Looking Forward: *Nuclear Energy Issues and Opportunities*

William D. Magwood, IV
Director-General
Nuclear Energy Agency

Kyoto University
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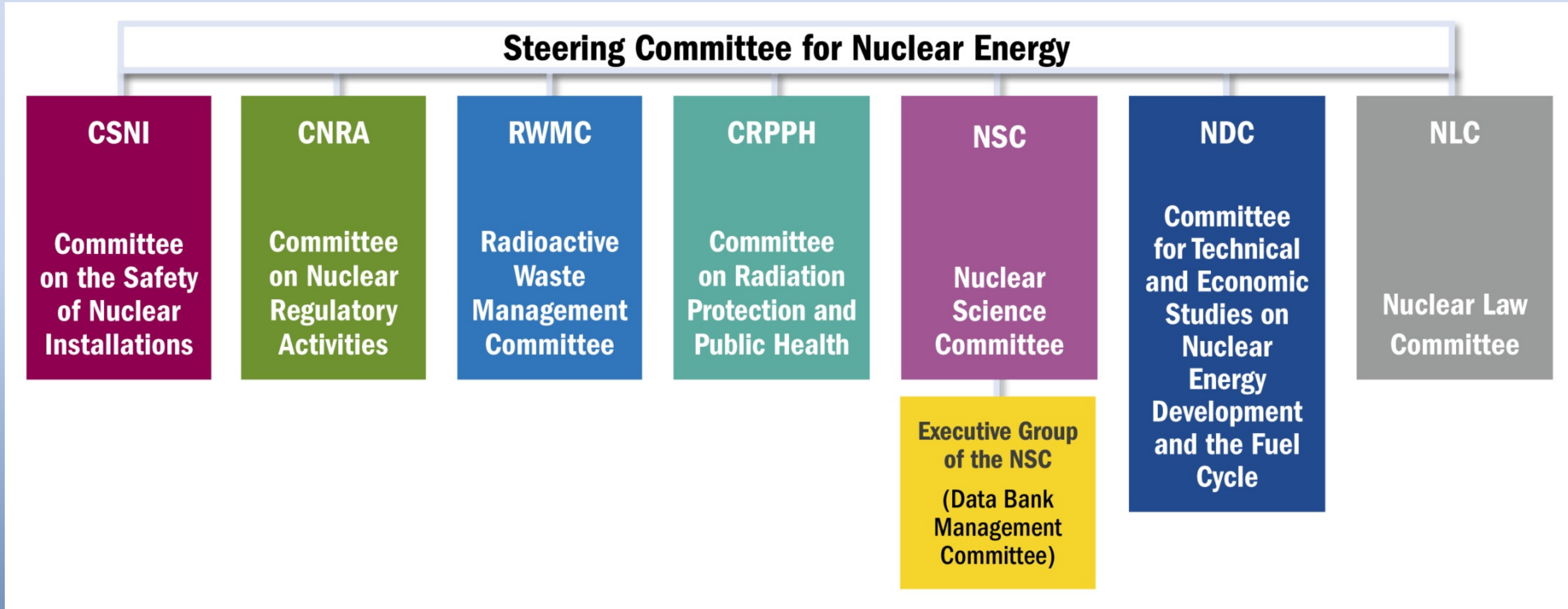
The NEA: A Forum for Cooperation

- Founded in 1958
- 31 member countries
- 7 standing technical committees
- 75 working parties and expert groups
- 21 international joint projects

NEA Committee Structure



The NEA's committees bring together top governmental officials and technical specialists from NEA member countries and strategic partners to solve difficult problems, establish best practices and to promote international collaboration

Major NEA Separately Funded Activities

Secretariat-Serviced Organisations

- **Generation IV International Forum (GIF)** with the goal to improve sustainability (including effective fuel utilisation and minimisation of waste), economics, 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.
- **International Framework for Nuclear Energy Cooperation (IFNEC)** forum for international discussion on wide array of nuclear topics involving both developed and emerging economies.

21 Major Joint Projects

(Involving countries from within and beyond NEA membership)

- **Nuclear safety research** and experimental data (thermal-hydraulics, fuel behaviour, severe accidents).
- **Nuclear safety databases** (fire, common-cause failures).
- **Nuclear science** (thermodynamics of advanced fuels).
- **Radioactive waste management** (thermochemical database).
- **Radiological protection** (occupational exposure).

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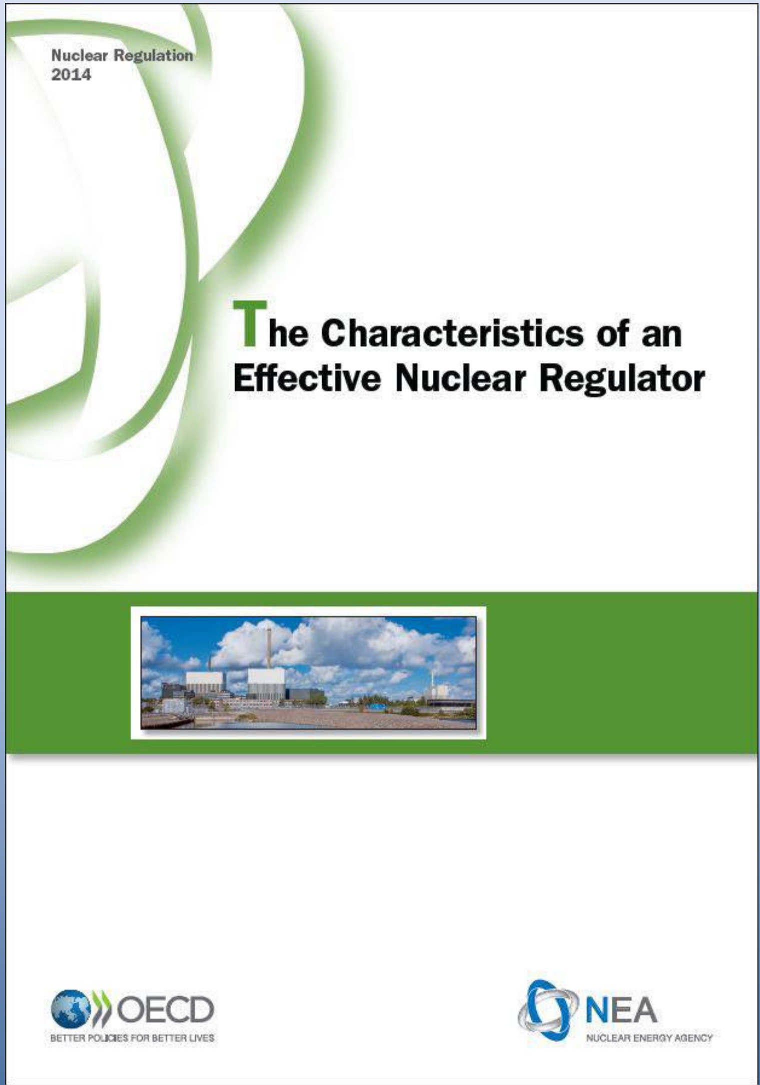
A Current Joint Project

BSAF: *The Benchmark Study of the Accident at the Fukushima Daiichi Nuclear Power Plant* – applying the scientific information gained from the Fukushima Daiichi accident to test and improve analysis tools used to ensure nuclear plant safety.

Fukushima Daiichi:
Learning the Lessons and Moving Forward

Fukushima Daiichi:
Key NEA Conclusions After the Accident

- NEA member countries determined that their reactors were **safe to continue operation**.
- New safety enhancements related to **extreme events** and severe accidents have been identified and are being implemented.
- A **questioning and learning attitude** is essential to continue improving the high level of safety standards and their effective implementation.
- Nuclear safety professionals have **a responsibility to hold each other accountable** to effectively implement nuclear safety practices.
- The Fukushima Daiichi NPP accident revealed **significant human, organisational and cultural challenges** — especially the need to ensure the independence, technical capability and transparency of the regulatory authority.



The Characteristics of an Effective Nuclear Regulator

NEA Regulatory Guidance Booklets
Volume 16, 2014, NEA/CNRA/R(2014)3


ATOM-NE!
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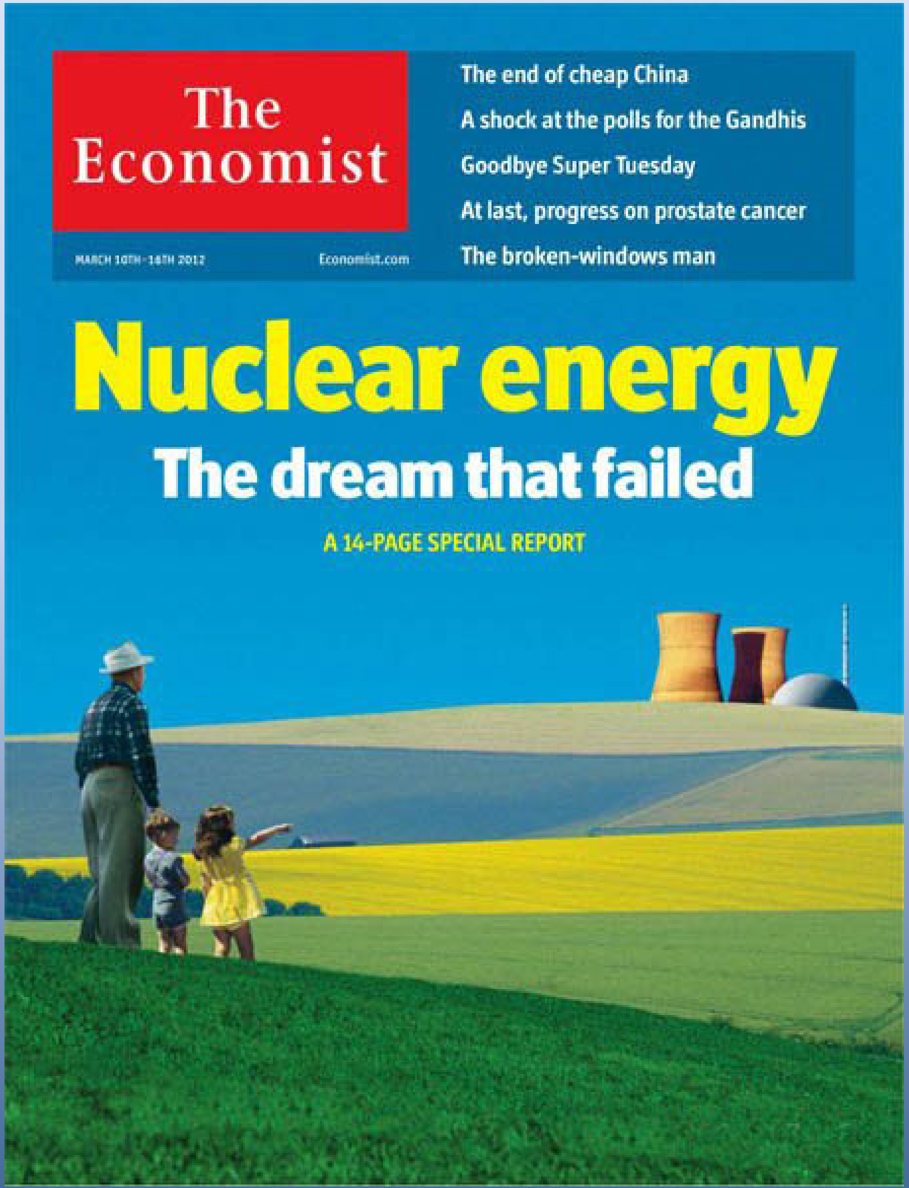
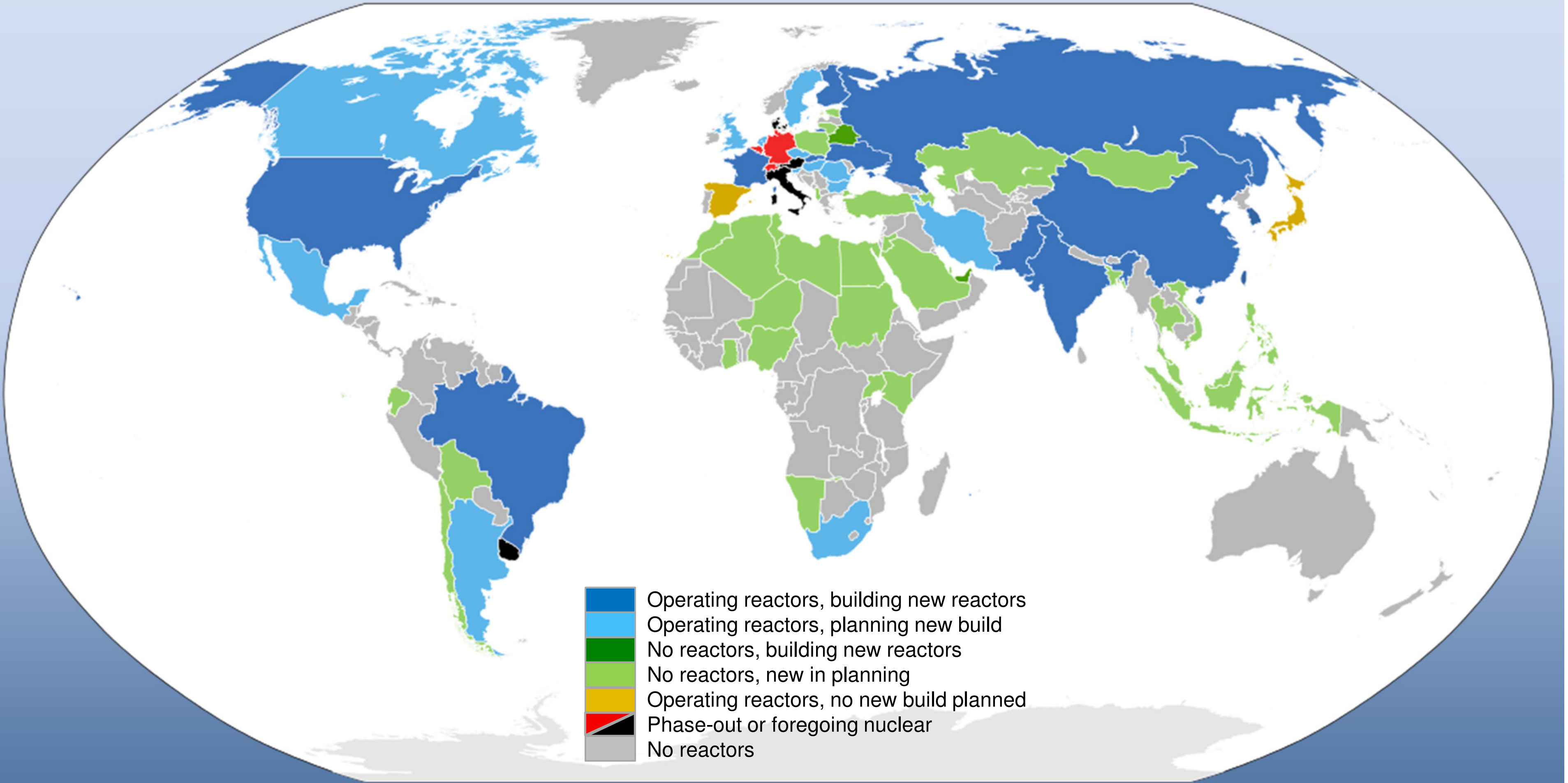
CHERNOBYL & FUKUSHIMA HAVE MADE IT CLEAR
PUT A FULL STOP TO NUCLEAR
NO TO NUCLEAR..
GREENPEACE
NO NUKES
RETIRE VERMONT YANKEE

Nuclear Energy Agency



Global View of Nuclear Power Today



Source data: World Nuclear Association
Update 2015

Nuclear Power Plants under Construction

(June 2015)

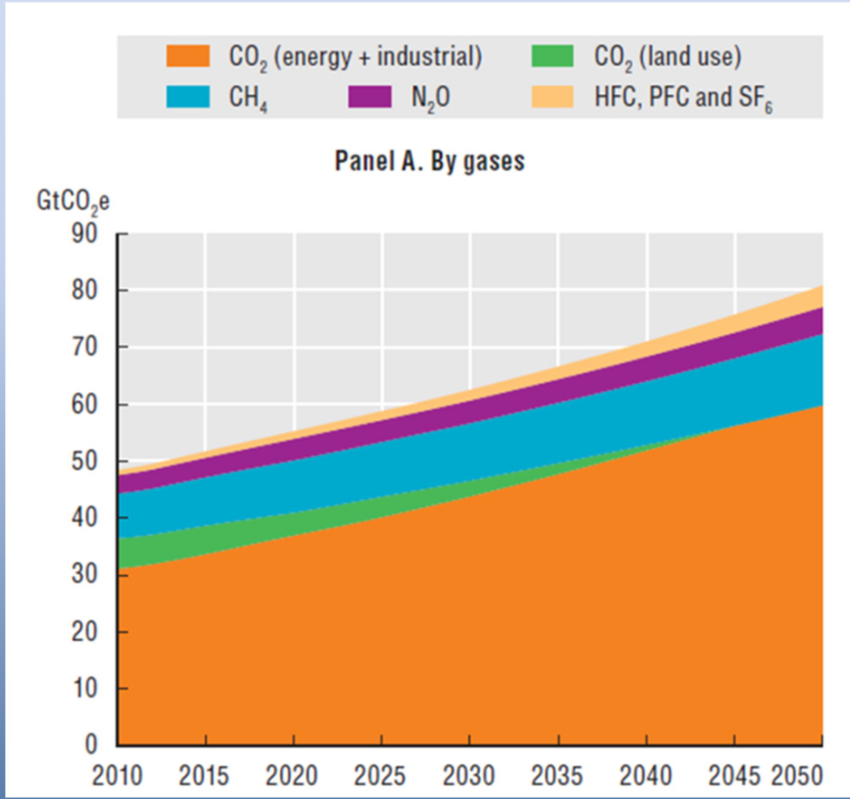
Location	No. of units	Net capacity (MW)
Argentina	1	25
Belarus	2	2 218
Brazil	1	1 245
China	24	23 738
Finland	1	1 600
France	1	1 630
India	6	3 907
Japan	2	1 325
Korea	4	5 360
Pakistan	2	630
Russia	9	7 371
Slovak Republic	2	880
Ukraine	2	1 900
United Arab Emirates	3	4 035
United States	5	5 633
Other: Chinese Taipei	2	2 600
TOTAL:	**67**	**64 097**

Source: IAEA PRIS

COP 21 is Around the Corner

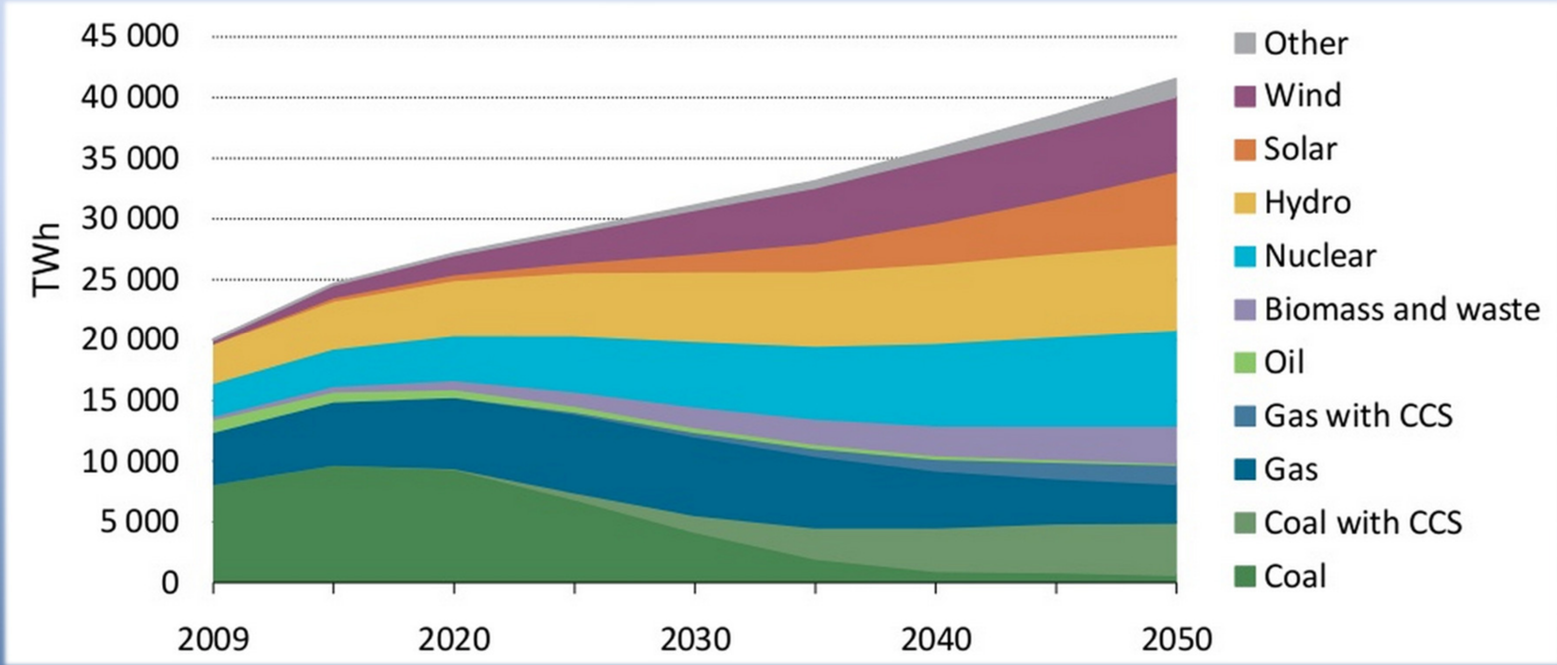
- UN-sponsored meeting begins November 2015 in Paris. 40,000 attendees are expected.
- Countries plan to negotiate an agreement intended to limit global warming to below 2°C by reducing global CO_2 emissions by 50% from 1990 levels.
- Energy represents 60% of global CO_2 emissions and the power sector produces the largest share of energy-related CO_2.

GHG emissions – baseline scenario:

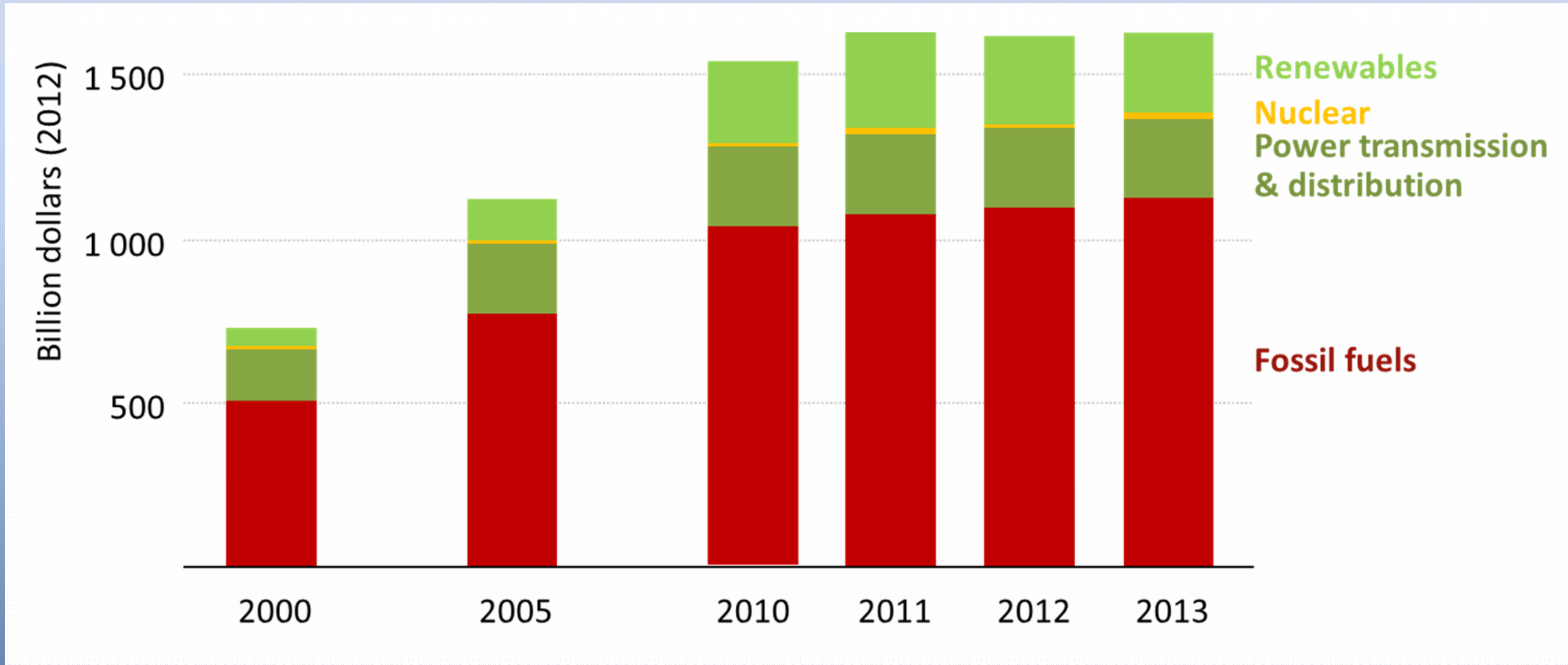


Source: OECD Environmental Outlook 2050

IEA 2°C Scenario:
Nuclear is Required to Provide the Largest Contribution to Global Electricity in 2050



Investment in Energy Supply: *Dominated by Fossil Fuels*



Source: IEA (2014), *World Energy Investment Outlook*, International Energy Agency, OECD/IEA, Paris.

2015 NEA/IEA Technology Roadmap

Contents and Approaches

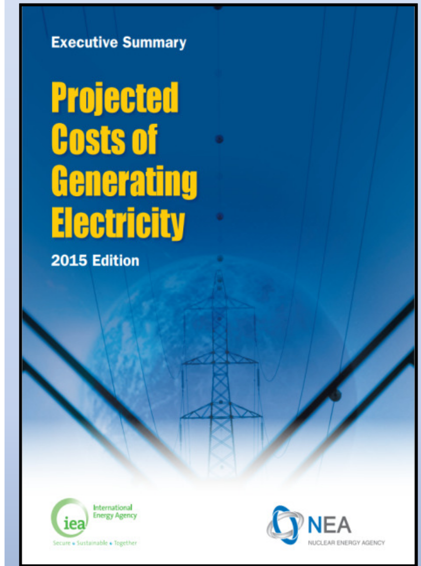
- Provides an overview of global nuclear energy today.
- Identifies key technological milestones and innovations that can support significant growth in nuclear energy.
- Identifies potential barriers to expanded nuclear development.
- Provides recommendations to policy-makers on how to reach milestones & address barriers.
- Case studies developed with experts to support recommendations.

2015 NEA/IEA Technology Roadmap

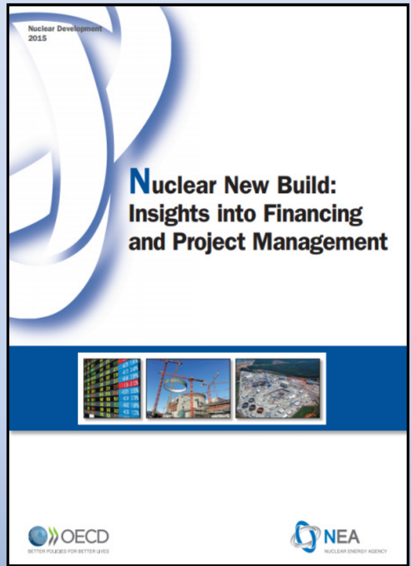
Key Roadmap Recommendations

- **Governments should recognize the value of low-carbon capacity.**
- **R&D is needed to support long-term operation.**
- **Industry needs to optimise constructability of Gen III designs.**
- **Accelerate development of SMRs.**
- **Support development of one or two Gen IV reactors.**
- **Demonstrate nuclear desalination or hydrogen production.**
- **Invest in environmentally sustainable uranium mining.**
- **Continue cooperation and discussions on international fuel services.**
- **Establish policies and sites for long-term storage and disposal.**

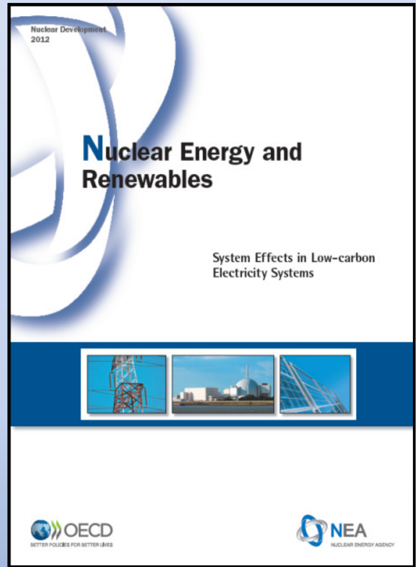
New Build



Review of project costs for new plants highlight concerns over FOAK project cost overruns

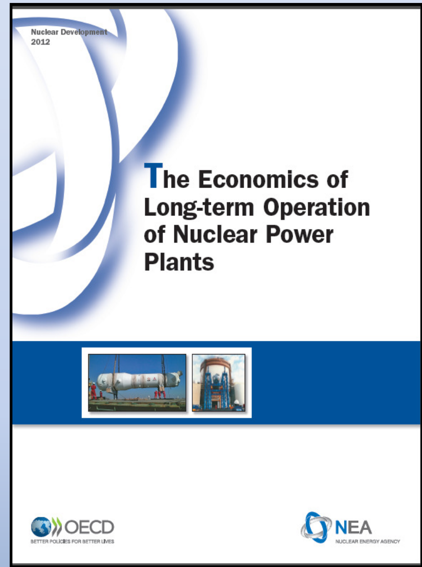


An overview of the principal challenges facing nuclear new build today, as well as ways to address and overcome them



High penetration of renewables impact baseload power plants and overall system reliability; system costs should be accounted and allocated

Existing Reactors



Capital investments to support long-term operations are expected to reach 500-1100 USD/kWe, including about 100-200 USD/kWe for post-Fukushima safety enhancements.

Levelling the Field for Low-Carbon Technologies

- **Low-carbon technologies:**
  - high ratios of fixed-to-variable costs
  - high certainty of prices and revenues over their lifetime
    - Nuclear investors spend 70% of *total lifetime costs* before operation
    - Wind and solar investors spend 90%
- **Deregulated electricity markets intrinsically favour fossil fuels**
- **Levelling the field for low-carbon technologies requires alternative market approaches such as:**
  - long-term power purchasing agreements (PPA)
  - Contracts for difference (CfD)
  - Regulated or guaranteed electricity tariffs covering average costs

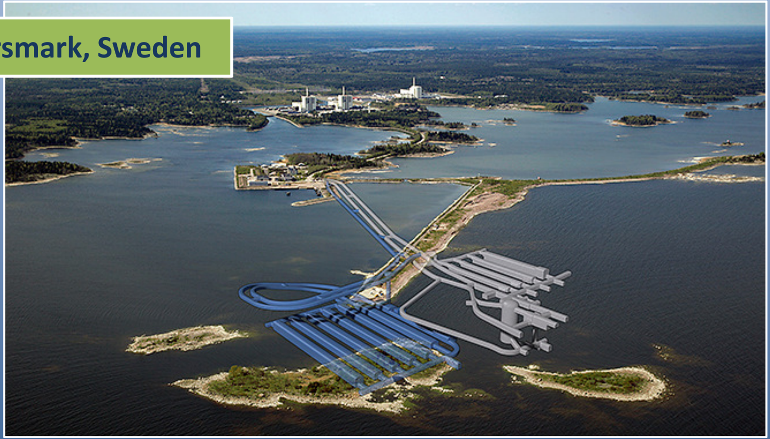
Public Views of Nuclear Waste

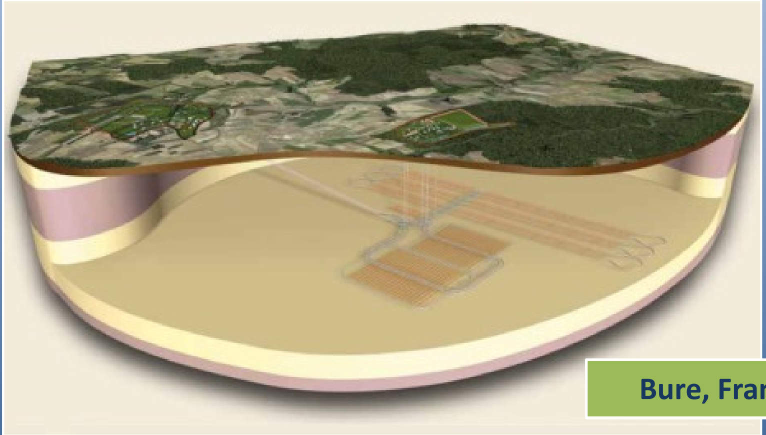
Nuclear Waste: An Area of Continuing Study

Global Leaders in HLW Disposition

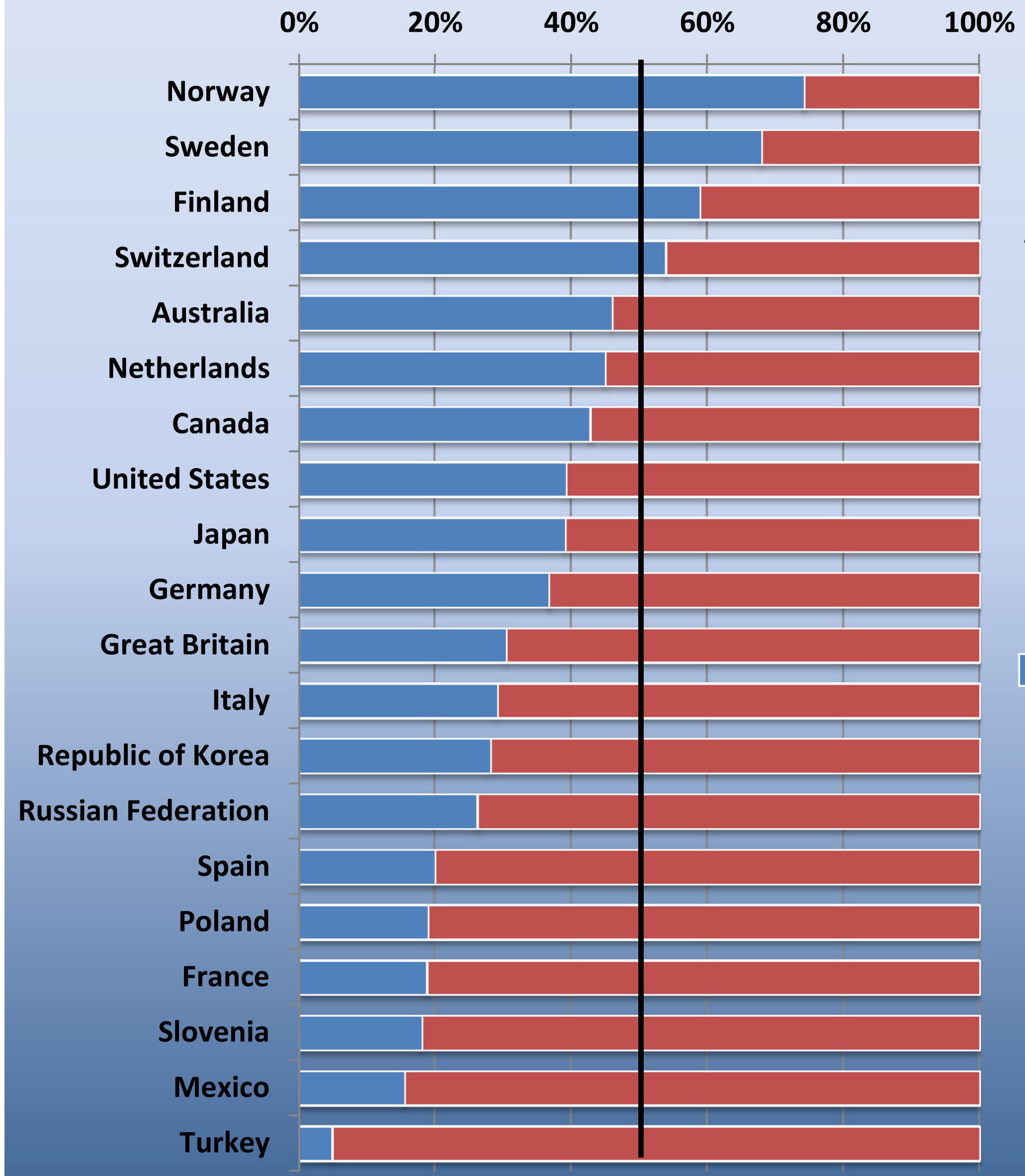
Waste type	Country	Location	Formation	Status	Projected Start of Operations
HLW/SF	Finland	Eurajoki	Crystalline rock	Licence pending	2020
HLW/SF	Sweden	Forsmark	Crystalline rock	Licence pending	2025
HLW/SF	Switzerland	3 potential sites	Opalinus clay	Siting regions identified	~2040
LILW-LL & HLW/SF	France	Region of Bure (URL)	Callovo-Oxfordian Clay	Siting region identified	2025

Forsmark, Sweden





Bure, France



The Trust Factor:

An Element of National Policy in NEA Member Countries

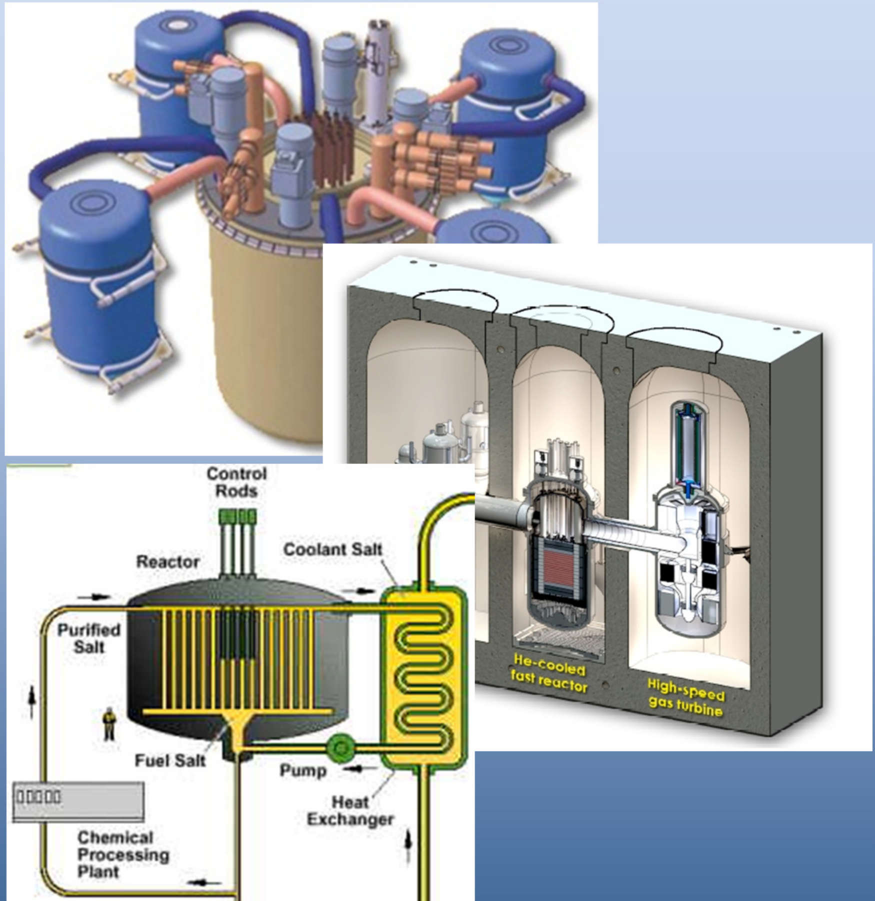
Respondents agreeing that "most people can be trusted"

Source: Data from the fifth World Values Survey (2005 – 2008)
www.worldvaluessurvey.org

Key Actions for the Next 10 Years

- **Ensure global nuclear safety**. Enhance peer oversight and cooperation of both regulators and operators.
- Establish a **level playing field for all low-carbon technologies** — favouring one technology over another distorts the market and impacts overall grid reliability.
- **New plant projects** in OECD countries must show success in completing projects on time and to budget.
- **Continue improvements in current technology**, especially to allow for long-term operations.
- Gain **political and public consensus** for long-term radioactive waste management strategies.

For the Longer Term Future:
Nuclear Innovation 2050



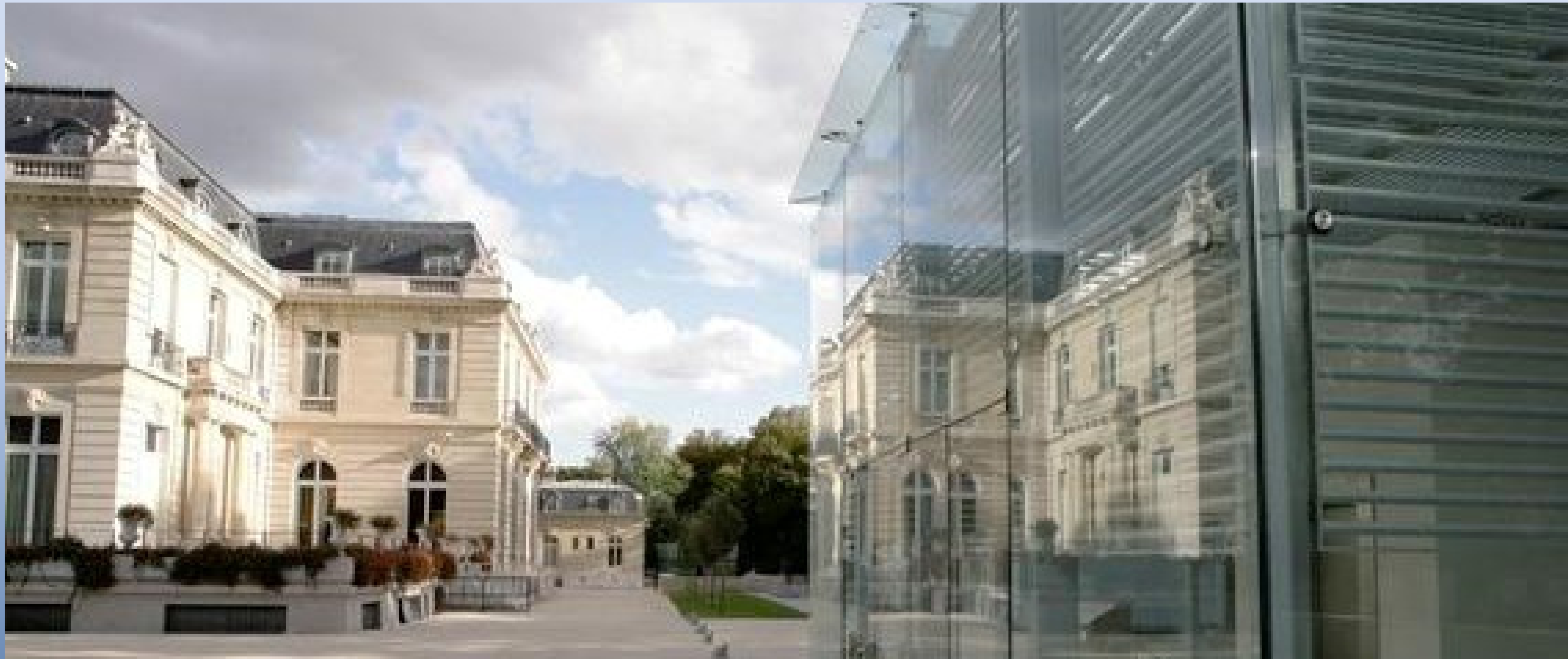
- What technologies will be needed in 10 years? 30 years? 50 years?
- What research and development is needed to make these technologies available?
- Is the global community doing the R&D needed to prepare for the future?

Questions for You

Can Engineers and Scientists:

- **Address the need for long-term sustainability?**
- **Resolve public concerns about nuclear safety?**
- **Meet the challenge of nuclear waste?**
- **Improve their ability to listen to and address public concerns?**
- **Address the "trust deficit" ?**

Thank you for your attention



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