Nuclear Energy:
Dead or Alive?

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Outline

- World energy and climate context
- Electricity
- Status and prospects for nuclear energy
- Features
- Challenges
- Dead or Alive?


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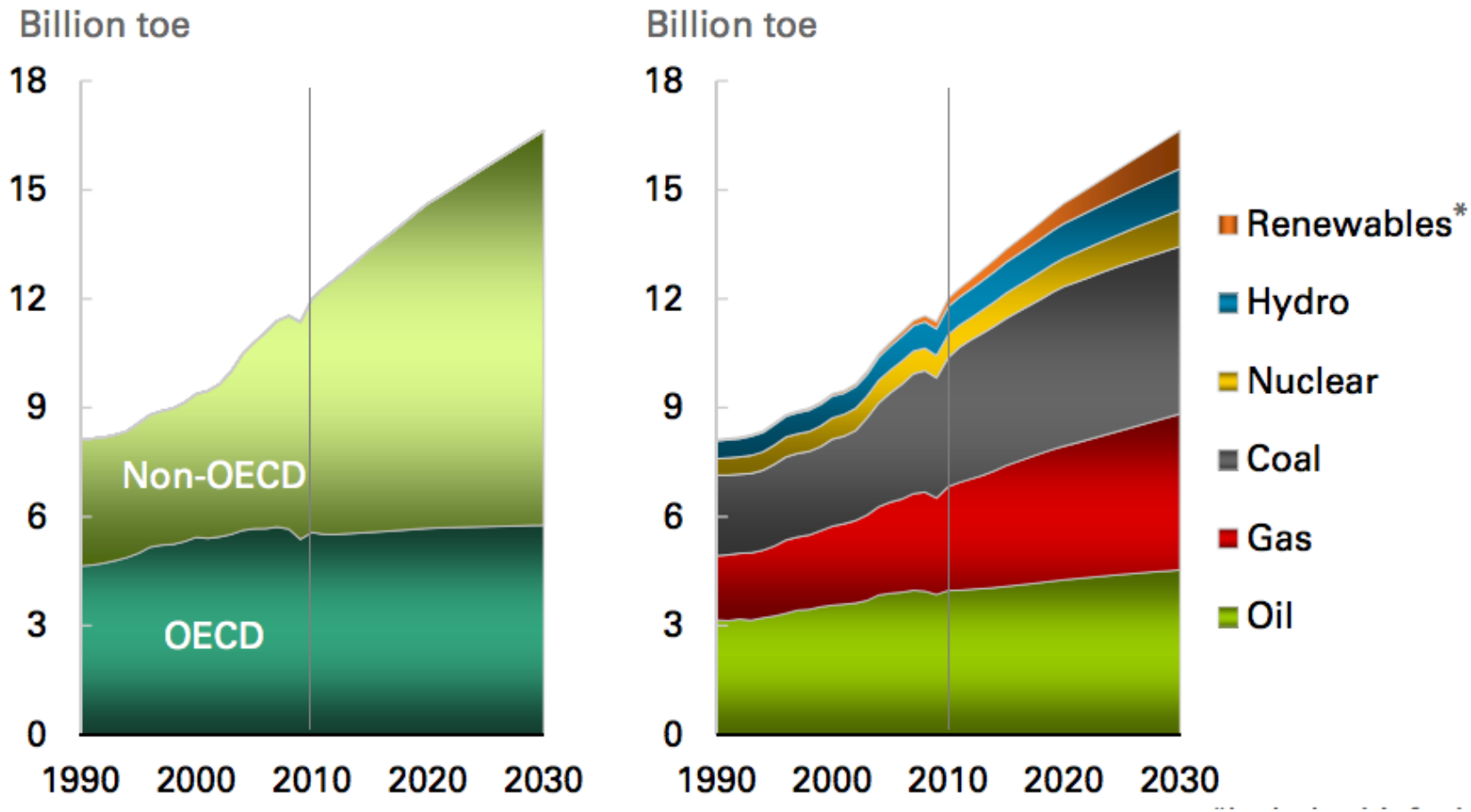
Generation by fuel type (IESO)
(http://www.ieso.ca/)

IESO

- Shares of nuclear and wind
- Base : low fuel costs, nuclear and hydro
- Intermediate: gas, hydro and wind
- Peak : low capital costs, gas.
- Complementary

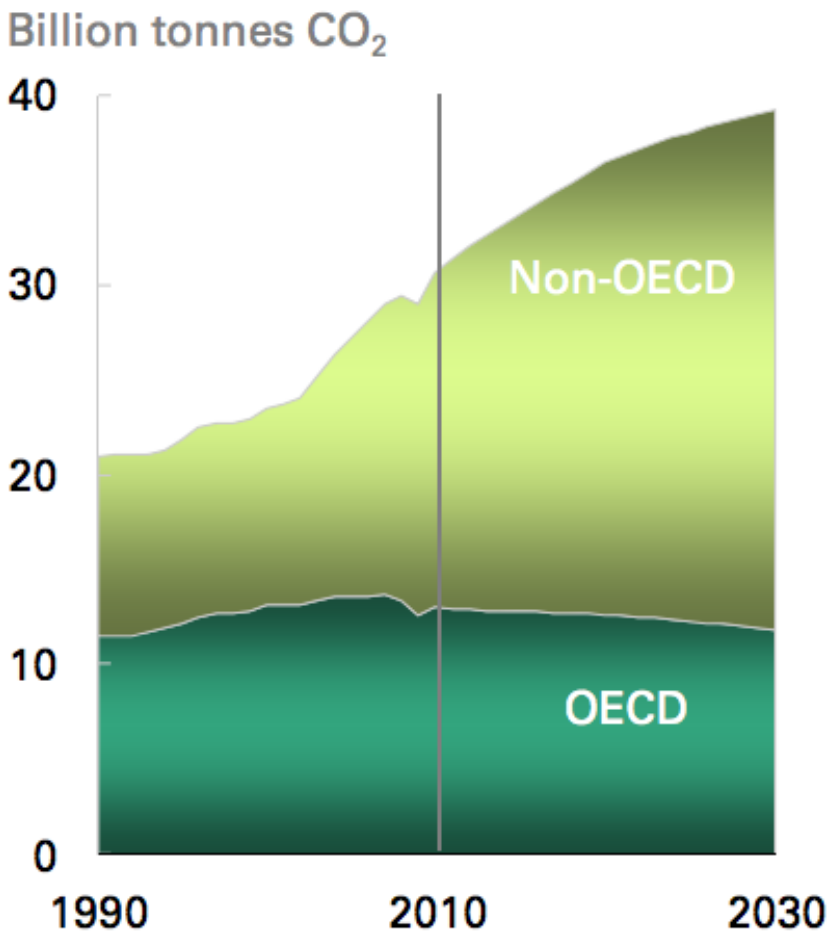
Non-OECD Drive - Primary (BP)

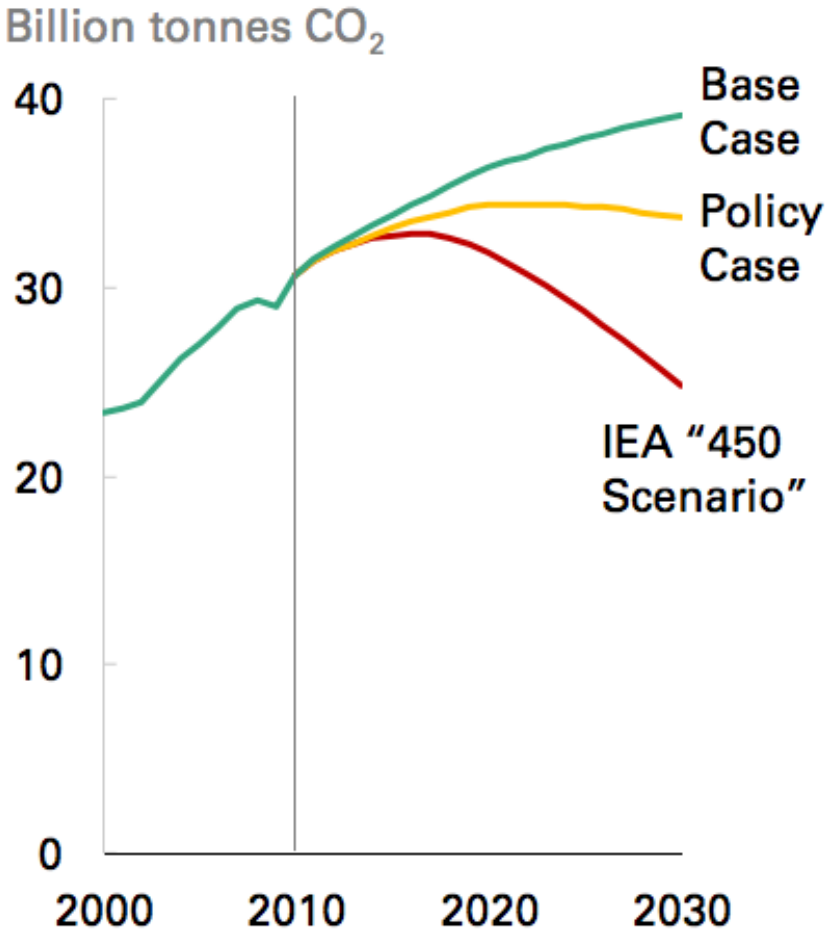


CO_2 and Climate Change

- Assume climate warming real and man-made
- High probability of high impact
- CO_2 from fossil fuels the key driver
- Emissions about 30 Billion tonnes CO_2/yr
- Need to cut drastically for 2 degree scenario
- Conservation, efficiency, low-carbon fuels
- Need many wedges of a billion tonnes each

Global CO_2 emissions from energy use





World Electricity

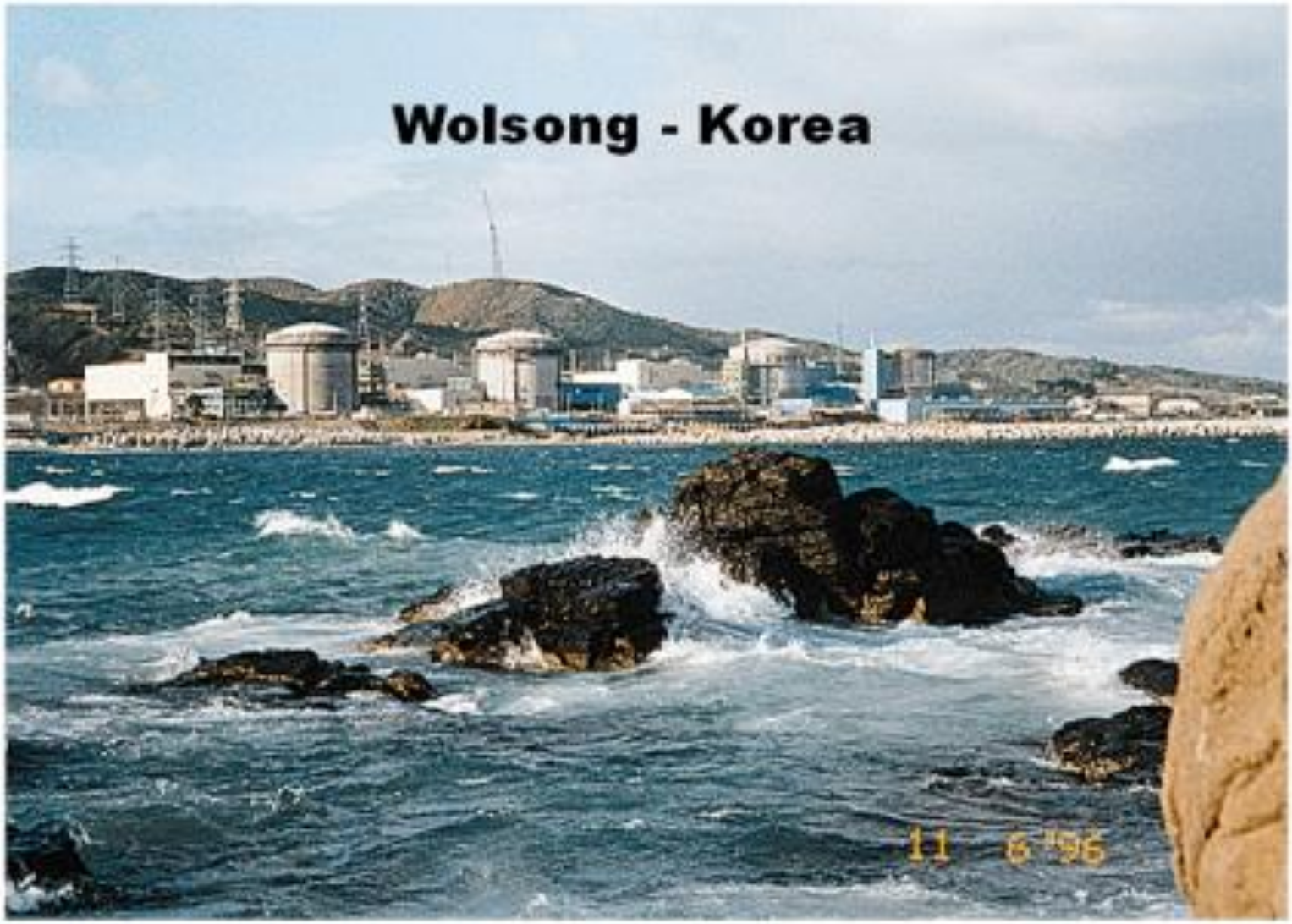
- One third of world primary, and of CO2
- Also mostly fossil, 40% coal
- 1.2 billion without access
- Flexible carrier: fossil, hydro, nuclear, renewables, geothermal
- Best chance to switch to low-carbon fuels

Status and prospects for Nuclear

- 400 GW in 30 countries , 13%
- Fukushima: Japan, Germany, Switzerland, France
- Going to 580 GW in 2035 (IEA)
- Growth in China, India, Korea, Russia , other non-OECD
- OECD fairly flat: issue of replacement

Nuclear as a Wedge

- Globally, nuclear avoids about 3 BT CO2 per year re coal
- 1 BT C02 re natural gas
- Good wedge to achieve reductions
- Choice of technology important


Wolsong - Korea
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Nuclear Energy in Ontario

- Canada's electricity capacity is about 120 GW
- Mostly hydro, unlike other industrial countries
- About 12 GW of nuclear, mostly in Ontario
- 60% of Ontario's electricity
- Maintain at 50%
- Replace nuclear with nuclear

Features of Nuclear (1)

- Energy density
- 1 tonne uranium = 15 000 tonnes coal
- Easier to transport and stockpile
- Wastes in proportion
- Virtually no emissions of C02, no pollution
- Low external costs (ExternE)
- Baseload power

Features of Nuclear (2)

- Diversity and security of supply
- Uranium abundant , low-cost
- Different geology from fossil
- Recycling extends resources by factor of 50
- Like fossil, sustainability issue is more with the use and the waste

Challenges for Nuclear

- Cost
- Waste
- Safety
- Weapons
- Public opinion and political support

Cost

- High capital cost, financial risk
- Low fuel and operating costs
- Long approval and construction times
  - The interest rate cast in concrete
- Cost overruns and delays on some projects
- Others on time and on budget – China, Korea
- Challenge to compete with gas in North America

Waste (1)

- Wastes are contained, operator responsible
- Paid for by current consumers
- Safe storage for decades at reactor sites
- But move more quickly to dry storage

- Short term, external: distance and shielding
- Long term, internal: isolation from biosphere
- Deep geological repository


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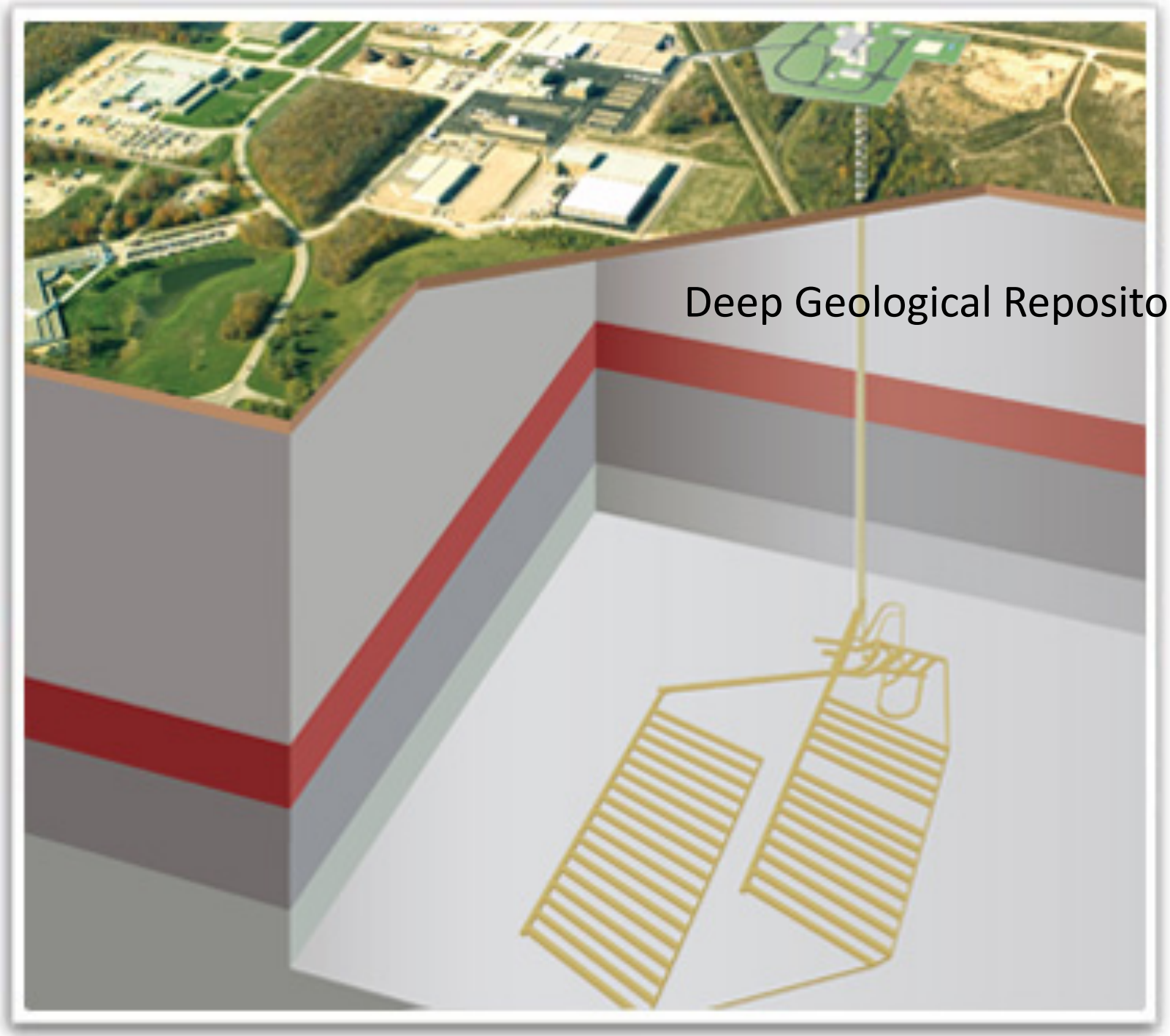
Deep Geological Repository

Waste (2) Disposal Concept

- Vault 500 metres down
- Design against water in, contaminants out
- Fuel form - hard ceramic in cladding
- Container - non-corrosive
- Bentonite clay buffer
- Host rock, low water movement
- Once sealed, no institutional control needed

Waste (3) NWMO

- Fund, site, build, operate, fund
- Consultation and participation
- Move forward but leave options open
- Adaptive phased management
- Volunteer communities
- 23 communities have shown interest

Safety (1)

- Risks and benefits
- Hazardous: need for pervasive safety culture
- Onus on operator, but need regulator
- Defence in depth, backup

Safety (2)

- Tsunami and Fukushima accident unique
- Main tragedy the tsunami – 20 000 dead
- Made in Japan ?
- Nuclear accident severe in own right– station blackout, core melt, hydrogen explosions, release of radiation, evacuations

Safety (3)

- High consequence , low prob events
- Unique, no stats, even prob uncertain
- Cannot defend against all unlikely events
- But many things can be done , whatever the immediate cause
- Management, policy and safety culture

Safety Improvements

- Flexible backup pumps and generators
- Flood proofing
- Passive hydrogen recombiners
- Coping with station blackout
- Severe accident management
- Emergency measures generally
- Safety culture, vigilance

Nuclear Weapons

- Basically a political problem
- Civilian energy programme not the best route
- But can serve as a cover
- National sensitive facilities are a challenge
- International facilities for reprocessing and enrichment , with guarantees of fuel
- Strengthen safeguards , sanctions

Dead Or Alive ?

- Public Opinion and Political Support

- What say you?