Global Trends in Nuclear Power and Fuel Cycle and IAEA Activities

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IAEA
International Atomic Energy Agency

Global trends in nuclear power and fuel cycle

IAEA's role and activities

Summary

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Global Trends in Nuclear Power & Fuel Cycle
- Installed generating capacity -

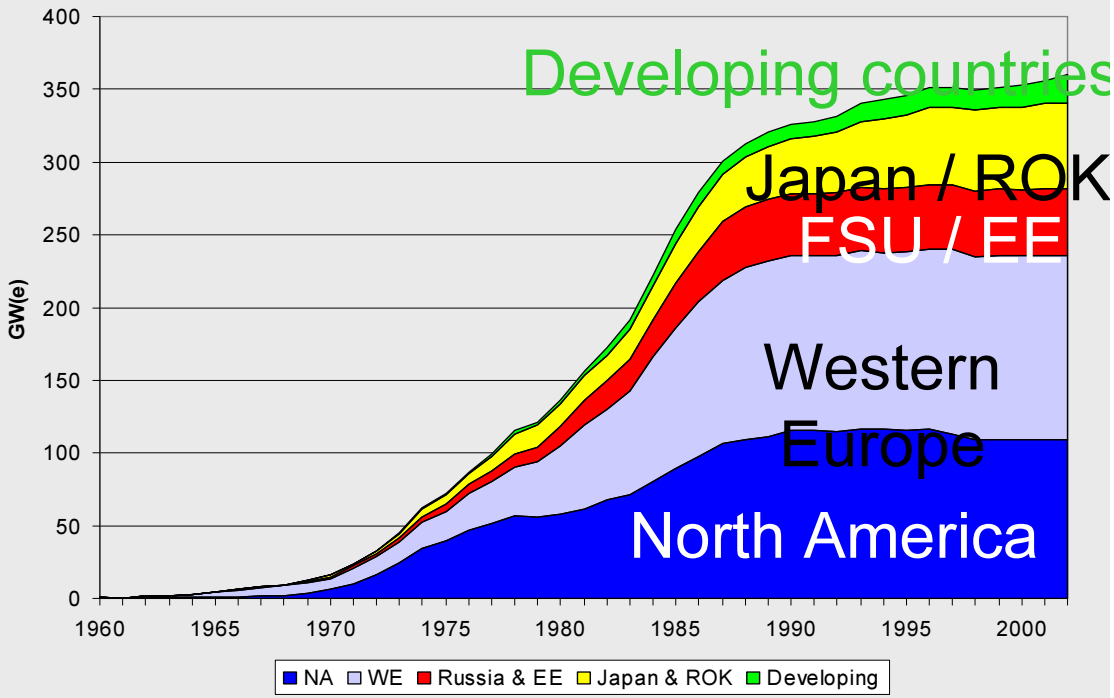
1. Current worldwide nuclear generating capacity

- ✓Commercial NPPs in Operation **435** (**367.8** GWe)
- ✓Share of electricity **16%**

2. Slowdown of capacity addition since late 80's

- ✓Electricity market deregulation
- ✓Slow growth of electricity demand in advanced countries
- ✓Public Perception
- ✓Economic reforms in Russia and Eastern Europe

3. Current expansion mainly in Asia



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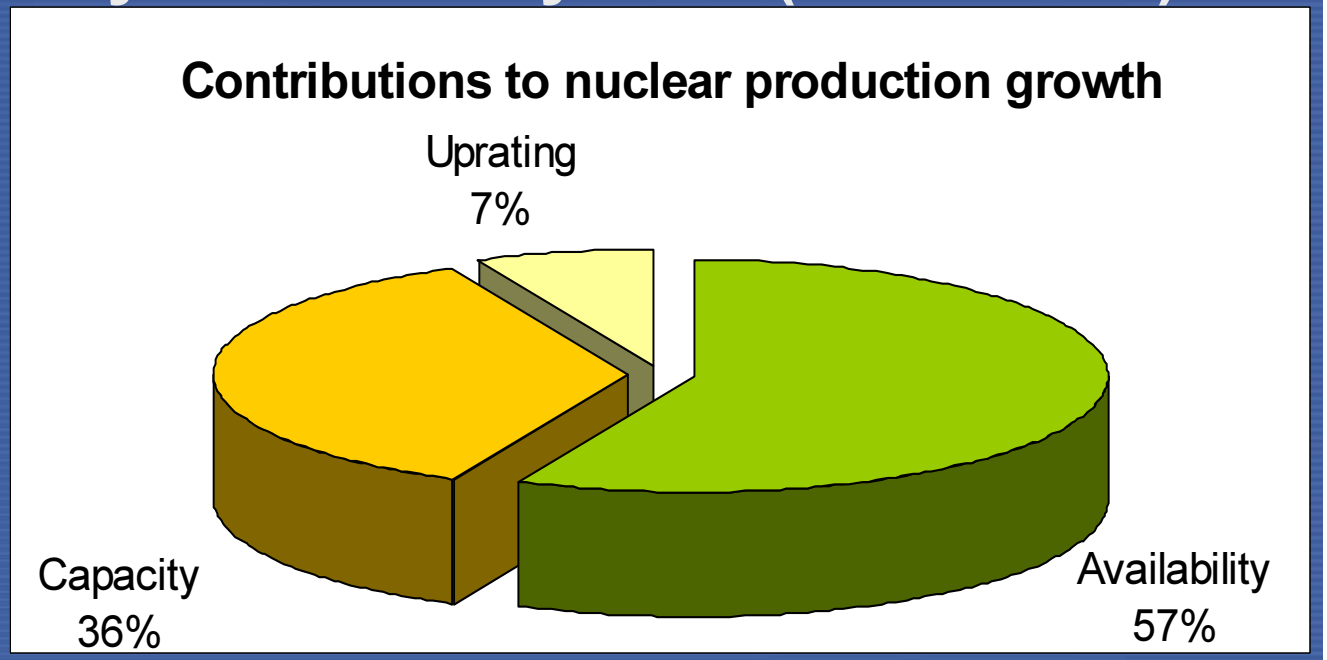
Global Trends in Nuclear Power & Fuel Cycle - Operation -

4. Nuclear electricity increase by 40% (1990-2005)



Capacity factor improvement by:

- ✓Best practice prevailing
- ✓Consolidation to those who perform best
- ✓Risk-informed regulation

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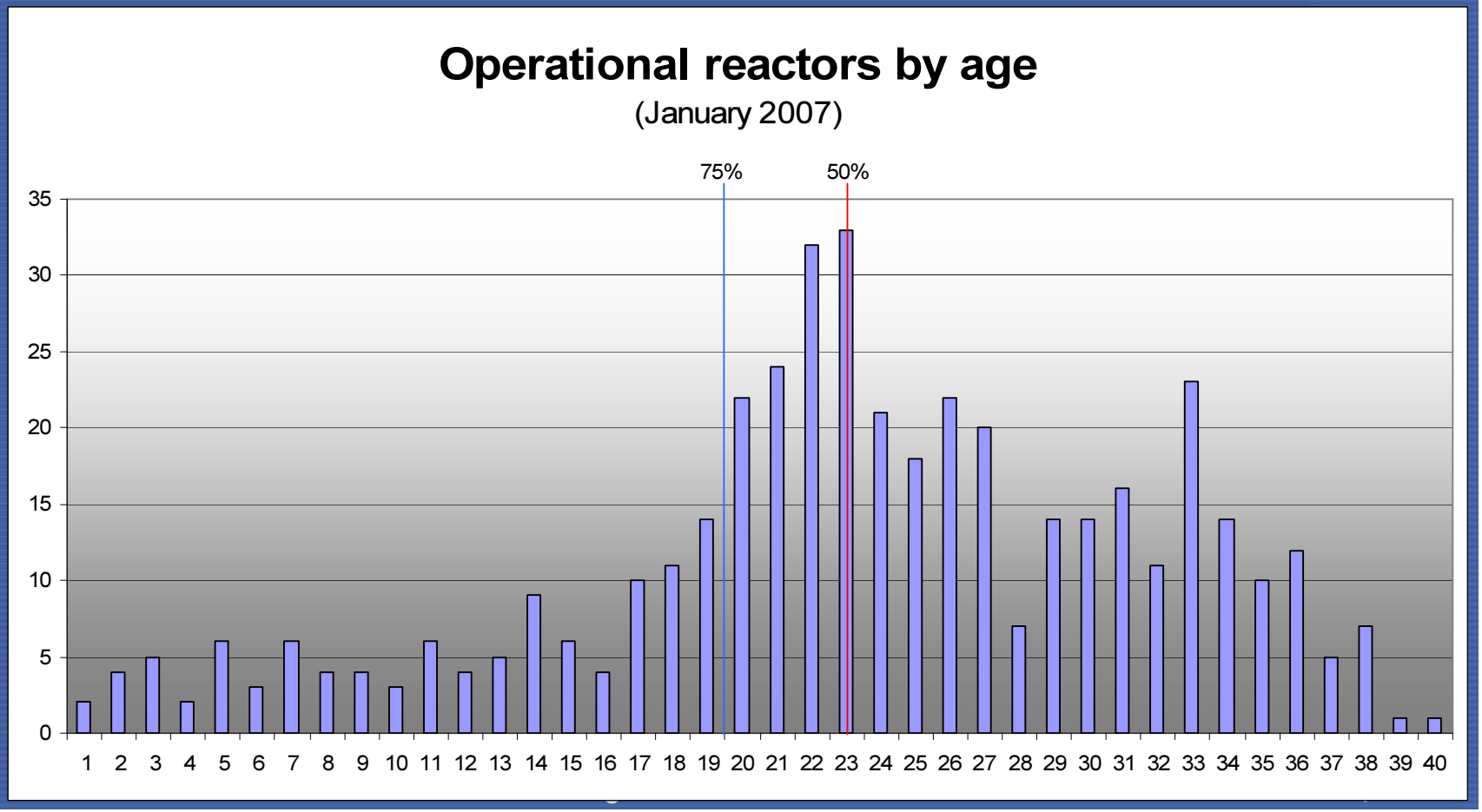
Global Trends in Nuclear Power & Fuel Cycle
- Aging and long-term operation -

5. Long-term operation and power uprating

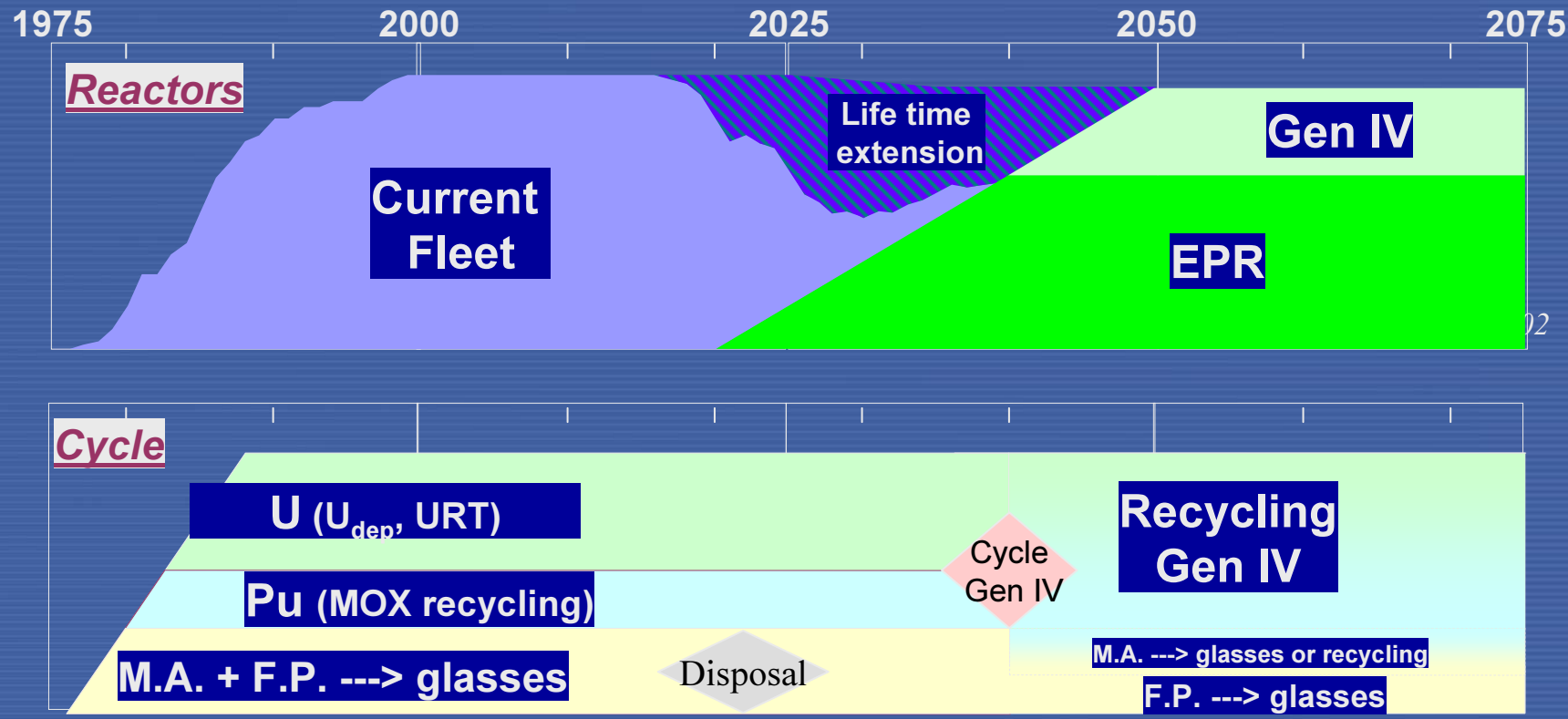
- Long term operation through continuous monitoring, replacement and regulatory review

Age distribution (327/435 over or equal to 20 years)



Global Trends in Nuclear Power & Fuel Cycle- - To the future -

6. Design evolution and innovation



Transition scenario from current fleet of LWR to Gen-IV
- Case of France : CEA proposal -

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Global Trends in Nuclear Power & Fuel Cycle
- To the future -

7. New initiatives proposed
   - ✓MNA (M. ElBaradei)
   - ✓Global Nuclear Energy Partnership (GNEP) (USA)
   - ✓President Putin's initiative to develop a Global Nuclear Power Infrastructure (GNPI) (Russia)

8. Rising expectations for the role of nuclear power

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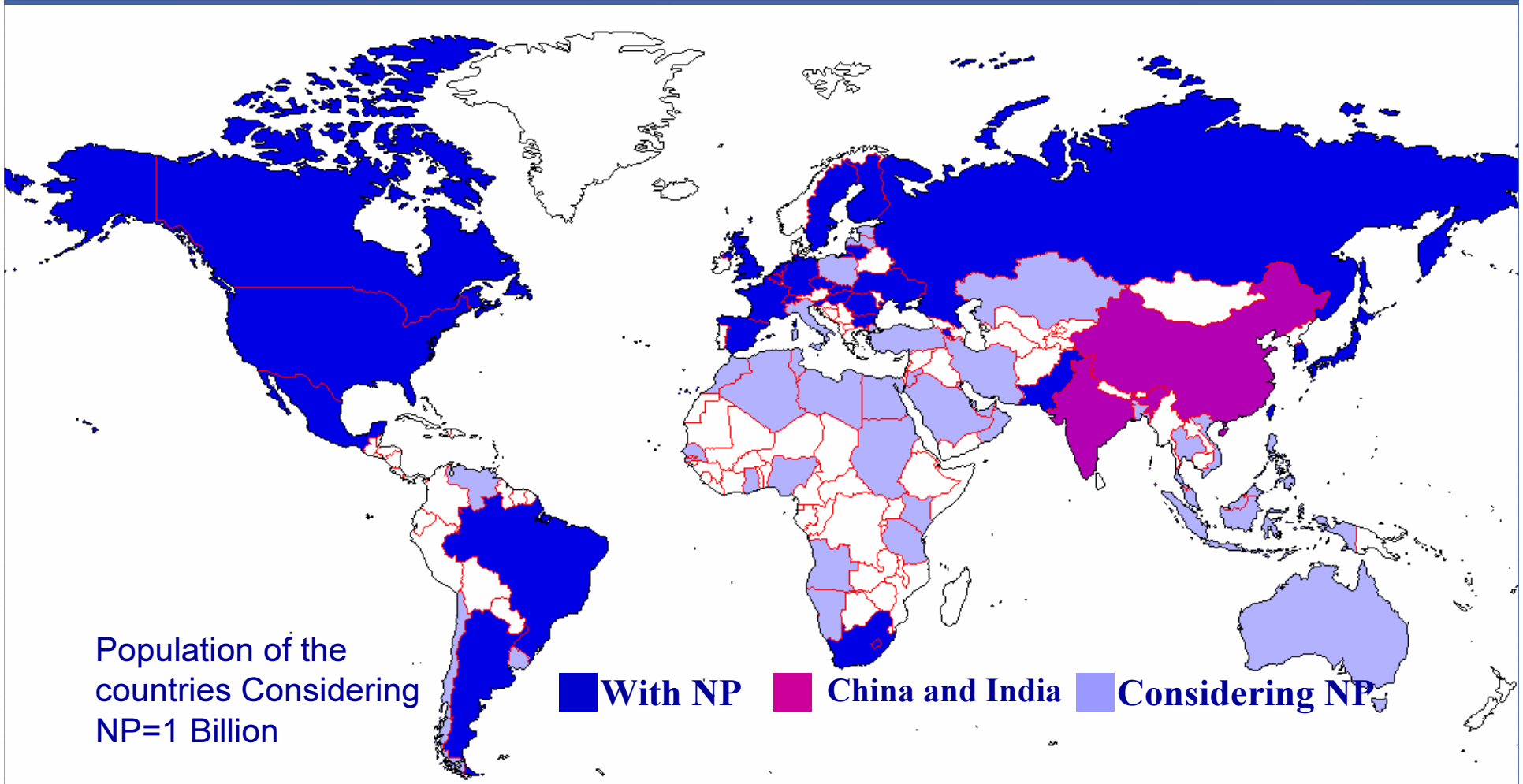
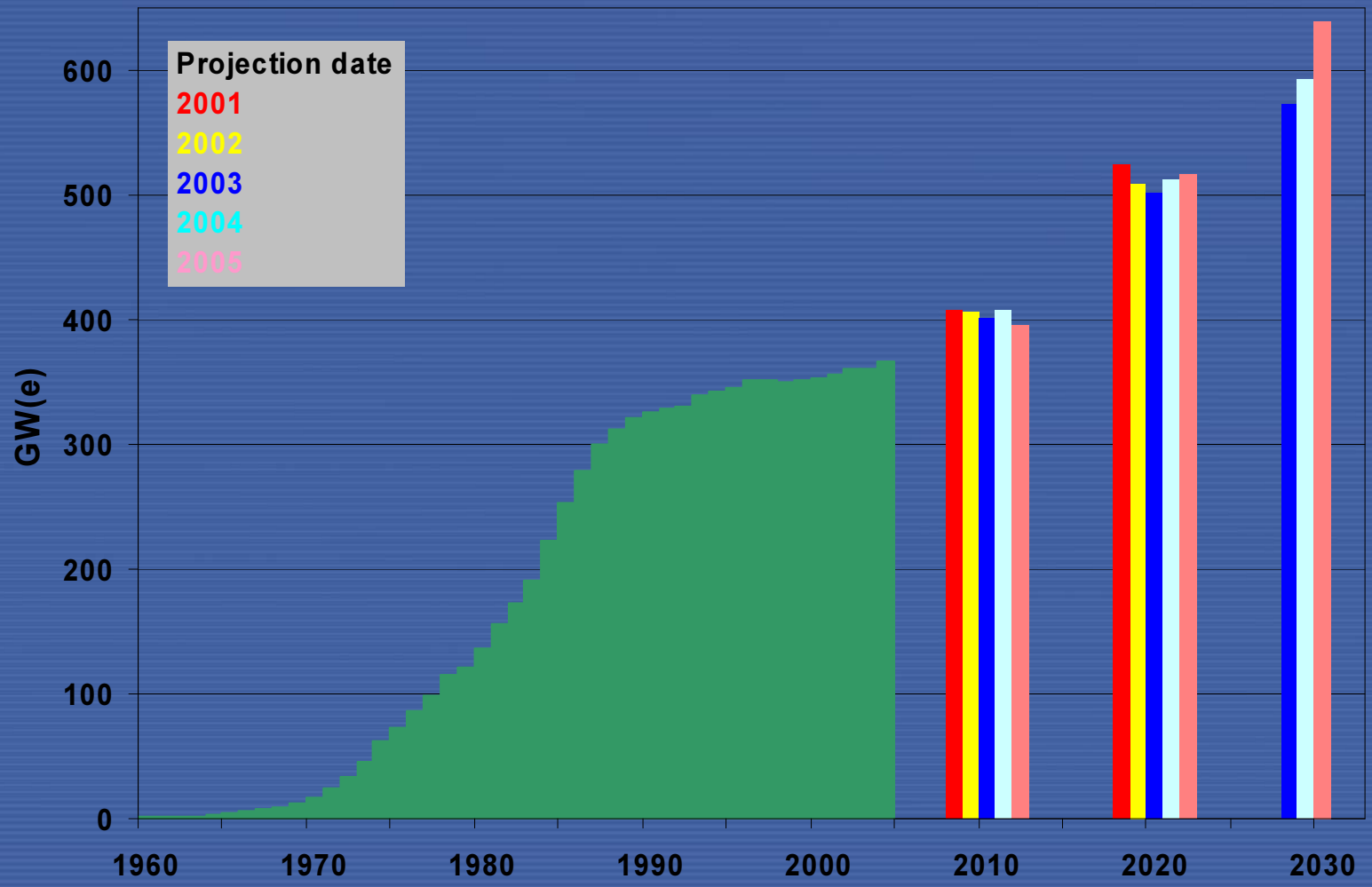
Increasing Nr. of countries considering introduction of nuclear power



IAEA's high projections



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Global trends in nuclear power and fuel cycle

IAEA's role and activities

Summary

IAEA's role

1) To ensure ***protection:*** that, wherever nuclear energy is used to produce energy , it is used:
   - Safely, Securely, and
   - With minimal proliferation risk.

2) To ensure continued ***technological innovation*** to improve its attributes in safety, security, economics, proliferation-resistance, environment and waste

3) To ensure that the needs of ***developing countries*** are taken into account:

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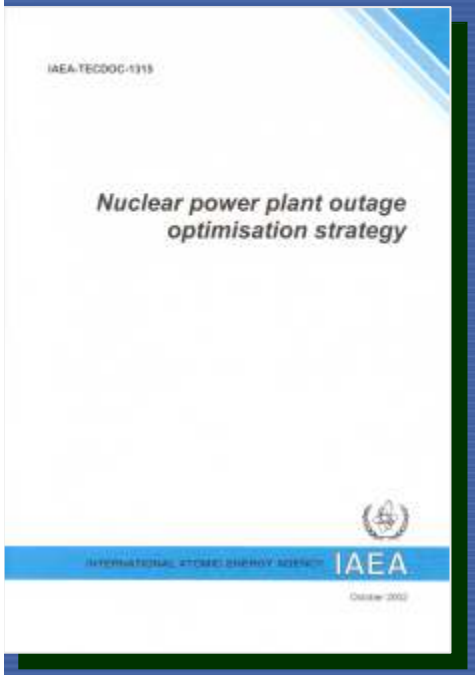
Activities by the Department of Nuclear Energy

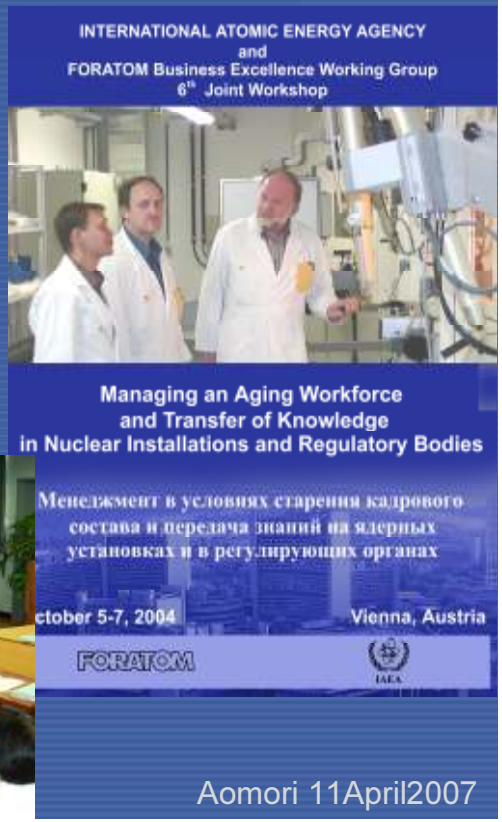
Mission

1) Support to existing Nuclear Power for excellence & to new countries for infrastructure development
2) Catalyse innovation for sustainable development
3) Build national capability



Activities

-Develop methodology
- Information sharing
- Coordinated research
- Technology transfer
- Review services



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1. Knowledge Management

- Issues Member States face:
  - ✓ Sustaining existing knowledge for the continued safe operation of existing nuclear installations
  - ✓ Human resources development in new countries
  - ✓ Preservation of knowledge before it degrades or is lost
- IAEA activities in:
  - ✓ Methodology and guidance
  - ✓ Educational networks
  - ✓ Knowledge preservation

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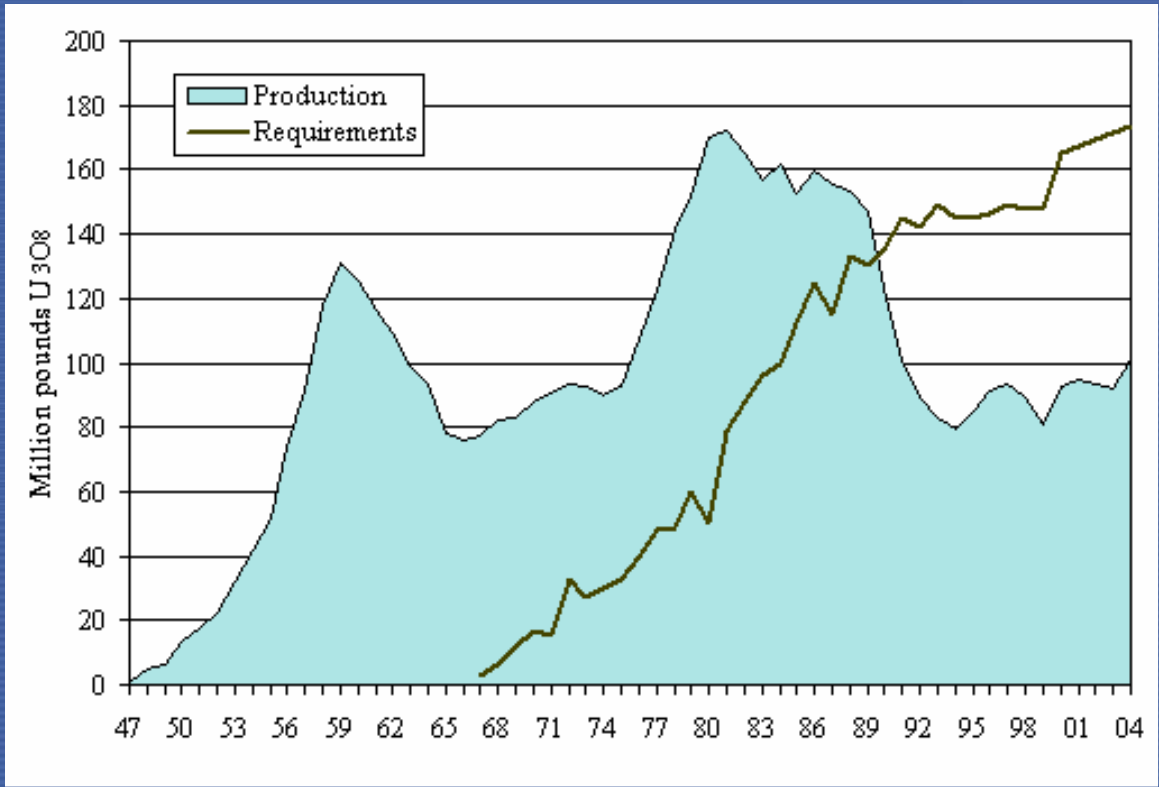
2. Uranium resources

After 2 decades of very low U price, price tripled in the last 2 years; make up by inventory drawdown is very uncertain

- Support to new Uranium exploration activities
- Support training for Uranium exploration & other activities
- Sharing information through meetings & databases

  "Red book" with OECD/NEA

Inventory drawdown since 1990



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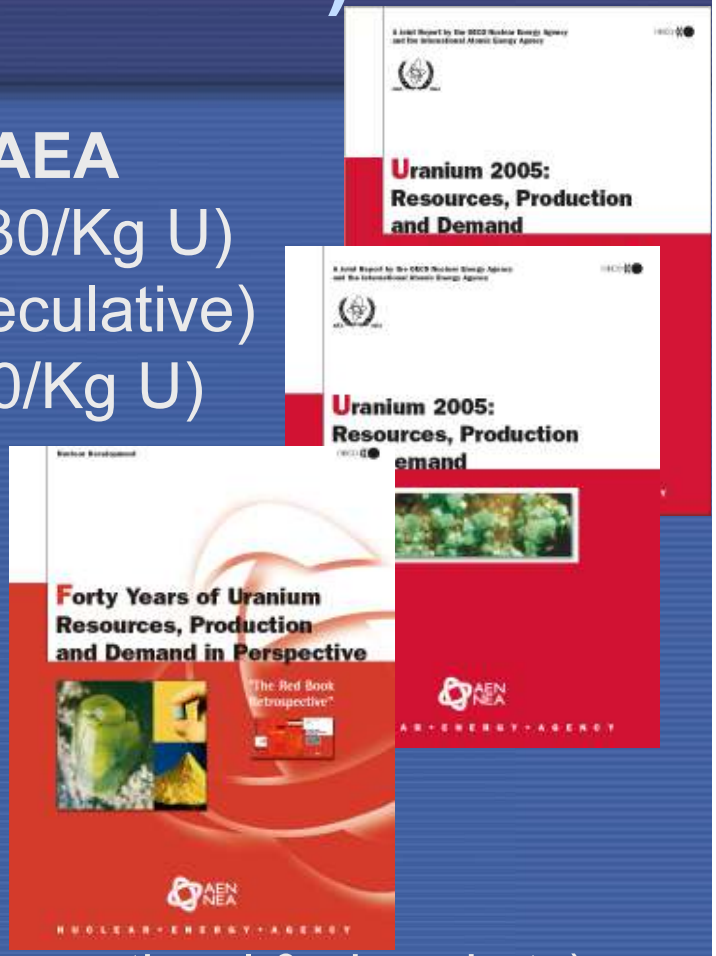
Uranium resources (“red book”)

- **“Uranium 2005” by OECD/NEA and IAEA**
  Total identified 4.7 Million Ton (<USD130/Kg U)
  Total undiscovered (Prognosticated & speculative)
  10 Million Ton (<USD130/Kg U)

- **Current consumption**
  = 68,000 Ton/year for 360GWe
  - Resource/Consumption with margin
  - Closed fuel cycle using FR
    further extends this margin



	R/P (total conventional)	R/P (conventional & phosphate)
LWR	270 years	675 years
Fast Reactor	8000 -16000years	20,000~40,000 years

Source: Uranium 2005
NTR2007

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3. Support for building infrastructure

- Infrastructure is a key to successful introduction/expansion
  legal and regulatory framework, human resources, industrial background etc
- Guidance for the introduction of nuclear power and for development of infrastructure
  - Numerous guidance documents
  - Filling in gaps & updating guidelines
  - Milestones document & its implementation (self-assessment and review by international experts)
  - Encouraging regional approach for efficiency
- Institutional issues (Assurance of supply, Financing, Licensing)

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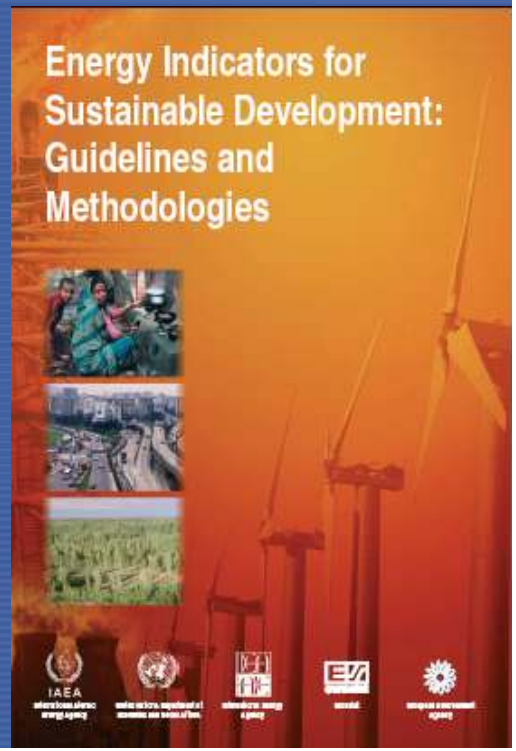
4. Energy Indicator for Sustainable Development (EISD)

- Many attributes of nuclear energy have potential to contribute to improve indicators of sustainable development
  - * "**development that meets the needs of the present without** compromising the ability of future generations to meet their own needs ", Brundtland, Our Common Future, 1987

- Potential to improve EISD of a nation by having NE in the energy portfolio
  29 EISD indicators :
  Society (4), Economy (15), Environment (10)
  - ✓ Usable to
    - Analyze past trends and current situation
    - Measure distance to target
    - Formulate strategy



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5. Stimulating innovation

- *"Technological and institutional innovation is a key factor in ensuring the long-term sustainability of nuclear power"*

- DG statement at 50th GC, 2006

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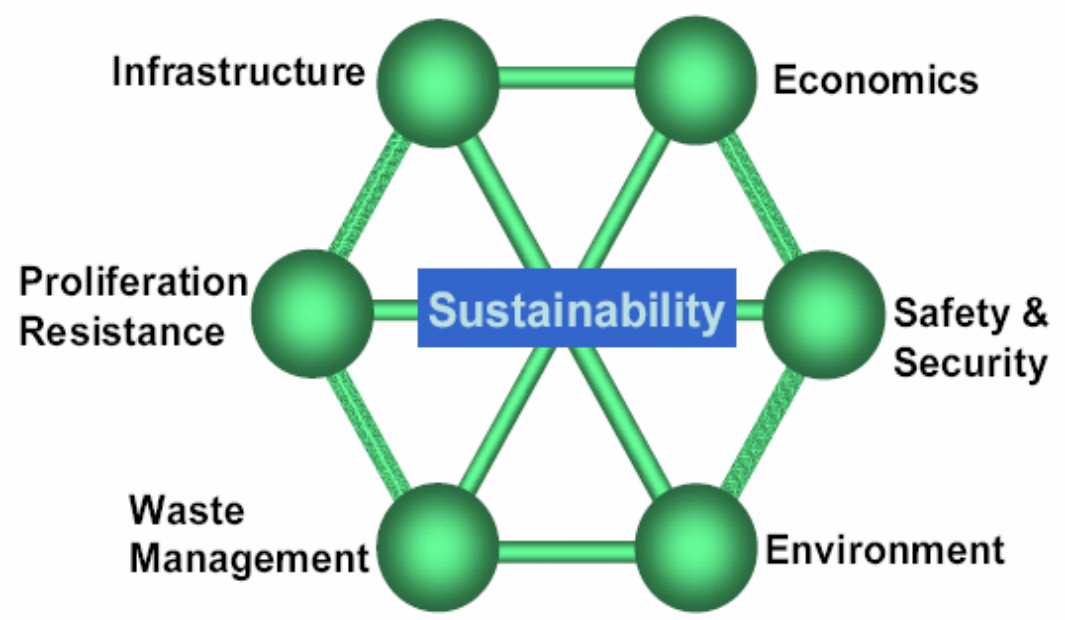
Three directions of current INPRO activities

1. Methodology improvement

Methodologies/Indicators
- assessment of different systems and scenarios
- screening of reactor and fuel cycle system



2. Institutional/Infrastructure

3. Collaborative Project

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Summary

Summary

1. Rising expectations for the role of nuclear power after 20 years of stagnation

2. The mission of NE, as one of the Agency's three pillars:
   - Support Member States' safe, reliable operation in a technically sound manner & infrastructure building for introduction/expansion of Nuclear Power
   - Catalyze innovation, and
   - Support Member States' capacity building and knowledge management

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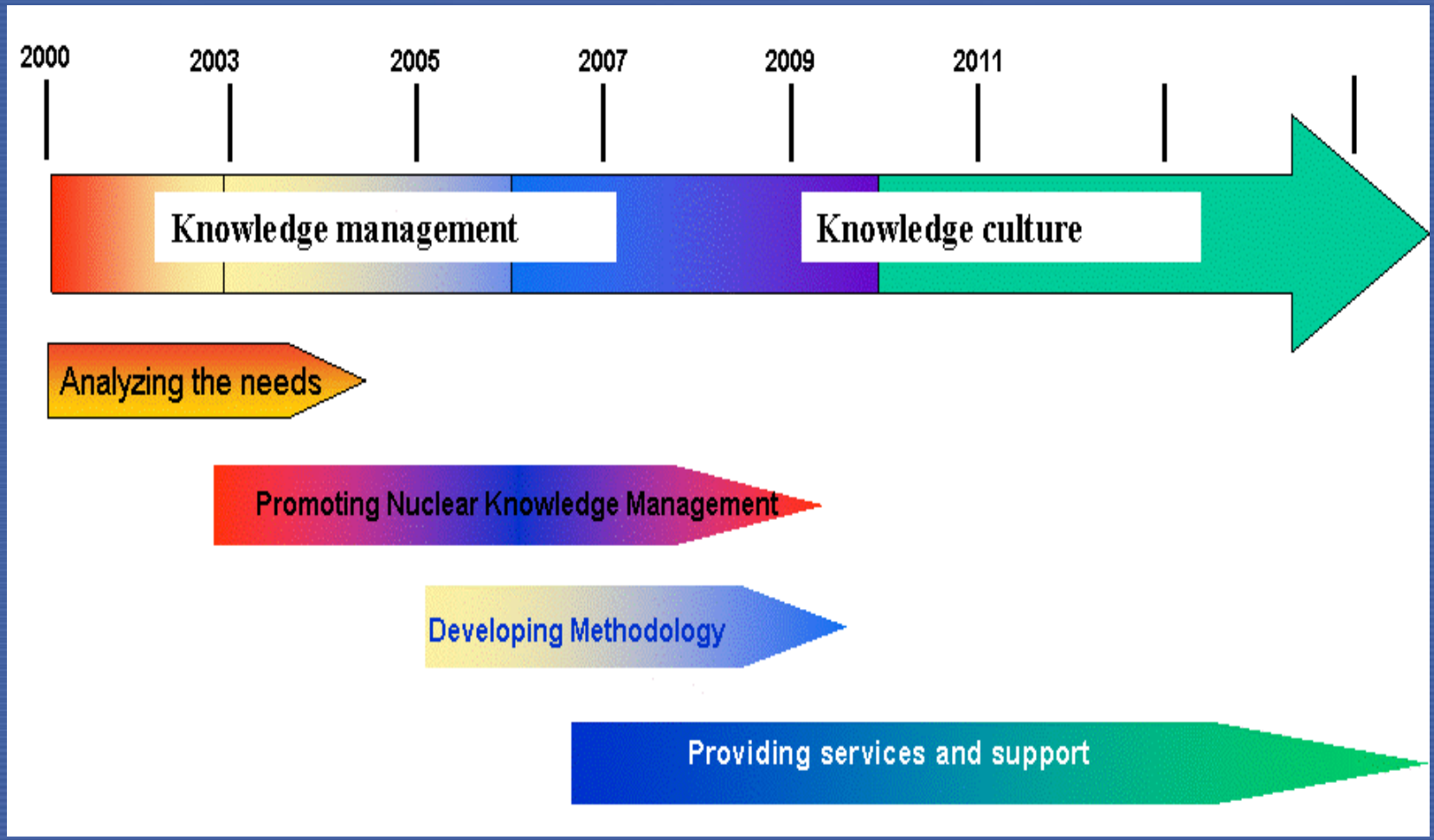
IAEA Activity development



IAEA's role

Statute article II: Objectives

- The Agency shall seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose.

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Uranium mining and milling

- Agency's support
  - ✓Identification of uranium deposits
  - ✓Training for exploration activities
  - ✓Best practices in mining and milling
  - ✓Environmental effects of mining and milling
  - ✓Closing of mining and milling facilities
  - ✓Environmental restoration of old mines

- Past experiences of MSs support
  - ✓China, Pakistan, Argentina - Exploration and prospecting techniques
  - ✓Egypt – Uranium resources development
  - ✓Romania – Restructuring of the uranium mining industry

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EISD in "Society" dimension

Theme	Sub-theme	Energy Indicator	
Equity	Accessibility	SOC1	**Share of households (or population) without electricity or commercial energy, or heavily dependent on non-commercial energy**
	Affordability	SOC2	**Share of household income spent on fuel and electricity**
	Disparities	SOC3	**Household energy use for each income group and corresponding fuel mix**
Health	Safety	SOC4	**Accident fatalities per energy produced by fuel chain**

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EISD in "Economy" dimension

Theme	Sub-theme	Energy Indicator	
Use and production patterns	Overall Use	ECO1	Energy use per capita
	Overall Productivity	ECO2	Energy use per unit of GDP
	Supply efficiency	ECO3	Efficiency of energy conversion & distribution
	Production	ECO4	Reserves to production ratio
		ECO5	Resources to production ratio
	End-use productivity	ECO6	Industrial energy intensities
		ECO7	Agricultural energy intensities
		ECO8	Service / Commercial energy intensities
		ECO9	Household energy intensities
		ECO10	Transport energy intensities
	Fuel Mix	ECO11	Fuel Shares in energy and electricity
		ECO12	Renewable energy share in energy and electricity
	Prices	ECO13	End use energy Prices by fuel and by sector
Security	Imports	ECO14	Net energy import dependency
	Stocks	ECO15	Stocks of critical fuels per corresponding fuel consumption

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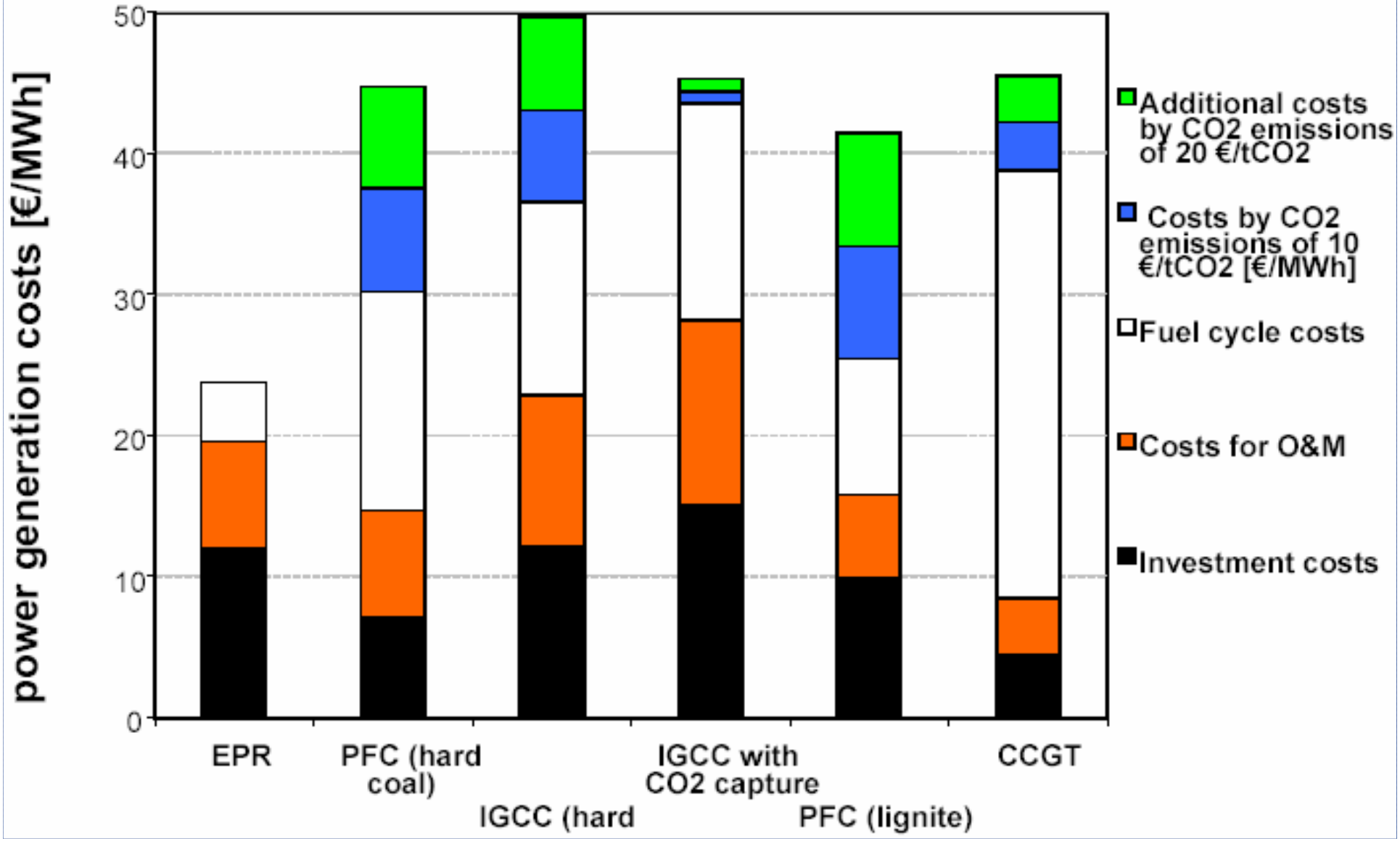
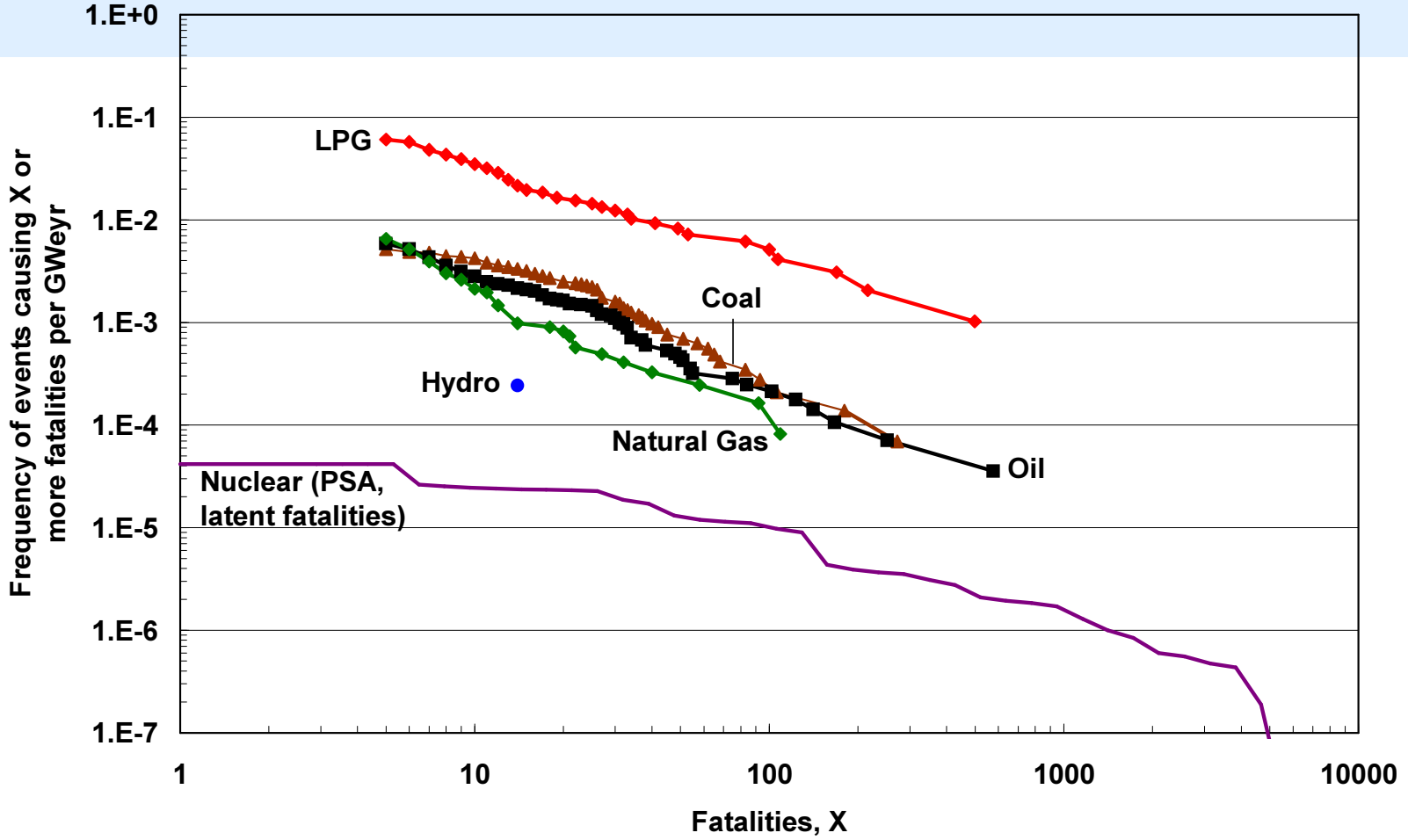
The impact of the emission trading on the electricity generation cost (Prof. Voß , Univ. of Stuttgart)

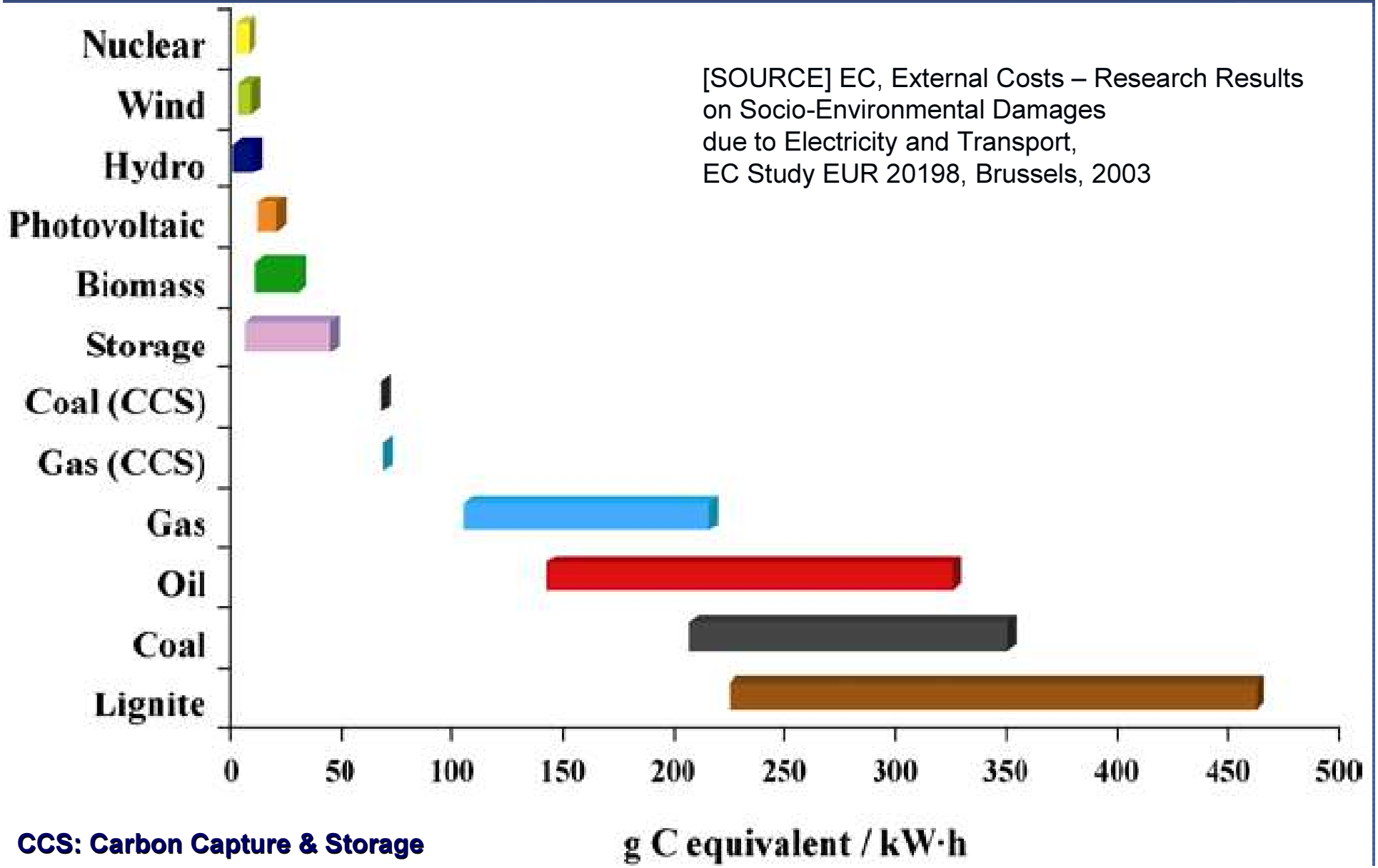


Frequency-Consequence Curves for Severe Accidents in Various Energy Chains, OECD countries, 1969-2000



[Source] Burgherr & Hirschberg, 2004

CO2 emission rates from electricity generation



[SOURCE] EC, External Costs – Research Results on Socio-Environmental Damages due to Electricity and Transport, EC Study EUR 20198, Brussels, 2003

CCS: Carbon Capture & Storage