L’energia nucleare venti anni dopo: Prospettive, opportunità, rischi

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Comunicato della Casa della Sinistra - Bari

Il processo di unificazione della Sinistra è stato avviato in Puglia alcuni mesi fa ed ha toccato alcune tappe significative.
Occorre ora fare un passo in avanti, decidere insieme le azioni future e passare ad una fase più propositiva, che consenta sia una maggiore partecipazione attiva, sia un maggiore approfondimento dei temi sui quali costruire l'unità.

Proponiamo una conferenza programmatica pugliese, aperta ai partiti, alle associazioni ed ai singoli aderenti alla Sinistra preparata da Assemblea Regionale Pugliese per l'Unità della Sinistra il giorno 3 dicembre 2007, ore 17 presso la Regione Puglia (sala riunioni) Extramurale Capruzzi 212

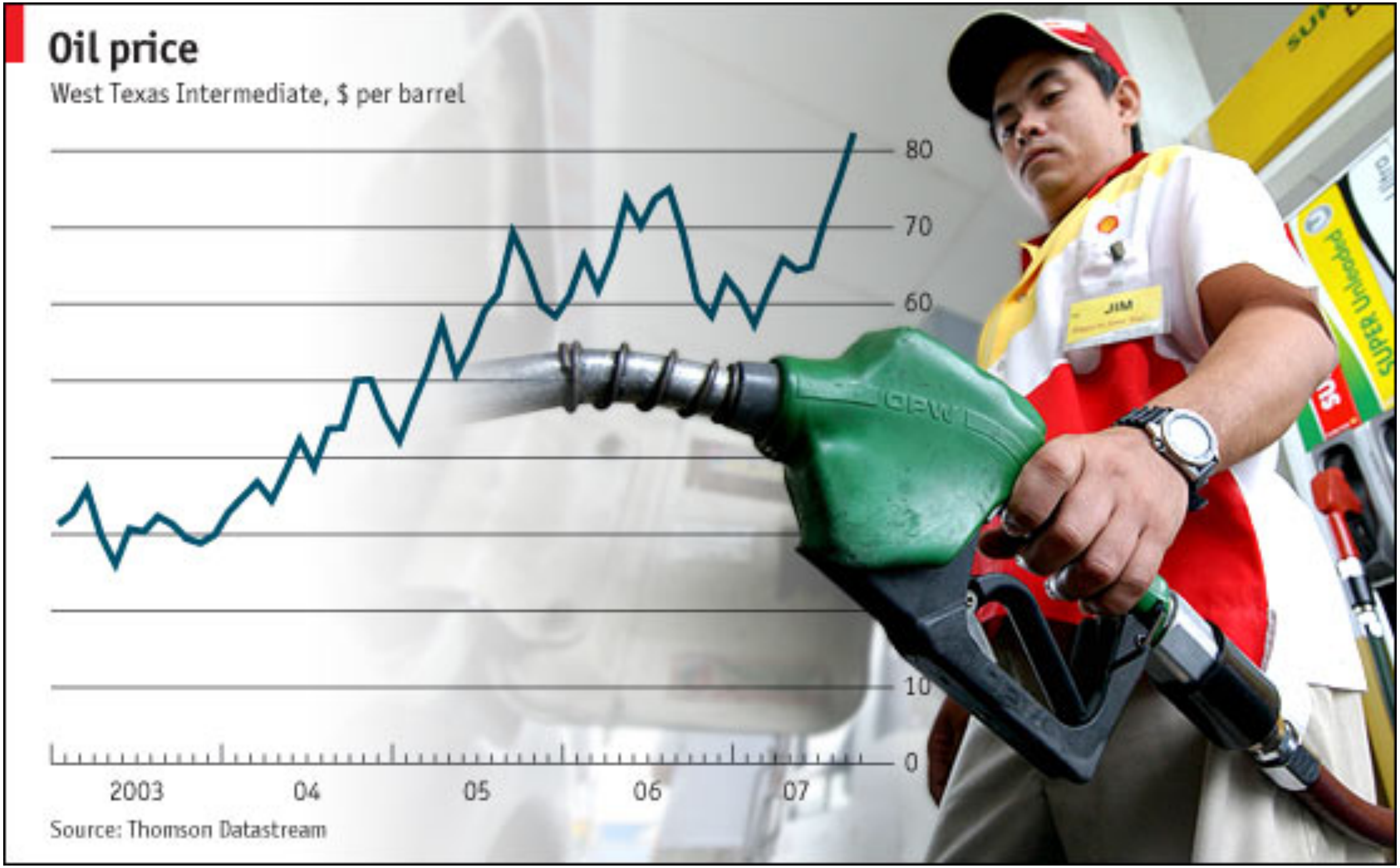
http://casasinistra.blogspot.com/

Sommario

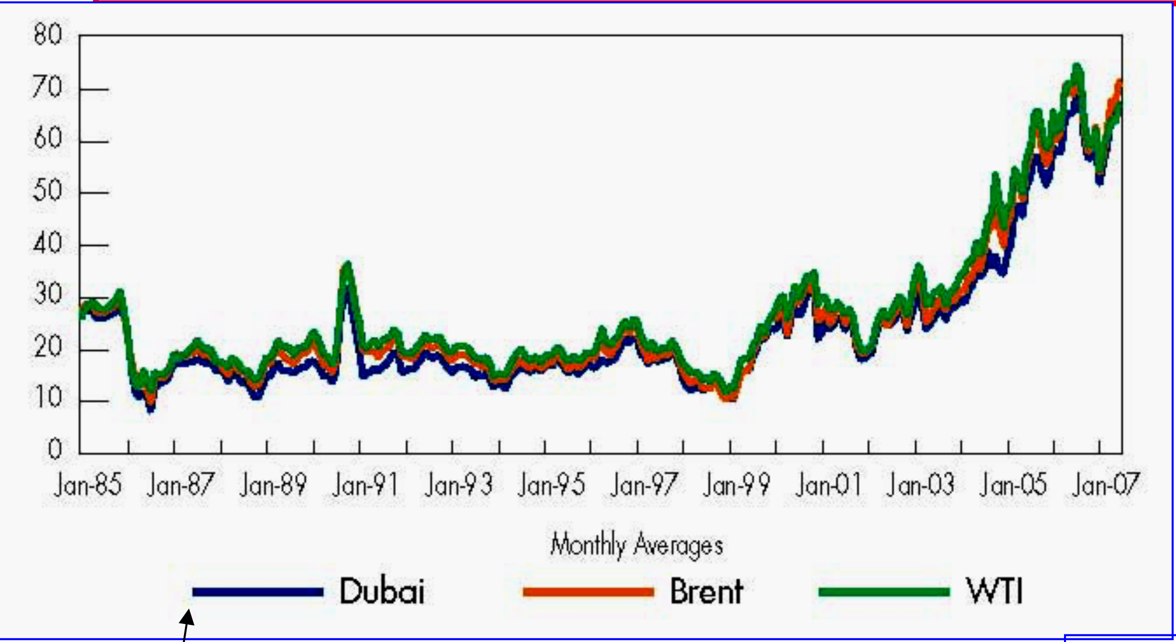
- **Previsioni: la capacità nucleare globale crescerà da 371 GWe a 400~600 GWe nel 2030, fino a un possibile 1000 Gwe nel 2050 (triplicazione)**
- **Il numero dei paesi con piccola capacità nucleare crescerà sensibilmente (da ca. 30 a ca. 50)**
- **Espansione e diffusione della capacità di controllare il ciclo del combustibile**
- **Crescita dello stock di materiale fissile**

Ragioni economiche

21/11/07: 99,29$

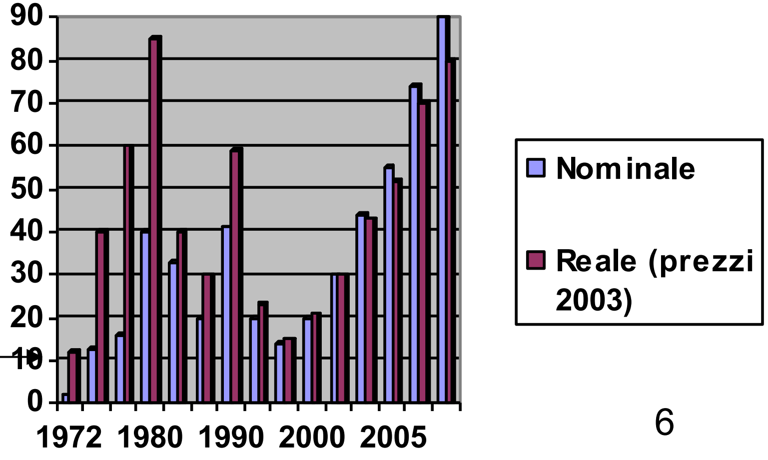


Prezzi in dollari al barile

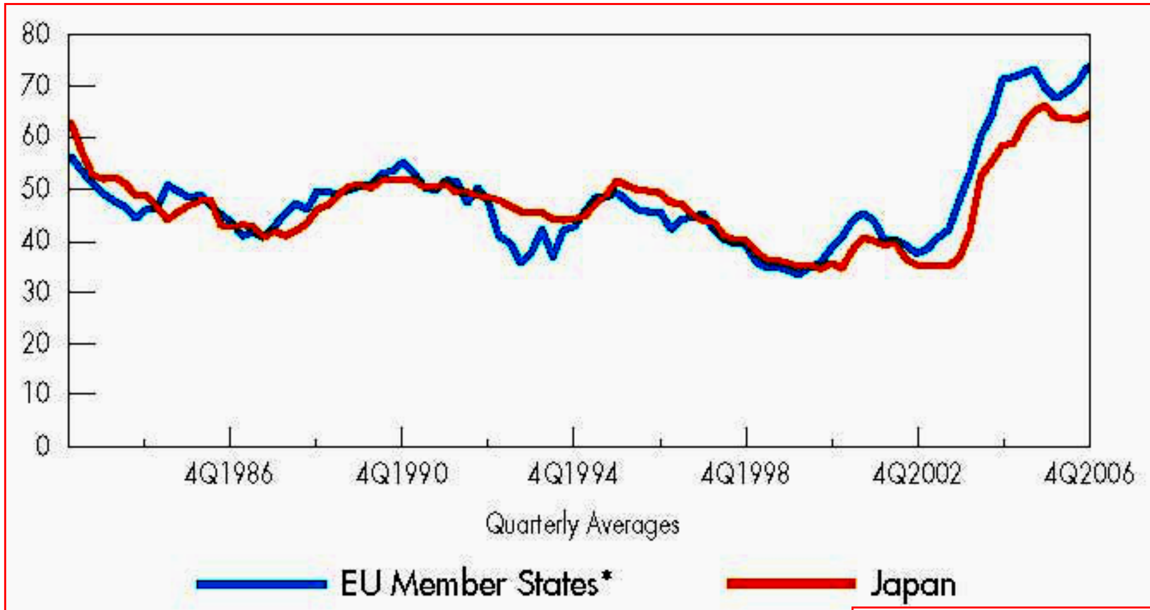


Dal 1985

Dal 1972

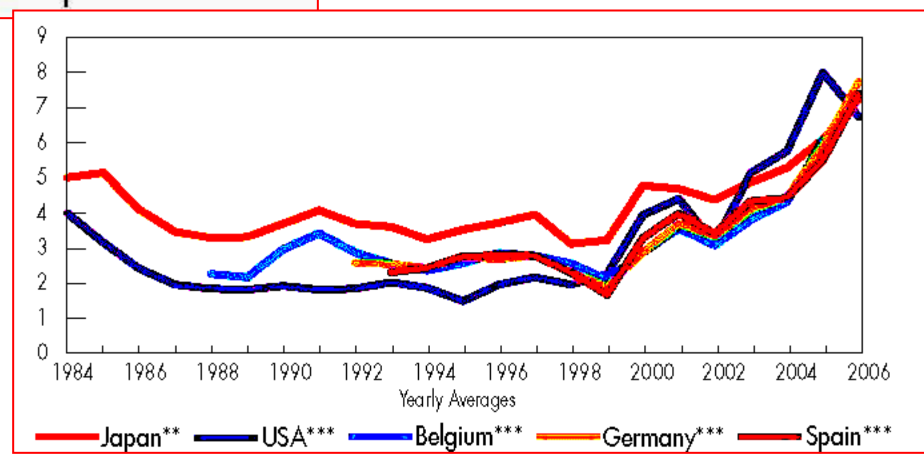


Altre fonti (prezzi dell'import)

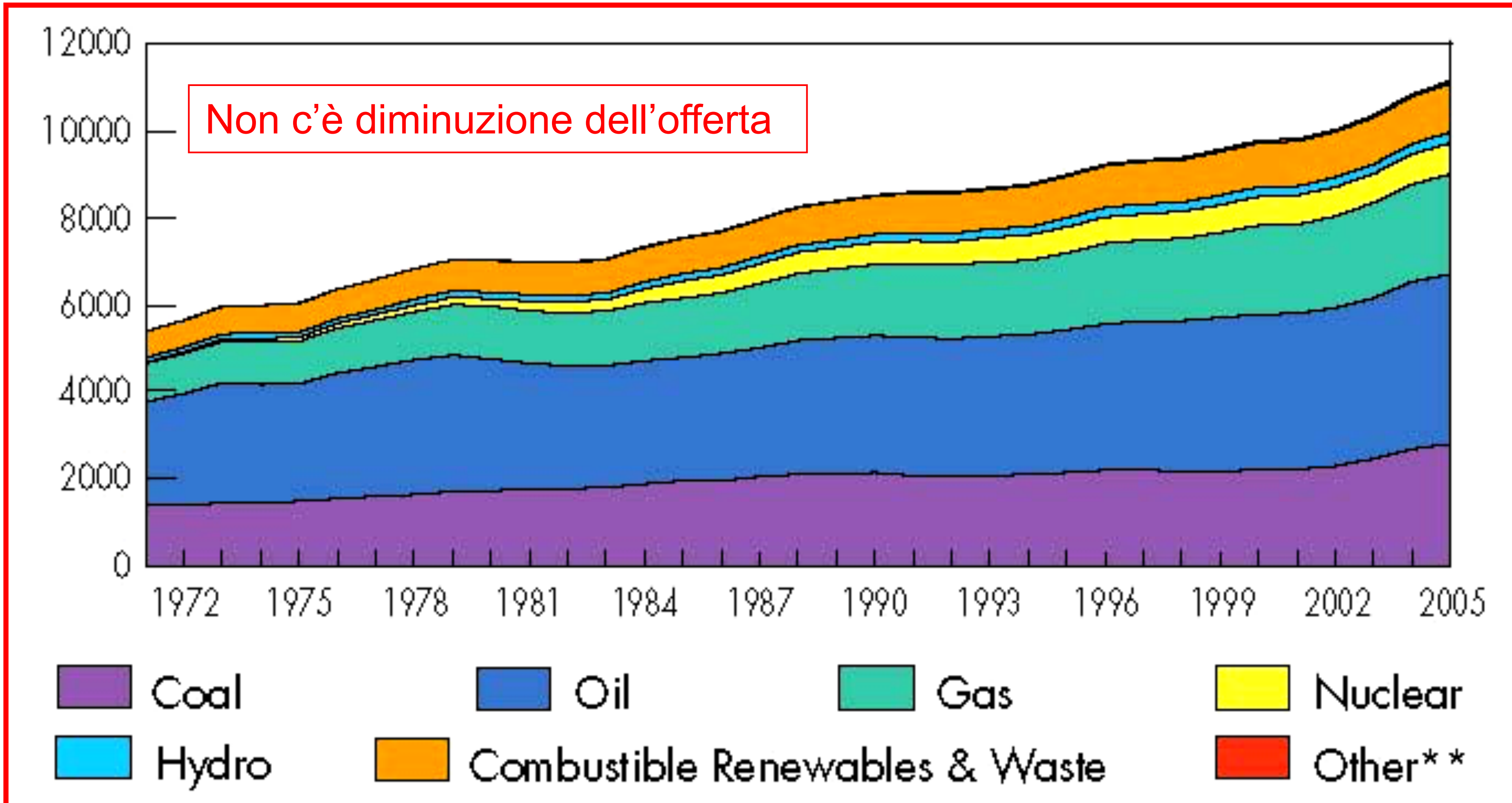


Carbone ($ a tonn.)

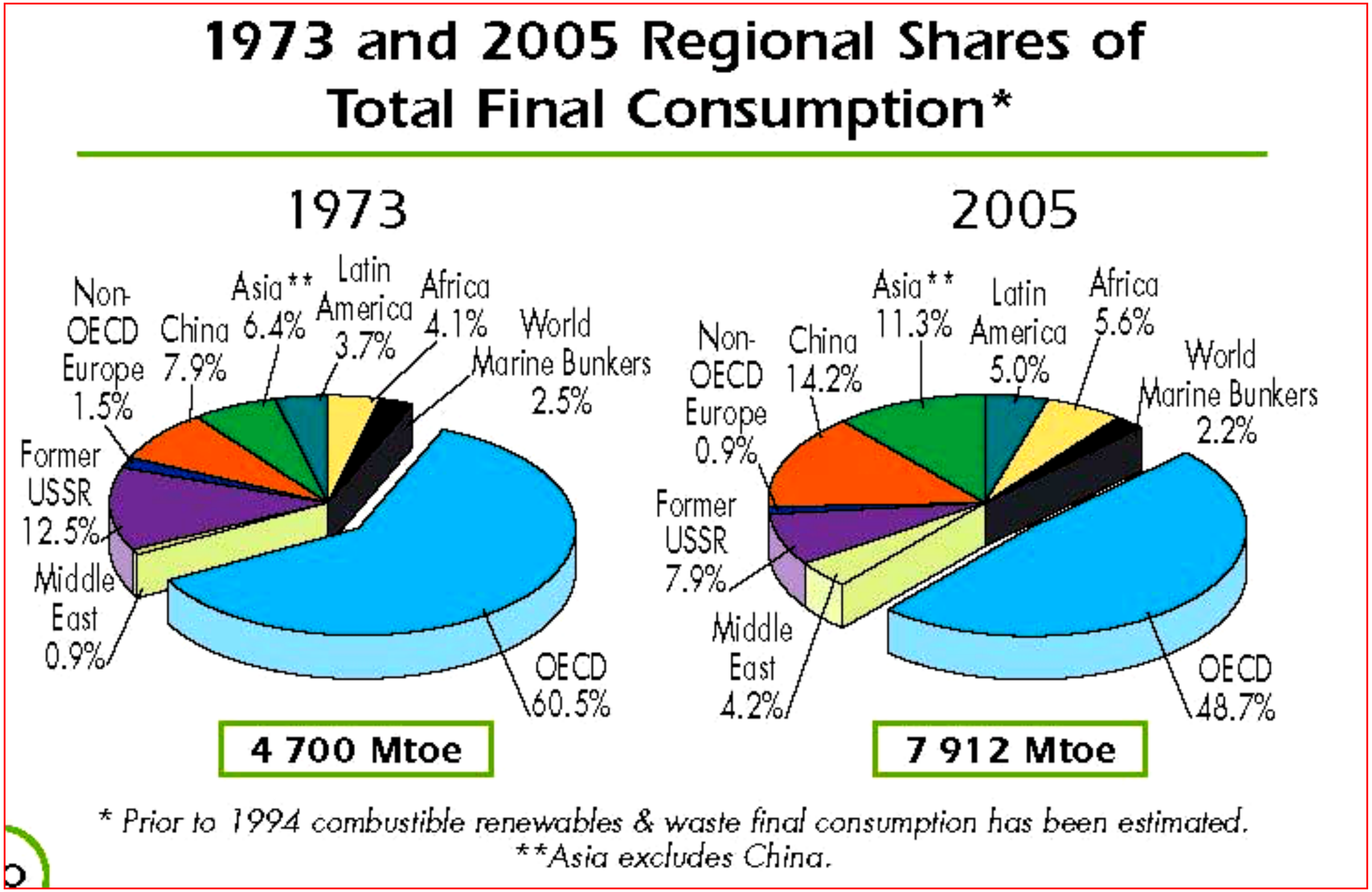
Gas ($ a MBtu)



Produzione globale di energia (MToe)



Consumi per aree regionali



Competitività del nucleare

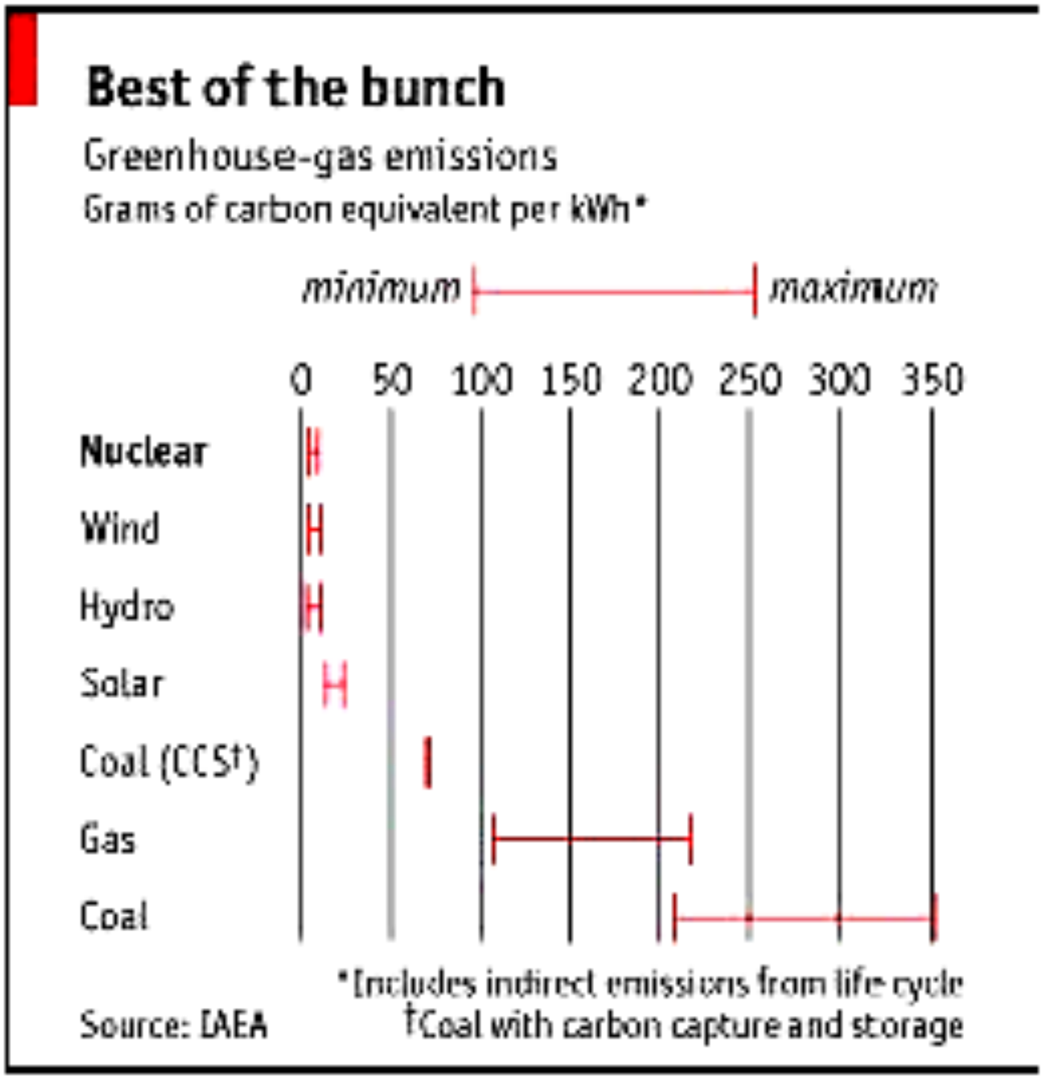
1. **Costi di gestione**

   Il costo medio del kWh in USA era nel 2005 di 5 cent$, quello del nucleare oggi è 1.7 cent, con margini del 200%

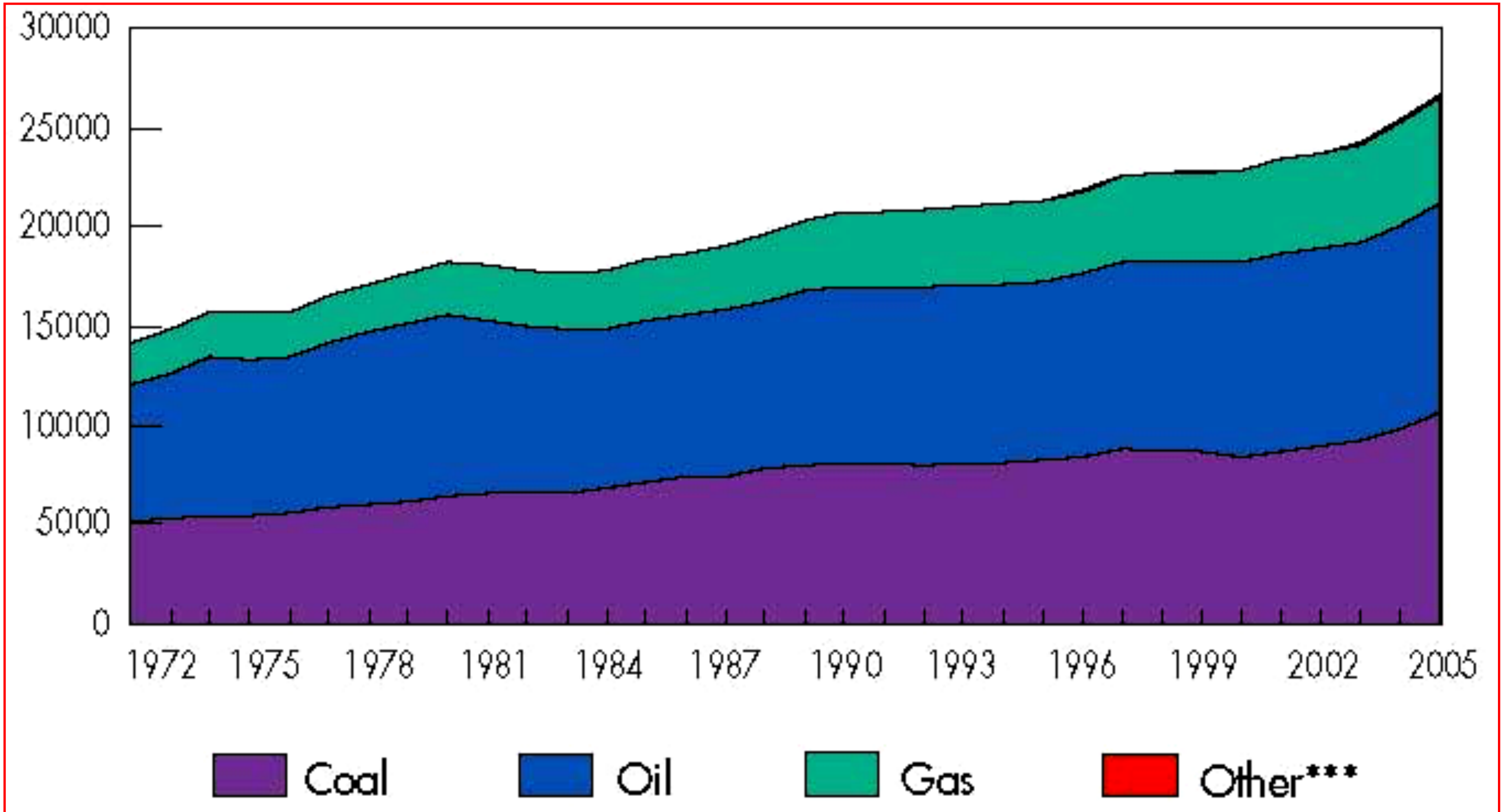
2. **Crescita dei costi del carbone, per ridurre gas serra (USA)**

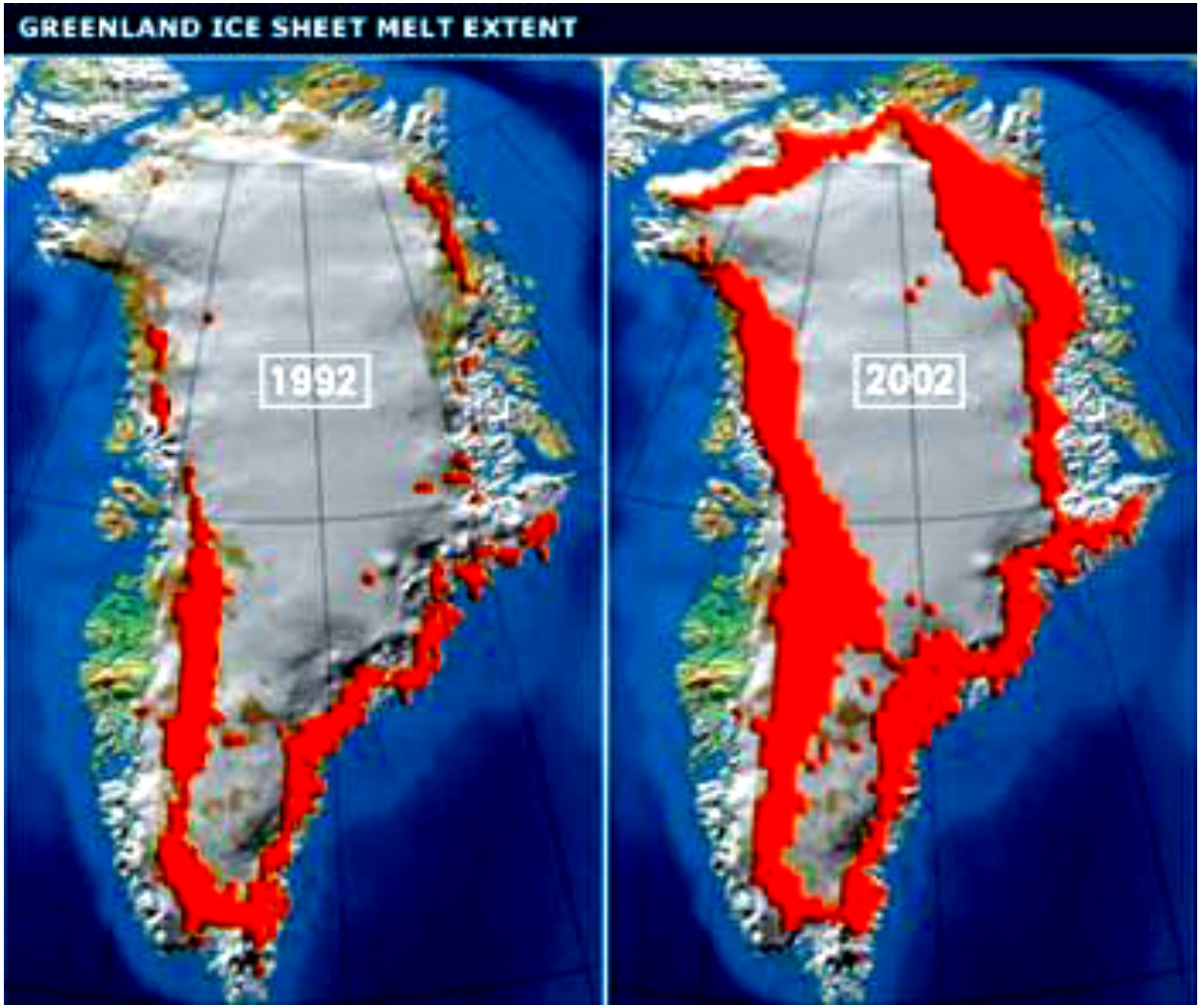
Motivazioni ambientali

Motivazioni ambientali



Emissioni di gas serra secondo le fonti (serie temporali)

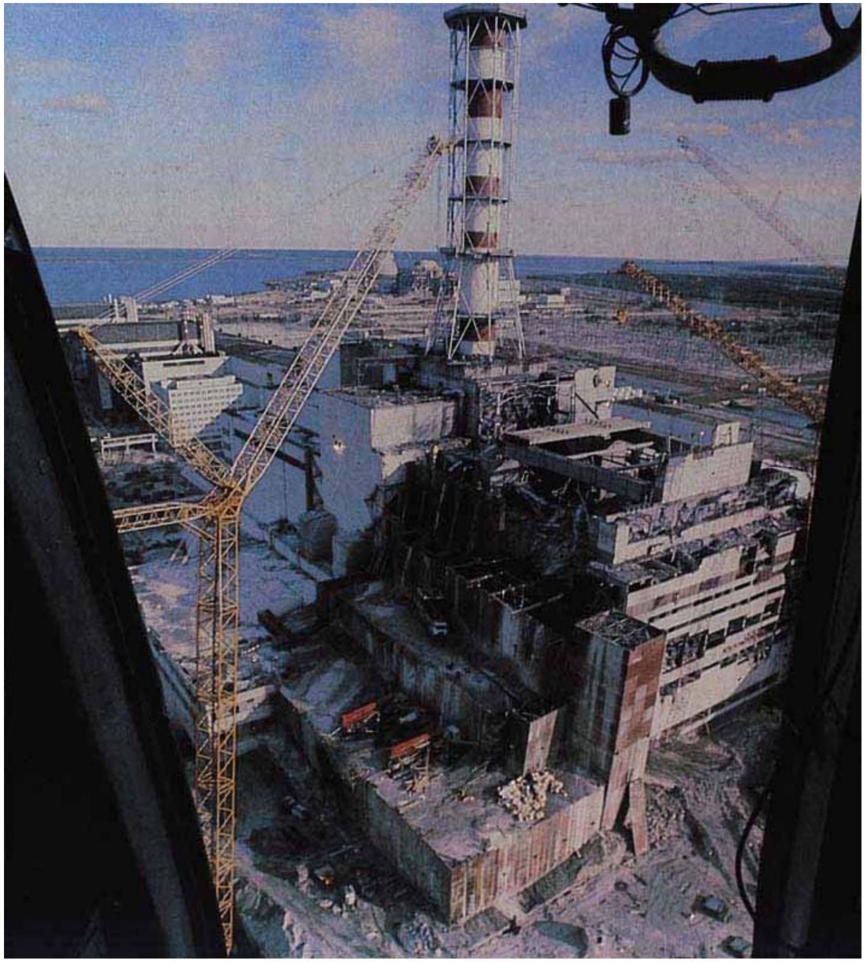




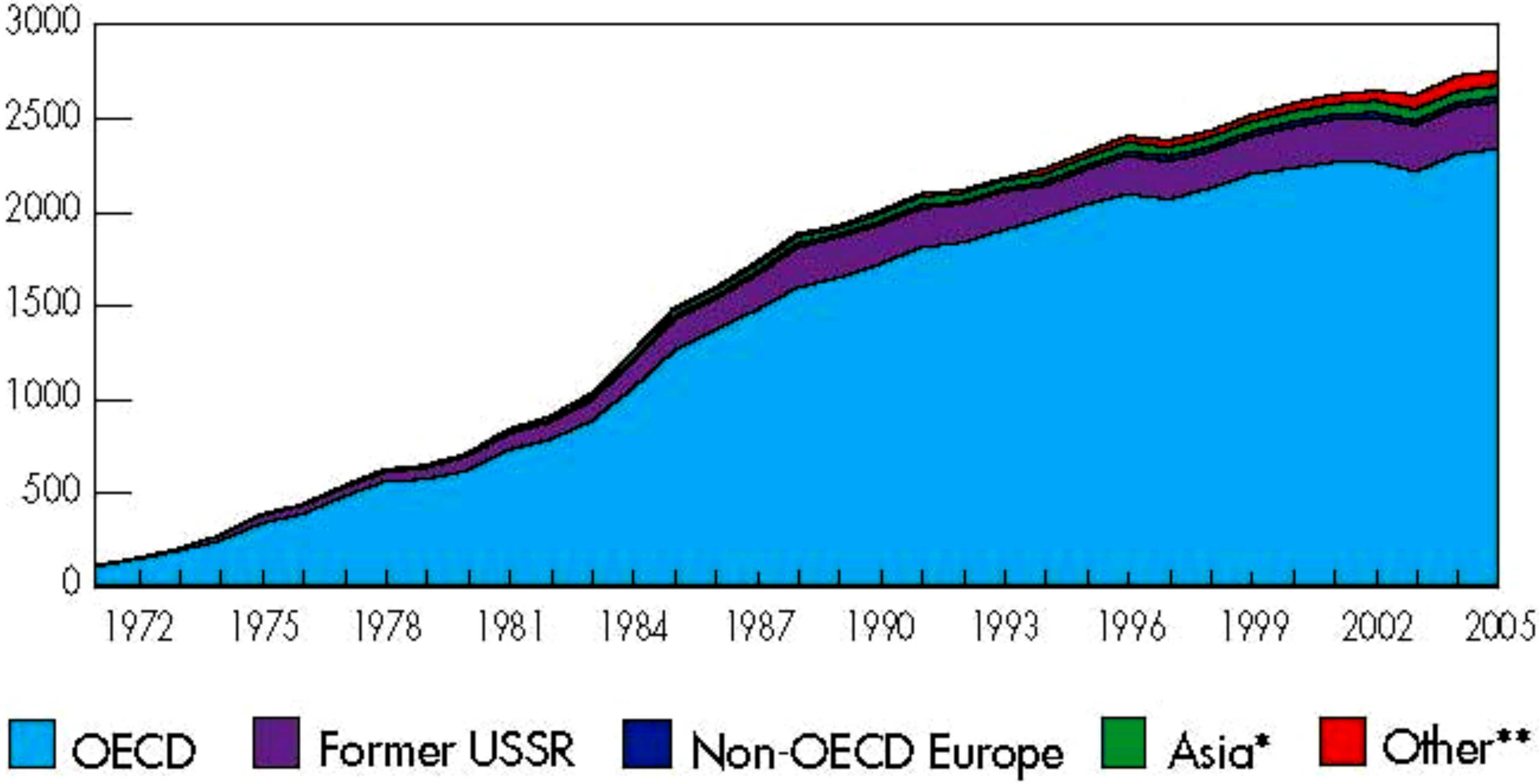
Cosa si cerca nelle terre emerse della Groenlandia?

Revival: miglioramento della tecnologia e non solo

1. Sicurezza
2. Efficienza
3. Tempi più rapidi di costruzione
4. Divisioni nel fronte ambientalista
5. Minore ostilità opinione pubblica
6. Crescita dei consumi globali di elettricità



Produzione di energia nucleare dal 1971 al 2005 (TWh)



Situazione attuale

- Alla fine del 2006, **435** impianti in funzione in 31 paesi, con una capacità netta di ca. **370 GW(e)**
-
- **~80%** di questa capacità in paesi OECD (Organizzazione per Cooperazione Economica e lo Sviluppo)
- **6** unità (4 GW) in via di chiusura
- Ca. 30 unità (24 GW) in costruzione,, **13** in Asia
- **Nucleare fornisce il ~15% dell'elettricità globale**

Source: International Atomic Energy Agency, "Energy, Electricity and Nuclear Power Estimates up to 2030," 2007 edition.(2007)

I dati della rinascita del nucleare

- **Per i paesi OECD la costruzione di nuove centrali serve a mantenere lo status quo**
  - **197 unità (171 GW) dovrebbero essere rimpiazzate entro il 2025**
  - **Ci si aspetta che nonostante le nuove richieste (in USA: 12+15) il ruolo del nucleare in questi paesi declini dal 15% al 10% (18% -> 15% in USA, 28% -> 12% in EU)**
- **In Asia: Giappone, S. Korea, Cina, India espanderanno il ruolo del nucleare**
  (aggiungendo 70GW entro il 2030)
  - **La percentuale di energia prodotta dal nucleare arriverà per Cina ed India al 6~9%**

Proiezione al 2030

	2005 (Actual,GWe)	2030 Estimate (GWe)	
		Reference Case	High Growth Case
OECD/IEA	368	416	519
IAEA	362	414	679
IEEJ	385	499	568

Altri paesi (I)

- Vietnam, Indonesia, Australia potrebbero ospitare impianti nucleari entro il 2020
  – Recente rapporto in Australia raccommanda 25 reattori per il 2050 (nessun impegno ufficiale per ora)

  Ma: occorre una solida infrastruttura sociale ed industriale per l'introduzione dell'energia nucleare

Altri paesi (II)

- Hanno mostrato interesse (in Medioriente):
  - Algeria, Egitto, Iran, Giordania, Libia, Marocco, Arabia Saudita, Tunisia, Turchia, Yemen
- In questo caso, anche se i programmi nucleari saranno piccoli, le implicazioni internazionali potrebbero essere grandi
- Interesse non motivabile da politiche energetiche e ambientali -> motivazioni forse politiche

Number of countries with nuclear power reactors could significantly grow

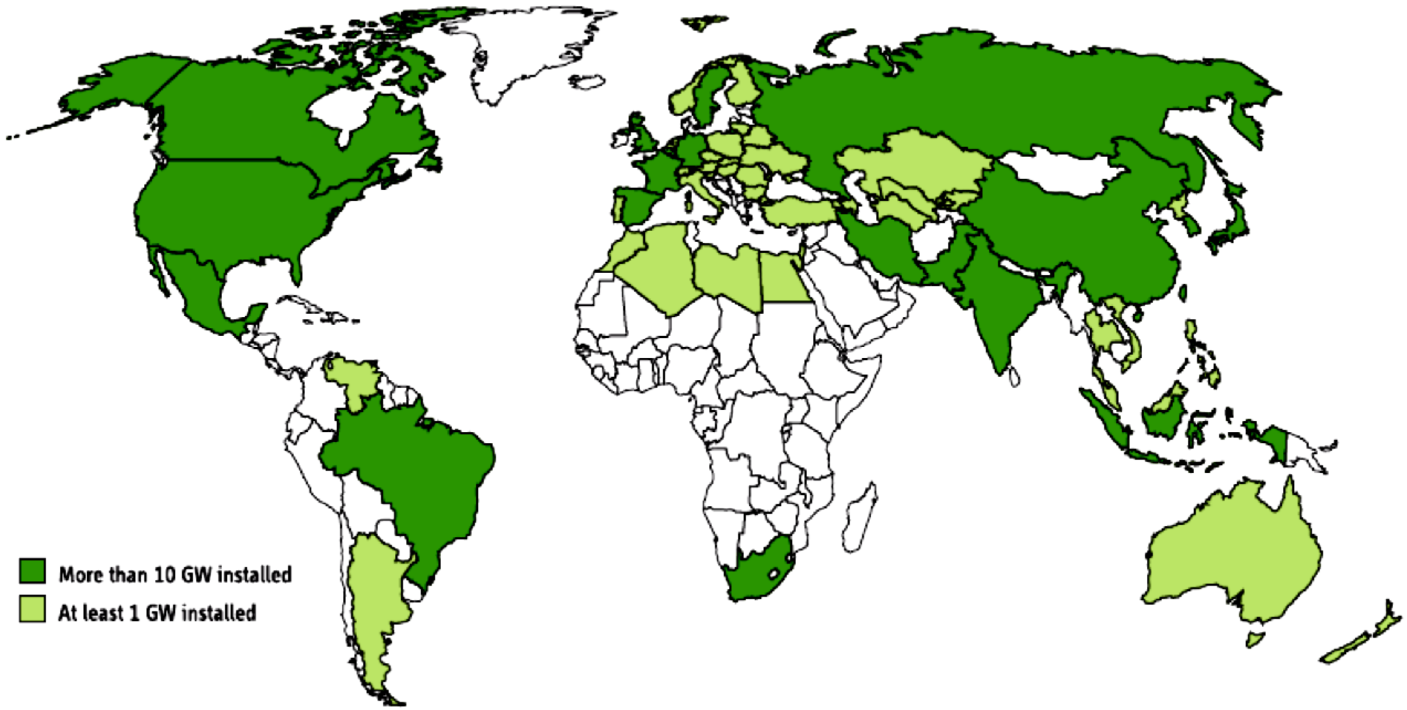


Figure 7.1. MIT's 1500 GWe high-growth nuclear scenario predicts reactors in 58 countries.[314]

Source: International Panel on Fissile Materials (IPFM), "Global Fissile Material Report 2007",p.84

Rischi

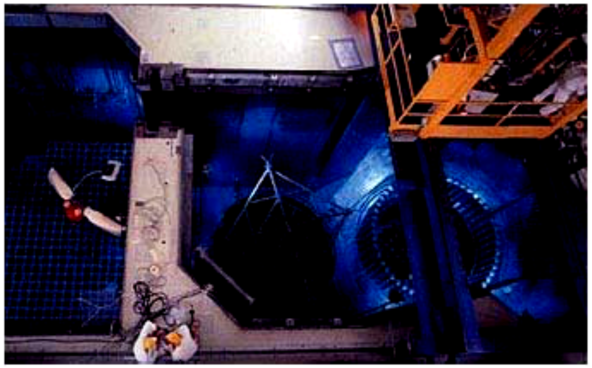
- **Proliferazione** (Uso militare)
- Sia a monte (arricchimento) sia a valle (management delle scorie)
- Ruolo accresciuto della AIEA-Vienna che sovrintende al rispetto del Trattato di Non Proliferazione Nucleare

A Multilateral Approach?
No past proposals have been realized

- Baruch Plan: proposed an International Atomic Development Authority – 1946
- Atoms for Peace: speech to UNGA by US President Eisenhower – 1953– proposed an IAEA
- IAEA Statute (1956): Article III.B.2 and Article XII.A.5 provide for Agency control over excess special fissionable materials
- IAEA study project on regional nuclear fuel cycle centres (RNFC) –1975 to 1977
- Committee on International Plutonium Storage (IPS) – 1978 – 1982
- International Fuel Cycle Evaluation Programme (INFCE) – 1977 to 1980
- United Nations Conference for the Promotion of International Cooperation in the Peaceful Uses of Nuclear Energy (UNCPICPUNE) - 1987
- Committee on Assurances of Supply (CAS) – 1980 to 1987
- International Symposium on Nuclear Fuel and Reactor Strategies:Adjusting to New Realities (1997)
- Technical, Economic and Institutional Aspects of Regional Spent Fuel Storage Facilities (RSFSF) – 2003 IAEA TecDoc

Vincoli a questa espansione

1. Rischio dell' investimento
2. Fiducia dell'opinione pubblica
3. Sicurezza



The blue glow in the fuel storage pool next to the nuclear reactor is a result of radiation being absorbed by the water and made visible in the form of harmless blue light (so-called Cerenkov radiation). Open reactor during annual inspection (right); (left) storage pool for spent fuel. (Photo: Gösgen NPP)

The Gösgen-Däniken nuclear power plant. (Photo: Comet)

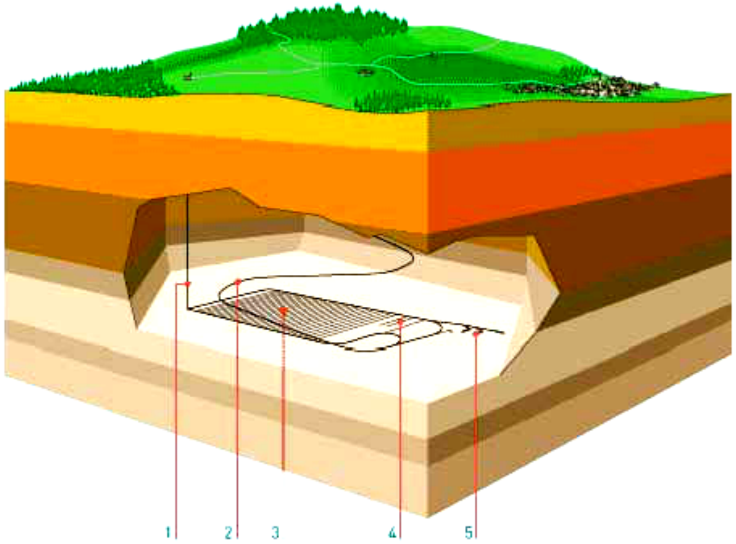
4. Smaltimento delle scorie

Management delle scorie e del combustibile “spento”

Necessaria capacità di stoccaggio del combustibile spento per evitare il riprocessamento

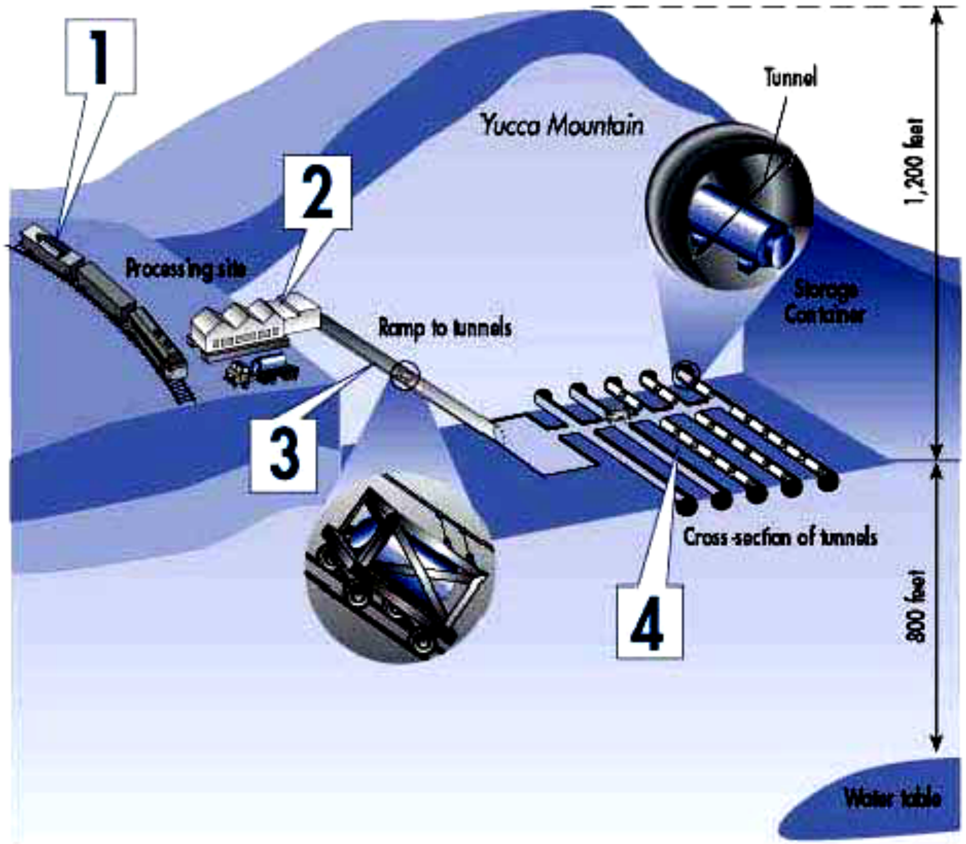
Geological repository for HLW, SF and ILW

The HLW repository is foreseen for direct disposal of spent fuel from the Swiss nuclear power plants or high-level waste from reprocessing. Besides the emplacement tunnels for high-level waste and spent fuel, there will be separate tunnels for long-lived intermediate-level waste. The repository will be required from around 2040.



A vertical shaft or a ramp will provide access to the disposal zone located at a depth between 400 and 1000 metres. After closure of the repository itself, the behaviour of the safety barriers can continue to be monitored in the pilot facility.

Conceptual Design of Yucca Mountain Disposal Plan



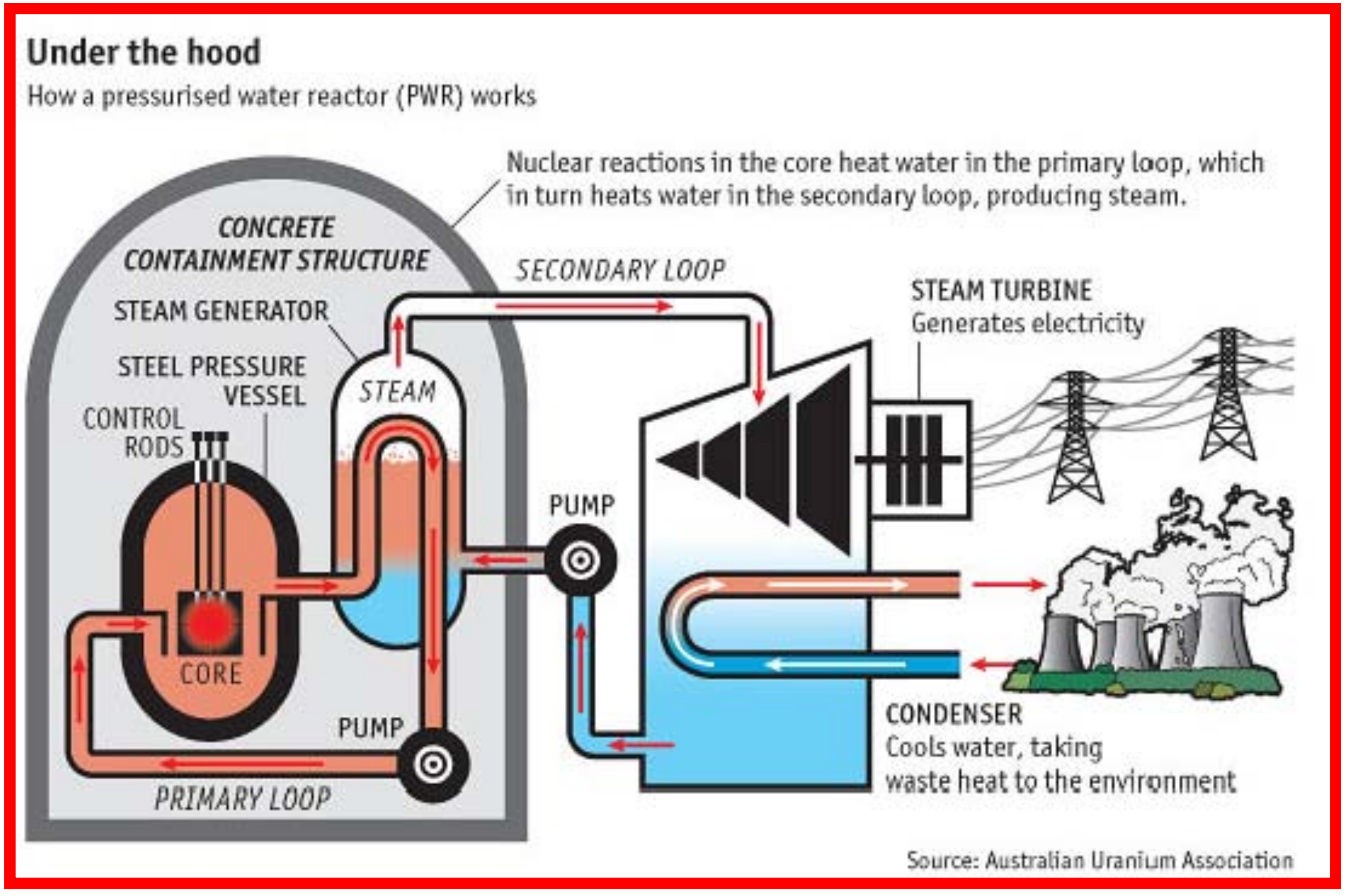
1. Canisters of waste, sealed in special casks, are shipped to the site by truck or train.
2. Shipping casks are removed, and the inner tube with the waste is placed in a steel, multilayered storage container.
3. An automated system sends storage containers underground to the tunnels.
4. Containers are stored along the tunnels, on their side.

Il caso Italia

- Gli ostacoli per l'Italia sono difficilmente superabili per ora: alti costi e rischi d'investimento
- Lavorare in un'ottica di integrazione europea e non di autarchia energetica
- Occorre puntare su risparmio e fonti rinnovabili, in particolare solare/fotovoltaico
- Utile rilanciare la ricerca su nucleare e fonti rinnovabili (in assenza di know how si perdono le occasioni)

BACKGROUND SLIDES

Principi di funzionamento



Civilian HEU in the World

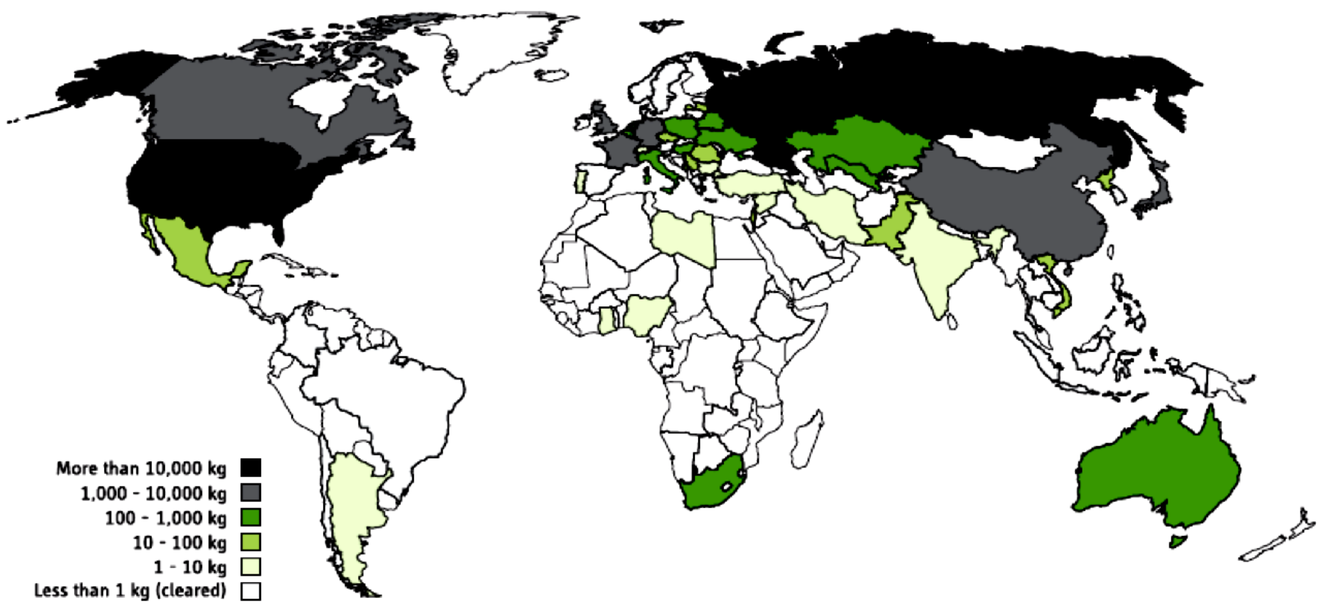


Figure 1.3. Civilian HEU is still distributed around the globe in large quantities. International efforts to convert HEU-fueled research reactors to LEU have reduced the annual demand of the material by about 250 kg of HEU per year. Yet, there are still about 100 sites in 40 countries where the material can be found in significant quantities, at operational or shut down, but not yet decommissioned HEU-fueled reactors.

A monte:

Global HEU Stockpile (2006)

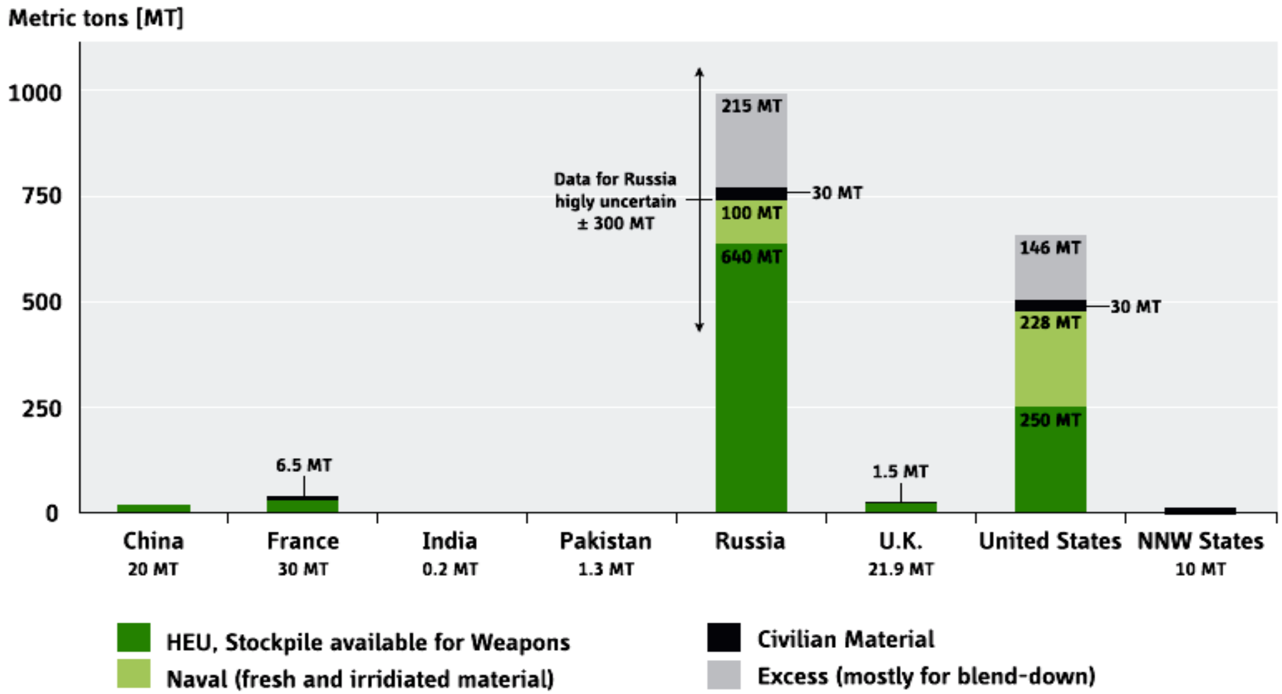


Figure 1.2. National stocks of highly enriched uranium as of mid-2007. Only the numbers for the United Kingdom and United States are based on official information. Other numbers are non-governmental estimates, often with large uncertainties.[10]

Source: IPFM (2007), p.10

Global Pu Stockpile (2005)

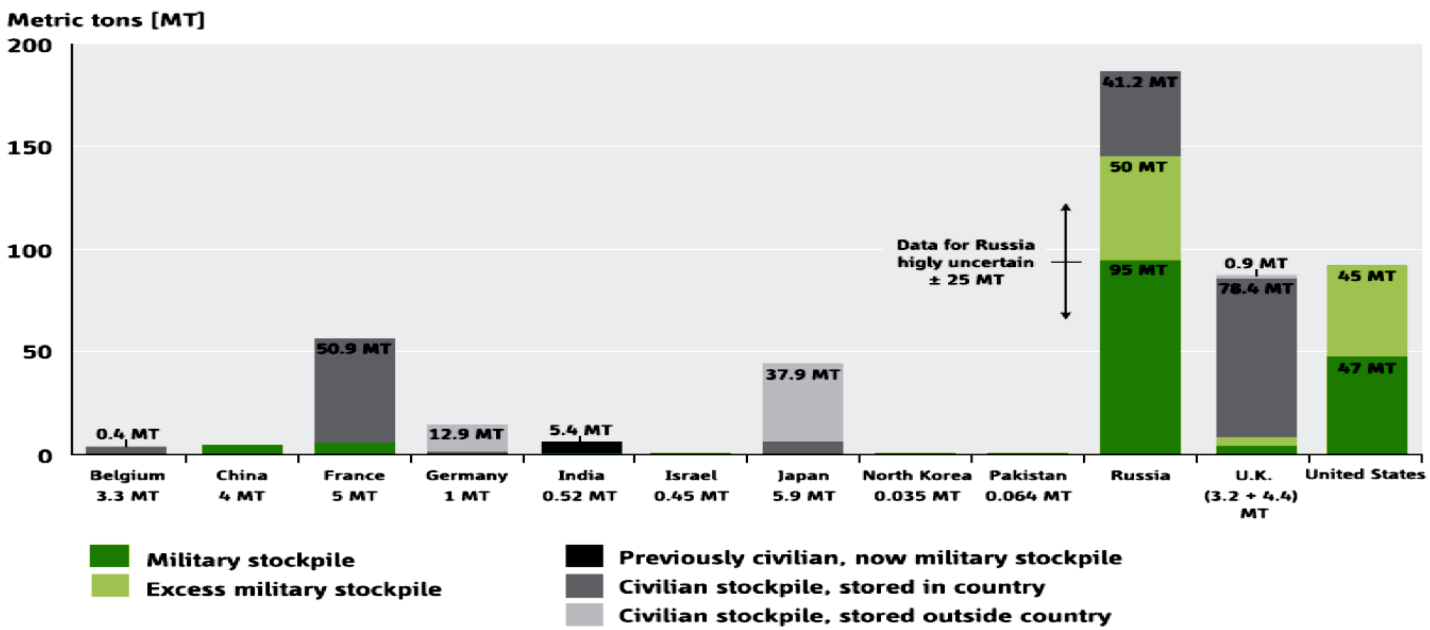


Figure 1.4. National stocks of separated plutonium.[32] Civilian stocks are for December 2005 and based on the latest INFCIRC/549 declarations (when available and with the exception of Germany, see also Appendix 1B to this chapter). Civilian stocks are listed by ownership, not by current location. Weapon stocks are based on non-governmental estimates except for the United Kingdom and the United States, whose governments have made declarations. India's plutonium separated from unsafeguarded spent PHWR fuel is assigned to its military stockpile.

Source:IPFM (2007), p.14

Motivazioni ambientali

Climate change : the physical science basis (IPCC - WG1 – AR4 – 2007)

- + 20 % CO_2 forcing from 1995 to 2005
- Warming is unequivocal :
  - Global scale : air, ocean, snow and ice meting, sea level rise
  - Regional scale : artic T and ice, heavy precipitations, droughts, intensity of tropical cyclones
- Most of the observed warming of the last 50 years is **very likely** due to the observed increases in GHG

Climate change : the physical science basis (IPCC - WG1 – AR4 – 2007) (2)

- Projections of future climate change

  - Next two decades : + 0,2 °C /decade

  - 2100 :

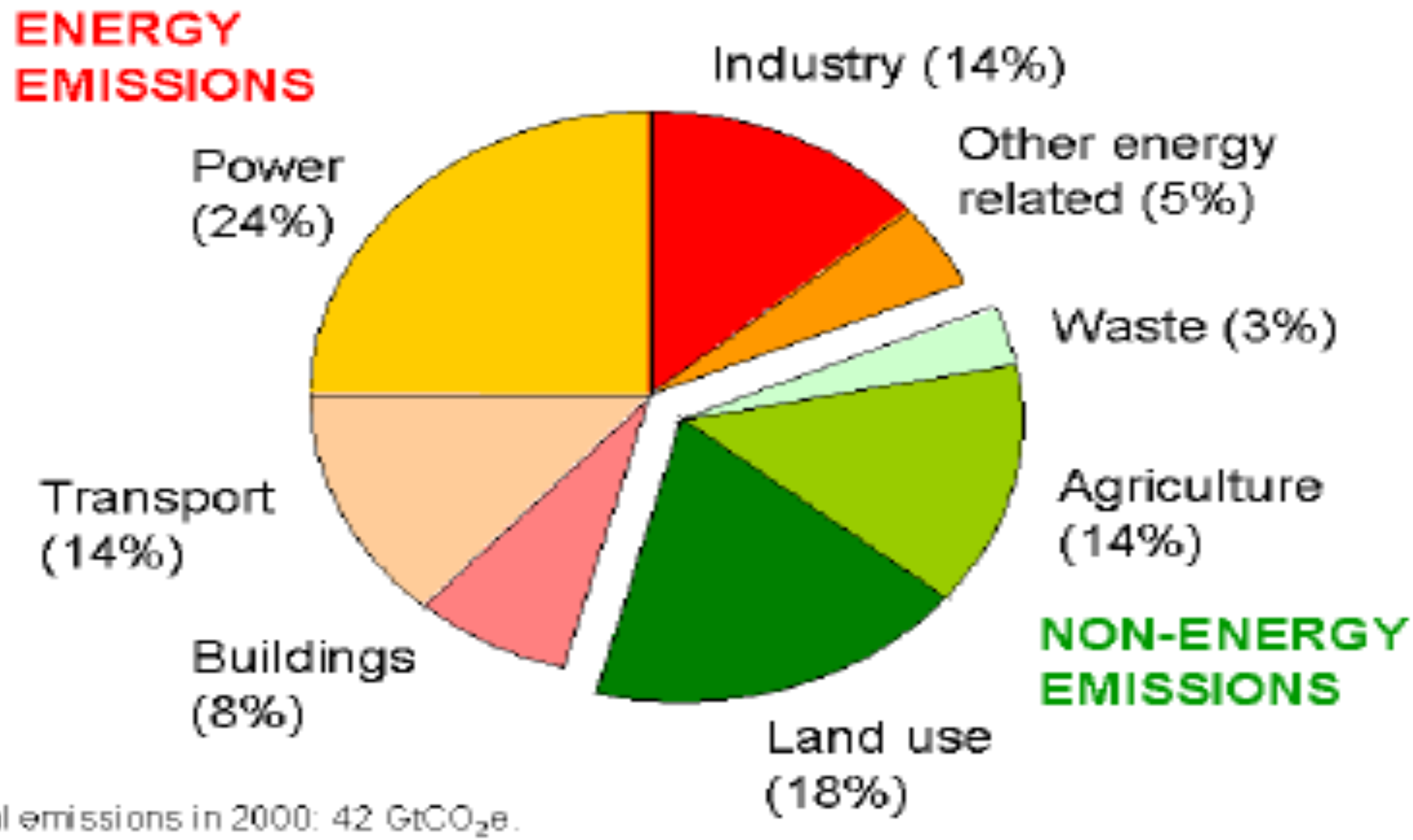
high scenario : best estimate **4.0** °C [2,4 – 6,4 °C]

low scenario : best estimate **1,8** °C [1,1 -2,9 °C]

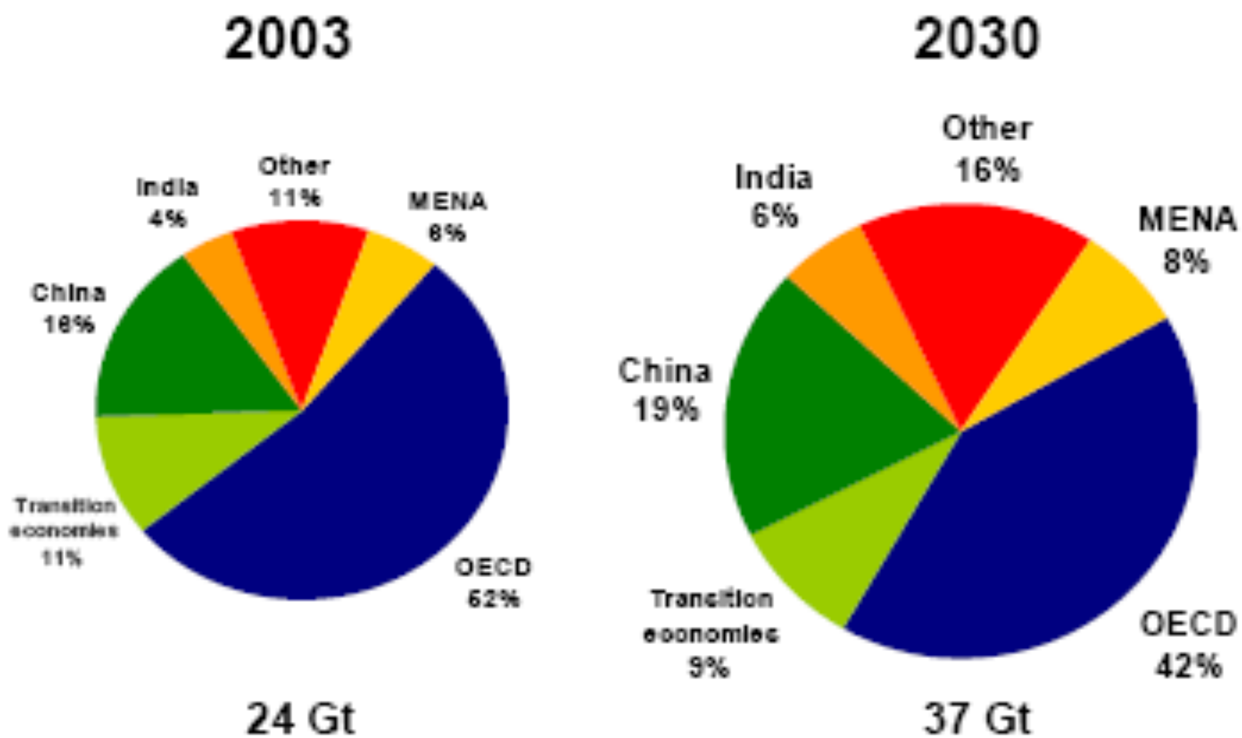
  - Impacts : sea level rise, sea ice decrease, heat waves, heavy precipitations, intensity of tropical cyclones, changes in precipitation

Global Emissions by Sector

Source : Stern report presentation, 2006



IEA scenario Reference scenario energy related CO2 emissions



Global emissions grow by just over 50% between now and 2030, with the bulk of the increase coming from developing countries

- energy system (mainly fossil fuels) is the major contributor
- Industrialised countries are responsible for the main part presently, developing countries in the next decades
- Present situation :
  - Global GHG emissions have increased by 20% (mainly in developing countries) since 1990 (the Kyoto Protocol reference year),
  - with a rise of + 2.9% since 2000 in the countries committed to the Kyoto Protocol,
  - and a general uncontrolled increase in the transport sector (+25% between 1990 and 2004 in the rich countries committed to the Kyoto Protocol).

Country	Number of reactors	Installed capacity (GW)	Gross nuclear electricity generation (TWh)	Share of nuclear power in total generation (%)	Number of nuclear operators
OECD	**351**	**308.4**	**2 333**	**22.4**	**68**
Belgium	7	5.8	48	55.2	1
Canada	18	12.6	92	14.6	4
Czech Republic	6	3.5	25	29.9	1
Finland	4	2.7	23	33.0	2
France	59	63.1	452	78.5	1
Germany	17	20.3	163	26.3	4
Hungary	4	1.8	14	38.7	1
Japan	56	47.8	293	27.7	10
Republic of Korea	20	16.8	147	37.4	1
Mexico	2	1.3	11	4.6	1
Netherlands	1	0.5	4	4.0	1
Slovak Republic	6	2.4	18	57.5	2
Spain	9	7.6	58	19.5	5
Sweden	10	8.9	72	45.4	3
Switzerland	5	3.2	23	39.1	4
United Kingdom	23	11.9	82	20.4	2
United States	104	98.3	809	18.9	26
Transition economies	**54**	**40.5**	**274**	**17.0**	**7**
Armenia	1	0.4	3	42.7	1
Bulgaria	4	2.7	17	39.2	1
Lithuania	1	1.2	10	68.2	1
Romania	1	0.7	5	8.6	1
Russia	31	21.7	149	15.7	1
Slovenia	1	0.7	6	39.6	1
Ukraine	15	13.1	84	45.1	1
Developing countries	**38**	**19.0**	**135**	**2.1**	**11**
Argentina	2	0.9	6	6.3	1
Brazil	2	1.9	10	2.2	1
China	9	6.0	50	2.0	5
India	15	3.0	16	2.2	1
Pakistan	2	0.4	2	2.8	1
South Africa	2	1.8	12	5.0	1
Chinese Taipei	6	4.9	38	16.9	1
World	**443**	**367.8**	**2 742**	**14.9**	**86**

Sources: IAEA PRIS and IEA databases.

Nuclear Renaissance and Managing Civilian Nuclear Fuel Cycle: Need for New Approaches

October 23, Bari, Italy 2007

The 57th Pugwash Conference on Science and World Affairs

Tatsujiro Suzuki

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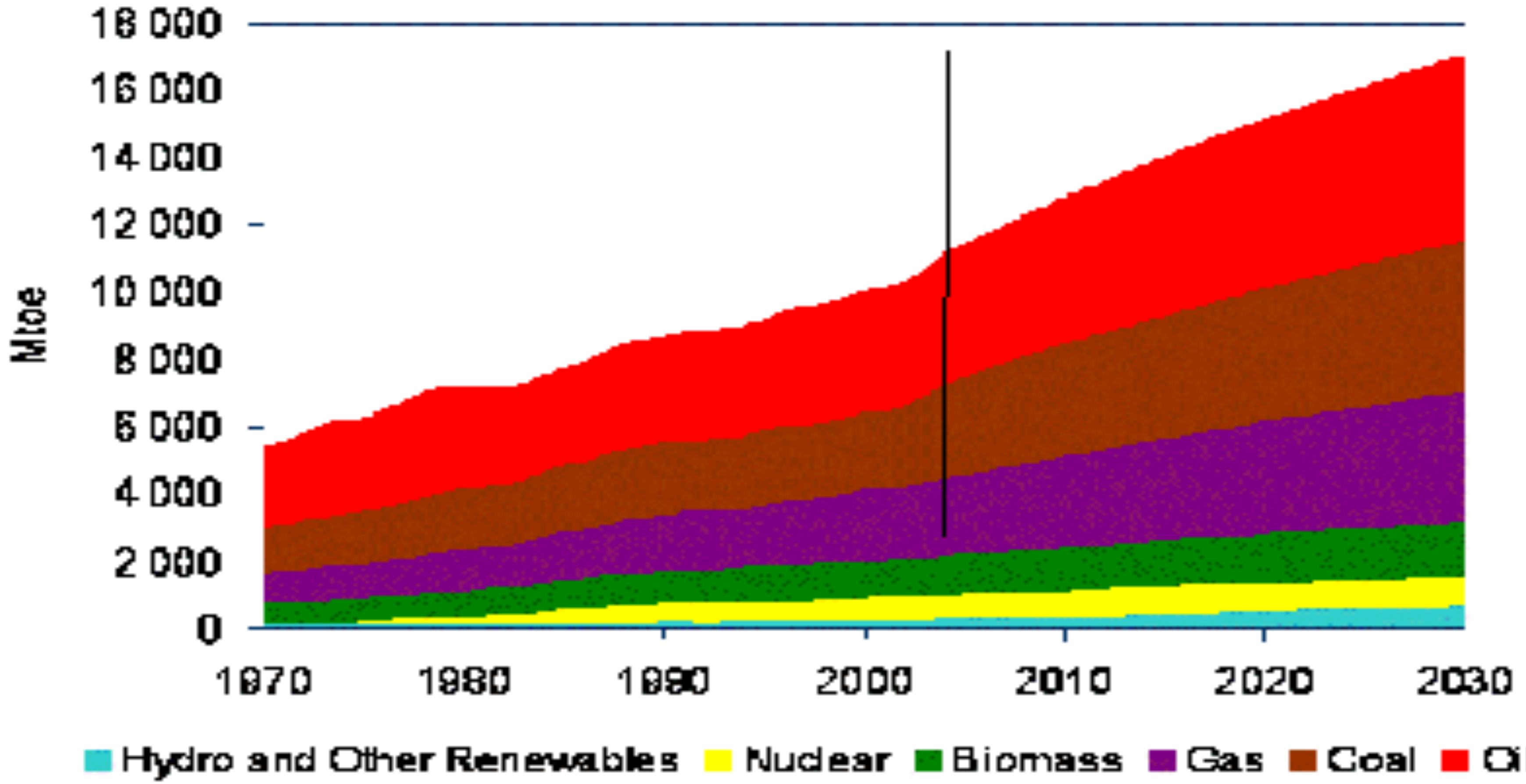
Renewable energies as a sustainable component of the solution to climate change

- X Conferenza Internazionale USPID (Unione Scienziati Per Il Disarmo) Castiglionecello ,
- Livorno Settembre 2007
- Venance Journeé
- CNRS

World Primary Energy Demand by Fuel in the Reference Scenario

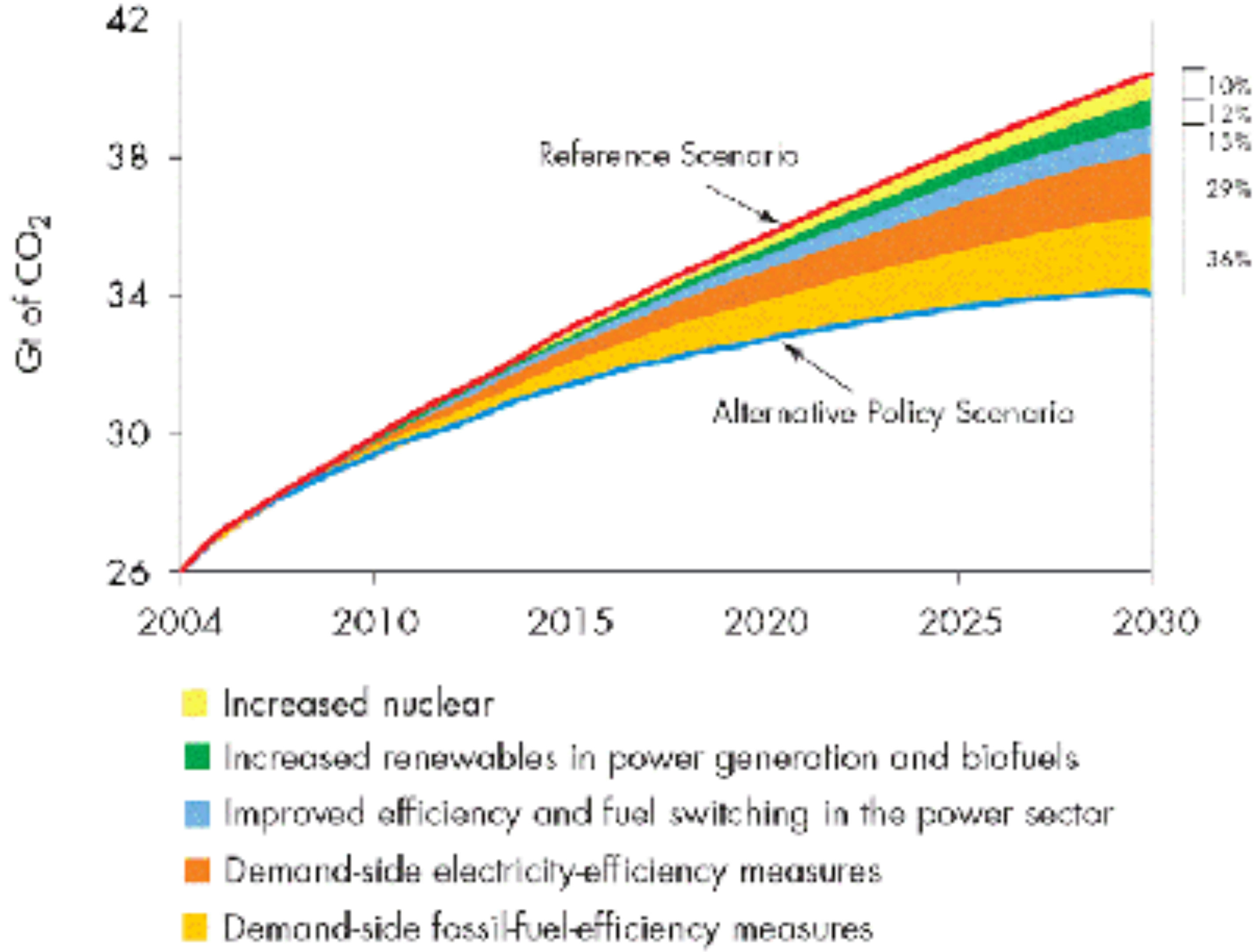


E / cap = 1.47 – 1.75 toe (1970-2004)

IEA World alternative policy scenario

- Analyses impacts of new environment and energey-security policies worldwide
  - OECD policies currently under consideration
    - Example of EU policies :
      - Power generation : RNE directive met and extension to 2020, combined heat and power directive
      - Transport sector : tightening of coluntary agreements with car manufacturers, biofuels targets met
      - Emission trading scheme for power generation and industry
  - Non Oecd : same and includes more rapid decline in energy intensity

Global Savings in CO_2 Emissions in the Alternative Scenario Compared to the Reference Scenario



- According to IEA World energy outlook (2005), present policies will lead to an increase of 52 % of global energy related CO_2 emissions between 2003 and 2030.
- Which represent 13 $GtCO_2$ over the 2003 level at a growth rate of 1,6 % per annum.
- Alternative Policy Scenario : energy demand is 10 % lower in 2030 compared to 2004. CO_2 emissions could be reduced by 16 % in 2030 (emission growth could be reduced by 2) : Share of renewable in the primary energy mix would then rise to 16 % compared to the 14 % in the reference scenario.

- Energy efficiency :most important potential for emission reductions

- Energy efficiency – savings is critical
- Limit 2°C can be reached with strong and combined policies :
  - **energy efficiency improvement**
  - **non CO_2 emitting energies : renewable energies or nuclear**
  - **and cleaner fossil fuels (??)**

What are RNEs ?

- Photonic energy : from the Sun
- Mechanical energies :
  * wind energy
  * hydraulic energy
  * tide energy
  * ocean energy
- Thermal energy :
  * geothermal
- Combustion energy :
  * biomass (from photosynthesis)

The issue of RNEs is complex :

- many different technologies, each technology is unique
- different sources (wind, sun, hydro, biomass)
- at different stages of development
- different locations
- different needs (heat, fuels, electricity) which may need a specific energy source
- data problems.

Comparison of RNEs with conventional energies (1)

- RNEs are energy fluxes : not constant over time (sun, wind), needs storage
- RNEs cannot be transported in their original form (most of them, apart from biomass, have to be used where they are produced)
- RNEs belong to everybody
- no risk of RNEs resource depletion, but competing access to resource : ex alimentation/energy, irrigation/electricity, etc

Comparison of RNEs with conventional energies (2)

- RNEs regional distributions are not concentrated, every region in the world can have access to some RNEs to meet part of its energy needs.
- smaller production units : this is often considered a disadvantage, but this can be compensated by the possibility of cogeneration (CHP).
- RNEs are also well suited for small off-grid applications, good for remote areas.
- decentralised : distributed energy systems, address the need for energy security, economic prosperity (particularly in poor regions), and environmental protection

3 types of technologies (1)

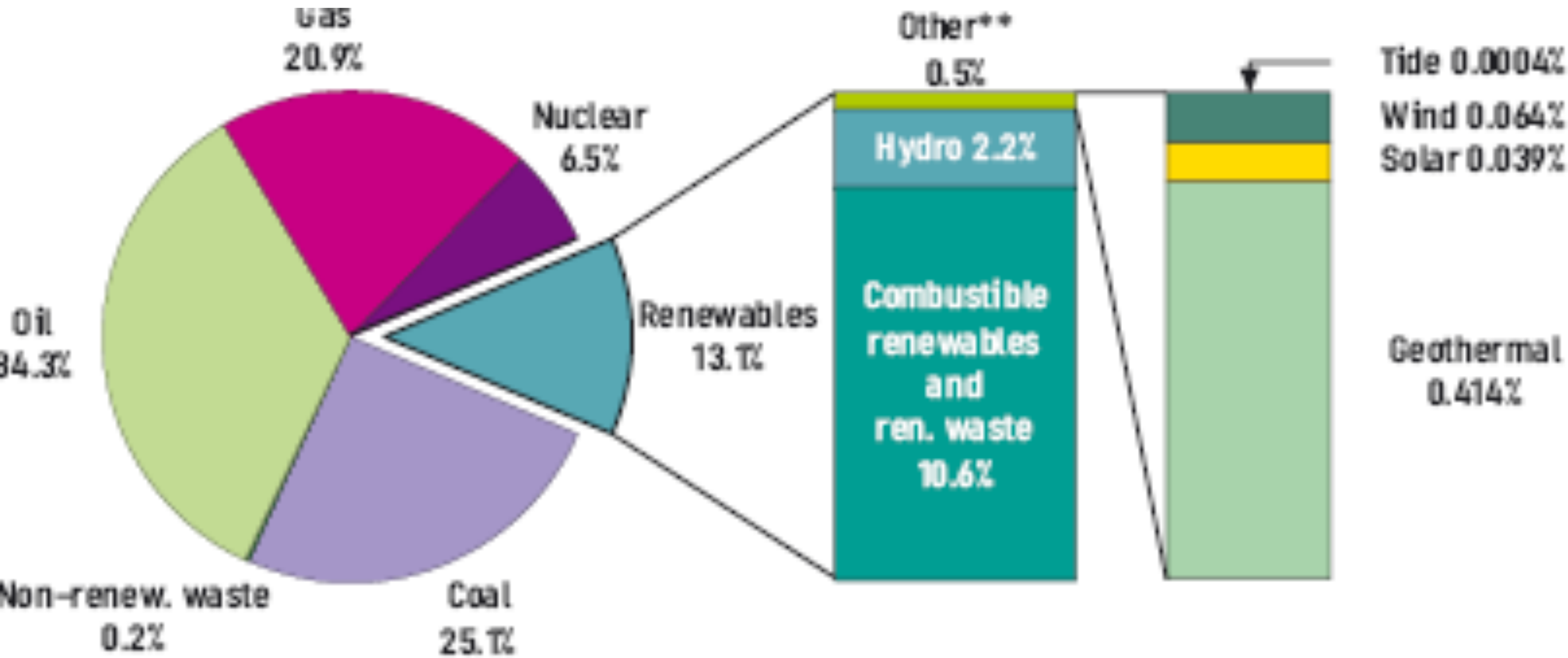
- 1) **Well established technologies** (hydropower, biomass and geothermal)
  - Proportion in world energy production is stable, or declining (biomass in DCs), are used for base load power, permanent
  - Geothermal : power generation, space heating or cooling
  - large hydro : 16 % of world electricity, scope for expansion is limited in ICs, in DCs considerable potential exists, but limited by social, financial and environmental constraints.

3 types of technologies (2)

- 2) **Second generation** RNEs : (wind, solar hot water, solar photovoltaics and advanced bioenergy) are starting from a much lower base, but are increasing rapidly. Result of RD programs which started in the 70s.
- 3) **Third generation** : concentrated solar power, ocean energy, advanced geothermal, advanced biomass and biorefinery technologies : still under development, great potentialities.

2004 Fuel shares of world total primary energy supply (IEA, 2007)

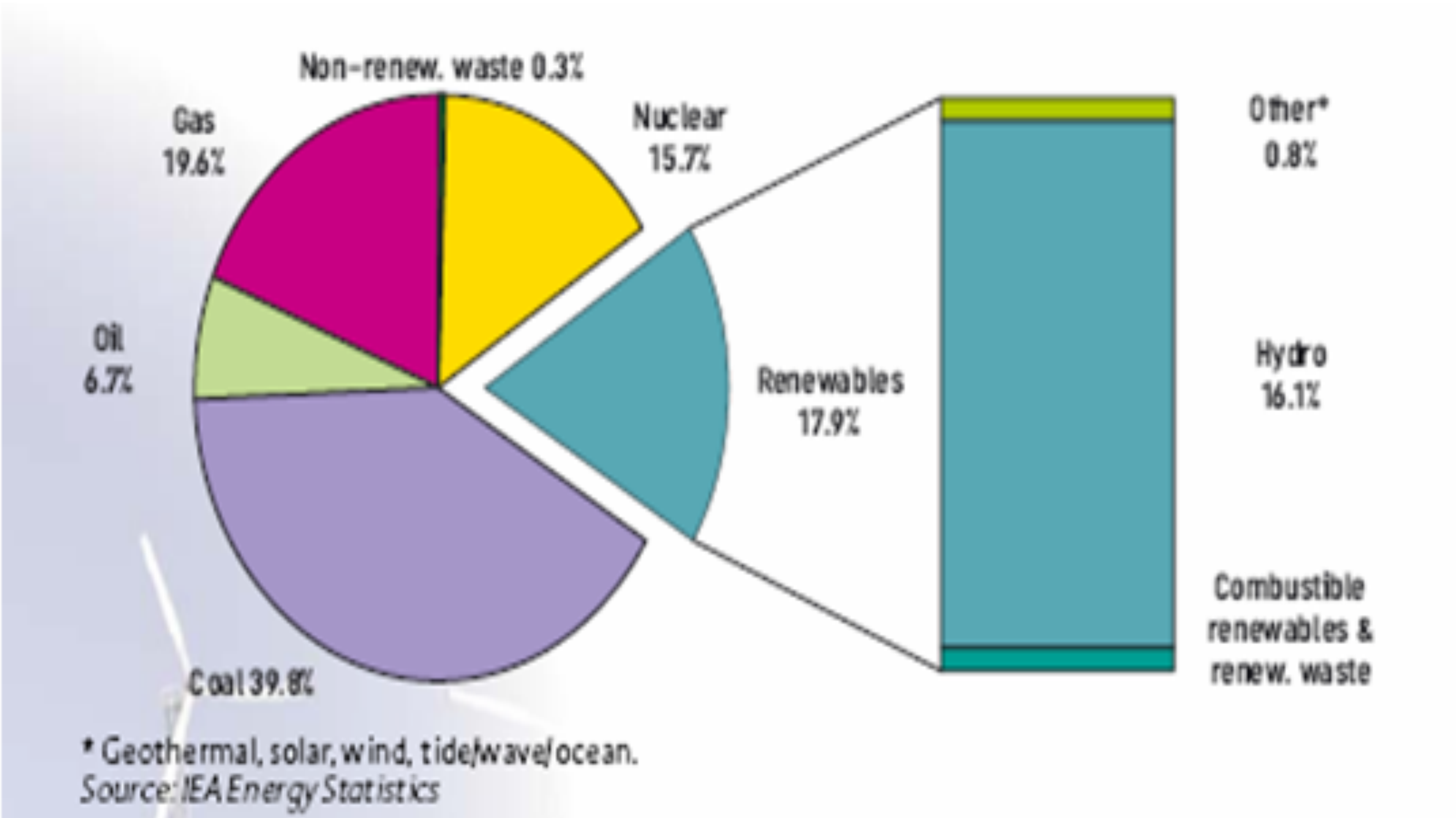
Due to high share of biomass in total RNEs, Asia, Africa and Asia are main RNEs users (residential sector, cooking and heating). For hydro or new RNEs, ICs are main users.



Current status of RNEs

- 13,1 % of 11 059 Mtoe world total primary energy supply (2004)
- More mature technologies : hydropower, geothermal, and bio-resources have mainly contributed up to now
- New resources (wind) are becoming competitive

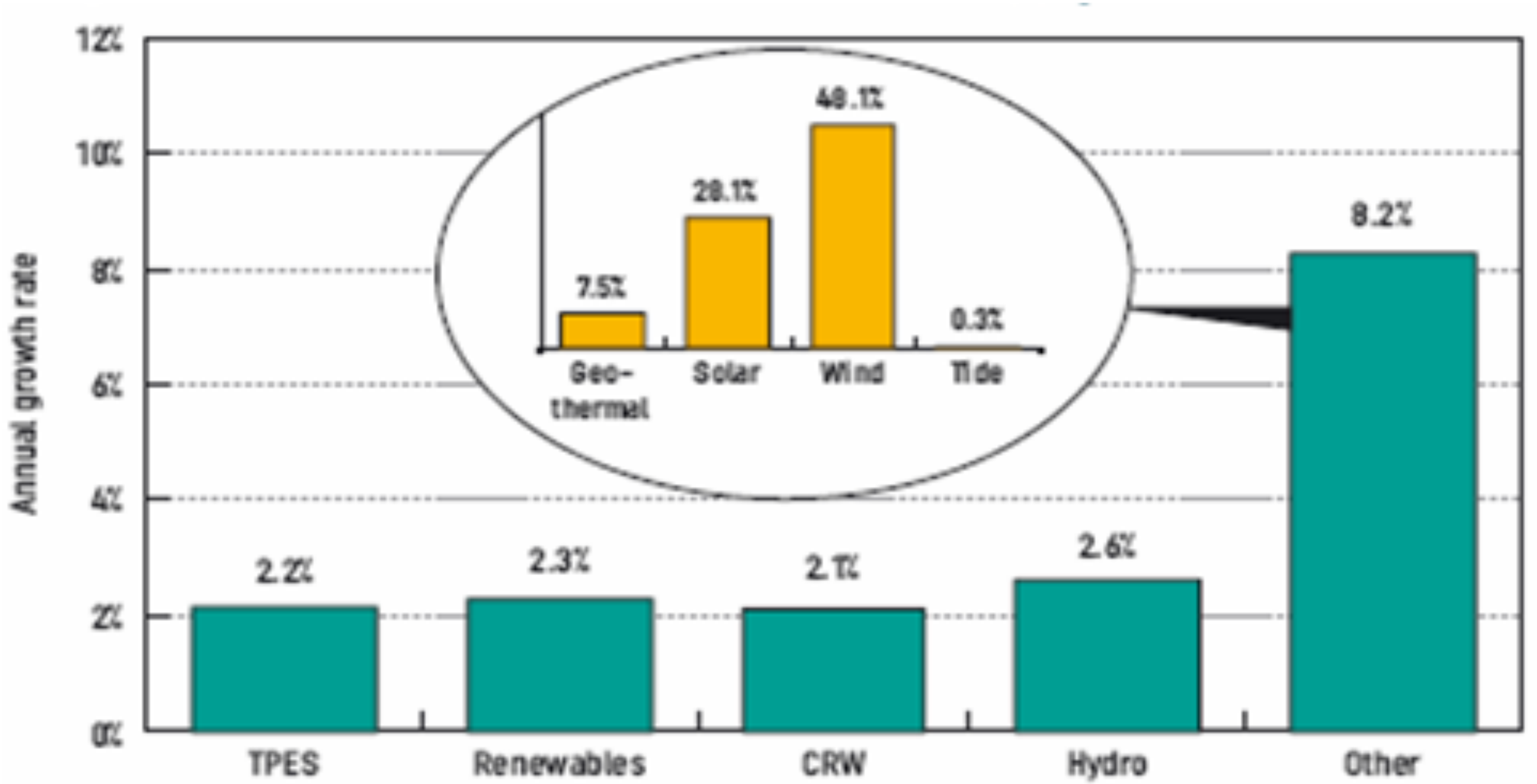
2004 energy shares in electricity production (IEA, 2007)



RNEs in electricity production

- World electricity is mainly produced by coal (oil is low)
- RNEs contribute to electricity production more than nuclear
  - 90 % of electricity generated from RNEs comes from hydro
  - 6 % comes from combustible renewable and wastes
  - Only 4,5 % comes from geothermal, solar and wind.

Annual growth rates of RNEs supply – (1) (1971-2004) (IEA – 2007)



Source: IEA Energy Statistics

Annual growth rates of RNEs supply (2)

- Growth rate of RNEs has not exceeded the growth rate of energy demand
- Still small fraction of total energy use
- Growth of wind and solar is concentrated in very few countries
  - wind : Denmark, Germany, Spain, US
  - solar photovoltaic: Japan, Germany, US
- Electricity production from solar photovoltaic systems as well as grid connected wind turbines : + about 30 % /y
- A few countries have adopted ambitious targets.

Drivers of RNEs increase :

- Resource availability : Space (biomass) and duration (wind)
- Status of conversion technologies
- Costs

Summary of global fossil and fissile resources (thousand of exajoules)

(Source : World energy assessment 2000, UNEP)

	Up to 98	In 98	reserves	ressrc	Res. base	Addl occurences
Oil	**5,14**	**0,14**	**11,11**	**21**	**32**	**45**
Gaz	**2,38**	**0,08**	**14,88**	**35**	**50**	**900**
coal	**5,99**	**0,09**	**20,67**	**180**	**200**	
nuclear		**0,04**	**113**	**214**	**330**	**430**
total	**13,51**	**0,36**	**160**	**446**	**575**	**1400**

Summary of renewable resource base (exajoules / year)

(Source : World energy assessment 2000, UNEP)

	Current use	Technical potential	Theoretical potential
Hydro	9	50	147
Biomass	50	> 276	2900
Solar	0,1	> 1575	3 900 000
Wind	0,12	640	9 000
Geothermal	0,6	5000	140 000 000
Ocean			7400
Total	56	> 7600	**> 144 000 000**

- **RNEs : resources are 3 orders of magnitude larger than current global energy use, although these potentials do not take into account all limitations, for ex. the adequacy of presence of resource and need)**
- **RNEs use will depend upon conversion technologies and market**

Wind

- Power : up to 5 MW
- World capacity (2004) : 74 GW
- Increase 20 % / year (2000- 2006)
- 2006 : 150 000 jobs, 18 billion euros
- World wind electricity prod. : 150 TWh (1%)
- 20 % electricity production in Denmark
- World wind capacity (WGBU) : 39 000 TWh
- Cost (2020) : 3-6 euros cts/kWh
- Industry scenarios : 2050 : 1500-7900 TWh

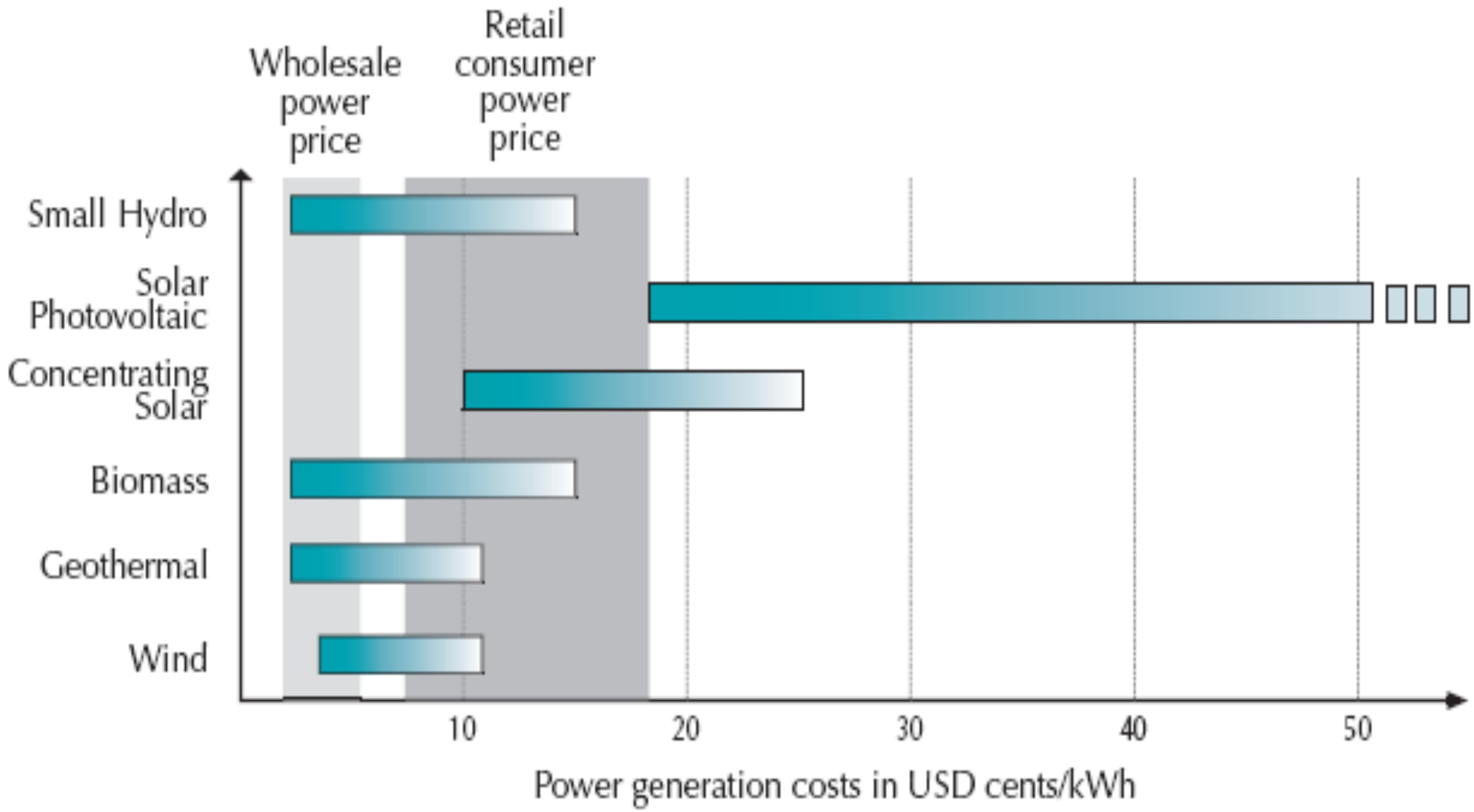
Biofuels

- Ethanol – Biodesel
- Feedstocks : grain, vegetable crops – converted into liquid fuels
- Strong government policies and rising price of oil
- Can use the existing distribution network
- RD priority : more efficient conversion technologies
- Could replace significant share of oil : 37 % of US oil in 25 years, 75 % if fuel efficiency was increased.
- EU : 20-25 % (sustainability)
- Sugar cane alone could replace 10 % of gasoline world wide
- Big potential for production in tropical countries.

Biofuels – second generation

- Feedstoks : cellulose rich organic materials : wood, tall grasses, crop residues,
- much more abundant, less interference with food economy, less strain on land and water resources
- Need advanced conversion processes
- Could reach 1000 EJ in 2050

Costs (1)
(Source : Renewable energies, RD priorities Insights from IEA Technology Programmes, IEA, 2006)



Costs (2)

- Main problem to advancing RNEs is said to be cost
- Except for large hydropower and combustible renewable and waste plants, the average costs of renewable electricity are not competitive with wholesale electricity prices
- However, depending on the technology, application and sites, costs are competitive with grid electricity or commercial heat production.
- Under best conditions, optimised system design, location and resource availability, electricity from biomass, small hydro, wind and geothermal can produce electricity at costs 0,002 - 0,05 US$/kWh

Costs (3)

Energy market distorsions impede the development of RNEs

- Price structure does not reflect the full cost of producing energy to society : external costs are not taken into account (impact on health, local and global environmental damage)
- The competitive position of RNEs would improve substantially if a market price were attached to CO2 and other gas emissions.
- The added values of RNEs for diversification, reduced portfolio risks, job creation, industrial competitiveness not accounted for

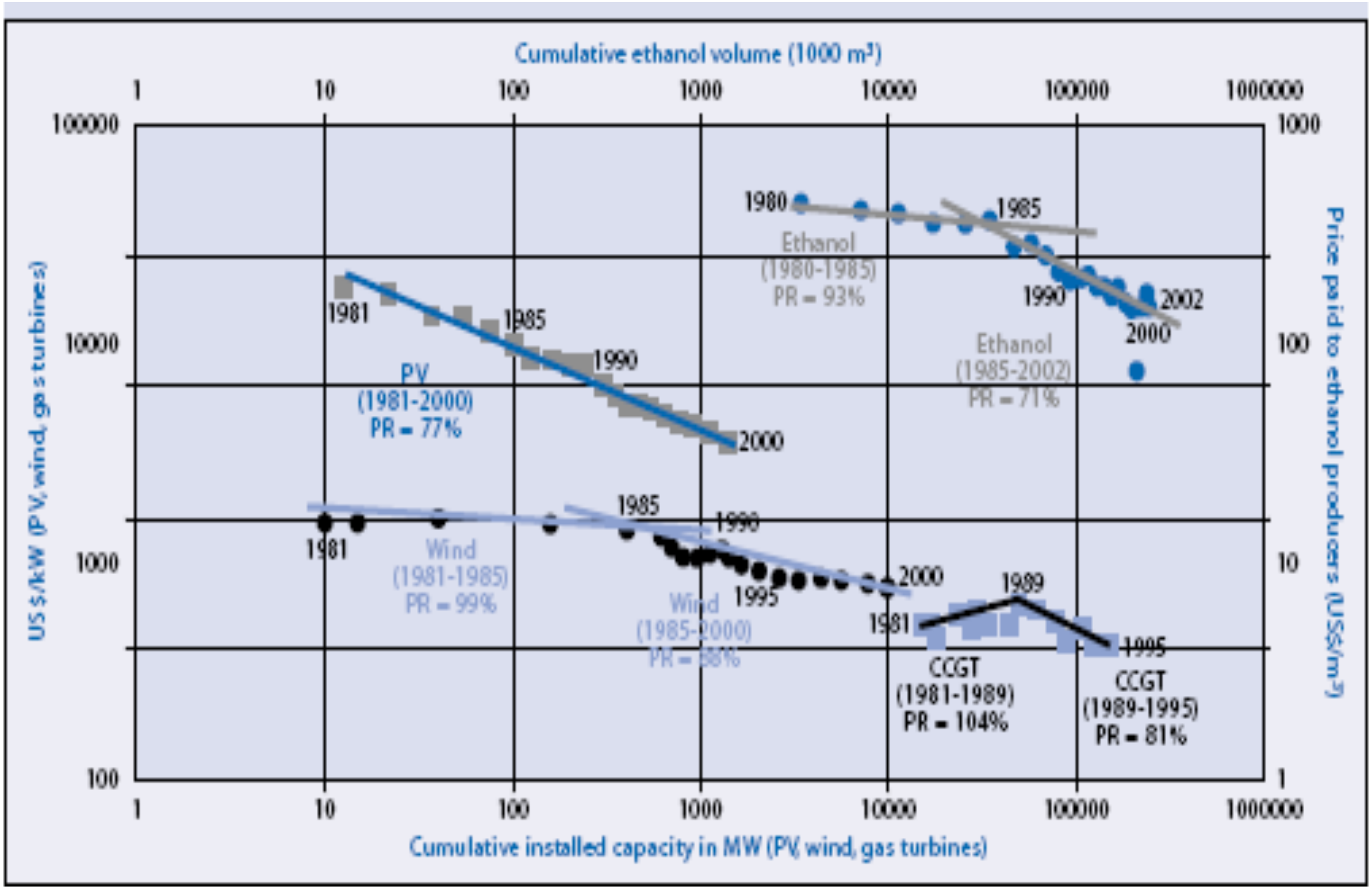
Costs (4)

- Conventional energies are heavily subsidised in many countries.
- World Bank has estimated that annual fossil subsidies in the OECD and 20 largest countries outside the OECD amount to US$ 58 billion
- The UNDP 2000 WEA estimates that global subsidies to fossil fuels and nuclear energy in mid 1990s reached around US$ 250-300 billion annually
- Difficulty of getting the numbers
- Many indirect or cross sectors subsidies.

Learning curves (1)

- Provide means for assessing potential future cost reductions
- Defines the unit cost of a given technology as a function of the total installed capacity : cost of electricity generated through RNEs sources are a function of the cumulative installed capacity
- Progress ratio X : the price is reduced to x % of the previous price after a doubling of its cumulative sales.
- Industry costs declines 10-20 % for each cumulative doubling of solar photovoltaic, wind generators, …

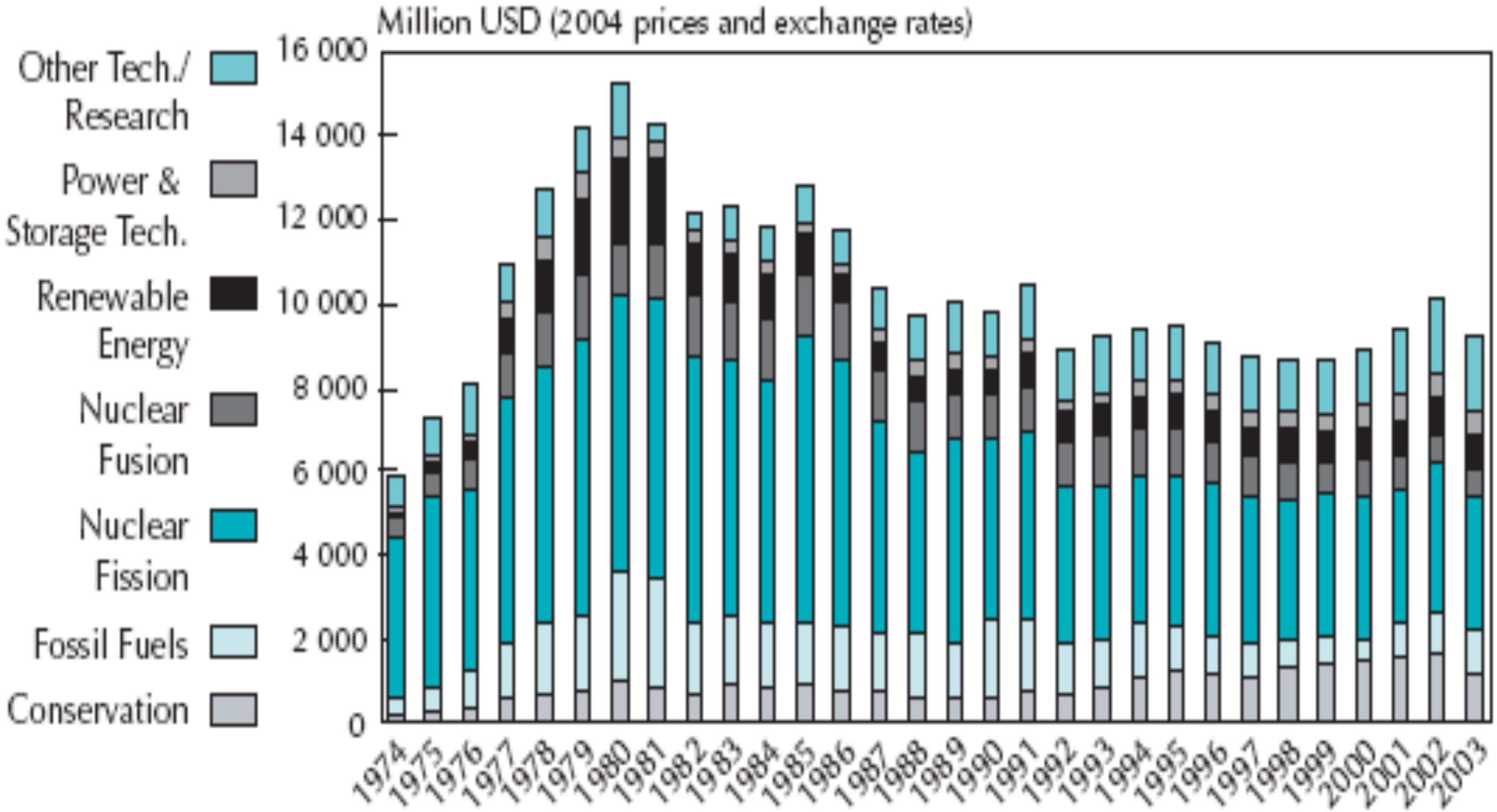
Learning curves for photovoltaics, windmills, gas turbines and ethanol production (**source : WEA 2004**)



Learning curves (2)

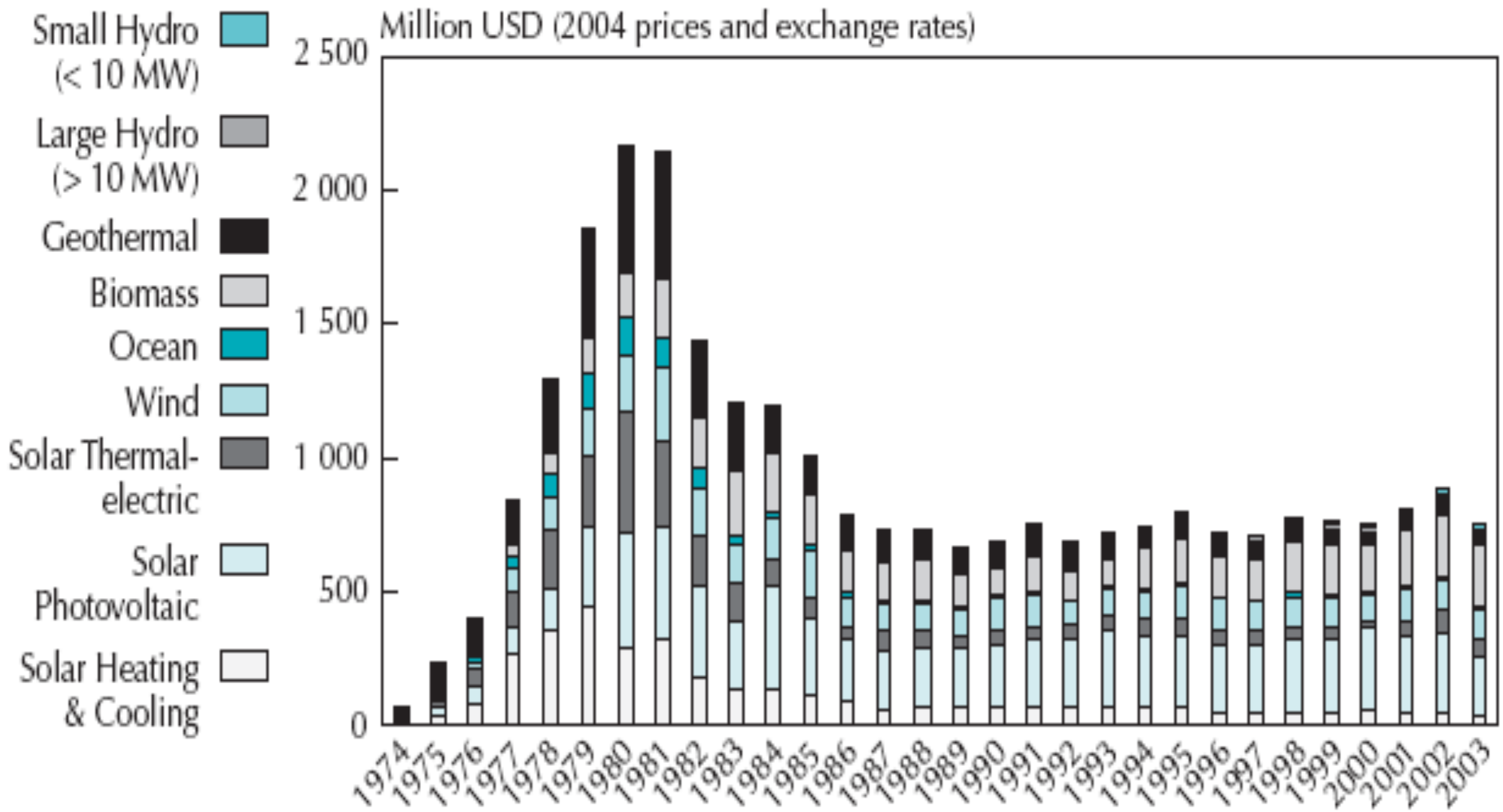
- Many RNEs technologies have matured during the last decades, and achieved major costs reductions, attracting large industrial companies and financial institutions.
- Geothermal heat and electricity production, small hydropower, low temperature solar heat production, biomass, and solar electricity in remote areas.
- Biomass can be economically produced with minimal or even positive environmental impact through perennial crops.
- Solar thermal heat and hot water are competitive in some countries.
- Wind power in coastal and other windy regions in the short term (Denmark)

Gvt RD energy budget in IEA countries
(Source : Renewable energies, RD priorities Insights from IEA Technology Programmes, IEA, 2006)



Gvt RD RNEs budget in IEA countries

(US military RD budget : 38 Billion 2001 US$)
World military spending has increased of 37% in the last 10 years, reaching 1204 billion US dollars in 2006 – Sipri)



RD budgets (in IEA countries) (1)

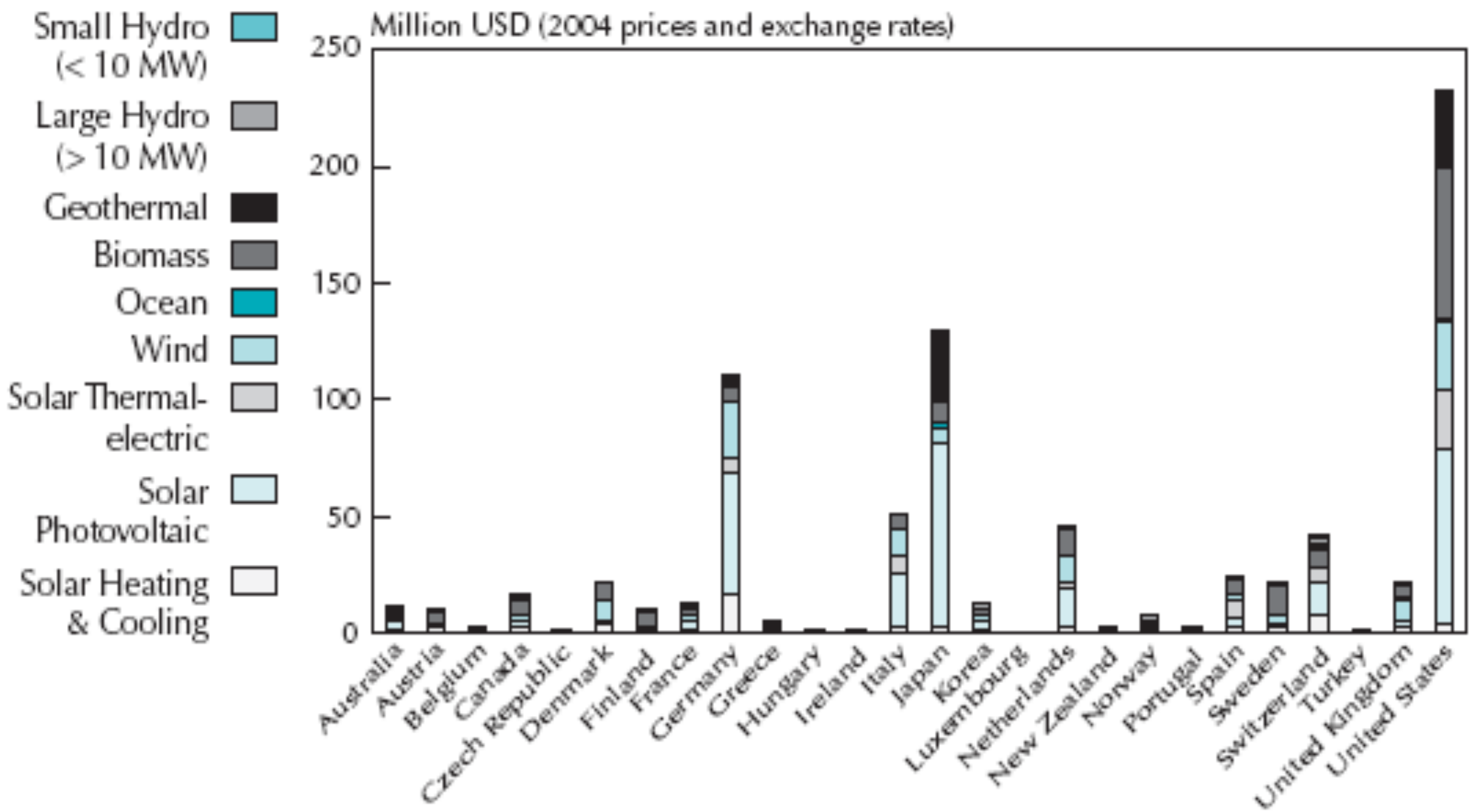
- RNEs RD budget increased sharply after the oil shocks and decreased substantially after the counter oil shock
- RNEs technologies are 7,7% of total government energy RD funding from 1987 to 2002.
- “The sharp decrease of public funding for RNEs RD funding is inconsistent with presumed political intentions in many IEA countries to increase the share of RNEs in TPES” (IEA, 2004)
- RNEs RD spending in the private sector is not public domain, then difficult to assess the impact of private spending on RNEs markets (private sector invests mainly in large hydro)

RD budgets (in IEA countries) (2)

- Limited resources are allocated to address the problem of reliability.
- Only a handfull of countries have invested in RNEs and have achieved substantial cost reductions as a result of their market experience, indicating the success of government intervention
- Germany, Japan and US account for 70 % of RD budget in IEA countries

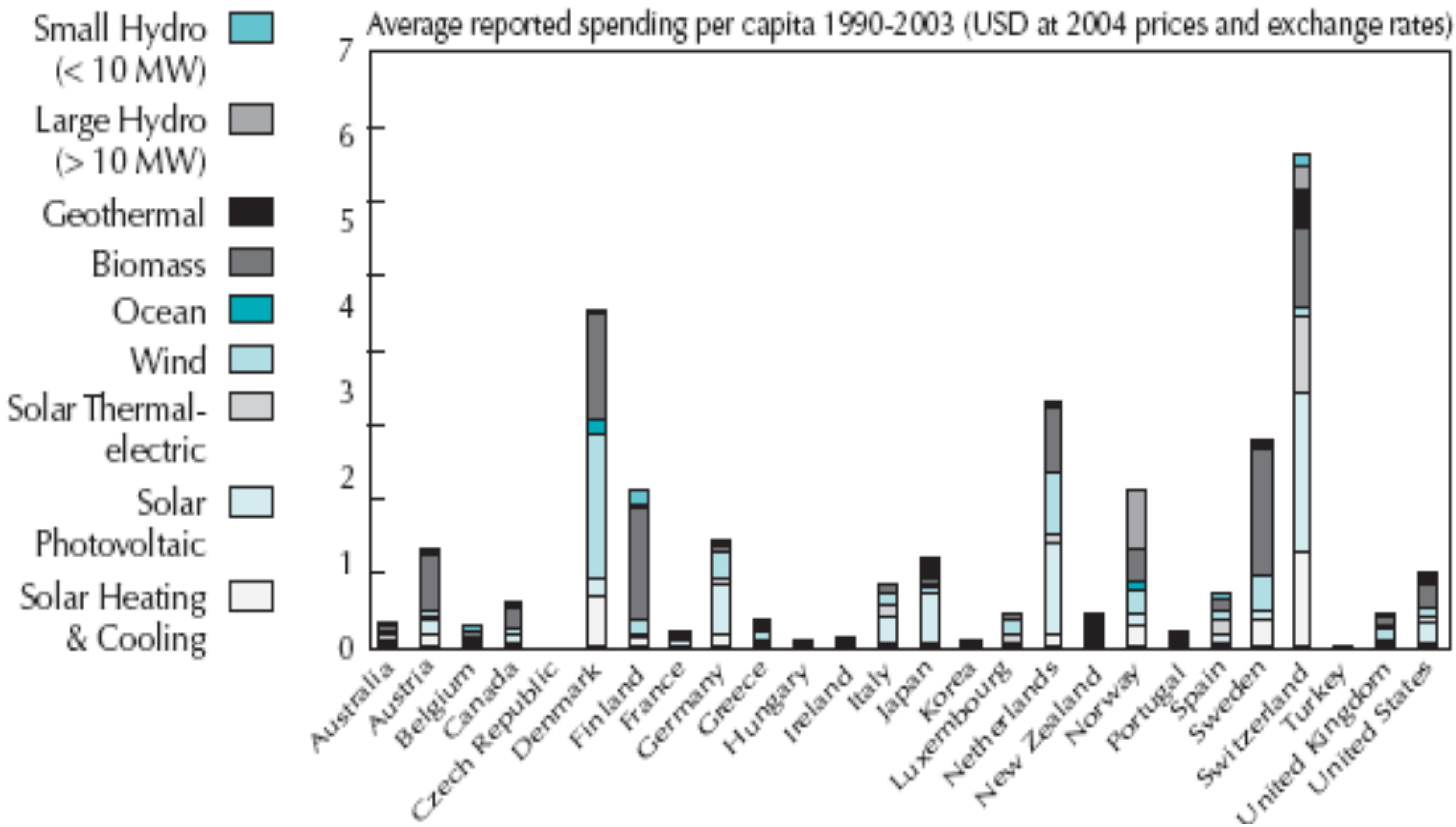
Average RNEs RD annual spending (1970-2003)

(Source : Renewable energies, RD priorities Insights from IEA Technology Programmes, IEA, 2006)



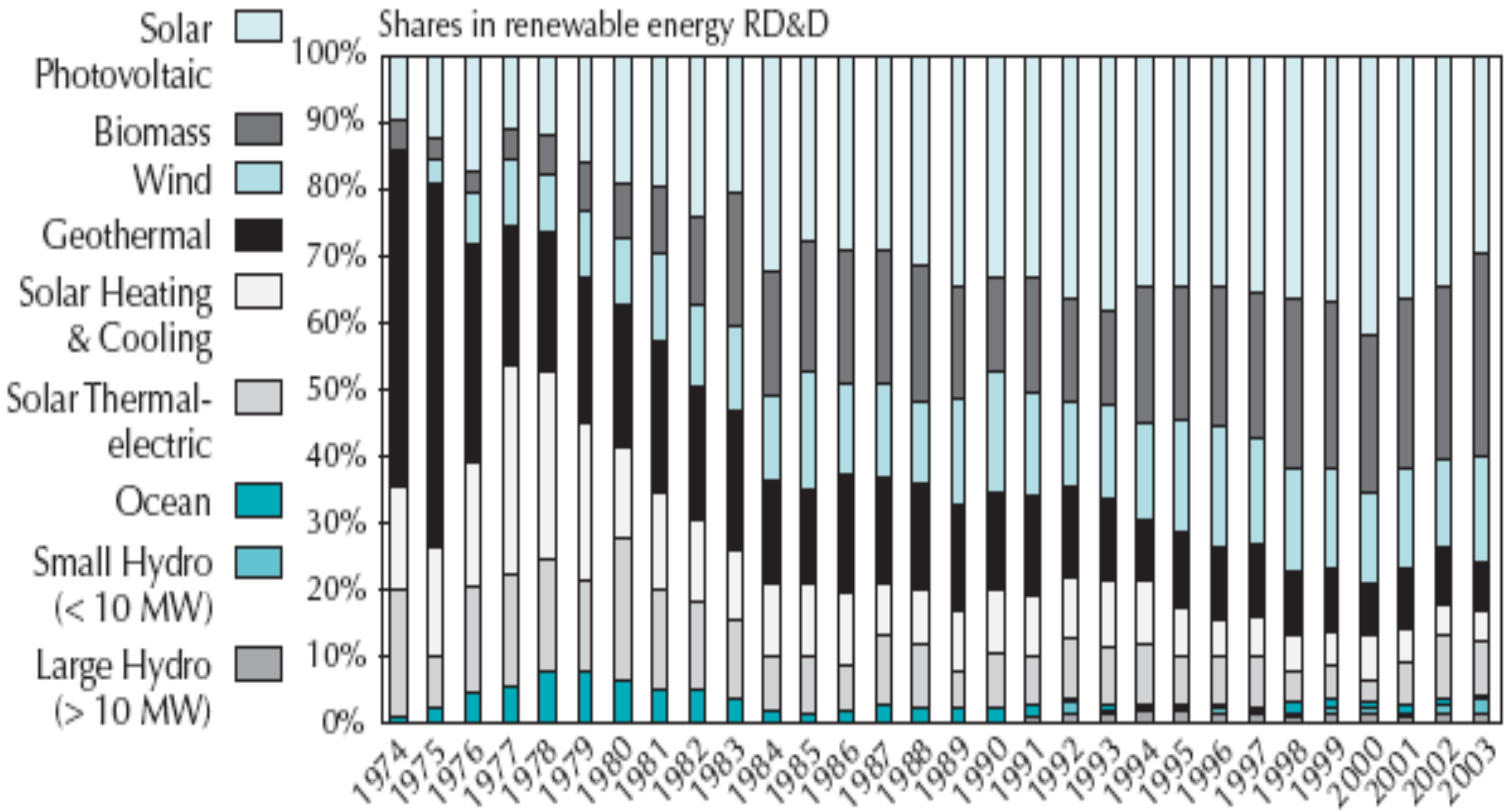
Average RNEs RD annual spending (1970-2003) (per capita)

(Source : Renewable energies, RD priorities Insights from IEA Technology Programmes, IEA, 2006)



Shares of technologies in public spending

(Source : Renewable energies, RD priorities Insights from IEA Technology Programmes, IEA, 2006)



- 86 % of installed wind capacity in only 4 IEA countries
- 84 % of installed capacity of Photovoltaic in only 3 countries
- All are leaders in RD&D spending

RNEs have a great potential for

- 1) improved energy security : abundant supplies, diverse and indigenous, no resource exhaustion constraints
- 2) greatly reduced GHG emissions when used in place of fossil fuels.
- 3) diversity of energy supply : improved options to meet specific needs
- 4) address problems of economic development, use in rural areas, employment opportunities, in industrialised as well as in developing countries.
- 5) address problems of local environmental pollution

Rapid expansion of RNEs will require

- Greatly enhanced RD budgets
- Decrease of the relative costs of RNEs in their early stages of development and commercialisation.

- Actions to stimulate the markets
- Tax credits, and "green incentives"
- Take into account full costs of conventional energies

- Realistic but ambitious targets