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**Nuclear fuel resources**

## **Integrated life cycle management of nuclear fuel resources for sustainable energy: A concept note**

**Prepared by the Nuclear Fuels Working Group and the Sustainable  
Development Goals Delivery Working Group of the Expert Group on  
Resource Management**

### *Summary*

This concept note explores the imperative for accelerating the transformation to a sustainable energy system to realize countries' climate and development goals and the role of an optimal low-carbon energy mix, including nuclear energy. The COVID-19 crisis has brought into focus the importance of progressing with the Sustainable Development Goals (SDGs) with renewed vigour. Clean and affordable energy underpins the realization of all SDGs and will play a central role in the recovery from the economic impacts of the pandemic. Nuclear energy makes a significant contribution to today's global electricity system, providing 10 per cent of global electricity generation in 2018. In the United Nations Economic Commission for Europe region, the nuclear-generating capacity represented about 11 per cent of total electric generating capacity in 2018. In developed countries, nuclear power produced 40 per cent of all non-fossil electricity generation. To understand the role of nuclear energy in sustainable development, assessing from a life cycle perspective using the United Nations Framework Classification for Resources (UNFC) and the United Nations Resource Management System (UNRMS) under development will be essential. This concept note provides a brief overview of the proposed new study that will address and assess the nuclear energy system on a whole life cycle basis based on UNFC and UNRMS.



## **I. The sustainable energy system in the Decade of Action**

1. The 2030 Agenda for Sustainable Development (2030 Agenda), adopted by all United Nations Member States in 2015, provides a blueprint for peace and prosperity for people and the planet, now and into the future. At the heart of the 2030 Agenda are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries – developed and developing – in a global partnership. SDG 7, 12 and 13 are closely linked SDGs, which set targets for clean energy resources within the constraints of global development. Sustainable energy and resource management are at the core of the strategies for sustainable development.

2. While some progress is visible, overall action to meet the 2030 Agenda is not yet advancing at the speed or scale required. The world has agreed to make 2020 the year to usher in a decade of ambitious action to deliver the SDGs by 2030.<sup>1</sup> Unfortunately, the end of 2019 and the beginning of 2020 have brought in more enormous challenges in the form of the COVID-19 pandemic, which is not only causing substantial human suffering but also grinding the global economy to a halt. One unintended positive consequence of this challenging crisis is the temporary lowering of CO<sub>2</sub> emissions and a drastic reduction in air pollution in cities across the world.

3. While the world should collectively do everything to stop this pandemic and recover from its widespread impacts on the economy, the events over the first three months in 2020 reinforce that the 2030 Agenda remains more relevant than ever. The world should increase its efforts to attain the SDGs and consider all means to achieve them most cost-effectively.

4. The International Energy Agency (IEA) noted that the coronavirus crisis emphasizes the indispensable role of electricity in society. Reliable electricity supply is crucial for teleworking, e-commerce, operating ventilators and other medical equipment. Also, firm capacity or baseload power is a crucial element in ensuring electricity security. Policymakers will need to design new markets to promote a diversified mix to strengthen resilience and energy security.<sup>2</sup>

## **II. Building resilience and progressing towards a low-carbon future**

5. Long-term economic recovery from the COVID-19 pandemic and building resilience will require that the 2030 Agenda be pursued with more vigour than ever.

6. With possible economic stress caused by the pandemic, there could be a move to adopt non-optimal solutions, especially where energy is concerned. The impact of such short-term fixes could undermine sustainable development and aggravate the impacts of climate change. Such a situation will not be desirable for the world economy, which has already been debilitated by the pandemic. The United Nations Framework Classification for Resources (UNFC) and the planned United Nations Resource Management System (UNRMS) based on UNFC are global systems for description and management of all energy resources for sustainable development. These tools offer possibilities to develop a multilateral and collaborative platform to facilitate the world to move in the direction of a clean energy transition in the Decade of Action (2020 – 2030). It is intended that application of UNFC and UNRMS will offer countries a way to view the optimal mix of energy sources that will deliver long-term sustainability and support robust growth. It is vital to consider all energy systems, including nuclear energy which is the focus of this note, under the UNFC and UNRMS framework for their accelerated deployment in support of the Global Goals.

7. The Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report<sup>3</sup> made it clear that greenhouse gas (GHG) emissions need to reduce rapidly to avoid the worst

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<sup>1</sup> See UN Decade of Action <https://www.un.org/sustainabledevelopment/decade-of-action/>

<sup>2</sup> See International Energy Agency (IEA) <https://www.iea.org/commentaries/the-coronavirus-crisis-reminds-us-that-electricity-is-more-indispensable-than-ever>

<sup>3</sup> See IPCC (2014) AR5 Synthesis Report: Climate Change <https://www.ipcc.ch/report/ar5/syr/>

impacts of climate change. Revisiting sustainable development and the optimal energy mix required brings the Food-Energy-Water (FEW) resource nexus into focus. From this perspective, UNFC and UNRMS are intended to provide tools not only for capital allocation, but also to ensure that the infrastructure and facilities needed to support holistic and diversified development of the economy are in place. An essential aspect of this development is integrated consideration of all energy sources to benefit from their synergies. Integrated resource management using UNFC and UNRMS will facilitate this integration.

### III. Clean energy mix and 2°C pathways

8. Demand for energy is expected to double over the coming decades to meet the needs of a growing and developing global population. In that same timeframe, to limit global warming to well below 2°C rapid and deep decarbonization of energy supply worldwide is required. This transition will include deploying a range of technologies such as high-efficiency low-emissions (HELE) for fossil fuels, carbon capture and storage (CCS), renewable energy, energy efficiency and nuclear energy. Meeting the 2°C challenge also opens the opportunity to design systems and select technologies that will minimize adverse impacts on the environment, climate, and human health, as well as relieve rapidly growing pressure on the wider FEW resource nexus. In that regard, all energy technologies should also be assessed on the nature and extent of their contribution to the transition to a circular economy. An integrated approach should not place technologies in competition with each other but make them complementary according to local priorities and needs.

9. Nuclear energy is one of the low-carbon technology options that could be considered for inclusion in the optimal energy mix. It is an individual country's choice whether or not to adopt nuclear energy – some countries have chosen not to adopt nuclear energy as part of their energy mix or to disengage from current use; others, including several ECE member States, continue to deploy and expand their use of nuclear power to improve their energy supply security while mitigating climate change.

10. Nuclear energy makes a significant contribution to today's global electricity generation, providing 10 per cent of global electricity supply in 2018. In the United Nations Economic Commission for Europe (ECE) region, the share of nuclear energy amounted to about 11 per cent of the electricity generating capacity (273 gigawatt-electric (GWe) producing 1,986.6 terrawatt-hours (TWh)) in 2018. In the advanced economies as a group, nuclear power is the largest low-carbon source of electricity, providing 40 per cent of all low-carbon generation. The ECE Pathways to Sustainable Energy Project<sup>4</sup> P2C scenario suggests a significant increase in nuclear energy capacity to provide low-carbon baseload power, pushing the uptake of nuclear energy in the whole ECE region to 452 GWe by 2050. The outputs of the Pathways to Sustainable Energy Project will help countries make informed decisions to attain sustainable energy. The IPCC 1.5°C report<sup>5</sup> middle-of-the-road scenario estimates nuclear energy would need to generate 25 per cent of electricity by 2050, six times the amount of electricity it generated in 2010.

11. In addition to electricity generation, nuclear energy can provide solutions to an even more comprehensive range of applications. Innovative nuclear technologies, such as small modular reactors (SMRs), would complement existing large reactors to decarbonize heating, industry and the generation of hydrogen and to create synthetic fuel.

12. Aspects of the potential contribution of nuclear to the energy transition are addressed in ECE publication *Redesigning the Uranium Resource Pathway* (ECE ENERGY SERIES No. 57 and ECE/ENERGY/124).<sup>6</sup> This publication emphasizes that UNFC and UNRMS can

<sup>4</sup> See UNECE (2020) *Pathways to Sustainable Energy – Accelerating Energy Transition in the UNECE Region* [https://www.unece.org/fileadmin/DAM/energy/se/pdfs/CSE/Publications/Final\\_Report\\_PathwaysToSE.pdf](https://www.unece.org/fileadmin/DAM/energy/se/pdfs/CSE/Publications/Final_Report_PathwaysToSE.pdf)

<sup>5</sup> See IPCC (2018) *Global Warming of 1.5°C* <https://www.ipcc.ch/sr15/>

<sup>6</sup> UNECE (2019) *Redesigning the Uranium Resource Pathway, Application of the United Nations Framework Classification for Resources for Planning and Implementing Sustainable Uranium*

provide a comprehensive framework and the necessary tools and conditions for integrated resource management.

#### **IV. Integrated life cycle management of nuclear energy**

13. This concept note provides a brief overview of a proposed new study to address the integration of the energy system on a whole life cycle basis – with a focus on nuclear energy – using UNFC and UNRMS. The analysis will cover the development of uranium resources, the construction/operation of nuclear power plants through to their decommissioning and management of used fuel to potential reprocessing and reuse as part a closed nuclear fuel cycle within the circular economy. The study will analyze nuclear energy’s role, GHG mitigation potential and environmental impacts, and implications for natural resource use, including steel, concrete, and other resources such as water and land.

14. The proposed study will aim to inform policymakers on the role nuclear energy could play in an optimal low-carbon energy mix all the while noting that it is an individual country’s choice whether or not to adopt nuclear energy. The study will also present concise information on the social, environmental and critical raw material implications of nuclear energy deployment.

#### **V. UNFC and UNRMS – Key to life cycle assessment of sustainable energy systems**

15. It will be crucial to develop UNRMS for the management of energy resources from a life cycle perspective and to minimize environmental and health impacts and support sustainable development. The process of sustainable resource management starts from an understanding of the world’s natural capital and natural resources, including efforts required to refine, process and use them to produce valuable benefits such as clean energy. Integrated resource management remains crucial for sustainable development, including steady progress towards the circular economy (see “United Nations Resource Management System Concept Note: Objectives, requirements, outline and way forward” ECE/ENERGY/GE.3/2020/4<sup>7</sup>).

16. The provisional Principle 5 of UNRMS is to enable a full life cycle view: “Resources shall be managed with a life cycle view encompassing resource discovery to its production, final use, reuse, and recycle”. Any resource use, including nuclear energy, has to consider a life cycle assessment to assure sustainability. A life cycle perspective denotes the system boundaries of a full life cycle assessment study, considering all life cycle stages, including raw material production, processing, transformation, transport, use and eventual reuse.<sup>8</sup> Life cycle assessment is also a vital component of a systems view to sustainable resource management and ties to the “integrated and indivisible” approach called for in the 2030 Agenda. The systems approach to energy policy development and implementation, can address multiple global goals and is no longer an option but is the only way forward for a societal transformation to achieve global sustainability.

17. Framing nuclear energy resources in the optimal low-carbon energy mix using UNFC and the planned UNRMS will provide a new view on integrated energy development. Such a harmonized approach will be helpful for decision-making in the clean energy transition and placing the nuclear industry vision to deliver on the Harmony goal of generating 25 per cent of global electricity by 2050 in the proper perspective.<sup>9</sup> Creating a level playing field in

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Projects, ECE Energy Series No. 57 and ECE/ENERGY/124 (2019)

<https://www.unece.org/index.php?id=52290&L=0>

<sup>7</sup> United Nations Resource Management System Concept Note: Objectives, requirements, outline and way forward

[https://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm11\\_apr2020/ECE\\_ENERGY\\_GE.3\\_2020\\_4\\_UNRMS\\_final.pdf](https://www.unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm11_apr2020/ECE_ENERGY_GE.3_2020_4_UNRMS_final.pdf)

<sup>8</sup> See International Resource Panel (IRP) (2019) Global Resources Outlook

<https://www.resourcepanel.org/reports/global-resources-outlook>

<sup>9</sup> See WNA The Harmony Programme <https://www.world-nuclear.org/our-association/what-we-do/the-harmony-programme.aspx>

energy markets, harmonized regulatory processes and an effective safety paradigm for all technologies are vital to realizing this goal.

18. A preliminary outline of the Table of Contents of the proposed study is provided in the Annex.

## **Annex**

# **Integrated life cycle management of nuclear fuel resources for sustainable energy: Study/report outline**

## **1. Introduction**

- The FEW resource nexus
- Sustainable energy systems and 2°C pathways
- IPCC 6<sup>th</sup> assessment report and implications
- Role of nuclear energy in climate actions and sustainable development
  - Messages from Uranium Pathways document (2019)
  - Messages from Nuclear Entry pathways document (2020)
  - UNFCCC and IPCC messages
  - What is an integrated life cycle?
- Why is an integrated life cycle management critical?
- Life cycle management, UNFC and UNRMS

## **2. Integrated life cycle management of nuclear fuel and energy activities**

- Inventory of applications
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- Material depletion
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## **4. Cumulative Implications of decarbonization pathways**

- Decarbonization Pathways: Transition to a circular economy, waste prevention and recycling

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- Enhancing food production
- Leveraging sustainable transport
- Energy system design
- Social and environmental assessments

**6. Conclusion: UNFC and UNRMS key to enabling a low-carbon future**

- The central role of nuclear technology
  - Integrated life cycle management as an enabler of sustainable development
  - UNFC and UNRMS as a support system for integrated resource life cycle management.
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