

Perspectives by Co-Lead Countries

Under the Clean Energy Ministerial (CEM), the U.S. Department of Energy (DOE), Natural Resources Canada (NRCan), Ministry of Economy, Trade, and Industry (METI) of Japan, and the Department of Business, Energy, and Industrial Strategy (BEIS) of the United Kingdom, seek to accelerate global clean energy transitions.

This commitment is reflected in our continued support of technology development and innovation in our current and future energy systems. Our organizations have each supported a variety of research and development activities and initiatives in collaboration with national laboratories, academia, and industry partners that explore and utilize different technologies to meet a variety of energy demands.

Nuclear energy is an important part of the global clean energy supply, providing nearly one-third of the world's non-emitting electricity and complementing and enabling other clean energy sources, including renewables. Recognizing this current and future potential for nuclear energy, the Nuclear Innovation: Clean Energy Future (NICE Future) initiative was launched in 2018 at the Ninth CEM in Copenhagen, Denmark.

Since its launch, the NICE Future initiative has succeeded in initiating broad, cross-sectoral dialogue among CEM member countries to highlight the roles that nuclear energy can play in bolstering economic growth, energy security, and access, and environmental stewardship. This includes exploring and building awareness about how innovative nuclear energy technologies across both large and small-scale applications, such as small modular reactors (SMRs) and other advanced reactors, can drive clean growth.

To explore and communicate the increasingly flexible roles that nuclear energy technologies can play in integrated clean energy systems of the future, the NICE Future initiative proudly launched the Flexible Nuclear Campaign for Nuclear-Renewables Integration (Flexible Nuclear Campaign) at the 10th CEM in Vancouver, Canada in 2019.

The International Energy Agency's (IEA's) *2019 World Energy Outlook* forecasts that electricity generation from variable renewables could range from 36% to 67% by 2040. As more renewables connect to the grid, many countries are developing innovative options to employ more flexible operation of traditional and base load energy sources, like nuclear, to produce electricity and heat to meet demand.

This report brought together experts from around the globe to share expertise and study opportunities for innovative and advanced nuclear systems to operate flexibly and work in tandem with renewables, contributing to clean energy systems of the future.

As demonstrated in technical analyses summarized in this report, nuclear energy offers flexibility in certain electricity markets around the world, and new nuclear technologies could extend the versatility of nuclear energy systems further.

At its most basic, nuclear energy can operate flexibly by ramping power output up or down to match grid demand; however, nuclear energy's services extend beyond just electricity generation.

This document encompasses one section of a larger report, titled [Flexible Nuclear Energy for Clean Energy Systems](https://www.nrel.gov/docs/fy20osti/77088.pdf). The full report can be found at <https://www.nrel.gov/docs/fy20osti/77088.pdf>. The author(s) of each section is/are solely responsible for its content; the publication of these perspectives shall not constitute or be deemed to constitute any representation of the views or policies of any Governments, research institutions, or organizations within or outside the NICE Future initiative.

Around the world, research is underway to explore how nuclear systems can use generated thermal energy directly to heat households, drive industrial processes, or produce nonelectric commodities such as purified water. In some instances, hydrogen produced by nuclear systems can be used to store energy for later electricity production or used as a feedstock to produce a variety of products, from fertilizers and steel to new synthetic fuels. Additionally, by operating alongside chemical plants and renewables, current and future nuclear energy systems can be used to generate a host of alternative revenue streams and help lower emissions of carbon dioxide, sulfur dioxide, nitrogen oxide, mercury, and particulates that cause smog across the energy, transportation, and industrial sectors. With new smaller reactors currently under development and anticipated for near-term deployment, nuclear can bring this versatility virtually anywhere at almost any scale by matching a community's energy needs with a specific reactor technology.

We are excited about the innovative systems that are being explored to power our future. By harnessing nuclear energy innovation through closer global cooperation, the world will be cleaner, healthier, and more prosperous.

Dr. Rita Baranwal
Assistant Secretary for Nuclear Energy
U.S. Department of Energy (DOE)

Mollie Johnson
Assistant Deputy Minister
Low Carbon Energy Sector
Natural Resources Canada (NRCan)

Kihara Shinichi
Deputy Commissioner for International Affairs
Agency for Natural Resources and Energy (ANRE)
Ministry of Economy, Trade and Industry (METI), Japan

Stephen Speed
Director for Civil Nuclear
UK Department for Business, Energy and Industrial Strategy (BEIS)