

Nuclear's contribution to achieving the UN Sustainable Development Goals

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**Nuclear energy provides the clean, on-demand affordable electricity needed to meet the world's growing energy demands, while fulfilling the climate objectives of the Paris Agreement. But nuclear technologies do so much more! The planet and humanity are much better off because of the many nuclear contributions to achieving each of the 17 UN Sustainable Development Goals.

Sama Bilbao y León Director General. World Nuclear Association



Nuclear requires very little land to generate massive quantities of low carbon energy. This low land footprint brings numerous benefits, not only in terms of reduced visual impacts. A lower land footprint reduces the loss of habitats, thus helping to support biodiversity goals.

Yves Desbazeille Director General, FORATOM



**Nuclear is a key energy source to balance the so-called three Es: energy security, economic efficiency, and environmental sustainability. It is a reliable, established technology that can contribute significantly to a sustainable future.

Shiro Arai President, Japan Atomic Industrial Forum



Advanced and existing nuclear reactors can provide new possibilities to support clean industrialization worldwide. They are uniquely positioned to provide clean electricity, decarbonize our resource extraction and heavy industries, work in tandem with renewables and can be used to produce hydrogen in a cost-effective, clean way using either electricity or heat processes.

John Gorman

President and CEO, Canadian Nuclear Association



**Nuclear energy provides skilled, well-paid, long-term jobs that are essential to a just transition. Jobs in nuclear drive valuable investment into local communities and create real opportunities for the next generation to build a better life.

Tom Greatrex Chief Executive, Nuclear Industry Association



Reliable nuclear carbon-free energy provides the foundation of a clean energy future to reach climate goals and improve public health and quality of life.

Maria Korsnick
President and CEO, Nuclear Energy Institute



Nuclear generation helps reduce poverty and stimulates economic growth

- Nuclear generation provides affordable and reliable electricity supplies without greenhouse gas emissions or air pollution.
- Investment in nuclear energy boosts economies and provides employment.

Globally, more than 700 million people do not have access to electricity. Billions more have unreliable supplies.

A reliable, clean and affordable electricity supply is essential to enable people to rise out of poverty and improve their quality of life. It is also a prerequisite for achieving many of the other UN Sustainable Development Goals.

Alleviating poverty also means providing people with well-paid jobs and supporting economic growth, particularly in developing countries. The construction and operation of nuclear plants provides such employment opportunities, as well as stimulating investment in infrastructure and education, and having a strong multiplier effect on national economies.

The impacts of poverty are particularly acute in the least developed countries, but fuel poverty can be experienced by low-income households in even the most developed countries.

Nuclear generation costs are much less susceptible to fuel price volatility than fossil fuel generation costs, particularly gas. This can help mitigate the impacts of fossil fuel price spikes on energy prices, which disproportionately affect poorer households.

Strategies to decarbonize electricity supplies should also take account of the potential impacts of higher generation costs on those least able to pay. Extending the operation of existing reactors is one of the lowest-cost ways of producing low-carbon electricity.

Nuclear provides reliable and affordable low-carbon electricity





Nuclear techniques help reduce pests and develop better crops

- Nuclear technologies help fight against pests, avoiding the need to resort to harmful pesticides.
- Using nuclear techniques to develop new plant breeds means that farmers can grow crops that need less water and that are more resistant to the impacts of climate change.
- Fresh food can last longer if irradiated, and this process also kills E. coli, listeria and salmonella.

Worldwide, 822 million people are afflicted by malnourishment, approximately 9 million people die every year of hunger and

approximately 9 million people die every year of hunger and hunger-related diseases. Every year up to 40% of crop yields and millions of livestock are lost due to pests and disease.

The sterile insect technique (SIT) uses ionizing radiation to sterilize

specially bred male insects, which then compete with wild males to mate with females. The females that mate with the sterilized males produce infertile eggs, reducing the insect population. This technique has been used successfully to control two serious fruit fly pests, the Mexican fruit fly and Mediterranean fruit fly, as well as livestock-killing insects in sub-Saharan Africa.

The crop mutation technique can accelerate the process of breeding new crop varieties by using radiation to speed up and mimic the natural process of spontaneous mutation, the driving force behind evolution. In Peru, this technique led to improved barley and amaranth varieties that have adapted to climatic conditions in high altitudes. The new barley variety increases crop yields and contributes roughly US \$32 million annually to the Andean farmers.

Food can be preserved for longer using irradiation. This technique can be used to kill pathogens such as E. coli, listeria and salmonella, as well as bacteria that would otherwise cause food to rot more quickly.

Nuclear technologies in food and agriculture improve the yield of crops, help reduce the losses due to pests and insects, and help maintain food fresh for longer, thus increasing the global available food supply.

Zanzibar's cattle
have been free of
the tsetse fly since
1997 thanks to
nuclear technologies
for pest control





Nuclear medicine helps tens of millions of people every year

- Every year, nuclear medicine helps doctors diagnose and treat tens of millions of people.
- Nuclear materials are essential for medical research, as they are used to analyse specific molecules inside the body.
- Radiotherapy helps treat and cure many kinds of cancer.
- Irradiation is used to sterilize medical equipment, such as syringes and catheters.

Over 40 million nuclear medicine procedures are performed each year

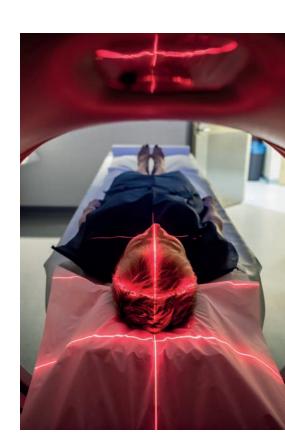
Nuclear medicine is a critical component in diagnosing health problems related to the function of organs, tissues, or bones. Radioisotopes, which can be produced by nuclear reactors, are used as 'tracers' in PET scans, one of the most accurate means of detecting and evaluating most cancers.

Biotechnologists analyse specific molecules inside the body using nuclear materials. These techniques are an essential research component for chronic illnesses like AIDS and Alzheimer's disease.

Radiation therapy (radiotherapy) can cure many different types of cancer, as well as other conditions, such as Graves' disease (the most common cause of hyperthyroidism). In the case of cancer, most cancerous growths are sensitive to radiation.

There are numerous different treatment options, either with external or internal radiation, that can control or eliminate cancer by irradiating the area containing it.

The nuclear by-product cobalt-60 can kill off harmful and deadly bacteria, making it an effective solution to sterilize medical equipment, such as syringes and catheters.





Nuclear companies invest in training and education of their employees

- The nuclear industry offers long-term, high-skill jobs.
- Companies invest in training and education to encourage the development of a workforce with the skills required to construct and operate their plant.

A new nuclear plant can generate 1,000 apprenticeships during its construction

Further education is part of new nuclear projects, whether in countries developing the skills of future staff for their first plants, or in countries with well-established nuclear programmes, seeking to train the next generation of employees.

In the UAE, the Energy Pioneers Program provides UAE nationals with the opportunity to gain specialist expertise and practical experience to pursue a range of careers across the country's nascent nuclear energy industry. The UK, with a long-established nuclear industry, continues to offer further education opportunities. Hinkley Point C, currently being built in the UK, has 1,000 apprenticeships during the construction phase.

The World Nuclear University has a mission to offer comprehensive leadership, communications, and technical training to support the next generation of nuclear leaders. It was founded by World Nuclear Association, the World Association of Nuclear Operators, the International Atomic Energy Agency, and the Nuclear Energy Agency.

The WNU has a worldwide network of nuclear education and research institutions offering training programmes for future leaders on nuclear energy, radioisotope production and applications of ionizing radiation in medicine and industry. Sponsorship by the IAEA enables students from emerging nuclear and developing countries to attend the WNU's six-week Summer Institute course.

In countries, for example the US, nuclear plants create local tax revenue, which helps support a strong school system.





The nuclear industry is committed to improving the representation of women in the workforce at all levels

- Lack of access to clean, reliable and affordable energy disproportionately disadvantages women and girls.
- Nuclear companies have signed up to initiatives encouraging young women to move into STEM careers, and to provide training to prevent discrimination and fight against bias.

The UK's Nuclear Sector Deal aims to have women making up 40% of the nuclear industry workforce by 2030

The role of reliable and affordable energy in the emancipation of women should not be underestimated. By powering domestic appliances, energy freed women and girls from menial labour-intensive tasks many were compelled by societal pressures to perform, giving them more time to pursue other, more rewarding, activities.

But these benefits have not been universally available. If we are to achieve gender equity worldwide we must ensure all women have access to reliable electricity supplies, and that families have the economic resources to be able to purchase the domestic appliances that provide a better quality of life.

To have the highest-skilled workforce, an industry needs to attract the best talent from all genders. As with many industries in the science, technology, engineering and mathematics (STEM) fields, women are under-represented in the nuclear industry, making up less than 25% of the workforce worldwide.

Globally, the "Equal by 30" campaign, a joint initiative between the International Energy Agency and the Clean Energy Ministerial, aims to accelerate the participation of women in the world's clean energy transition and to close the gender gap in employment opportunities and earnings. Many companies in the nuclear industry have signed up to the initiative and made commitments such as strengthening the diversity of their teams and management, partner with schools to encourage young women to move into STEM careers or provide training to prevent discrimination and fight against bias.





Nuclear desalination provides clean water without greenhouse gas emissions

- Nuclear energy has a central role to play in achieving universal access to clean water and sanitation.
- Desalination of seawater using heat generated by nuclear reactors produces pure, clean water, without the greenhouse gases emitted by the fossil fuel plants that power desalination units.

Nuclear reactors can be a source of clean water for communities and countries in need

Clean and accessible water supplies are essential for economic development and human health. The World Health Organization predicts that by 2025, half of the world's population will be living in water-stressed areas.

Desalination of water can address the challenges water-stressed areas face, but most desalination plants are powered by fossil fuels, resulting in the emission of greenhouse gases.

Nuclear reactors, in addition to providing electricity, can be a source of clean water. Nuclear reactors produce steam heat that drives turbines to make electricity, and leftover heat can be used to boil ocean water. The steam that condenses is clean, and the remaining salt can be returned to the ocean.

Nuclear science can also be used to clean water. The textile industry consumes huge amounts of water and chemicals, such as dyes, starches, acids, salts, and detergents. These would normally be treated chemically, creating secondary waste. However, nuclear electron beam technology is used instead. The electron beams break apart the chemical bonds of clothing dyes and removes pollutants, allowing recycling of the water for reuse. At one textile factory in Southern China the technique saves up to 4.5 million m³ of fresh water annually, equivalent to the water consumed by about 100,000 people.





Nuclear power plants provide large amounts of clean, reliable, affordable energy

- Demand for electricity is increasing, driven by a growing global population, increasing electrification of energy supply, and the needs of the billions of people who still don't have access to affordable and reliable electricity supplies.
- Meeting this increasing demand for electricity by burning fossil fuels is not sustainable. Switching to clean technologies such as nuclear energy is vital.
- If the world is to help lift people out of poverty and meet energy demand, then significant investment ir low-cost, low-carbon nuclear energy is needed.

Nuclear projects are long-term investments that could operate for 80 years or more

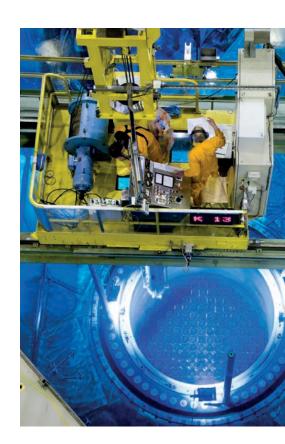
The use of fossil fuels for generating electricity has detrimental impacts on people and the environment, causing air, water, and soil pollution and producing large quantities of greenhouse gas emissions that drive climate change.

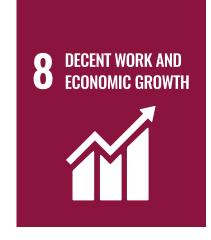
Sustainable development can be achieved only with access to clean, reliable and affordable energy. Energy is connected to all human activities and is the engine for economic sectors like agriculture, heavy industry, commerce and transport.

Nuclear power plants provide large amounts of clean, reliable, affordable energy and, regardless of the weather, can run for long periods of time without interruption. They are the ideal complement to wind, solar and storage for developing an affordable, reliable and low-carbon electricity grid.

In addition, through nuclear cogeneration, the heat generated by reactors can be redirected to power processes that are presently hard to decarbonize, such as domestic and industrial heating.

Nuclear projects are long-term investments and can operate for up to 80 years or more, making them cost-effective and affordable.





The nuclear industry provides well-paid, high-skill jobs and investment that supports local communities

- Construction of a new nuclear power plant generates thousands of jobs onsite and thousands more in the supply chain.
- The operation of a nuclear power plant provides hundreds of high-skill jobs for people in local communities for many decades.
- A nuclear power plant brings broader investment that benefits local economies.

The nuclear industry generates a broad range of jobs, including engineering, technical, and other specialist roles.

For each 1,000 MWe of nuclear capacity constructed, some 200,000 job-years of employment are created. Nuclear sector pay tends to be higher than average, reflecting the specialist skills of the employees.

Nuclear energy projects also involve significant investment and regional infrastructure development, which contributes to economic growth and international exchange.

Nuclear energy projects increase gross domestic product growth in the short and long term. In addition, nuclear energy can have a positive impact on local employment, with a higher proportion of jobs being generated near to the location of the power plant than is the case with other low-carbon generation.

The nuclear industry helps to support jobs directly and indirectly. For each direct job, approximately 2.5 to 3.5 indirect and induced jobs are generated.

For each 1,000 MWe of nuclear capacity constructed some 200,000 job-years of employment are created





Nuclear can supply the electricity and heat needed to support sustainable industrialization

- Innovative designs allow nuclear reactors to operate in new locations and enable decarbonization in new applications beyond electricity supply.
- High-temperature reactors will offer an alternative to fossil fuels for process heat and provide new options for hydrogen production.
- Innovations in nuclear fuel can enhance the performance of reactors in operation today.

Innovative nuclear technologies offer sustainable energy with the high-power density necessary for industrialization

Innovation is expanding the potential of nuclear technologies. The nuclear industry is pursuing the development of more efficient fuels that could enhance the performance of reactors currently in operation, as well as developing new reactor designs that will have a broader range of applications.

Industrial development is frequently energy-intensive. Nuclear reactors have the large output required to support such demand. In addition to the supply of electricity, high-temperature reactors will be able to replace fossil fuels as a more sustainable supply of process heat, with applications including the production of hydrogen.

New nuclear build projects support the many manufacturing companies in the supply chain that produce the components required for construction. Increasingly, new nuclear power projects are structured to support the local and host country supply chains, promoting more inclusive and sustainable industrial development. Once in operation, nuclear power plants continue to provide hundreds of high-skill employment opportunities for many decades.

Nuclear techniques can help make other industries more sustainable and safer. Nuclear non-destructive testing (NDT) is a quality-assurance procedure that helps verify the structural integrity of machines and materials without causing damage. One such technique is industrial radiography, which is used to inspect welds.





Nuclear protects low-income households, which are disproportionately affected by volatile electricity prices.

- The overall generation costs of nuclear plants are less susceptible to price volatility than fossil plants. Rising fuel costs can have an inequitably high impact on lower-income households.
- Using nuclear power enables those countries with limited domestic fossil fuel reserves to have greater control over their own energy systems.

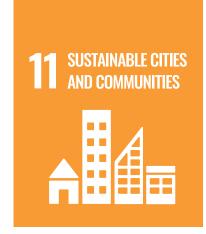
Nuclear fuel has a diverse supply chain and can be stored onsite

The unequal access to energy within and among countries has considerable detrimental impacts on individuals and economies around the world, ranging from ambient air pollution to price shocks brought on by supply shortages. Energy can – and has – been used as a political tool, and energy systems that rely heavily on imported fossil fuels are susceptible to external influence. This often particularly harms the most vulnerable, individuals as well as countries. Nuclear energy can help to reduce these inequalities.

Uranium, which fuels nuclear reactors, can be found in abundance in many locations globally. Nuclear fuel can easily be stored onsite for many years, providing an insurance against potential supply issues. This diversified supply chain and ease of storage provides nations with greater control over their own energy systems, thus reducing the considerable inequalities that currently exist among countries.

Nuclear reactors also help to protect individuals against the price shocks that disproportionately affects low-income households. Whilst fuel costs for fossil-fired plants can make up a very large percentage of their overall costs – thus exposing consumers to extreme price changes – the fuel costs of nuclear power plants make up less than 10% of the overall cost, so variations in the cost of uranium have a much smaller impact on overall generation costs. This means that nuclear energy also can help reduce inequalities by protecting low-income households from disproportionately paying for market volatility.





Nuclear helps make cities and human settlements inclusive, safe, resilient and sustainable

- Over half the population in the world's cities endures worsening air pollution. One major contributor to air pollution in cities are the exhaust fumes from petrol or diesel road vehicles.
- Using nuclear generation to recharge electric vehicles helps reduce transport greenhouse gas emissions as well as reducing air pollution in cities.
- Nuclear power plants can also be used for district heating, avoiding pollution from fossil fuels.

Nuclear power plants prevented more than 1.8 million air pollution-related deaths between 1971 and 2009

Governments around the world are introducing policies to phase out internal combustion engines as the power source for road transport and encourage the use of electric vehicles that will avoid the direct emissions currently produced by petrol or diesel.

However, if the electricity used for transport is produced using fossil fuels this will still result in air pollution, such as smog and ozone, as well greenhouse gas emissions.

A sustainable shift to electric vehicles will increase demand for clean energy, including nuclear energy. With overnight charging likely to be a popular choice, the high availability of nuclear power plants will be an important factor.

Hydrogen fuel cells may also have a significant role to play in future transport systems. Again, it will be essential to produce hydrogen from clean energy sources. Nuclear reactors can already be used to produce hydrogen by electrolysis, and high-temperature reactors will be able to produce hydrogen through thermochemical techniques.

Heating homes with low-carbon alternatives will also contribute to meeting the goals of SDG11. Low-carbon hydrogen could replace natural gas in central heating boilers or greater use could be made of electric storage heaters.

For smaller and remote communities, small modular reactors are well-suited to provide clean electricity and heat.





Nuclear reactors produce the electricity needed to meet global energy demand responsibly

- Responsible consumption and production should still allow everyone to enjoy a high quality of life, with sufficient energy supplies to enable the achievement of all of the Sustainable Development Goals.
- Nuclear power plants supply large amounts of electricity from compact sites, using fuel that has the potential to be recycled.

Nuclear plants
allow people to
improve their
quality of life while
using resources
responsibly

Many of the production and consumption patterns of the modern world are not sustainable.

Consumption and production must be carried out in a way that enables everyone to access a quality of life that allows them to realize their ambitions. At present billions of people are denied access to the type of lifestyle that has been enjoyed by developed countries for many decades.

Nuclear has already played a vital role in addressing this. Nuclear power has much lower raw material requirements per unit of electricity produced than other clean energy options. It also produces large amounts of electricity from an energy-dense power source, using a fuel that has the potential to be recycled through reprocessing or novel nuclear fuel cycles.

Nuclear technologies can also help to make other sectors more sustainable. Cotton is well-known for requiring a lot of water, but scientists have used nuclear techniques to develop an enhanced cotton plant that increases yields by at least 30%, which could help reduce the amount of water needed.





Nuclear energy is making a massive contribution to combating climate change

- The effects of climate change caused by anthropogenic (human-caused) emissions are numerous and far-reaching.
- Nuclear plants avoid the emission of over 2 billion tonnes of carbon dioxide each year.
- New nuclear power plants can be deployed at scale, enabling rapid decarbonization of a country's electricity generation mix.

The impacts of climate change can already be seen, from exacerbating global poverty, water scarcity and food insecurity to severely impacting public health due to the spread of diseases, extreme weather events and the destruction of ecosystems. By 2030, it is estimated that more than 100 million people will be forced into extreme poverty and some 250,000 additional deaths every year between 2030 and 2050 will be caused by climate change.

Nuclear energy has one of the smallest carbon footprints of all energy sources, and it is one of the largest low-carbon electricity generators globally. The use of nuclear power avoids more than two billion tonnes of carbon dioxide emissions every year, the equivalent of removing half of the world's 520 million vehicles.

Nuclear energy can be deployed at the rates required to avoid the worst effects of climate change. This has been seen in countries such as France and Sweden, where a rapid expansion of nuclear power in the 1970s and 1980s contributed to a high degree of decarbonization of their electricity systems, whilst delivering substantial economic growth.

Nuclear power plants avoid carbon dioxide emissions equivalent to half of those from the world's 520 million vehicles





Using nuclear energy avoids the emissions that cause ocean acidification

- By generating electricity without producing carbon dioxide, nuclear reactors help reduce ocean acidification caused by burning fossil fuels.
- Nuclear techniques can help monitor the health of aquatic ecosystems.

Marine biodiversity is in significant decline across the world as a direct result of human activity.

Ocean acidification caused by fossil fuels has detrimental impacts on marine life and poses an especially big threat to coral reefs around the world. Coral reefs are the nurseries of the oceans and more than 25% of all marine life depend on them, despite occupying less than 1% of the ocean floor. It is estimated that they provide food to hundreds of millions of people, and supply resources and services (including jobs, food, and protection from storms and erosion) worth more than \$375 billion every year.

Nuclear power can play a major role in reducing ocean acidification and thus protect the immense biodiversity of the oceans, thanks both to its low-carbon credentials and the fact that it does not cause chemical emissions that pollute waterways – unlike many other energy sources.

Nuclear and isotopic techniques can also help understand aquatic ecosystems, assess pollution and verify the effectiveness of clean-up and remediation techniques. These techniques can also be used to evaluate past changes in ocean acidity, as well as the ocean's capacity to store carbon and the potential impact this will have on the climate in the future.

The ocean has absorbed almost half of the CO₂ emitted by burning fossil fuels





Nuclear power plants produce large amounts of electricity from small land areas

- Nuclear energy plays an important role in preserving biodiversity, thanks to its uniquely small physical footprint.
- Mining for coal to power fossil fuel generation plants can result in destruction of forests.

Human activities have transformed the face of our planet. Unsustainable practices in activities such as fuel extraction and agriculture, as well as climate change, pose a significant threat to biodiversity across the world.

The world's forests are central to keeping climate change in check as they absorb a third of all carbon dioxide emissions. However, logging, land degradation and desertification threatens forests worldwide, which in turn results in additional desertification, degradation and biodiversity loss. Forests can also be threatened by coal mining. The Hamabacher Forest in the west of Germany has been almost completely destroyed by mining for lignite, which emits particularly high levels of carbon dioxide when burned.

In comparison to other low-carbon energy sources, nuclear power requires the smallest amount of land per unit energy produced, leaving more undisturbed land for natural habitats.

Nuclear techniques can be used to assess soil quality and study how crops take up nutrients. This helps in the development of more efficient soil management and crop production methods.

Experts can also track and stop contaminants from harming the environment, by using nuclear science to identify certain isotopes in different contaminants to measure their concentration and trace their source.

Compact nuclear plants leave more space for nature





The Non-Proliferation Treaty promotes cooperation on the peaceful uses of nuclear technology

- Signatories to the Non-Proliferation Treaty undertake to not pursue a nuclear weapons programme and cooperate on peaceful uses of nuclear technology.
- Nuclear techniques can also be used to detect weapons and drugs.

National nuclear power programmes contribute to peace. The development of national nuclear power programmes plays a key role in the non-proliferation of nuclear weapons.

In return for access and cooperation on the peaceful uses of nuclear technology, countries that have signed the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) undertake to not pursue a nuclear weapons programme.

Compliance with the NPT is verified through inspections carried out by the International Atomic Energy Agency, ensuring that fissile material in NPT signatory countries is not diverted for weapons use.

Nuclear techniques can also help enhance security in other fields. Neutron scanning devices can be used to detect explosives, drugs or weapons, with applications in airport security, forensics and crime scene investigation. The IAEA verifies compliance with the NPT through inspections





Nuclear organizations work with stakeholders to help meet the Sustainable Development Goals

- To implement the other 16 Sustainable Development Goals, governments, civil society, scientists, academia, and the private sector need to work together, combining their skills and expertise to be better able to achieve a common objective.
- Organizations such as CNA, FORATOM, JAIF, KAIF, NEI, NIA and World Nuclear Association bring representatives of different nuclear companies together to work on areas of common interest and engage with other stakeholders.

Governments, civil society, scientists, academia, and the private sector need to work together, combining their skills and expertise

Strong partnerships between the nuclear industry and other stakeholders enable nuclear technologies to contribute to meeting the Sustainable Development Goals.

A key partnership in Canada is the Darlington and Bruce refurbishment projects, a collaborative effort between the nuclear industry and the Government of Ontario. This effort will ensure the life extension of 10 reactors. The refurbishment project, which will last approximately 15 years, is creating thousands of jobs and extending the operating lifetime of the reactors for another 30 years or more.

Launched in June 2021, the IAEA's "Nuclear Saves" Partnerships provide an opportunity for companies and organizations to support the IAEA in transferring nuclear science and technology to countries to improve the health and prosperity of millions of people around the world. The Nuclear Energy Institute, World Nuclear Association and Westinghouse Electric Company are Nuclear Saves partners with the IAEA.

The nuclear industry conducts outreach with developing countries, and has partnerships with governments, NGOs and UN bodies such as the IAEA and UNECE. One example is the International Framework for Nuclear Energy Cooperation, which is a partnership of countries that share knowledge and experience with developing countries so that they can make informed decisions regarding the establishment of nuclear facilities.



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