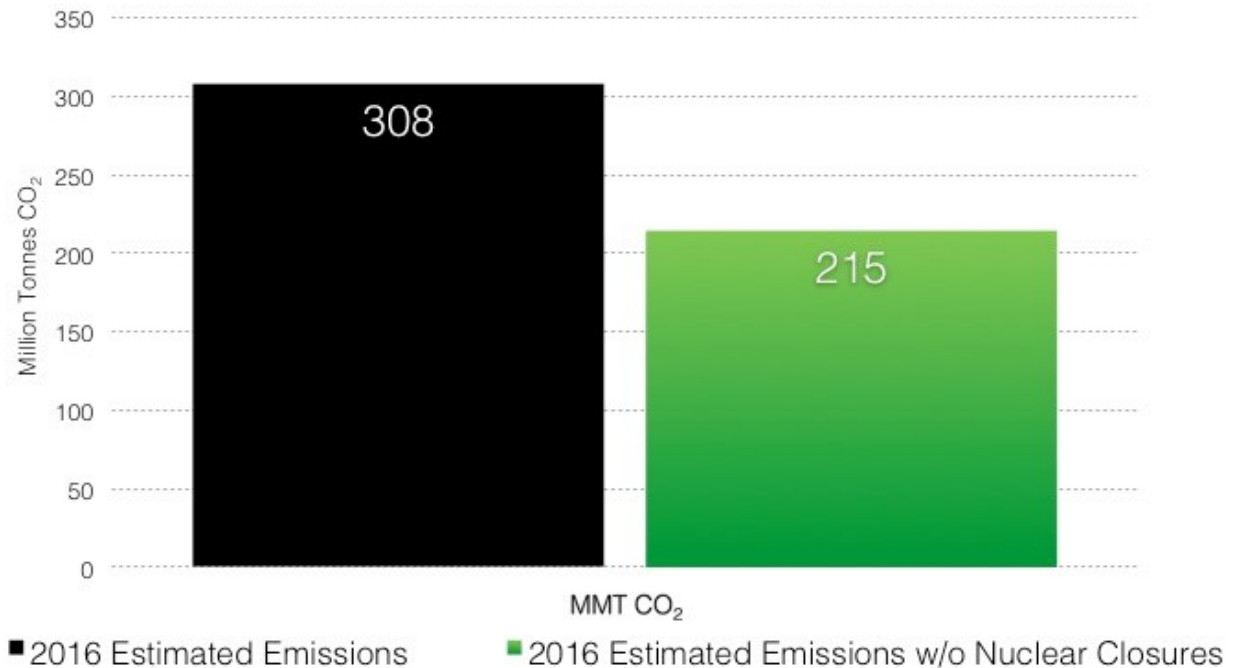
And after adding 10 percent more wind turbine capacity and 2.5 percent more solar panel capacity between 2015 and 2016, less than one percent more electricity from wind and one percent less electricity from solar was generated in 2016. So, not only did new solar and wind not make up for the lost nuclear, 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?"?

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.

Changing the discussion – It's all about people

"It's always amazing when a United Nations report that has global ramifications comes out with little fanfare." So starts an article in Forbes talking about the most recent UNSCEAR report on the consequences of the Fukushima accident in Japan. Three years after the accident, UNSCEAR, the United Nations body mandated to assess and report levels and effects of exposure to ionizing radiation has reported and its result could not be more clear. ***"The doses to the general public, both those incurred during the first year and estimated for their lifetimes, are generally low or very low. No discernible increased incidence of radiation-related health effects are expected among exposed members of the public or their descendants."***

This result is in stark contrast to a number of more recent accidents in other industries, all with a large number of fatalities. Whether it is a plane lost in Malaysia, a ferry sinking in Korea, an oil explosion in Quebec; the list goes

on. Unfortunately there is no shortage of examples of terrible accidents resulting in loss of life. And yet, in comparison to these many tragic events, it continues to be nuclear accidents that many people fear the most.

But the reality is quite different. When it comes to nuclear power, we have now seen that even in the worst of the worst nuclear accidents (Chernobyl and Fukushima), we can protect people and minimize fatalities from radiation. In other words, the decades old belief that nuclear accidents are very low probability but exceptionally high consequence; effectively resulting in the end of the world as we know it (i.e the doomsday scenario), is just not the case.

For those that have been reading my blog for a while, it was about a year ago that I wrote about the need for a new paradigm to communicating the risks and benefits of nuclear power for the future with an emphasis on refining the message to reflect current reality. The message on safety should be:

- The risk of a nuclear accident is very low and is always getting even lower
- In the event of an accident the risk of releasing radiation to the environment is also very low; and
- Even in the unlikely event that radiation is released, the public's health and safety can be protected.

Of course, this does not mean we should become complacent.

Certainly the industry is doing the right things to make sure a similar accident cannot happen again. Many improvements have been made in plants around the world to both reduce the risk of an accident and in the event of a severe accident, reduce the risk of radioactive releases.

For example, here in Canada, we have broadened our safety objective to ***“Practically eliminate the potential for societal disruption due to a nuclear incident by maintaining multiple and flexible barriers to severe event progression”***. Setting

societal disruption as the measure is definitely something new as move forward post Fukushima.

As an industry, we are excellent at learning from every event and making improvements to reduce the risk of a similar event in the future. The global nuclear industry should be proud of its unwavering commitment to safety.

But that being said, while making technical improvements and reducing the risk of future accidents is essential; unfortunately this will be unlikely to result in the public feeling safer. I would argue that in general, the public already believe the risk of an accident is low – the problem is they also believe the consequence of an accident is unacceptably high. So no matter how low we make the probability, they will remain afraid of the consequences. In other words, as we continue to talk about improving technology to reduce risk; we need to enhance the discussion to talk about people and how to both keep them safe (the easy part); and of even more importance, feel safe (now here is the challenge).

Therefore an important lesson from Fukushima, is that accidents, however unlikely are indeed possible. And it is because of the perceived consequence of an accident that the public continues to be afraid. In fact, fear is an understatement. We know that nuclear accidents cause not only fear but outright panic. And this panic is not limited to people in the immediate area of the plant but is experienced by people all over the world. Not a week goes by when there is not some news item on how radiation from Fukushima is about to land on the North American west coast. While there is little risk of any radiation issue, to the public, it continues to stoke fear.

So now that we know that there is little to no health impact from radiation after Fukushima, does that mean the discussion is over? No, the next step is to address the real health

consequence of a nuclear accident – mental and social well-being. Fear of radiation is a complex issue. While people will happily accept significant doses of medical radiation as they believe (quite rightly so) this will improve their health, they remain terrified of radiation from sources such as nuclear power plants.

In their report UNSCEAR noted, *“The most important health effect is on mental and social well-being, related to the enormous impact of the earthquake, tsunami and nuclear accident, and the fear and stigma related to the perceived risk of exposure to ionizing radiation. Effects such as depression and post-traumatic stress symptoms have already been reported. ”*

They continue, *“The evacuations greatly reduced (by up to a factor of 10) the levels of exposure that would otherwise have been received by those living in those areas. However, the evacuations themselves also had repercussions for the people involved, including a number of evacuation-related deaths and the subsequent impact on mental and social well-being (for example, because evacuees were separated from their homes and familiar surroundings, and many lost their livelihoods).”*



And this is where we need to do more. Once we accept that

even after implementing our best efforts, there may well be another accident someday, there needs to be increased focus on accident management and recovery. This means clear guidelines on when to evacuate, what is required to remediate a contaminated area and when it is safe to go home again. A huge source of fear is the unknown and after a nuclear accident, people impacted are very worried about their futures. They want to know – will I get sick, how about my children and grandchildren – can I go home again – and if so when? And basically how and when will I be able to resume my normal life?

UNSCEAR noted that *“estimation of the occurrence and severity of such health effects are outside the Committee’s remit”*. Given these are important and significant health impacts; it is time for the industry to take action. As an industry we have long been leaders in industrial safety. Now we have the opportunity to be leaders in post-accident recovery psychological research. We need new research to better understand the impact to people in affected areas following nuclear accidents so we can better plan how to reduce their fear and indeed, have a happy and healthy future. This will lead to better decisions following events based on science rather than short term fear issues. It is important to understand that protecting people means much more than emergency planning to get them out of harm’s way when an accident happens. It also means meeting their needs right up until they can resume their normal lives.

The most important lesson from Fukushima is not technical. Of course we will learn how to avoid similar accidents in the future and make plants safer. But if we really want to change the dialogue and increase public support for the industry, we must also recognize the future is all about people – building confidence and reducing fear.

While the press is reporting doom and gloom in Japan, progress is being made.

Over the summer we talked about Pandora's Promise, where 5 prominent environmentalists had changed their mind from being against to being supportive of nuclear power. They visited Chernobyl and Fukushima, explored the realities of the technology, sought the scientific truth and came away supportive.

That being said, looking at the news over the past few weeks, it would appear that the crisis at the Fukushima nuclear plant in Japan is getting worse, not better. But is this really the case?

In late August, TEPCO reported a contaminated water leak from storage tanks for water used to cool the reactors. Articles with headlines like *"Fukushima operator reveals leak of 300 tonnes of highly contaminated water"* start off with *"Frantic efforts to contain radioactive leaks at the wrecked Fukushima Daiichi nuclear power plant have been dealt another blow after its operator said about 300 tonnes of highly contaminated water had seeped out of a storage tank at the site."* *"With regard to TEPCO's handling of contaminated water, it has been just like whack-a-mole,"* said industry minister Toshimitsu Motegi, in reference to the anarchic fairground game in which players bash creatures that pop up from random holes. And finally Japan raised the severity level of the event from INES 1 to INES 3. The inference is that the situation at the plant remains grave and that we should continue to be afraid of potential consequences to the environment and most of all to

the Japanese people.

Then in mid September we saw headlines such as *"Japan to be nuclear free again as last reactor goes offline"* reporting that Ohi 3& 4 the only two reactors to be restarted after the Fukushima accident are now down for routine maintenance. Again, implying that Japan is going down a path to no nuclear for the foreseeable future.

And finally, only a week or so ago, Prime Minister Abe visited the Fukushima site to provide assurance to the world that the situation is under control. To achieve this objective, he said *"I've urged Tokyo Electric Power Company to deal with the contaminated water leakage as its priority. I gave them three demands. These demands include earmarking discretionary funds that managers on site can use to implement necessary safety measures. It also includes a deadline to complete the purification of waste water stored in tanks at the plant and decommissioning the idle No 5 and 6 reactors and concentrate efforts to solve problems"*.

Looking at the above press stories, it is hard to see a silver lining in what is going on in Japan. But progress is being made.

The new regulator, the NRA, is closely monitoring progress at the site. In a presentation to the IAEA this month, they reported that on August 14, TEPCO's implementation plan for clean up at Fukushima was approved and that Fukushima Daiichi is now under the systematic regulatory system with NRA oversight going forward. With respect to the recent water leaks, yes, there have been issues containing the large amount of contaminated water. As for the 300 tonne leak reported in August, it was stopped and cleaned up. And there is a plan to reduce the risk of new leaks. The volume of water to be managed is large and the issues are not trivial. But while there was a significant reporting of the leak and its apparent radioactivity, there was little reporting that most of all the

sampled sea water remains under the detection limits for radiation and where there has been some detection, the levels have not changed following the leak – and that they remain well below allowable limits.

Fukushima is not the only lingering issue following the earthquake and tsunami of March 2011. Remember the tsunami killed more than 19,000 and displaced over 300,000 (about half those displaced were due to Fukushima the rest due to their homes being destroyed by the tsunami). Recovery from such a natural disaster of this magnitude has been slow and painful.

But while the press continues to feed the fear, in reality, nobody died from radiation from the Fukushima accident and no one is likely to die in the future from radiation. It is the fear that is most damaging to people and their health and the continuing dramatic reporting of potential danger without context is not helping. As a result of such reports a South Korean airline cancelled flights to the area, Tepco's stock price plunged and Tokyo's bid for the Olympic Games in 2020 was put in jeopardy (although they did succeed but only after Prime Minister Abe gave assurances as to the safety of Fukushima). Unfortunately it also leads to governments making decisions not based on the scientific realities but to appease the fear – which usually does the opposite as it confirms the need to be afraid.

Unnecessary fear was addressed recently by a number international radiation protection experts who have written messages to the Japanese people to explain the health impacts of the Fukushima accident. These are posted on the web site of Prime Minister Abe. Of importance, the United Nations body, UNSCEAR, expects that no resident of Fukushima prefecture would be exposed to more than 10 milliSieverts over their entire lifetime. This is far below any possible threshold for potential future cancers. As stated by Gerry Thomas of Imperial College in London, *“Worrying about what might happen can have a very bad effect on quality of life,*

and can lead to stress-related illnesses. All scientific evidence suggests that no-one is likely to suffer damage from the radiation from Fukushima itself, but concern over what it might do could cause significant psychological problems."

But in spite of the fear, in spite of the ongoing challenges at the site, Japan continues to move forward. Whereas one year ago, it was reported that the previous Japanese government was looking to eliminate all nuclear power from Japan by 2040, there is now recognition of the importance of nuclear power to Japan and its economy. Plans are now in place to restart most if not all of the remaining nuclear plants over the next two to three years. Japan is doing its best to learn from this event and now plans to have the safest nuclear program in the world. To that end, the new regulator, the NRA, has issued its new safety standards in July of this year. Already 14 units have applied for restart under these new standards. This includes two of the most advanced BWR units owned by Tepco. It will take months to review these applications but we can expect to see restarts as early as later this year and certainly early in the new year. Back to the gloom and doom news about Ohi 3&4 going down. It should be understood that when their operation was approved following the accident it was under the old rules. Now they will have to show compliance with the new rules before they go back up and this will take some time – but they will return to service.

The Japanese people are still suffering after the great earthquake and tsunami of March 2011 and the subsequent effect of the resultant accident at Fukushima. Most of all the suffering is a result of fear – fear of the unknown – and fear fueled by the fact that people have lost trust in their government. The Japanese people trusted the authorities to safely manage their nuclear program and now feel this is not the case. Not knowing who to trust increases the fear – and the psychological impacts that comes along with it.

Our last blog was mostly about Germany. The contrast with Japan is stark. The Fukushima accident happened in Japan – not Germany. The people are suffering in Japan, not Germany. Prior to the accident both countries had about 30% of their electricity generated by nuclear power. Japan went to zero as it struggles with the aftermath. Germany shut down about half its fleet immediately and still has nuclear providing much needed power as they work to transition. Japan is an island where all other forms of energy have to be imported at high cost to the people and their economy. Germany is part of the European grid and can easily import power and fossil fuels – and in fact are building new coal stations to cope.

But most of all, the German people have decided they don't want nuclear in the future believing it is an unsafe technology although they have had no negative experience in Germany with their plants. Yet, in spite of ongoing issues at Fukushima the Japanese government is pragmatic and supportive of restarting reactors.

It is certainly not easy for Japan or the nuclear industry to recover from the events of March 2011. A lingering distrust of authorities remains and that is the industry's biggest problem everywhere. I admire Japan and I hope that they can progress to reduce the public fear while rebuilding their nuclear program to have a strong electricity system for the future on a foundation of safety and transparency.

**If we don't make decisions
based on science.....what else**

is there?

I have written much about the strength of our beliefs and how they influence important decisions. A case in point is the decision to close nuclear stations early in Germany. As we in the rest of the western world try and understand the German approach to eliminating nuclear power on the road to their Energiewende (energy transition), we must remember that this plan started in 2010, a year before the Fukushima accident. This energy transformation is a monumental task and a source of pride to most Germans. It has a very aggressive target of reducing emissions by 80 per cent and providing for 80 per cent of the country's electricity consumption from renewable sources by 2050 all while *"aiming for a market-oriented energy policy that is free of ideology and open to all technologies, embracing all paths of use for power, heat and transport."*

Much has already been said about the challenges along the way. We now know that raising renewables quickly to as high a level as Germany has done has an impact on the stability of the system; is severely affecting the electricity markets at times when high levels of subsidized wind and solar drive down prices for all other forms of generation risking putting conventional generators out of business; all while increasing fossil generation in the short term at least to make up for lost nuclear with a resultant increase in carbon emissions.

It wasn't supposed to be this way. As stated in the 2010 policy paper, the purpose of the policy is to secure a reliable, economically viable and environmentally sound energy supply for the 21st century. While targeting renewable energy to account for the biggest share in this future energy mix; in 2010 it was also accepted that nuclear energy would be a bridging technology on this road. In fact, the plan made maximum use of the existing nuclear fleet during the transition. Look at the following excerpt of the policy on the continued use of nuclear energy.

"A limited extension of the operating lives of existing nuclear power plants makes a key contribution to achieving the three energy policy goals of climate protection, economic efficiency and supply security in Germany within a transitional period. It paves the way for the age of renewable energy, particularly through price-curbing impacts and a reduction in energy related greenhouse gas emissions.

The operating lives of the 17 nuclear power plants in Germany will be extended by an average of 12 years. In the case of nuclear power plants commissioned up to and including 1980 there will be an extension of 8 years. For plants commissioned after 1980 there will be an extension of 14 years.

Additionally, the regulations on safety requirements for German nuclear power plants will be expanded, with requirements remaining at the highest technical level, in the framework of a 12th amendment to the Atomic Energy Act.

The extension of operating lives also creates the opportunity to increase financing in the fields of renewable energies and energy efficiency. To this end – in addition to the tax on nuclear fuel limited to the end of 2016 – a contractual agreement will be concluded with the operators of Germany's nuclear power plants on absorbing additional profits resulting from the extended operating lives."

In summary they want to get rid of their nuclear plants while also acknowledging they are currently both very economic and safe. Therefore nuclear plant operating lives would be extended to make more money generating more taxes to pay for the energy transformation to enable nuclear to ultimately be eliminated.

And then it happened, the accident at Fukushima. The result; this plan was abandoned and 8 nuclear units were shut down immediately while the remaining 9 will no longer get life extensions. This makes for a much harder transformation with

coal use having increased from 2011 to 2012 with most electricity continuing to be generated from fossil fuels followed by nuclear (at about 16% now about half of its pre-Fukushima peak of around 30%). Acknowledging that Fukushima increased the fear of nuclear, is it rational to accelerate the removal of nuclear from the system when a plan was already in place to eliminate it; to the short term detriment of emissions and costs? But what is rational? If it means exhibiting behaviour consistent with your beliefs, then this decision may indeed be rational. But is it reasonable to not challenge one's beliefs to determine if they are valid at times like this?

And hence, the film Pandora's Promise. I was able to attend a showing where Robert Stone was also there to take questions from the audience. It made for a lively discussion and an overall fun evening.

First and foremost, I found it absolutely riveting to see the transformation of these five environmentalists as they came to understand the facts about nuclear energy. They talk about being a member of the environmental movement and how it went without saying that one would also be strongly opposed to nuclear power. After all, it was an evil technology and radiation kills. Frankly nuclear power can destroy the planet.

For some reason, these folks took the time to listen and see that much of what they believed in the past about nuclear power was simply wrong. I am sure that most of you in the nuclear industry have been providing these facts consistently to all that would listen over the last 30 plus years. So why are they listening now? Why listen when you haven't in the past? The facts are the same. But in this case the driver is different. This group is overwhelming alarmed by the threat of climate change. And as such (and different to many others), they decided to explore ALL the options; even the ones that would have seemed ludicrous to them in the not too

distant past. Or in other words, they chose to challenge their strongly held beliefs.

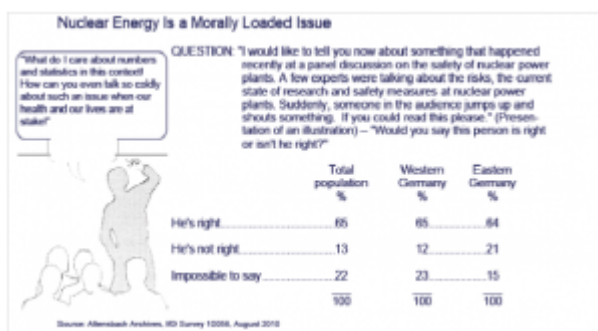
The film was not so much about advocating nuclear power (although it does) but rather of documenting the journey of these five individuals. They visit plants. They visit Chernobyl and Fukushima and they explore the realities about the technology. What I found the most compelling was the hand held dosimeter they carried as they traveled that showed radiation levels no higher at Chernobyl or Fukushima than most of the rest of the world. This kind of evidence is hard to argue with.

But as interesting as this all is, this post is not about a group of environmentalists who have decided to put their faith in science as search for the truth. Rather it is about why so many others don't do the same. It seems as science is always appreciated when it supports your side of an issue. i.e. science is proving climate change which is pro-environment so science is right. Science shows that nuclear power is good but that disagrees with environmental dogma so sweep it aside. It's good news when those who use science to make their climate case are realizing they should do the same when they evaluate nuclear power. We should applaud anyone who takes the time to challenge a long held belief.

So, while Germany is aiming for a market-oriented energy policy that is free of ideology, why are they so dogmatic that nuclear needs to go and the quicker the better? I recently was provided with a copy of a very interesting presentation made by Dr. Thomas Petersen at the Jahrestagung Kerntechnik 2013 in Berlin this past spring that explores "Nuclear energy and the perception of risk in Germany". While presented at a conference the presentation has not been available on line to date. I want to thank Dr. Petersen for giving me permission to post it so you can see what I think is a remarkable set of data.

Most of us outside of Germany probably believe that Germany is a world leading innovator when it comes to technology. Yet in this presentation it would appear that most Germans do not have faith (or trust) in experts when it comes to science. They overestimate risk and consequences and are extremely averse to taking any risk they perceive can cause harm. The slides note that a majority believe life is becoming more dangerous with time; are concerned that technological progress is risky and that research into certain technologies should be stopped; and that in politics, decisions are too often made on the basis of facts rather than how people feel.

When it comes to nuclear power, it is high on the list of technologies that carry too much risk. Consider the following slide:



Pulling all of these thoughts together is saying something along the lines of "I believe what I believe – I know that nuclear power is dangerous so please don't try and deter me with facts or truth". The really scary part is that in today's western democracies this is indeed how we make decisions. And while we may want to laugh, or cry; it is always important to remember these decisions have very real consequences. Less nuclear, more carbon. Fact. Less nuclear, more fossil fuels. Fact. Less nuclear, more coal – and more illness and fatalities from pollution. Fact.

So what is happening in Germany? The great transformation. Yes, they are doing great things with renewables. There is no doubt. But at what cost in the short term? The subsidies are

destroying European energy markets, new coal plants are being built and carbon emissions are going up. All to replace perfectly safe well run nuclear plants before they reach their end of life. Nuclear plants have never hurt a single individual in Germany and likely never will. So what exactly are these people being protected from?

The answer is clear as I close with this final quote from a pro-transition blog that disputes the negative impact on coal use of the policy by arguing it is a short term blip. When talking about the reduction in nuclear generation over the last two years, the author concludes, *"This reduction is a long-hoped for goal and the inspiration for the nation's energy transition. Germans don't want nuclear reactors. They haven't since the 1970's and they really don't want them after Fukushima."*

We can see that five environmentalists have taken on their beliefs due to a larger concern – climate change. I wonder what issue it will take, if anything, for Germans to do the same?

Note:

In addition to the film, Pandora's Promise, Mark Lynas has released a short book called Nuclear 2.0 available on Amazon in electronic format only. I have read it and frankly it is extremely well done. It meticulously addresses the concerns with nuclear one by one by one with clear and effective information to make the reader see the facts. I recommend it if you haven't had a chance to read it.

The only thing more powerful than the truth is fear

As I was thinking about what to write this month, I was invited by my dry cleaner to attend a protest in a nearby park against genetically modified food. This somewhat infuriated me as I know without doubt that GMO has helped millions around the world and had never killed anyone (although denial of these foods has), yet, as with nuclear power, opposition remains strong, especially in Europe.

My dry cleaner argued trying to tell me that 500,000 were killed in India due to GMO and, as you can imagine, there was no winning the argument. Mark Lynas, who I have quoted in previous posts has recently taken a hard stand against those who oppose GMO. Mark makes his position clear in his talk at Cornell University this past April where he opens with the following: *"I think the controversy over GMOs represents one of the greatest science communications failures of the past half-century. Millions, possibly billions, of people have come to believe what is essentially a conspiracy theory, generating fear and misunderstanding about a whole class of technologies on an unprecedentedly global scale."*

It is no mistake that environmentalists like Mark have also changed their views on nuclear power and are now vigorously supporting it. The simple reason is that Mark and others like Stewart Brand and George Monbiot, are taking positions that are founded in science rather than a set of beliefs that may feel right, but cannot be supported by scientific evidence.

Most of the opposition to nuclear power is founded in fear – primarily the fear of radiation. However, scientific evidence continues to grow demonstrating the benefits of nuclear power while disproving widely held beliefs of many who oppose it.

For example, this past week (on May 23), a new study was reported on by the Canadian regulator (CNSC) looking at cancer rates near Canadian nuclear plants. Not surprisingly, once again the results were clear. No indication of any increases in cancer near nuclear stations relative to the rest of the province. *"The most important finding of this study is no evidence of childhood leukemia clusters in the communities within 25 km of the Pickering, Darlington and Bruce NPPs."*

Next I return to the study I wrote about last month published in the Journal of Environmental Science and Technology by Pushker A. Kharecha and James E. Hansen of the NASA Goddard Institute for Space Studies and Columbia University Earth Institute. They found that nuclear power has saved an estimated 80,000 lives annually – 1.84 million in all – since widely introduced in the 1970s and could save another 5 million if construction continues at a decent pace due to a reduction in air pollution. Nuclear power has also reduced carbon emissions by 64 Gt over the same period.

And finally UNSCEAR has now released the results of its latest study on the Fukushima accident. It clearly concluded *"Radiation exposure following the nuclear accident at Fukushima-Daiichi did not cause any immediate health effects. It is unlikely to be able to attribute any health effects in the future among the general public and the vast majority of workers"*. But of even more importance this study also concluded that there are health effects from the Fukushima accident stemming from the stresses of evacuation and unwarranted fear of radiation.

So what does all this tell us? Looking at these three studies we can confirm that

- i) operating nuclear power plants do not cause cancer to the residents of nearby communities from normal operations;
- ii) over the past 40 years nuclear power has in fact saved

almost 2 million lives through a real reduction in pollution by not burning fossil fuels and its resultant health impacts; and finally

iii) that after the biggest nuclear accident in the last 25 years, radiation has not harmed any of the people of Japan and is unlikely to do so in the future.

Considering these kinds of results, why aren't we seeing this reported in the main stream media? With this kind of story there should be universal praise of nuclear power and strong support for its expansion. Frankly, if it were any technology other than nuclear that was reported to have saved millions of lives we likely would have seen it in the headlines at CNN, BBC and other mainstream media. So why are we primarily seeing these nuclear studies reported in trade magazines and blogs? Why is the world not blown away by this fantastic evidence of the benefits to our lives of nuclear power? As I was pondering these developments I came upon a chapter title in the book I am currently reading by Ben Goldacre called "Bad Science" (Good book by the way). The chapter title is "**Why Clever People Believe Stupid Things**". The chapter then goes on to discuss many of the things we have discussed in this blog before such as confirmation bias, seeing patterns where there are none and a host of other standard reasons why people tend stick to their beliefs in light of strong evidence that they should consider alternatives.

The reality is that some people will never change their view of nuclear power and will oppose it no matter what evidence is brought before them. But for those of us who are frustrated, there is hope. We are starting to see positive change. We have well known environmentalists seeing the benefits of nuclear power. This is now captured in the new documentary "Pandora's Promise" coming in June. Film maker Robert Stone is quoted as saying *"It's no easy thing for me to have come to the conclusion that the rapid deployment of nuclear power is*

now the greatest hope we have for saving us from an environmental catastrophe," Entertainment Weekly says *"the film is built around looking at an issue not with orthodoxy, but with open eyes"*. (I know some of you have already seen it. I haven't seen it yet but I am looking forward to it).

Our story is strong. The message is positive and one of hope for the future. But overcoming fear is no easy task. Fear is a powerful emotion. It will take hard work, commitment – and most of all – time. But if we all persevere, the future is bright. The time has come to get the message out and show how much nuclear power contributes to society, and how necessary it is in a high energy and resource intensive world.

Learning the right lessons – a new paradigm to build a brighter future

Last month we talked about Fukushima two years on and focused our discussion on making sure we remember the real people whose lives continue to be severely impacted by this accident. This month, as we also remember Chernobyl on its 27th anniversary, I wanted to talk about the legacy of these events and focus on learning the lessons that are necessary to make the industry stronger and, most of all, improving its support amongst the public.

There have been a number of important positive reports recently that can lead to a better understanding of the consequences to the public of nuclear power.

The **first** being a study by Japanese researchers who found that

internal radiation levels in the population around Fukushima are very low. *“Some 99% of residents of Fukushima prefecture and neighbouring Ibaraki have barely detectable levels of internal exposure to cesium 137, a group of Japanese researchers has found. Of the remaining 1%, all showed levels well below the government-set limit.”* Of interest, the levels are much lower than following the Chernobyl accident and indicate low levels of contamination in the food. This builds on the recent WHO study I reported on last month that says the risk of adverse health impacts from radiation to the Japanese population is very low.

Second, a study was published in the Journal of Environmental Science and Technology by Pushker A. Kharecha and James E. Hansen of the NASA Goddard Institute for Space Studies and Columbia University Earth Institute. They found that nuclear power has saved an estimated 80,000 lives annually – 1.84 million in all – since widely introduced in the 1970s and could save another 5 million if construction continues at a decent pace due to a reduction in air pollution. Nuclear power has also reduced carbon emissions by 64 Gt over the same period. This study is important because it quantifies the benefits of nuclear power being clean compared to burning fossil fuels. Its author, James Hansen is considered an environmental activist who has taken hard positions on a number of environmental issues.

And **finally** a new draft document by the US Environmental Protection Agency that *“would change its long-standing advice to state and local governments about how to limit long-term exposure to radiation after a reactor accident or a “dirty bomb” attack. By reducing the projections for how much radiation exposure is likely in the years after such an episode, the proposal could also reduce the amount of contaminated land that would have to be abandoned.”* This is critically important because finally there is starting to be a discussion on how to best respond in the event of an accident

in addition to how to prevent accidents in the first place.

So why talk about reports such as these? Because I think they are a critical step to ensuring we learn the right lessons following Fukushima. This will lead to improving the response following accidents, and then ultimately starting a meaningful dialogue to reduce the public fear of nuclear power.

In the industry we often see the focus continuing to be on how to both reduce the risk of accidents in the first place and then ensure that even when there is an event there are no releases of radiation to the environment. These post-Fukushima lessons learned fall into three broad categories:

- Reducing the risk of an accident by building better protection against such hazards as earthquakes and tsunamis
- Ensuring continued cooling of the reactors following an event through the use of portable accessible temporary power to replace safety systems that may have been damaged or destroyed on site; and
- Better Severe Accident Management Guidance (SAMG) so that even after a severe accident there would be no releases. This includes such protections as hardened vents and recombiners to lower the risk of hydrogen explosions and various sorts of strategies for in-containment retention of any melted core.

But while this is all good, it is not going to get us to the solutions we need as it only goes part of the way there. We also need to demonstrate that we have clear and effective strategies so that even if there are releases we can protect people and keep them safe. This means a better understanding of the real health risks of radiation exposure so there can be clear guidelines on when to evacuate and of even more importance when to allow people to return. And there also needs to be clear guidelines for remediation of land following any amount of contamination and how to go about it.

The latter is absolutely necessary because when it comes to public safety and hence public support, the real issue with nuclear power continues to be fear. While most people would probably accept that nuclear power provides safe and clean electricity under normal operating conditions; the real fear comes from the belief that even if the risk is small, the consequences of a nuclear accident are too severe to be tolerated by society. And as long as this belief holds, no matter what the industry does to reduce the risk of an accident, the fear will never change. The more emphasis we put on trying to make it almost impossible for there to be an accident with releases, the stronger the belief that we must do this because the consequences of releases are just too severe to even contemplate.

This makes nuclear a hard sell to the public because the consequence is seen as real while the risk is less relevant. People evaluate risk by focusing on the severity of consequences and considering their perceived control over them. Some people are afraid of flying and not driving even though we all know the risk of dying in an auto accident is significantly higher than in a plane crash. Why? In part because we all believe that we are good drivers (control) and even if we have an accident we can survive because not all individual car accidents kill people (severity). Therefore we can convince ourselves that we likely won't have an accident and even if we do, it won't be a bad one. On the other hand, we may fear flying even though we know the risk is small because we also know that if we are the unlucky ones to be on the one plane that does go down, then we will surely die. And so it goes for nuclear. While safe most of the time, the public believes that IF there is an accident our communities will be destroyed by contamination and we will either die or even worse our children and grandchildren may also die from cancer in the future.

This is why need a change of paradigm. What studies such as

the ones above actually show is that:

- Safely operated nuclear plants save lives every day by not polluting our environment as does burning fossil fuels. These are real lives saved and the numbers are big.
- Radiation is not as dangerous as most people think especially at low levels of exposure. While it is a carcinogen, it is a far less potent carcinogen than many others we see in our everyday lives from many forms of pollution. In fact we use radiation in medicine to save lives by both diagnosing illness and treating diseases such as cancer.
- Following really bad accidents such as Fukushima; where the entire area was devastated by a huge natural disaster that made it increasingly difficult to manage the nuclear accident at three reactors at the same site; we have still been able to protect people from radiation. The result being that to date not even one person has died from it; and studies show the risk of dying in the future to be too low to measure.

But we also know that through extreme fear people have died being evacuated in haste; that people have had their lives disrupted with extreme fear of not knowing if they will have health impacts or not; and that governments do not have clear and effective guidelines for how to remediate following such an event leading to fear causing irrational decisions that actually further fuel the fear. And that is why we need more effort on managing consequences and improving accident response.

So let's learn the right lessons and start the hard work of changing the paradigm. Let's demonstrate to the public that they don't need to be afraid; that nuclear accidents are very rare; that even when the next accident happens (and it will) that we can effectively keep the public safe from health impacts and protect their homes and their families.

Let's explain to the public that while the risk of a nuclear accident is much lower than being in a plane crash (and air travel is very safe), so are the consequences. Because we also know that if we are in a plane accident we will most likely die. What we need to know is that even after the worst possible nuclear accident we will likely not die – and that our families and children will not suffer serious health impacts.

This is the big change. Understanding that the risk of a nuclear accident is low and the **consequences are indeed manageable** is essential to reducing the fear that is so strong amongst the public. And only without fear can nuclear power fully achieve its potential as the way forward to producing clean abundant energy for a better society. Now this would be a great lesson learned from Fukushima.

Fukushima – Nobody died from radiation and nobody will, but the fear remains

With the second anniversary of the Fukushima accident having just passed, it was with little fanfare outside of Japan. There were the requisite articles in the press about Japan and its quest to reform its energy infrastructure. There was talk about the devastating consequences of the tsunami and the Fukushima nuclear accident. Those who are pro nuclear continue to state how Fukushima shows that nuclear power is indeed safe while those opposed argue that Fukushima clearly demonstrates why all nuclear power should be eliminated.

Let's look at it from a different perspective. I titled this

post “Nobody died from radiation and nobody will...” for a reason. The WHO has just released its report on Fukushima and concluded that there will be an immeasurable increase in cancers in the long term from this event. While still a somewhat-flawed report (uses the too-conservative linear low dose theory) showing some increased risk for a small group; there is a clear conclusion that radiation from this accident has not been harmful to the people of Japan. This is great news. We can draw a conclusion that even after a very bad nuclear accident where there are releases, people can indeed be protected from radiation with no measurable health impact – a very important conclusion for the future of nuclear power and for how we manage possible future events.

There are important lessons the global industry must learn from this event but on this second anniversary I really want to focus on Japan. We tend to talk about how this accident impacts us as an industry arguing the merits of nuclear power – for now let’s keep our thoughts with the Japanese people who are living it day in and day out. For these people their suffering is far from over “...but the fear remains”.

First of all, I want to continue to express my sorrow to the Japanese people whose lives have been impacted by this horrific natural disaster. With over 19,000 dead and hundreds of thousands without their homes (either because it was destroyed or if they were evacuated due to the threat of radiation from the Fukushima accident) these peoples’ lives have been radically altered and to this day many have very uncertain futures. In addition to families, the economy of the region has been destroyed.

While we in the industry tend to focus on the accident from a technical point of view in most of our analyses, the focus is somewhat different in Japan (I was privileged to visit Japan this past year, but unfortunately not Fukushima). The following paragraphs come from the official report of the **National Diet of Japan Fukushima Nuclear Accident Independent**

Investigation Commission (NAIIC)– from the Chairman’s message.

“THE EARTHQUAKE AND TSUNAMI of March 11, 2011 were natural disasters of a magnitude that shocked the entire world. Although triggered by these cataclysmic events, the subsequent accident at the Fukushima Daiichi Nuclear Power Plant cannot be regarded as a natural disaster. It was a profoundly manmade disaster – that could and should have been foreseen and prevented. And its effects could have been mitigated by a more effective human response.

What must be admitted – very painfully – is that this was a disaster “Made in Japan.” Its fundamental causes are to be found in the ingrained conventions of Japanese culture: our reflexive obedience; our reluctance to question authority; our devotion to ‘sticking with the program’; our groupism; and our insularity.

Had other Japanese been in the shoes of those who bear responsibility for this accident, the result may well have been the same.

Many of the lessons relate to policies and procedures, but the most important is one upon which each and every Japanese citizen should reflect very deeply. The consequences of negligence at Fukushima stand out as catastrophic, but the mindset that supported it can be found across Japan. In recognizing that fact, each of us should reflect on our responsibility as individuals in a democratic society.”

Read the above carefully – and I invite you to read the entire report if you have not had a chance. So while we focus on the technical, the Japanese people are looking at this accident as a proxy for examining what is wrong with Japan and its culture. This is a defining event in the country’s history that is making the average Japanese citizen question key aspects of their culture.

Beliefs are powerful – so to note that some of what happened

and its severity are due to a set of beliefs must be very difficult. And as we all know, there is nothing like a crisis to start people thinking about things differently. Of course it's not my role to comment on someone else's culture but only to note how culture can impact us all so profoundly. If ultimately there is change in Japan, we should applaud the Japanese people as I cannot see anything more difficult than changing the way a society thinks.

I recently read "Strong in the Rain", one of the first books to chronicle the disaster (the tsunami, not just the nuclear accident). It tends to look at real families and the impact to them. It is an interesting read and does help you feel what the people were feeling.

Now let's go back to the accident itself. From a technical point of view, the Fukushima plant is now in a safe state. There is lots of news about how long it will take to complete the cleanup and decommissioning of the site and its cost, but the reality is that the plant is safe. The concerns going forward are with the contamination of the areas nearby and the ability for people to return to their homes and resume their lives.

We have also seen that the radiation levels in the nearby communities are dropping. A recent report has shown that levels are down by 40% and a number of people have been allowed to return to their homes. And, as stated in the WHO report, it is now very clear that none of the Japanese public will suffer direct health effects from exposure to radiation.

But that doesn't mean there are no health effects. Similar to those who experienced the accident at Chernobyl, the main impact to health is psychological. And this comes from the very basic issue of fear. People are afraid of the impact of radiation to them and their families. People are afraid of not having a future as their homes have been destroyed. And in the case of Japan, people are stigmatized – they are

ashamed to be from Fukushima. The result: depression, chronic anxiety, panic attacks, lack of understanding of what to do, PTSD, insomnia, headaches ,excessive smoking and alcohol, anger, irritation, anguish and loss of hope. And of most importance in a society like Japan, there has been a complete loss of trust in authority – people no longer trust the government. With trust gone, people don't know where to turn for credible information and, most of all, support as they do their best to recover from this disaster.

It is interesting that recently I have heard the term “social license” being used more and more in conferences and discussions. Plant owners around the world clearly understand they operate with the permission of the local community, and that sets how the relationship with the community must work. A loss of trust is a very difficult thing to overcome and rebuilding trust is a long term undertaking.

The fear associated with an accident of this magnitude has broader effects as well. With no clear standards for decontamination after an accident, the Japanese government set goals of bringing the levels down to pre-accident conditions. This target is very ambitious and also not likely necessary. Our extraordinary fears of radiation have resulted in poor decisions being made both during the event and after. It is now too late to try and convince evacuated people that they can go back to homes with higher levels of radiation than before even if the risk of health consequences is minute. The damage is done – trust is gone.

Then there is the impact at the national level. Before Fukushima, nuclear power produced about 30% of the Japanese electricity from 54 reactors. Now all are down except for 2 units. With the new regulator in place and their new rules also having been established, more are expected to be brought back this year. But most will take longer as improvements are made to meet the new requirements. At least things are going in the right direction. But in the meanwhile, Japan is being

forced to both reduce electricity use (greatly impacting Japanese industry) and pay huge costs for replacement power using fossil fuels, primarily LNG. Imports were up 25% at a cost of ¥2.5 trillion and about a 4% increase in carbon emissions even though total electricity usage was down.

Lack of a broader focus is not a uniquely Japanese problem – this is a global problem. We spend all of our energy on preventing accidents and convincing people they won't happen. We don't spend enough time on building a consensus on how to manage after it happens – and if we have learned anything from this at all – accidents will happen. So this is where we need to do better. We need to develop clear methodologies for accident mitigation and we certainly are; but once again we are very focused on how to ensure there are no releases in future events. We also need a consensus on developing safety guides for decontamination or how to manage once radiation has been released. And most of all we need to think about people; not only how we can best protect them, but then how to give them confidence that they are safe and secure.

There are many positives to be learned from this accident but at this time I leave these to another day. So to all the Japanese people we wish you well and hope you are all able to return to your lives as quickly as possible. Our hearts are with you and you are not forgotten.

There is a strength in the people and as Prime Minister Abe told a memorial service in Tokyo on the anniversary also attended by Emperor Akihito and Empress Michiko, "Our ancestors have overcome many difficulties and each time emerged stronger..... We pledge anew to learn from them and move forward, holding each other's hands."