

Does nuclear energy provide an answer to global warming?

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- widespread concern about global warming
- need carbon-free alternatives
- many people think nuclear power provides a solution

Is Nuclear an Answer?

- first, nuclear is not particularly carbon-free
- second, new nuclear could only make a small contribution to reducing CO₂ emissions
- third, nuclear is economically the worst way to reduce CO₂

How To Mitigate Climate Change?

1. Renewable energy
2. High efficiency technology, eg CHP
3. CO₂ sequestration
4. Low carbon fuels, eg gas not coal
5. Greater energy efficiency in homes etc
6. Nuclear power

ie, nuclear power = just 1 of 6 options in energy

How Carbon-free is Nuclear?

Nuclear Fuel Cycle and CO₂

- uranium mining + milling
- UF₆ conversion
- U-235 fuel enrichment
- nuclear fuel fabrication
- fuel transportation
- reactor operation
- waste encapsulation
- waste transportation
- future waste disposal?

UK Gov't Consultative Document

January 2006

<http://www.dti.gov.uk/files/file25079.pdf>

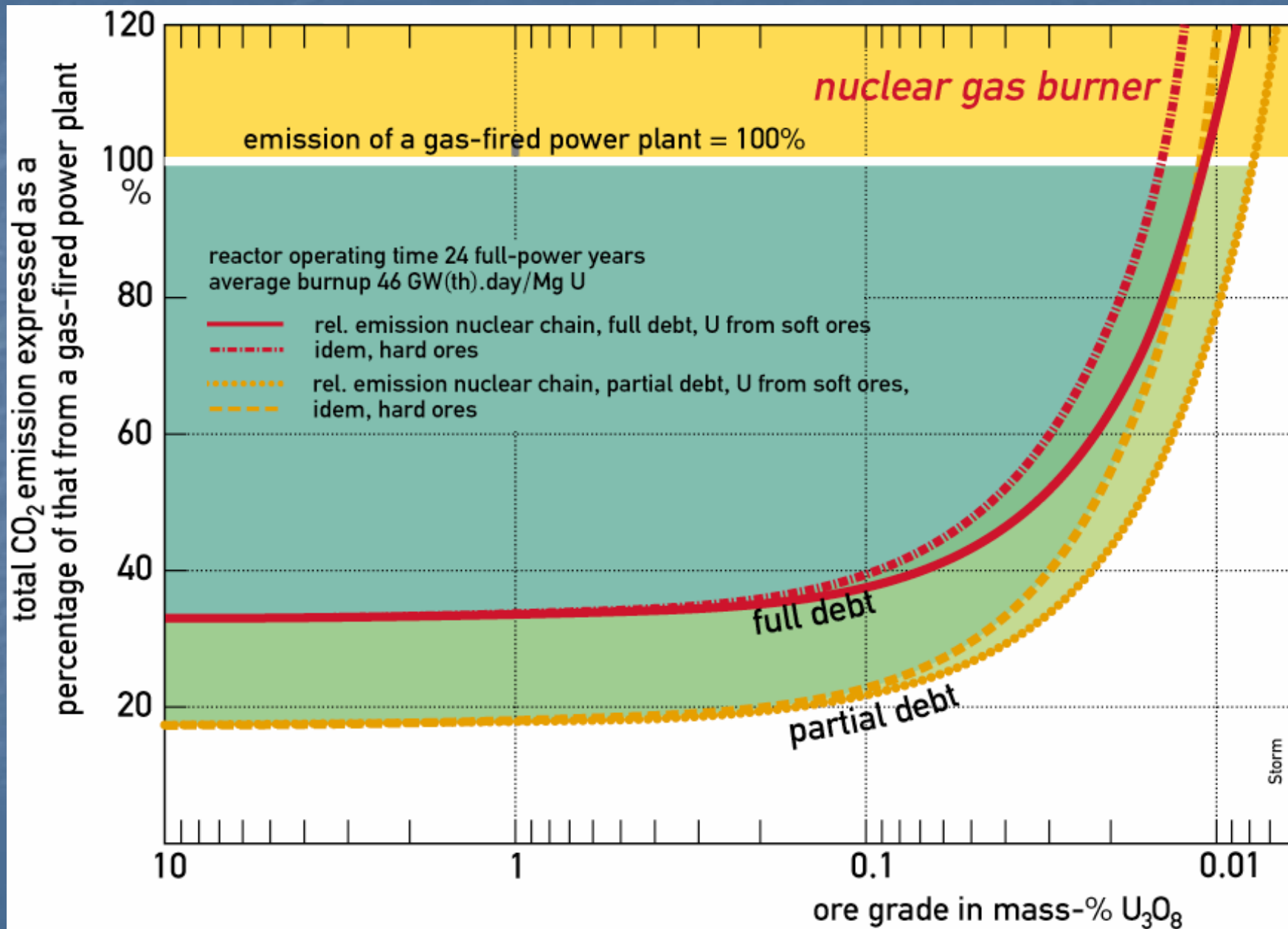
"Nuclear power plants emit almost zero carbon However the mining, refining and enriching of uranium, and plant construction and decommissioning, are carbon-intensive processes..."

Annex A: page 64

CO₂ emissions depend on

- uranium ore grade, type
- U-235 enrichment method
- future nuclear waste plans
- any underground repository

CO₂ and U ore grade



Two Independent Studies

1. Öko Institut (advisors to German Environment Ministry) in 2006

www.oeko.de/service/gemis/files/info/nuke_co2_en.pdf

- CO₂ savings with nuclear power were **poor** in comparison with renewable energies

2. Storm van Leeuwen in 2006

- nuclear produces **20% - 30%** as much CO₂ as modern gas-fired station www.stormsmith.nl

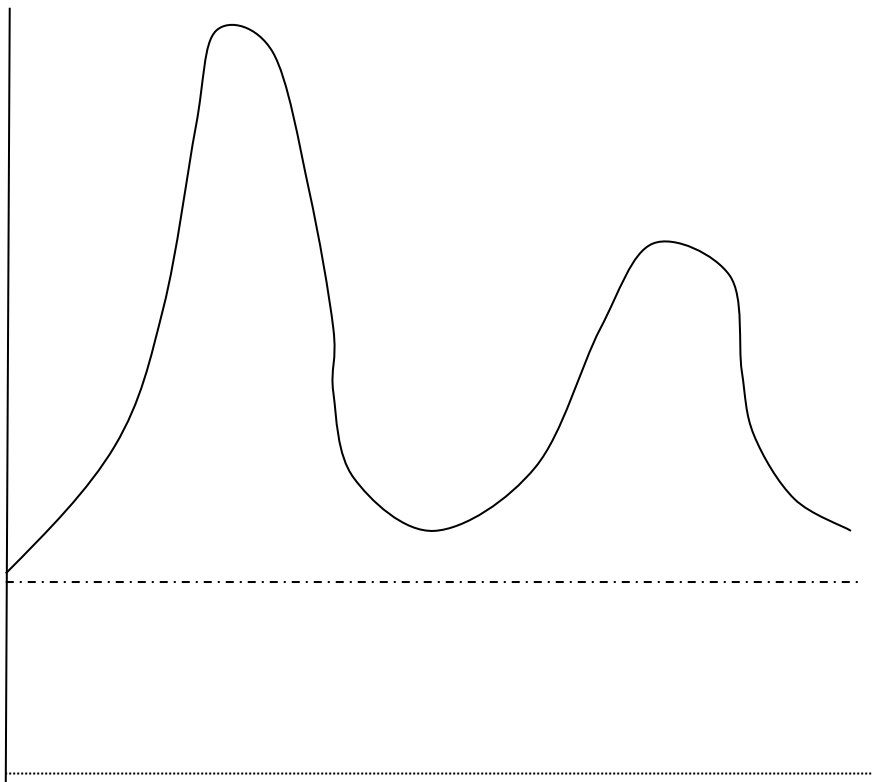
How Much Potential for
Reducing
CO₂ emissions?

Potential for UK CO₂ reduction

- electricity generation responsible for ~20% of UK annual CO₂ production
- maximum contribution of ~25% to electricity supply (because nuclear cannot follow demand)

$$20\% \times 25\% = \sim 5\%$$

Daily Electricity Demand





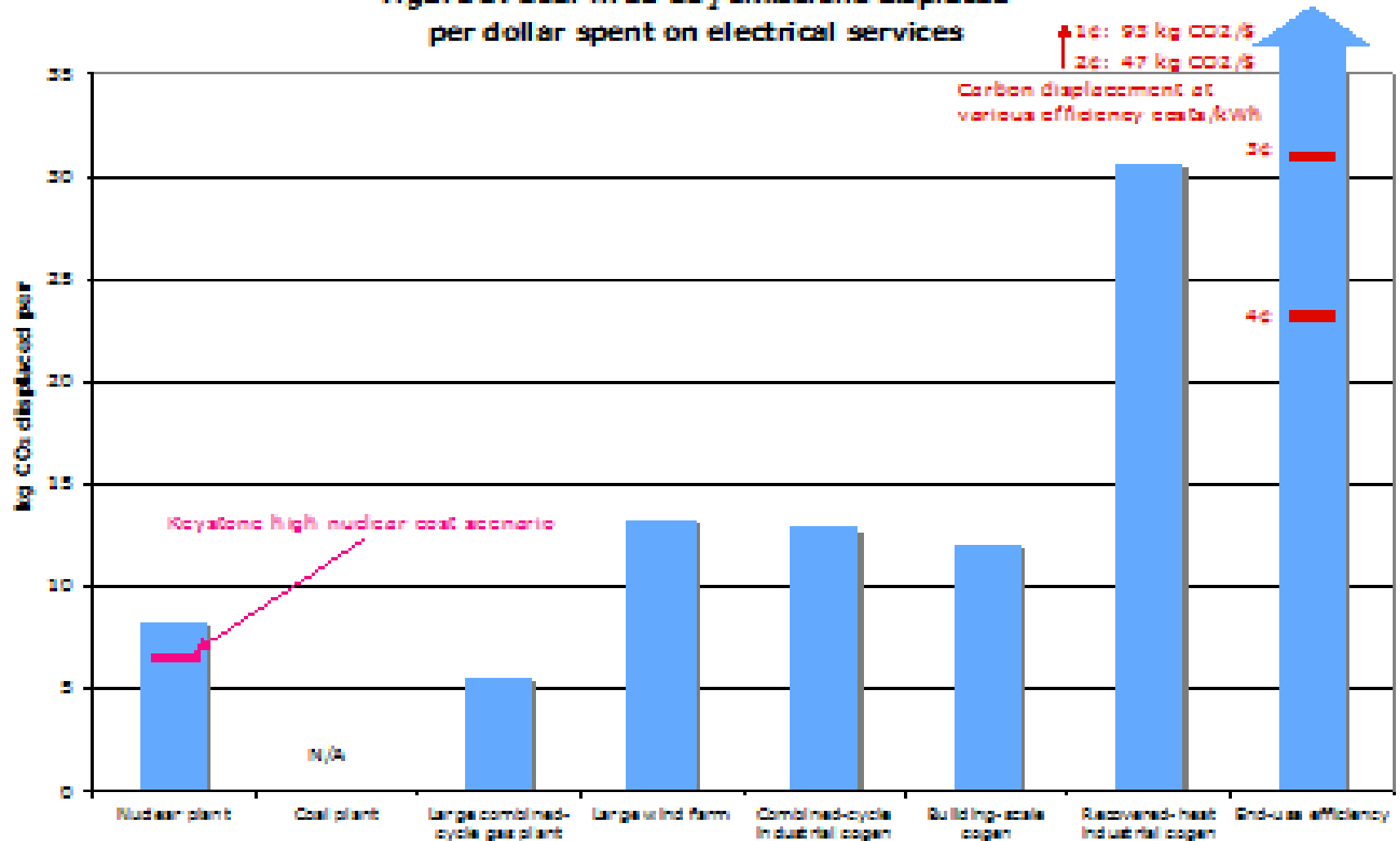
Sustainable
Development Commission

- a 10GW replacement nuclear programme would result in ... a 4% cut in CO₂ emissions from 1990 levels <http://www.sd-commission.org.uk/publications.php?id=344> (March 2006)
- concluded “Nuclear power is not the answer to tackling climate change ...”
<http://www.sd-commission.org.uk/pages/060306.html>

Is nuclear power a cost effective
way to reduce CO₂ ?

How much CO₂ saved per \$

Figure 3: Coal-fired CO₂ emissions displaced per dollar spent on electrical services

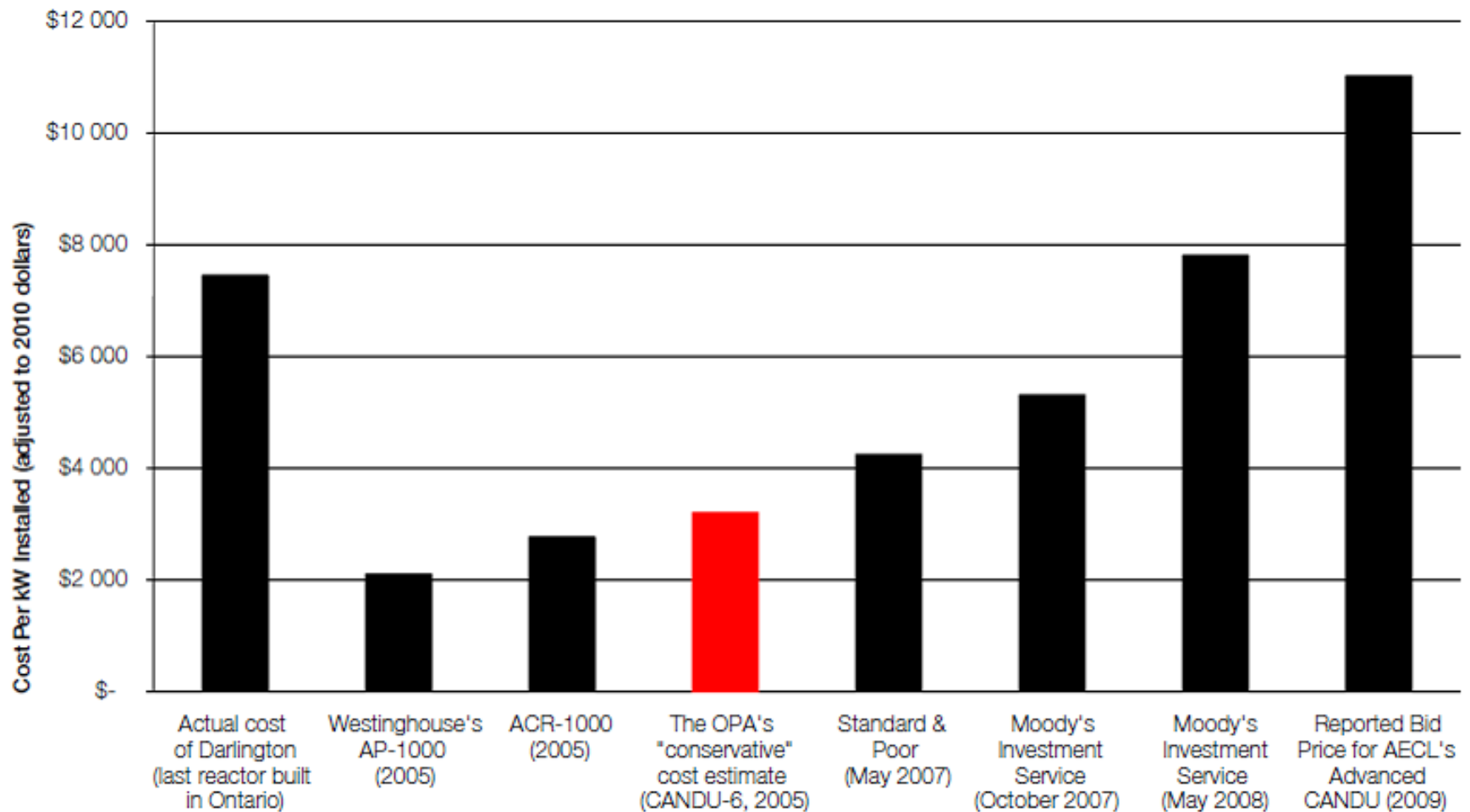


Nuclear capital costs

- extremely high

- AP1000 reactor = \$7 to \$12 billion
- ~15 x higher than gas-fired equivalent
- requires very large Government subventions, subsidies, insurance guarantees, and market interventions

Nuclear construction costs per kW



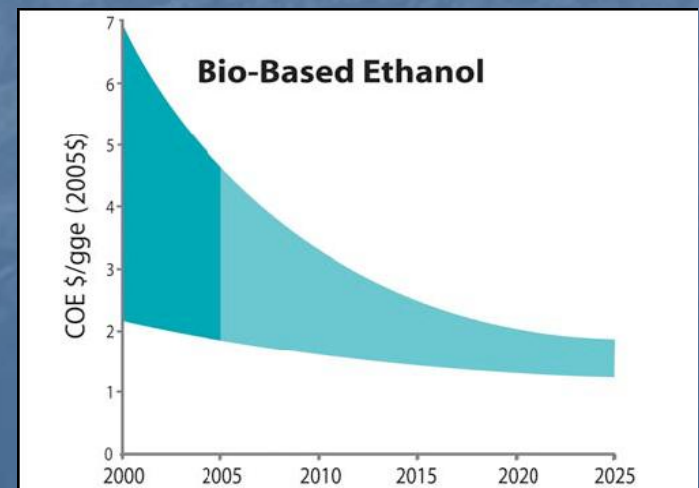
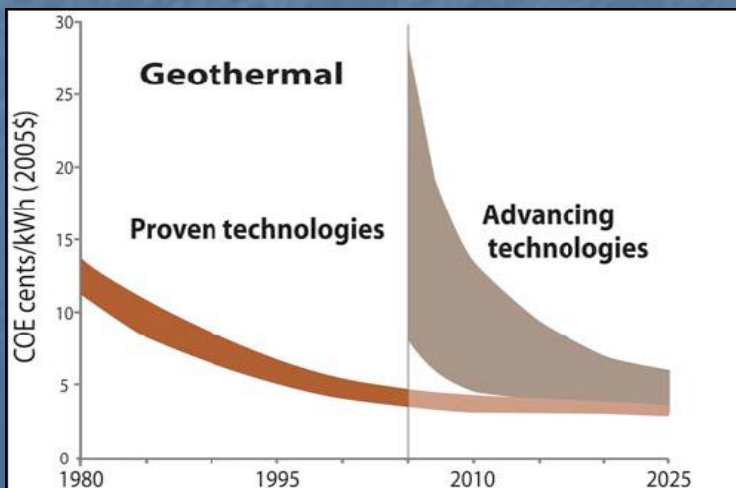
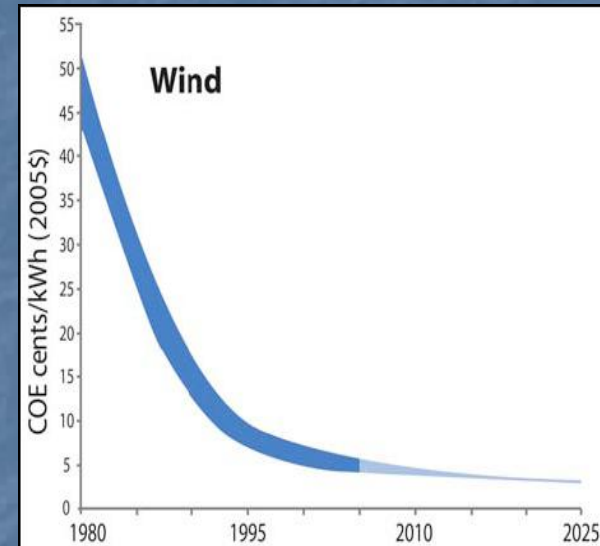
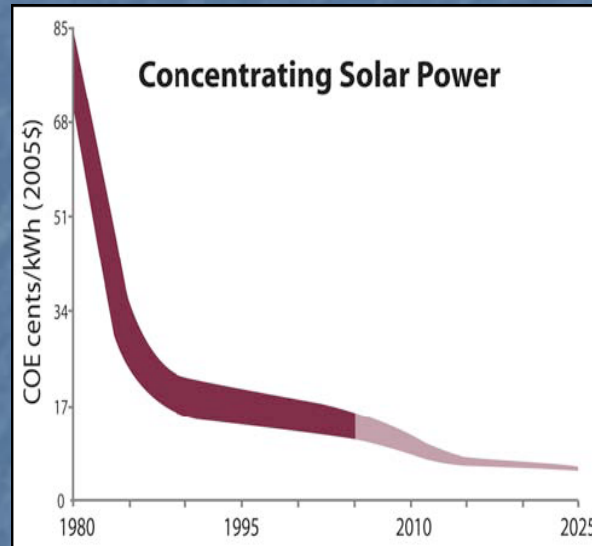
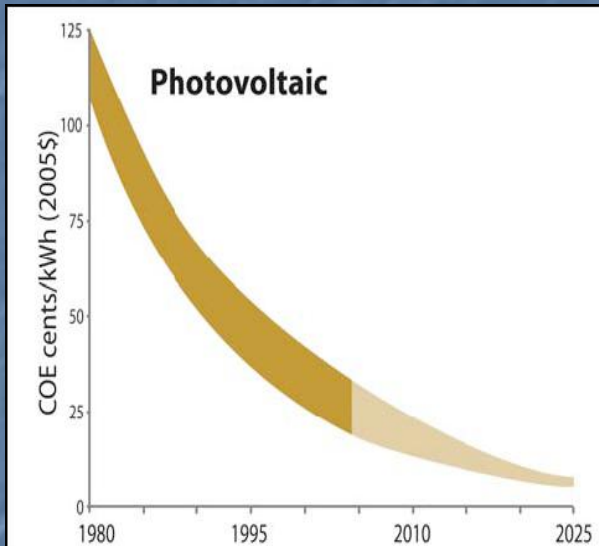
Sources:

Darlington construction costs, Ontario Hydro; Ontario Power Authority 2007; Standard & Poor and Moody's Investment Service; the Toronto Star.

Renewable Energy Cost Trends November 2005

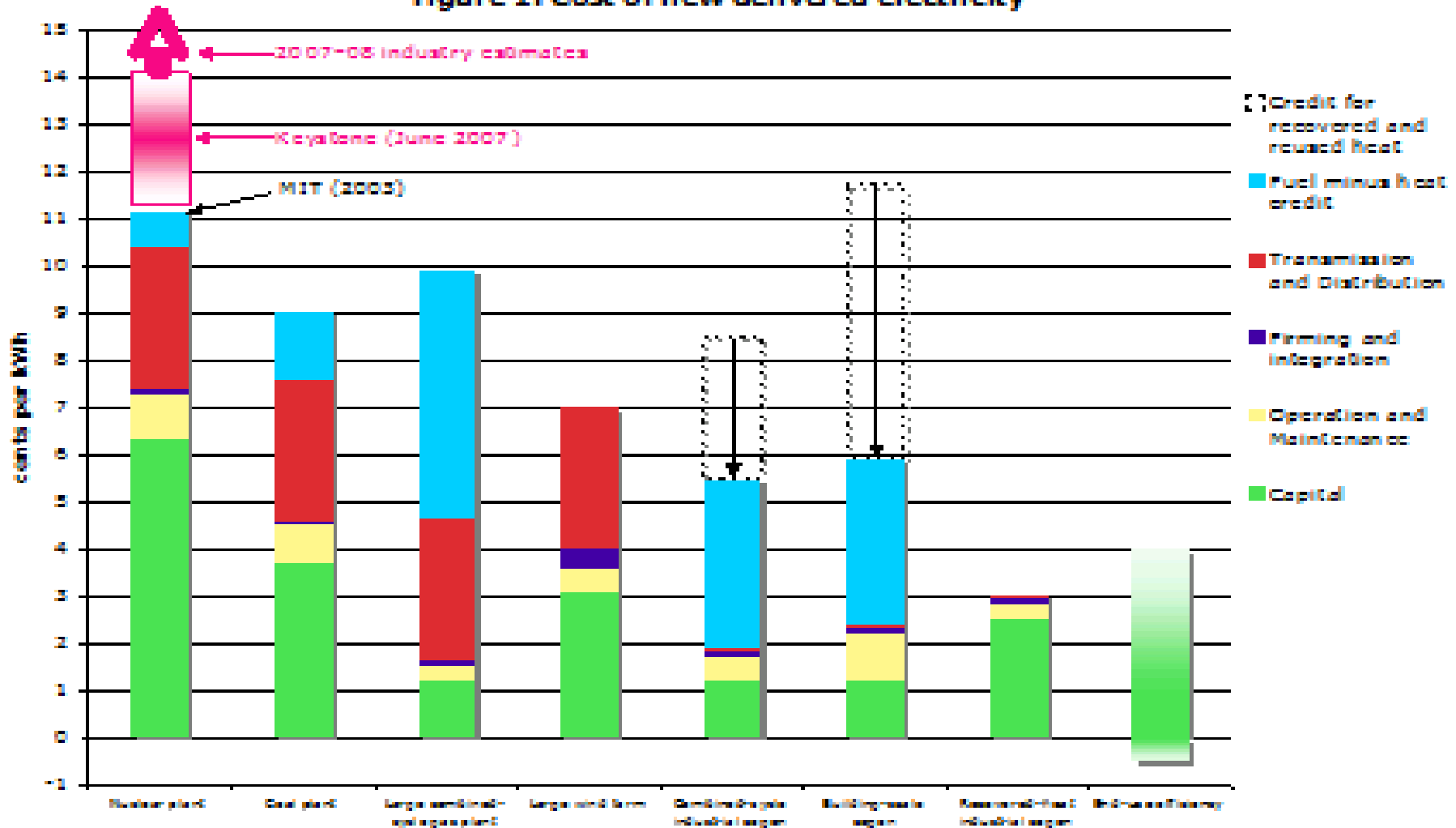
(levelised sent-out cost of energy in constant 2005 US\$, excluding subsidies)

Source: US NREL Energy Analysis Office www.nrel.gov/analysis/docs/cost_curves_2005.ppt



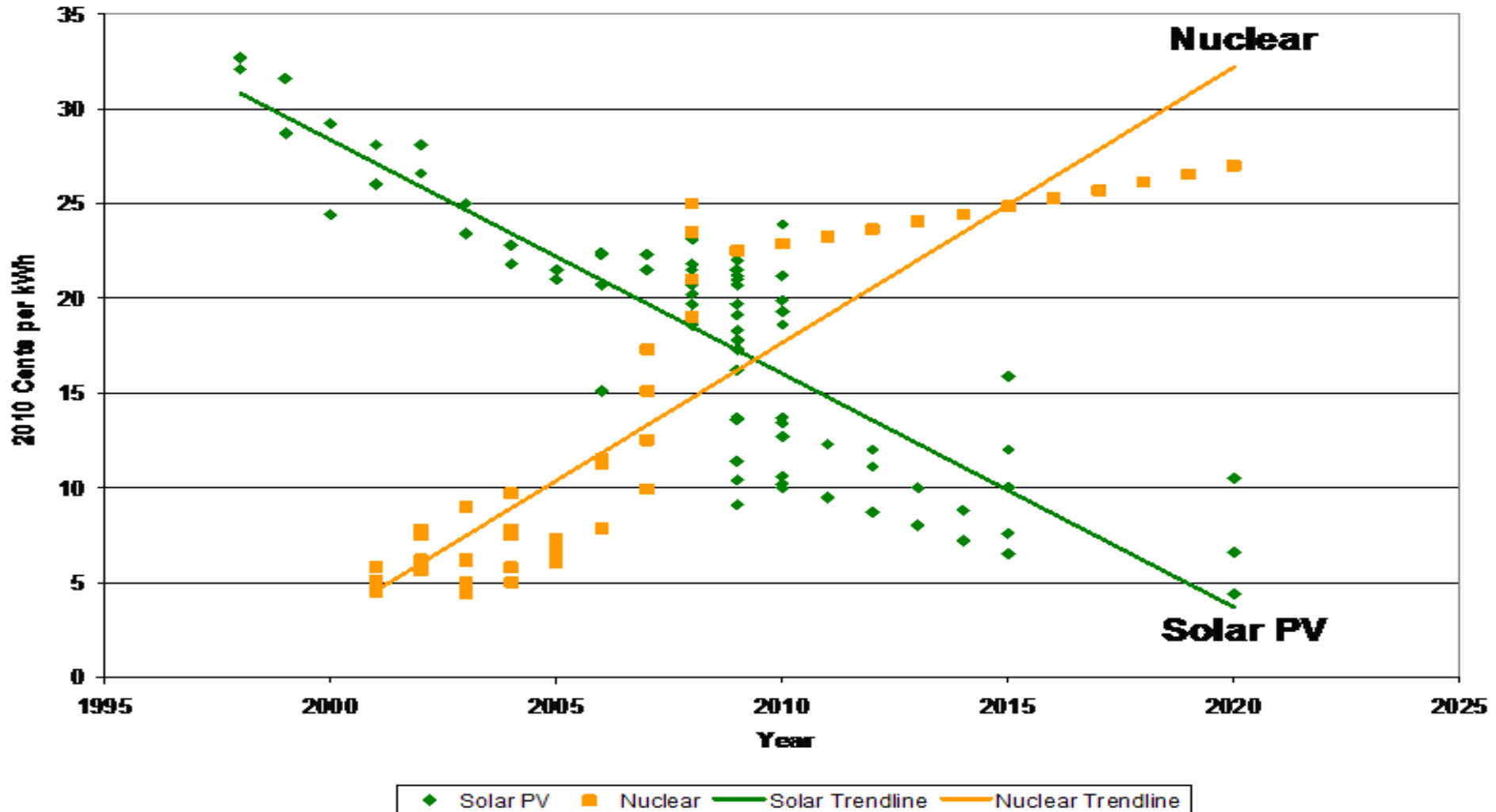
Comparison of generating costs

Figure 1: Cost of new delivered electricity



Nuclear vs photovoltaic

Solar-Nuclear Kilowatt-Hour Cost Comparison



Comparison

Nuclear

- Can't contribute in short term (~10 years to plan/build) or long term (exploitable reserves of U ore are limited)
- Dangerous – eg Chernobyl
- No solution in sight for radioactive wastes
- Proliferation of nuclear weapons
- Expensive: 15 x more than gas-fired station per GWe

Renewables

faster, cleaner, safer, cheaper, no emissions, no wastes, no proliferation, no resource depletion worries

A Nuclear Renaissance?

- globally, in last decade, >30 GW **nuclear** capacity has been closed
- in the same time, 70 GW **wind** + 70 GW **solar** thermal capacity has been installed

Nuclear Proliferation

“Should a state with a fully developed fuel-cycle capability decide, for whatever reason, to break away from its non-proliferation commitments, most experts believe it could produce a nuclear weapon within a matter of months.”

Mohamed El-Baradei (2003) former IEAE
director Oct 16 2003 The Economist

Chernobyl

- “foremost nuclear catastrophe in human history” IAEA (1996)
- “The magnitude and scope of the disaster, the size of the affected population, and the long-term consequences make it, by far, the worst industrial disaster on record” IAEA/WHO (2005a)
- “Chernobyl radioactivity was 200 times that from Hiroshima and Nagasaki” - WHO/IPHECA (1995)

Nuclear Waste

"There should be no commitment to a large programme of nuclear fission power until it has been demonstrated beyond reasonable doubt that a method exists to ensure the safe containment of long-lived, highly radioactive waste for the indefinite future"

UK Royal Commission on Environmental Pollution 1976

Managerial Disaster

“The failure of the [1980s] US nuclear power program ranks as the largest managerial disaster in business history, a disaster on a monumental scale.”

Cook J. Nuclear follies. Forbes, 11 February 1985.

Ethical questions about nuclear power

- a sustainable development?
- consistent with the Precautionary Principle?
- ethical to pass more radioactive waste to future generations?

Conclusions

- very small contribution to CO₂ reduction
- examine cheaper, more cost effective, quicker, safer options

= Renewables and Energy Efficiency

a radioactive future?



or a renewable future...?



- Öko Institut, Comparison of Greenhouse Gas Emissions and Abatement - Cost of Nuclear and Alternative Energy Options from a Life-Cycle Perspective, January 2006
- House of Commons Environmental Audit Committee Sixth Report "Keeping the lights on: Nuclear, Renewables and Climate Change" April 2006)
<http://www.publications.parliament.uk/pa/cm200506/cmselect/cmenvaud/584/58407.htm#a14>
- Sustainable Development Commission Report "[The role of nuclear power in a low carbon economy](http://www.sd-commission.org.uk/publications.php?id=344)"<http://www.sd-commission.org.uk/publications.php?id=344>
- Department of Trade and Industry Consultative Document "Our Energy Challenge" January 2006
<http://www.dti.gov.uk/files/file25079.pdf>
- US Department of Energy. National Renewable Energy Laboratory. Energy Analysis Office www.nrel.gov/analysis/docs/cost_curves_2005.ppt
- Jan Willem Storm van Leeuwen and Philip Smith (2006) "Nuclear power - the energy balance"
- DTI Analysis of Responses to the 2006 Energy Review Consultation
http://www.dtistats.net/ereview/review_consultation_responses.pdf