

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

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

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

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

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

With nuclear power growing once again, it is time to ensure its continuity by instilling this passion into a new

generation of young people. It is the fuel that will ensure the industry continues to be innovative and reaches its full potential going forward. That being said it is important to focus on what is important to this new generation of engineers and scientists; what will keep them enthused and committed. It is hard to imagine millennials thinking of utilities or large industrial companies as the growth companies of the future. Rather they think of companies like Google, Facebook and Uber when it comes to large innovative exciting companies – or they believe in being entrepreneurs and starting their own tech start-up. This ad campaign by GE (one example below) is a brilliant one as it tries to show young people that it can indeed be exciting to be in this large industrial company – that not everyone has to be coding and developing the next app that puts hats on cats – but that to truly change the world, it is the future of things like transportation and energy that really matters.

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

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

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

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

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

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

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

industry.

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# It's not about being "advanced", it is ongoing innovation that will keep nuclear strong

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

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



### **Futuristic Thorium Plant from the Norwegian series “Occupied”**

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

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

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

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

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

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

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

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

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

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

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

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## **It's time to put nuclear on the offensive – and make it the low carbon energy generation option of choice**

Have you ever seen something that just amazed you? We were wowed by a recent YouTube video showing what the Chinese have achieved in turning conventional high-rise construction on its head. A 57 story building was built in 19 days – yes – 19 days! Who would ever believe this could be possible? I live in Toronto, a city that has been undergoing a huge hi-rise building boom over the last few years and the time it takes to build these tall towers can be measured in months and years, not days. This just shows what can be achieved when the imagination is let loose and innovation results in outcomes never before thought possible.

We first wrote about the importance of innovation in the nuclear sector last year. In its history nuclear power has shown incredible innovation, leading the way in a range of technologies especially with respect to delivering a level of safety and security not seen in any other industry. More recently there have been dramatic improvements in operations as the global fleet has reached a level of performance never even dreamed of in the early days of the industry. Current new build projects are using the most up to date methodology in



modularization and other advanced construction techniques.

And yet when the IEA issued the 2015 version of its Energy Technology Perspectives (ETP 2105) report focusing on the need for energy technology innovation if the world is to address climate change; it doesn't mention this innovation, nor does it include discussion of potential future innovation with respect to the nuclear option.

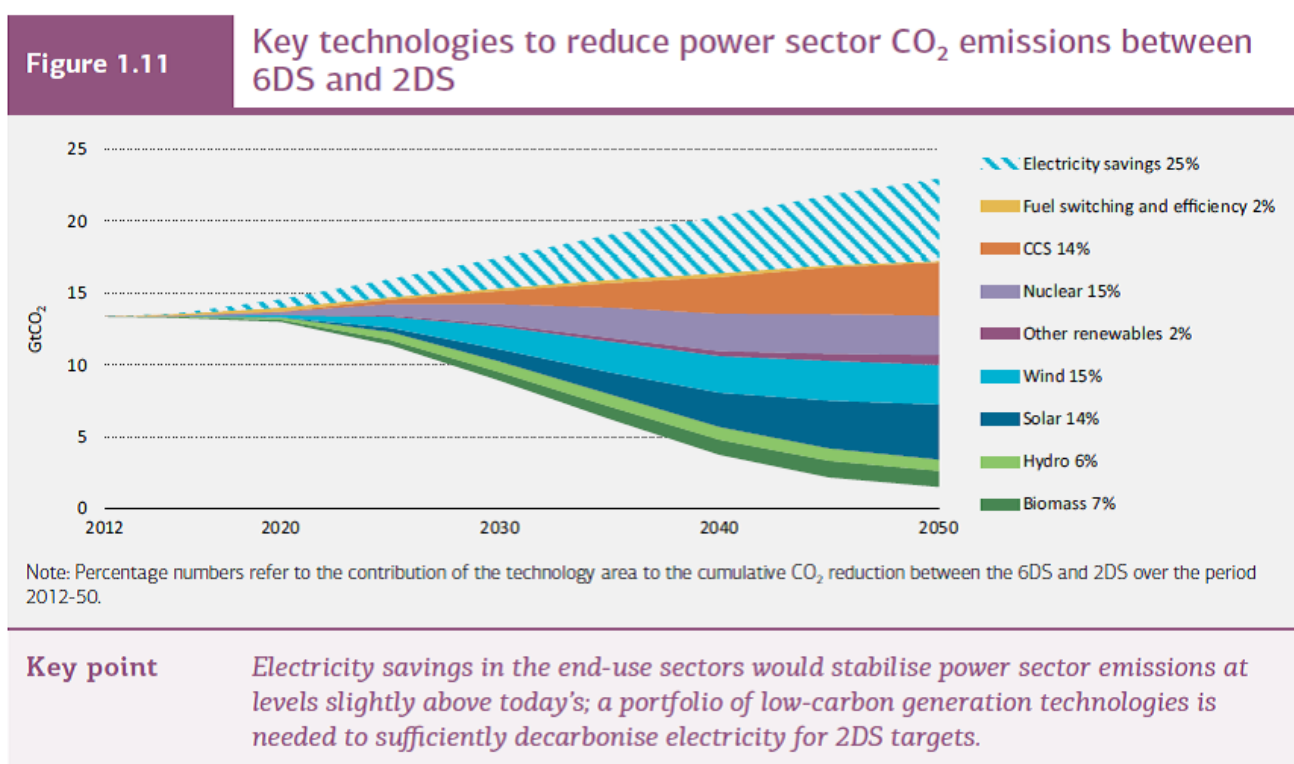
*As stated, "Energy technology innovation is central to meeting climate mitigation goals while also supporting economic and energy security objectives. Ultimately, deploying proven, cost-effective technologies is what will make the energy system transformation possible. Continued dependence on fossil fuels and recent trends such as unexpected energy market fluctuations reinforce the role of governments, individually and collectively, to stimulate targeted action to ensure that resources are optimally aligned to accelerate progress. Establishing policy and market frameworks that support innovation and build investor confidence over the long term is a first-order task to deliver."*

The report is clear when it says that *"Innovation support is crucial across the low-carbon technology spectrum"*. The discussion focuses on renewable technologies in the short term due their relative readiness and lack of a need for long term investment in development; and carbon capture (CCS) in the medium to longer term even though it requires substantive investment in development as it remains essential to address the large number of fossil plants being built and still in operation by 2050 that will require decarbonizing.

As usual, the same issues that have plagued nuclear for the last 30 years; primarily public acceptance issues, mute a positive discussion for the nuclear option. While recognizing its importance in achieving increased energy security, diversity of fuel supply and lower emissions, the report goes on to state *"this awareness has yet to be translated into*

*policy support for long-term operation of the existing fleet and construction of new plants” ... “to recognize the vital contribution that nuclear energy can make.”*

Yet the actual IEA scenarios have changed little from last year. As shown below, when considering technologies individually (rather than grouping into “renewables”), nuclear actually plays the largest role of any single technology in meeting carbon reduction targets showing that, even as it stands today, the nuclear option is absolutely essential to moving to the IEA 2 Degree Scenario (2DS).



This can only be the case if nuclear is currently meeting its responsibility to be economic and reliable while being an essential large scale low carbon option. Given that we know the largest challenges in building new nuclear plants is related to their relatively high capital costs and long project schedules relative to other options; consider the role nuclear can play if improvements similar to those demonstrated in the Chinese YouTube video were implemented. Not marginal improvements, but mind blowing changes in approach that shake

current thoughts about the costs and schedules of nuclear projects to their very core. This is the way forward. While discussion of next generation plants and SMRs is of interest, we need continued innovation that takes what we know now and improves it beyond what anyone can imagine.

The report shows that government investment in nuclear R&D has been dropping and in renewables has been increasing. This investment must be refocused on project improvement and innovation rather than the traditional areas of research such as safety and waste management where it has been spent for decades. While important for the nuclear industry, too much of this spending is focused in these areas just to pander to the ongoing public beliefs that safety and waste issues remain unresolved. Rather, emphasis should be on continuing to improve new build project performance. Let's think about new build nuclear in the same way we think about renewable technologies; that more investment and research will lead to shorter construction schedules and lower costs. It is time to let the innovation genie out of the bottle, stop being on the defensive and move forward with great things. With changes like this, the nuclear share will grow well beyond current expectations bringing a real solution to climate change while keeping electricity bills low and system reliability high.

So remember, nuclear power is essential in achieving increased energy security, diversity of fuel supply and lower emissions; and is already expected to have the largest impact on meeting climate goals of any other single technology. Today's plants are economically competitive and provide safe and reliable electricity. Talking about investing in energy innovation without a discussion of investing in nuclear, when it's currently the best option available, is absurd. Governments need to recognize the incredible innovation already achieved by the nuclear option, and unleash even greater potential by investing in this well proven technology.

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# **It's passion that will lead to brighter nuclear future**

Last month I talked about innovation in the nuclear industry focusing on the perception that nuclear is not innovative. Since then I attended the Canadian Nuclear Association annual conference. Its theme this year was "Developing the next generation" which in this case focused on developing the workforce of the future.

While the discussion at the event was about Canada, the theme can be applied to many countries. Essentially, it was noted that the industry has numerous opportunities that offer well paid interesting work for the long term. And, of more importance it was made clear that the industry is only as good as its people; hence the need to attract the best and brightest.

With all the good discussion, what caught my interest was the guest breakfast speaker, Taylor Wilson, known as the boy who played with fusion. At 19 years old, he gave a great talk (already having given two TED talks) about his passion for all things nuclear. I am not going to discuss Taylor's achievements or strong technical skills, both of which are certainly impressive; and he is also extremely articulate proving that scientists can indeed communicate well. But what really got me excited was his passion for nuclear science. This passion ignited the audience by reminding us all of our own passion for the industry.

I remember being a young student studying nuclear engineering at RPI in Troy New York during the 1970s. What drove me to go into nuclear was the mystery and excitement of this still

relatively young industry. I wasn't looking for a job; I was looking for a future. The oil shocks had happened and it was clear that the world needed alternate energy. Being able to provide almost limitless energy to power the world, nuclear power seemed to be the solution and I wanted to be part of it.

I was not unique. Many of my colleagues; many of whom (older than me) were the pioneers of nuclear energy, were inspirational in their dedication and passion for nuclear power. I am not talking about the early great scientists who harnessed the atom, but rather the next wave of people, both technical and political who drove the industry forward securing commitments to, and then building the 400 plus Generation II reactors in service today. This past December was the sixtieth anniversary of President Eisenhower's Atoms for Peace speech to the United Nations. This speech launched a new industry around the world. I would name some of those who contributed but they are too many and I don't want to leave anyone out. Rather, I invite you in your comments to note who inspired you either to enter the industry or along your career to keep on moving forward. (Some of the pioneers of the Canadian industry are listed here.)

And they succeeded. They developed one of the most important energy technologies known to man. In less than fifty years, an idea was turned into a commercially viable energy technology meeting about 12% of global electricity. And that number, of course, is deceptive since about half of the countries that rely on nuclear energy use it for 20% or more of their electricity supply.

Of course there have also been numerous challenges along the way that saw the industry slowdown in the latter part of the twentieth century. Recent developments as the world looks for solutions to climate change has re-ignited interest in nuclear power as a part of the solution. This is also in the context of the 2011 accident in Japan which once again raised fears of the industry and its potential negative impacts.

For most of us who have spent our careers in the nuclear industry, we remain just as passionate today as we were when we were young and our belief in the benefits that nuclear energy bring to society continues to be strong. There are others who have been worn down by the relentless effort required to sell these benefits and the years of attacks against the industry. The result is a defensiveness along with a weariness that has reduced efforts to move forward as many in the industry focus on survival. It is now time for a new generation of passionate young people like Taylor Wilson to take this industry into the future. I know they exist. There is the nuclear Young Generation Network (YGN) with chapters around the world. For those of you YGN members who read this, please give your views.

It is not just about opportunities for employment, but rather about opportunity to make a difference. The question becomes, not how do we find the nuclear workers of the future – but how do we inspire the passion in a nuclear future that we all had (and continue to have) when we started our careers to attract the best and brightest to our industry going forward? I would guess that if you went to any university graduating class and asked for the 10 most innovative and exciting industries of the future, we would likely not make the list.

I talk about communications in this blog quite often. But most of the time I talk about how we can promote the industry and reduce the fear of radiation in the public. But we must also consider how to communicate to a new generation of potential nuclear industry professionals the excitement, innovation and societal imperative so that they can develop their own passion.

I love working in this industry and I wouldn't change my experiences for anything. Now it's time to help build the industry of the future – and that means inspiring young people to take a leap of faith and jump on board.

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# The importance of innovation to the nuclear industry

A comment caught my attention at a recent nuclear industry event. The comment was that a hi-profile agency with a mandate to do research in advanced technology across industries had no interest in attending any events to learn more about nuclear power – primarily because “nuclear is not innovative”. In reality, there are numerous examples of how the nuclear industry has and continues to improve through innovation.

In exploring this comment, what we found was a belief (likely more prevalent than we would like) that renewables like wind and solar as well as various storage technologies are moving forward, innovating to become the energy source of the future, while old technologies like nuclear are past their prime heading into old age.

The discussion then moved to future reactor designs as proof of innovation in the nuclear industry. Look at fast reactors, thorium reactors or even SMRs. Although these are all interesting, it was pointed out that these represent “novelty”, not innovation. And to argue that a novel design is what is required to save the industry (although they will come) gives the message that today’s designs are just not good enough – and that is absolutely not true.

The public looks at nuclear power and sees a staid industry, some think in decline, that is building technology that has been around for 50 years. Granted some nuclear projects continue to be built above budget and over schedule, while other “newer” technologies continue to improve and reduce cost

and schedule – as would be expected when developing technologies of the future.

However, there are numerous examples of innovations across the nuclear industry. For example, China has made improvements to the Daya Bay CPR1000 design at Lingao. They increased the output by about 100 MW through an improved turbine, and made great advancements to the control systems by adding distributed control. At Nuclear Power Asia in Vietnam this past month, a presentation by Mitsubishi showed how they improved their construction schedule from 77 months to 50.5 months from the Ohi 1 project to Ohi 3. Westinghouse is learning lessons from its experience in China and is applying them to their AP1000 projects in the US using advanced modular construction technology. And here at home in Canada where Bruce Power, whose tag line is “Innovation at work”, has found ways to increase the life of its reactors well beyond what was thought possible only a few years ago.

The analogy can be made to cars. The cars we drive today are very similar to those we drove 30, 40 and even 50 years ago. Four wheels, combustion engine, rubber tires. But are they really? In fact almost nothing is the same. Our cars today are full of electronics controlling the engine; the bodies no longer rust away in a few short years, safety has been greatly improved through air bags and other enhancements; and tires rarely go flat so that many models no longer carry spares. In fact technology has advanced in leaps and bounds in the cars we drive every day. And even though we are now looking at next generation technology such as electric and hydrogen powered cars, these are still novelties. These types of advancements are not required to innovate our vehicles. In fact the opposite is true. It is the innovation in the everyday systems in our cars that continue to make them better. And the magnitude of these improvements is staggering.

Somehow this message is not getting through with our nuclear

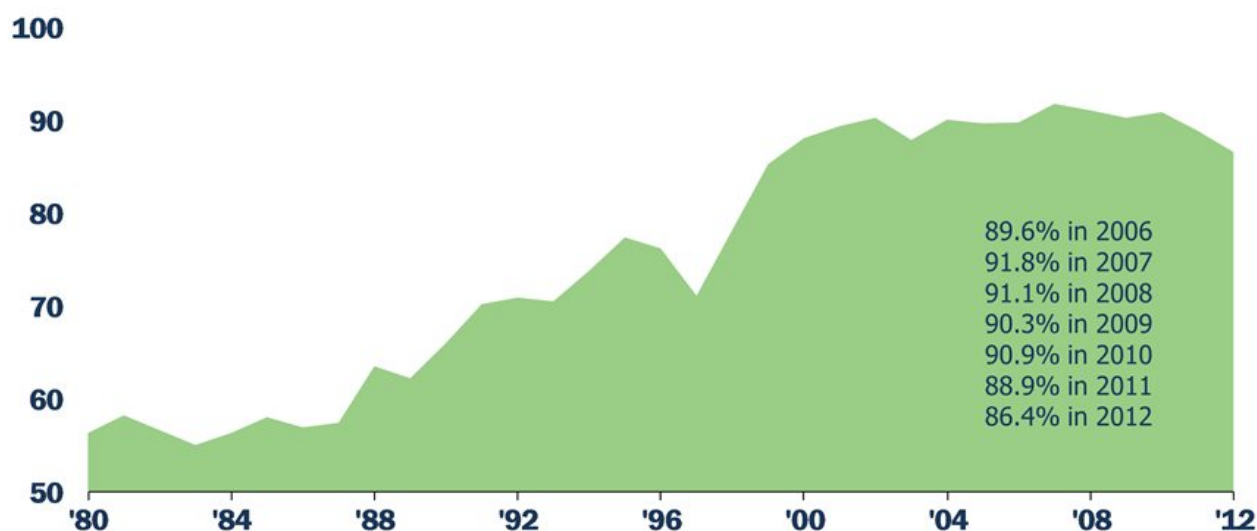


plants. It may be because we operate in a very rigorous regulatory environment that forces nuclear utilities to be extremely conservative as change creates risk. Add to that the magnitude of the capital investment in a nuclear plant and the conservatism increases further as the risk of an advancement is always taken into consideration when looking to the future.

That being said, the operators of today's fleet of nuclear plants have made incredible improvements to the operating fleet. This is why capacity factors (percent of maximum possible production) today can be 90% +. Back in the 1980s, a capacity factor in the mid 80% range was considered excellent. But no more. Today we expect better performance from our plants and we get it-through everyday innovation!

## Sustained Reliability and Productivity

U.S. Nuclear Capacity Factor, Percent



When it comes to operations, the improvements are easy to show through improved performance of the operating fleet. The issue we have had in the west is an insufficient number of new build projects to show the innovation that is happening every day in this industry when it comes to new projects. New build in western countries have had a rocky start after decades of not building. But as we move forward, this too will improve.

For new projects, we need to not only be building to budget and schedule, but also showing that costs and schedules are reducing with time. The Koreans, Chinese and Japanese have clearly demonstrated the benefits of standardized fleets to reduce costs and schedules as they build more and more plants. We see them innovating as they learn from each project and move on to the next one. We are already seeing improvement in the US as the Summer plant is taking advantage of lessons learned from the Vogtle plant; and both are benefiting from the experience in China.

We must be able to demonstrate that today's nuclear technology is a technology of the future and that advancements are indeed coming that make every project better than the last. If an agency looking to the future of energy thinks there is no innovation in nuclear, then we need to be more vocal about our achievements. We need to celebrate our innovation. And we need to continue to invest in further innovation because there is always room to get better.

Our strength is through our performance. And our performance continues to get better through innovation, each and every day. For those of you who have good examples of where innovation has benefited the industry, please post them as a comment.

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# **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. Sylvia 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?

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## **Today's hottest business model – FREE – Review of the book by Chris Anderson**

Just finished reading “Free – The future of a radical price” by Chris Anderson. It was interesting reading and builds on many of the themes from Jeff Jarvis’ book “What would Google do?” that inspired me to start this blog earlier this year.

This book is well written and makes a strong case for free as a business model. The argument is that the web provides an easy low cost way to distribute information at a near zero marginal cost. Therefore it is much easier to make information available rather than try and protect it. Of course many will argue against this principle; noting that people's time cost money and nobody (with some exceptions) works for free. However, reading between the lines I do believe that Chris Anderson recognizes that for FREE to work, money must be made somewhere. At a more strategic level, I think the main point of the book is that dramatic changes are happening in business models and to succeed – innovation in the way money is made is now a requirement.

Three FREE models are discussed.

1. Direct Cross Subsidies – where products or services are effectively bundled with some provided for free and the others for a fee. In this model, usually you need the

paid for product or service to get value from the free one. e. g. Cell phone is free, cost is to use it.

2. Three party or “two sided” markets – a traditional model in which one class of participant subsidizes the other. This is standard way of receiving a good at the cost to advertisers. e.g. any advertising supported delivery of content such as TV or ad supported web sites.
3. Freemium model – in which a basic service is free but there is a fee for a more sophisticated version. This has evolved into a model where the base free service is good and quite usable for a large quantity of users and that a smaller set of users are willing to pay for a premium service. e.g. Skype where there is free computer to computer talk but it costs to call a phone.

This book provides a good history of using free to entice customers to move up the value chain. What is different in today's world is that we now have services where a majority of the users will only use the free service and are subsidized by either a small group of specialty users or by advertising.

While this may be the case – is this model really sustainable?

Chris Anderson suggests that this is something that you can't fight. Trying to fight against free will ensure failure as a competitor will likely embrace it. This is where the discussion gets interesting. The challenge is to find new business models where something is free and new different ways of payment are discovered. The example is for consultants (since I am one – this is relevant) who provide free general information that results in paid individual consulting or speaking opportunities. Now of course, there may be a level of naiveté in this thinking. As consultants, one thing we always know is that any manhour not paid for is gone forever!! But what I do know is that things are constantly changing. As soon as you assume something new will work, it too is replaced by new thinking. Innovation is the new

constant! What we have in this era of almost unlimited free information is a huge global exchange of ideas. And this has extreme value – the question then becomes how to find that value. Malcolm Gladwell has another interesting view in his review of this book. This shows the level of debate which I think will continue for some time. However while the debate is raging, more and more still seems to be available for free.

As an energy economist, I find the economic model fascinating. What is being said here is that in the area fed by the internet, there is abundance. And as we know, abundance means a low price as economics clearly points out that we value what is scarce. But as is also pointed out in the book, every time we create abundance we end up with scarcity somewhere else. So in this case, the abundance of information means that our time to absorb, understand and use this information is becoming scarce. Or as the example goes – some people have more time than money and others have more money than time. For the latter group, payment to save them time is valuable indeed!

The other issue is that sometimes abundance isn't abundance. Externalities must be considered or we end up in the situation that we now find ourselves, warming the earth with green house gases because the true cost of the impact to society is not included. Abundance leads to waste and sometimes waste leads to societal damage elsewhere down the line.

But what is clear is that we have now moved to a state where certain things that we valued in the past; we are no longer prepared to pay for. Does this mean the end of these things? In fact no, they are shared freely because they are abundant. What it does mean is that we all need to think up new business models that make sense in the world of FREE.