

How to survive 2050? **Nuclear Energy**



Jan Leen
Kloosterman

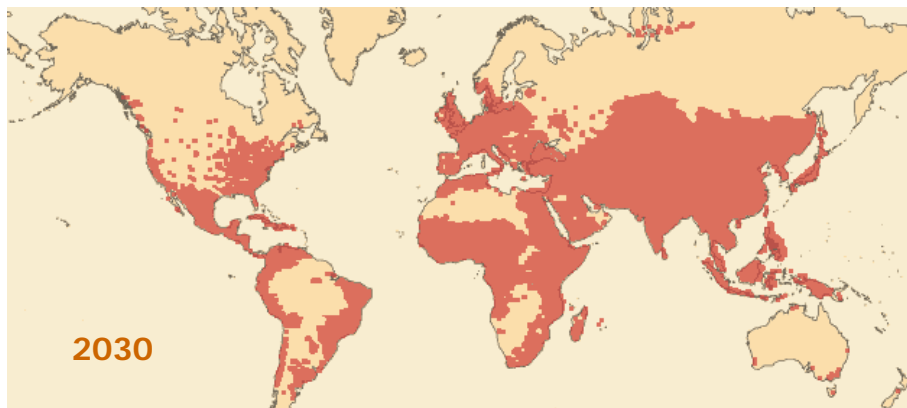
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World population

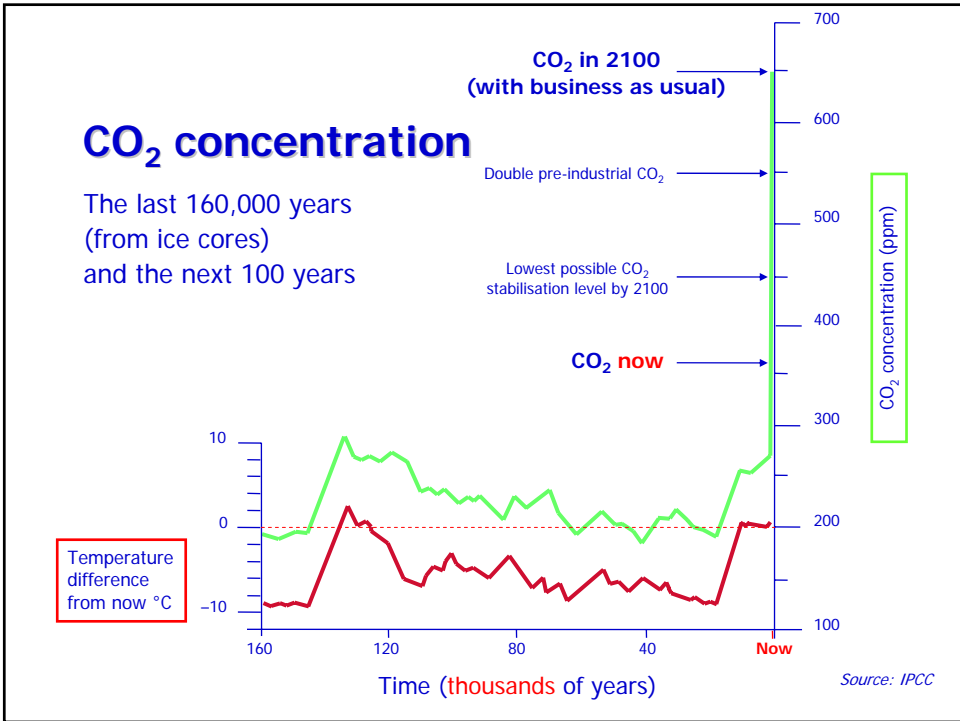
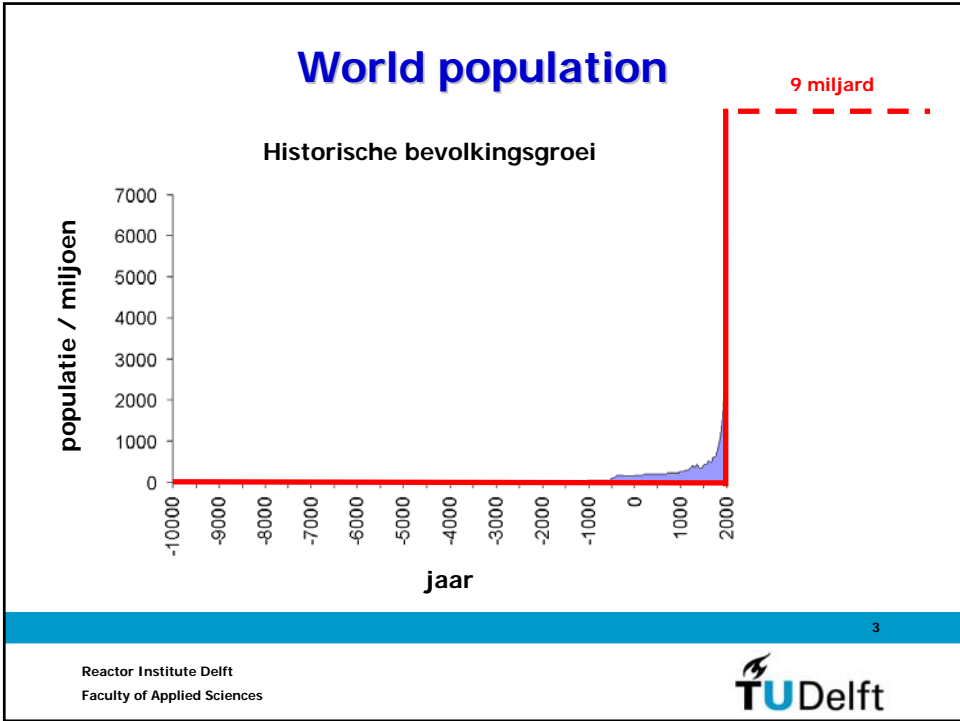
■ = 1 million people



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Source: www.pbs.org/wgbh/nova
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Land area below sea level

Sea level +1m

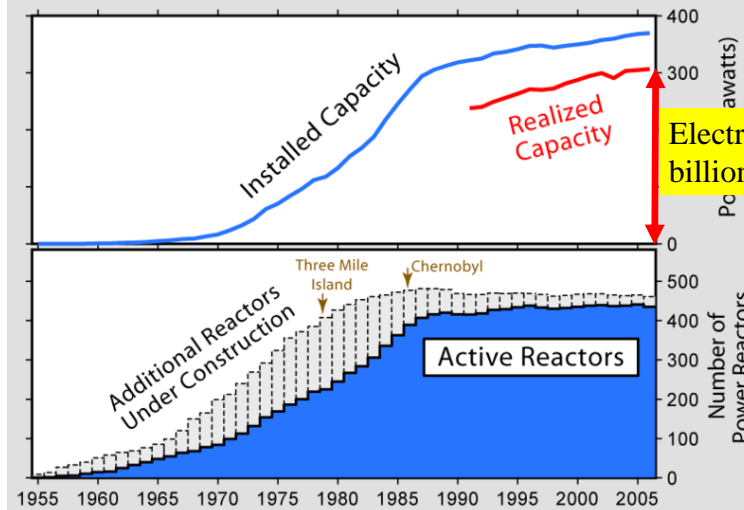


Sea level +8m



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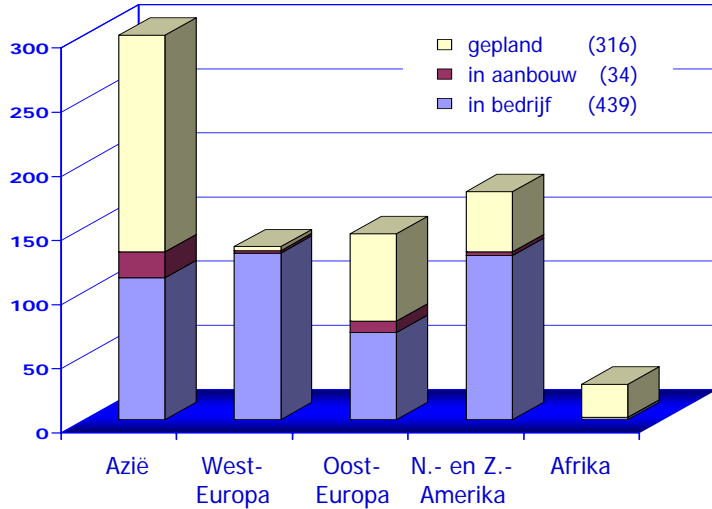
History of the Global Nuclear Power Industry



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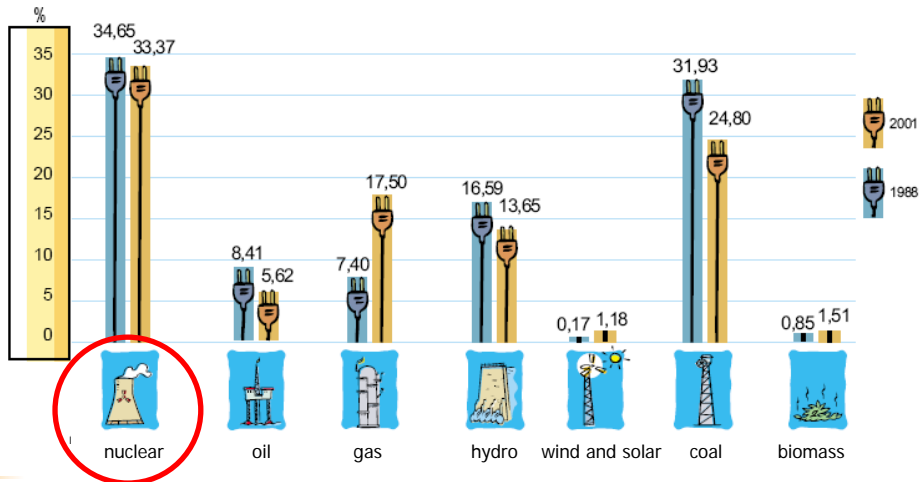
Status kerncentrales

januari 2008

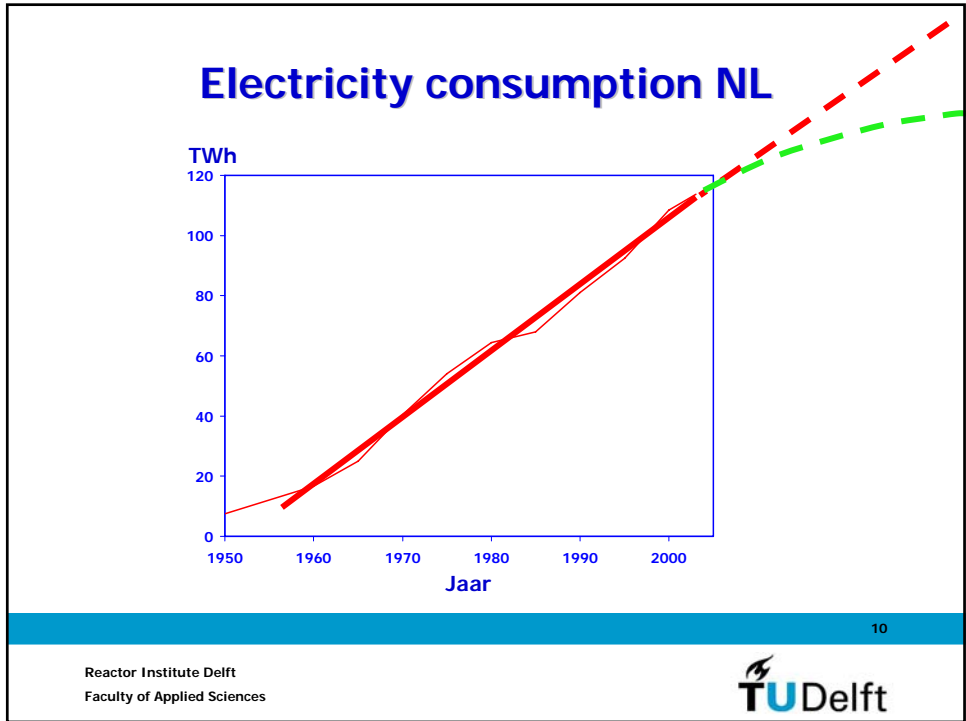
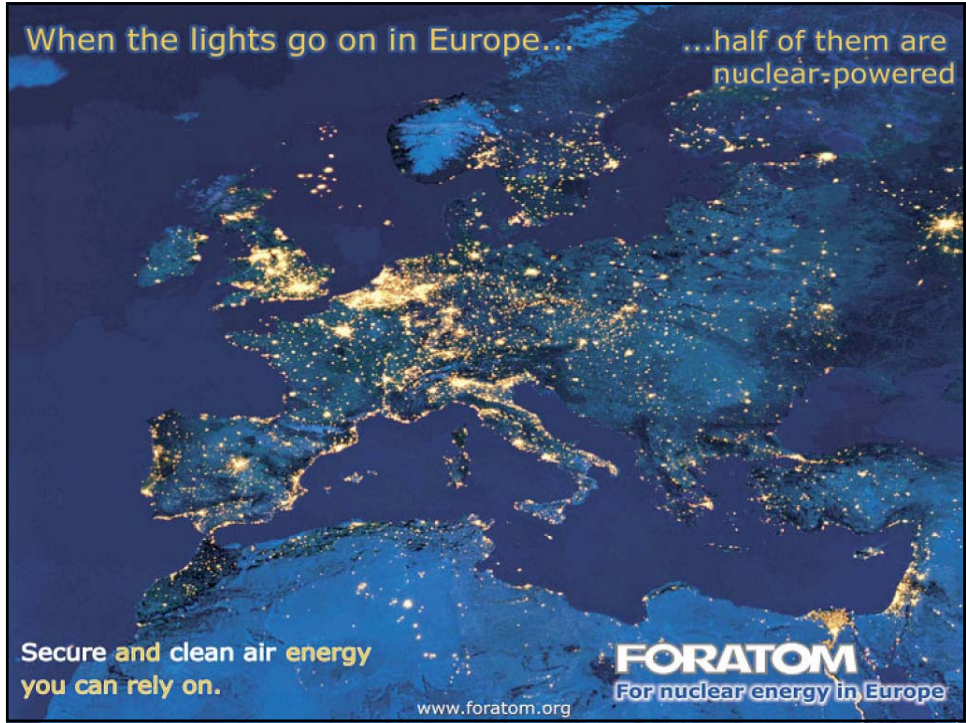


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Electricity production EU



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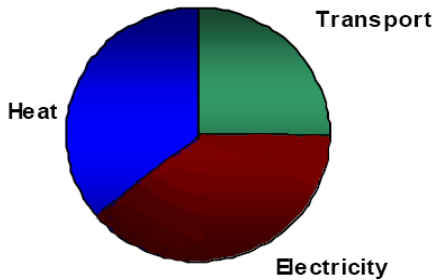


Elektricity consumption NL



caglecartoons.com

Why electricity consumption will increase



Low temperature heating (heat pumps)

Energieverbruik en CO₂-uitstoot voor verwarming en tapwater

	HH-hotel in standaard geïsoleerde woning	HH-hotel in extra aanvullende woning	Warmtepomp in extra aanvullende woning
Aardgasverbruik (m ³ /ja)	1470	875	—
Elektriciteitsverbruik (kWh/jaar)	160	135	1950
Verbruik primaire energie (MWh/a.a./jaar)	1510	910	500
Uitstoot CO ₂ (kg/jaar)	2700	1630	1105

Electric transport



More stuff



To stabilize CO₂ emissions by 2050 we have to ...

Savings

All cars:
Double the fuel economy



All residential & commercial buildings:
Use the best efficiency practices



'Transition'

Nuclear power:
Triple the number of nuclear power plants



Clean Fossil:
Capture and store carbon from 800 coal electric power plants



Renewables

Solar cells:
700 x the current capacity



Wind energy:
50 x today's wind energy



Biofuels:
50 x more ethanol production



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Source: *Carbon Mitigation Initiative*; www.princeton.edu
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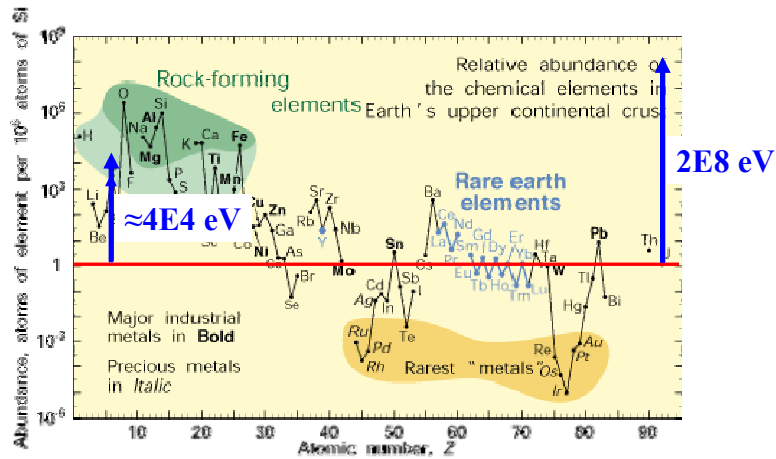
Uranium resources

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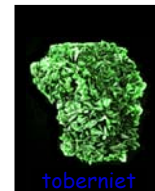
Element abundance in earth's crust



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Uranium resources

- The earth's crust contains 40 x as much uranium as silver
- Cheap uranium (up to 80\$ per kg): 3.1 million tons; enough for 50 years (0.1 ct/kWh)
- For the double price: 35 million tons; enough for 500 years using fast reactors: 30,000 years
- Uranium as byproduct from phosphate deposits (22 Mt recoverable)
- Uranium from seawater (450\$ per kg): 4 billion tons; enough for 6,000,000 years

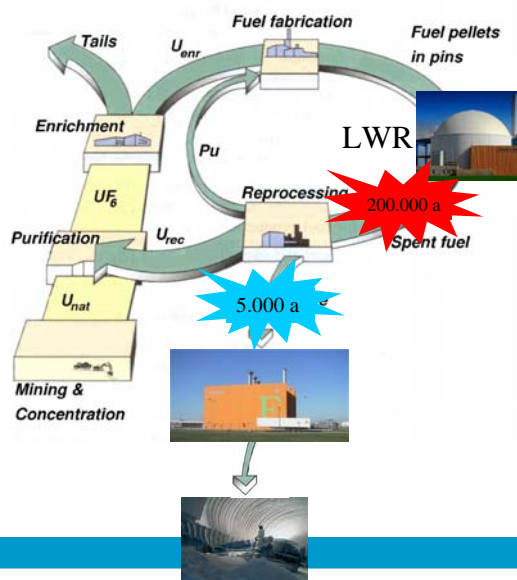


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Nuclear Fuel Cycle

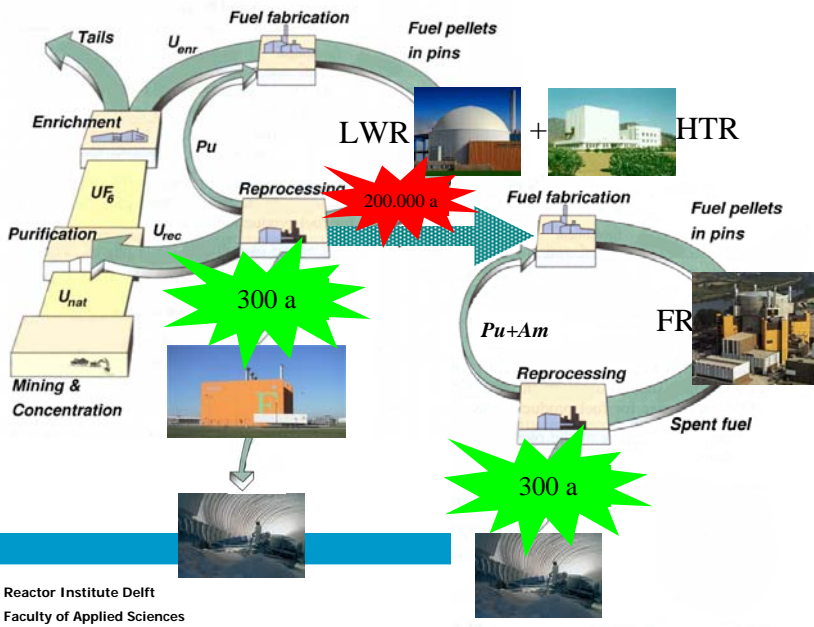
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Nuclear fuel cycle



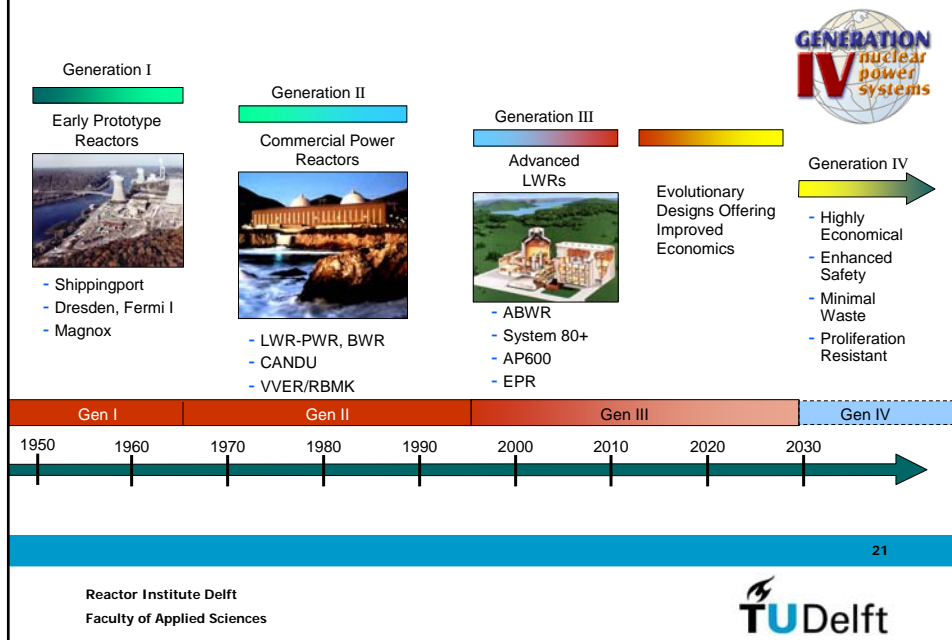
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Nuclear fuel cycle in 2050



Nuclear Reactors

Generations of nuclear reactors



The Generation-IV Initiative: *sustainable nuclear energy*

Argentine, Brazil, Canada, France, Japan, South Africa, South Korea, Switzerland, United Kingdom, United States and the European Union

The 6 selected reactor concepts

Hydrogen production:

- Very High Temperature Gas Cooled Reactor

Evolution of Light Water Reactors:

- Supercritical Water Cooled Reactor (thermal/fast)

Waste reduction and high efficiency:

- Gas Cooled **Fast** Reactor
- Sodium Cooled **Fast** Reactor
- Lead Cooled **Fast** Reactor

Very innovative:

- Molten Salt Reactor (epithermal)

