

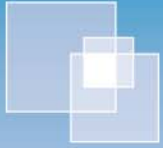
CEEDATA energy analysis

# Nuclear power - the glossy pretender

Manchester, 12 June 2009

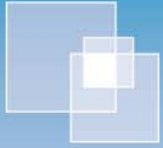
J.W. Storm van Leeuwen

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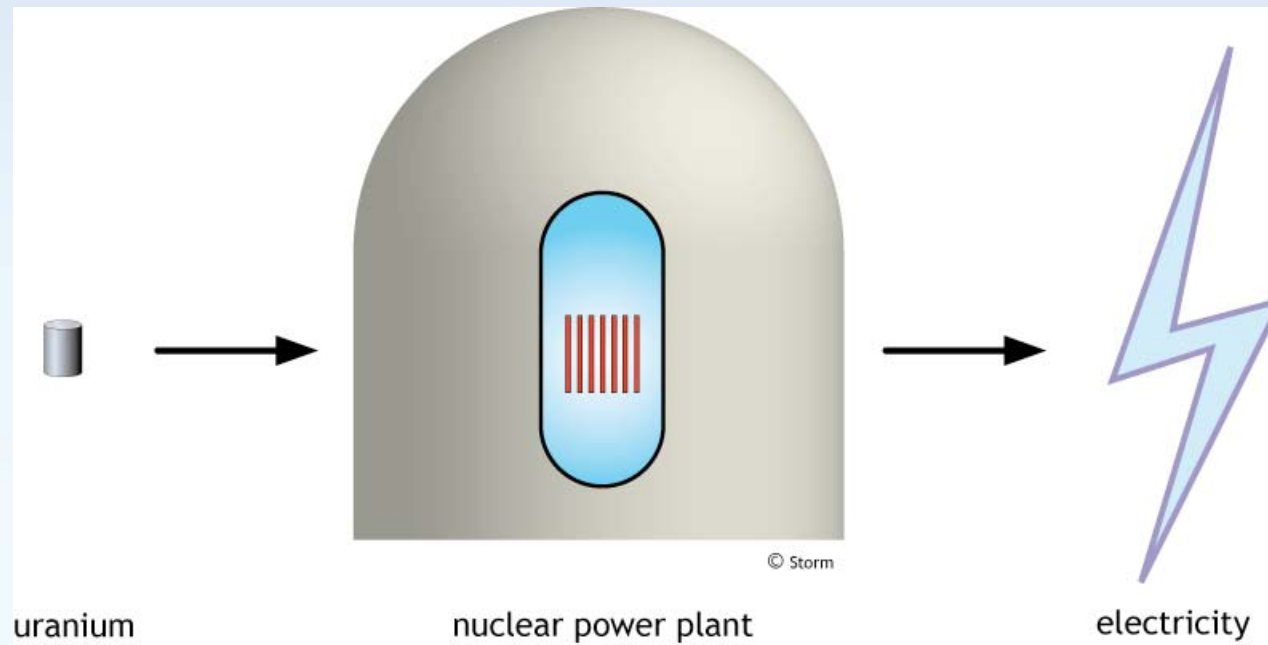


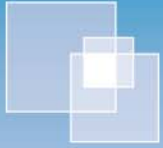
## Nuclear power - the glossy pretender



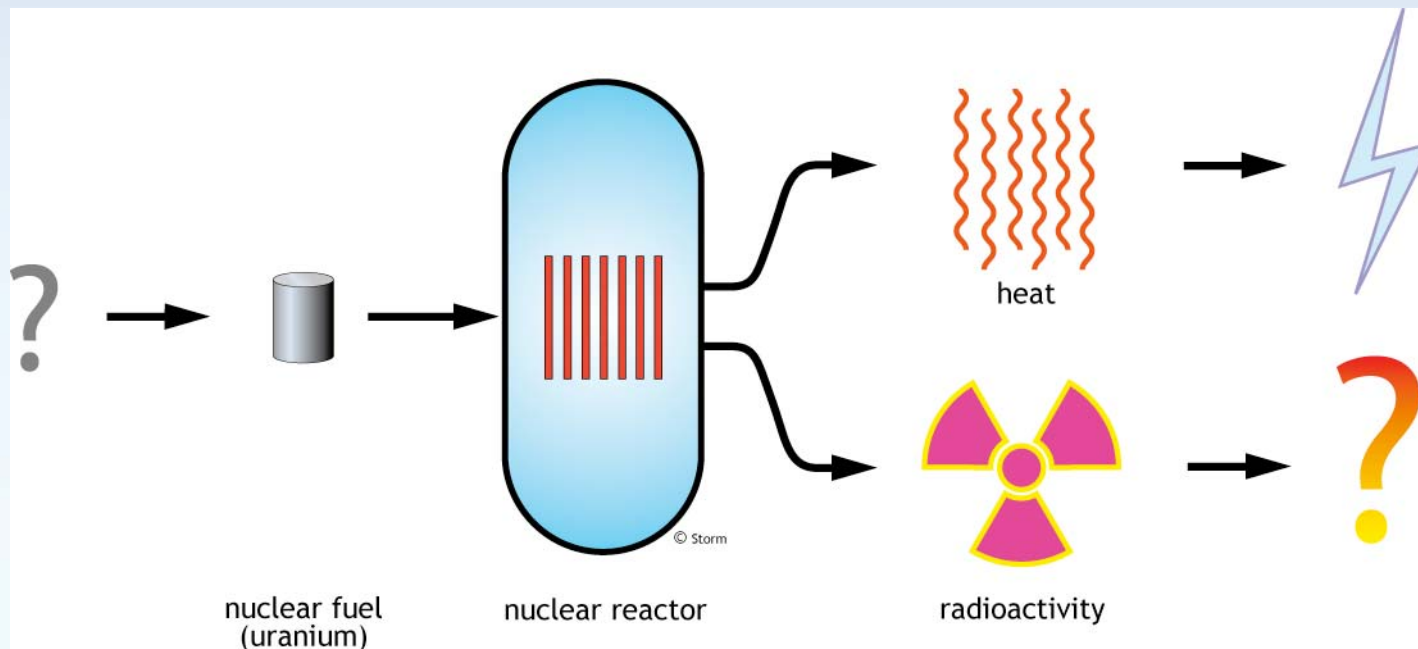


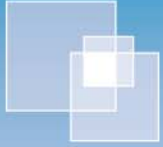
## A glossy image from the nuclear industry





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



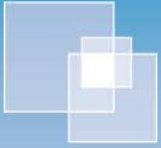


## Nuclear power - the glossy pretender

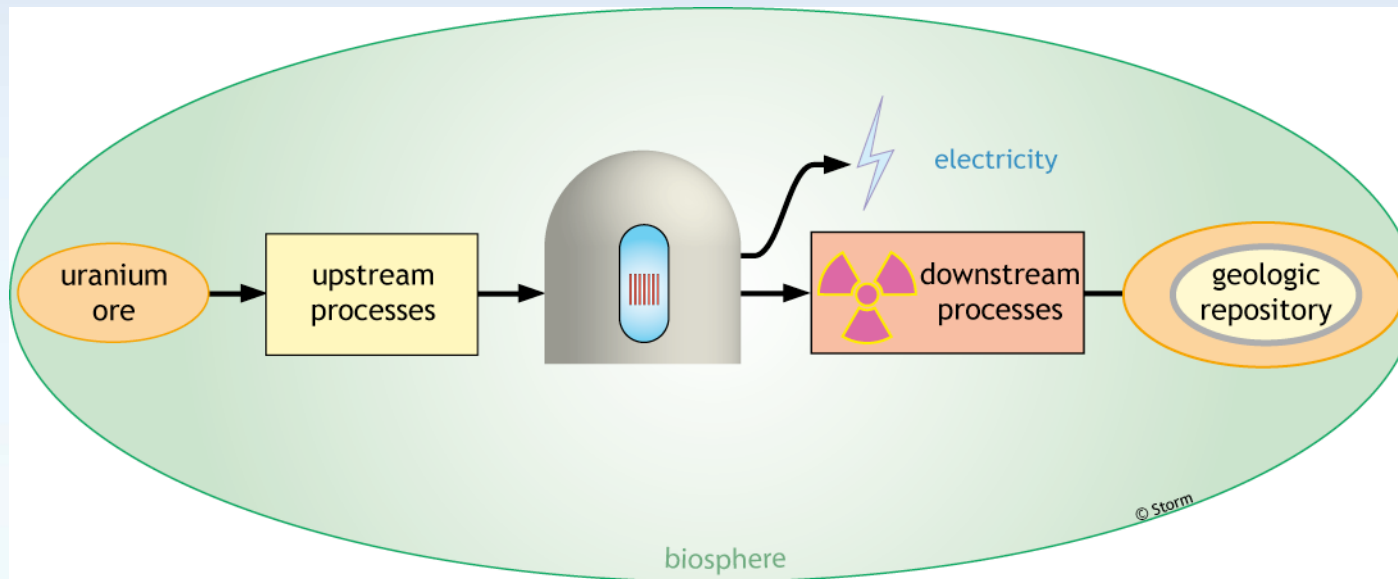
### Outline

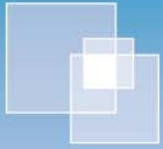
- nuclear chain
- energy quality of uranium resources
- coal equivalence
- energy cliff
- CO<sub>2</sub> trap
- energy on credit: energy debt
- do we need nuclear power?





# The nuclear chain: nuclear power from cradle to grave

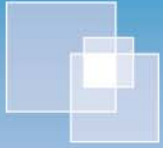




Nuclear power:  
Technically the most complex system ever

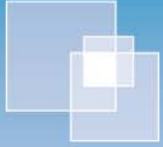
- inconvenient to policy makers
- costs and safety practically uncontrollable
- politicians advised by interest groups





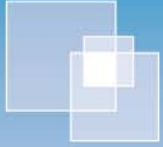
## Uranium ore E quality

energy to extract 1 kg U from a given ore



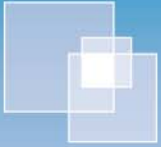
## Uranium resources and E quality

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

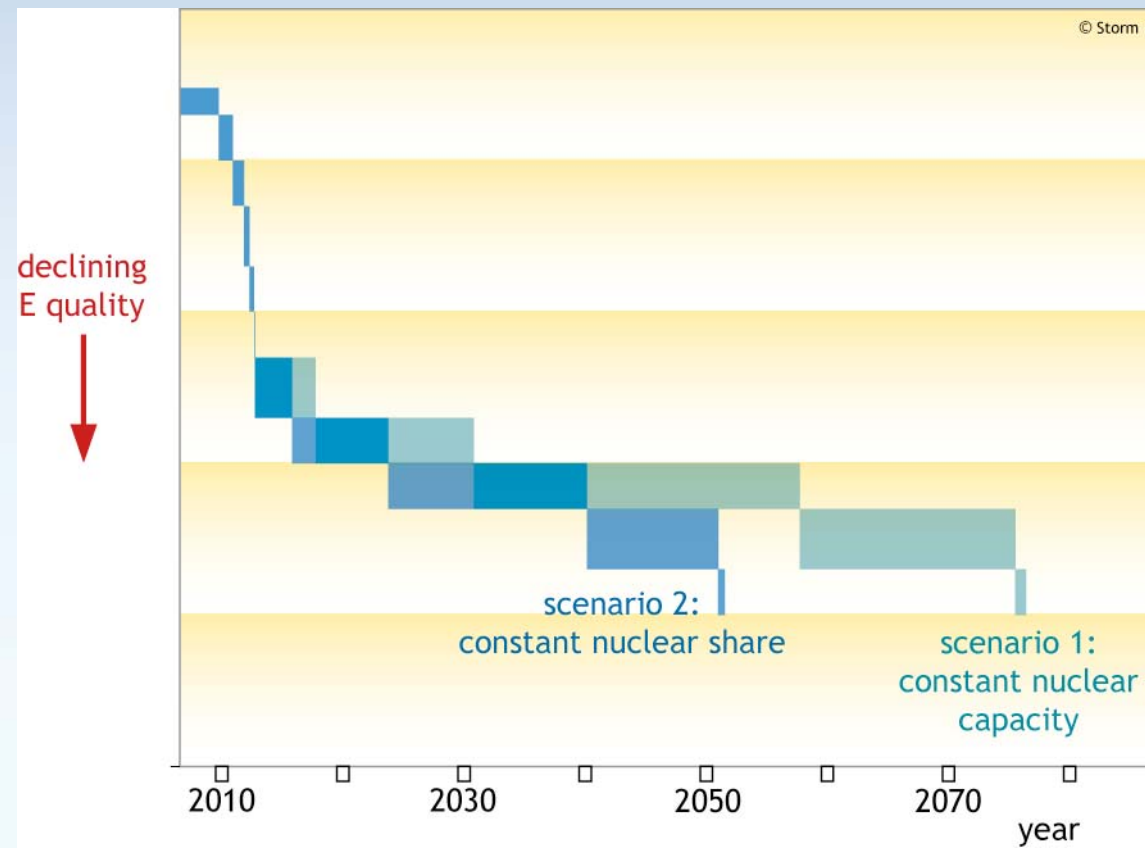


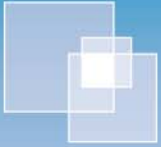
## Coal equivalence

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

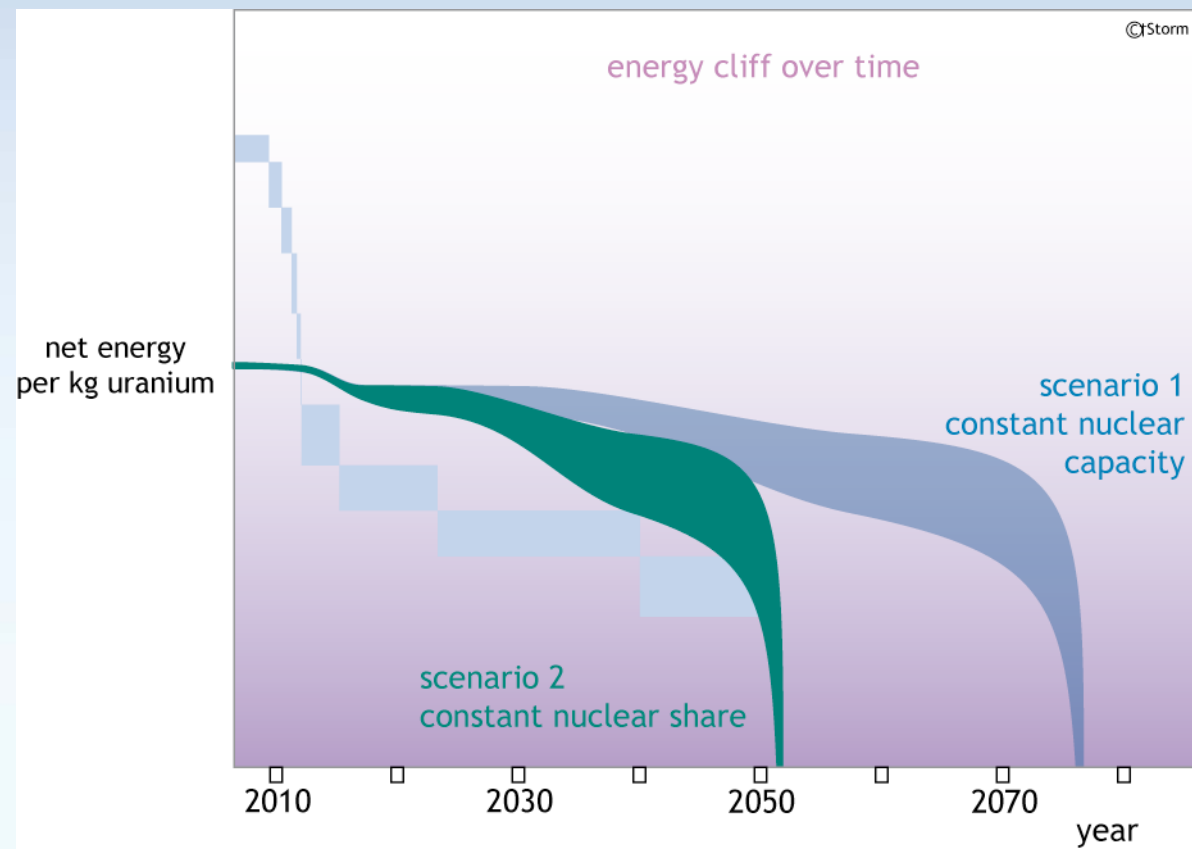


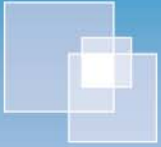
## Depletion of the known U resources



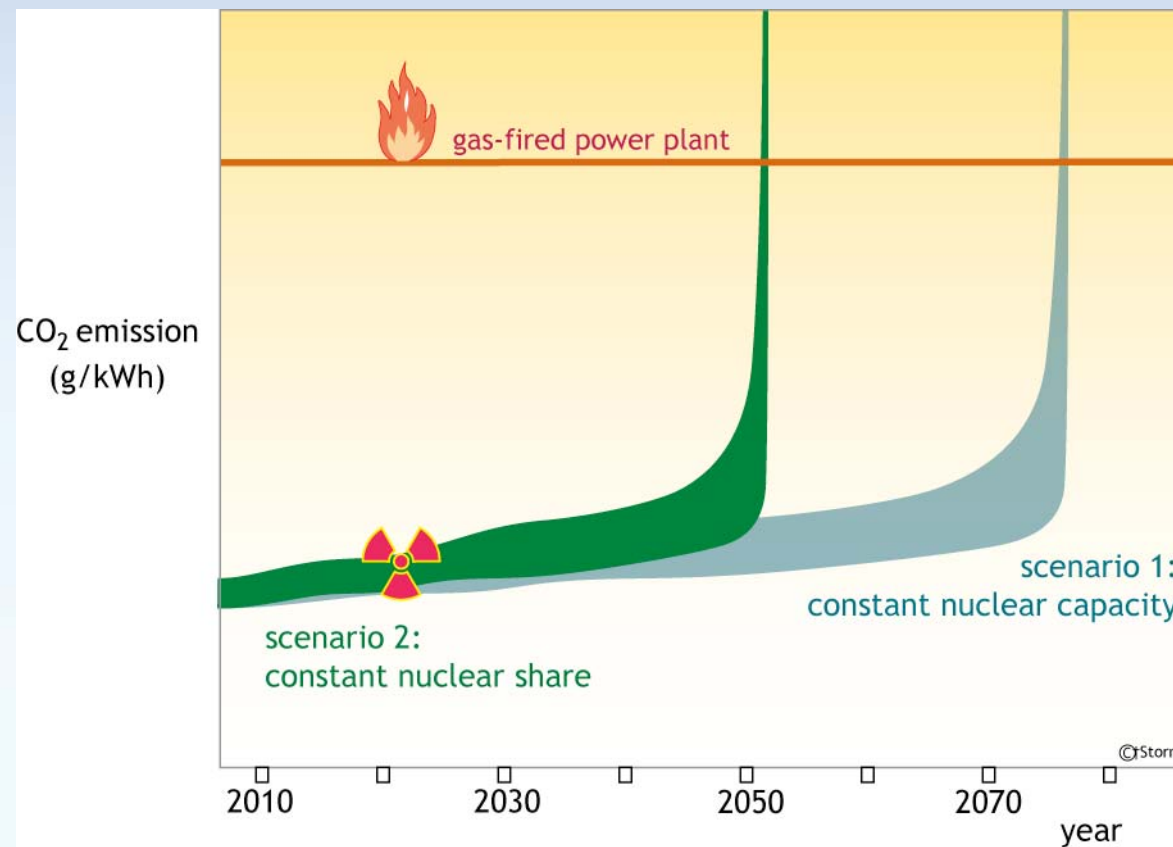


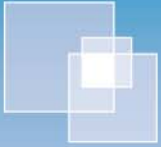
# Energy cliff over time



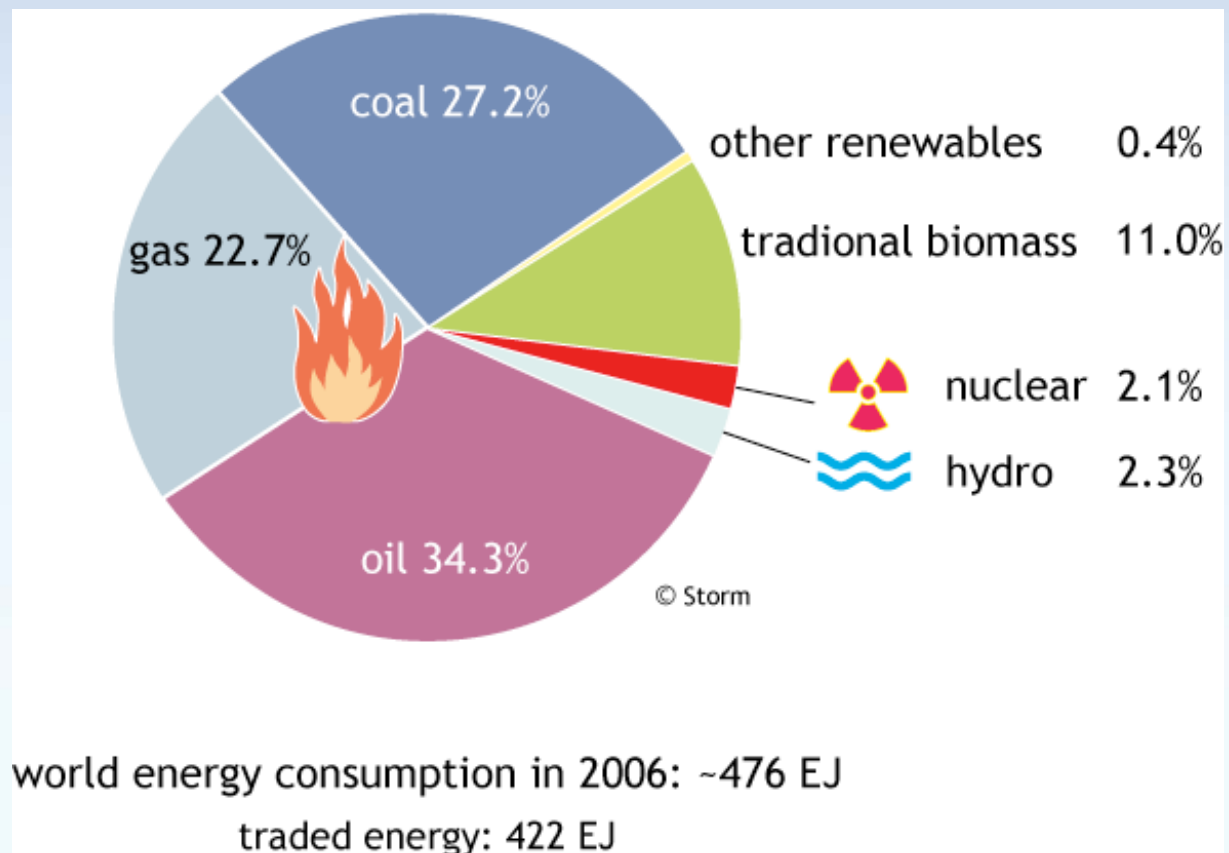


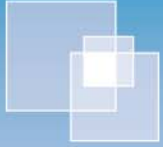
# The CO<sub>2</sub> trap: nuclear CO<sub>2</sub> emission over time





## Nuclear contribution to the world energy in 2006

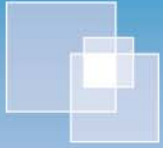




## Outlook uranium resources: economic view

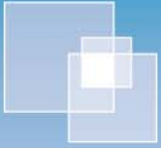
- criterion: price of U
- higher U price > more exploration >  
> more discoveries > larger U resources
- ergo: U resources practically inexhaustible



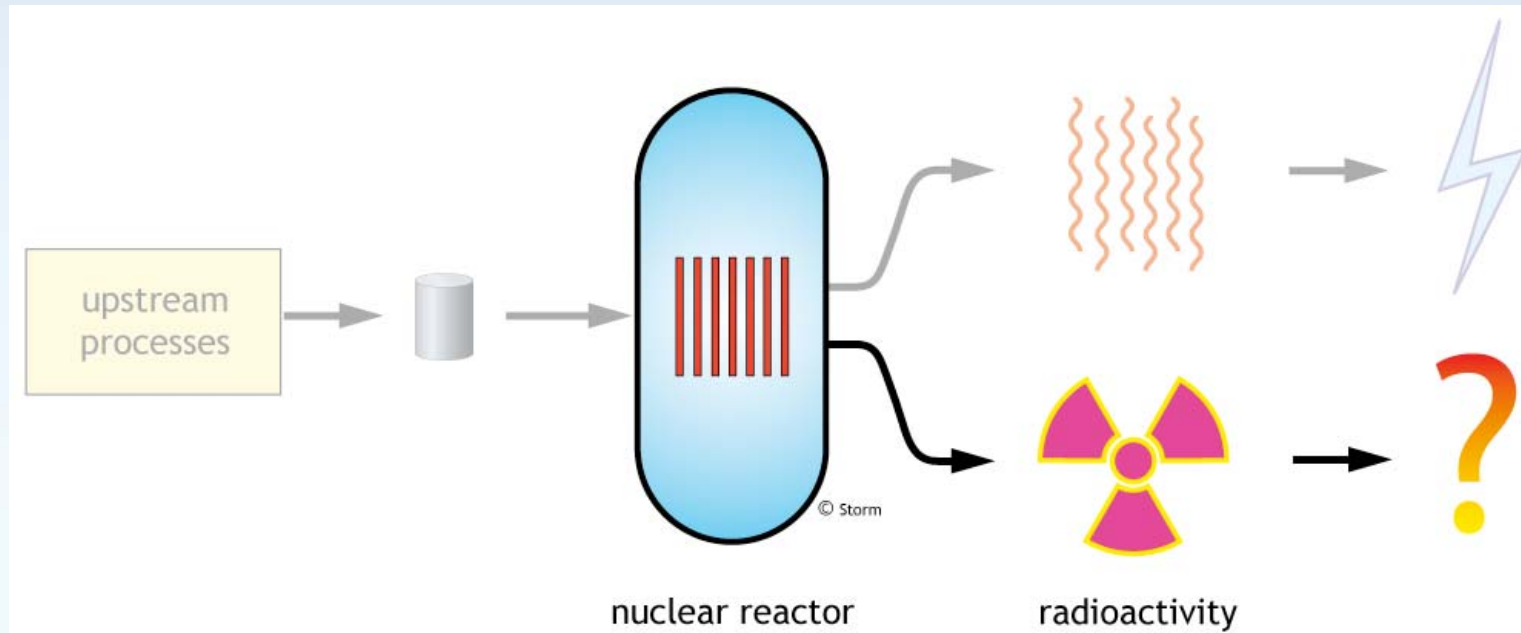


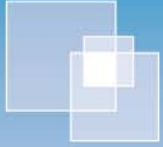
## Outlook uranium resources: energy view

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



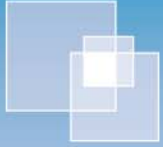
# Next question





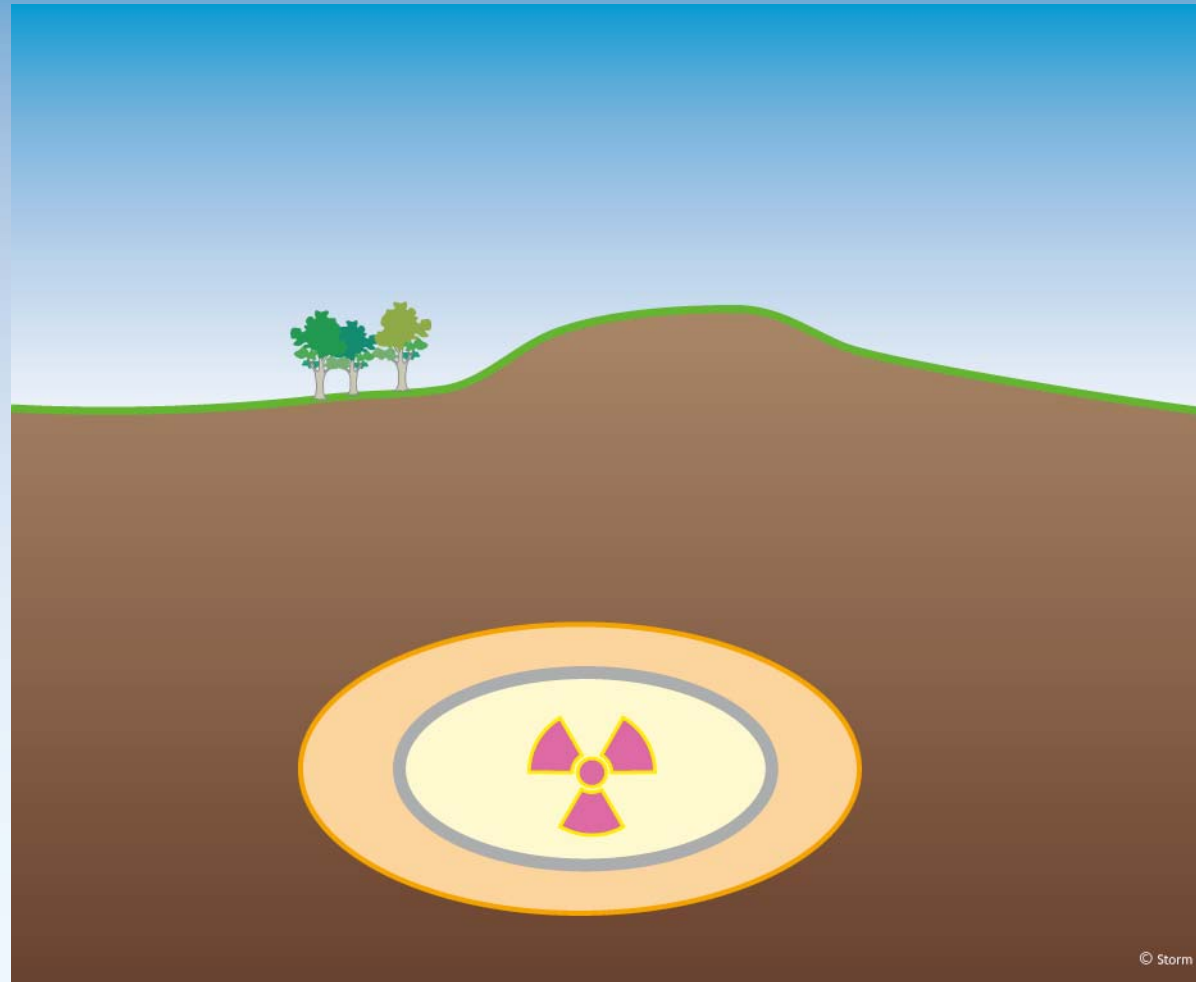
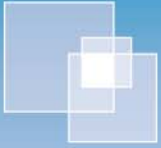
One reactor (1GWe) generates each year  
200 nuclear bomb equivalents of radioactivity

Each year 74000 nuclear bomb equivalents  
added to world radioactive inventory of  
2 million

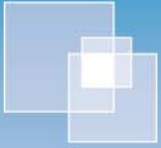


## We have just two options

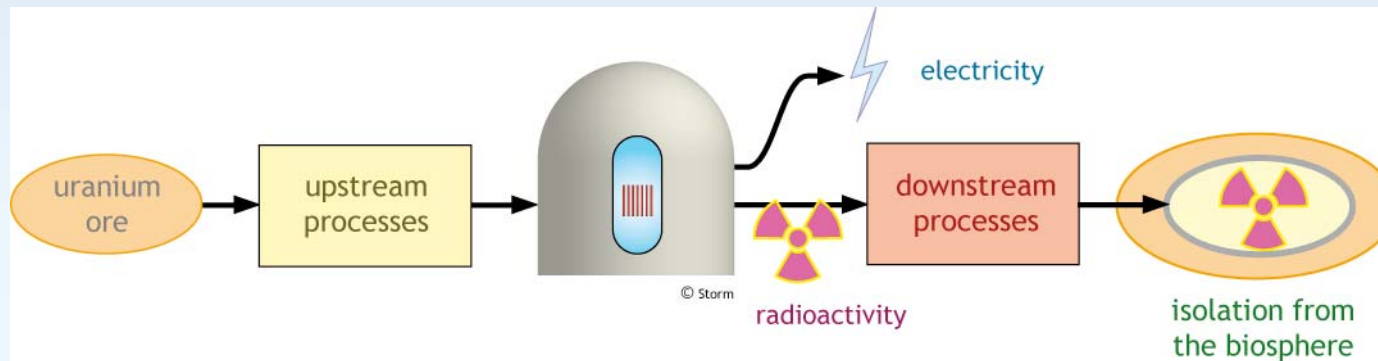
- 1 keeping the country habitable  
our responsibility
- 2 waiting for disaster  
*Après nous le déluge*



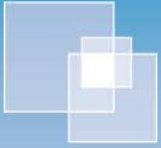
Isolation of radioactivity from the biosphere in a geologic repository



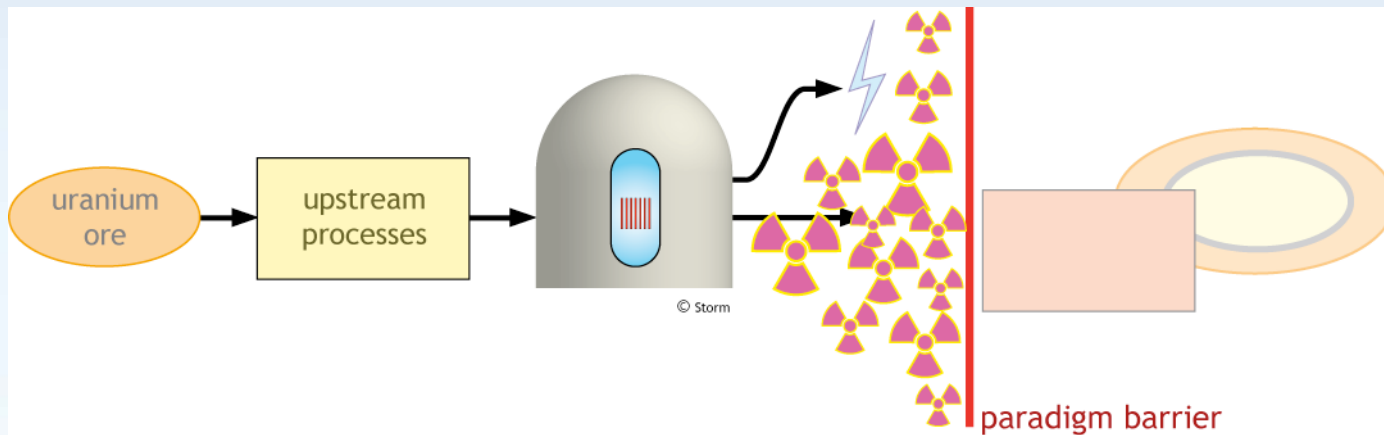
## The nuclear chain as it ought to be



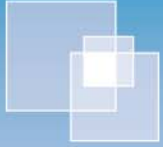
cooking the meal    consuming the meal    washing the dishes



## The nuclear chain as it happens to be



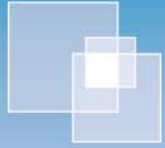
the dishes are piling up



## Paradigm barrier

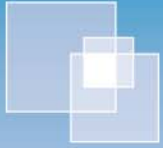
- Short-term profit seeking
- *Après nous le déluge* attitude



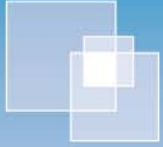


*Après nous  
le déluge*



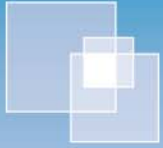


Dispersion of radioactivity from 1 source



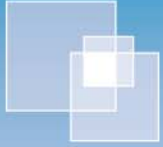
## Nuclear power: energy on credit

- Energy debt
- CO<sub>2</sub> debt
- Monetary debt
- Privatisation of the profits,  
socialisation of the costs



## Monetary debt, NDA first cost estimates:

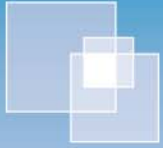
- cleanup and decommissioning
  - Sellafield reprocessing plant £50-100bn
  - 1 nuclear power station £4-8bn/GWe
- geologic repository £ ?bn



# Summary 1

## Essential notions

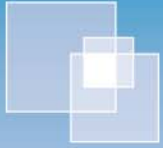
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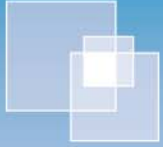
## Summary 2

uranium resources

- energy quality declines with time
- chance major new discoveries unknown



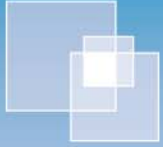
Do we need nuclear power?



We do not need nuclear power

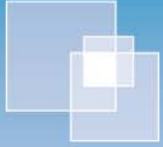
- nor for climate control
- nor for energy security
- nor for geopolitical stability





## Renewables

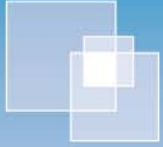
- free energy
- constant supply, flowing energy source
- constant quality
- accessible to everyone: geopolitical stability
- no debts: nor  $E$ , nor  $\text{CO}_2$ , nor €, £
- abundant



## New paradigm

For sustainable development we need to merge

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



## Nuclear power - the glossy pretender

thank you