

CEEDATA energy analysis

Nuclear power - the glossy pretender

Manchester, 12 June 2009

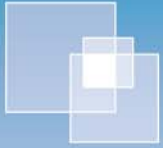
J.W. Storm van Leeuwen

storm@ceedata.nl

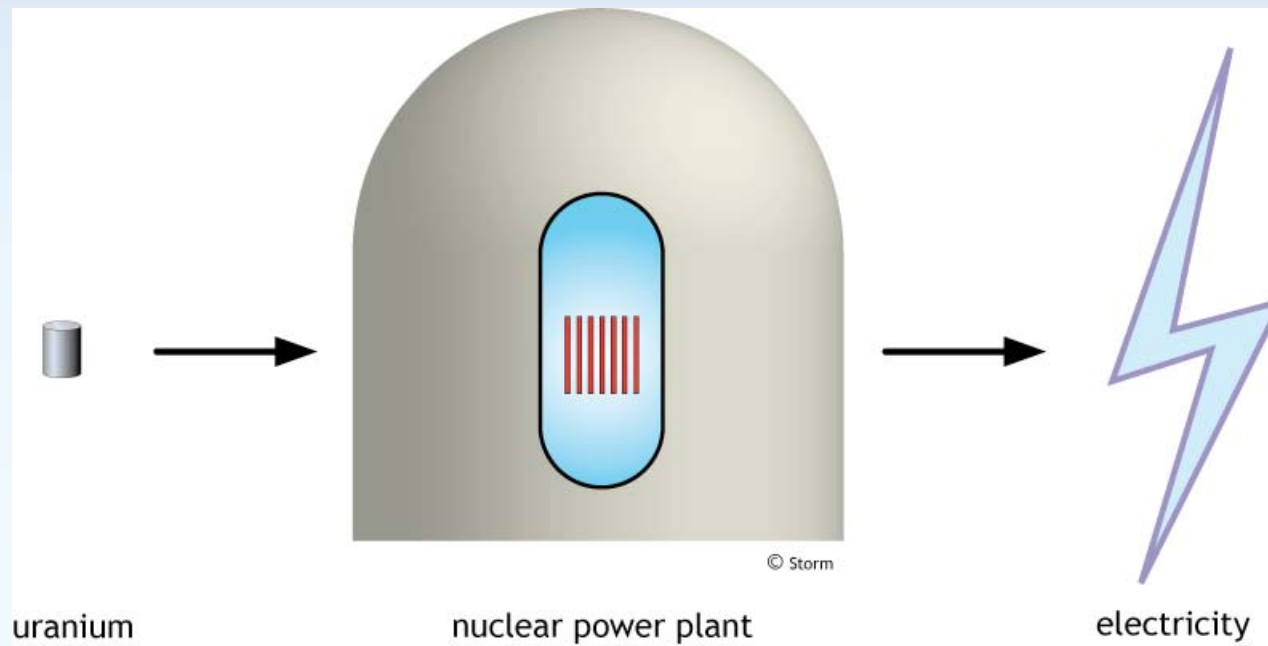


Nuclear power - the glossy pretender



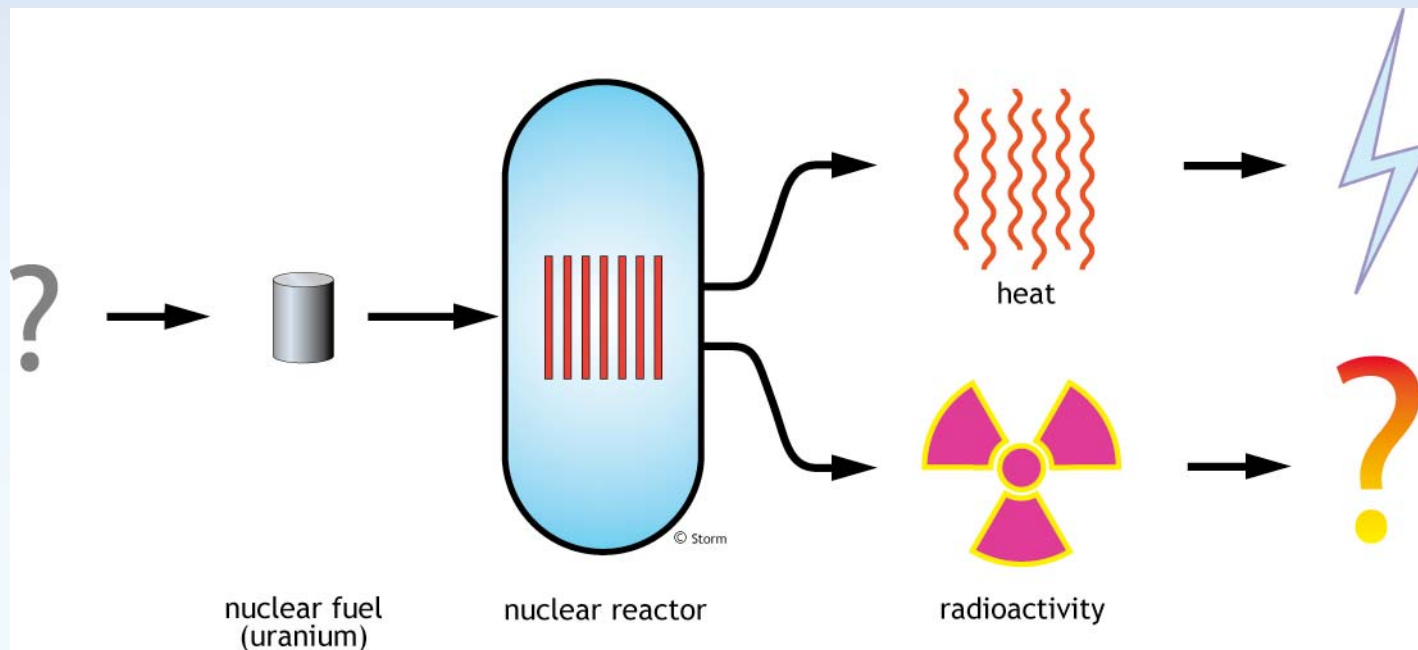


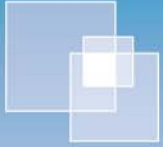
A glossy image from the nuclear industry





A nuclear reactor generates
heat and **radioactivity**
inextricable and irreversible



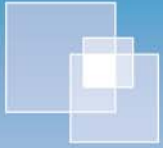


Nuclear power - the glossy pretender

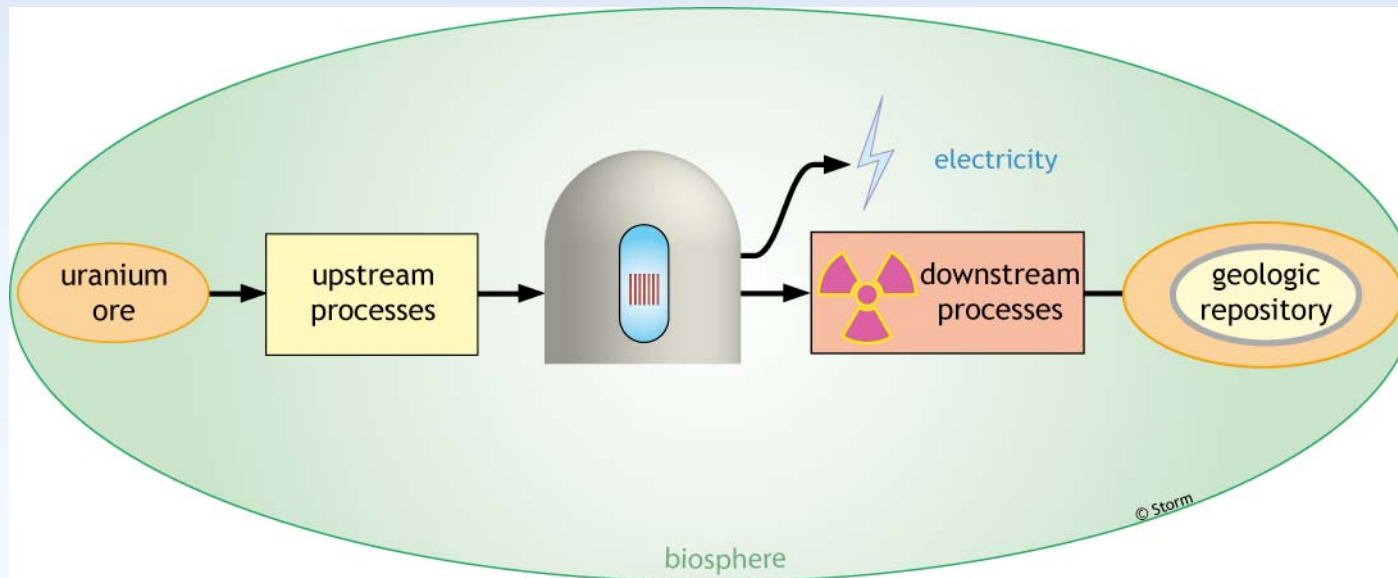
Outline

- nuclear chain
- energy quality of uranium resources
- coal equivalence
- energy cliff
- CO₂ trap
- energy on credit: energy debt
- summary
- do we need nuclear power?





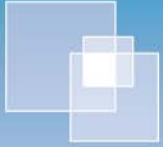
The nuclear chain: nuclear power from cradle to grave





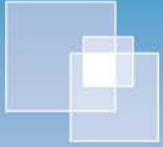
Nuclear power:
technically the most complex energy system ever

- inconvenient to policy makers
- costs and safety practically uncontrollable
- politicians advised by interest groups



Breeders?

- A 50 years old promise (cost: \$100bn)
- Not on line before 2050 (if ever)



Energy quality of uranium ore

energy to extract 1 kg U from a given ore



Uranium resources and E quality

The lower E quality of ore,
the more uranium present in crust

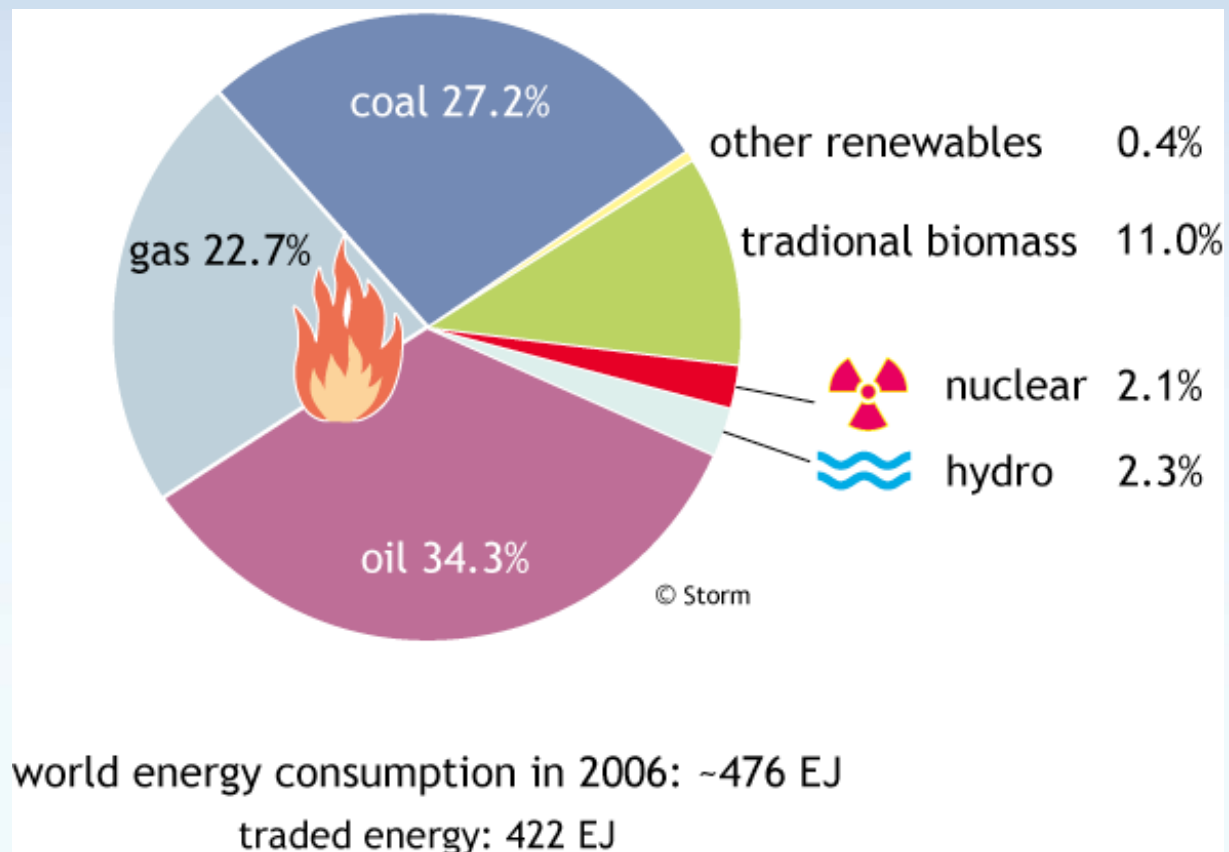


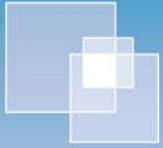
Coal equivalence

At 200 grams U per tonne rock:
mass of uranium ore = mass of coal
to produce same amount of electricity.

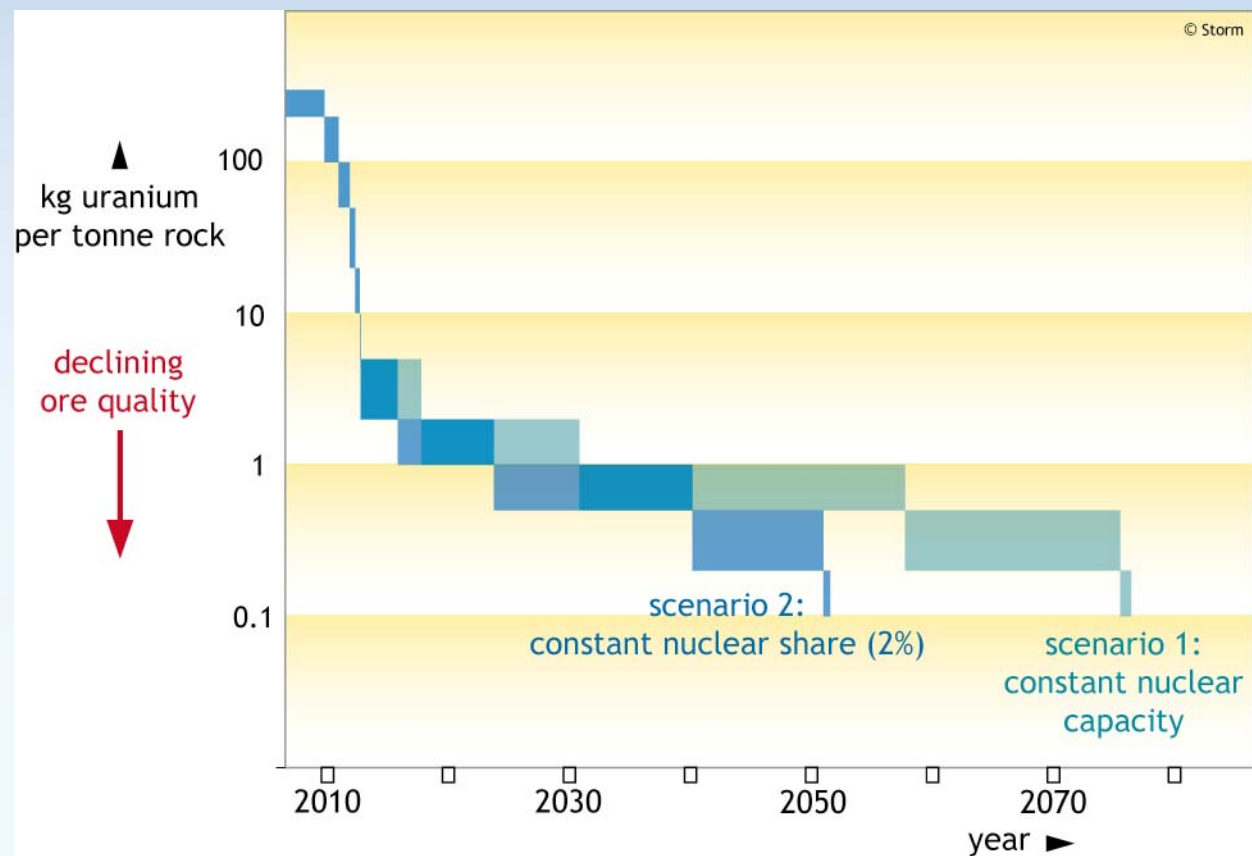


Nuclear contribution to the world energy in 2006



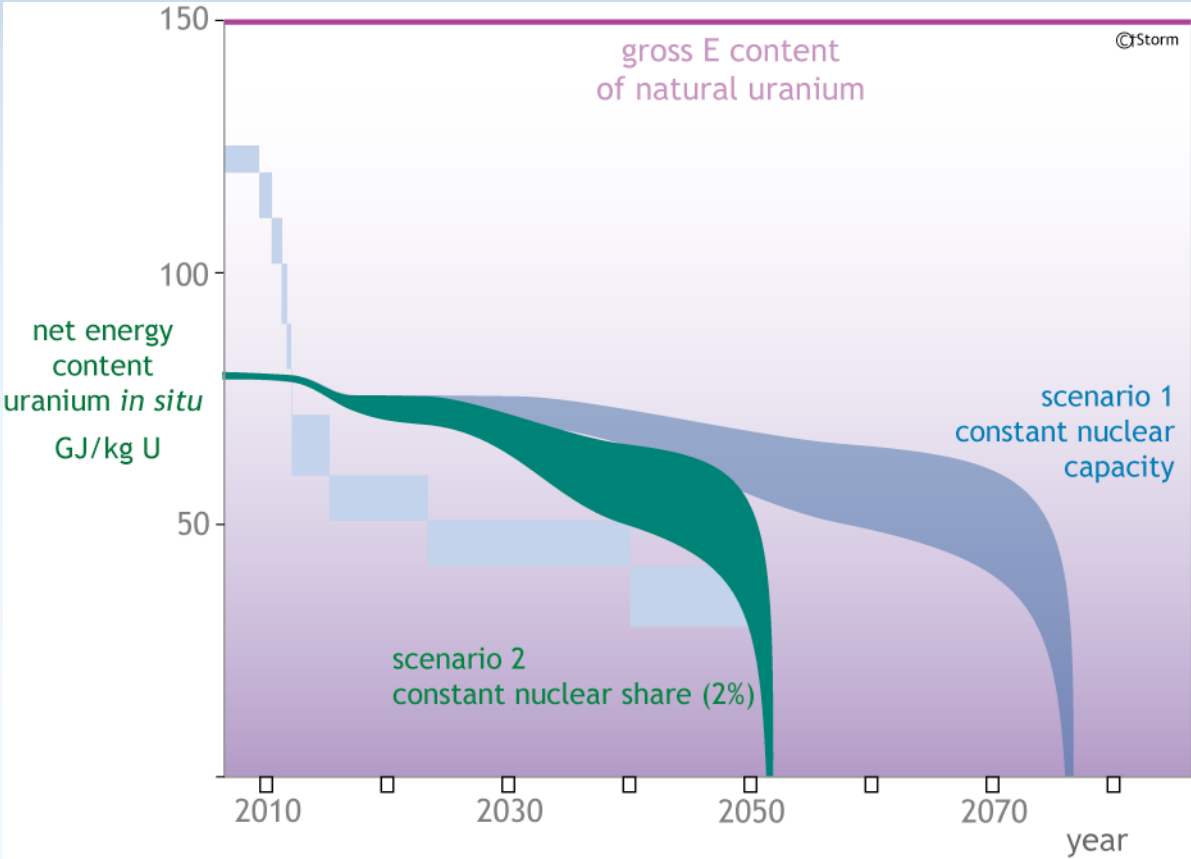


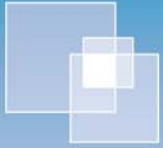
Depletion of the known U resources



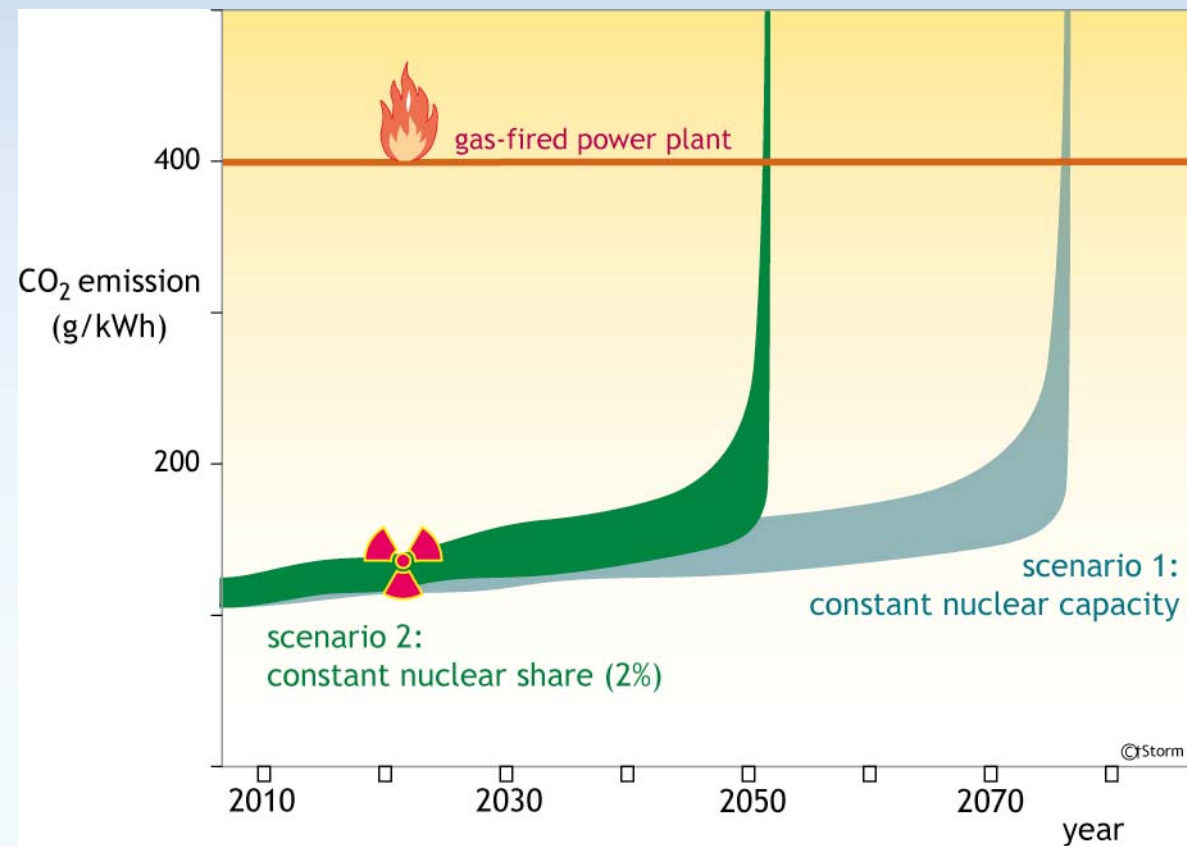


Energy cliff over time





The CO₂ trap: nuclear CO₂ emission over time





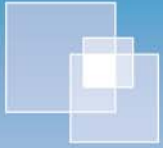
Outlook uranium resources: economic view

- criterion: price of U
- higher U price > more exploration >
> more discoveries > larger U resources
- ergo: U resources practically inexhaustible

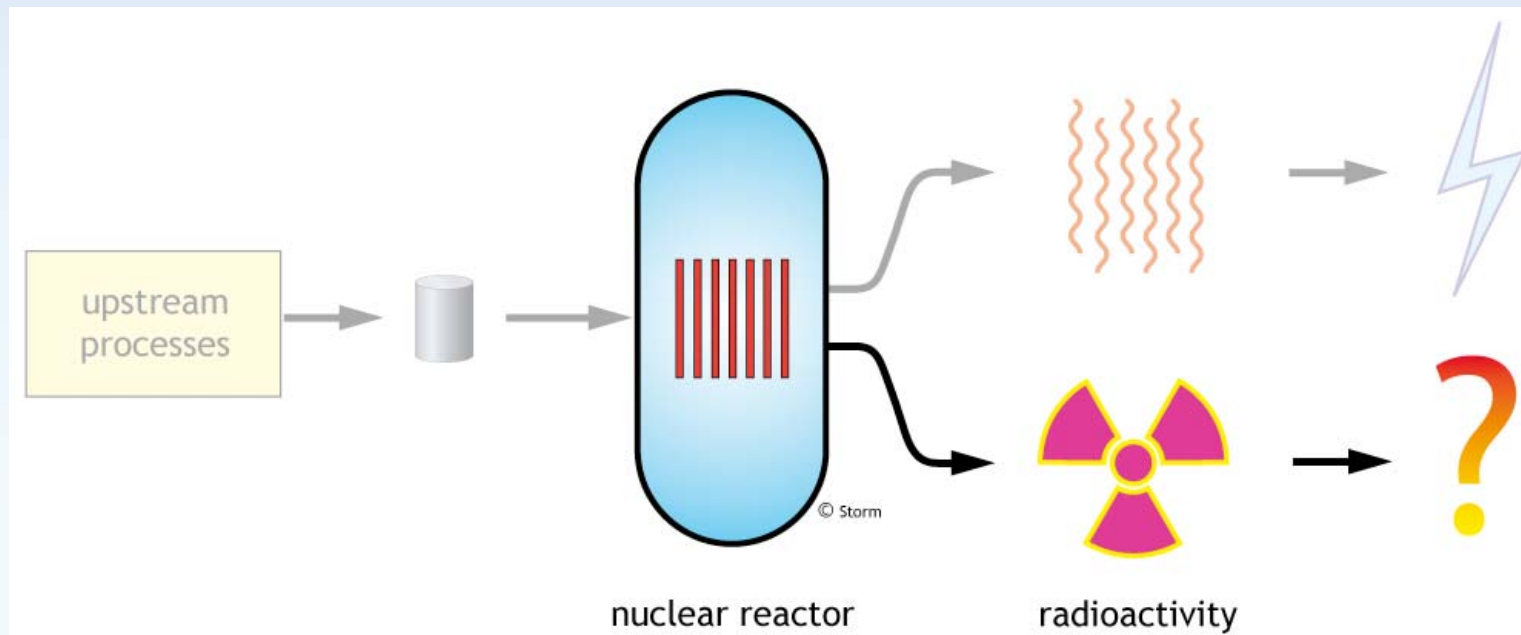


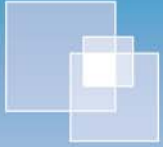
Outlook uranium resources: energy view

- criterion: extraction energy
- not U price, but ore quality decisive
- beyond energy cliff:
nuclear power = energy sink
- ergo:
net energy content world U resources limited



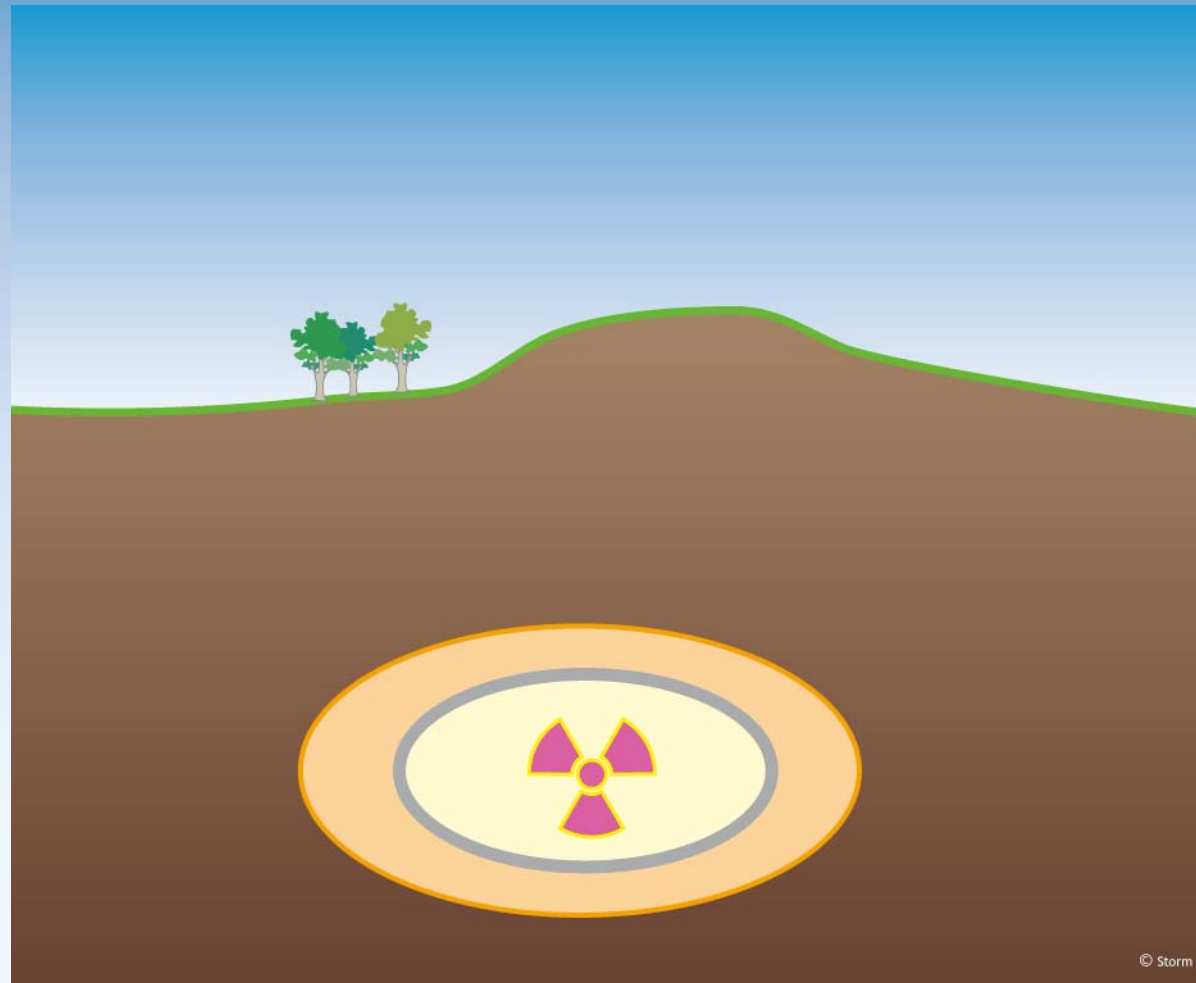
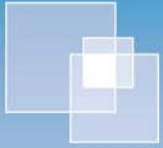
Next question



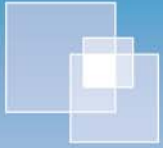


One reactor (1GWe) generates each year
1000 nuclear fission bomb equivalents (15 kt)
of radioactivity

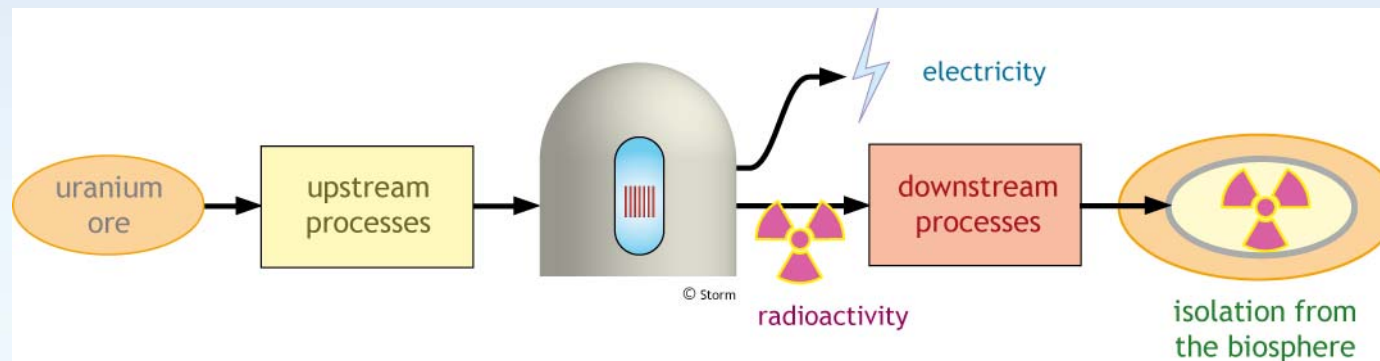
Each year 370000 Hiroshima bomb equivalents
added to world radioactive inventory of
several millions



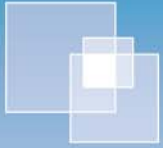
Isolation of radioactivity from the biosphere in a geologic repository



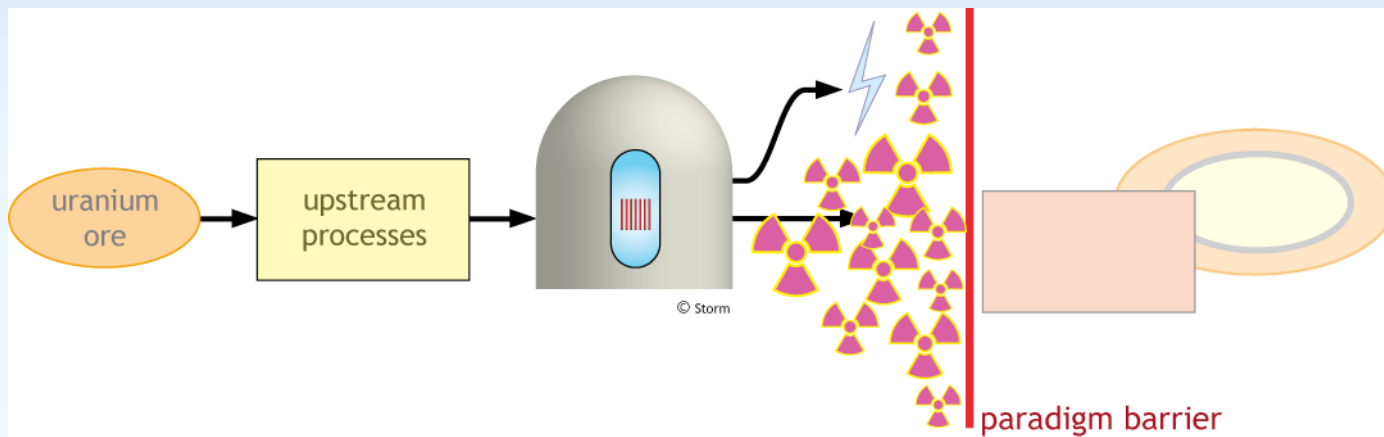
The nuclear chain as it ought to be



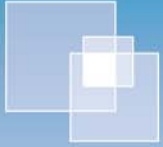
cooking the meal consuming the meal washing the dishes



The nuclear chain as it happens to be

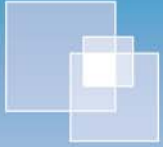


the dishes are piling up



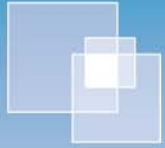
Paradigm barrier

- Short-term profit seeking
- *Après nous le déluge* attitude



We have just two options

- 1 keeping our countries habitable
taking our responsibility
- 2 waiting for disaster
Après nous le déluge



*Après nous
le déluge*





Dispersion of radioactivity from 1 source

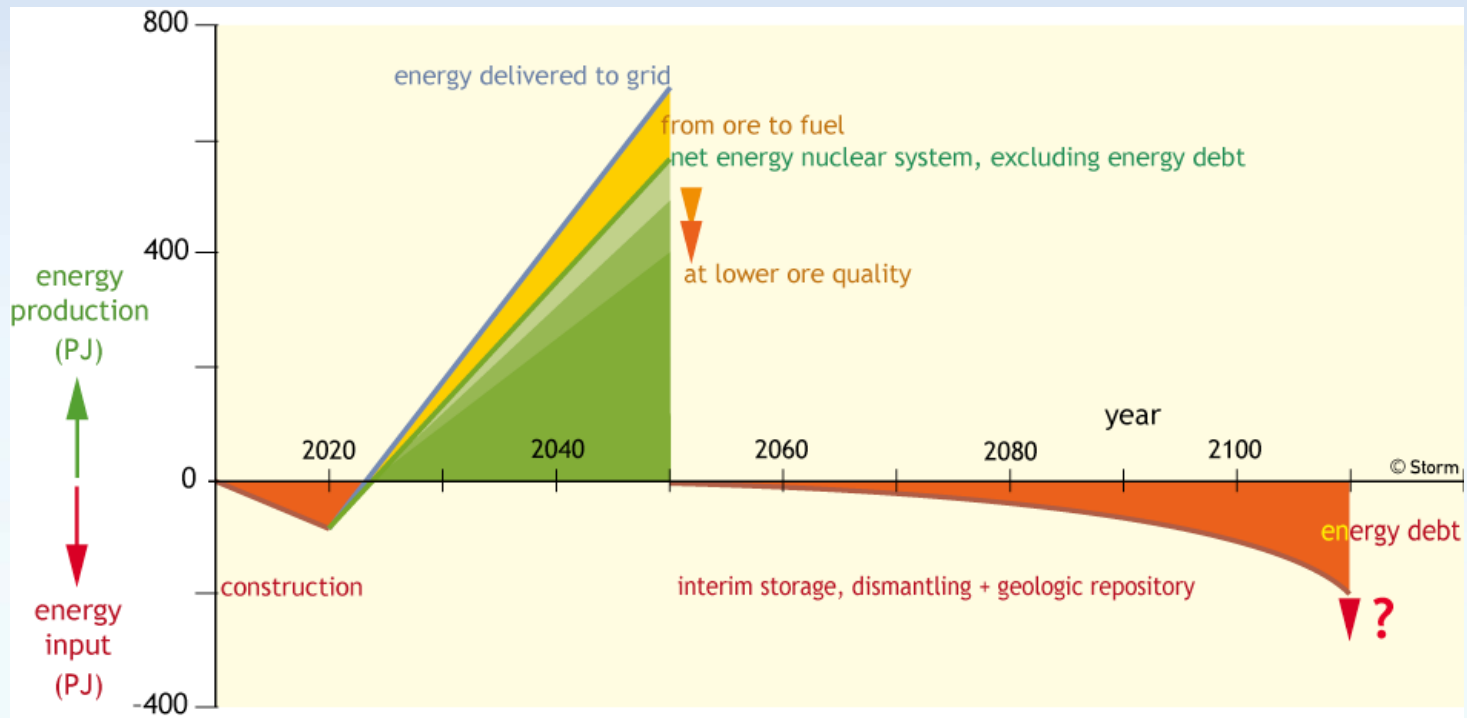


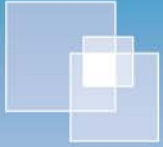
Nuclear power: energy on credit

- Energy debt
- CO₂ debt
- Monetary debt
- Privatisation of the profits,
socialisation of the costs



Energy debt





Monetary debt, NDA first cost estimates:

- cleanup and decommissioning
 - Sellafield reprocessing plant £50-100bn
 - 1 nuclear power station £4-8bn/GWe
- geologic repository £ ?bn



Summary 1

Essential notions

- energy quality of uranium resources
- coal equivalence
- energy cliff
- CO₂ trap
- nuclear bomb equivalent
- energy debt



Summary 2

uranium resources

- ore quality declines with time
- currently known resources may reach energy cliff within lifetime new nuclear build
- chances unknown of major new discoveries of high-quality ores



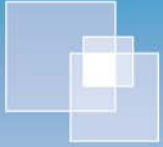
Do we need nuclear power?



We do not need nuclear power

- nor for climate control
- nor for energy security
- nor for geopolitical stability

Nuclear power is not sustainable



We do need a new paradigm

to implement the full potential of

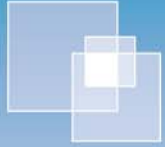
- energy efficiency
- renewables



New paradigm

For sustainable development we need to merge

- short-term business domain
- long-term physical domain



Nuclear power - the glossy pretender

thank you