The Nuclear Energy Future:
A New Window of Opportunity

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The NEA: 34 Countries Seeking Excellence in Nuclear Safety, Technology, and Policy

- A premier international platform for cooperation in nuclear technology, policy, regulation, research, and education.
- 34 member countries + strategic partners (e.g., China and India).
- 8 standing committees and more than 80 working parties and expert groups.
- Global relationships with industry, universities, and civil society.

Argentina	Australia	Austria	Belgium
Bulgaria	Canada	Czech Republic	Denmark
Finland	France	Germany	Greece
Hungary	Iceland	Ireland	Italy
Japan	Korea	Luxembourg	Mexico
Netherlands	Norway	Poland	Portugal
Romania	Russia	Slovak Republic	Slovenia
Spain	Sweden	Switzerland	Turkey
United Kingdom	United States		

NEA countries operate about 81% of the world's installed nuclear capacity

Major International Cooperative Frameworks

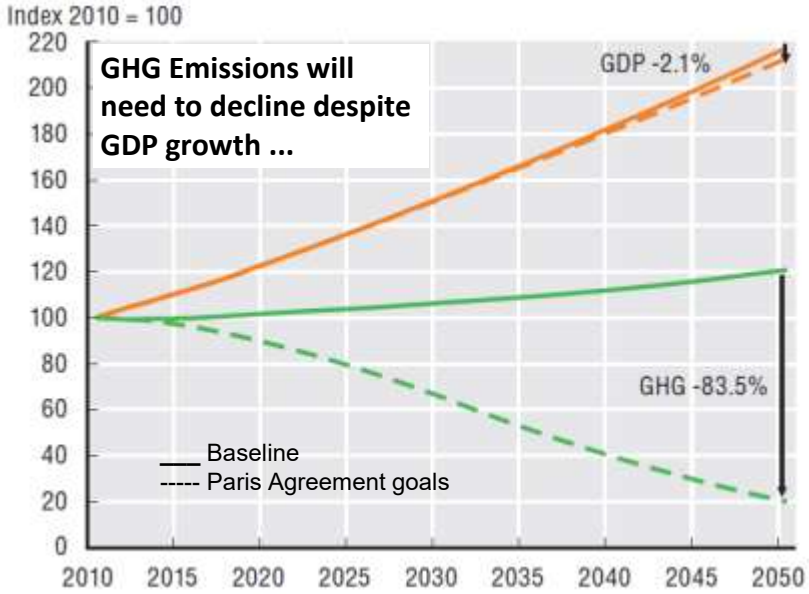
NEA Serviced Bodies

- **Generation IV International Forum (GIF)** with the goal to develop new fission technologies with greater sustainability (including effective fuel utilisation and minimisation of waste), economic performance, safety and reliability, proliferation resistance and physical protection.
- **Multinational Design Evaluation Programme (MDEP) -** initiative by national safety authorities to leverage their resources and knowledge for new reactor design reviews (ABWR, AES2006, AP1000, EPR, HPR1000).
- **International Framework for Nuclear Energy Cooperation (IFNEC) –** 65-country forum for multilateral discussion and analyses of a wide array of nuclear topics involving both developed and emerging economies.

27 Major Joint Projects

- **Nuclear safety research** and experimental data (e.g., thermal-hydraulics, fuel behaviour, severe accidents).
- **Nuclear safety databases** (e.g., fire, common-cause failures).
- **Nuclear science** (e.g., thermodynamics of advanced fuels).
- **Radioactive waste management** (e.g., thermochemical database).
- **Radiological protection** (e.g., occupational exposure).
- **Nuclear Education, Skills and Technology Framework (NEST)** (promoting the development of a new generation of subject matter experts.)

Paris Agreement Implies a 50 gCO2/kWh Target

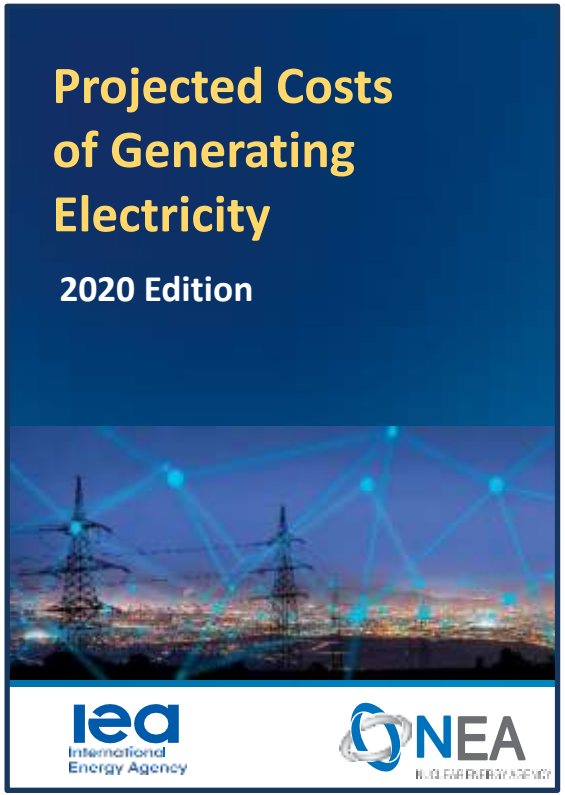


- Paris Agreement is intended to hold “increase in global average temperature to well below 2°C”.
- Current emission intensity is **570 gCO2/kWh** - target is **50 gCO2/kWh**
- Electricity contributes 40% of global CO2 emissions and will play key role. Annual emissions from electricity will need to decline 73% (global) and 85% (OECD countries).

Source: OECD Environmental Outlook

Key Observations

- **Electricity use is poised to increase dramatically** across the world due to electrification of transportation and many industries.
- **Coal use is shrinking** – the US Energy Information Administration (EIA) predicts that an additional 30 GWe of US coal capacity will shut down by 2025.
- **Countries are bringing their CO_2 reduction targets forward** – generally to 2030 – thereby forcing both increased investment and reality.
- **Many countries are considering nuclear energy as a key element in their decarbonization strategies**



Recent NEA Work: *Broad Conclusions*

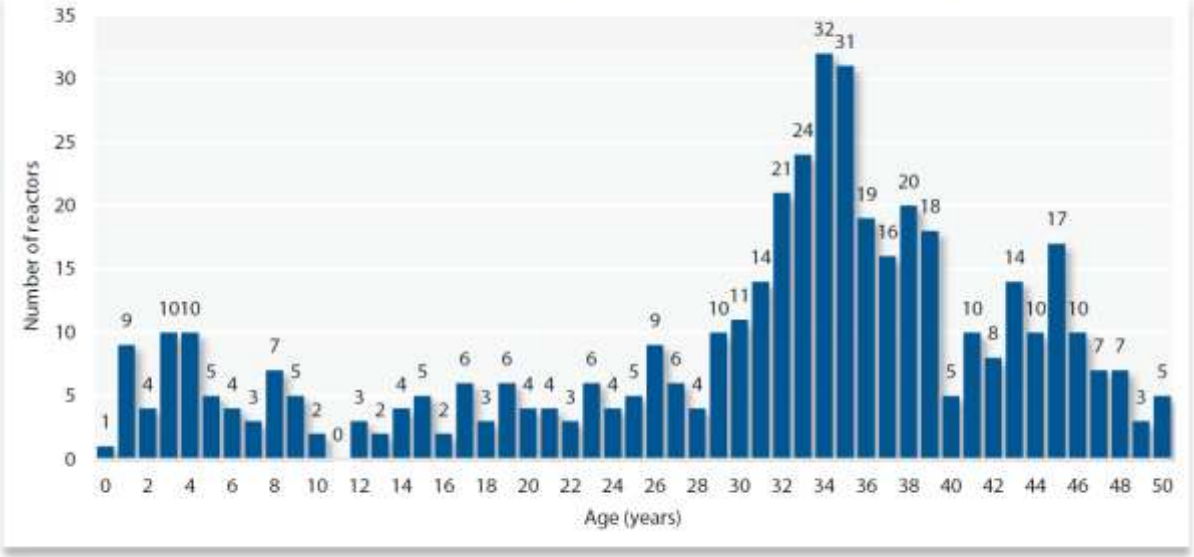
- Electricity from new nuclear power plants has lower expected costs in the 2020 edition than in 2015. On average, overnight construction costs reflect cost reductions due to learning from first-of-a-kind (FOAK) projects.
- Coal is no longer competitive in most markets. Gas-fired CCGTs dependent on the gas price – very competitive in North America, less so in Asia and Europe.
- **Nuclear is the dispatchable low carbon technology with the lowest expected costs in 2025**. Only large hydro reservoirs can provide a similar contribution at comparable costs.

Recent NEA Work: *Broad Conclusions*

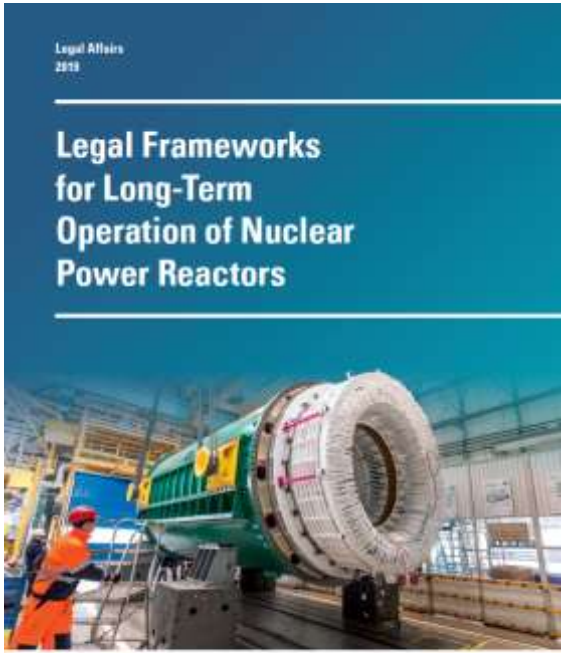
- To meet global energy and environmental requirements, **all low-carbon technologies** must be optimally applied—with all costs accurately allocated.
- The **electricity markets must be modernized**. Existing market structures make investment in any unsubsidised low-carbon technology very difficult.
- Large deployment of VRE will occur around the world – but the appropriate contribution of VRE in each country will depend on local conditions, including the cost of available resources.
- **Where dispatchable capacity is needed, nuclear can serve a large role—if it is compatible with evolving markets.**

Long-Term Operation: The Best Option

Figure 1.2. **Distribution of nuclear power reactors by age in the year 2019**



Source: Based on data from IAEA PRIS (accessed 21 June 2019).



www.oecd-nea.org/jcms/pl_15154/legal-frameworks-for-long-term-operation-of-nuclear-power-reactors

Long-Term Operation: The Best Option

Challenges

- **Views of LTO vary around the world due to differing policy and regulatory approaches. For example in many countries, the 40 year mark is characterized as "plant lifetime" and therefore license renewal can be very challenging.**
- **Some governments have made political decisions to shut down nuclear plants, despite the fact that doing so will lead to significant increases in carbon emissions.**


South Texas Project Unit 1 and Unit 2

- **Distorted, dysfunctional, and obsolete markets do not recognise the value of existing nuclear plants to system reliability and carbon reduction.**

SMRs: Innovation in Nuclear Energy

- *New Deployment Models*—Low cost modules can be installed as needed
- *Higher Flexibility*—small reactors may load-follow and be deployed in niche markets
- *Manufacturability*—enables factory construction, increasing quality and reducing cost, uncertainty, and schedule risk
- *Safety*—SMRs typically have small potential source term and large water inventories; potential for no need for offsite emergency response

GROWING GLOBAL INTEREST IN SMRS

- First technologies now nearing regulatory approval
- Major technology projects underway in US, France, UK, and other countries
- High interest in both OECD countries and emerging economies

NuScale Conceptual Design

SMRs: Innovation in Nuclear Energy

- *Baseload Small Modular Reactors*
  - Low cost modules can be installed as needed
  - Higher flexibility
  - Manufacturability increases quality and reduces cost and risk
  - Safety characteristics may dispense with need for offsite EP
- *Distributed Generation/Mobile SMRs*
- *Microreactors*
- *Generation IV reactors*
  - Next generation technologies beyond LWR

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NuScale Conceptual Design

"Disruptive Technologies"
Innovation Across Industries

- **Technologies such as additive manufacturing, Big Data, and artificial intelligence are beginning to revolutionize many industries**
- **These technologies could lead to lower costs to build and operate plants, higher quality, and higher levels of nuclear safety**
- **Adopting these technologies would also draw increased numbers of young scientists and engineers who, increasingly, view nuclear energy as an old technology**
- **Nuclear was largely left behind by the last digital revolution; it can't afford to miss the next one.**

3D printed nuclear reactor components manufactured by Oak Ridge National Laboratory

Global Challenge: Regulating Innovative Technologies

- Development and licencing of SMRs and other innovative technologies will be very expensive; some development, testing, and licencing costs could be shared
- Strategies for global deployment of SMRs are highly desirable:
  - *Success for small reactors requires significant production runs; good economies of sale are difficult if they are effectively limited to home markets*
  - *Like aircraft and other high-investment products, access to global markets is essential*
- Regulators can become a showstoppers to innovative technology if requirements are different in each country

Innovation and Nuclear Regulation

NEA Multi-sector Workshop on Innovative Regulation: Challenges and Benefits of Harmonizing the Licensing Process for Emerging Technologies

The NEA, in cooperation with the Canadian Nuclear Safety Commission (CNSC) hosted an international workshop in December 2020 that brought together regulators, industry, and various stakeholders to share information between the nuclear sector and other highly regulated industries (e.g., aviation, medical, transportation of nuclear material) towards harmonized regulatory processes in the context of innovation.

The workshop focused on practical examples of how regulators can address two key challenges:

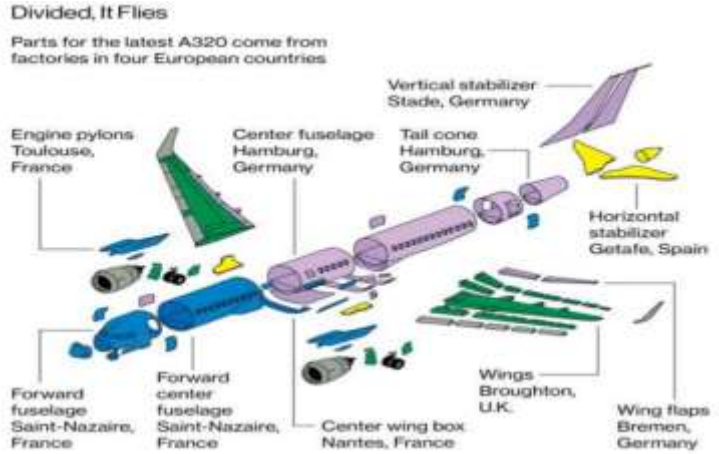
- How should regulators approach licensing of innovative and disruptive technologies?
- How can regulators leverage international co-operation?

https://www.oecd-nea.org/jcms/pl_46728/multi-sector-workshop-on-innovative-regulation-challenges-and-benefits-of-harmonising-the-licensing-process-for-emerging-technologies

Innovation and Nuclear Regulation

Example: Lessons from the Aviation Sector

- Unlike nuclear, the aviation industry developed with international exports in mind from the beginning – leading to a need to harmonize from the outset
- Modernization and innovation is desired by all players in the sector (including regulators) and is built on existing structures
- Governments, regulators, manufacturers, airlines, researchers, and academia collaborate to set global industry standards



The aviation example shows that design and technology are only a part of the regulation and innovation picture; there is a vital need to focus on the supporting infrastructures – especially industry standards

Innovation and Nuclear Regulation

Challenges and Observations

- **The nuclear sector does not have an integrated global framework**, which makes international harmonization very difficult
- **Innovation is moving at a very fast pace;** the nuclear sector can't wait for international standards to be developed.
- **With the benefits of innovative technologies still uncertain, industry is not always able to make the investments needed to support regulatory review**
- **Digital technologies bring greater uncertainties associated with cybersecurity—which is already a major challenge for the nuclear sector.**

For Climate Action to be Successful, An Enhanced Vision of the Future is Needed

If action on climate is associated with limits to life, economic growth, and freedom, a successful energy transition will be difficult.

Innovative Nuclear Technologies Help Provide a Solution Set

Thank you for your attention

More information @ www.oecd-nea.org

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