



NUCLEAR POWER FOR SUSTAINABLE DEVELOPMENT

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**How nuclear power can contribute
to sustainable development goals
in the age of climate change challenge**

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Developed and designed by Rusatom Overseas in 2019

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WHY WE BELIEVE NUCLEAR POWER CAN BE A DRIVER OF SUSTAINABLE DEVELOPMENT

THESE DAYS THE WORLD IS STRIVING TO ACHIEVE SUSTAINABLE DEVELOPMENT GOALS SET BY THE UNITED NATIONS. THE ENERGY SECTOR AND NUCLEAR POWER IN PARTICULAR CAN PLAY A MAJOR ROLE IN THESE EFFORTS

SUSTAINABLE DEVELOPMENT GOALS



It is the time to look at nuclear energy through the prism of sustainability and the UN's Sustainable Development Goals



Kirill Komarov,
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First Deputy Director General,
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INTRODUCTION

Today, the world is shifting towards new economic patterns that make sustainable development an even greater challenge.

In 2015, the UN launched the 17 Sustainable Development Goals, or SDGs, that cover a lot of ground and address various fields and sectors in social, economic and environmental dimensions. The SDGs have been adopted by 193 UN member states and can be applied to all countries regardless of their level of economic development, size or population. Achieving sustainable development goals has now become a driver for most of the world's

THE ROLE OF NUCLEAR POWER IN CLIMATE CHANGE MITIGATION IS BEING HIGHLIGHTED BY INTERNATIONAL COMMUNITY, INCLUDING THE INTERNATIONAL ENERGY AGENCY AND INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE. SPECIFICALLY IN ADVANCE OF THE UN CLIMATE CHANGE CONFERENCE COP 25, EUROPEAN PARLIAMENT ADOPTED A RESOLUTION STATING THAT "... NUCLEAR ENERGY CAN PLAY A ROLE IN MEETING CLIMATE OBJECTIVES BECAUSE IT DOES NOT EMIT GREENHOUSE GASES, AND CAN ALSO ENSURE A SIGNIFICANT SHARE OF ELECTRICITY PRODUCTION IN EUROPE".

economies. What is more, meeting sustainable development targets has become a responsibility not only for governments but also for businesses and financial institutions.

There is no denying that the energy sector is one of the key drivers for both social and economic development. Limited or unstable access to power is one of the key obstacles on the way to countries' comprehensive development. To ensure sustainable growth, it is therefore crucial for countries to ensure their energy mix is based on reliable, affordable and sustainable energy sources.

Moreover, decarbonization of the global energy mix is yet another high-priority goal to be achieved since the energy sector is one of the main CO₂ emitters. Nuclear power does not emit CO₂ during operation and contributes to achieving net-zero energy mix.

Nuclear power is a source of energy that provides dispatchable and clean electricity with a low carbon footprint and it is highly predictable in terms of costs and reliability of supply.

What is more, incorporating nuclear power into the national energy mix results in developing energy-intensive industries and GDP growth, social development by promoting education and innovation and climate change mitigation — the three pillars of sustainable development.

Most importantly, nuclear power projects are positive examples of strong international cooperation that brings together various stakeholders and provides for building solid long-term partnerships. That is why nuclear power should keep and even strengthen its position in the global energy mix.

At the same time, the global energy system is undergoing drastic transforma-

NUCLEAR POWER CONTRIBUTES TO



JOB CREATION

EACH NPP UNIT*
CREATES
200,000
JOB-YEARS
OVER ITS
LIFECYCLE

ECONOMIC



GLOBAL ENVIRONMENT

2.1 GT OF
CO₂ EMISSIONS
PREVENTED
ANNUALLY BY
449 NUCLEAR
POWER REACTORS**
OPERATING
WORLDWIDE

ENVIRONMENTAL



ACCESS TO ENERGY

ONE NPP*
CAN PROVIDE
ACCESS TO
BASELOAD
LOW-CARBON
ENERGY FOR
5 ABOUT
MLN PEOPLE

SOCIAL

THREE SUSTAINABLE DEVELOPMENT PILLARS

tion; while some regions are still struggling without basic commodities like heat and power, a comprehensive energy system is emerging.

The role of nuclear power is to ensure stability within modern integrated energy systems and contribute to achieving

Sustainable Development Goals by all nations. To succeed in building a sustainable energy system for the world to prosper we need to make sure that nuclear power continues playing its unique role in the global energy balance while doing no harm to the environment. ■

*1-unit NPP with 1,000-1,200 MWe capacity
**in 2019

1 Energy drives Sustainable Development



ENERGY IS SEEN AS THE CRUCIAL FACTOR IN ACHIEVING SDGs

WHY IS ENERGY SO IMPORTANT FOR SDGs?

There is no doubt that energy is a prerequisite to sustainable development with nuclear power being its essential part. Access to reliable and affordable energy services ensures continuous development both at social and economic levels. SDG 7 is dedicated to providing affordable and clean energy since production and consumption of electricity have an impact on all three pillars of sustainable development — economic, social, and environmental.

Stable supply of energy is essential for a long-term comprehensive economic and social development which makes a difference to people's everyday lives at all levels: safety on the

streets, telecommunication systems, business processes and modern technologies for education and healthcare largely depend on the efficient operation of energy systems.

Unreliable and unstable access to power is one of the top constraints¹ to the economic development alongside with corruption, political instability, taxes, shadow economy and lack of finance, skills or land.



860 MILLION PEOPLE STILL DO NOT HAVE ACCESS TO ELECTRICITY⁴

30.4% OF FIRMS SEE ELECTRICITY AS A MAJOR CONSTRAINT ON BUSINESS DEVELOPMENT⁵

POWER OUTAGES COST AFRICAN COUNTRIES **~1-4%** OF THEIR ANNUAL GDP⁶

ACCORDING TO THE IEA, GLOBAL POWER CONSUMPTION WILL MORE THAN DOUBLE BY **2040**

The good news is that the number of people without access to electricity fell from 1.7 billion in 2000 to 860 million in 2018² and by 2030 is projected to fall by 36%³, despite an increase in the global population.

Developing countries in Sub-Saharan Africa are making progress in decreasing the number of people without access to electricity; however, the electrification rate in this region is still below 45%. Asia has made significant progress in providing access to electricity for people and in

ACCESS TO SUSTAINABLE ENERGY CAN CHANGE LIVES

2016 reached the electrification rate of 89%, while in 2000 the indicator was merely 67%. It is expected that the universal access to electricity can be achieved in Asian countries by 2030. Latin America and the Middle East have already reached almost 100% electricity access (99% and 95%, respectively).

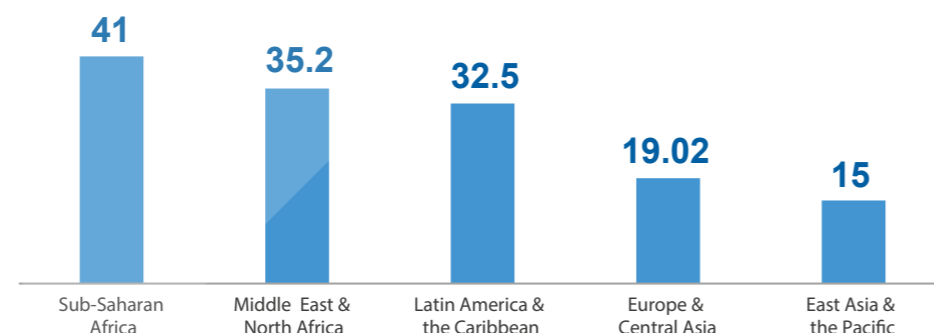
Even though the trend looks optimistic, by 2030 almost 8% of the world's population, which amounts to 670 million people, will still have no access to electricity.

Moreover, the mere access to electricity, which to many sounds synonymous to household access to electricity, is not itself enough to drive forward so-

The figures are self-explanatory: on average, 4.5% of annual sales are lost due to power outages globally, while for South Asia these losses account for almost 11%.

Limited access to power therefore goes far beyond just being an electricity and heat issue: it is an obstacle on the way to countries' sustainable development.

Share of firms that see electricity as a major constraint, by region



	Sub-Saharan Africa	East Asia and Pacific	Europe and Central Asia	Latin and Central America	South Asia	MENA
1st obstacle	ACCESS TO POWER	Corruption	Tax rate	Corruption	Political Instability	Corruption
2nd obstacle	Finance	ACCESS TO POWER	Political Instability	Skills	ACCESS TO POWER	Political Instability
3rd obstacle	Shadow economy	Skills	ACCESS TO POWER	ACCESS TO POWER	Corruption	Land
4th obstacle	Corruption	Political Instability	Corruption	Tax rate	Finance	ACCESS TO POWER
5th obstacle	Tax rate	Tax rate	Skills	Political Instability	Land	Shadow economy

cial and economic development. It is its quality and quantity that matter.

It is not uncommon for households to have only low-quality access: limited hours of electricity at low voltage and relatively poor reliability. Few people ac-

tually have high-quality and reliable access to power.

Power supply should be sufficient and stable while prices should not fluctuate much and should demonstrate predictability in the long run. ■

▲
Top 5 constraints

ELECTRICITY SUPPLY IS ESSENTIAL FOR BOTH DAY-TO-DAY LIFE AND LONG-TERM DEVELOPMENT

QUALITY OF LIFE

In general, energy ensures economic stability and development, creates jobs and improves living standards



BUSINESS

Electricity supply is a key condition for successful development of transportation and commerce, micro-, small- and medium-size businesses, agriculture and various industries



HEALTH

Modern health-care system cannot possibly exist without energy. It allows refrigerating various types of medicine, vaccines as well as operating and sterilizing medical equipment



EDUCATION

All kinds of educational institutions need electricity supply. It provides proper conditions for education, including incorporation of IT technologies into the educational process

2 The role of nuclear power in achieving SDGs

WITH A GROWING GLOBAL DEMAND FOR LOW-CARBON ENERGY, WORLD CAN BENEFIT FROM BUILDING NEW NUCLEAR POWER PLANTS

Lack of security, availability and reliability of the energy system can become a stumbling block to socio-economic development. For instance, power outages cost African countries ~1–4% of their GDP every year.

Moreover, 81% of the global energy mix is still based on fossil fuels, the same percentage as 30 years ago. Recent developments in the renewable energy sector are no doubt extremely significant, and renewables have been recognized as a very rapidly developing energy sector globally both in terms of capacities being installed and in terms of the total volumes of investments. However, the ener-

gy sector is still one of the main emitters of CO₂ and other GHGs that account for about 67% of total GHG emissions⁷, which worsens climate change. According to the World Health Organization, the health sector suffers an estimated direct damage of USD 2–4 billion each year due to the global climate change⁸.

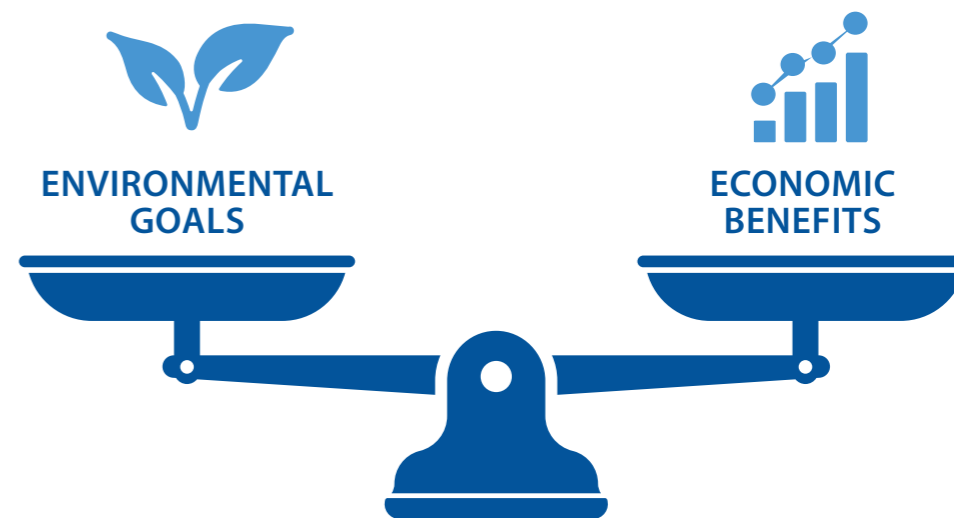
As a result, one of the key issues today is how to find the right balance between these two dilemmas: ensuring security of electricity supplies to boost economic development, on the one hand, and combating climate change efficiently, on the other. While some public groups are interested in environmental sustainability, others care more about GDP and income growth, which may go against the climate agenda.

Even though fossil fuels can provide the base load essential for economic growth, they barely contribute to climate change mitigation. At the same time, such low-carbon energy sources as wind and solar are intermittent and pose risks to the security of power supply, which is essential for heavy industries and medical institutions.

Here, the role of nuclear power cannot be overestimated.

TODAY, NUCLEAR POWER IS THE KIND OF BASELOAD CARBON-NEUTRAL ENERGY THAT MAKES IT POSSIBLE TO SUCCEED IN BOTH AREAS

Finding the right balance between economic and environmental goals





Ensure access to affordable, reliable, sustainable and modern energy for all



NUCLEAR ENERGY IS:

AFFORDABLE ENERGY

While NPP construction projects require substantial capital investments, their operational costs make up a relatively smaller share of generation costs.

Fuel prices account for less than 20% of NPP power generation costs. While conventional energy sources highly depend on fuel prices, nuclear power costs are hardly affected by fuel price fluctuations, which is crucial when energy sources are imported. This low dependency on fuel prices provides for cost predictability even in the long run and ensures energy security for more than 60 years.

Secondly, the fuel campaign for nuclear power is much longer than for other conventional energy sources. Uranium has the highest energy value compared to the most common fossil fuels used to generate electric power. While 1 kg of coal provides 8 kWh of electricity, 1 kg of

uranium generates 50,000 kWh, a figure which would require 2.7 million kg in coal equivalent⁹.

What is more, since all power plants invariably need fuels to operate, longer fuel campaigns typical of nuclear power plants may substantially increase logistics efficiency. For example, a large coal-fired power plant at full load requires at least one daily coal delivery of over 10,000 tons, especially in "peak seasons" when demand is at its highest¹⁰. Coal burning therefore heavily depends on the capacity to transport coal in sufficient amounts reliably and at reasonable prices. This means that final prices for consumers are affected not only by coal prices, but also by logistics. Nuclear power does not require frequent fuel deliveries so that reliability of power supply and generation costs do not so much depend on fuel transportation.

RELIABLE ENERGY

Nuclear power makes a significant contribution to ensuring energy security and optimizing the cost of electricity.

One factor that contributes to energy security is nuclear power plants' ability to be built on a wide range of sites and generate power regardless of climatic conditions. This overcomes the main limitation of renewable energy sources that are non-dispatchable and highly dependent on weather conditions. Today only very few countries in the world can achieve a renewables-on-

ly grid — since energy storage is still very expensive. These are well-off and developed countries with predominantly residential electricity consumption and favorable geographical and climatic conditions. Energy intensive industries currently cannot rely on wind or solar power. Therefore, even though renewable sources are clean, the electricity they generate is intermittent. At the same time, nuclear power ensures reliable base load supply during the whole 60+ year lifecycle.

SUSTAINABLE AND MODERN ENERGY

The energy industry is one of the biggest CO₂ producers. Unlike conventional power plants that have to use fossil fuels, nuclear power plants barely emit CO₂ throughout the entire lifecycle. For example, coal power plants emit 820 gCO₂eq/kWh during their lifecycle of which almost 760 gCO₂eq/kWh are direct emissions during operation.

For nuclear power, indirect emissions of CO₂ during the whole fuel cycle from mining to waste treatment are mere 12 gCO₂eq/kWh. What is more, NPPs do not have any direct CO₂ emissions or any biogenic CO₂ emissions. Wind power plants' indirect emissions during lifecycle average 11 gCO₂eq/kWh onshore and 12 gCO₂eq/kWh offshore. Solar PVs produce 48 gCO₂eq/kWh of indirect emissions¹¹.

NUCLEAR ENERGY IS THE ONLY EXISTING TYPE OF GENERATION THAT MEETS ALL THE CRITERIA OF SUSTAINABLE ENERGY SYSTEMS AT ONCE



COST PREDICTABILITY FOR POWER GENERATION



NON-INTERMITTENT POWER SUPPLY



MINIMUM CARBON DIOXIDE EMISSIONS DURING LIFECYCLE

CLIMATE CHANGE MITIGATION

ENERGY SECURITY

ACCESS TO ENERGY

STABLE POWER SUPPLY FOR 60+ YEARS

Since 1980, total CO₂ emissions have almost doubled and reached the historic peak. At the UN Climate Change Conference COP-21 held in Paris in 2015, the leaders of 150 nations pledged to keep the increase in global temperatures by 2100 well below 2°C and as close as possible to 1.5°C compared to pre-industrial levels.

However, global emissions continue growing: in 2018, the volume of global emissions set another gruesome record of 55.3 GtCO₂e¹².

Despite this, global energy mix is still based on fossil fuels with energy consumption and production standing behind around 2/3 of the global GHG emissions. According to the International Energy Agency, IEA, in 2018 global energy-related CO₂ emissions rose by 1.7% to reach a historic high of 33.1 Gt CO₂¹³ driven by higher energy demand in 2018.

In order to succeed in limiting global warming to below 2°C and 1.5°C, by 2030 emissions have to be lower than in 2018 by 25% and 55% respectively. That means that the energy sector has to evolve and one of the options is adding nuclear capacities into the global energy balance.

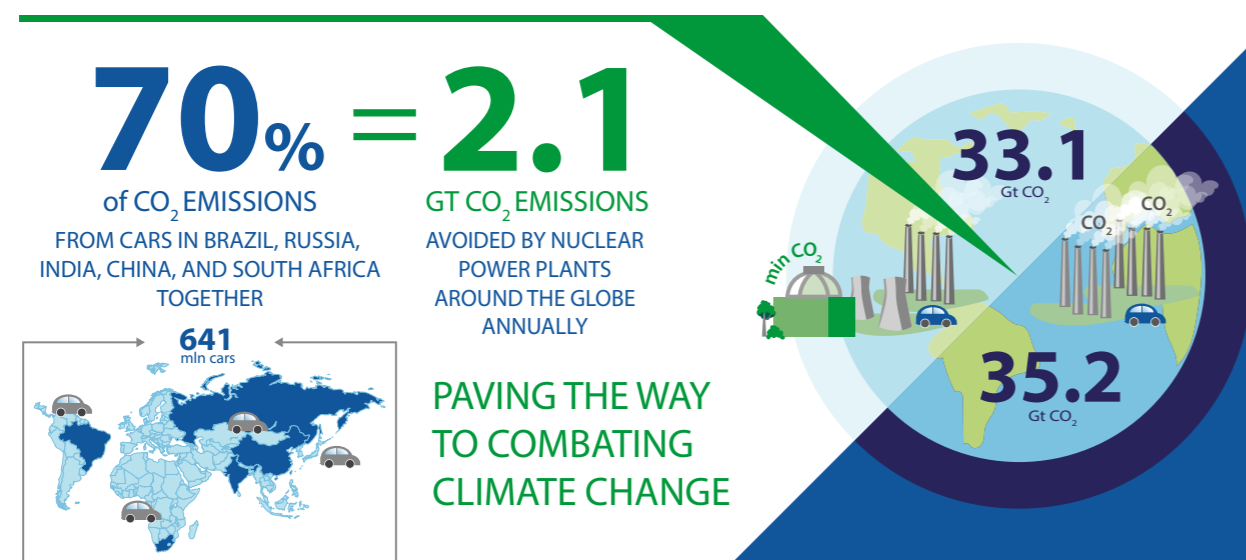
According to the International Atomic Energy Agency, IAEA, nuclear power

plants help to prevent 2.1 Gt¹⁴ of CO₂ emissions annually, while over the period 1970–2015, nuclear power prevented around 68 Gt of CO₂¹⁵, close to the total emissions from the entire power sector over 2010–2015.

2.1 Gt CO₂ is comparable to 70% of emissions from the combined car fleet of the BRICS countries (Brazil, Russia, India, China, South Africa), which amounts to 641 million vehicles¹⁶.

All NPPs around the globe help to avoid almost as much CO₂ as is absorbed by global forests each year: in accordance with a NASA-led study, all forests absorb almost 2.5 Gt CO₂ annually¹⁷.

WITHOUT NUCLEAR POWER, GLOBAL CO₂ EMISSIONS FROM ELECTRICITY GENERATION WOULD HAVE BEEN ALMOST 20% HIGHER OVER THE LAST 50 YEARS



NUCLEAR POWER HELPS TO ACHIEVE NOT ONLY CLIMATE BUT ALSO ECONOMIC GOALS

Nuclear energy goes further than just bringing light to houses — it gives the green light to the countries' economic growth and social development while paving the way to combating climate change.

All modern economies need power even though different countries have different economic models. Some focus on heavy industry or machinery sectors development that require a reliable source of base load energy. Others develop the service sector driven by public-oriented services such as light industry, agriculture and tourism that require clean and reliable electricity supply when and where it is needed. Digital economies focus on innovation and digital aspects such as the development of data centers, high-tech and computerized services. For them, a stable and reliable source of power is one of the top priorities.

Depending on its exact needs and long-term goals, each nation chooses a certain development vector. Nuclear power can be integrated effectively into any of these models.

For countries with overreliance on any particular source in the energy mix, nuclear power is a tool to diversification while meeting the growing demand for reliable electricity supply and combating effects of climate change by cutting CO₂ emissions.

What is more, nuclear power plants can contribute to renovation of power capacities by reducing the average age of installed capacity and thus contributing to stability within the energy system.

Nuclear power plants benefit countries by creating jobs during NPP con-

struction and operation, both directly and indirectly: 1 job created at an NPP leads to 10 jobs created in other fields.

Although part of NPP project implementation costs are associated with the construction or renovation of grid infrastructure, railways, bridges, roads, etc., this infrastructure can be used for purposes not related to further operation of nuclear power plants.

NPP projects lead to the creation and development of the urban environment around the nuclear power plant.

200,000 JOB-YEARS OVER A LIFE CYCLE ARE CREATED BY EACH NPP CONSTRUCTED¹⁸

Nuclear power plays an important role in boosting socio-economic development both in the short-term and long-term perspectives: construction of an NPP results in comprehensive spillover and multiplier effects on GDP throughout the NPP lifecycle.

NPP construction provides outstanding opportunities for local companies to gain the required competencies to operate in international markets. By participating in NPP construction, local industries can be involved in the global value chains and international projects, which will increase their country's investment attractiveness. ■

3 Nuclear power contributes to SDGs



AS A RESULT, NUCLEAR POWER HAS A **DIRECT IMPACT** ON FOUR SUSTAINABLE DEVELOPMENT GOALS



WITH **MORE POSITIVE EFFECTS** ON OTHER SUSTAINABLE DEVELOPMENT GOALS

NPP construction is a comprehensive and complex project that reaches out far beyond just the power sector. Nuclear power is indeed an efficient tool to continuously provide a number of benefits to the country employing it for more than 60 years. Countries can fully rely on NPP projects in accomplishing their ambitious sustainable development goals.



DIRECT IMPACT

MORE POSITIVE EFFECTS



7 AFFORDABLE AND CLEAN ENERGY
GOAL 7: Affordable and Clean Energy

8 DECENT WORK AND ECONOMIC GROWTH
GOAL 8: Decent Work and Economic Growth

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
GOAL 9: Industry, Innovation and Infrastructure

13 CLIMATE ACTION
GOAL 13: Climate Action



1 NO POVERTY
GOAL 1: No Poverty
 Reliable electricity supply is essential for production activities (agriculture, industrial or service sectors), which as a result boosts development and reduces poverty.

2 ZERO HUNGER
GOAL 2: Zero Hunger
 Nuclear energy can ensure food supply and security: electricity helps the agriculture sector to improve by operating machinery and equipment, heating or cooling stocks, and providing light on farms.

3 GOOD HEALTH AND WELL-BEING
GOAL 3: Good Health and Well-Being
 Nuclear power ensures stable electricity generation that enables medical clinics and hospitals to provide all the required services: operate and sterilize medical equipment, refrigerate vaccines, etc.

ECONOMIC

6 CLEAN WATER AND SANITATION
GOAL 6: Clean Water and Sanitation
 An efficient water cycle is part of nuclear power plant operation. Therefore, high standards for water treatment and purification are set at all NPPs.

12 RESPONSIBLE CONSUMPTION AND PRODUCTION
GOAL 12: Responsible Consumption and Production
 All stages of nuclear facilities construction, operation and decommissioning are strictly regulated and controlled both by the hosting country's regulating authority and the vendor's standards, which prevents significant harm to the environment and ecosystems. All NPPs are also under international supervision of the IAEA.

14 LIFE BELOW WATER
GOAL 14: Life Below Water
GOAL 15: Life on Land
 For all NPP projects, an environmental impact assessment is required to ensure that all the specific features of local land and water ecosystems are taken into account to avoid any harm to the environment

ENVIRONMENTAL

4 QUALITY EDUCATION
GOAL 4: Quality Education
 Nuclear power enhances human resources development since NPPs require highly educated and trained personnel.

10 REDUCED INEQUALITIES
GOAL 10: Reduced Inequality
 Nuclear community is smoothing inequality barriers between emerging and developed economies by ensuring access to reliable energy for all as a foundation for consistent economic growth.

16 PEACE, JUSTICE AND STRONG INSTITUTIONS
GOAL 16: Peace and Justice Strong Institutions
 One of the objectives of the IAEA Statute is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world".

SOCIAL

REFERENCES

- 1 What are the Links between Power, Economic Growth and Job Creation?, CDC Group, 2016, table 8, p. 18
- 2 SDG7: Data and Projections. Access to Affordable, Reliable, Sustainable and Modern Energy for All, IEA, Flagship report, November 2019
- 3 World Energy Outlook 2017, International Energy Agency, p. 48
- 4 SDG7: Data and Projections. Access to Affordable, Reliable, Sustainable and Modern Energy for All, IEA, Flagship report, November 2019
- 5 Enterprise Surveys, the World Bank Group
- 6 Financial Viability of Electricity Sectors in Sub-Saharan Africa, Policy Research Working Paper, World Bank, 2016, p. 8
- 7 Shaping the Future of Energy, World Economic Forum
- 8 Climate Change and Health, the World Health Organization, 2018
- 9 Nuclear Power and Sustainable Development International, International Atomic Energy Agency, 2016, p. 58
- 10 Heavy Metals in the Environment, Lawrence K. Wang, Jiaping Paul Chen, Yung-Tse Hung, Nazih K. Shammas, 2009, p. 54
- 11 Intergovernmental Panel on Climate Change Report, Annex III Technology-Specific Cost and Performance Parameters, p. 1335
- 12 Emissions Gap Report 2019, UN Environment Program, Executive summary, p. IV
- 13 Global Energy & CO₂ Status Report, International Energy Agency, 2018, p. 3
- 14 Calculated Data Based on Average CO₂ Emissions per TWh and IAEA Nuclear Electricity Production (TWh) (<https://www.iea.org/statistics/electricity>)^(1 2 3)
- 15 Climate Change and Nuclear Power, International Atomic Energy Agency, 2018, p. 46
- 16 Average CO₂ Emissions of a Typical Passenger Vehicle, United States Environmental Protection Agency
- 17 NASA Finds Good News on Forests and Carbon Dioxide, Last Updated: Aug. 7, 2017
- 18 Measuring Employment Generated by the Nuclear Power Sector, OECD-NEA, p. 12