

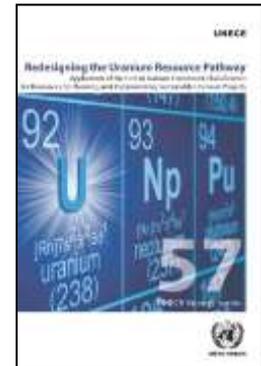
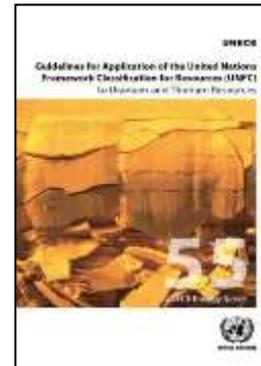
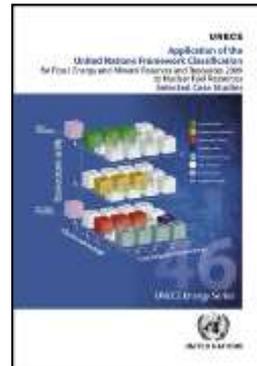
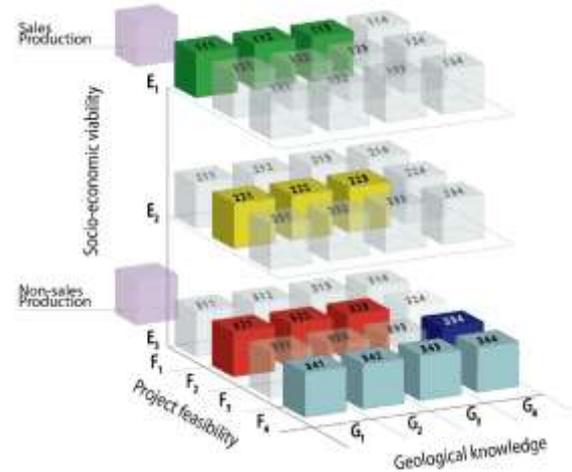
UNECE The Use of Nuclear Fuel Resources for Sustainable Development: Entry Pathways



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Director Harmony Programme

Application of UNFC to Nuclear Fuel Resources

- United Nations Framework Classification for Resources (UNFC) is a classification system for defining the environmental-socio-economic viability and technical feasibility of projects to develop resources.
- Application of the United Nations Framework Classification (UNFC) for Fossil Energy and Mineral Reserves and Resources 2009 to Nuclear Fuel Resources – 2015
- Guidelines for Application of UNFC to Uranium and Thorium Resources – 2017
- Redesigning the Uranium Resource Pathway - Application of the UNFC – 2019



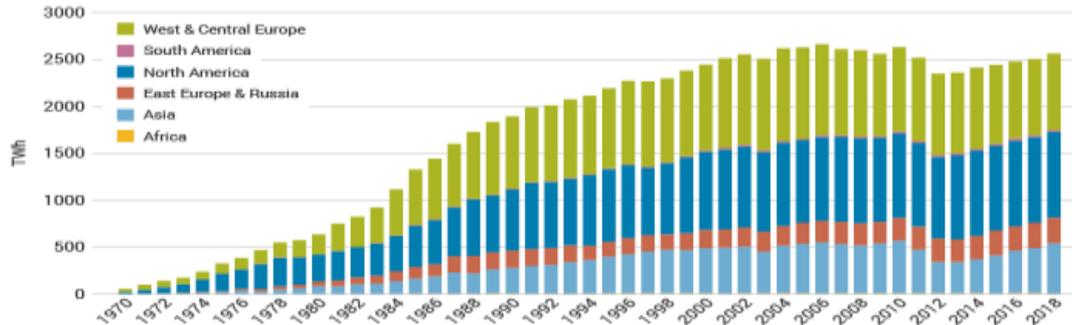
Entry Pathways: overview

- Entry Pathways report was initiated in April 2019.
- Published as an UNECE report in March 2021.
- A major collaborative effort with contributions from over 20 experts from many ECE member states.
- Technical integrity reviewed by experts at the International Atomic Energy Agency (IAEA), Organisation for Economic Co-operation and Development Nuclear Energy Agency (OECD-NEA) and World Nuclear Association (WNA).



Entry Pathways - objectives

- This report aims to inform sound policy formulation for countries considering nuclear energy programmes and to help them define locally relevant pathways to support sustainable development.
- Complement the previous reports to support the application of the United Nations Framework Classification for Resources (UNFC) and United Nations Resource Management System (UNRMS).
- Particular attention is given to newcomer countries and the deployment of SMRs.
- The report explores pathways in the context of local and regional factors, including the utilization of domestic uranium resources, that could facilitate nuclear energy and economic development.



Source: World Nuclear Association and IAEA Power Reactor Information Service (PRIS)

Status of plans in nuclear newcomer countries

- Nuclear power plants under construction: Bangladesh, Belarus*, Turkey, United Arab Emirates*. (*First nuclear power reactor has now started operation.)
- Contracts signed, legal and regulatory infrastructure well-developed or developing: Egypt, Uzbekistan.
- Committed plans, legal and regulatory infrastructure developing: Ghana, Jordan, Nigeria, Poland, Saudi Arabia.
- Well-developed plans but commitment pending/deferred: Ethiopia, Indonesia, Kazakhstan, Lithuania (deferred), Malaysia (deferred), Philippines, Thailand (deferred), Vietnam (deferred).

Potential newcomers

- Developing plans: Algeria, Bolivia, Estonia, Kenya, Laos, Morocco, Rwanda, Sri Lanka, Sudan, Zambia.
- Discussion as policy option: Albania, Azerbaijan, Chile, Croatia, Cuba, Israel, Latvia, Libya, Mongolia, Namibia, Paraguay, Peru, Qatar, Serbia, Singapore, Syria, Tunisia, Venezuela.

Entry Pathways Report Content

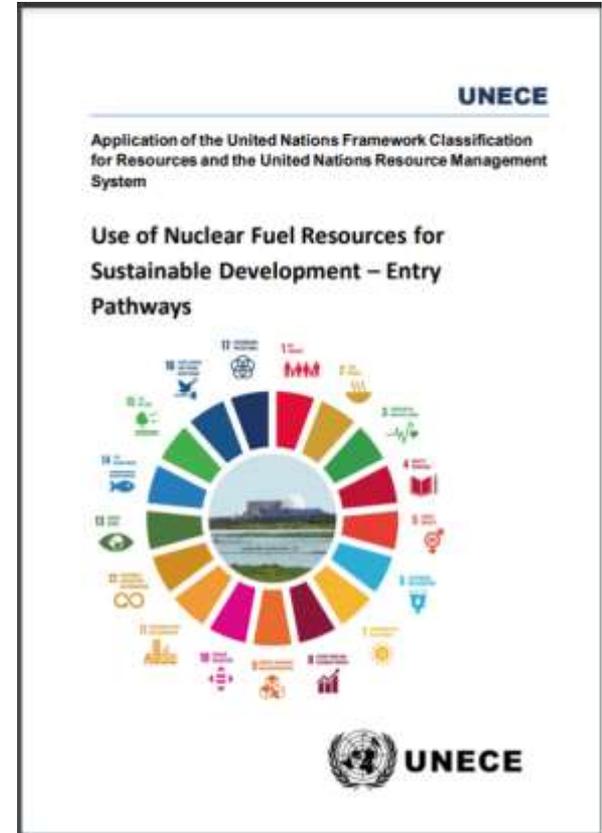
Chapter 2 Nuclear Energy and Sustainable Development. How nuclear energy relates to the SDGs and its potential role in the future decarbonized energy mix.

Chapter 3 Nuclear Development Considerations. Five common nuclear development factors include energy planning, socioeconomics, environment, legal and regulatory framework, and economics, which are key to making a decision on whether to pursue a nuclear energy programme and then making sure the programme remains aligned with principles of sustainable development.

Chapter 4 National and Regional Considerations. The broader nuclear fuel cycle and the relative advantages of developing domestic facilities versus potential regional or international options, as well as strategies for radioactive waste management and disposal.

Chapter 5 Nuclear Technology Options. The range of ‘gigawatt-scale’ nuclear technologies available today as well as SMRs, which are rapidly approaching commercialization. Analysis of their techno-economic performance and how they can help support future hybrid-energy systems, including low-carbon heat and hydrogen production in a high-renewables future mix.

Chapter 6 Nuclear Energy Entry Pathways. The role of policy – how the existing policy framework can help a country make a decision on whether to pursue a nuclear energy programme, and the policy initiatives that can help to improve the economics of a programme and build public support for it once a decision is taken.



Chapter 2: Nuclear energy and Sustainable Development



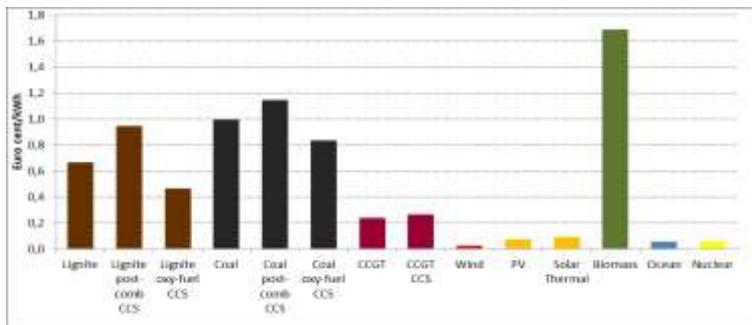
Nuclear energy technology contributes to ALL the Sustainable Development Goals

Chapter 3: Nuclear Development Considerations

- Energy system evaluation and planning
- Socioeconomic development factors
- Environmental factors
- Establishing the legal and regulatory framework
- Economics and project financing

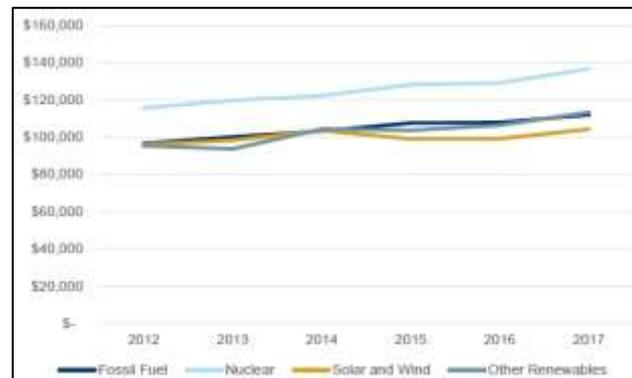


IAEA Milestones approach



Health effects, measured by their external costs

Source: NEEDS (2009), New Energy Externalities Developments for Sustainability,

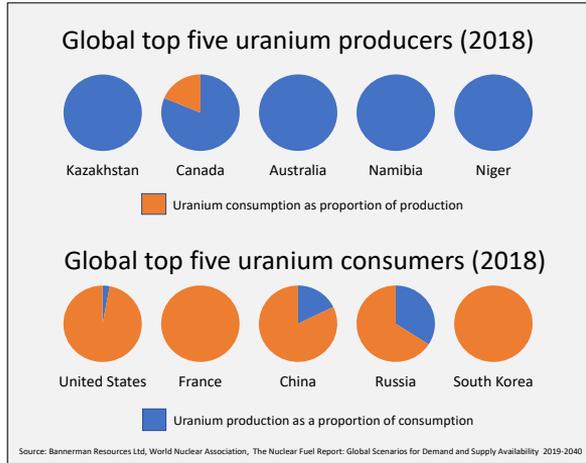


Average salary of a US energy worker

Source: Oxford Economics

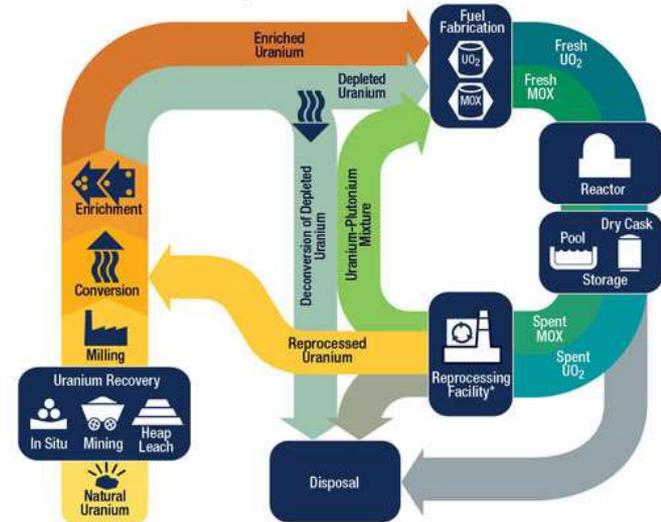
Chapter 4 National and Regional considerations – the nuclear fuel cycle

- Utilising local uranium resources
- Developing the nuclear fuel cycle
- Sustainable management of radioactive materials and waste
- Focus on decommissioning
- Disposal of high level waste



The global distribution of uranium production and consumption

The Nuclear Fuel Cycle



* Reprocessing of spent nuclear fuel, including mixed-oxide (MOX) fuel, is not practiced in the United States.
Note: The NRC has no regulatory role in mining uranium.

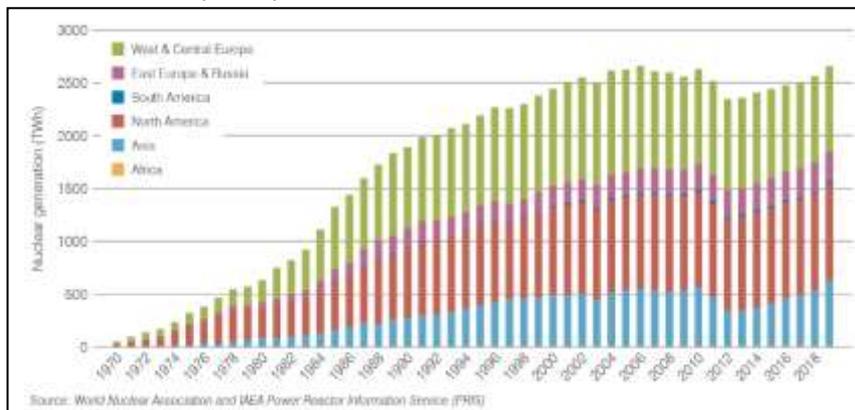
As of January 2019

Chapter 5 Nuclear Technology Options – Current large reactors

The nuclear power plants operating across the world are based on proven technology, which has evolved and matured over the past 40 years. These reactors are available in capacities from about 600MWe to 1700MWe.



Tianwan nuclear power plant units 1-6



Nuclear electricity production

Chapter 5 Nuclear Technology Options – Small modular reactors and hybrid systems

SMRs and floating nuclear power plants for small grids or remote communities



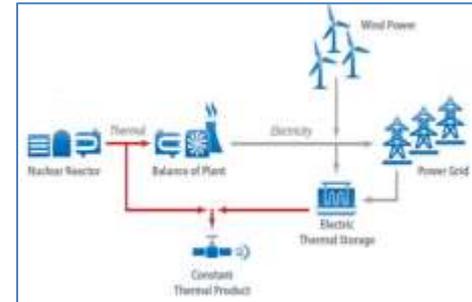
Hydrogen production



High temperature gas reactors for industrial heat



Integrated nuclear-renewable energy systems



Nuclear Energy Entry Pathways

Nuclear energy supports the realization of a number of national policy goals, including; affordable and clean energy provision, mitigating climate change, enhancing energy resilience, development of industry and infrastructure.



The four units of the Barakah nuclear power plant in UAE

Policies that support nuclear energy

- A roadmap to sustainable development
- A plan for transitioning to a low-carbon economy
- Electricity market design
- Policies for improving energy security and resilience
- Integrated industrial development

Entry Pathways Report main findings

- Nuclear energy is an indispensable tool for achieving the global sustainable development agenda. It has a crucial role in decarbonizing the energy sector, as well as eliminating poverty, achieving zero hunger, providing clean water, affordable energy, economic growth, and industry innovation. Improved government policy and public perception along with ongoing innovation will enable nuclear energy to overcome traditional barriers to deployment and expand into new markets.
- Nuclear energy entry pathways for newcomer countries align with the 2030 Agenda for Sustainable Development. Nuclear energy programmes, based on the IAEA's Milestones Approach, support national energy needs, socio-economic, and environmental goals, and can help countries meet international climate commitments.
- There are many sustainable options for implementing a nuclear fuel cycle and waste management strategy. Countries should adopt such strategies based on their needs (e.g. enhancing economic development and security of supply) as well as the presence of domestic mineral resources, technical capabilities, and the economic opportunities they see in the different fuel cycle options.
- For a nuclear programme to be successful, policy makers should prioritize: nuclear energy policy, electricity market design, international cooperation, regulatory harmonization, nuclear skills and supply chain development, project structuring and management, public engagement, and building diversity and inclusivity.

WORLD NUCLEAR ASSOCIATION

The Harmony programme is a global initiative of the nuclear industry coordinated by World Nuclear Association.



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