

At COP26 – the nuclear young generation showed the world the future of nuclear

The role of nuclear power in supporting global decarbonization was discussed more at this COP than at any previous one. We have seen articles with headlines like **“Nuclear Was the Quiet Hero of COP26”** talking about the gains made in getting people to listen to the arguments in support of nuclear power. World Nuclear Association Director General Sama Bilbao y León was in attendance and noted, *“There has been a change in how nuclear is perceived at this COP.”*

While there were many hard-working people who deserve thanks for their efforts in advancing the discussion on the merits of nuclear power, it is the energy and commitment of the nuclear young generation that really stood out.



NIYGN at COP26

The Nuclear Young Generation consists of groups of young people in 50+ country/continental chapters around the world that come together as the International Youth Nuclear Congress. For COP26 they were organized by the Nuclear

Institute Young Generation Network (NI YGN). Their small team was supported by about 80 volunteers from countries around the world.

Their efforts to advocate for nuclear power and influence world leaders and policy makers were well received. Their message was heard in numerous talks and panel sessions right across the conference.

What was amazing is the way in which these young people engaged. There were no old men in white lab coats giving monotonous lectures on the how nuclear power works. Rather there were symbols like Melty the polar bear and Bella the 3 metres tall inflatable gummy bear who represents the amount of uranium that could power all of Glasgow's electricity for 16 months.

Their voices were heard. And they made a difference. They even organized a flash mob to get attention to their slogan for the event – Net Zero needs nuclear. Antinuclear activists and aligned politicians have called this video cringe worthy. Yet in their criticism they also widely shared the video giving it even more attention.

As stated in one of the articles coming out of COP26, *"Nuclear is losing its stigma, in other words, it's been invited to the cool kids' table."* And these cool kids are smart passionate young people who are well on their way to being the future leaders of a strong global industry that is playing a major role in solving climate change. From those of us that are not as young as we once were, but remain passionate about nuclear power, and are still young at heart – thank you. The future is in good hands.

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 its 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 unmistakable 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 growing 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 as 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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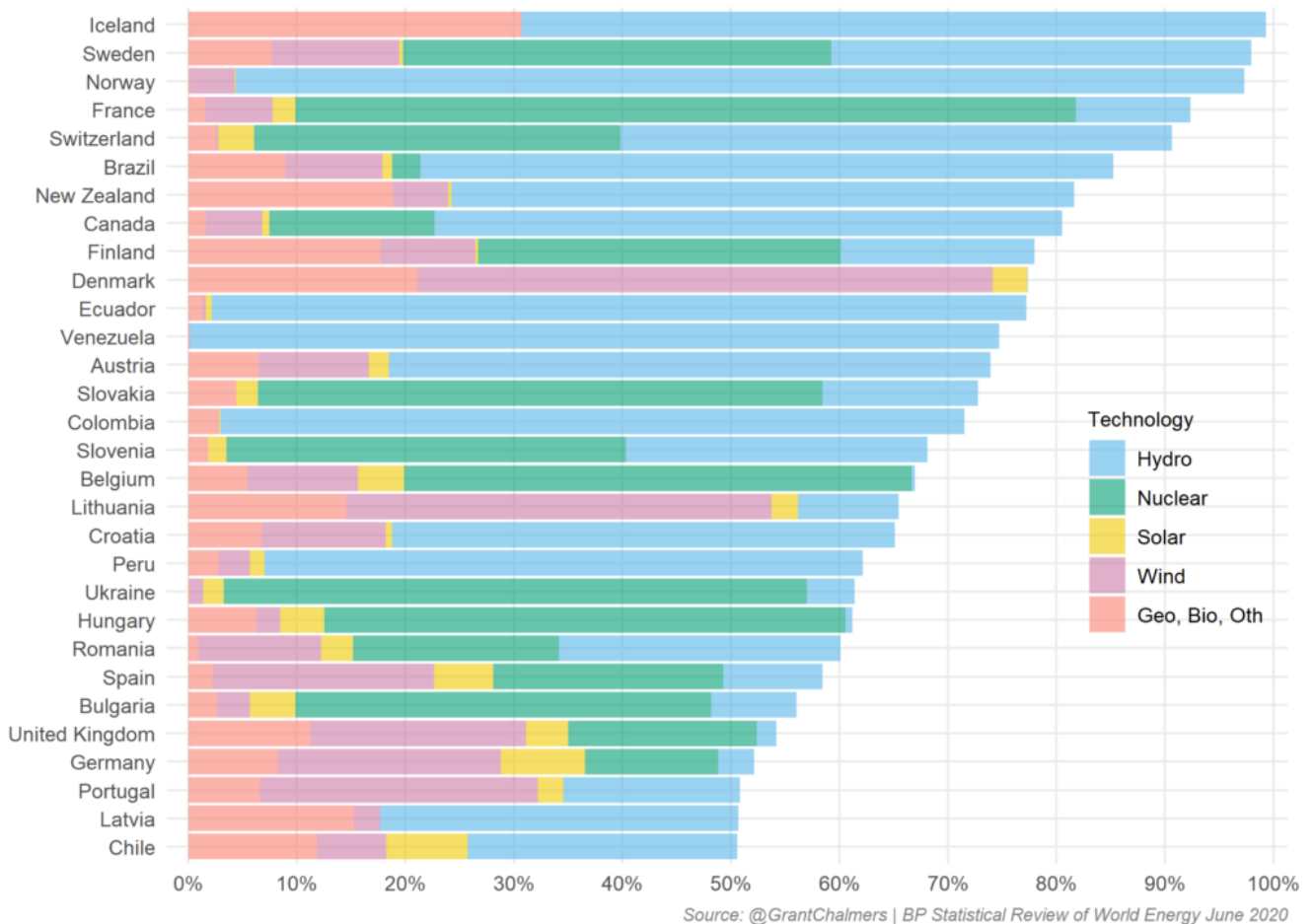
Welcome nuclear newcomer

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.

Percentage of electricity generation from low-carbon sources in 2019



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 its 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](https://www.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."*

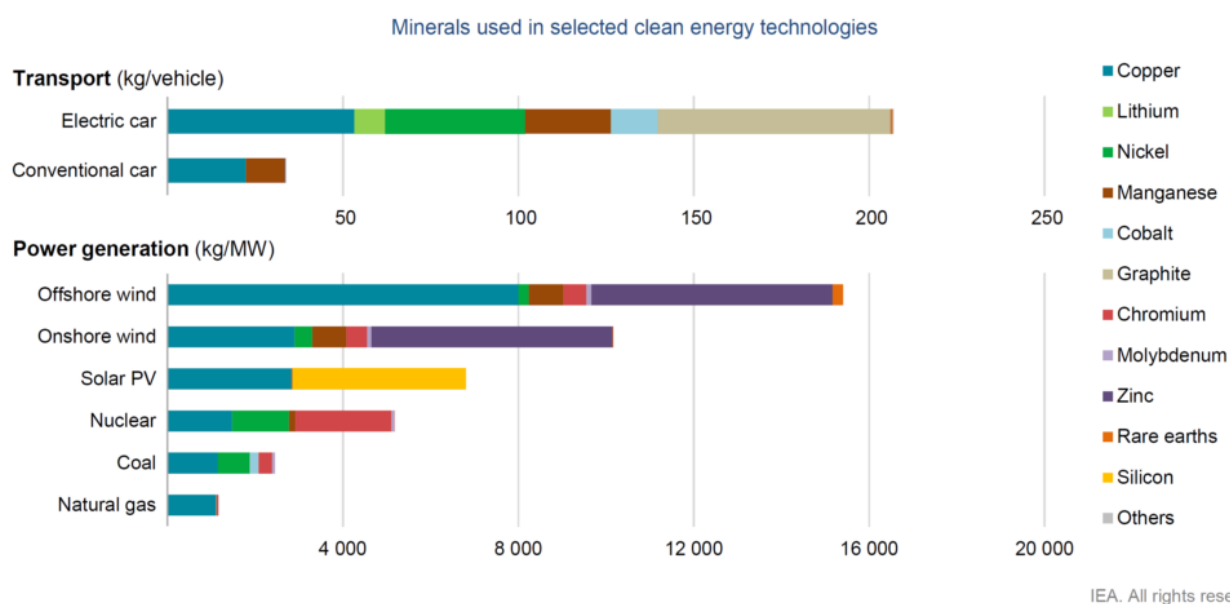
Reading this report, one thing is for certain – **demand for minerals goes up, way up.** [all numbers in the next paragraphs come directly from the IEA report.]

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.

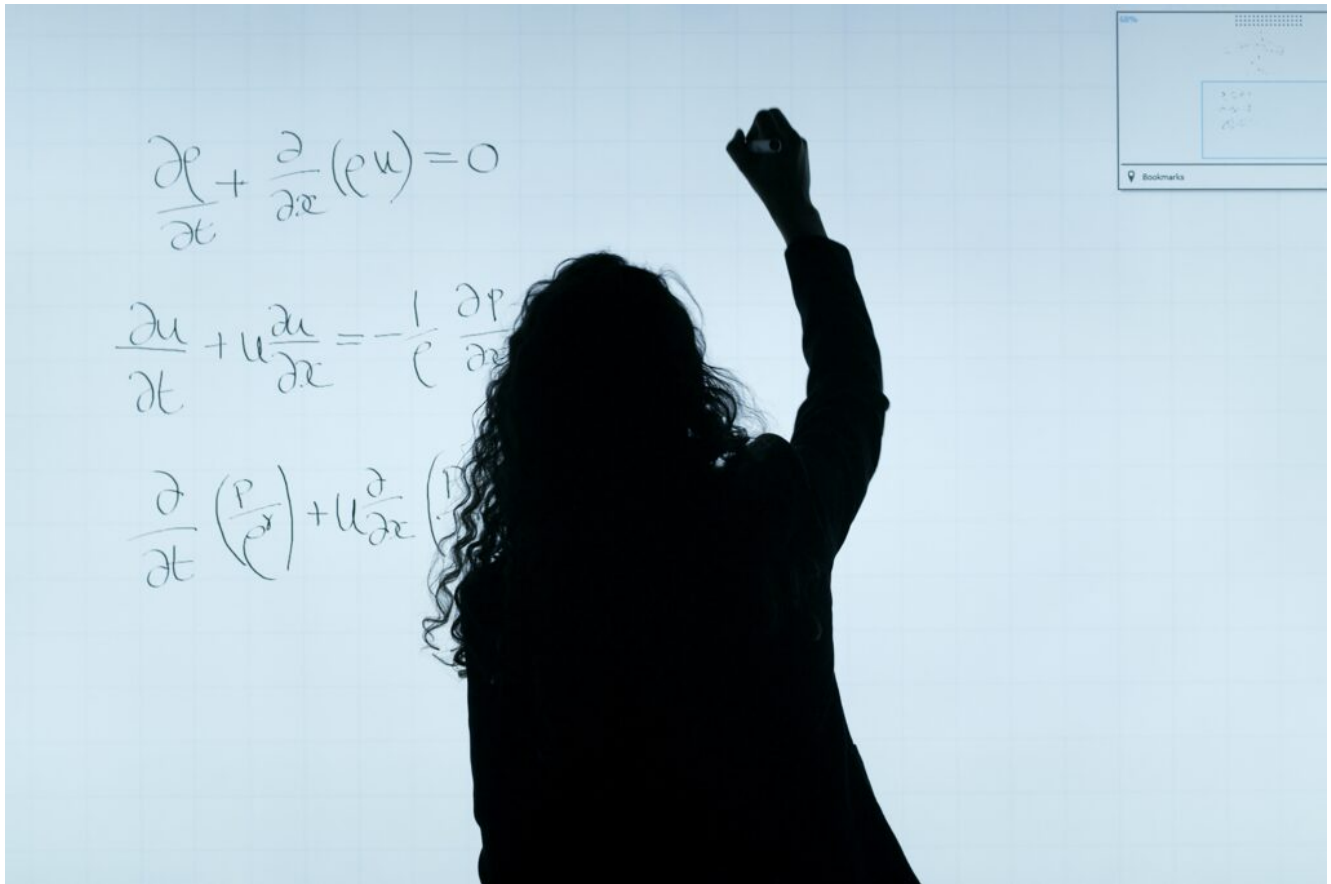
This is where nuclear power shines. It is extremely energy dense and operates at very high-capacity factors. The IEA report notes that nuclear has comparatively low mineral requirements. But the figure above is deceptive. Comparing on a MW capacity basis does not reflect the true nature of the mineral 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 “**

Fukushima 10 years later – its time to focus on the social science

Ten years have passed since Japan suffered the great Tohoku earthquake and tsunami that killed 20,000 people, caused US\$300 billion of damage and initiated the accident at the Fukushima Daichi nuclear power plant.

Reviewing the media reporting last month, the nature of the stories has changed. There were of course many articles that continued to talk about the dangers of nuclear power but there were also numerous articles noting the real lesson to be learned from the accident is that nuclear power is safe. And when news outlets associated the deaths in Japan with the nuclear accident, complaints resulted in many of them accepting their articles were wrong and issuing corrections to state the deaths were all due to the earthquake and tsunami.

When it comes to the actual impact of the accident on human health, the science is absolutely clear. No one died from

radiation from this event (the Japanese have associated one death of a nuclear worker with radiation, but the science does not support it). A recently (2020 edition) updated United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) report on the levels and effects of radiation exposure due to the accident said that future health effects, e.g. cancer directly related to atomic (nuclear plant) radiation exposure are unlikely to be discernible. But that doesn't mean there was not a large impact on people and Japanese society as a whole. People are suffering consequences related to the fear of radiation and its potential impact to them and their families, rather than from the radiation itself. As stated in the earlier 2013 UNSCEAR report, *"The most important health effect is on mental and social well-being, related to the enormous impact of the earthquake, tsunami and nuclear accident, and the fear and stigma related to the perceived risk of exposure to ionizing radiation."* Addressing this impact is essential for both the Japanese people that continue to suffer and to minimize these kinds of impacts in the future.

How society feels about different technologies and their dangers vary dramatically resulting in a broad range of public views when accidents happen. Let's look at some of the tragic events that have happened around the world in recent years and how society reacted.

In 2018 and 2019 two Boeing 737 MAX aircraft crashed (in Indonesia and in Ethiopia) killing 300 people. After the second accident the world reacted (two accidents so close together for a new design has never been seen in the history of modern aviation), and these planes were grounded for over two years as serious safety culture issues were identified at Boeing. Changes have been implemented to correct the deficiencies with the planes now declared safe and returned to service. Why did it take so long for the industry to react and why did the public not become more concerned about

flying? Flying is important to the world as we all want to travel. We accept flying as safe and are willing to overlook an accident as a rare event even though the consequences are tragic. (Since the pandemic we miss travelling more than ever.) Reporting was more related to how the issue can be resolved to get the planes flying again than in creating fear of flying.

Last summer, a large amount of ammonium nitrate stored at the port of the city of Beirut, the capital of Lebanon, exploded, causing at least 215 deaths, 7,500 injuries, and US\$15 billion in property damage, and leaving an estimated 300,000 people homeless. This was a huge tragedy, with the blame focused on the corruption of the Lebanese government. There was no reporting talking about this dangerous substance and its risks. No one was asking how it should be safely stored and transported and whether there are shortcomings in the regulations on how to keep people safe. In fact, the industry that creates the chemical was nowhere to be seen in the discussion.

Finally, as we all continue to feel the impact of this global pandemic that to date has infected more than 145 million and killed more than 3 million, we still have many who are fighting against public health directives focused on keeping us safe and some who simply choose to not accept the danger posed by this disease. With the end of the pandemic now in sight because of the amazing success of vaccines developed in record time, the biggest risk remains vaccine hesitancy. Somehow there are many people who are more afraid of the vaccine than the disease.

Looking at these examples, we see that:

- It takes two crashes to convince authorities to look for problems with a new aircraft design. The public, although concerned, does not become afraid to fly as

long as it is on a different aircraft model (easily compartmentalizing the risk to a specific model) and most are likely to feel comfortable flying on the 737 MAX now that it has been approved to fly again;

- A devastating explosion of a dangerous chemical raises no questions at all about the chemical itself. The public are comfortable allocating the blame to government incompetence without any thought to whether or not others are unsafe who are using this substance;
- A global pandemic that to date has killed more than 3 million people and completely disrupted all of our lives for over a year is not enough for some to follow the science while erroneously worrying that the cure may be more dangerous than the disease risking a delay to the end of the pandemic; and
- An accident at a nuclear plant resulting from an extreme once in a hundred-year natural disaster disrupts the lives of many and kills no one. The conclusion for some is the technology is so dangerous that there are calls to completely shut down the industry, with some countries like Germany who have no plant models that are similar to Fukushima nor the conditions for a similar event deciding the risks are too great.

Our purpose here is not to go into detail but to contrast how we as a global population choose to see threats and risks and respond to them. Each one of these examples demonstrates a vastly different response as the public has varying degrees of concern when evaluating risk. Often many of us try and discuss why we think this is the case. However, truly understanding these differences in perception and reaction is a task for the social scientists. The issues are complex. Studies are needed to learn how to better address public concerns and develop strategies to ensure that risks are contextualized, and science better explained to ensure the best possible response when tragic events occur.

It is a good thing the nuclear industry learns lessons from its experience to make nuclear better, but we also seem to define ourselves by our accidents rather than by our successes. Perhaps its time for that to stop. It may have taken a decade, but the world is realizing the benefits of nuclear power far outweigh the risks (a phrase we hear every day about vaccines) and that climate change is the greater threat to humanity that needs to be addressed now, with nuclear power being an important part of the solution.

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 inherit 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.

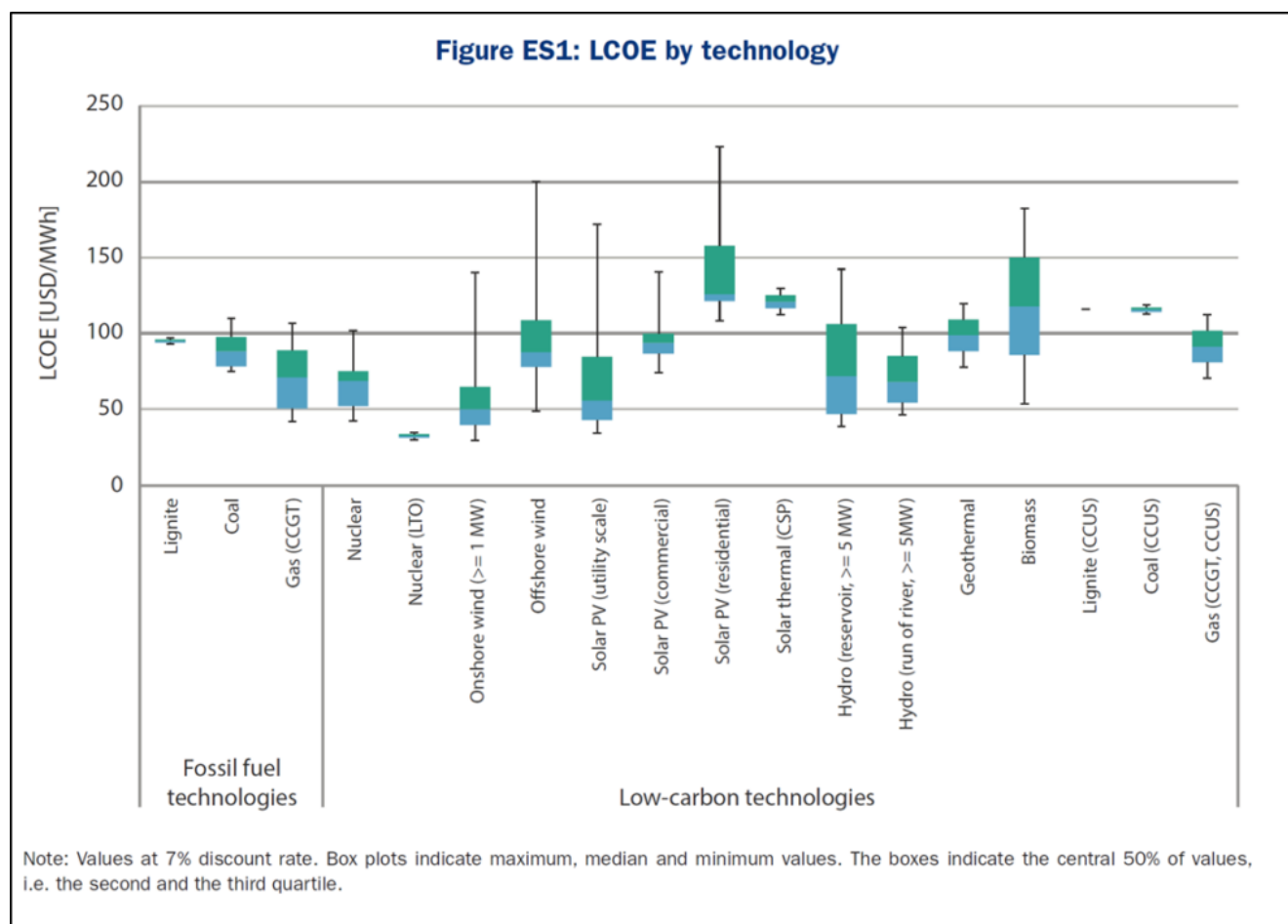


Source: [pexels.com](https://www.pexels.com)

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.

2020 was a year of global challenge – working together will make 2021 much better

What a year it has been! A year ago, we were all looking forward to the possibilities of a new decade. Today, as the year comes to a close, we are happy to see 2020 behind us.

We don't usually write about events outside the energy industry. But this year is different. And most of you are probably feeling somewhat like we are – exhausted, frustrated and just plain sad. That being said; we must also acknowledge we are definitely the lucky ones. Most of us are able to work from home and maintain our incomes while generally being able to minimize our risk to the virus that is spreading pretty much everywhere.



Source: pexels.com

A global pandemic with catastrophic impact. Over 80 million cases of covid-19 and approaching 1.8 million deaths. In less than a year this virus has impacted almost every country on earth. It cares not **what nation you live in, what your politics are, the colour of your skin or your religion.** Unfortunately, it does highlight the inequities in our societies and our weaknesses. Who is not completely overwhelmed by the disproportionate share of fatalities in old age homes highlighting how little we spend on caring for our elders (yet somehow, we can effectively maintain a bubble to keep professional athletes safe)? While many of us work from home to keep the virus away, those that earn the least are now classified as “**essential workers**” making sure we all have food on the table at considerable risk to themselves and their families. Health care workers are exhausted as ignorant so-called freedom fighters argue the importance of having freedom to get a hair cut or cite the attack on our civil liberties when asked to maintain distance or wear a mask.

And nothing frustrates us more than the ongoing war against science. From bizarre conspiracy theories (Bill Gates is trying to insert chips to control us,) to many just believing

this virus is a hoax, **the move away from being interested in truth is alarming.** When asked to pull together for the war effort our parents and grandparents did what was necessary. And while some may have disagreed with government policies, there was no one who said our leaders were lying to us and the war was a hoax.

Thankfully, science knows no borders. The **absolutely miraculous rate at which vaccines have been developed** are testament to the hard work of scientists around the globe who worked together. The Chinese published the genome of the virus back in January for all to use. Vaccine trials took place in many countries to ensure the best possible data in the shortest time. Yet now we face the next threat to defeating this virus, **vaccine hesitancy.** Even prior to this pandemic the WHO defined vaccine hesitancy as a rising threat to global health.

2021 can be a year to look forward to. It will be difficult at the beginning, but it can also be the year the pandemic comes to an end. However, the speed at which we come out of this is not guaranteed. As with most things in life, **success is up to us.** For the best possible outcome, we need to focus on three things:

- **Acknowledging the science and taking the advice of professionals,** both to protect ourselves, our families and our friends and colleagues from infection; and to encourage all to take the vaccine when available to them;
- In spite of our increasing pandemic fatigue, be willing to continue to **sacrifice** for the common good. As a society we have become selfish and value our own wants before the needs of others. This is **a teachable moment for our children.** Learning the value of sacrifice to the benefit of others is a life lesson that will benefit them forever; and
- All work together to our common goal. **Leaving poor**

countries behind will not hasten the end of this pandemic. It took only months for the virus to reach every corner of the earth. To end, the efforts to eradicate it must have the same reach.

The nuclear industry has done well throughout these difficult times. This is because we have developed the systems necessary to keep our plants running and our workers safe. For that we should all be proud. **We are always prepared for a crisis and know exactly what to do when one is upon us.** We put the safety of our workers and the public above all else. And we collaborate to ensure the lessons learned from all the world's operating plants are known to each of us so we can keep improving.

For most of us, never have we had to face the fact that our normal daily activities can result in real, measurable, and immediate consequences. What each one of us does each day determines the path of this virus, with daily numbers of the sick and the dead, and the associated economic impact, showing us the outcome of our actions. The only viable answer is to work together to make good choices and exhibit the right behaviours to save lives, shorten the pandemic and ultimately eliminate the virus as a global threat.

Hopefully, we will then take the time to learn the important lessons from this experience and make the societal changes necessary to protect and improve the lives of those who are most vulnerable while being better prepared for the next challenges the world throws at us.

Once again thank you for reading our blog this year. Wishing you and your families a very happy and healthy 2021.

If you have an interest in seeing a topic covered in one of our upcoming blogs, please let us know. We welcome the opportunity to write about new topics of interest to you, our readers.