Nuclear Energy Summit – Broadening the nuclear coalition

In our last two posts we looked at the pledge signed by more than 20 countries at COP28 in Dubai to triple the amount of nuclear globally by 2050 and the pledge made by more than 120 companies in the nuclear industry to meet this challenge. This month we comment on the first global Nuclear Energy Summit held in Brussels March 21, 2024.

The summit photo had Brussels' Atomium as its backdrop (Image: Klaus Iohannis/X)

This summit, organized by the IAEA together with Belgium, included senior government delegations from 32 countries, coming together for the sole purpose of discussing the future of nuclear energy and its role in supporting countries' climate and energy security goals.

The list of 32 countries includes 14 additions to those who signed the nuclear pledge at COP28 (not all COP28 signatories

participated in this event). This includes new countries with long histories of nuclear power like Argentina, India, Pakistan, and Slovakia, to those who are active nuclear newcomers (Bangladesh, Egypt, and Turkey) and those who are aspiring to bring nuclear power to their countries (Philippines, Saudi Arabia, and Serbia). The list also includes China, who has 55 operating nuclear plants and another 36 under construction, the world's most active nuclear program, and Kazakhstan, the world's largest supplier of uranium.

Just the fact that the summit was hosted by Belgium is important, given that it only recently abandoned its plan for a full nuclear phase out. And add Italy to the list of countries who have not been supportive of nuclear in the recent past.

The resulting declaration stated "*We, the leaders of countries operating nuclear power plants, or expanding or embarking on or exploring the option of nuclear power … reaffirm our strong commitment to nuclear energy as a key component of our global strategy to reduce greenhouse gas emissions from both power and industrial sectors, ensure energy security, enhance energy resilience, and promote long-term sustainable development and clean energy transition.*"

The declaration identified a range of topics where policies need to evolve (for a more complete description refer to the WNA release) including increased financing, workforce development. and support to nuclear newcomer countries. We will discuss each of these items in future posts. They are all critical to a healthy growing global nuclear sector. Why is this important? Because rather than continuously debate whether to pursue nuclear, the discussion has finally moved on to collaborating to create the necessary conditions for success.

In support of the government's declaration, global industry

associations released a joint statement noting their strong support to ensure governments can meet their nuclear ambitions. In addition, a group of 20 NGOs from around the globe issued a Declaration on the Future of Nuclear Energy jointly calling for the efficient and responsible expansion of nuclear energy.

This first nuclear summit shows the collation of countries, industry and NGOs supporting and actively promoting nuclear power is growing rapidly. It is unprecedented in the level of national leader support for nuclear since President Eisenhower's Atoms for Peace speech 70 years ago. The time has come for action, and the stage is set to put in place the necessary policies to enable the rapid scaling of nuclear in meeting all our climate and energy security needs. The future is bright. But the work ahead is hard. This is only the beginning.

[*Complete list of those signing the declaration: Argentina, Armenia, Bangladesh, Belgium, Bulgaria, Canada, China, Croatia, the Czech Republic, Egypt, Finland, France, Hungary, India, Italy, Japan, Kazakhstan, Netherlands, Pakistan, Philippines, Poland, Romania, Saudi Arabia, Serbia, Slovakia, Slovenia, South Korea, Sweden, Turkey, United Arab Emirates, UK, and the USA*]

Tripling the global nuclear fleet will require massive capacity building

In our last post we looked at the pledge signed by more than 20 countries at COP28 in Dubai to triple the amount of nuclear

globally by 2050. This month we consider the pledge made by more than 120 companies in the nuclear industry to meet this challenge and support a tripling of nuclear power by 2050. This is all part of the Net Zero Nuclear initiative started by the WNA (World Nuclear Association) and ENEC (Emirates Nuclear Energy Company) calling for unprecedented collaboration between government and industry leaders to at least triple global nuclear capacity to achieve carbon neutrality by 2050.

Some of the companies that have signed the industry pledge
Source: WNA photo COP28 December 2023

Tripling the global nuclear capacity is no small feat. Today there are 437 reactors in operation with a combined capacity of about 400 GW. Tripling means adding another 800 GW by 2050. In a combination of large nuclear and new Small Modular Reactors (SMRs), this would mean anywhere from 800 to 2500 or so new units being built around the world. Currently, there are 61 units representing about 68 GW under construction, only 7.6% of the way there. And two thirds of these units under construction are in or exported by China and Russia. In other words, the western nuclear industry has a long way to go to do their part in achieving this lofty goal. The question is then, how can we get there from here and why is this pledge so important?

Some say it is a pipe dream. We say the first step in solving any problem is to clearly define it. In this case, to express an ambition – and that was clearly set out at COP28.

Understanding the need, the question then becomes how the industry can scale to meet this demand? This requires a rapid increase in development of both the global supply chain and the human talent needed to deploy at this scale.

This is huge change for the industry. It is (except for China, Russia and possibly Korea) used to being in a global market with few new projects and too many suppliers. On top of that there have been many false starts on a renewal (or renaissance) in the past that did not work out. So, the industry has been reluctant to make the necessary investments to support the capacity building needed.

The first step is to firm up this new demand. This must be driven by government. And it has begun. Already since COP, France has announced its plans to build 14 new EPR2 units by 2050 and the UK has issued its nuclear plan on how it will meet its target of 24 GW by 2050. The UK document is clear in that capacity building and human workforce development is a critical part of this plan. Here in Canada work is underway to look at how to scale to meet 2050 growth projections as well. The US has a lot of work to do to determine how to deliver its ambition of 200 GW of new nuclear by 2050. And yes, where will the resources then come from for projects in Poland, Czechia, Estonia, Slovenia, Bulgaria, Saudi Arabia, South East Asian countries and the many possible nuclear newcomers in the global south?

The nature of global competition will also change. There will be enough work to support multiple vendors, both for traditional large nuclear and SMRs. To be successful, there must be a focus by each vendor on delivering fleets of their designs to be as efficient as possible. This can then support development of global supply chains with sufficient capacity and the human talent needed for delivery. The potential volume of work will encourage productivity improvements resulting in more on time and on budget delivery at lower total cost.

To meet the goals of net zero by 2050 and global energy security, the effort to build industry capacity is required now. All countries interested in new nuclear need to work on developing the people they will need to succeed. The ambition is clear – now is the time to act.

The World Pledges to Triple Nuclear Power at COP28

Earlier this year, we wrote a post stating that "*in 2022 the world acknowledged that net zero needs nuclear – in 2023 it will realize it needs a whole lot of it.*" Well, as 2023 draws to a close, it has! This month at COP28 in Dubai, more than 20 countries[1] (some with operating nuclear and some with ambitions for nuclear) got together and pledged to triple the amount of nuclear power globally by 2050.

Photo taken by Milt Caplan, December 2, 2023, Dubai

Why is this so important? For the first time at a COP meeting, there was a clear acknowledgement by governments that nuclear power is an essential part of the path to net zero. Of the countries represented at the announcement of the pledge were 8 presidents and several senior ministers, each who stood up and stated the importance of nuclear power to their countries' net zero ambitions. This is a far cry from COP meetings as recently as 3 years ago where the nuclear advocates were not welcome within the government sanctioned blue zone (the blue zone is the area restricted to government authorized delegates while the green zone is open to the public).

This year at COP28, there were multiple booths within the blue zone focused on nuclear – including the IAEA, nuclear for climate, net zero nuclear and others . At each one of these there were events and panels discussing a variety of issues as

they pertain to meeting this pledge. There was a high level of interest from attendees in learning more about this low carbon energy source.

This was followed up later in the week by a Net Zero Nuclear Industry Pledge from over 120 members of the nuclear energy industry agreeing to work towards at least a tripling of global nuclear capacity by 2050. We will discuss the importance of this industry commitment further in a future post.

As COP28 came to a close, more history was made in the official Global Stocktake – that the world must transition "*away from fossil fuels in energy systems, in a just, orderly and equitable manner….so as to achieve net zero by 2050 in keeping with the science*." It then noted this should be achieved by "*accelerating zero- and low-emission technologies, including, inter alia, renewables, **nuclear**, abatement and removal technologies such as carbon capture and utilization and storage, particularly in hard-to-abate sectors, and low-carbon hydrogen production.*" This is the first time a COP has noted that fossil fuel use must be reduced and the first time nuclear is part of the solution.

Being in attendance at this historic event was a wonderous experience. After years of hard work by so many, we are seeing a strong government commitment to nuclear power as an essential part of the climate story. This commitment now sets the stage for government to follow up with policies to implement the pledge. The political climate for nuclear has never been better. After all, **in 2022 the world acknowledged that net zero needs nuclear – in 2023 it fully accepted it needs a whole lot of it**. Now begins the real challenge – delivering on this ambitious commitment.

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[1] United States, Armenia, Bulgaria, Canada, Croatia, Czech

Republic, Finland, France, Ghana, Hungary, Jamaica, Japan, Republic of Korea, Moldova, Mongolia, Morocco, Netherlands, Poland, Romania, Slovakia, Slovenia, Sweden, Ukraine, United Arab Emirates, and United Kingdom.

Achieving Net Zero – A global problem requires global solutions

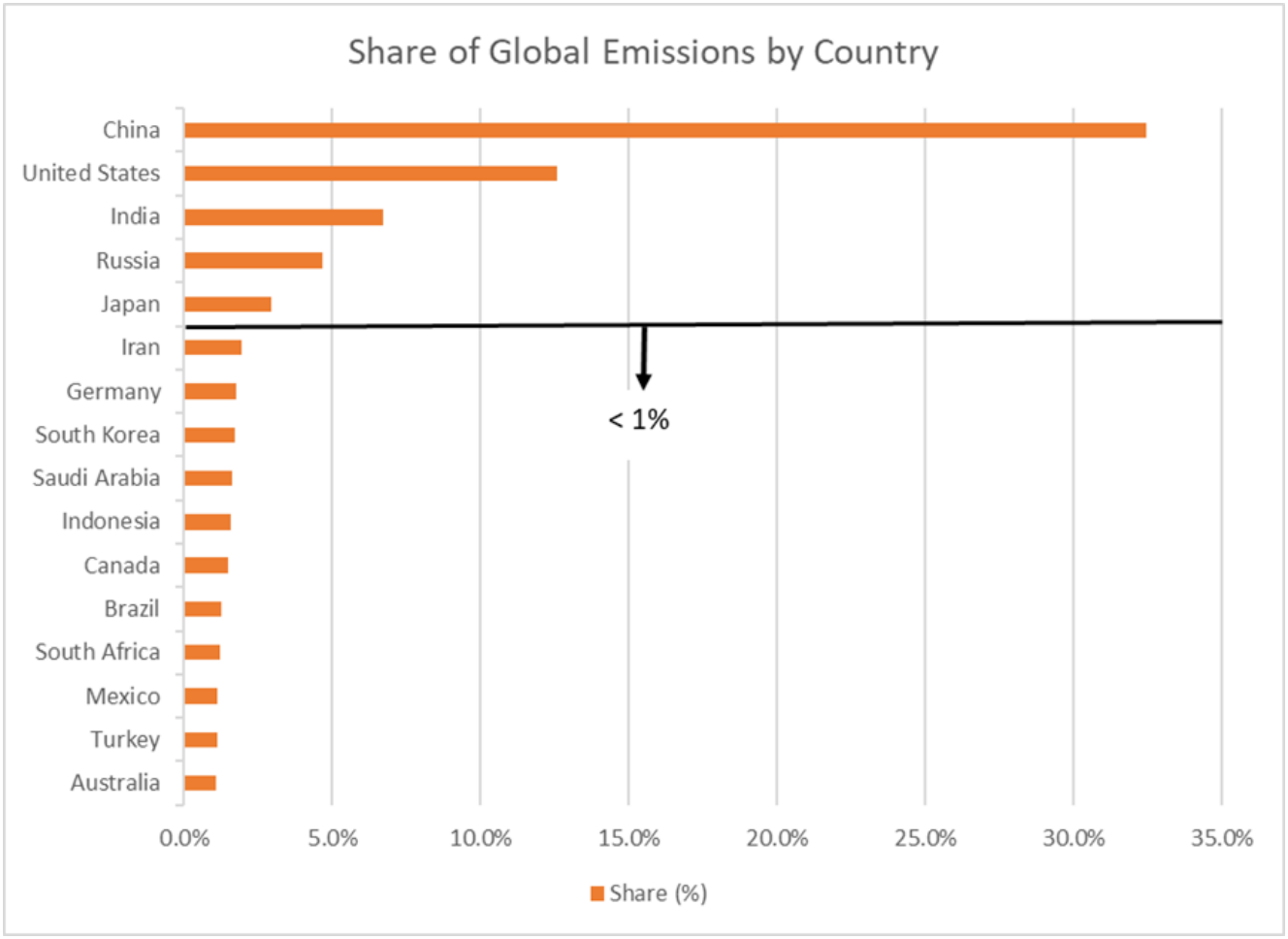
If you live in a relatively rich country (other than the United States), how often have you heard someone bemoaning government policies to cut carbon emissions say something like – "*since we only emit about 1% of global CO2, we could cut our emissions to zero, and it would make no difference. It is the large emitters like China and the United States who have to lead, not us.*"

Well, it is true that the United States and China account for about 45% of global emissions. But does that really mean that what the rest of us do doesn't matter when it comes to combatting climate change?

Source: istockphoto.com

Global emissions are indeed concentrated in a very few countries. In fact, the top 5 emitters, China, United States, India, Russia, and Japan account for about 60% of global emissions (2020 data). China is by far the leader at about 32%. Continuing down the list, there are only 16 countries that emit more than 1% of global emissions with the remaining 195 or so countries in the world each emitting less than 1% of global CO2.

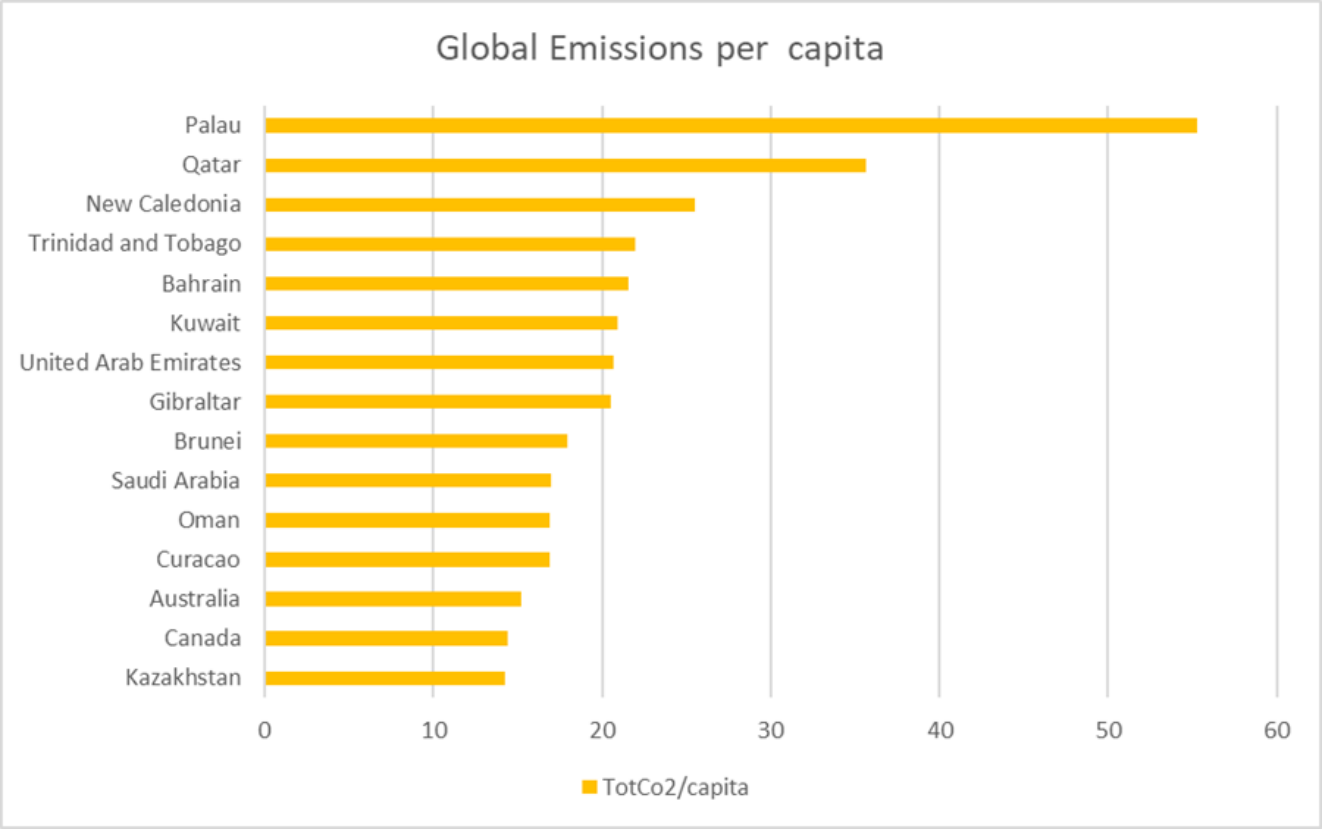
Does this then mean the rest of us need do nothing? Do we look to the top 5 emitting countries to do it all on the assumption that our efforts are just not worth the outcome? Of course not. At the simplest level, if we truly want to achieve net zero emissions, and assuming the biggest emitters do their part, then we can get 60% (assuming they go to zero) of the way there, but another 40% of emissions would remain. There would still be much more to do with each remaining country contributing a little bit. It is somewhat similar to replacing coal plants with gas fired plants. A big help, yes – they cut emissions in half, but then what?



Source: https://worldpopulationreview.com/country-rankings/carbon-footprint-by-country (Year 2020)

In any case, are emissions by country even the best metric when considering global policies to reduce carbon? What about individual emissions? It should come as no surprise that India and China are in the top 5 since about a quarter of the world's population lives in these two countries alone. Yet if we look at where individuals use the most energy (and are responsible for the most individual emissions) it is in the smaller population richer countries. In this case the top 5 are: Palau, Qatar, New Caledonia, Trinidad and Tobago, and Bahrain. Of the big country emitters, the US is 16th on an individual level, Russia 23rd, Japan 29th, China 35th and India is way down the list at 133rd. This means that those countries that emit the most may use less energy per person than others but simply have very large populations. Can we expect India to do the heavy lifting to reduce emissions when every Indian

used about 1/8 of the energy of the average American? Are small richer countries given a pass even though each resident emits a lot? Since access to affordable energy is directly related to quality of life, do poorer nations not have a right to a better life through using the same amount of energy of those in rich countries? (And of course, geography plays a part in energy use as does the current energy mix in each country, but this is beyond the scope of this discussion.)



Source: https://worldpopulationreview.com/country-rankings/carbon-footprint-by-country (Year 2020)

Of course. the largest emitters need to show leadership as they will have the largest impact. But we cannot expect them to reduce their emissions at a cost to their people's quality of life. And they cannot do it alone. Access to affordable low carbon energy including nuclear power is what is required for all the world's population to prosper. Climate change is a global problem that requires global solutions. And that means cooperation. So next time someone tells you that even if we in smaller emitting nations reduce our emissions to zero it will make no difference, disagree. We can choose to lead,

collaborate, or in some cases, even follow, but we cannot do nothing.

Nuclear project structures – it’s about managing risk

In our recent post on nuclear project financing, we noted the importance of reducing risk to investors to ensure projects can raise sufficient competitively priced capital needed to build them. Today we will discuss project structures. What are they and why are they important?

The project structure is how the project is organized contractually to build the plant and then sell the electricity to the market. Good structures help the project to succeed while poor ones end up with lawyers arguing where to lay blame rather than people delivering on their commitments.

Source: pexels.com

There are four major categories of participants in a large energy project.

- The customer – who needs the energy and pays for it to be reliably delivered to their home or business;
- The owner/operator (yes these can be separated, but we will keep them together for simplicity), who is responsible for building and operating a generating station to provide the energy to the customer;
- The contractor(s), who have technology, design, and construction capabilities to build the plant; and
- The investors, who provide the funding to support this construction and who will be repaid during plant operations when there are revenues from selling electricity.

When talking about contractual structures, the primary relationships are between the owner/operator and the customer (market structure); and between the owner/operator and the

contractor (project structure).

There are a whole range of contractual structures for both relationships. Some are simple and some are complex. None are perfect. Historically, electric utilities tended to be vertically integrated monopolistic companies, often owned by governments, who were charged with delivering electricity to customers at low cost. Utilities carried most project risks and passed them on to the customers. A government regulator was charged with setting rates for customers (while looking out for their best interests) based on the utility costs and performance.

Poor project performance and a belief that competition would incent better results led to a shift to deregulated markets in many jurisdictions in the early 1990s whereby the utilities would be broken up and generators would have to compete to sell their electricity to the market. (We wrote a previous post on why these deregulated markets do not work well for building new low carbon generation.)

Being forced to take on more risk by their customers, owners wanted more certainty of outcomes and believed contractors, as the experts in performing the work, were in the best position to take on these risks. Wanting this work, contractors agreed to take on more project risk, for a price. This provided a sense of security to the owners that their risk was limited, and that they could rest easy, knowing it would be up to others to ensure successful project delivery.

Unfortunately, this has been proven to be nothing more than an illusion. In reality, the contractor’s ability to take on additional risk is limited and when project costs increase, they will generally make a claim for a change in scope requiring additional funds. This often results in contractual disputes that slow down project progress and negatively impact company relationships. In the end, there is no escaping the project risks for the owner, as it is their project and their

money. After all, there is no scenario where the contractor fails, and the project succeeds.

The lesson is that when developing project structures, the objective is to manage risk while incentivising the behaviours from the project stakeholders necessary for project success; not to decide who suffers the most in the case of failure. Because for **long term commercial success**, there is one truth. All costs must be borne by the customer. There is no one else (unless government provides a subsidy in which case taxpayers are involved which is a different discussion – we will talk about the potential role of government in mitigating risk in a future post). When the investors state that they do not want to be exposed to excessive risk, what they mean is that they want a credit worthy borrower who can reliably replay loans and deliver a return on equity. And while ensuring they are contractually protected from risk is important, the best way forward is to confidently deliver projects to cost and schedule.

This is changing the way that projects are structured to more collaborative models whereby all parties' objectives are aligned, and everyone sinks or swims together. Good project contracting is important in defining the project, but on its own is insufficient to ensure good project outcomes. Successful project delivery results from good project planning, doing enough work upfront to set a realistic cost and schedule; and excellent project management, supported by a high level of transparency together with a strong set of project metrics to enable informed rapid decision making to keep the cost and schedule under control. Continuously improving the ability to deliver successful projects to cost and schedule will ensure that nuclear power can meet its full potential on the road to a Net Zero future.

In 2022 the world acknowledged that net zero needs nuclear – in 2023 it will realize it needs a whole lot of it

Early last month, Vogtle Unit 3, the first new nuclear plant to be built in the United States in decades, went critical, meaning it started to nuclear fission and move down the path to producing its first electricity and becoming operational. This was great news as the project has had a troubled history of delays and cost overruns. Once fully operational the Vogtle site will have four operating units and be the largest nuclear operating site in America.

But this was not the most important nuclear news coming out of the US this past month. On March 21 the US Department of Energy released its "*Pathways to Commercial Liftoff*", a set of reports to strengthen engagement between the public and private sectors to accelerate the commercialization and deployment of key clean energy technologies. This included a report on "*Pathways to Commercial Liftoff: Advanced Nuclear*" in which the DOE estimated a need for an additional 200 GW of advanced nuclear by 2050 on the path to net zero. This is a huge change from the past (equivalent to tripling the current fleet) when most felt that nuclear would struggle to play an important role in the country's future.

Source: istockphoto.com

And the US is not the only country to set huge nuclear ambitions. In December of 2022 in Canada, the Ontario Independent Electricity Operator issued a report, ”Pathways to Decarbonization”, in which it suggested Ontario may need another 18 GW of new nuclear to complement its current 14 GW fleet.

In the UK, the government has set a target of 24 GW of nuclear by 2050 delivering about 25% of UK demand. In France, work is underway to deliver 6 new EPR units followed by another 8 by 2050 for a total of about 22 GW of new nuclear.

Meanwhile South Korea, after suffering an administration that wanted to phase out nuclear energy, is planning to expand its nuclear fleet in its *10th Basic Plan for Electricity Supply and Demand (2022 – 2036).* The plan includes 6 new 1.4 GW units coming into service and nuclear reaching 34.6% of electricity generation by 2036 as coal use declines. And even in Japan, 12 years after the accident at Fukushima caused by

the Great Tohoku earthquake and tsunami, has adopted a plan to extend the lifespan of nuclear reactors, replace the old and even build new ones as part of its commitment to fighting climate change.

This commitment to large new nuclear fleets is not only by countries that have nuclear power, but even those just planning their first plants. For example, Poland, Europe's largest coal burning country, is planning at least 9 GW of new large nuclear plus a range of small nuclear power plants by 2040.

Why is this important? In the last year more and more governments have accepted that nuclear power must be part of any climate plan that achieves net zero targets by 2050. Nuclear was accepted (albeit marginally) in the European taxonomy as a low carbon technology, the UK is defining nuclear as green, and many other governments have noted there is no path to net zero without nuclear.

And then there is the war in Ukraine increasing concerns about energy security to a level not seen in many years. This is hastening the movement away from fossil dependence which further supports the energy security strengths of nuclear power.

So, if 2022 was the year that governments around the world finally embraced nuclear power as a necessary part of the path to net zero, 2023 will be the year they start to accept this means building a whole lot of it, expanding the global nuclear fleet at a pace and scale not seen before. What does this mean for the global nuclear industry as it readies itself for this massive increase in demand? This is a topic for another day.

Financing nuclear power – some basics

We often hear that financing is a major issue for nuclear projects that creates significant impediments to new projects moving forward. There are myriads of thoughts and ideas on how to fix this, from various clever project contractual structures to identifying new non-traditional sources of funds. But other than stating "financing nuclear projects is difficult", what are the issues? After all, we can't solve a problem if we don't fully understand it. For this post, we are not going to talk about solving problems. Rather in the first of a series of posts on financing, let's start by understanding some of the basics.

Source: pexels.com

The reality is there is lots of money in the world looking for good places to invest. So, the question becomes – are nuclear projects attractive to investors? To answer that question,

let’s not think about financing as an input to developing a project, let’s consider it as an outcome. In other words, if we successfully structure a project, getting the risk profile right, with an appropriate revenue stream; then our nuclear project should attract the necessary funds to proceed.

Fundamentally attracting investment is all about managing risk. Investors want to put their money into investments where they understand the risk and are then appropriately compensated for taking on this risk.

What are some of the key risks related to a new nuclear project?

1. Size – these projects are generally very big and require large volumes of funds. Projects in excess of $10 billion are common.
2. Duration – nuclear plants take a relatively long time to build (6 to 10 years) meaning there is more risk of things going wrong before the plant is completed and the asset starts to generate revenue.
3. Credit worthiness of the owner/operator – Only the largest companies have the capacity to raise the volume of funds required on their balance sheet. Even the largest nuclear utilities often seek out partners to raise all the funds necessary for large nuclear new build.
4. Project performance – there is a history of large infrastructure projects (not just nuclear plants) struggling to be completed on time and on budget – with numerous examples of projects taking years longer and being completed at much more than the original planned costs and schedule.
5. Political risk / bias – there are many governments and other nongovernmental actors that work to ensure nuclear is unable to raise capital on ideological grounds.
6. ESG – there is growing interest in ensuring capital

flows to environmentally sustainable and ethically run projects. There are those that do not think nuclear is ESG compliant.
7. Operating performance – as a mature industry there is good experience with plant operations and as such, nuclear operators are generally able to raise the funding needed for ongoing operations.

What does this all mean? There is much work to do to successfully finance new nuclear projects that can include:

1. Reducing the size and duration of the project – this is one of the primary goals of Small Modular Reactors (SMRs) – to reduce project risk by making them smaller and faster.
2. Structuring the project to reduce the risk to investors – we hear of many ideas for project structure that allocate less risk to investors, moving the risk to industry, government, or the customer, depending upon the model.
3. Ensuring the environmental attributes are recognized and that governments support nuclear as a sustainable option for the future – being excluded from the sustainable finance market greatly reduces the funds available – the long battle to get nuclear into the European taxonomy is testament to how those opposed try to ensure funding is made unavailable to nuclear projects.
4. Developing knowledge and capability in the financial community to be able to understand and assess nuclear projects.

Most of all, it is about project performance. If investors know that the project is likely to deliver on its financial projections, there will be interest to participate. This does not solve everything, as managing political risk and raising large volumes of funds will always create challenges.

What we do know, is that more and more countries agree that nuclear is needed to achieve their net zero 2050 goals and to address energy security issues. This is resulting in a renewed interest for new nuclear that will literally require trillions of dollars to deliver in the decades ahead. We will talk further about some of the solutions above and their impact in more detail in later posts.

Canada's nuclear industry continues to shine

On December 15, 2022, the Ontario Independent Electricity System Operator (IESO) issued "Pathways *to Decarbonization – A report to the Minister of Energy to evaluate a moratorium on new natural gas generation in Ontario and to develop a pathway to zero emissions in the electricity sector*". This report considers a decarbonized supply mix in the Canadian province of Ontario by 2050 with contributions from new nuclear, conservation, demand response, renewables and storage. This includes **18,000 MW** of new nuclear.

So ended a year of major steps forward for the nuclear industry in Canada.

Source: pexels.com

Nuclear power produces about 15% of the Canada’s electricity with operating plants in two provinces, Ontario, and New Brunswick. In both provinces nuclear power is essential to their electricity generation with Ontario getting about 60% of

its electricity from nuclear while New Brunswick uses it for about a third.

This year the federal government made its view of nuclear clear when the Canadian Minister of Natural Resources stated unequivocally there is no path to net zero without nuclear power and included funding to support this statement in its 2022 budget.

Here are some of the major achievements for nuclear in Canada in 2022.

- Both Ontario Power Generation (OPG) and Bruce Power (BP) are continuing with their combined $26 Billion dollar refurbishment (life extension) programs for their Darlington and Bruce plants respectively. These programs are going extremely well, both on time and on budget. OPG has completed it first unit and is in the final stages of reassembly of its second while BP is in the final assembly phase of its first. These projects are being executed brilliantly to the point where OPG has recently been awarded second place for the Project Management Institute's global PMO (Project Management Organization) of the year award.
- OPG announced it is assessing the feasibility of refurbishing the Pickering nuclear station, currently scheduled to shut down in 2026.
- Bruce Power, already the largest nuclear operating site in the world, is working to increase the output of its site by 700 MW by 2030 through unit uprating
- OPG is moving forward with its first grid scale SMR project, a BWRX-300, at its Darlington site and has started site activities this year as well as submitting an application to the regulator for a licence to construct. This unit is expected to produce first power around the end of 2028. The Canada Infrastructure Bank has announced an investment of up to $970 Million for

the early works of this project.

- OPG is also a partner in Global First Power, who are in the process of establishing the first micro reactor, a USNC MMR, at the Chalk River site. Licensing activities are underway.
- New Brunswick has announced it is working with two SMR vendors (Moltex and ARC) to establish SMRs in the province. The Belledune Port Authority (BPA) says an ARC-100 providing energy for hydrogen production and other industries could be in operation by 2030-2035.
- SaskPower has selected the BWRX-300 for its first nuclear plants in the province to be in operation in the mid 2030s.
- Alberta is contemplating nuclear using its ability to generate heat to help it decarbonize its oil extraction.

And there is more. But you get the point. Nuclear Power is alive and well in Canada. But why is this important? Because when it comes to nuclear as a solution for climate change, in Canada, we are walking the walk. We have a vibrant industry currently demonstrating that complex large scale nuclear projects can be completed on time and on budget. Based on this success, we have the confidence to take on First of a Kind (FOAK) risk by building the first of more than one SMR design setting the stage for global fleet deployment. This is only the beginning. With demand for clean energy increasing, we can expect to continue with life extensions (refurbishment), new SMRs and yes, even new large nuclear.

And most of all, if a jurisdiction like Ontario, Canada with an already heavily decarbonized electricity system producing well under 100 kg/kWh of carbon is saying it needs to more than double the nuclear fleet to fully decarbonize; just imagine what other jurisdictions still heavily dependent on fossil fuels need to do. The world needs nuclear power and lots of it.

Canada’s success is based on many factors, but transparency is key. Constant listening and learning assure the program continues to improve. To that end, we are ready and willing to share what has been learned to help others succeed just as we are. There is little doubt that collaboration is essential if the global industry is to meet its full potential – and we in Canada are ready to play our part.

As another year comes to an end, we want to thank you all for reading our blog and wish you a very happy and healthy 2023!

Achieving net zero requires building all low carbon technologies including lots of nuclear

In its 2022 report on the role of nuclear power in fighting climate change, “*Nuclear Power and Secure Energy Transitions*”, the International Energy Agency (IEA) says “***Nuclear energy can help make the energy sector’s journey away from unabated fossil fuels faster and more secure***.”

It goes on to clearly lay out why nuclear power is so important to a clean energy future noting that achieving net zero globally will be **harder** and **more expensive** with less nuclear.

Source: Pexels.com

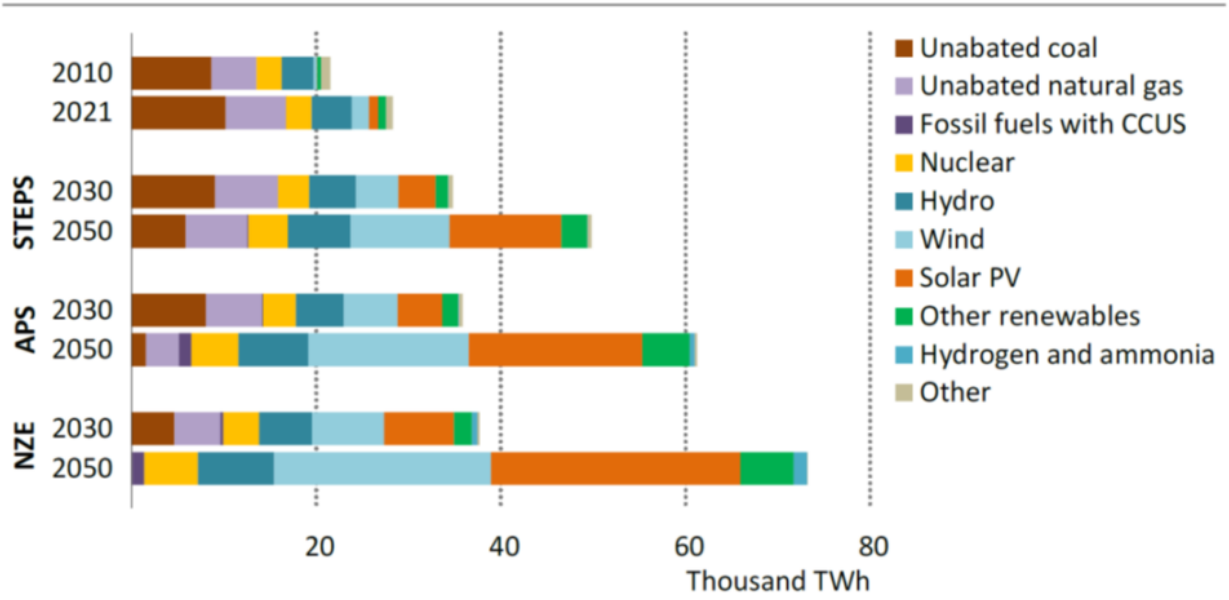
The report also notes there are challenges to further nuclear deployment emphasizing the importance of continuing to reduce costs and ensure projects are built to cost and schedule. These are indeed justifiable issues and there is no doubt the industry must perform for long term success.

While the IEA may say nuclear is important for net zero, this has not resulted in projections for a large new nuclear program. Rather, as is shown in the 2022 World Energy Outlook (WEO 2022) just released from the IEA, the role for nuclear remains modest. Yes, there is a doubling of nuclear capacity to 2050, but because of continued electricity demand growth the nuclear share falls from 10% of global electricity supply to only 8% in its Net Zero Scenario.

On the other hand, renewables are projected to account for the majority of capacity additions over the outlook period (to 2050). In the base STEPS scenario, wind and solar PV together set new deployment records every year to 2030 and then

continue with increased annual growth through to 2050. For the IEA Net Zero scenario, wind grows by a factor of 12 and solar even faster with 27 times more solar in 2050 than in 2021. The assumption when it comes to renewables growth is that there are no limits. No concern about land use, or volume of critical materials required, or how storage technology will develop to support increasing the share of renewables from its current 28% of electricity supply to 88% of a larger global electricity system. Yet we know from experience in Germany, California and others where variable renewables have successfully achieved a relatively high share of electricity supply, that system reliability suffers, often requiring fossil fuel back up to support their intermittency.

Figure 6.7 ▷ Global electricity generation by source and scenario, 2010-2050



Electricity generation from unabated fossil fuels peak by 2030, as low-emissions sources ramp up and renewables dominate electricity supply in all scenarios by 2050

Note: Other renewables include bioenergy and renewable waste, geothermal, concentrating solar power and marine power.

Notes: STEPS (Stated Policy Scenario), APS (Announced Policy Scenario), NZE (Net Zero Scenario)
Source: IEA World Energy Outlook 2022

To be fair, we don't blame the IEA for their views. Based on

recent experience in western countries with little ongoing nuclear new build and projects that have gone over budget and schedule, it may be difficult to see a path for more rapid nuclear growth. But that certainly doesn't mean there shouldn't be a challenging goal. Just look at China that has built over 50 GW of nuclear capacity in the last 20 years and has approved 10 new large reactors this year alone. In the west we have examples as the US built about 100 units and France built a fleet of 59 units in less than 30 years. Twenty years ago, there was little confidence in the ability of renewables to scale and here we are today, now assuming almost unlimited growth given their success. Just as with renewables, increasing the scale and pace of nuclear new build as we have achieved in the past is also possible given the political will.

There is an international study that considers a more balanced growth for all the clean technologies. UNECE (United Nation Economic Commission for Europe) has recently released its report "*Carbon Neutrality in the UNECE Region Technology Interplay under the Carbon Neutrality Concept*" which takes a fresh look at how to use a broad range of technology, both existing and new to meet its net zero challenge.

This report finds "*there are achievable pathways for governments to design and implement a carbon-neutral energy system through technology interplay.*" In its carbon neutrality innovation scenario, UNECE considers the potential of three innovative low- and zero-carbon technologies: a new generation of nuclear power, CCUS, and hydrogen – to deliver on carbon neutrality. In this scenario nuclear grows to 3.4 times its current base in the region by 2050 (as opposed to 2x by IEA*) and reaches 27% of energy supply (compared to 8% by IEA*). It also notes challenges with all technologies. For example, it predicts 4,430 TWh of solar power in the region by 2050 (compared to the 27,000 TWh globally in the IEA net zero scenario) and notes this requires 7 million utility scale

panels covering an area equal to 2.8 million football pitches equal to the entire surface area of Belgium.

There is little doubt the challenge of achieving net zero emissions in our energy systems by 2050 is enormous. Given the view to electrify everything, electricity use will at least double. To meet this growth, it has been generally accepted that nuclear power has a critical role to play, but the size of that role remains in question. Concerns about the industry's ability to deliver has limited its potential in many studies such as the IEA WEO 2022. However, UNECE has taken a different approach and explored a more rapid expansion of all low carbon technologies, rather than assuming wind and solar can do all the heavy lifting. This seems a more viable model. Get all technologies growing as fast as possible to ensure the primary goal of carbon neutrality is achieved. We only have one world, and we need to build all low carbon technologies as quickly as we can if we really want to reach our climate goals.

* *It should be noted the UNECE projects are limited to the UNECE region and the IEA projections are global.*

Energy economics – why system costs matter

In our last post, we quoted from recent reports that clearly lay out the environmental benefits of nuclear power. This month we want to start off the year by launching a short series addressing some of the issues that impact energy economics. Today we will talk about the importance of **system costs** in understanding the relative costs of different

generation technologies.

Last year at this time we wrote about the IEA/NEA report, Projected Cost of Electricity 2020, that shows nuclear is competitive with alternatives in most jurisdictions using the traditional Levelized Cost of Electricity (LCOE) approach. LCOE is a great way to compare costs of electricity as it is generated from two or more different options to be implemented at a single spot on the grid with similar system characteristics. With intermittent variable renewables on the system, LCOE alone no longer provides a sufficient basis for direct comparison. By their very nature, deploying these renewables add costs to the system to be able to deliver reliable electricity in the same way as more traditional dispatchable resources like nuclear, hydro and fossil generation.

Source: pexels.com

What are system costs? In a report issued by the OECD Nuclear Energy Agency (NEA), system costs (see the report for a full definition) are basically the additional costs to maintain a

reliable system as a result of intermittent variable renewables only producing electricity for a limited number of hours when the resource is available (e.g. daytime for solar), their uncertainty due to the potential for days with little resource (e.g. rainy or cloudy days), and the costs to the grid to be able to access them given their more distributed nature (e.g. good source of wind but far from demand).

A 2018 study undertaken by MIT "The Future of Nuclear Energy in a Carbon Constrained World" considers the impact of nuclear power on the cost of electricity systems when deep decarbonization is desired. It looks at various jurisdictions around the world and the conclusion is always the same; the cost of electricity is lower with a larger nuclear share than trying to decarbonize with intermittent variable renewables (and storage) alone.

The reason for this impact is fundamentally due to the relatively little time these resources produce electricity. Solar and wind only generate when the sun shines and the wind blows, meaning they produce only some of the time and not always when needed. The average capacity factors of these technologies vary by location with world average capacity factor of just below 20% for solar and about 30 – 35% for wind (capacity factor is the amount of time a resource produces compared to if it would produce 100% of the time). Contrast this with the 24/7 availability of nuclear power, which can operate at capacity factors of more than 90%.

The impact on electricity systems is clear. Given the limited duration of operation of intermittent variable renewables, there is a need to dramatically overbuild to capture all the electricity needed when the resource is available to cover periods when the sun is not shining, and the wind is not blowing (all assuming there is reasonable efficient storage available which is not yet the case). The result is a system with much larger capacity than a system that includes nuclear (or any other dispatchable resource). In the MIT study for

example, the system in Texas would be 148 GW including nuclear but would require 556 GW of capacity with renewables alone. In New England a system with nuclear would have a capacity of 47 GW but would require a capacity of 286 GW with renewables alone. In the UK this would mean 77 GW with nuclear compared to 478 without. And so on. The costs of adjusting the system to accommodate these much larger capacities is significant.

Since that time study after study finds the same result. This includes a study in Sweden in which 20 different scenarios for full decarbonization always come out the same; in every scenario the most cost-effective system has continued long-term operation of existing nuclear. And more recently a study in France has shown that decarbonizing without nuclear means a system more than twice as large as one with nuclear and the more nuclear in the system, the lower the overall average cost of production.

So, what does this mean for planning? The approach to implementing a reliable economic low carbon electricity grid must start with looking at the entire system. A study should assess the total costs of deploying the system under a range of scenarios using different shares of available resources. Different forms of generation have different capabilities and these need to be modelled. Once an efficient mix is determined, a plan should be put in place to implement it (i.e., X% nuclear, Y% solar, Z% wind, A% storage, etc.). When looking to deploy each technology, LCOE can be used to compare various options. For example, when comparing one solar project to another or one nuclear project to another. And of course, should the costs of any given technology vary too significantly from the assumptions in the system study that determined the efficient mix, then the system study should be updated.

Today’s energy markets are most often based on the assumption that all electricity generated is the same (to be discussed in a future post). This is true at the moment of generation when

yes, an electron is an electron. Unfortunately, the ability of any given technology to actually be there to produce at the moment it is needed varies substantially. Therefore, a direct comparison of the LCOE of one option vs another is only part of the story.

To fully understand the costs of electricity generated, the costs of integrating any given technology into a reliable system must also be considered. After all, what really matters is how much we pay as customers for our electricity and the studies are clear, nuclear as part of a fully decarbonized system is always lower cost than a system based on renewables alone.