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; Phosophorus-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.

Optimism is the way forward – Nuclear Power delivers

We had an important piece of good news this month as Sendai Unit 1 was restarted in Japan, ending a long period of no nuclear generation in that country after the Fukushima accident in 2011. Sendai Unit 2 is following close behind and Japan will continue to restart many of its nuclear plants as

it moves to put the accident behind it and reap the benefits of nuclear generation once again. Recent experience without nuclear has led the country to import vast quantities of fossil fuels, increase its carbon emissions and damage its balance of trade. While difficult for many, the Japanese understand the benefits of continuing with nuclear power are essential to the well-being of their society.

Sendai Nuclear Power Plant

Unfortunately as we have learned from this accident so far, it is fear of radiation that is having the largest impact on peoples' health rather than the radiation itself. To date no one has died from radiation at Fukushima and no one is likely to die from radiation in the future, yet fear is what is consuming these people and their lives – and the policy decisions being taken by government.

Of course, we must always think about those that were directly impacted by the accident. Many remain out of their homes and those that are permitted to return are often afraid. We must continue to understand their plight and work together to help them get their lives back and of most importance, once again have hope for their future.

A couple of weeks ago I was watching Fareed Zakaria on CNN interview President Obama about the Iran nuclear deal. I don't want to talk about that here but I do want to share Fareed's thoughts on President Obama's optimism. He suggested that Obama is an optimist and noted that "*history suggests that it's the optimists who have tended to be right*". He went on to say that "*today we are awash in pessimism, with people who see the world as a dark and dangerous place, where threats are growing and enemies are gaining strength*."

It made me think of our own world of nuclear power, where we are awash in pessimism; And it is easy to be pessimistic when articles such as the one by Michael Ignatieff, (who has previously run for Prime Minister of Canada) concludes after his visit to the Fukushima area with a message that seems to be the prevailing view of nuclear power to many. *"For the rest of us, outside Japan, we have moved on, more dubious about nuclear power than before, but still locked into the energy and economic system that requires it. Fukushima is now classed with Three Mile Island and Chernobyl in a trio of warning disasters, but so far none of these has persuaded the world,* ***at least so far****, to exit nuclear*." Clearly the message is – we need it for now, but when are we going to realize that the risk is just not worth the benefits?

It is easy to be pessimistic when there are documentaries that reach similar conclusions. In "Uranium – Twisting the Dragon's Tail" by Dr. Derek Muller, a physicist by training, the two part series focused on the bomb in Episode 1 and on the accidents at Chernobyl and Fukushima in Episode 2. Watching one can see that positive facts are presented such as

radiation is not as dangerous as people think but the series is not about the benefits of nuclear power – rather it focuses on fueling the fear.

And there is no doubt the biggest issue is fear of radiation. As stated in Mr. Ignatieff's article, "*Today, Tokyo shoppers still won't buy rice, soya, or miso produced in the region and nobody will touch the catch from the local fishermen, even though the fish have been pronounced safe*." On his visit to the region he says "*In the enclosed valleys, as our bus climbed up the winding roads towards the coast—still many miles from the nuclear plant—radiation rose to double the levels in Tokyo. We're told it's safe to travel to Namie but it's still not clear what safe means*." After this accident trust is in short supply and lack of trust definitely increases the fear.

What is also clear is that setting policy based on fear does not result in good policy. In Germany, they prematurely shut down safe, effective and economic plants much earlier than needed. Even while building a huge amount of renewable generation, the Germans had to also build new coal plants both increasing electricity costs and emissions. It doesn't take much to realize that even with a strategic goal of eliminating nuclear power, taking the time to build clean replacements and shutting the existing plants down more slowly would have worked just fine – but setting policy driven by short-term fear of radiation doesn't allow for sensible decisions. With over 200 nuclear plants throughout Europe, nuclear power has been a safe and essential element of electricity generation for decades without a single incident of harm.

Going back to what was said by Fareed Zakaria, "*history suggests that it's the optimists who have tended to be right*", we definitely choose to be optimistic and here is why.

The world needs clean and abundant energy for a better future for us all. For those with limited or no access to a reliable

source of electricity, providing this resource makes a huge positive impact in their standard of living. And while we all agree that in richer countries there is opportunity to become more energy efficient, just look how dramatically our lives are impacted if there is an outage for any sustained period of time. Nuclear energy meets that need. It provides clean, abundant, economic and reliable electricity. Its energy density is matched by none so it can provide huge quantities of electricity from very small quantities of fuel, clearly what will be needed as the world population approaches 9 billion in the years to come.

The rapidly growing economies in the world like China and India are very aware of the benefits that come with robust nuclear programs as they embrace nuclear power to support their rapid growth in energy demand. Other energy-poor countries are also eager to move forward. The 67 units under construction around the world represents the largest new build program in decades and while many (25) are being built in China, the rest are distributed in 12 different countries.

But most of all what makes us optimistic about the future are the large numbers of energetic, bright and talented young people entering the industry. This month I had the opportunity to lecture at the World Nuclear University Summer Institute in Uppsala, Sweden. The current generation of young engineers and scientists have grown up in an era where they are strongly supportive of technology and believe that anything is possible if they put their mind to it. It did not take long to see that the future of the industry is in good hands.

The time has come to get off our hind foot and stand up proudly and proclaim what we know to be true – that nuclear power has an important place in the world and will continue to expand its role as we need reliable economic and abundant energy for society. It is an essential energy option of choice, not of last resort, that we shouldn’t wish we could do without.

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 Fukishima, 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.

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 that 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."

Dr. Sylvia Fedoruk – A great innovator bringing the benefits of nuclear to the world.

I want to commend the Saskatchewan government for honouring Dr Sylvia Fedoruk by renaming the Canadian Centre for Nuclear

Innovation located at the University of Saskatchewan the Sylvia Fedoruk Canadian Centre for Nuclear Innovation.

Dr. Fedoruk died on September 26 at the age of 85. When I thought about writing this post, I asked myself why would those who read this blog – who usually are from as many as 25 different countries want to read about Dr. Fedoruk? And the answer was simple. Probably not well known outside of Canada, you should all know her. She spent her life making the world a better place so I hope you will be as inspired by her as I am.

Dr. Syvia Fedoruk defined the word "innovation" when it came to bringing the benefits of radiation and nuclear to mankind. Born in the small town of Canora, Saskatchewan Dr. Fedoruk was the only woman who in the 1950s was conducting medical-physics research in Canada. At a time when it was unusual for a woman to enter the field of medical biophysics, her groundbreaking achievements have earned her worldwide recognition, bringing honour to the University of Saskatchewan, her home province, and Canada.

In 1951 she was one of the team that developed Cobalt 60 therapy to treat cancer. It is estimated that this work led to the treatment of some 70 million people worldwide by the end of the century. She later was involved in the development of the dosimeter as well as the first uses of radioisotopes to scan for cancer in the thyroid and liver.

After a long career as a researcher, Dr. Fedoruk was the first woman member of the Atomic Energy Control Board (predecessor of the CNSC, Canada's nuclear regulator), became the Chancellor of the University of Saskatchewan bringing her drive for innovation to a new generation of young people and then served the people of Saskatchewan as its Lieutenant Governor from 1988 to 1994.

At a time when the nuclear industry is fighting to demonstrate

the numerous benefits we bring to society; we must always remember those like Dr. Fedoruk who spent their lives using nuclear technology to save lives and made the world a truly better place for us all.

Today, the world still has many great young innovators but we are having trouble inspiring them to turn their passion to the nuclear industry like many did a generation ago. Rather it is a calling in IT or other industries that seem to be of most interest. Yet we all recognize the need for clean reliable economic energy for a better future. And we recognize that the latest developments in physics at the Large Hadron Collider which confirmed the existence of Higgs boson particles and the complementary experiments at the Sudbury Neutrino Observatory (SNO), recently revisited by Stephen Hawking have the potential to radically revise our understanding of the world. With these and other developments we need to reinvigorate the imagination of young people, be it in physics, nuclear medicine or electricity from nuclear power plants so that the world's brightest students still come and spur innovation in the nuclear industry to ensure that we meet the needs of future generations.

So I ask you two questions when you comment on this post. First, who inspires you in the industry today? Let's celebrate those (and there are many) who keep moving the nuclear industry forward. And second, what are your thoughts on inspiring a new generation of innovators to enter into this industry so that we continue to have the world's best and brightest?

We need vocal public support for nuclear – this is the industry's most pressing challenge.

I participated in the WNA Annual Symposium in London earlier this month. During the event I had ample opportunity to discuss my last post on developing a better understanding of the beliefs behind the public's view of nuclear power and what we as an industry need to do going forward.

But in the meanwhile, we have had quite a bit of unsettling news. The push towards reducing the use of nuclear energy in the established nuclear countries has been accelerating. Most of all we see that Japan is moving towards a policy of no nuclear post 2030s. During the symposium the common thought was that the 15% option may win the day but when the 0% option seemed to be the one moving forward, most of the industry were somewhat stunned. To date this policy has not been implemented as Japan's business and industrial sector has finally spoken up. But this is far from a win. The reality is that in Japan 70% of the public are opposed to nuclear and would like to see it phased out over time.

Other countries have seen similar outcomes. Belgium has decided to close its Doel 1&2 units in 2015 rather than have their lives extended for 10 more years. In Canada the new government of Quebec has announced it will not refurbish and life extend the Gentilly-2 station and even in France, the most nuclear country in the world, government has announced that Fessenheim will be closed in 2016 and a long term goal of reducing the reliance on nuclear from its current 75% to about 50%.

We have become somewhat battle weary in the industry so we tend to rationalize the bad news and look to the good news – and there is considerable good news. The UK is supporting new nuclear and moving forward, new build is underway in the US, Canada is committed to refurbishing its Darlington station and new build continues to move forward, albeit slowly. The middle east is embracing nuclear with the UAE having its project well underway and Saudi Arabia committed to a new nuclear program. India and Russia are both growing their programs; and of course, China is going to be booming and building, leading the world in new nuclear.

So why am I so concerned with the recent trends in some countries? It is not simply the act of shutting down plants or reducing the share of nuclear – it is the rationale behind these decisions. The fundamental belief driving these policies is "less nuclear is better than more" – or in other words, if we can do without nuclear then we should. Now why would anyone believe that less is better than more – there is only one reason and that is the real underlying belief – that **nuclear power is dangerous**. That's it. If we didn't believe that nuclear is dangerous there is no reason to reduce reliance on what is actually a carbon free and environmentally benign energy source. And this is not a belief that we should let stand.

Look at the recent decision in Canada. The newly elected Premier of Quebec Mme Marois has stated "I want this gesture to become a symbol of Quebec's commitment to the environment and the welfare of future generations". Or let's look at the decision in France to close Fessenheim, France's oldest station in 2016 when it reaches its 40 year life. (This is even though the French regulator has already approved its suitability to operate for another 10 years). These decisions are purely political – with the belief that this is what the public wants. In the case of France, a national debate will be launched to discuss the impeding "energy transition".

The issue was wonderfully set out by Mark Lynas in his presentation at the WNA Symposium. In his talk, he told a story of a Japanese couple on a train somewhere in the north of England, who pointed out of the window and asked him if a power station in the distance was nuclear. When Mark made it clear that no, it was not a nuclear plant but rather a coal station, the couple were clearly relieved. And this led Mark to ask himself if the world had gone mad. How could a power source that kills more people every day than nuclear has done in 50 years of operation be the preferred choice for anyone?

Well, looking at what is happening in Germany, in Belgium, in France and in Japan – the question becomes a valid one. Has the world gone mad? Is turning our backs on the world's safest, cleanest and most efficient energy source the way to the future?

To some extent the answer is yes, the world has gone mad. But I say yes, not for the reasons you would think, but because as the world works to turn away from nuclear for reasons that make no sense in science; as the public believes that nuclear power is inherently dangerous and the issue is whether or not we can safely manage these dangerous machines; and as these decisions have real negative impacts to environments, economies and the health and safety of people in these countries; where are the supporters? Now I don't mean the supporters from the industry, the scientists or the industrialists who all understand the benefits of nuclear; the so called "experts", but are also all seen as biased and prejudiced in their support. I mean those members of the public who should be leading the charge to fight to stop the nonsense. After all, the public are ones to really suffer from a dirtier environment and more expensive electricity.

The industry needs an ever growing group of activists who represent the public, not the industry, to fight for more nuclear. We need those who believe that the world is a better place with nuclear power in it than without it. We do see in

France, industry is speaking out. In Japan industry is working hard to keep government from making a decision that will have profound impact on the economy of Japan. And as I have said in earlier posts, we have some key environmentalists who have seen the benefits of nuclear power and how it can contribute to their cause. Those like Mark Lynas, George Monbiot and Stewart Brand and others. These guys are all working hard and speaking out on the side that is less popular with their peers – thus giving even more credibility to them and their arguments. And there is progress. NEI just reported that public support for nuclear is rising in the US, closing in on pre-Fukushima levels.

In his WNA talk, Mark Lynas notes that rebalancing public perceptions of risk more towards what science can tell us objectively is central to any nuclear renaissance and that unbalanced risk perceptions are behind nuclear's major challenges.

This is true. I agree. We also need to note that the way forward is long and hard because decisions are made based on emotion, not scientific fact. What we need are public protests in Germany demanding that nuclear not be shutdown. We need public protests in Japan supporting nuclear restarts. And to get to this point, most of all we need the public not to be afraid. Fear is a powerful emotion that is very difficult to overcome.

The road is a long one. We need to work with experts in public opinion and make the arguments available to opinion leaders in the communities. For example, we know the benefits of nuclear medicine for our health, yet anecdotally, we also understand that doctors were just as afraid after Fukushima as anyone else. There were cases where they were recommending and then performed abortions for fearful mothers. Yet we also know that these same doctors would not hesitate to prescribe a CT scan or x-ray, even if the benefit is doubtful just to placate a patient who has health worries. And the likelihood

is that the dose from these medical tests would be greater than the exposure from Fukushima.

We also argue that we must educate people when they are young. We must bring nuclear energy into the schools so that students understand it more and fear it less. But we also know that teachers as a group tend towards being anti-nuclear.

Hence the problem. Those that are trusted in society like our doctors and teachers are not necessarily on our side. These are the groups that should be more open to scientific proof. These are two groups that we need to work on to move our arguments forward. This is just an example but I think it shows that the climb is a steep one and the work is hard. But now is the time to move. We must all work together to build public support – and that means combating the key issue – that nuclear is inherently dangerous. We must work to help people understand the reality that nuclear power is less dangerous than most alternatives and that the positives are essential for a prosperous, healthy future for us all.

So coming back to Mark Lynas and his thesis. We need to do much more to use science as the source of information to make arguments and formulate public policy. But is that enough? The real question we all need to ask ourselves is what do we need to do so that the Japanese couple Mark met on the train is no longer afraid?

We are all talking to each other but is anybody out

there really listening?

Was just in Oxford where I gave a lecture to the WNU Summer institute – a great group of young people who are committed to working in the nuclear industry and doing what they think is best for their and our collective futures. Oxford is a great place to quietly contemplate recent events and consider whether or not we are going in the right direction. (Not to mention I enjoyed having lunch in the "Harry Potter" dining hall).

As were many, I was interested in the recent paper written by Ten Hoeve and Mark Jacobson from Stanford University, 'Worldwide health effects of the Fukushima Daiichi nuclear accident' published in the journal Energy and Environmental Science basically predicting that there will be 130 cancer deaths globally from the Fukushima accident. While it would easy to simply accept this outcome since the number of deaths is relatively low, especially in the context of the large number of deaths caused by the earthquake and tsunami in Japan, the study has been criticized as poor science – and very effectively by Mark Lynas. It is not the criticism that I find interesting but the comments on Mark's blog by those both supporting and opposing the study, including the authors. Now I don't want to spend my time discussing the study as in my opinion Mark did a fine job – but rather the implications of the two sides debating it.

I recently read "The Believing Brain" by Dr. Michael Shermer (as well as some other stuff) that helps to create some understanding of the situation that we find ourselves in.
What I found fascinating about the debate on the Stanford study is not whether or not it is accurate or nonsense, but the fact that independent of the facts, the chance of either side changing their opinion in any way based on the debate is effectively zero. Or in other words as clearly stated by Michael Shermer – beliefs come first – we then look for

information to support these beliefs and the more we investigate the stronger we believe. We have natural filters to dismiss opposing views and carefully collect supporting evidence for our position.

The issue is important because we as scientists and engineers love to believe that if only we can better educate the public then they will come around to see what we so obviously see. Well, unfortunately nothing can be further from the truth. Most peoples' beliefs are so embedded that no matter how much more information is provided, they are most unlikely to change their point of view.

Let's come back to the fundamental issue of concern. The public generally believes that nuclear power is inherently dangerous. So what we really need to do is to try and understand where these beliefs come from and then work to get to the source and see if over time we can change some of these perceptions. And frankly as I have stated before, we are inadvertent contributors to this belief as we in the industry love to explain how difficult it is to manage nuclear power and how seriously we take safety thus reinforcing that it must be very dangerous indeed.

I visited the Atomic Test Site Museum in Las Vegas a couple of weeks back and it is obvious that the association of nuclear power with nuclear weapons is a powerful one. In the museum there was mention of TMI and Chernobyl as examples of when the peaceful use of this technology went wrong. And this even translates to popular culture. In the recent Batman movie, the core of a new advanced fusion reactor is designed for good to power the world and yet is removed and transformed into a weapon of mass destruction in mere moments by a very smart scientist (although apparently there is only one such smart guy). While only a movie the connection between atomic weapons and power is simple and clear.

Going back to the debate over the Stanford study, let's

consider other examples that I have used in the past. First we recently had the final report released on the cause of the Air France crash out of Brazil a couple of years back. It found root causes, suggested corrective actions and that was that. There is no "anti flying" group that came out and said, "see – look what happened here – clearly air travel is too dangerous and it should be abolished." In fact we laugh at the thought of it. Yet more people died on this one flight than the nuclear industry has killed in its entire history. This is because we fundamentally believe that air travel is safe. That's not to say that at some level of accidents, the public would stop flying – but where is this level? I don't know.

The same with the organic food farming incident in Germany. Killed 50 hospitalized 4000 and there is no anti organic food group writing reports on the dangers of organic farming and calling for an end to it.

Yet every nuclear incident is more proof of why nuclear power shouldn't exist. As told to me by my very talkative taxi driver in Vegas on the way to the airport- we have solar and wind, we don't really need nuclear power. The implication being that we all know nuclear power is dangerous and that if we have alternatives, we should use them first.

Of course the truth is actually the opposite. Nuclear power is economic, clean, efficient, reliable and concentrated using very little land. This makes it a great option for long term power production, not the option of last resort.

So if we can't change people's minds through education alone, what do we do next? Well, an unexpected event or crisis is what will cause some people to revisit their beliefs. In this case the recent crisis is negative for the industry (Fukushima) so many are now questioning nuclear power. Yet somehow in a number of countries support for nuclear power remains strong.

In the UK, support for nuclear power is rising, even following Fukushima and with their close neighbours Germany deciding to abandon their nuclear program. Why is this? Well one thought is that the British understand that they are in dire need of electricity and are very concerned about being overly dependent upon gas from Russia (the crisis). Another contributing factor would be the post Fukushima conversion of George Monbiot to nuclear supporter. He is credible with the public and has taken tough stands on many popular issues. There is no doubt that if he changed his mind on nuclear that is food for thought to the public.

In the US, energy independence is an important issue. Americans do not want to be overly dependent upon middle eastern states for their energy and are looking for ways to be more self sufficient. Nuclear power is one option to help them solve this issue. But of course this support can be somewhat fragile unless we get to the root of the public's concerns. For example, now in the US, gas prices are low once again allowing another viable option to overtake increasing support for nuclear.

So what am I getting to here? Well let's put in one final quote from Dan Gardner's book "Future Babble" which is actually a quote from Leon Festinger. "*Suppose an individual believes something with his whole heart. Suppose further that he has a commitment to this belief, that he has taken irrevocable actions because of it; finally, suppose that he is presented with evidence, unequivocal and undeniable evidence, that his belief is wrong; what will happen? The individual will frequently emerge, not only unshaken, but even more convinced of the truth of his beliefs than ever before*." (I really liked this book and will cite it further in a future post.)

So does this mean the situation is hopeless? Not at all but we must fundamentally change how we approach the problem. We need to make use of experts as do other industries to better

understand the driving issues behind negative views on nuclear power and then address the root cause. We must accept that the task at hand is large and may take a generation to accomplish and most of all we must acknowledge that there will be setbacks along the way. We must bring credible opinion leaders on side and we must have a global concentrated effort to demonstrate the benefits of nuclear power with simple focused and effective messages; but most of all provide a better understanding of the risks and note that the doomsday scenario is for the comics and not for real life.

I would like to know your thoughts on how we should work together as an industry going forward to really make headway on this important issue of the power of belief. After all, as are those who disagree with us, we are all committed to our beliefs – so how can we make the progress we need to bring more understanding and support for our answer to global energy needs?