Preparing for COP26 – a little less conversation – a little more action

In advance of COP26, the next important global meeting to discuss climate change, the International Energy Agency (IEA) released it World Energy Outlook 2021 (and for the first time is offering it for free). And while it notes "*a new energy economy is emerging*", it is telling us what we all know – "that *this clean energy progress is still far too slow to put global emissions into sustained decline towards net zero, highlighting the need for an unmistakeable signal of ambition and action from government leaders at COP26.*"

Source: Unsplash.com

If you are anything like us, as this pandemic has continued, your normal day is probably something like this – check email, join a Zoom, WebEx or Teams meeting – then the next one after

that and so on – and sprinkle in a good number of fascinating webinars through the week to keep you glued to your seat.

After a year and a half of this routine, one thing has become clear. We talk a lot. Really a lot. We all have great ideas on how to do better, how to improve the climate, and in our case, how and why nuclear power should play a bigger role. Or as so eloquently put by Greta Thunberg – "*Build back better. Blah, blah, blah. Green economy. Blah blah blah. Net zero by 2050. Blah, blah, blah*".

Yes, we have learned some things from all this talk; that reaching our global climate goals by 2050 is extremely difficult. Even with massive growth in renewables and extraordinary efforts in improving efficiencies, the goal is eluding us. We know nuclear, one of the only scalable baseload low carbon options, must be part of the solution.

Yet we are still fighting to get nuclear accepted within the EU taxonomy (the decision to include nuclear was just delayed once again). We are still fighting the early shutdown of perfectly good operating plants even though they are most often replaced by increasing use of fossil fuel. In many markets we have projects ready to go but securing government approvals seems to be a never-ending task.

Every year we talk without action is one less year we have to reach our goals by 2050. Thinking we can do everything we need at the last minute is a plan to fail. Tackling climate change is hard. And making hard decisions is not easy for governments. We have seen in the last year governments around the world delay hard decisions needed to defeat the covid pandemic. Or try to choose balance and compromise. In all of these cases, the result was more suffering and death than we would have had if decisions were taken more quickly.

Independent of politics, climate change is about science. And math. Between now and 2050 carbon emissions will either rise

or fall. And if we all are convinced the right thing to do is to make them fall, and fall dramatically, then we need to take the hard decisions required to make this a reality.

Nuclear power can play a critical role in helping us all achieve our climate goals. The WEO 2021 and many other forecasts suggest that the amount of nuclear will double between now and 2050. But we can do more. The global nuclear industry has set a target of reaching 25% of global electricity generation by 2050 (WNA Harmony goal). This would require increasing the amount of nuclear by a factor of 5. The time has come to make things happen. Solar and wind are growling rapidly. Nuclear needs to do the same and this requires commitment.

We need governments to declare that nuclear is a clean low carbon energy source that must contribute to achieving global climate goals and then step up and make strong commitments to making this happen. There have been many recent announcements demonstrating that progress is being made. But more is needed. Governments need to:

- Stop the early phaseout of safely operating plants and provide the necessary supports to keep them operating
- Accept nuclear into the EU taxonomy
- Approve new projects that are ready to go – Sizewell C in the UK, the 6 new EPRs in France, new build in India etc. Only China is consistently approving new build at a rate of many units per year.
- Advance the development of new projects in the planning phase such as in Ukraine, Poland and Romania with a focus on getting these projects built sooner rather than later; and
- Approve first of a kind SMR projects to launch these programs in the US, Canada and elsewhere and quickly move on to deploying a global fleet.

And of course, it is not all about government. Goals can only

be reached if the industry performs. The industry has done a superb job of keeping the existing fleet operating safely, economically and at high capacity factors, even as they age.

However, the experience on new build has been mixed. Countries with vibrant programs like Russia, China and Korea have built new plants quickly and efficiently. Other projects, especially those with first of a kind designs and in markets where there have not been new builds for a long time have struggled. The industry must work together to learn the lessons required and deliver a large new global nuclear fleet on time and on budget. This is possible but not guaranteed. What will make it happen is orders and lots of them. This will drive efficiencies and create even more innovation just at it has done for renewables.

The most likely outcome of COP26 will be meetings and new targets and pledges. We will all then go back to our daily routines of talking and meeting. But if we truly want to reach the stated climate goals, the time for talk is over – it is now the time to do, and do more than we ever have before. As Elvis Presley sang so many years ago – A little less conversation, a little more action.

For a little Elvis press play!

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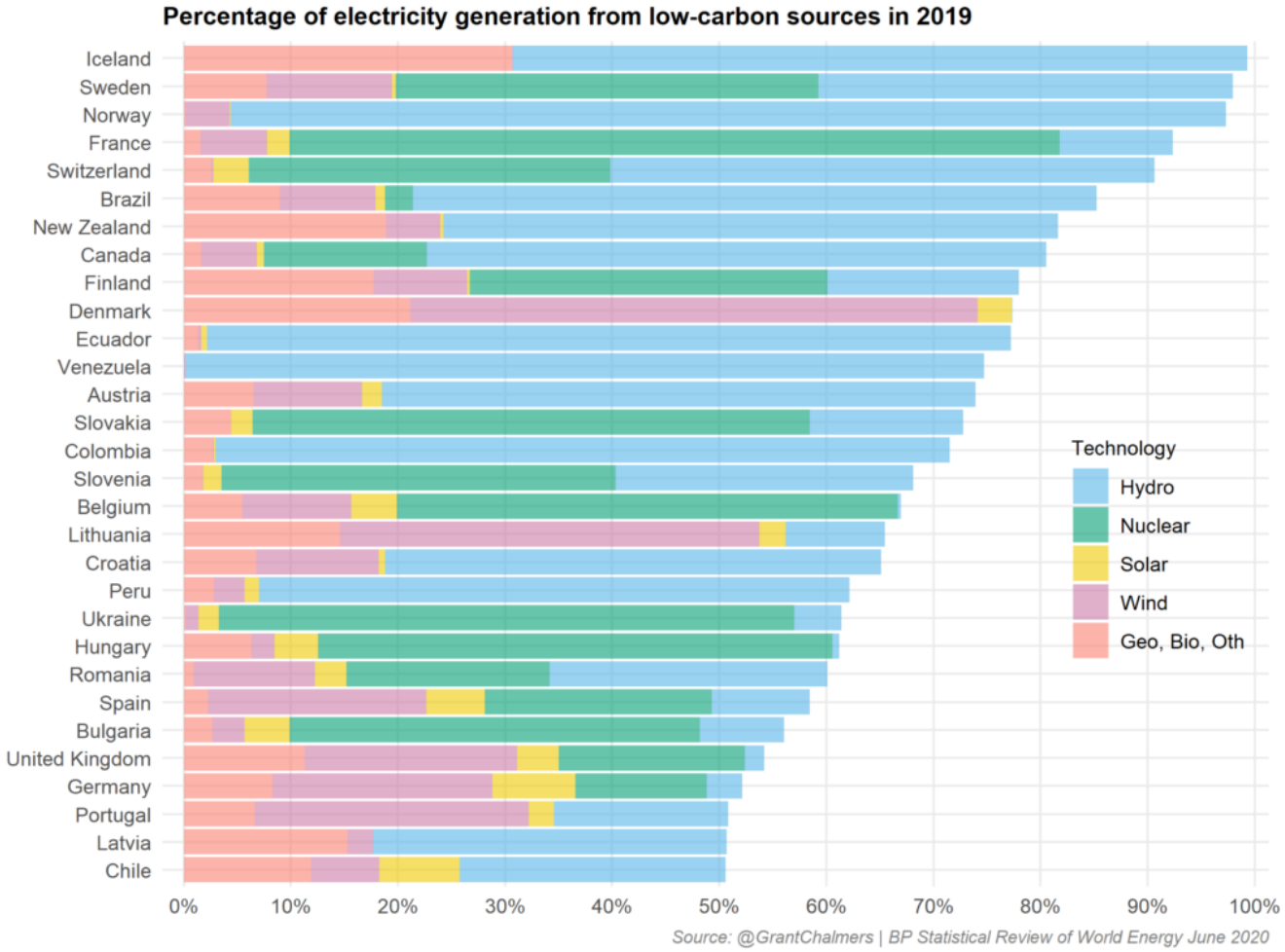
Welcome nuclear newcomer

countries to the nuclear family

So far in 2021 two new countries have started producing nuclear energy for the first time. The UAE has put the first unit of its 4-unit Barakah plant into service with the second one following close behind. In Belarus, it is the same story, as the first unit of the Ostrovets station entered service and the second is going through its start up.

We know that the countries that have the lowest carbon emissions rely on either hydro or nuclear power (or both) as the backbone of their electricity systems. And these countries have achieved this low carbon footprint in reasonable time frames. So, a country like the UAE who has almost 100% fossil fuelled electricity will quickly decarbonize as the four-unit Barakah plant comes into service at which time nuclear will be 25% of their mix. Their further investments in renewables will help them meet their carbon targets.



Often when considering the future of nuclear power, the case of Germany comes up. Here we have a high-tech industrialized country who has decided to not only meet its climate goals without nuclear power but has put phasing it out as a higher priority than reducing emissions. This is often given as the example to demonstrate that nuclear has no future in a clean energy world.

Nothing could be more wrong. These decisions tend to be purely for ideological reasons. Germany who has invested heavily in renewables while at the same time phasing out nuclear power has struggled to meet its carbon objectives. Belgium announced it would build new gas plants to replace its nuclear fleet given its commitment to a nuclear phase out. Frankly, these countries have every right to meet their carbon targets as they see fit. But if they are so certain that renewables can do it alone, then they should just do it and remove nuclear when it is no longer needed. But this is not the

case. Each of these countries has had to rely more on fossil fuel when nuclear is removed from their systems even as they invest heavily in new renewables.

Given the urgency of decarbonizing the world, the solution is clear. Countries that rely on fossil fuel for their energy should pursue both hydro and nuclear for their baseload needs and supplement with renewables to fully decarbonize their systems. Unfortunately, hydro is limited by geography but nuclear can be implemented almost anywhere. This means nuclear is an important option and countries planning to decarbonize are taking note.

According to the IAEA there are up to 30 countries looking into nuclear power for the first time.

The World Nuclear Association (WNA) has just this month updated it biannual Nuclear Fuel Report. In this report the industry surveys companies around the globe to develop its scenarios. This year's update sees an expansion of the market with new countries embarking down the path of deploying nuclear power. In the reference scenario there are 9 new countries including Bangladesh, Egypt, Ghana, Indonesia, Kenya, Poland, Saudi Arabia, Turkey and Uzbekistan. Of these countries, Bangladesh, Egypt and Turkey have their first plants under construction. The Upper Scenario adds an additional 7 countries: Chile, Jordan, Kazakhstan, Nigeria, Philippines, Thailand and Vietnam. And there are others who are starting to consider nuclear for their future.

All of these projections do not take into consideration the increased demand on energy systems as the goal becomes net zero carbon emissions. Once those pledged to meet net zero by 2050 start to develop their plans, and with the new nuclear options such as SMRs entering the market, we expect to see many more countries taking a hard look at implementing nuclear as part of their future energy systems.

So, for those countries that are truly committed to decarbonizing their energy systems and want to deploy nuclear as part of their solution – welcome to the nuclear family – you are on the path to abundant, reliable, and economic low carbon energy.

It's time to rethink the South Korean nuclear phase out policy

President Moon Jae-in of South Korea followed through on his campaign pledge to reduce Korea's reliance on nuclear power only a month after his inauguration in May 2017. He quickly announced Korea would stop building new reactors and not life extend those in operation. The objective was to replace nuclear with other clean energy options over time. This policy was developed following the 2011 Fukushima accident in Japan and a 2016 movie (Pandora) which fictionalized a similar accident in Korea. Now, with the next presidential election coming up in March of 2022, this policy is becoming an election issue – as it should.

We first wrote about Korea's current anti-nuclear policy three years ago when they decided to shut down the Wolsong 1 reactor and decommission it. So far Korea has only closed two reactors. Kori unit 1, the nation's oldest PWR, was closed rather than life extended in 2017; and Wolsong 1. The narrative is that Wolsong 1 was closed only 3 years before its end of life. Although that would have been when its licence expired, it was far from its end of life. Just a few years earlier, in 2011, Wolsong 1 had been refurbished, a life

extending process for pressurized heavy water (CANDU) plants, where the key nuclear components are all replaced allowing for another 30 years operation. There is no doubt this unit was sacrificed to support the phase out policy and should be operating today, together with Wolsong units 2, 3 and 4, providing clean carbon free energy to the Korean grid.

The skyscrapers of Seoul light up as evening comes on in South Korea. Source: iStockphoto.com

In December 2020 Korea issued its Ninth Basic Plan for Electricity Supply and Demand for the years 2020-2034. This plan suggests that supply will increase by just over 50% while reducing dependence upon coal and nuclear power. 30 coal plants will reach their end of life by 2034 reducing the share of coal in the system from 40 to 15%. Unfortunately, 24 of these coal plants will be converted to gas. While we know that gas produces less carbon emissions than coal, entrenching fossil generation for the long term is not a path to net zero emissions. Today Korea's electricity sector emits over 500 g/kWh and has a long way to go to decarbonize.

The goal is to increase renewables from its current 6.5% to

about 42 percent of capacity. Nuclear will be reduced from its current 25% to just over 10%. It is always important to remember that plant capacity is not the right metric for comparison since renewable sources of energy such as solar and wind produce much less energy than equivalent sized coal and nuclear plants due to the limited time the wind blows and the sun shines. This means more plants are needed to produce the same amount of electricity.

And these plants all require land, and lots of it. This creates further challenges as Korea is a small mountainous country with limited space to implement large scale renewable solutions. The most promising source of renewables is offshore wind. In February, plans to invest $43.2 Billion in the world's **largest** single offshore wind project with a capacity of 8.2GW (today Korea has only 1.67 GW of wind capacity) by 2030 were reported. This is a technically challenging project and claims this would produce the energy equivalent to the output of six (1.4 GW) nuclear reactors is somewhat deceptive because as stated above, a nuclear plant will produce more than double the energy as a similar sized wind turbine, i.e., 4 GW of nuclear would produce more energy in a year than 8 GW of wind.

Korea is a global industrial powerhouse and as the world's 9th largest energy consumer in 2019 needs access to economic reliable energy to fuel its dynamic economy. This is not easy as South Korea has little to no domestic energy resources and is one of the world's top five importers of liquefied natural gas (LNG), coal, and oil.

Trying to decarbonize without nuclear power means that Korea will lock in fossil use (gas) for decades to come. In addition to increasing risk to their energy security, recent reports are suggesting the era of cheap gas is coming to an end. Spurred by increasing global demand, LNG prices in Asia have increased about six-fold in the last year.

Korea once made a bold decision to implement nuclear power in a big way to reduce its dependence on foreign supplied fossil fuel and provide large amounts of low carbon economic and reliable energy to fuel its growing economy. Through dedication and hard work, it went from an importer of nuclear technology to becoming self sufficient and then exporting the technology; its export to the UAE is a source of great pride.

This also resulted in a very high level of both technology and human development. Nuclear power creates high quality jobs for thousands of Koreans. This expertise is valued all over the world. Unfortunately, it doesn't take long for negative policies to start to degrade this expertise. Young people will not choose nuclear as a career if government policy is to phase it out even if there are still years of operations that require trained experts. And for those more experienced, there is a whole world out there that would value their excellent Korean qualifications.

The International Energy Agency (IEA) has stated that net zero emissions cannot be reached without nuclear continuing to play a critical role. Governments around the world are becoming more vocal in their agreement. In Canada and the United States, both governments have stated unequivocally that nuclear is needed to reach these goals. In Europe a group of 87 parliamentarians have signed a letter supporting nuclear to be included in the EU taxonomy as a sustainable clean generating option. China and Russia are pursuing large nuclear expansions and Japan continues to declare that nuclear must be part of its energy mix.

Nuclear power in Korea has been an unqualified success and is the example to be used for other nations wisely choosing to deploy nuclear as part of their climate and energy infrastructure. Korea needs nuclear to maintain its industrial base and meet its climate goals. And the world needs Korean nuclear experience and expertise. The time is right for a discussion with the Korean people on the nuclear

phase out policy – and an election is a good time to have it.

The Energy transition requires a huge increase in mining of critical minerals

When considering the sustainability of future low carbon energy sources, the focus tends to be on where the energy comes from. Renewable energy is seen as environmentally sustainable in that it is both low carbon and the resource unlimited; energy from the sun, wind and water will never run out. But, as with everything in life, nothing is perfect. All these energy sources require a variety of critical minerals for their manufacture. This means mining – a lot of mining. The issue is so important to the energy transition, the International Energy Agency (IEA) recently (May 2021) released a World Energy Outlook Special Report, "*The Role of Critical Minerals in Clean Energy Transitions.*"

Source: istockphoto.com

As stated by IEA Executive Director Fatih Birol, *"Today, the data shows a looming mismatch between the world's strengthened climate ambitions and the availability of critical minerals that are essential to realising those ambitions."*

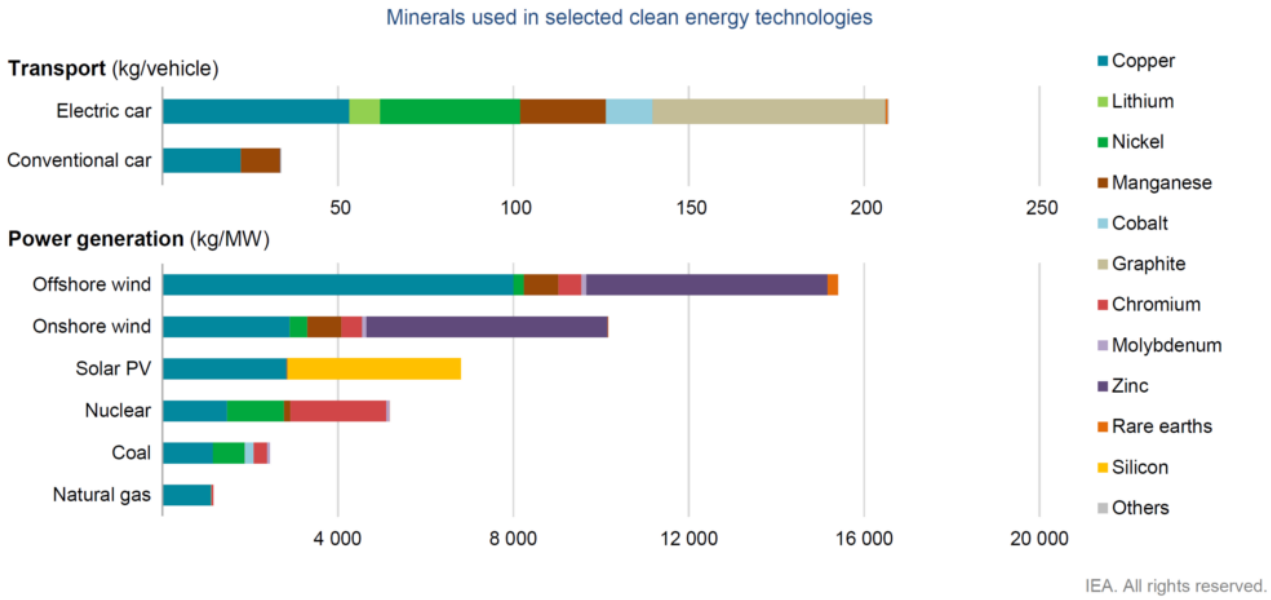
Reading this report, one thing is for certain – **demand for minerals goes up, way up.** [all numbers in the next paragraphs come directly from the IEA report.]

An energy system powered by solar, wind and electric vehicles (EVs) requires more critical minerals than today's fossil fuel-based generation and transport. An electric car requires six times the critical mineral inputs of a gas fuelled car, and an onshore wind plant requires nine times more mineral resources than a gas-fired power plant. Since 2010, the average amount of critical minerals needed for a new unit of power generation capacity has increased by 50% as the share of renewables has risen.

And this is going to increase even faster going forward. To hit net-zero *globally* by 2050, would require six times more critical minerals in 2040 than today. Examples of the magnitude of this growth would see critical mineral demand for

use in EVs and battery storage grow at least **thirty times** to 2040.

This represents dramatic change. Prior to the mid-2010s, the energy sector represented only a small part of total demand for most minerals. Now, clean energy technologies are becoming the fastest-growing segment of demand. In order to meet the Paris Agreement goals, clean energy technologies' share of total demand rises significantly by 2040 to over 40% for copper and rare earth elements, 60- 70% for nickel and cobalt, and almost 90% for lithium. EVs and battery storage have already displaced consumer electronics to become the largest consumer of lithium and are set to take over from stainless steel as the largest end user of nickel by 2040.



This rapid increase in demand and the world's hunger for these critical minerals will also change the geopolitical landscape. In the past, much of the world was concerned about security of supply of fossil fuels, primarily oil. Policy makers will now have to consider the challenges with security of supply and prices from a different set of resources which are mostly concentrated in a small number of countries.

And of course, with expanded supply, comes the issues of expanding waste volumes as these new sources of energy reach their end of life. In 2016, IRENA (International Renewable

Energy Association) estimated there would be up to 78 million tons of used solar infrastructure to look after by 2050. However, this assumed solar panels would all stay in service to end of life. But newer better solar panels have people replacing their panels early so that this number can increase by 2.5 times if the current trend continues. To date there is no clear path as to who will pay for this disposal and/or recycling.

With massive projected growth in renewables as they become the main source of energy replacing fossil fuel in the IEA scenarios, we can see the impact of their low energy density and relatively low resource availability. In other words, while these technologies produce very low carbon renewable energy, they do not use minerals very efficiently.

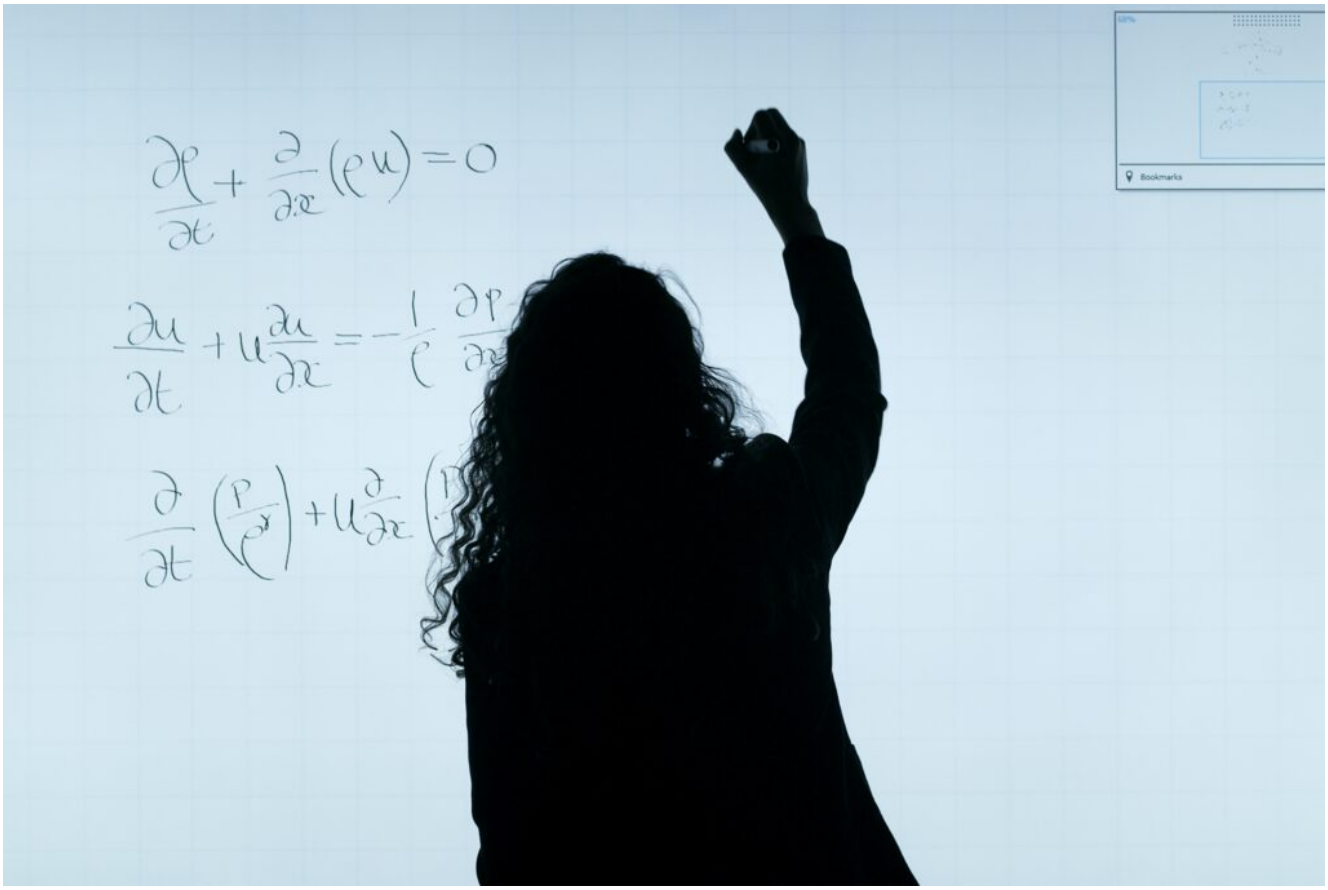
This is where nuclear power shines. It is extremely energy dense and operates at very high-capacity factors. The IEA report notes that nuclear has comparatively low mineral requirements. But the figure above is deceptive. Comparing on a MW capacity basis does not reflect the true nature of the mineral use as 1 MW of solar does not produce the same amount of energy as 1 MW of wind which does not generate the same amount of energy as 1 MW of nuclear. So, while it may look like solar uses 40% more and wind double the materials used in nuclear from the figure, this is not the whole story. Solar generates energy less than 20% of the time (when the sun shines) and wind about 35% of the time (when the wind blows), much less than nuclear that operates more than 90% of the time. And the average life of a solar or wind farm is 30 years or less while a nuclear plant lasts 60 years or more. In other words, a nuclear plant will produce between 10 and 15 times more energy per kg of critical materials used over its life than a solar panel or a windmill making nuclear plants much more mineral efficient. And, given the long life of a nuclear plant, this also greatly reduces the future mineral waste burden.

We often write about nuclear being a low carbon, reliable and economic source of electricity. Now we can add another important environmental attribute, it uses much less critical minerals than renewables per unit of energy produced. Therefore, increasing the share of nuclear power in the future energy mix will greatly reduce the burden on the mining industry (and the planet) as it tries to keep up with a rapidly growing critical mineral demand.

When ideology wins over science, we all lose

Europe is fully committed to addressing the climate crisis, targeting a 55% reduction in carbon emissions by 2030 (from 2020 levels) and then becoming the world's first carbon neutral continent by 2050. Today, almost half of its low carbon electricity comes from nuclear power as Europe has the world's largest operating nuclear fleet with more than 100 operating units in 13 countries.

Nuclear power brings many benefits to the people of Europe providing reliable clean economic electricity, while supporting about 1 million high-quality jobs. But Europe is also home to a vibrant anti-nuclear movement, that has varying levels of support in the governments of its many nations. This opposition tends to be strongly ideological in nature to the extent that for some, phasing out nuclear and its large role in providing clean electricity has become more important than their commitment to reduce carbon emissions.



Source: Pexels.com

The result is that some countries in Europe are implementing policies to phase out existing nuclear plants. France has shut down its two oldest units at Fessenheim (its regulator was clear they could safely operate for another decade). Sweden has shut down units when they could have operated longer even though they are committed to maintaining a nuclear fleet. Belgium has just recommitted to its nuclear phase out by 2025 and is replacing these nuclear units with gas generation, thus increasing their carbon emissions. Germany has shut down much of its fleet and is phasing out the rest even though it has been replacing much of this energy with coal generation. A recent report suggests that its objective to eventually phase out coal means it will end up with more gas.

This is hard to understand. Only those ideologically opposed to nuclear can find this approach of removing operating low carbon nuclear before its time and increasing carbon emissions with fossil fuels sensible. Clearly, they fear nuclear power

more than they fear climate change. When new gas and coal plants are built to replace retiring nuclear, fossil use is being institutionalized for decades. No new plant is built to operate for just a few short years. The International Energy Agency (IEA) in its most recent Projected Cost of Electricity report has added a new category of generation – life extended nuclear – and finds it to be the least cost of any new generation option. For governments that believe future energy needs can be met with renewables alone, it would make most sense to eliminate fossil fuel first to keep emissions coming down and then remove operating nuclear when a low carbon replacement is available. Rather than supporting a renewable future, supporting new fossil generation is tacit acceptance that renewables can't do it all.

Those who are against nuclear and don't accept its low carbon credentials, have worked hard to keep nuclear out of the European Taxonomy, the classification system of activities deemed beneficial to the climate to be eligible to attract various forms of green financing. As the taxonomy was being created, an assessment of nuclear by the technical expert group (TEG) (the group tasked with reviewing activities to determine their adherence to taxonomy principles) determined that nuclear power does produce very low carbon electricity. This was not sufficient to convince detractors of the merits of nuclear. For these groups the TEG raised questions about whether or not nuclear meets the other criteria for acceptance into the taxonomy, the Do No Significant Harm principle. This was based on the premise that nuclear waste may do significant harm to the environment. It was agreed that further study of this issue would be undertaken by an expert group (known as the JRC). In March 2021 the JRC issued its report and was unequivocal in its conclusion – "**there is no science-based evidence that nuclear energy does more harm to human health or to the environment than other electricity production technologies already included in the EU Taxonomy as activities supporting climate change mitigation** ".

Many did not like this conclusion as no science-based argument can deter them from their righteous path. Countries like Germany have decided to phase out nuclear power and would like to see others do the same. The Energy minister of Luxembourg stated that the EU JRC nuclear report is biased, unscientific and complains over lack of transparency, calling the EU JRC a "pro-nuclear, industry organisation". Of course, why task an expert group with studying an issue if you are unwilling to accept its conclusions unless it confirms your current beliefs. Ultimately it is because when you are a believer, and something does not support your point of view, it must be wrong.

It is good to know that as of now, it looks like science is winning and the EU taxonomy will include nuclear, but in a separate delegated act to come out later this year. However, there will be many who fight to see this does not happen. If one argument fails, there will always be a new one to take its place. If science is demonstrating that nuclear power is indeed safe and that waste can be safely managed, the argument moves on to cost (no one is suggesting that a project proceed that does not meet economic criteria). And if that doesn't work, the current argument is that new nuclear just takes too long to make a difference and thus, deflects from the real solutions to climate change.

As stated by Bill Gates in his new book, nuclear power is "the only carbon-free energy source that can reliably deliver power day and night, through every season, almost anywhere on earth, that has been proven to work on a large scale". Accepting the science that nuclear power is a safe reliable low carbon option does not require any jurisdiction to build one if they don't want to or feel they have other better options. However, those that support it will be helping the environment. And for those that oppose, please don't shut down safely operating plants early and replace them with higher carbon options, especially new fossil plants. The

objective is to reduce carbon emissions, not increase them.

After all, you asked the scientific community to give its opinion on nuclear power and it has stated its result as clearly as it can – "**there is no science-based evidence that nuclear energy does more harm to human health or to the environment than other electricity production technologies already included in the EU Taxonomy as activities supporting climate change mitigation** "

The energy transition must make society better and not leave people behind

In December we wrote about the world's drive to achieve net zero carbon emissions by 2050. A laudable goal, the World Energy Outlook (WEO) 2020 illustrates a possible path to getting there. This would be achieved through electrification (using clean electricity sources), efficiency gains and behaviour changes. The first two of these require technology solutions. The third, behavioural change, requires human commitment to change, often meaning a form of personal sacrifice. Turn down the thermostat in winter and up in summer, walk or bike instead of drive, eat less meat, and so on.

Source: pexels.com

In other words, stating a need for behavioural change is a way of saying that human beings are excessive users of the planet's limited resources which can only be overcome if we temper our desires. Unfortunately, telling people they have to endure some level of hardship may work for some in the environmental community who believe we need to pay for our environmental recklessness, but in real life, we are not going to achieve our goals by asking people to lower their standard of living.

The ongoing covid pandemic provides lessons to us all. It has highlighted current inequities in our societies in a way that we can no longer ignore. There are two economies, one for the well off, who can work from home and are saving money as they temporarily consume less. Then there are those who earn lower incomes who still must go out to work risking both their and their families' health. We even call them "essential workers" although we certainly don't treat them as such.

We are all living in a temporary state of emergency, where we are asked to change our behaviours to keep ourselves, our

families, and our communities safe. Even faced with daily numbers of sick and dead, many are not willing to maintain these behaviours as they are anathema to our normal lives. If we can't convince people to temporarily change their behaviour in a short-term crisis, how will we convince them to permanently change to benefit the longer term? Are we really going to make our lives less comfortable so that our grandchildren will inherent a better world?

The reality is no. We may give up plastic straws and put a solar panel on our roofs. There are no shortages of gestures we can do to tell the world we are trying and have good intention. But in reality, no one is willing to make their life more difficult because it is good for society. After all, access to economic abundant energy has made our lives better in every way. We will not move backwards.

One example is our use of cars. The WEO suggests this an area where behavioural change is required. Slower speeds and less automotive use (walk or bike for shorter trips) are needed. Unfortunately, if we look to North America as an example, the trend has not been positive. In recent years people have moved away from small cars in droves to larger SUVs, to the extent that some major auto manufacturers are removing many standard vehicles from their offerings. For example, Ford has said that in excess of 90% of its sales in North America are for trucks and SUVs, to the point where it has stopped production of all but two of its passenger cars.

And doing with less is only a possibility for those that have in the first place. For those less fortunate, they suffer from not having enough access to energy. And the access they have is not easily modified. We all understand that a price for carbon can be an effective way to incentivize change. However, it must be accompanied with reasonable alternatives to be effective. For those earning minimum wage who drive to work without access to any alternative means of transport, even a modest increase in their weekly fuel cost can be

economically devastating.

The answer is clear. Provide access to abundant economic reliable clean energy. And this is where nuclear power shines. With its high energy density, low carbon footprint and nearly endless supply of fuel, it is well positioned to power our society into the future. This will not require sacrifice and can bring energy to those who are currently under served.

Bill Gates has been out promoting his new book, "How to Avoid a Climate Disaster: The Solutions We Have and the Breakthroughs" noting we need to go from emitting fifty-one billion tons of greenhouse gases every year to zero. This requires we make big and hard changes. (Have not yet read the book and will comment more after I have.) He notes there is a "green premium", the increased cost of doing something in a low carbon way compared to the current higher carbon way. He suggests the priority should be to innovate to reduce these Green Premiums; not to make people suffer from these higher costs, nor to ask them to make do with less. His objective is to get these premiums "*so low that even developing countries with growing energy needs and relatively scant financial resources will adopt zero-carbon ways of doing everything from making steel and cement to generating electricity.*"

Fighting climate change needs to reduce inequities to succeed, not force those among us who are least advantaged to do the heavy lifting, nor expect that others will happily find a way to do with less. This means providing abundant, economic, reliable and clean energy to make a better future for us all – and nuclear power is the energy source that can help us get there.

Yes – Nuclear power is an economically competitive low carbon energy source

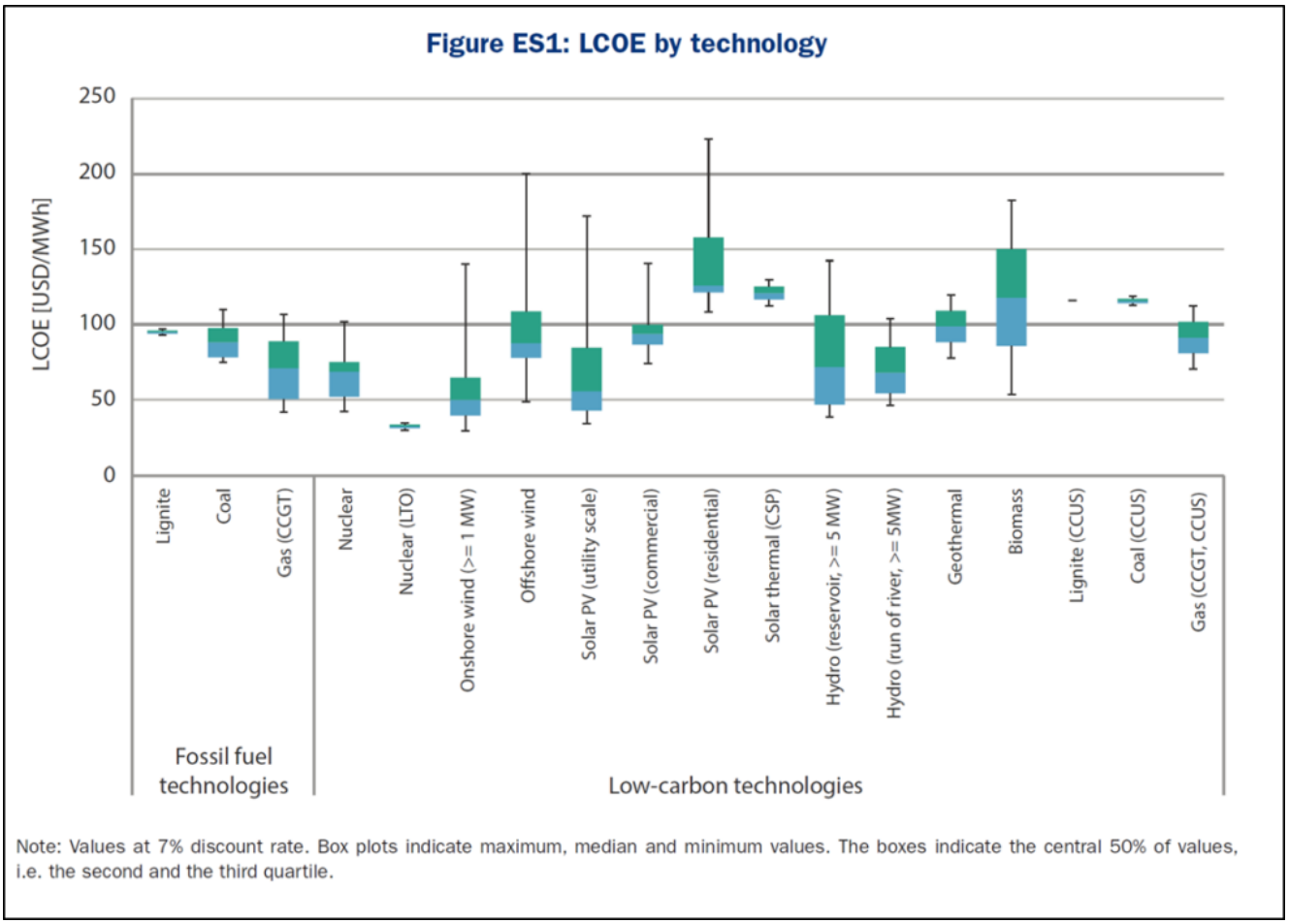
When it comes to the economics of electricity, there is no report more important than **Projected Cost of Electricity**, issued every 5 years by the International Energy Agency (IEA) and the OECD Nuclear Energy Agency (NEA). This report (now in its 9th edition) collects electricity costs of various technologies from a range of countries and reports on the competitiveness of each. The 2020 version of this report was issued in December and its conclusion is clear – nuclear power is the dispatchable (meaning always available) low-carbon technology with the lowest expected costs.

Source: pexels.com

This is in stark contrast to what we often hear – that even though nuclear power may well be a low carbon solution, its

costs are much too high to consider. Recent projects that have not gone well, primarily in the west due to a long absence from nuclear construction coupled with the challenges of building first of a kind (FOAK) designs are the evidence to support this argument. The successful economic deployment of nuclear in countries like China, Korea and Russia are ignored. We even have a good example that new countries can successfully build nuclear plants with the start up of the Barrakah nuclear power plant in the UAE.

This report sees through this bias. This is not a nuclear report. It is about electricity and its costs. The conclusions are based on the results of the analysis, not on any preconceived biases. It concludes that all low carbon options have improved their costs since the 2015 version.



Projected Cost of Electricity 2020 (IEA/NEA)

One change since the 2015 version of this report is the inclusion of nuclear life extension or Long-Term Operation (LTO) in addition to the traditional consideration of the

economics of nuclear new build. The results show that LTO provides the lowest cost electricity of all technologies considered. This makes for a very simple message – for the best low carbon, low-cost option – invest in keeping the current nuclear fleet operating.

Given the changing generating mix from traditional fossil fuelled plants to more and more variable renewables; there is an acknowledgement that to truly understand their economics the costs to the system of incorporating these variable resources must be considered. A model, called the Value Adjusted Levelized Cost of Electricity (VALCOE) has been developed but adds considerable complexity given, as would be expected, results are very sensitive to the actual system being analysed. This approach continues to be a work in progress. We should expect a more fulsome analysis in the next edition.

When it comes to nuclear, this report notes that countries willing to pursue the nuclear option have three main technology solutions to reduce cost at the system and plant level (interestingly consistent with our previous series on Saving the Planet):

1. LTO or investing to keep the current fleet operating into the future.
2. Building existing Generation III reactors. These designs have now passed their FOAK demonstrations and are ready to demonstrate improved economics going forward; and
3. New designs being developed such as Small Modular Reactors (SMRs). These designs are poised to extend the value proposition of nuclear power.

The IEA/NEA, in its updated Projected Cost of Electricity report, has assessed the costs of the many low carbon options to meet electricity needs going forward. Based on this analysis, nuclear power is well positioned to continue and expand its role in providing reliable, economic, low carbon

electricity to the world.

Net Zero needs more nuclear – it’s time to get on with it

Adopted in 2015, 196 countries signed the Paris Climate Agreement (to date 188 of them have ratified it) accepting global ambition to limit global warming to “well below” 2C and adding an aspirational goal of limiting warming to 1.5C. The Paris deal also commits signatories to balance greenhouse gas emissions and sinks in the second half of this century. This has become understood to mean “Net Zero” emissions.

By the end of August 2020, over 125 countries (including the European Union) had set or were actively considering long-term net-zero emissions targets by about 2050. As opposed to strategies to simply reduce emissions by 20 or 30%, a net zero target requires finding ways to totally eliminate fossil emissions and meet all of our energy needs with very low carbon options.

Source: istockphoto

The magnitude of the challenge is enormous, and more and more governments are realizing this means there is no single technology that can provide the complete solution. Rather, the time has come to stop thinking about competition between different energy sources and instead look at how they can best work together if there is to be a realistic chance of success.

In its current World Energy Outlook (WEO 2020), the International Energy Agency (IEA) recognized this push to net zero. In addition to its traditional Stated Policies Scenario (STEPS), based on today's policy settings and Sustainable Development Scenario (SDS) which examines what actions would be necessary to achieve 2030 climate goals; it created a new scenario, the Net Zero by 2050 (NZE2050) scenario to show a possible path for the world to reach net zero by 2050.

The NZE2050 scenario assumes large reductions in energy demand and massive increases in renewable generation, with a modest

increase in nuclear power, all to replace fossil fuels which show dramatic decline. This is a useful exercise. However, rather than provide a clear path to net zero, this scenario succeeds in demonstrating the sheer magnitude of the challenge ahead if we are to meet this ambitious goal.

For example, in this NZE2050 scenario primary energy demand falls by 17% between 2019 and 2030, to a level like 2006, even though the global economy is twice as large. This would be achieved through electrification, efficiency gains and behaviour changes. To put this in context, this same report estimates that energy demand will fall by about 5% in 2020 because of the global covid pandemic and the associated reduction in economic activity. It also points out there will be around 660 million people who will not have access to electricity and 2.4 billion who will not have access to clean cooking by 2030 globally if we stay on the stated policy scenario path. This makes it very hard to imagine achieving a demand reduction of 17% by 2030 with a fully recovered healthy global economy while trying to bring energy to those that are currently under served.

And yes, we certainly do agree that solar development has been nothing short of astounding and fully support continuing with this rapid growth. At the same time, it is hard to imagine the optimum solution to massive energy transformation requiring the large-scale replacement of much our energy infrastructure could be led by the electricity source (solar) that has the lowest energy density (requiring huge amounts of land) and that produces electricity only between about 13 and 23% of the time (when the sun shines). The WEO recognizes this large growth in variable renewables leads to issues related to system flexibility and creates further challenges requiring large investments in infrastructure including new sources of energy storage.

On the positive side, the IEA, as do many others, now clearly acknowledge that nuclear power is an important low carbon

source of energy and that it must play a role. In its analysis, nuclear and renewables grow while fossil use drops. The problem is that in this scenario, nuclear power only grows by about 36% to 2050. The result is the global share of nuclear hardly moves from today with renewables left to do the heavy lifting.

A larger nuclear share would provide energy security, reliability and be cost effective, mostly by reducing the large system (flexibility) costs required to implement such a large share of variable renewables all while reducing the pressure to reduce overall energy use. The IEA itself acknowledges that nuclear power plays a much larger role in many Intergovernmental Panel on Climate Change (IPCC) 1.5 °C scenarios, than in its NZE2050. (Half of IPCC 1.5 °C scenarios imply an increase in nuclear generation of 60% between 2019-30 compared with a 36% increase in the NZE2050).

The nuclear industry through the World Nuclear Association (WNA) has proposed its Harmony goal of 25% electricity generated from nuclear by 2050. This means about 1,000 GW (1000 large reactors) of new nuclear by then, which would be equivalent on an energy delivered basis to the growth assumed for solar adding a large amount of always on, 24/7 energy to the system. Achieving this goal requires strong commitments from governments and industry. This would complement the growth in renewables nicely and result in less pressure on demand reduction, less issues with flexibility requiring less infrastructure development and an overall lower cost energy system.

We are seeing exceptional innovation as vaccines for covid are being made available in time frames never before seen to address this pandemic. This shows what we can do as a society when we all work together to a common goal. As stated by Associate Deputy Minister of Natural Resources Canada Shawn Tupper in a web chat with OECD Nuclear Energy Agency Director-General William Magwood, “We’ve got to stop talking about

Utopia; we've got to stop just talking about what our targets are and actually articulate our plan starting tomorrow … what are the building blocks to getting there."

So, the time has come to talk less and do more to make sure nuclear can reach its full potential and set the world on a real path to net zero.

Delivering reliable electricity – nuclear plants just keep on running

On October 22, 2020 Darlington Unit 1 achieved a milestone never achieved before by a nuclear power plant running for 1,000 days continuously without an outage, either unplanned or planned[1]. And it is still running. This unit, operated by Ontario Power Generation (OPG) secured the world record for continuous operations last month, when it hit 963 days to take over from the Kaiga 2 unit in India, the previous record holder at 962 days achieved in 2018. Kaiga took the record from Heysham 2 in the UK which reached 940 days in 2016 breaking the record set by the Canadian Pickering Unit 7 reactor 22 years earlier[2].

Why does this matter?

Source: istockphoto.com

The world runs on energy. We need it to keep warm (or cool, depending upon the climate), cook our food, light our homes, communicate with one another and travel from place to place; and to enable pretty much everything that drives our economies. We need this energy to be affordable and most of all, we need it be reliable. For most people in the developed world, we fully expect that when we flip the switch, the lights will come on. Not sometimes, but each and every time. We also want this energy to not harm the environment (although unfortunately we will concede on the environment rather than do without).

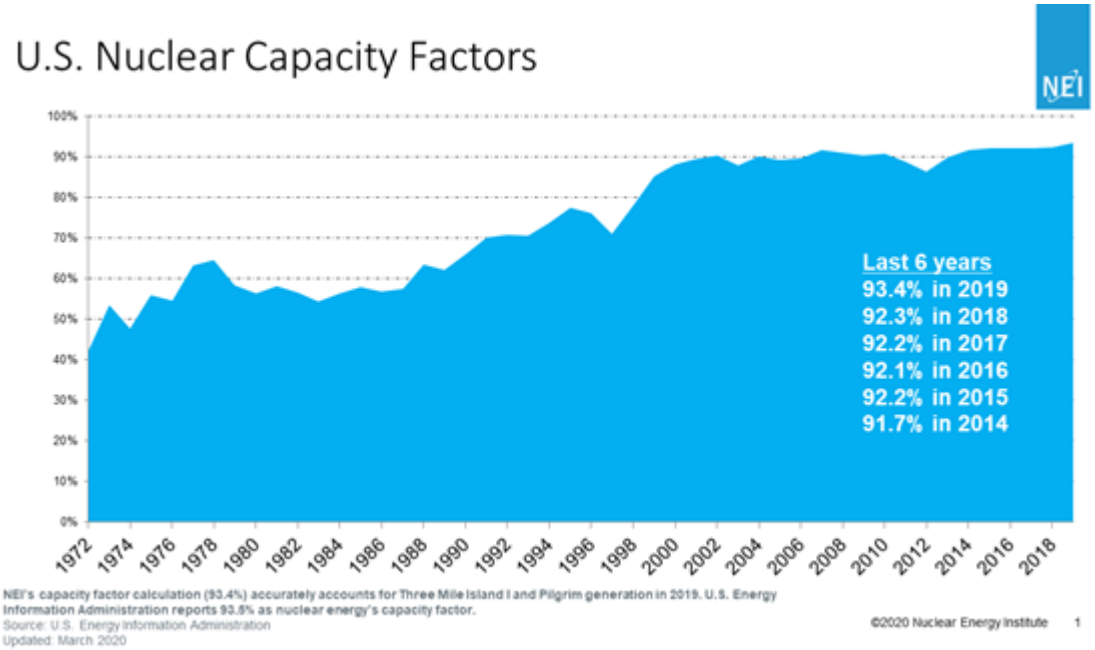
And there is no more reliable low carbon source of energy than from nuclear plants. Once in operation, they just run and run and run, like the energizer bunny. These plants run in bad weather and good, during the day and during the night, providing 24 / 7 electricity to their customers.

System reliability is not something we often think about until we experience an issue. It came as a shock to many this year

when California suffered ongoing blackouts and energy shortages. There are many contributing factors to poor reliability as electricity grids are complex systems that require a never-ending balance between supply and demand, meaning a need for reliable generation and a robust transmission and distribution system. In this case, the California Independent System Operator described the conditions that caused demand to exceed available supply: scorching temperatures and diminished output from renewable sources and fossil-fuelled power plants when electricity was needed most.

The president of the system operator blamed the California Public Utilities Commission for not ordering companies to make available sufficient supply. A critical issue is the changing mix of generation with solar growing quickly without sufficient back up when the sun goes down and the air conditioning load remains high. This demonstrates that solar power alone cannot meet the future energy needs of large energy intense systems like that of California, and that reliability must always be considered as we make structural changes to these systems.

On the other hand, the US nuclear fleet continues to hum along providing 20% of the country’s electricity supply.



Source: NEI.org

Once again in 2019, the US nuclear fleet operated at a very high capacity factor (the percentage of time the plant is producing compared to if it ran 100% of the time) achieving 93.4%. The US fleet continues this stellar performance, even as it is aging. For the past 20 years the fleet has produced in the range of 90% capacity factor or more, demonstrating how robust a technology nuclear power really is.

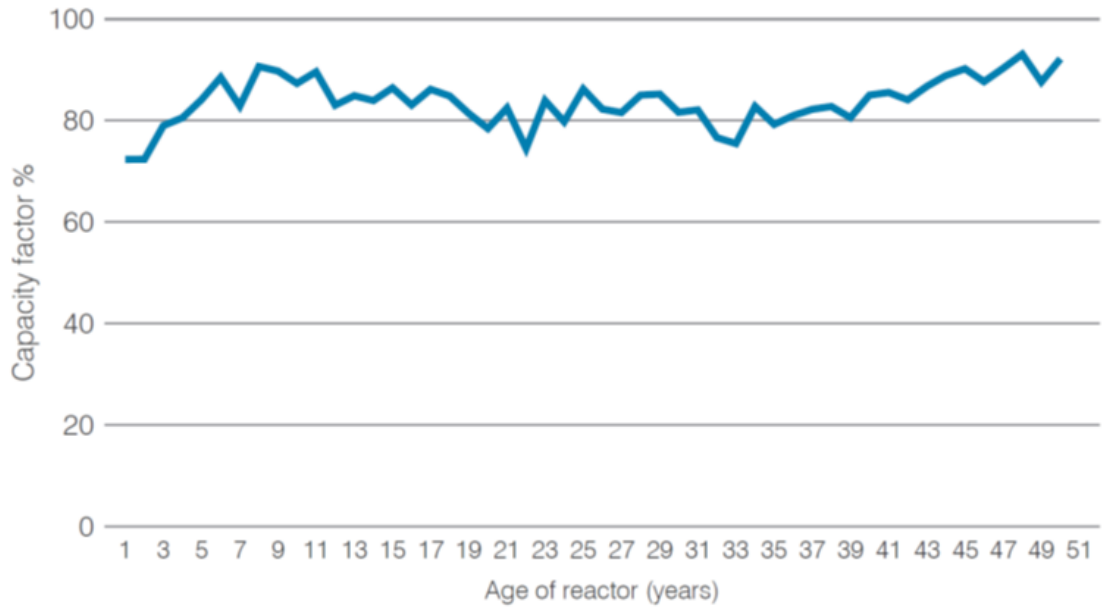
This is not just true of the US. It is true for the entire global nuclear fleet. As shown in the WNA Nuclear Performance report 2020, more than a third of the world's plants operate at 90% capacity factor or above and a full two thirds operate at capacity factors greater than 80%.

Nuclear technology is so robust that this excellent performance is not restricted to one specific type of plant. Light water reactors, gas cooled reactors, heavy water reactors – they all operate great. The distinguishing factor is more related to the expertise and excellence of the individual operator and to specific local market conditions, not to any specific technology. International cooperation through organizations like INPO (Institute of Nuclear Power Operators) and WANO (World Association of Nuclear Operators) ensure best practices are shared and that all have access to

the tools they need to achieve a high level of performance. This is an industry that collaborates to ensure continuous improvement across the global fleet.

What really demonstrates the strength of nuclear technology is the continued strong performance, even as the plants age. Heysham achieved it record run at 28 years of age and Darlington Unit 1 is 30 years old with only a year or so left before going down for refurbishment and a life extension outage. Many would expect that the life cycle of a nuclear plant would look like an inverted bathtub, with less than average performance when it is new as the kinks are worked out and then declining performance with age as it nears its end of life. But this is not the case. Nuclear plants run well when they are new, when they are middle aged and actually tend to run their very best as they get old.

Figure 7. Mean capacity factor 2015-2018 by age of reactor



Source: World Nuclear Association, IAEA PRIS

Need reliable electricity supply even when the sun is not shining, and the wind is not blowing? When it comes to reliable low carbon electricity, nuclear plants set the bar very high. They just run and run and run some more…….

[1] Every station in Canada had at least one unit set a station performance record this year.

[2] It should be noted that the AGR units in the UK and the PHWR units in Canada and India use on-power fuelling, so they are not limited by the need for refuelling outages.

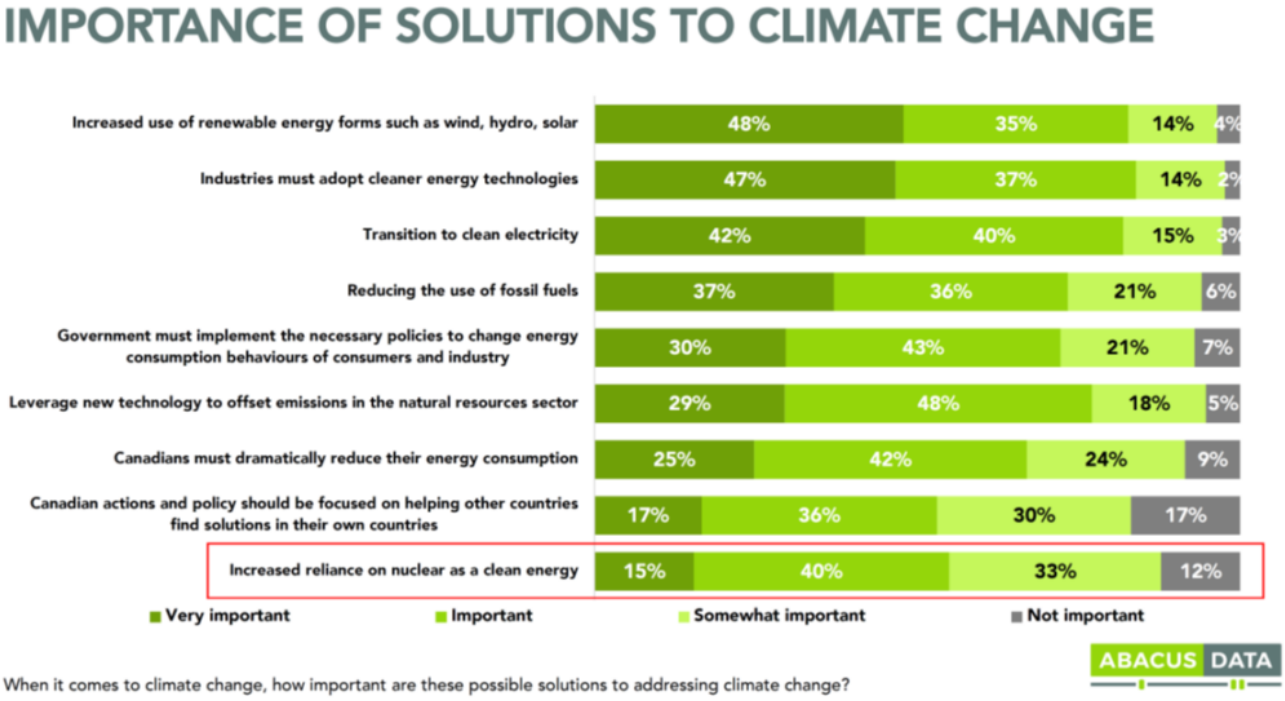
Forget about public acceptance for nuclear power – it's time for public enthusiasm!

Nuclear power can provide almost limitless economic, reliable, low carbon electricity to power the world, yet it continues to struggle to achieve the respect it so desperately seeks. For 40 years we have been hearing the same thing – that for nuclear power to achieve its potential we must work harder on securing public acceptance. This is seen as a one of the main impediments to future nuclear growth. As technocrats, we often think that if we can just educate the public on the technology, they will see the light and come to accept us. After years of effort and somewhat limited success, the time has come to refocus and set the bar even higher. Let's forget about trying to convince people to "accept" nuclear and strive to create true public enthusiasm for a technology that has the potential to solve the issues they care about most.

And we won’t get there until we focus on the right things. After all, why should anyone even think about nuclear power, never mind come to love it? It is definitely not by explaining all the reasons they shouldn’t worry about it; where it really starts is by having a clear understanding of the issues that are top of mind.

So, what are people concerned about?

A recent study from the Canadian Nuclear Association suggests that climate change continues to be a top of mind issue, with concerns not falling even though we are in the midst of a global pandemic. The large majority (82%) of Canadians are somewhat, very, or extremely concerned about climate change. Almost 8 in 10 (76%) feel that climate change or global warming are issues we currently face that are at least “serious” and a majority (57%) rate that the impact of climate change or global warming on themselves or their loved ones has been “Extremely/Very much”.



The challenge is that even with these concerns most people are completely unaware that nuclear power can be a solution. 68% of Canadians had no idea that nuclear power is the country's second largest source of low carbon electricity (15% of total generation) after hydro power. This is then re-enforced as nuclear is at the bottom of the list in solutions to solve climate change (although support remains strong). Keep in mind that Canada is a very nuclear-friendly nation with more than 60% of the electricity in the province of Ontario and more than 30% in New Brunswick coming from nuclear. So, it should be of no surprise this lack of awareness is not unique to Canada. A similar recent poll in the US showed that nuclear power is a very unpopular form of electricity generation, second only to coal. And even in the country with the most nuclear power in the world, France, most think nuclear contributes to, rather than is a solution to, climate change.

We first discussed how we need to take back the narrative from nuclear opponents in August of 2019. The industry has been complicit (although well intentioned) by endlessly trying to defend nuclear by explaining ad nauseum how safe it is and why people shouldn't be worried about nuclear waste. This

strategy has failed because the more time spent talking about why people shouldn't worry about these things, the more they understand there must be something to worry about. Rather, the priority should be on the important benefits nuclear brings – **reliable, economic, low carbon electricity in vast quantities to fuel an energy hungry world – and the many high-quality jobs and the positive economic impact to communities that support nuclear power plants.** This is what can get people excited, and only then, will they be willing to have a discussion on those aspects of the technology where they have concerns.

And yes, we are making progress. It is becoming clear that renewables alone cannot fuel a decarbonized world and that nuclear power is an important option to help meet the energy needs of the future. It has been recognized by global institutions like the International Energy Agency and most recently, Holland, with its single operating nuclear power plant, has joined the growing list of countries expressing interest in considering nuclear for the future.

Here in Canada, the Minister of Natural resources has been extremely clear – reaching net zero carbon emissions without nuclear is simply not feasible.

But this is not enough. People love the idea of renewables and strongly support them as THE solution to climate change (although they may feel somewhat different when a wind project is promoted in their backyard – but that is another story.) Many are eager to spend their hard-earned money to install solar panels on their roofs or buy electric vehicles even if they are expensive. This is because they know they are doing good in the battle for the planet and they accept and support that these technologies are the future.

While it is common to express concerns with nuclear power such as asking about nuclear waste for example, these questions are never considered when talking about renewables. Solar waste?

Low energy density land use? Variable generation dependent upon resource availability requiring not yet available storage solutions, mining of rare earths and other needed minerals? These are just silly questions that get in the way of environmental progress. Smart people will solve all. This is the strength of "knowing" that going down a given path is simply right. We don't want to hear about challenges for solutions we believe in, while we are happy to question those options we are suspicious of.

The world can only close its eyes to the truth for so long. As more people start to accept that renewables cannot be the sole solution, support for nuclear is rising as its potential as a low carbon option is being better understood. However, it is important that nuclear be considered because it is an excellent solution to climate change as well as providing reliable economic energy to society, not because the favoured options are falling short, forcing us consider this less desirable option of last resort. Accepting nuclear should never be like taking your bad tasting medicine. You accept it may be good for you, but you hold your nose while taking it and wish you didn't have to.

And positive change is in the air. We see many amazing groups, primarily a new generation of younger people who are making the positive case for nuclear power. There are pronuclear demonstrations, funny videos explaining nuclear on YouTube and even a pro nuclear rap song. If you are part of a group that is driving support for nuclear, please let us know in the comments below.

We live in a time where there are many that question technology with some causing more fear than others. We are in a horrific pandemic yet fear of vaccines is making many worried about taking one when available. There are even people who think 5G mobile technology is causing covid. Therefore, after decades of anti-nuclear activism, it should come as no surprise that many are concerned about nuclear

technology. And while more and more environmentalists are now seeing the opportunity to fight climate change that nuclear brings, many are still fundamentally opposed. Here in Canada, famed environmentalist David Suzuki said “I want to puke” in response to the Minister’s support for new nuclear.

We live in a time of both science skepticism and a lack of belief in facts. But we should not be daunted as both the facts and the science are clear. We have a great story to tell. Nuclear power is AWESOME and can help to save the world. So, let’s stop talking about public acceptance and all work together to generate a real sense of public enthusiasm to support this technology as a path to a better world where energy is economic, reliable, abundant and has little impact to the environment.