CEEDATA energy analysis

Nuclear power - the glossy pretender

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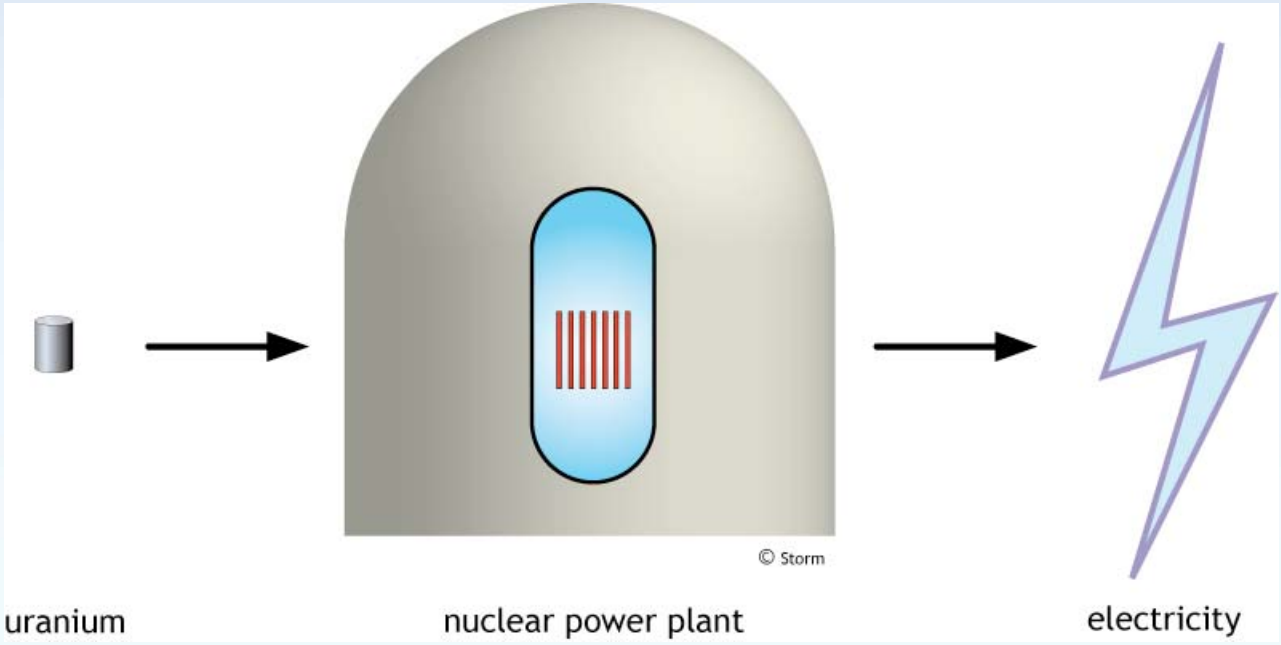
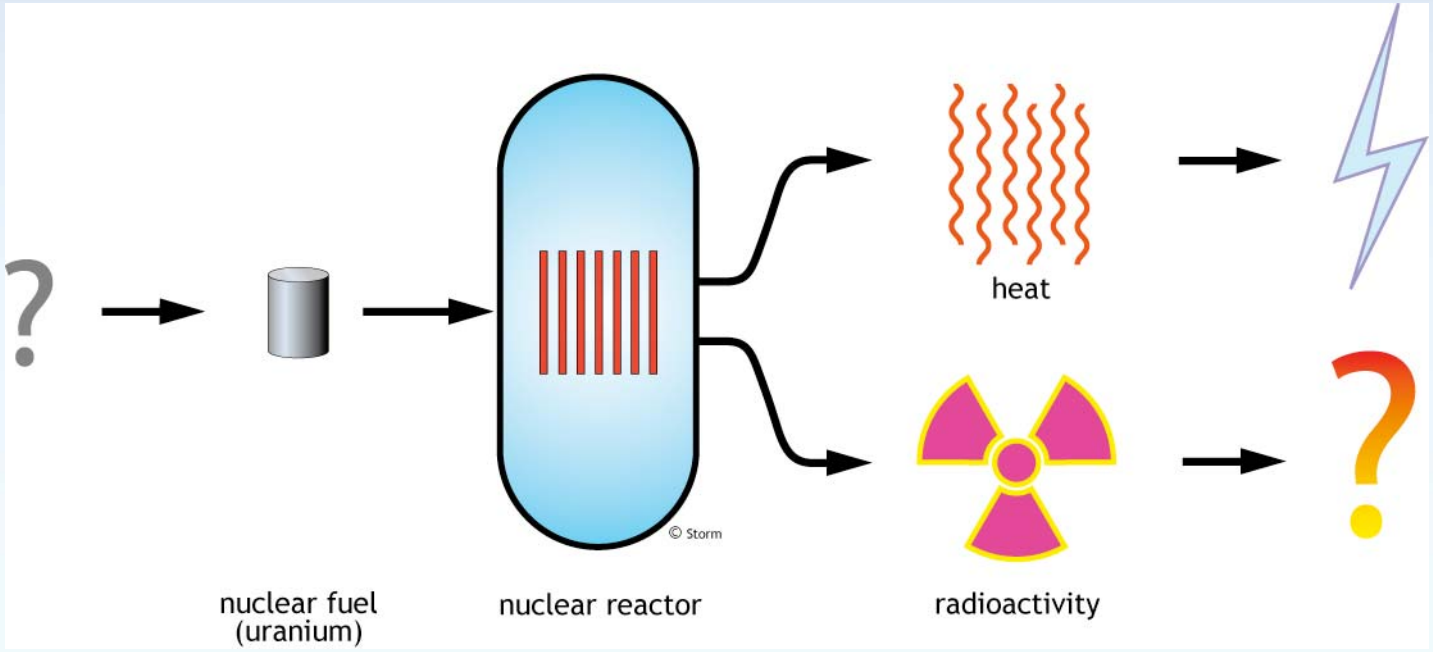
What lies behind and ahead of this glossy image?

A simple image of nuclear power



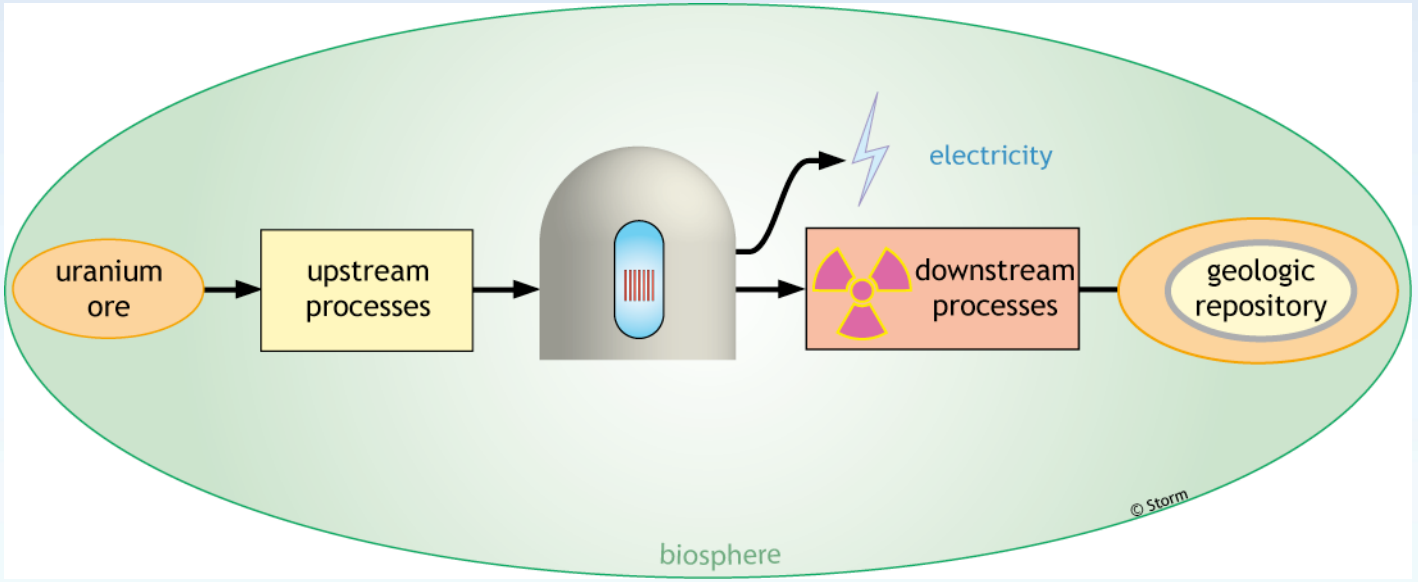
A nuclear reactor generates
heat and **radioactivity**
inextricable and irreversible



Outline

- nuclear energy system
- energy security: energy cliff
- climate control: CO_2 trap
- consumption of materials
- energy on credit
- conclusions

The nuclear chain:
nuclear power from cradle to grave



Nuclear power:
technically the most complex energy system ever

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

Breeders?

- 50 years old promise (cost: $100bn+)
- Not on line next 50 years, if ever

Thorium?

Even more remote

Energy quality of uranium resources: the ignored factor

E quality of a uranium resource =

E generated in reactor from 1 kg U

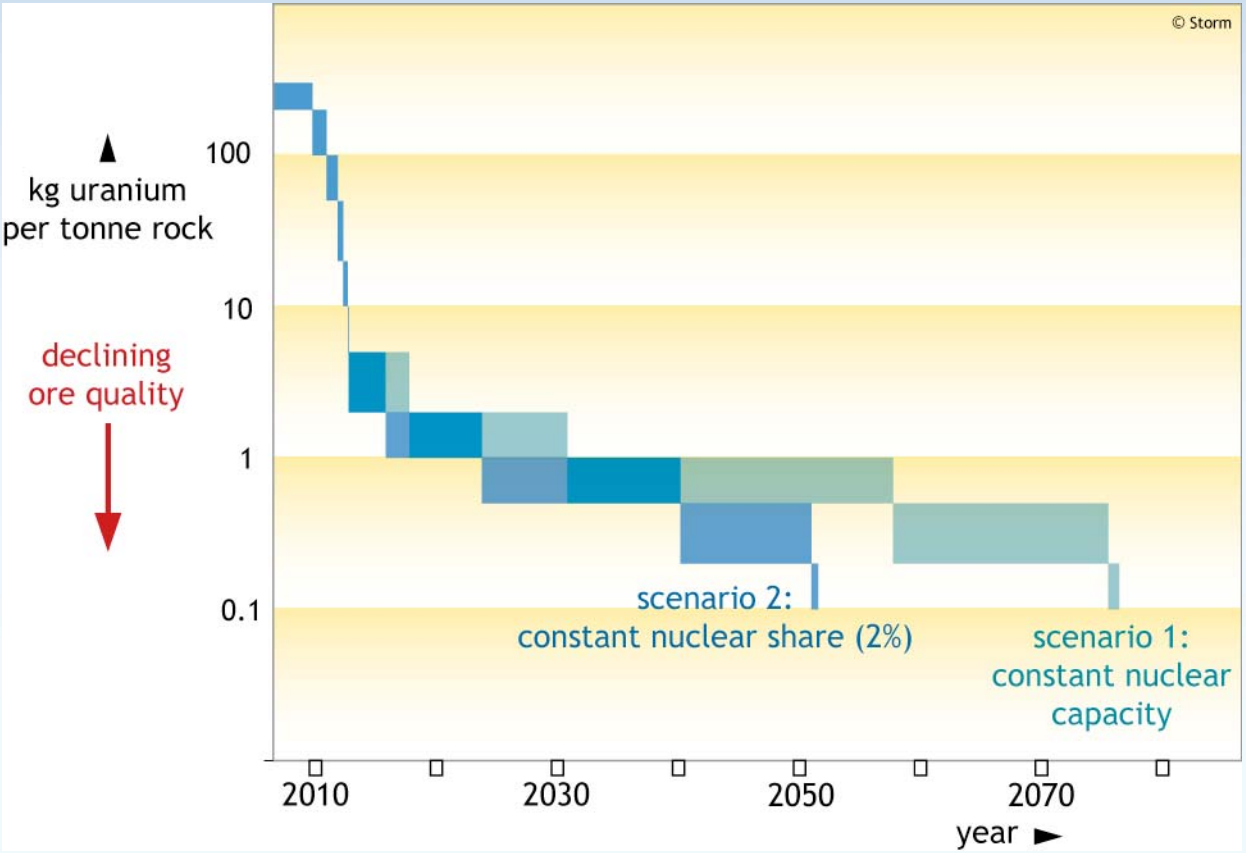
minus

E consumed for extraction 1 kg U from that resource

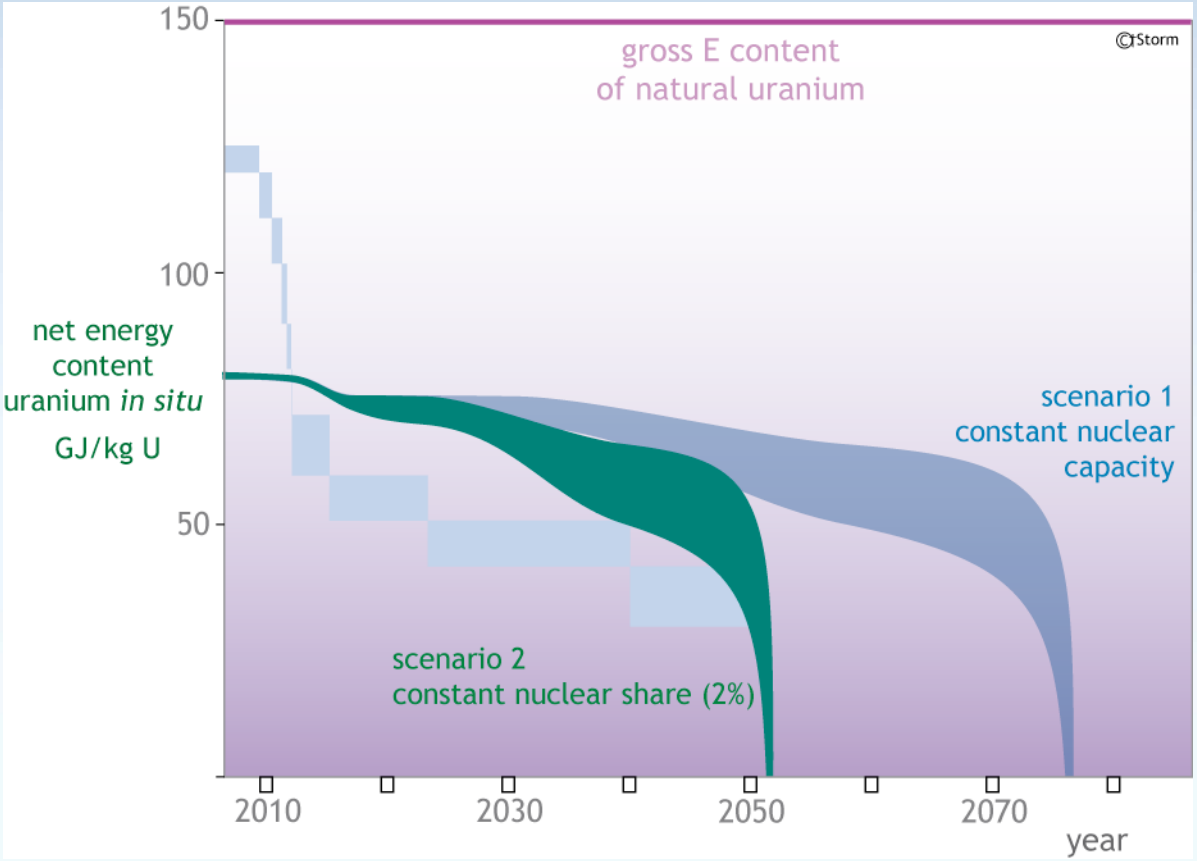
The larger a uranium resource,
the lower its E quality

The *average E quality* of world uranium resources goes down over time

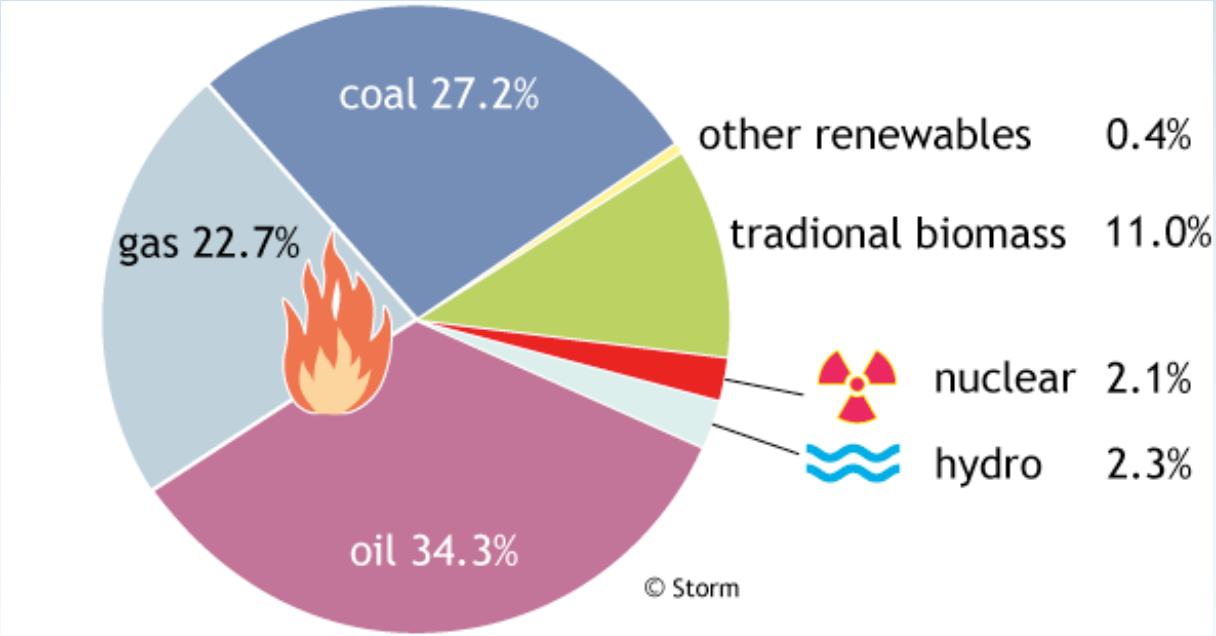
Depletion of the known U resources



Energy cliff over time



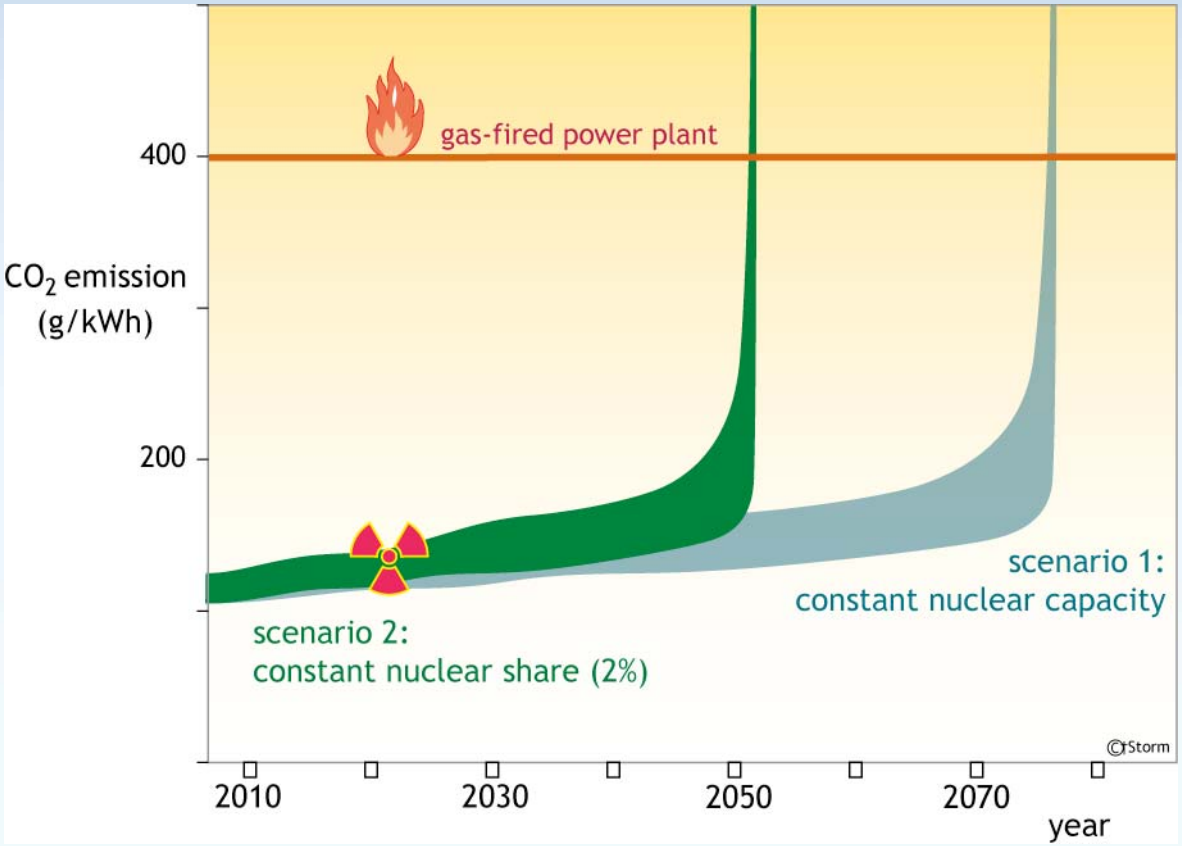
Nuclear contribution to the world energy in 2006



world energy consumption in 2006: ~476 EJ

traded energy: 422 EJ

The CO_2 trap: nuclear CO_2 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

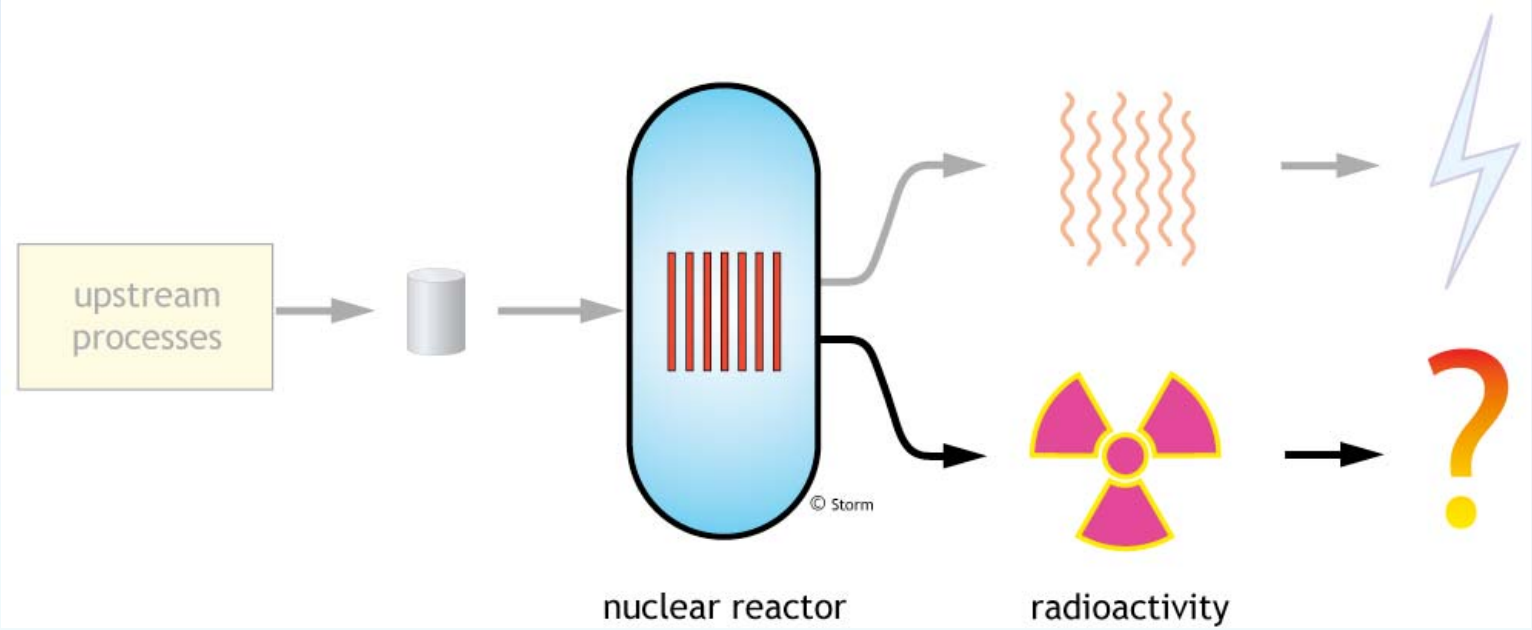
- criterion: net energy
- not U price, but E quality decisive
- beyond energy cliff: nuclear power = energy sink
- ergo: *net energy* content world U resources limited

Materials involved in nuclear and wind power, excluding nuclear waste management (UK)

	nuclear gram/day/person	**wind** gram/day/person
construction	175 - 700	325 - 850
high-grade, lost forever	25	–
natural uranium	2.83	–
chemicals U extraction *	101 - 609	–
U ore processed *	2025 - 12175	–
rock mined *	8125 - 48750	–
CO_2 emission *	10000 - 50000	750 - 1500

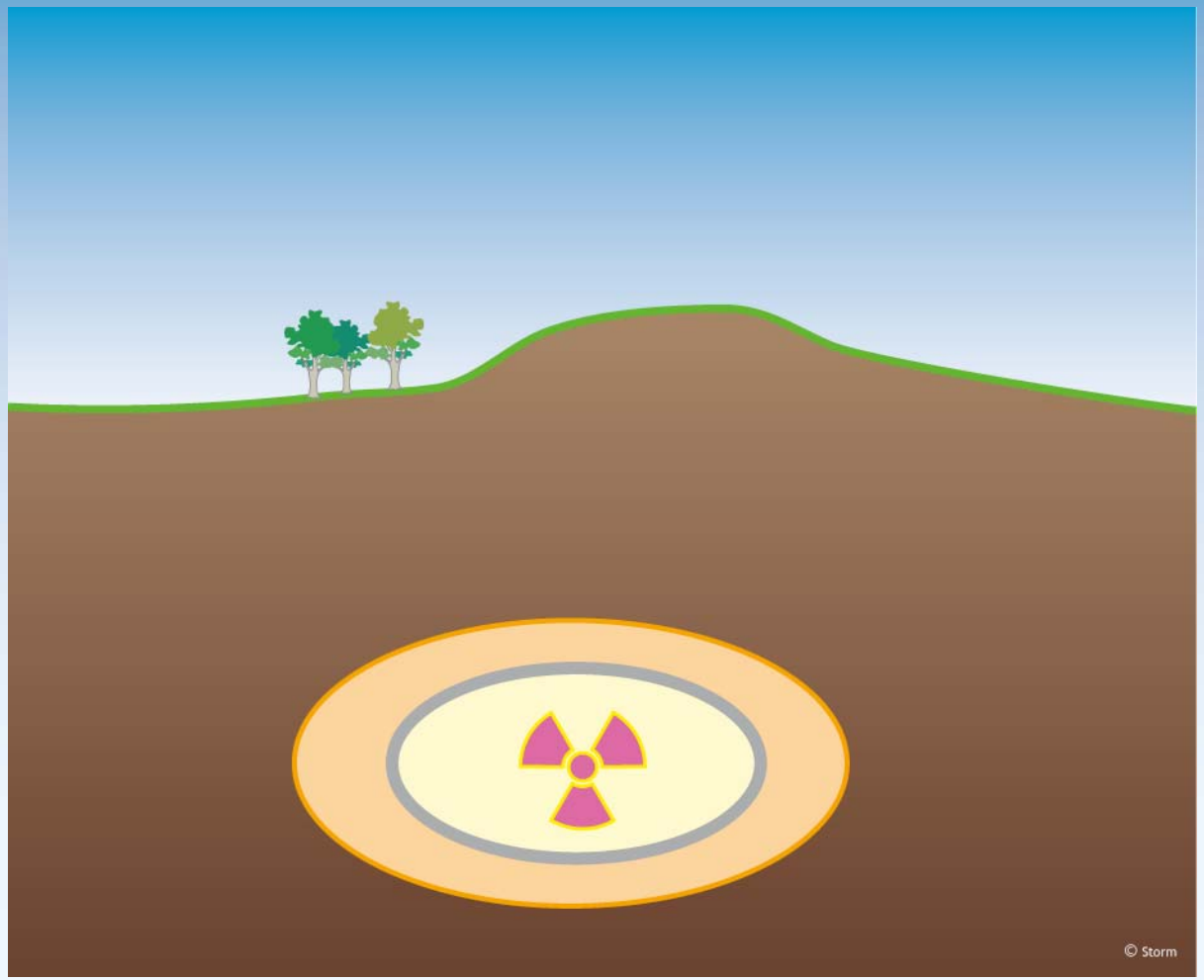
* ore grade dependent

Next question



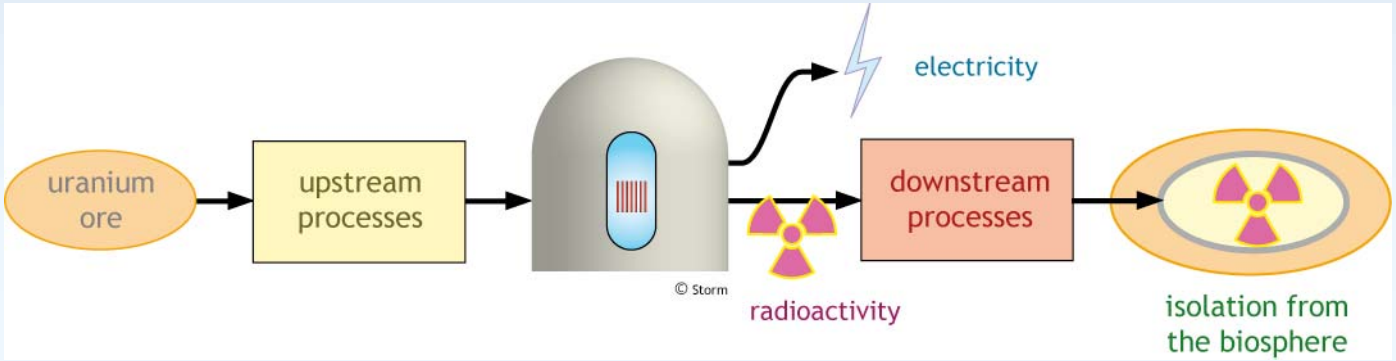
One reactor (1GWe) generates each year
1000 nuclear fission bomb equivalents (15 kt)
of radioactivity

Each year 370000 Hiroshima bomb equivalents
added to world radioactive inventory



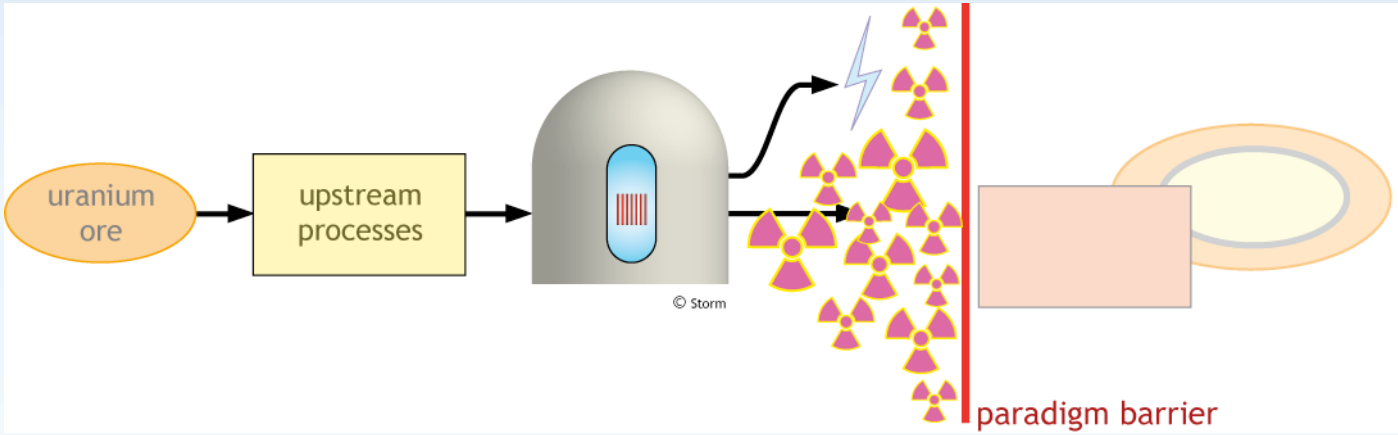
Isolation of radioactivity from the biosphere in a geologic repository

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

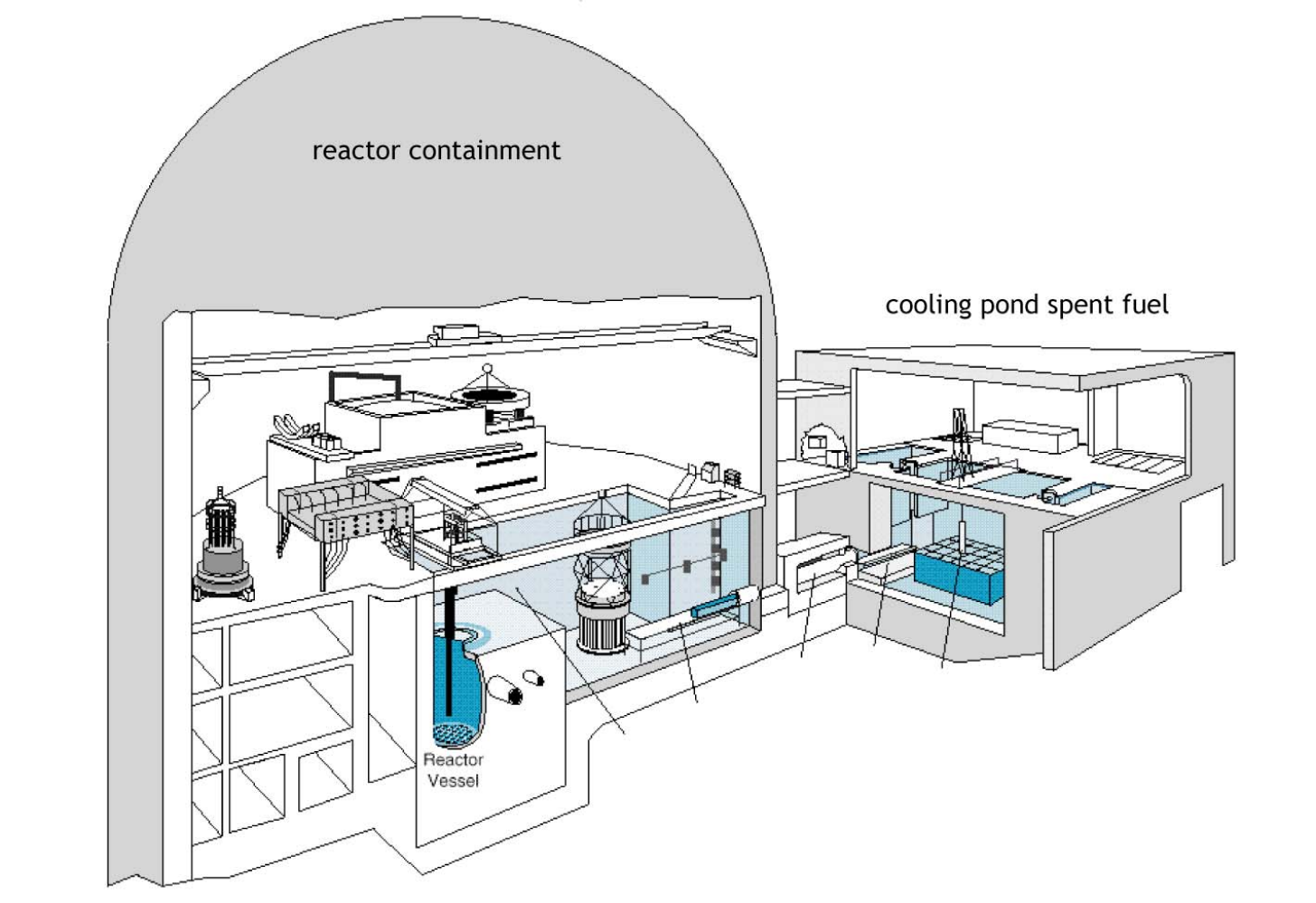


the dishes are piling up

Paradigm barrier

- Short-term profit seeking, living on credit
- *Après nous le déluge* attitude
- Belief in unproved concepts

Après nous
le déluge



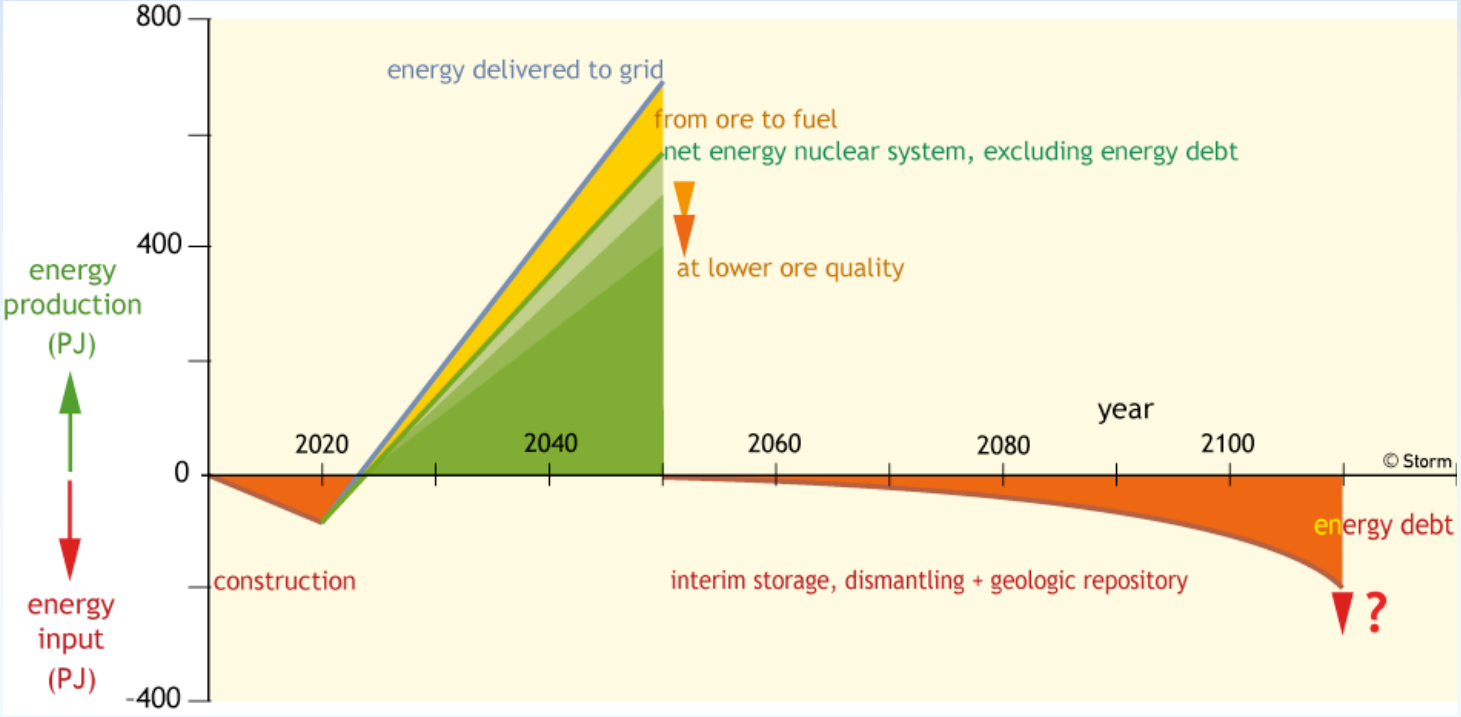
Spent fuel storage at reactor site

Dispersion of radioactivity from 1 source

Nuclear power: energy on credit

- Energy debt
- CO_2 debt
- Monetary debt
- Privatisation of the profits,
  socialisation of the costs

Energy debt


800
400
0
-400
energy production (PJ)
energy input (PJ)
energy delivered to grid
from ore to fuel
net energy nuclear system, excluding energy debt
at lower ore quality
year
2020
2040
2060
2080
2100
© Storm
energy debt
construction
interim storage, dismantling + geologic repository
?

Monetary debt, NDA first cost estimates:

- cleanup and decommissioning
  excluding final storage
  - Sellafield reprocessing plant £**50-100bn**
  - 1 nuclear power station £**4-8bn**/GWe

- geologic repository £**xbn**

Man on the moon (Apollo project)
final cost (£2008) £80bn

Conclusion 1

Nuclear power does not comply with any sustainability criterion

Conclusion 2

Nuclear technology indispensible in society

Uranium as energy source
= outdated concept

Conclusion 3

Choice for nuclear power
seriously delays
transition to sustainable energy supply

Conclusion 4

We do not need nuclear power: there are by far better solutions

- cheaper
- faster
- safer
- constant flow (inexhaustible)
- constant quality
- capacity meets world demand
- without further deterioration of the biosphere
- secure supply to all people

Conclusion 5

It is not a technology problem
We just need a new paradigm

to implement the full potential of

- energy efficiency
- renewables

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