Nuclear Energy and Addressing Climate Change

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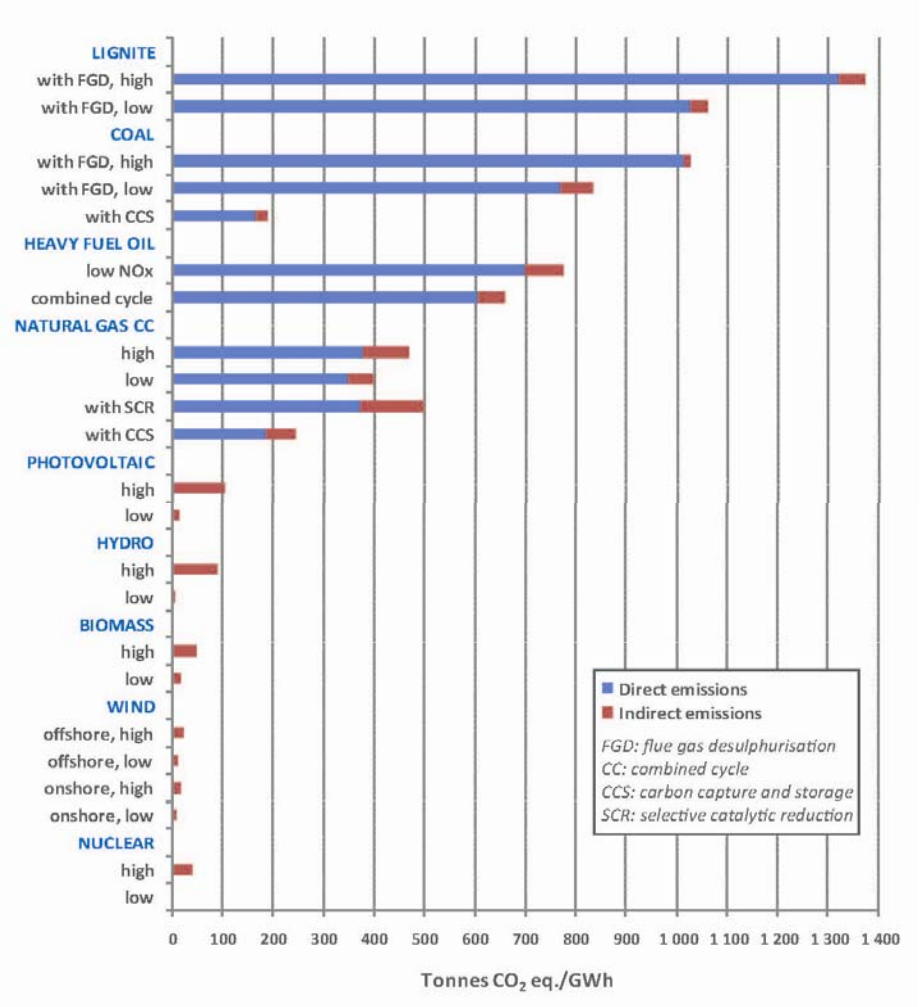
Does nuclear power produce CO2 emissions?

- Yes, it produces some indirect emissions
- These emissions are rather small, however (less than 0.01 tonnes per MWh), comparable to wind and other renewables
- They are much smaller than emissions from fossil fuels (up to 1 tonne per MWh for lignite).

Direct and indirect greenhouse gas emissions for alternative electricity generation systems.

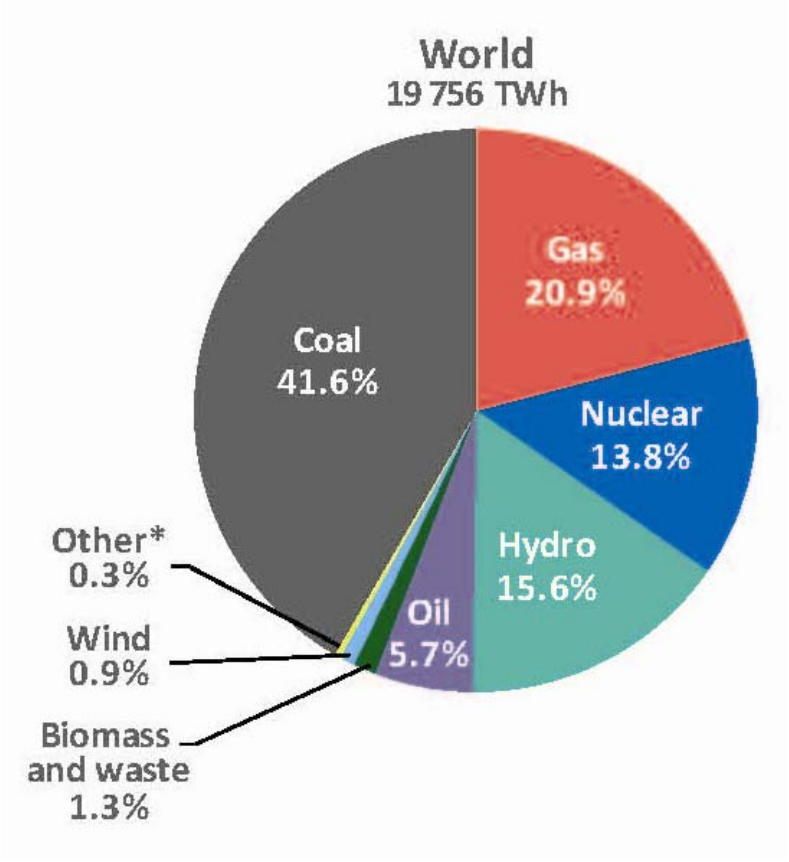


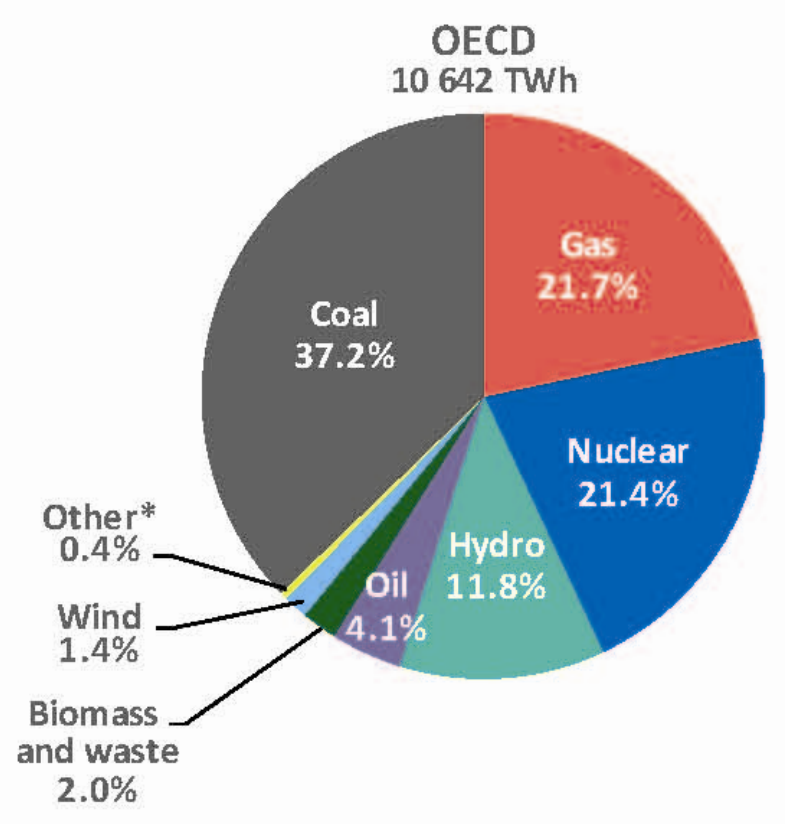
Source: *Mitigation of Climate Change*, Intergovernmental Panel on Climate Change, 2007.

What is the current contribution of nuclear power?

- In 2007, nuclear power produced 14% of global electricity (21% in OECD countries);
- If substituted by coal, global emissions would rise by 3 Gt; OECD power sector emissions would be up to 1/3 higher;
- For the period 1971 – 2004, cumulative emission savings were about 58 Gt from (compared to 218 Gt total OECD power sector emissions).

Electricity generation by source in 2007, worldwide and for OECD countries.



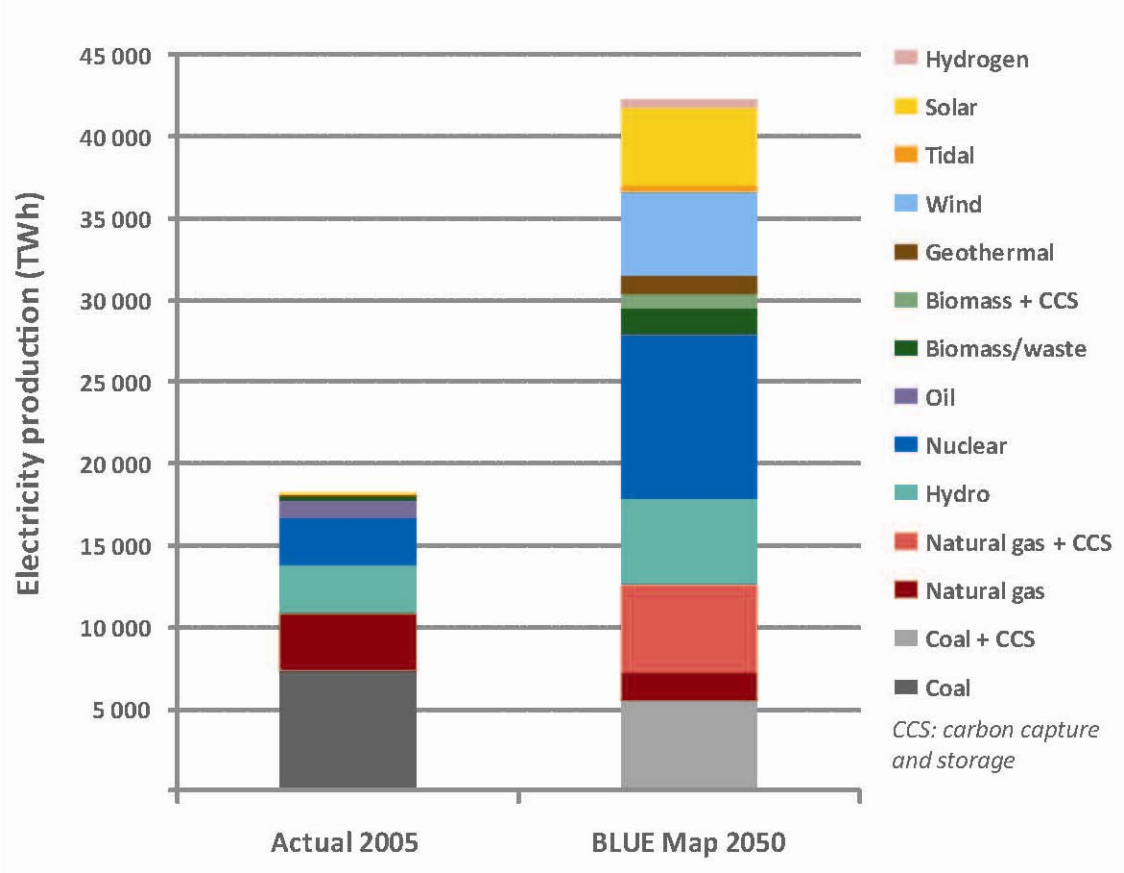


Source: *World Energy Outlook*, International Energy Agency, 2009.

What could be the future contribution of nuclear power?

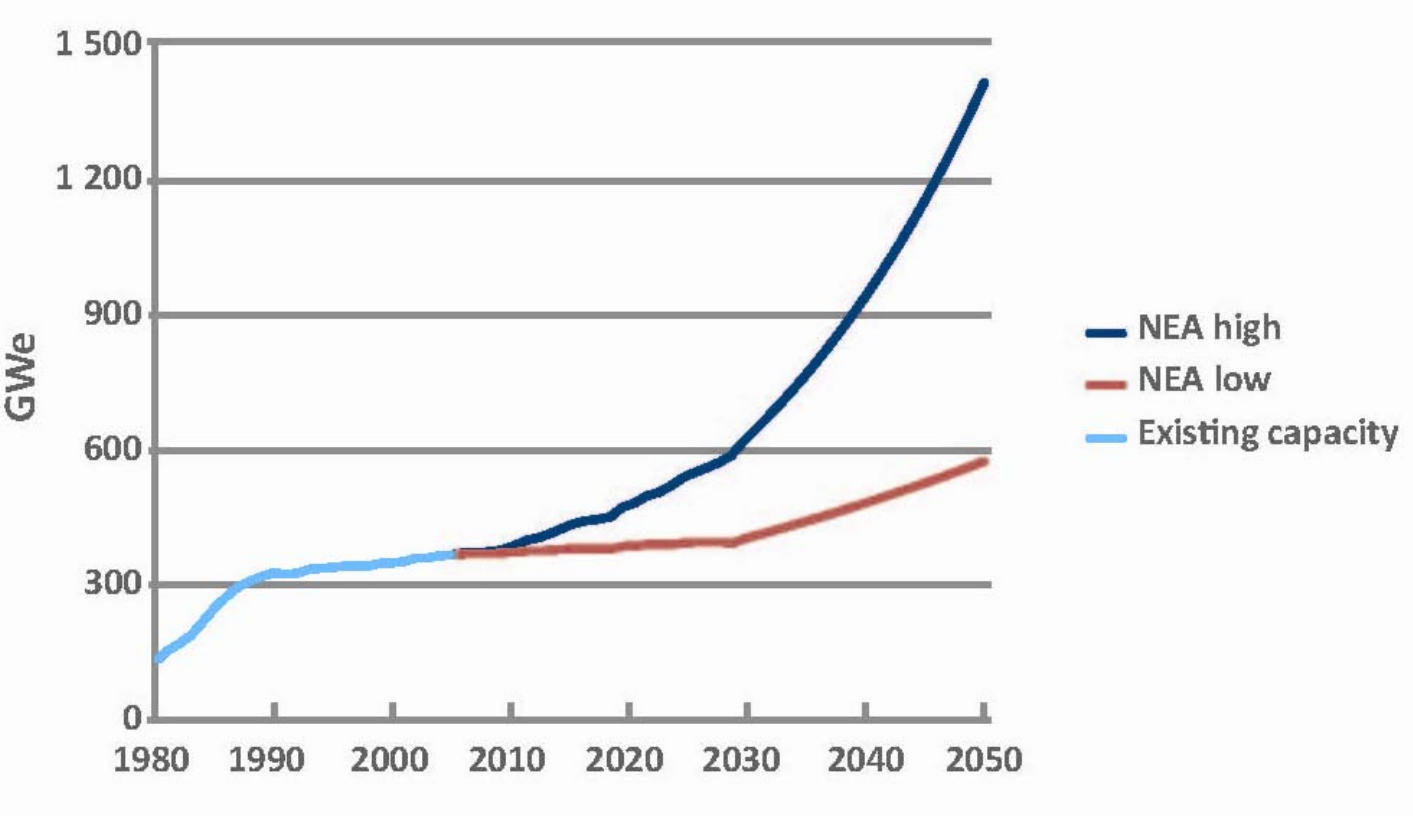
- Nuclear is a mature technology; barriers to its expansion are social, political and financial rather than technical;
- In the IEA 2050 “BLUE Map” scenario (roughly, halving CO2 emission, while doubling electricity output) nuclear increases from 370 GW today to 1250 GW (*NEA Nuclear Outlook 2008* “High scenario” 1400 GW, “Low scenario” 600 GW);
- This implies 20 1500 GW plants per year during the 2020s and 30s and 25-30 plants per year during the 2040s;
- May seem high but needs to be compared to up to 30 plants per year during early 1980s (22 yearly average for decade);
- Today China and India would be added users.

"BLUE Map" scenario for electricity supply in 2050, which would reduce CO2 emissions to half of 2005 levels.



Source: *Energy Technology Perspectives*, International Energy Agency, 2008.

NEA scenarios for nuclear expansion to 2050.



Source: *Nuclear Energy Outlook*, OECD Nuclear Energy Agency, 2008.

Do we have the resources for such an expansion?

- A significant expansion of nuclear power would face industrial challenges as well as questions about uranium supplies;
- Industrial challenges are addressed in the current re-configuration of the reactor supply chain;
- Uranium prices low until 2003 due to release of government stocks (current production 2/3 of consumption; expected to rise, exploration already rising);
- On current levels of availability known conventional resources and consumption, reserves would last for about 100 years;
- Many more years with unconventional resources and/or fast neutron reactors;
- Enrichment capabilities would also need to be increased; this sensitive technology is possessed only by few countries; proposals range from guaranteed supply contracts to multilateral solutions (IAEA “fuel bank”).

Ratios of uranium resources to present (2006) annual consumption, for different categories of resources, showing the impact of recycling in fast neutron reactors (in years).

	Known conventional resources	Total conventional resources	With unconventional resources
With present reactor technology	100	300	700
With recycling using fast neutron reactors	> 3 000	> 9 000	> 21 000

Source: *Nuclear Energy Outlook*, OECD Nuclear Energy Agency, 2008.

What about safety, waste, proliferation and capabilities?

- Nuclear safety certainly an issue due to (1) limited experience with radiation and (2) potential high impact events; overall performance good, especially in comparison with other technologies;
- “Passive safety” features (automatic shut-downs in case of problems) currently integrated; international safeguards will continue to be needed;
- Deep geological disposal for high-level nuclear actively pursued by Finland, France and Sweden; so far few problems compared with toxic wastes ; long half-lives pose new questions that should be solvable;
- Proliferation needs to be watched closely; the Treaty on Non-Proliferation (TNP) under IAEA is working but may need strengthening;
- As previous generations of nuclear experts retire, existing and new competences need to be preserved (new entrants need institutions and human capital); industry and governments actively involved.