Mapping Nuclear Tedchnology to the Sustainable Development Goals

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Today, there are about 440 nuclear power reactors operating in 30 countries providing about 10 per cent of the world's electricity. Over the past 50 years, the use of nuclear power has reduced CO2 emissions by about 60 gigatonnes, or nearly two years' worth of total global energy-related emissions, as shown in Figure 2.5. In addition to electricity generation, nuclear reactors can provide solutions to an even wider range of energy applications such as high temperature process heat, and district heating. Nuclear energy can also be used to generate hydrogen and to create synthetic fuel.

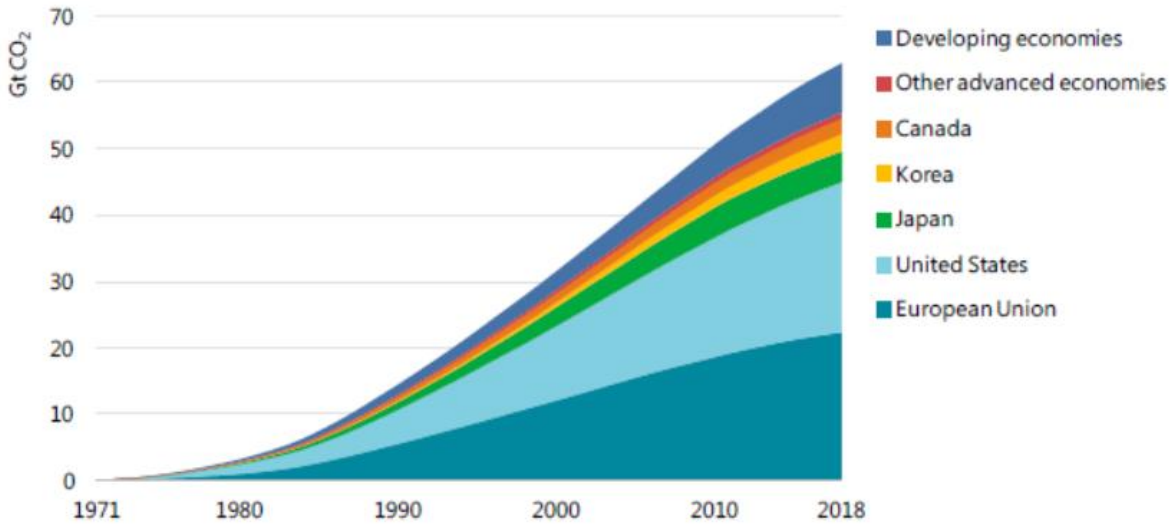

Figure2.5. Cumulative CO2 emissions avoided by nuclear power by region. Source: OECD IEA[18]

[18] OECD IEA, 2019, Nuclear Power In A Clean Energy System

Nuclear reactors are also used to create radioisotopes that are used in a number of medical, environmental and industrial applications all over the world. Generally these radioisotopes are made in special purpose reactors, but some power reactor designs can also produce useful isotopes. Every year, about 30 million people benefit from a diagnostic procedure or treatment by nuclear medicine and the numbers are steadily increasing. Radioisotopes and radiation used in food and agriculture are helping the fight against world hunger. Food irradiation exposes foodstuffs to gamma rays that kill bacteria that can cause food-borne disease, thus increasing their shelf-life. Radiation is also used for agricultural pest control via the Sterile Insect Technique, which reduces the use of pesticides, thus benefiting public health and the environment. Isotope hydrology techniques help tracing and measurement of the extent of underground water resources and any sources of contamination. They improve the management and conservation of existing supplies of water, and in the identification of new sources.

As shown below nuclear energy has the potential to contribute to all of the SDGs (Figure 2.6). Many of these contributions are spelt out in greater detail in the chapters which follow. Nuclear energy has the most direct relevance to SDG7[19], but increasing energy access enables economic growth which is pivotal to many other SDGs. The nuclear sector is also a major industrial employer which demands high-standards and competencies as well as international cooperation and a commitment to ongoing research and development.

There are opportunities to integrate the SDGs into core business activities of the nuclear sector, and nuclear energy companies can benefit from collaborating with stakeholders to broaden their impact and enhance their ability to leverage additional resources to achieve the SDGs. The SDGs are “interlinked and indivisible”, requiring approaches that promote synergies and manage trade-offs. Worldwide, countries are moving towards full alignment with SDGs and integrating them into policy. International, regional and national policies and plans, as well as business opportunities, will be shaped by maximizing alignment with them. Mapping nuclear technology to the SDGs can help the industry to:

- Understand current trends, challenges and opportunities in sustainable development;
- Define the business system interconnectedness and boundaries;
- Recognize the strengths of partnerships.

Road to development and carbon neutrality

Until the 1930s, Finland’s economy was predominantly agrarian and, as late as in the 1950s, more than half the population and 40 per cent of output were still engaged in the primary sector. The nineteenth-century saw the modest beginnings of industrialization and in the twentieth centure Finland came out of World War II with a severely crippled economy. Gradually the productive capacity was modernized, and the whole industry was reformed. To meet energy demand, Finland introduced nuclear energy in 1978. Finland today has four nuclear reactors providing about 30 per cent of its electricity. A fifth reactor is under construction, and another is planned, to take the nuclear contribution to about 60 percent. Finland's four existing reactors (about 2700 MWe net total) are among the world's most efficient, with an average lifetime capacity factor of over 85 per cent and average capacity factor over the last ten years of 95 per cent. In June 2019, Finland announced a new energy policy to achieve carbon neutrality by 2035. The policy would see a complete phase-out of coal power by May 2029.

[19] As spelt out in IAEA, 2017, Nuclear Power for Sustainable Development

SDG 1 - No Poverty

Nuclear energy helps the economy by supporting direct, indirect and induced jobs during construction and operation of nuclear facilities. The cost competitive and stable electricity supplied by nuclear power plants attracts energy-intensive industry, thus creating more jobs. Nuclear energy can power the development of local small and medium enterprises and support non-polluting e-connectivity for economic development. These enterprises also generate significant local economic activity in the form of jobs, revenues and local spending. As an energy technology that is almost entirely immune to fluctuations in the weather, nuclear also helps build climate resilience for the economy.

SDG 2 - Zero Hunger

Nuclear energy helps to power sustainable food production. In addition, many countries use nuclear techniques to develop sustainable agricultural practices, establish and improve nutrition programmes and ensure stable supplies of quality food. Sterile Insect Technique Irradiation, for example, is providing a powerful line of defence against agriculture's most damaging pests. Water desalination projects can also be nuclear powered and help to build climate resilience in agriculture.

SDG 3 - Good Health and Wellbeing

Nuclear contributes to a reliable and resilient energy supply that is needed to power modern health infrastructure. This is even more essential during a crisis such as the COVID-19 pandemic. Reliable energy also enables the automation of dangerous and unpleasant tasks. As a very low emissions technology, nuclear energy helps to ensure clean air, water and land thereby improving the health of communities.

Nuclear techniques play an essential role in diagnosing and treating various health conditions, in particular, non-communicable diseases such as cancer and cardiovascular diseases. Irradiation technologies can also be used to sterilize medical equipment. A nuclear-derived technique known as RT-PCR is being used to identify cases of the corona virus accurately within hours[20].

SDG 4 - Quality Education

Nuclear science and technology is used in many fields including energy, medicine and agriculture. The need for skilled technicians, engineers, physicists, radiation experts and nuclear medicine specialists creates many opportunities for national and international education and training efforts. Opportunities in the nuclear sector can help boost interest in Science, Technology, Engineering, Mathematics (STEM) subjects in younger students. Some countries also grant educational scholarships to individuals in energy and medicine to secure the provision of talent needed for their national programmes.

SDG 5 - Gender Equality

In emerging countries increased access to cheap and reliable energy helps enhance labour emancipation and reduce jobs involving drudgery, which disproportionately affects women. The nuclear community, with the active participation of leading international agencies, is currently committed to attracting and retaining qualified women to the nuclear science and technology sector. As a traditional engineering field, men currently outnumber women in the nuclear industry, but many companies are now actively and publicly addressing the gender balance. As a result, the number of women in leadership and technical positions is increasing.

[20] See How is the COVID-19 Virus Detected using Real Time RT-PCR? https://www.iaea.org/newscenter/news/how-is-the-covid-19-virus-detected-using-real-time-rt-pcr

SDG 6 - Clean Water and Sanitation

Nuclear energy can be used to power desalination facilities and provide clean water to communities, helping to support energy-water-food nexus activities.

Various nuclear techniques help scientists to study the quality and quantity of water resources. Naturally occurring isotopes in water can be used to determine the water's origin, age, vulnerability to pollution, as well as how water resources move and interact with each other.

SDG 7 - Affordable and Clean Energy

Nuclear energy is complementary to renewable energy sources. When used together these technologies can help to achieve decarbonized electricity systems at low cost to consumers – as has been proven by France and Sweden. Nuclear power technology is evolving, and a range of new reactor technologies are being developed that offer greater flexibility and efficiency. These can more readily contribute to a greater range of energy services such as industrial heat and synthetic fuel production.

SDG 8 - Decent Work and Economic Growth

The nuclear industry supports a diverse range of jobs, including various engineers, technicians, and other specialists. Sector pay tends to be better paid than average, reflecting the specialist skills required. In addition, nuclear energy is providing many developing countries with access to cheap, reliable and carbon free electricity which increases quality of life and productivity in their economies. These two effects combined act as a 'job-multiplier', greatly boosting regional employment. Nuclear energy projects also involve significant investment and regional infrastructure development, which contributes to economic growth and international exchange. In addition, the safety culture promoted throughout the global nuclear industry has resulted in one of the safest industrial workplaces.

SDG 9 - Industry, Innovation, and Infrastructure

In simple terms, a nuclear power plant is major infrastructure development. With maintenance and periodic upgrades, a nuclear power plant can operate for 60 to 80 years, thereby reducing the volumes of new materials needed for energy production. Innovation is integral to achieving this longevity and enabling plants to operate at ever greater performance levels. Nuclear innovation is also resulting in spinoff technologies that can be used in other fields such as material research and structural mechanics. Nuclear energy is not yet widely deployed in the least developed countries and there is vast potential for increased international outreach to help introduce the technology in these countries. As a dispatchable low-carbon electricity source with low operating costs, nuclear is a perfect fit for 24x7 data centres and other technology industries.

Radioisotope techniques can help make products safer and improve their quality. These techniques can also make industrial processes more efficient, environmentally friendly, and cost-effective.

SDG 10 - Reduced Inequalities

Nuclear project developers must typically engage stakeholders in extensive consultation before beginning construction, making sure that different voices get their say, including indigenous and marginalized groups. As a centralized form of electricity generation run by large companies with a culture of regulatory compliance, it should be easier to enforce anti-discrimination policies within a nuclear workforce than in some others. Universal access to low-cost clean electricity will help reduce socio-economic inequalities.

SDG 11 - Sustainable Cities and Communities

Nuclear energy can support urban development. Nuclear plants provide affordable reliable electricity which is well-suited to supplying cities where there is 24-7 energy demand. Nuclear energy assists in the electrification of public transport, and especially rail networks, without contributing to air pollution. It supports municipal waste management and recycling. Since nuclear facilities are mostly located in rural communities, but headquarters and governments are based in cities, the nuclear industry creates links to different regions within a country. In addition, nuclear projects will result in significant economic development for the rural communities in which they are sited. Small Modular Reactors (SMRs) and micro reactors are a promising potential source of electricity, district heating or desalination for off-grid remote communities.

SDG 12 - Responsible Consumption and Production

Nuclear energy generally requires fewer mineral inputs than other energy sources, including critical raw materials[21]. Its primary ongoing mineral input is uranium; however, there are no primary competing peaceful uses for this. The uranium resource is ample and distributed widely across the globe, and its mining and processing are subjected to high standards. Nuclear energy does produce waste – notably high-level radioactive waste – but the volumes are small. They need to be responsibly managed before final disposal. Most of the materials and components of a plant are suitable for release based on nuclear regulatory control and therefore available for reuse or recycling. Only a small percentage of the total mass of a plant needs to be disposed of. Innovations such as new fuel designs can increase the efficiency of nuclear power plants, reducing all materials requirements even further.

SDG 13 - Climate Action

Nuclear energy is the world's second-largest source of low-carbon electricity behind hydro power and it displaces fossil fuel sources that would produce about two gigatonnes of CO2 every year. Evidence shows that nuclear energy can be scaled up in a country quickly compared to other low carbon technologies, and including it in future energy pathways will help to reduce the time, costs, and risks of decarbonization. Nuclear plants can be engineered with a high degree of climate-resilience and are less prone to many climate/weather disruptions than other low-carbon energy forms. Future reactor designs will be able to supply industrial heat and assist the production of synthetic fuels for transport applications, thereby further reducing CO2 emissions from these sectors.

SDG 14 - Life Below Water

Nuclear energy does not produce CO2 emissions which contribute to ocean acidification or other chemical emissions that pollute waterways. Scientists are using nuclear techniques to monitor and studying ocean acidification and understand how it affects marine life and ecosystems, and identify ways to protect the ocean and coastal communities.

SDG 15 - Life on Land

Nuclear energy has a very high energy density, and facilities take up minimal land. Plant boundaries are often set quite large for safety and security purposes, and within these wildlife habitats are often found. Often plant operators support conservation activities which help to protect local species.

[21] See for example US DOE, 2015, Quadrennial Technology Review.

Experts use nuclear techniques to assess soil quality and study how crops take up nutrients, as well as how soil moves. This can also be used to combat desertification.

SDG 16 - Peace Justice and Strong Institutions

Civil nuclear programmes require the development of strong national institutions, while nuclear facilities are subject to robust regulation that is often backed by international conventions. Notable conventions include the Convention on Nuclear Safety, the Convention on Physical Protection of Nuclear Material as well as the Paris and Vienna conventions (which covers third party liability).

SDG 17 - Partnerships for the Goals

The nuclear community has developed partnerships with governments, NGOs, educational institutes and many UN bodies, helping them to contribute their skills and resources to the sustainable development of nuclear technology. IAEA promotes policy coherence by establishing safety standards, and providing security recommendations and technical guidance to its member states. The IAEA also develops partnerships through technical cooperation programmes. There is enormous potential to support newcomer governments in the development of sustainable nuclear energy entry pathways.

With a "foot on the first rung of the ladder of development."

At the time of its independence in 1971, a vast majority of Bangladesh's population of 75 million lived in poverty and depended on subsistence agriculture. Fast forward to 2018, and Bangladesh has emerged as one of the fastest-growing economies in the world. Bangladesh has made great strides in social and economic transformation. Since 2005, Bangladesh has grown at an average rate of over 6 percent annually. In 2015, the country graduated from the World Bank-defined low-income group to the lower-middle-income group. The country has undergone some structural transformation over the past four decades, where the share of agriculture in GDP declined from around 60 per cent in the early 1970s to 15 per cent in 2016. The structural transformation through an emphasis on manufacturing requires energy. Bangladesh started construction of its first nuclear power reactor in November 2017. Commissioning is expected in 2023. Construction of a second unit commenced in July 2018, with commissioning planned in 2024. More reactors are proposed, which will propel Bangladesh forward as a prosperous country in the next couple of decades.

Nuclear energy and technology ccontribution to UN SDGs