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The role of nuclear energy in green growth and sustainable energy strategies

Ferenc L. Toth
IAEA, Vienna
Austria

Strada Costiera, 11 - 34151 - Trieste - Italy • Tel. +39 0402240111 • Fax. +39 040224163 • sci_info@ictp.it • www.ictp.it
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The role of nuclear energy in green growth and sustainable energy strategies

Ferenc L. Toth

Planning & Economic Studies Section (PESS)

Department of Nuclear Energy

IAEA-ICTP Workshop on

"Sustainable Energy Development: Pathways and Strategies after Rio+20"

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Overview

1. Green energy to fuel green growth

2. NE is GE: Economic criteria

3. NE is GE: Resource efficiency criteria

4. NE is GE: Environmental criteria

5. Main messages

1. Green energy to fuel green growth

Green economy (UNEP):

- results improved human well-being and social equity
- reduces environmental risks and ecological scarcities

Developing country fears: Green Economy

- too costly; holds back growth, destroys jobs

→ unaffordable

Green growth ('GGG') >>> green economy:

growth not contributing to:

- CC
- environmental degradation
- unsustainable use of natural resources

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1. Green energy to fuel green growth

Indicator groups and topics for monitoring GG (**UNEP**):

Green transformation of key sectors and the economy:

> shares of investments in renewables,

> shares of output and emplmt in sustainable sectors

> growth of envir. friendly goods, services, jobs

Decoupling and efficiency: resource use, envir impacts:

> energy, water, material use, waste generation, GHG intensity = per unit of GDP

Aggregate indicators of progress and well-being:

adjusted net savings, indices of well-being and poverty reduction, Genuine Progress indicator

1. Green energy to fuel green growth

Green energy: follows from Item 2 of UNEP's list:

> efficient use of NRs, prevent environmtl degradation

OECD - green energy: efficiency, renewables, CCS, *nuclear*, new transport technologies

Clear but: confusing diversity of definitions and criteria:

Non-traditional and:

alternative ≈ clean ≈ renewable: alternative to fossil

Green: less polluting, environmentally benign ≈ clean

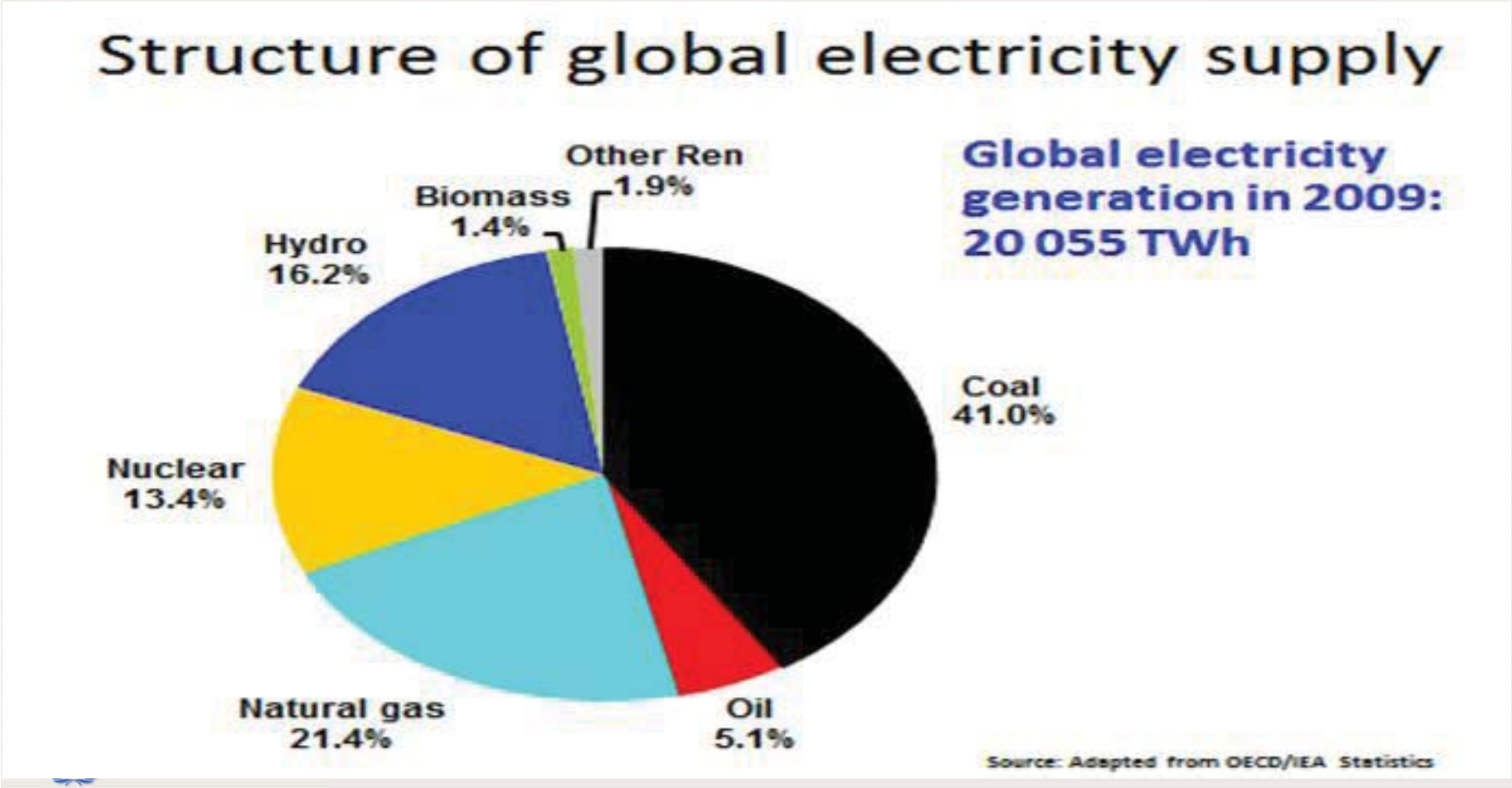
Large lit survey - Typical criteria for green energy

1. Green energy to fuel green growth

Criteria	Green Energy
High security of energy supply	●
Long term cost reduction	☺
Low air pollution	●
Low GHG emissions	●
Low generating costs	☺
Low energy waste	●
Low noise/ visual pollution	●
Minimum land required / least land-use intensive	☺
Minimum depletion risk	●
No direct threat to biodiversity & human security	●
No reliance on fossil fuels	●
Reduced material intensity	●

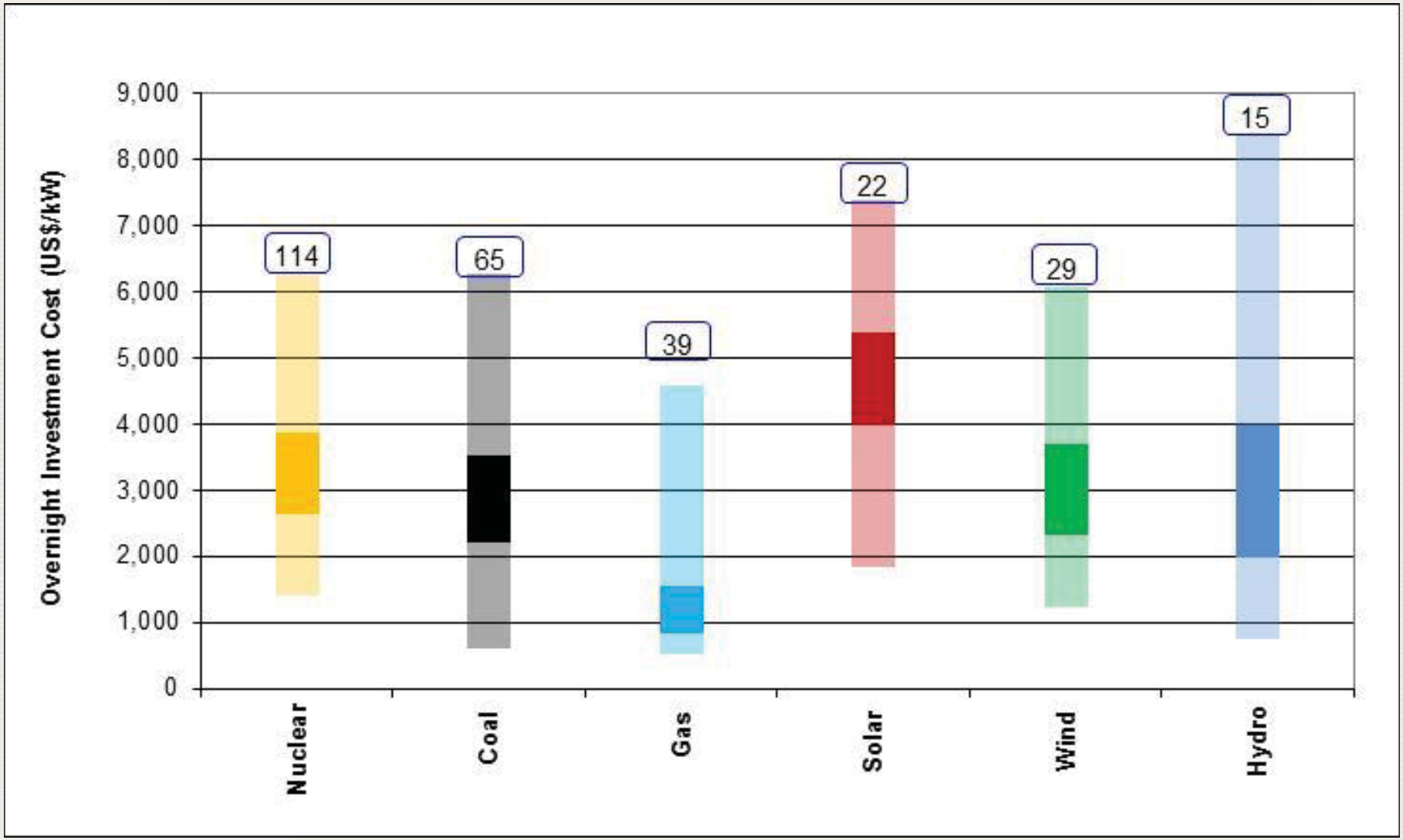
2. NE is GE: Economic criteria

Where we are: >2/3 from fossil



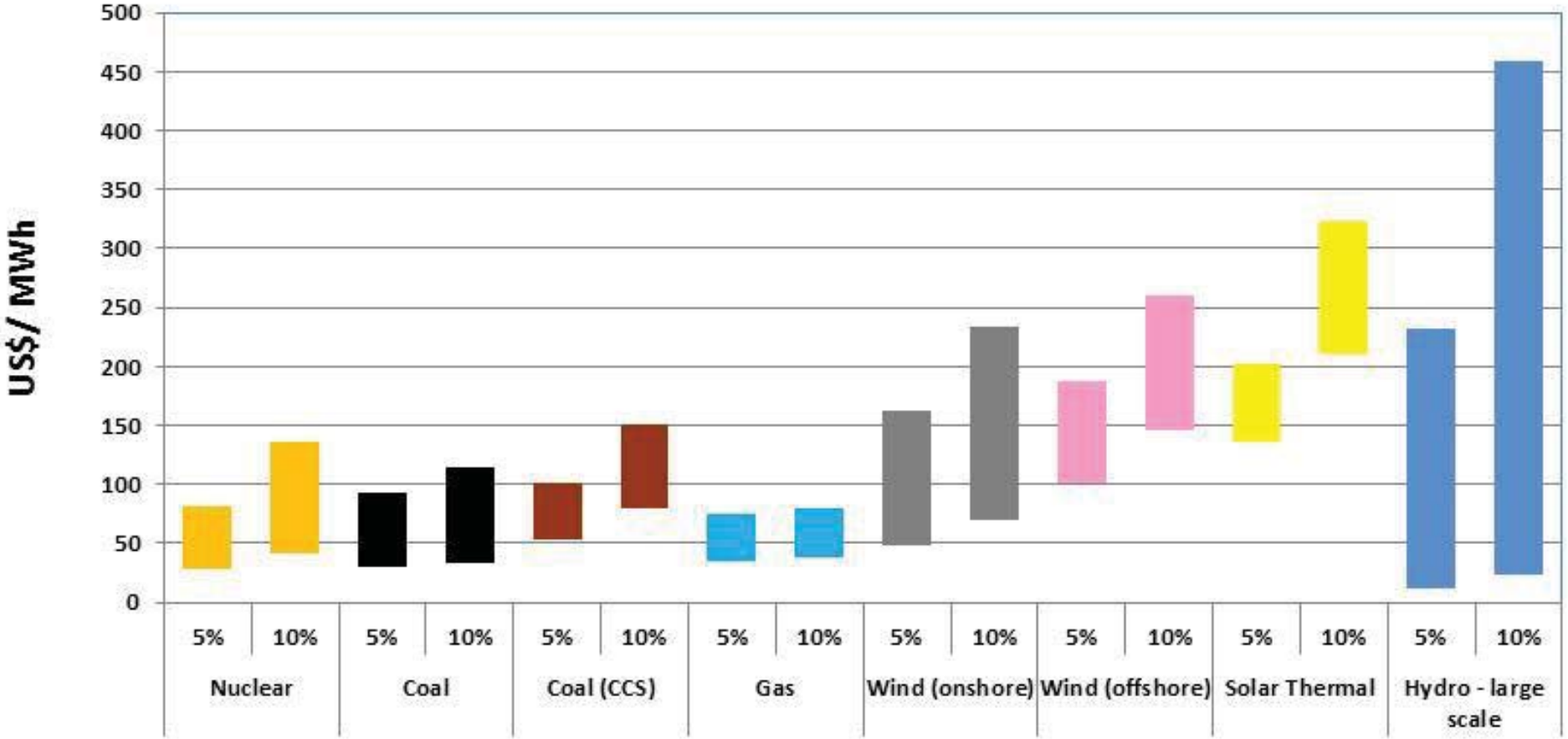
2. NE is GE: Economic criteria

ON investment costs power generation technologies:



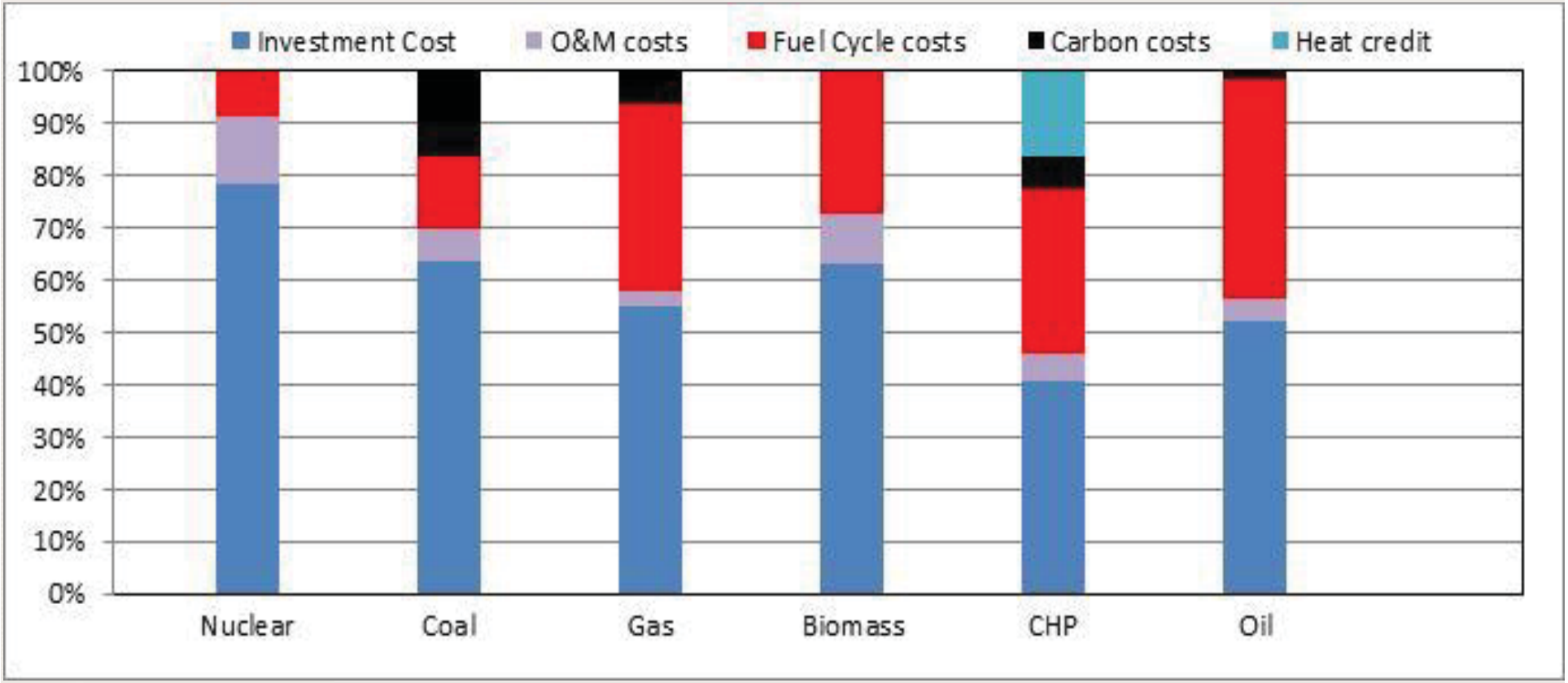
2. NE is GE: Economic criteria

Competitive - What matters: Levelized costs of electricity no carbon price (IEA/NEA 2011)



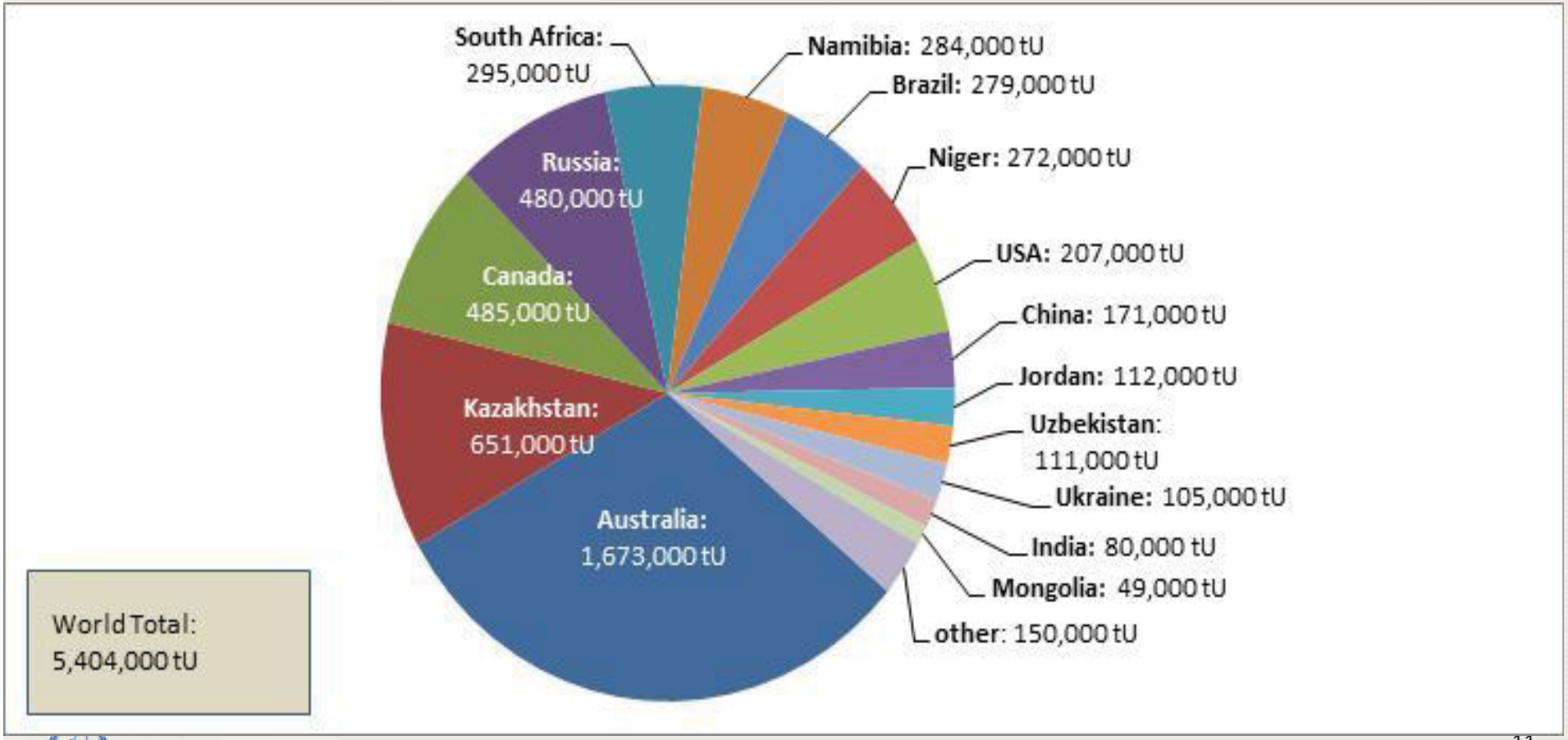
2. NE is GE: Economic criteria

Efficiency: Ratios of cost components: 2009 prices assuming CO2 tax (IEA/NEA)



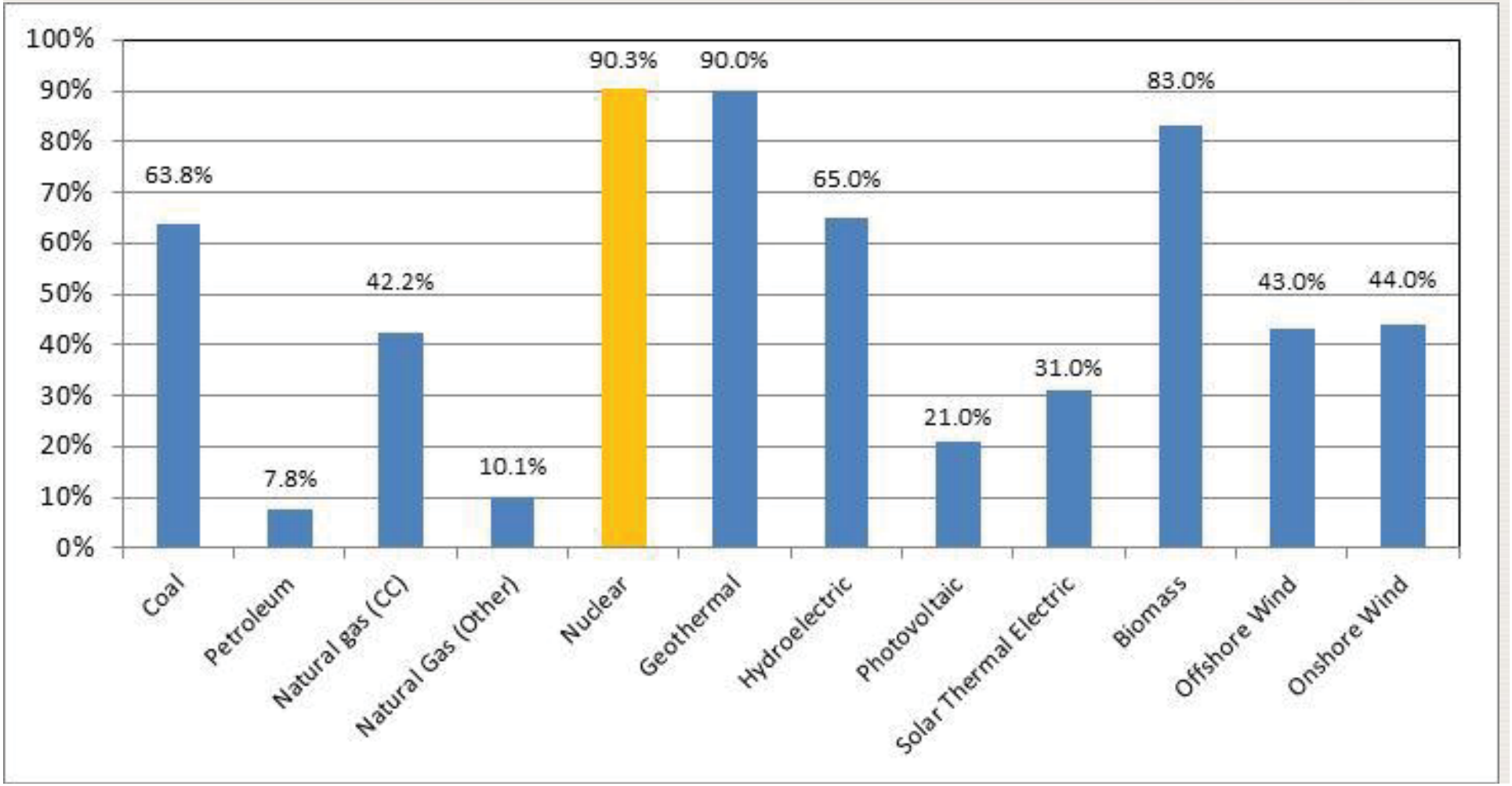
2. NE is GE: Economic criteria

Supply security: World uranium reserves – No OUEC



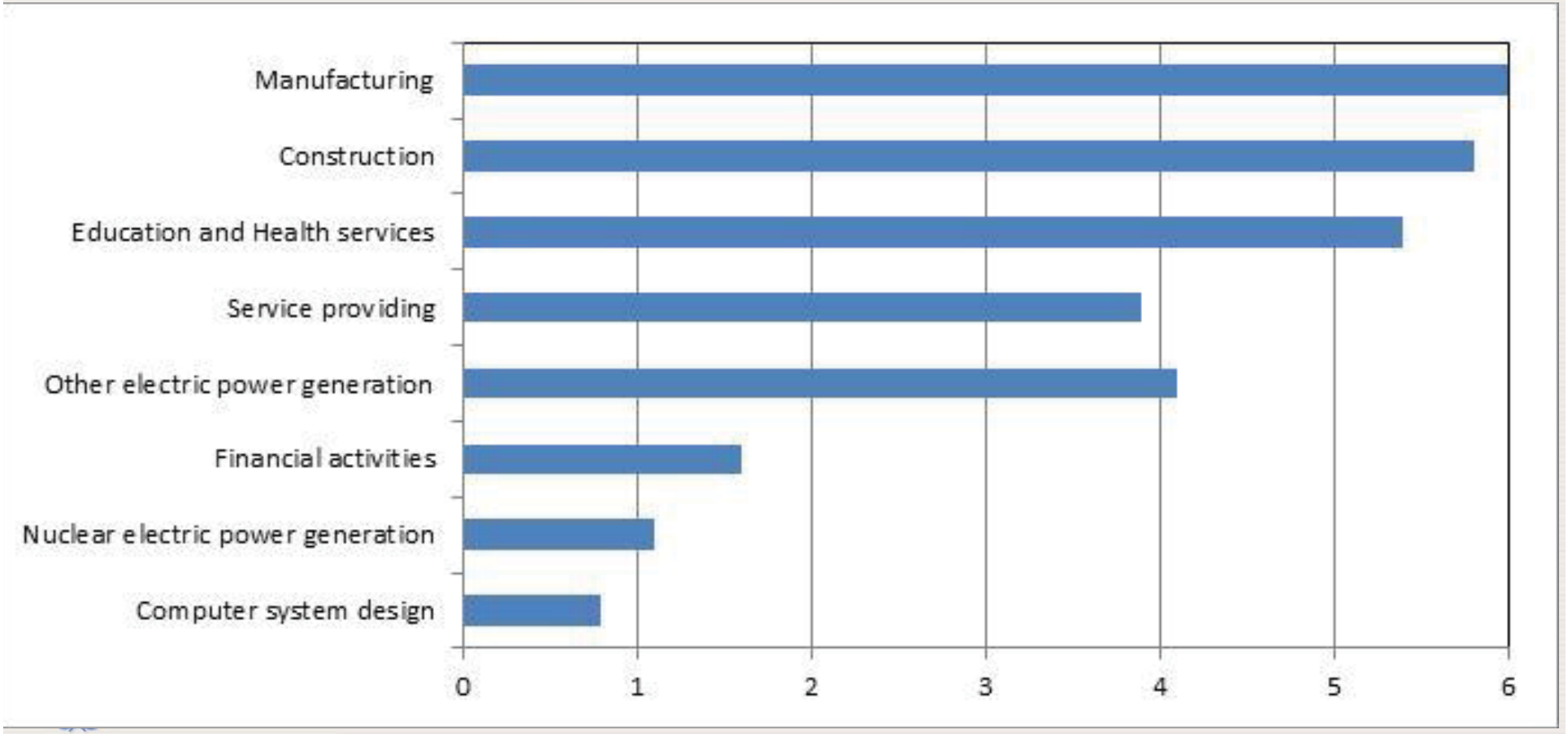
2. NE is GE: Economic criteria

Efficiency: average capacity factors - USA



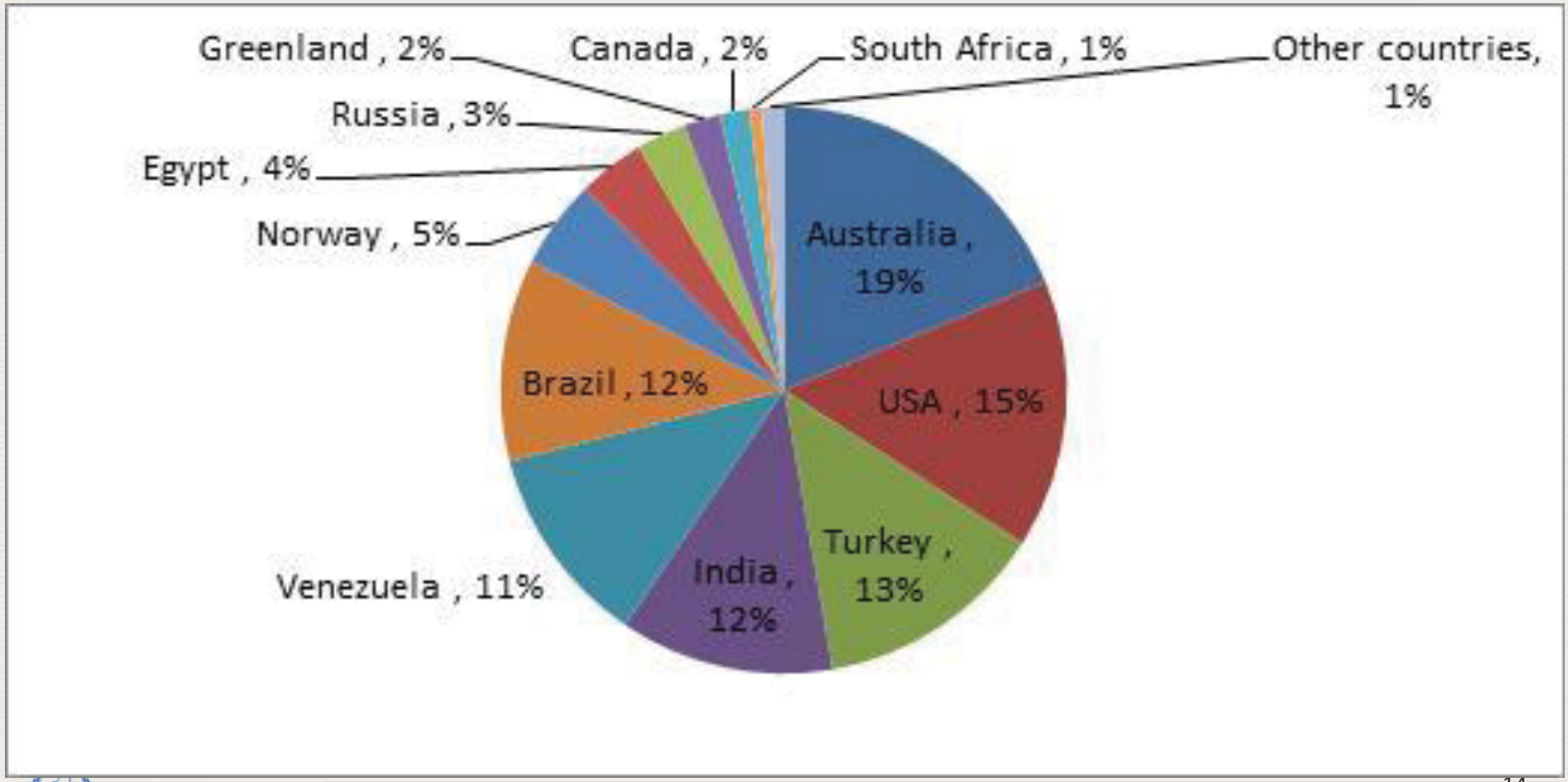
2. NE is GE: Economic criteria

Economic – social implication: Nonfatal occupational injuries and illnesses per 200,000 worker-hours (USA)



3. NE is GE: Resource efficiency criteria

Resource abundance - Thorium



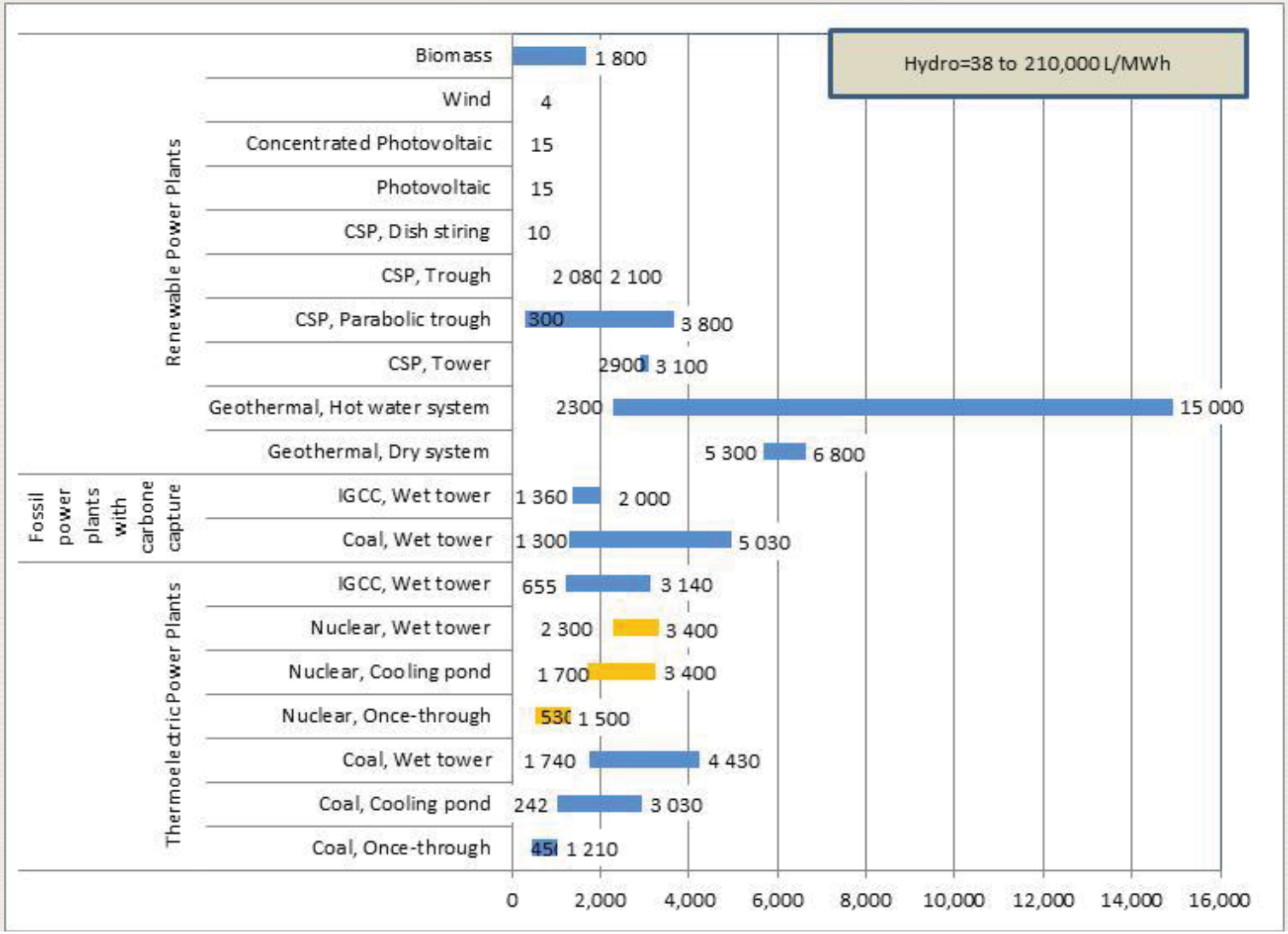
3. NE is GE: Resource efficiency criteria

Energy density:

Energy Source	Fuel	Energy
Coal	1 kg	3 kWh
Oil	1 kg	4 kWh
Uranium	*1 kg*	*50,000 kWh*

3. NE is GE: Resource efficiency criteria

Water consumption by water cooling types (l/MWh)



3. NE is GE: Resource efficiency criteria

Land use (km^2/MWe)

Energy Source	**Land use**
Fossil and nuclear sites:	1–4 km^2
Solar thermal or photovoltaic (PV) parks:	20–50 km^2 (nearly a small city)
Wind fields:	50–150 km^2 (nearly a small city)
Biomass plantations:	4000–6000 km^2 (a province)

3. NE is GE: Resource efficiency criteria

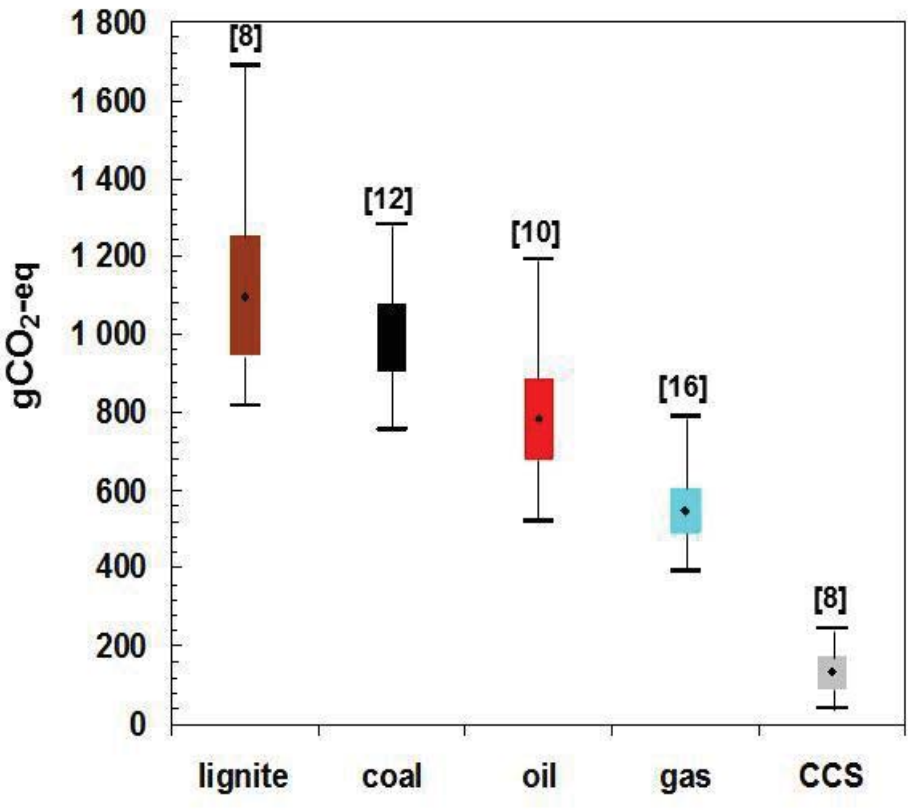
Material requirements (life cycle)

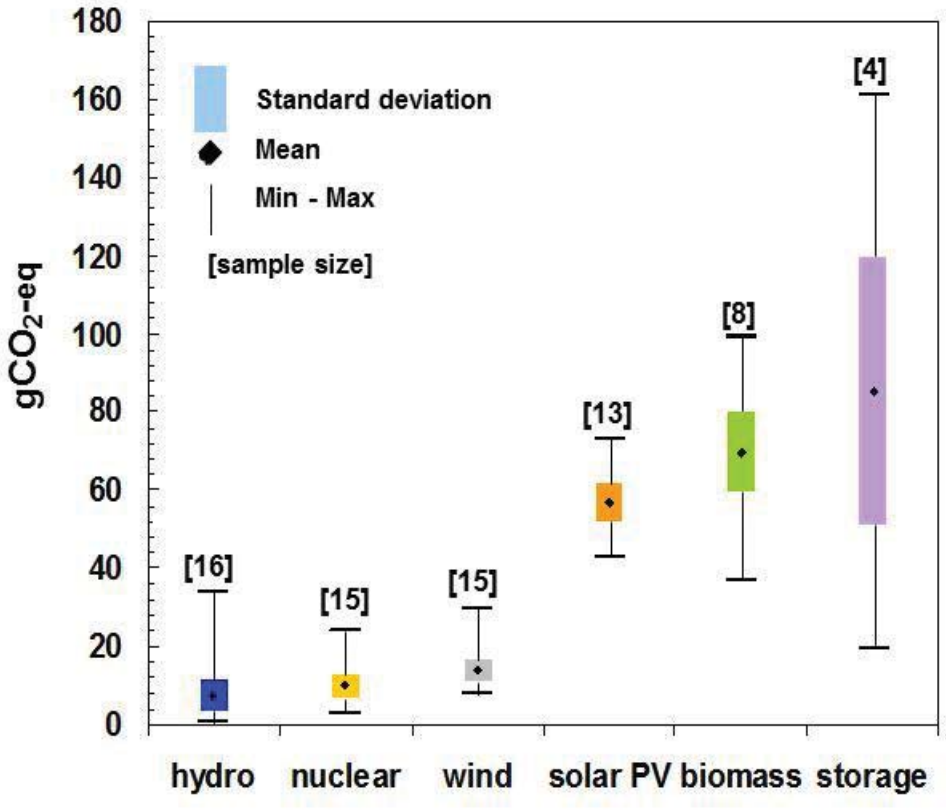
	Iron kg/GWhe	Copper kg/GWhe	Bauxite kg/GWhe
Hard coal	2,700	8	30
Lignite	2,314	8	19
Gas combined cycle	1,239	1	2
Nuclear (PWR)	457	6	27
Wood CHP	934	4	18
PV 5 kW poly	4,969	281	2,189
Wind 1.5 MW at 5.5 m/s	2,066	52	35
Wind 1.5 MW at 4.5 m/s	4,471	75	51
Hydro 3 MW	2,057	5	7

Source: Voss, 2007

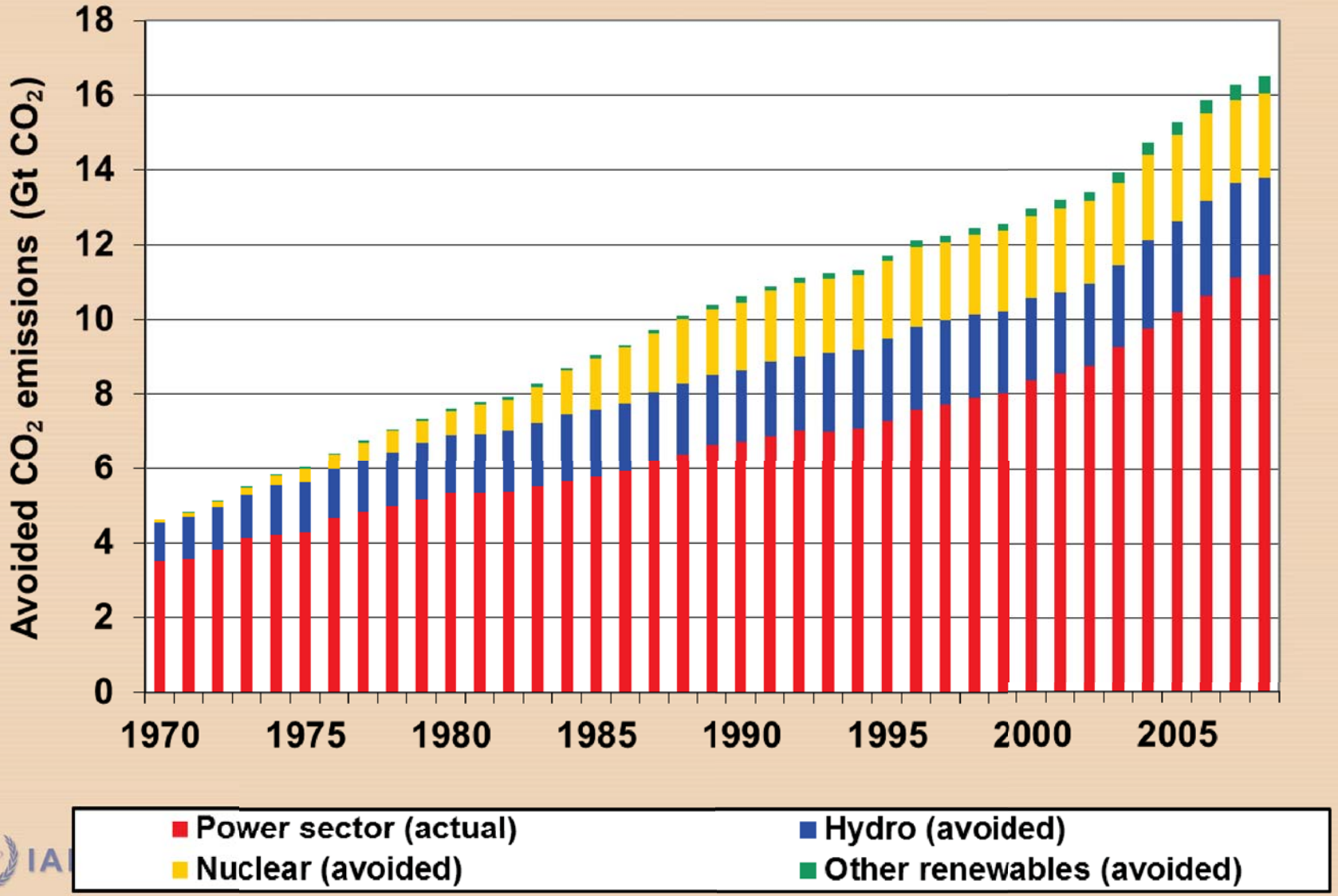
4. NE is GE: Environmental criteria

Life-cycle GHG emissions of electricity generating options – scales!





4. NE is GE: Environmental criteria



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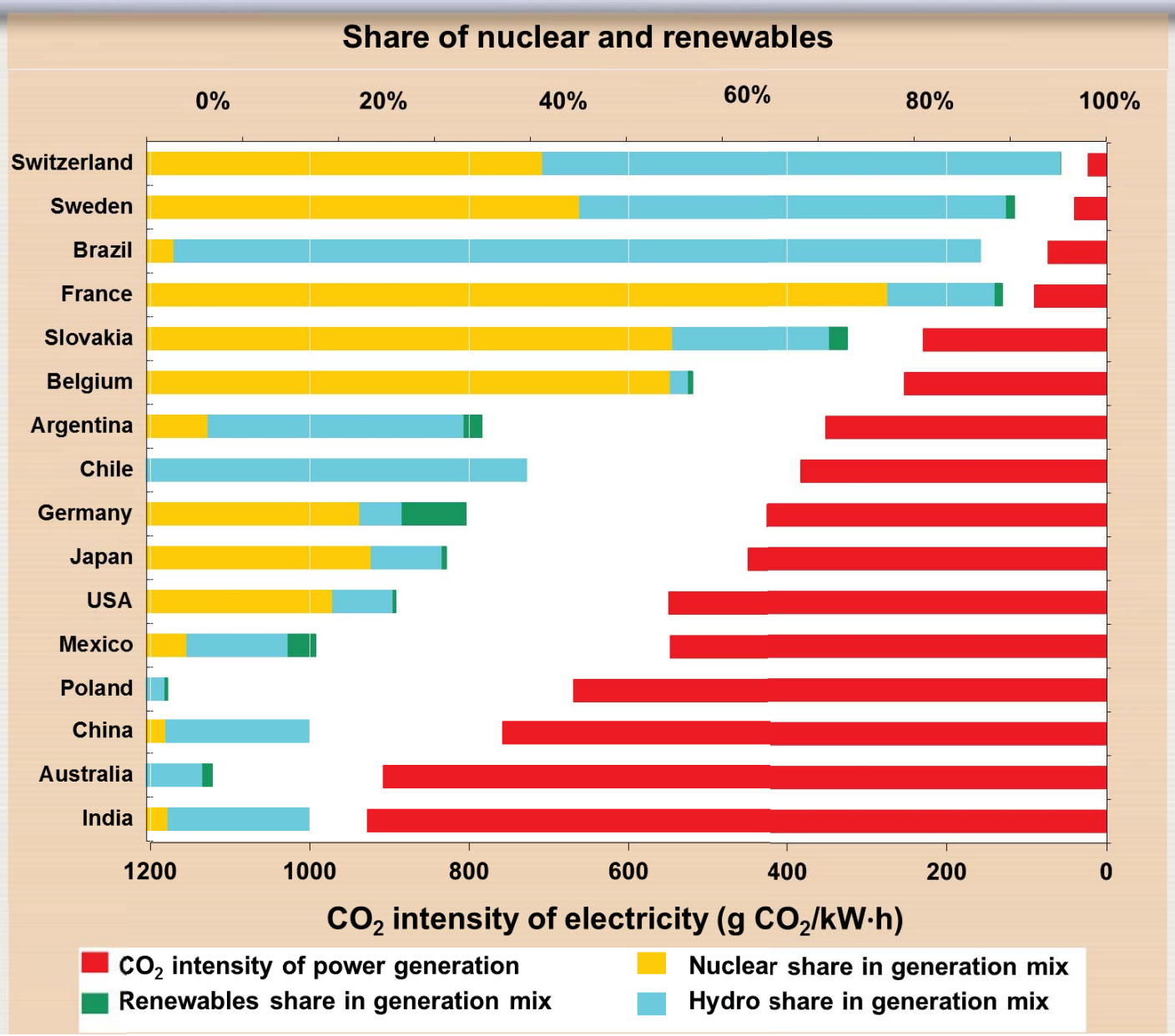
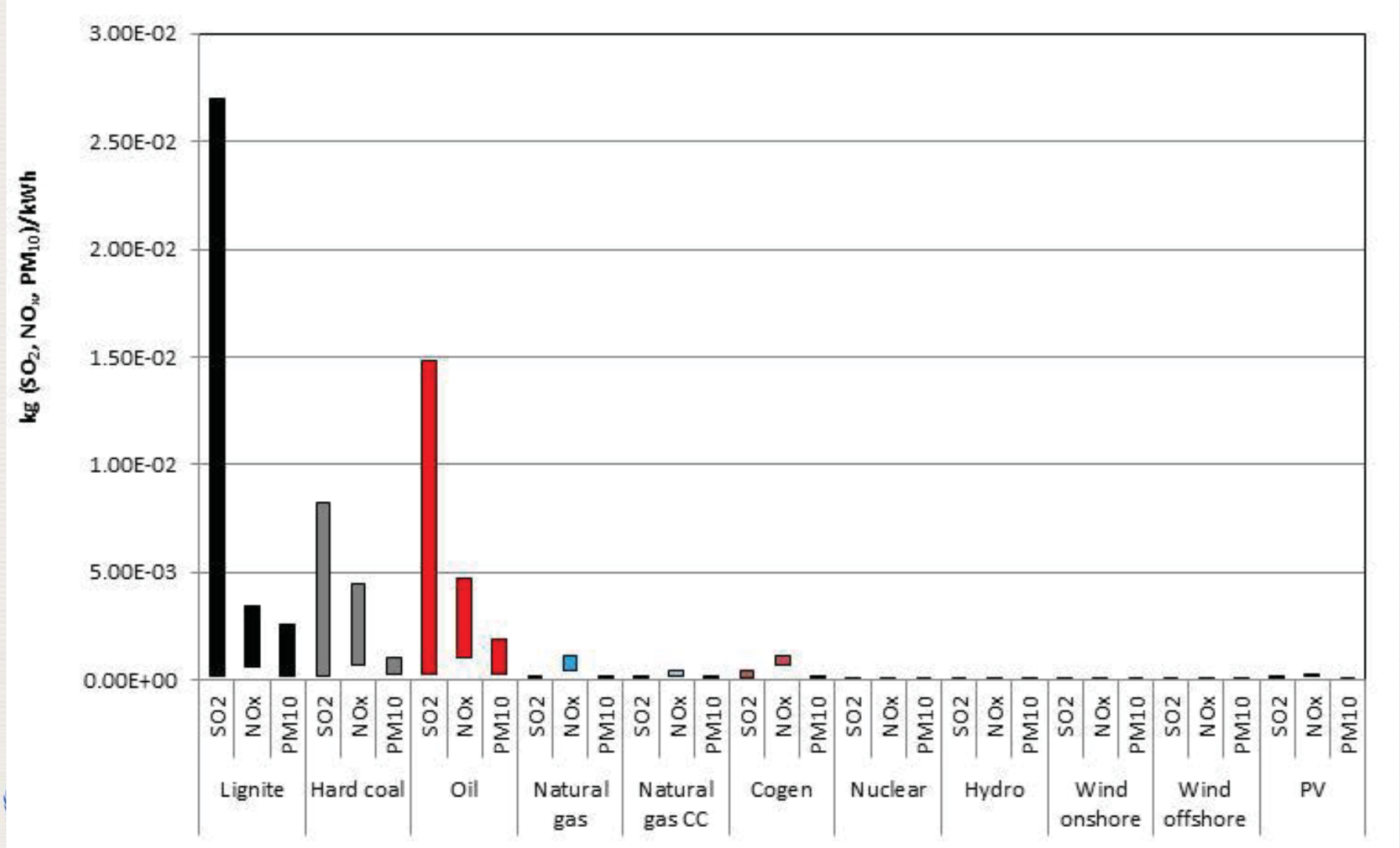


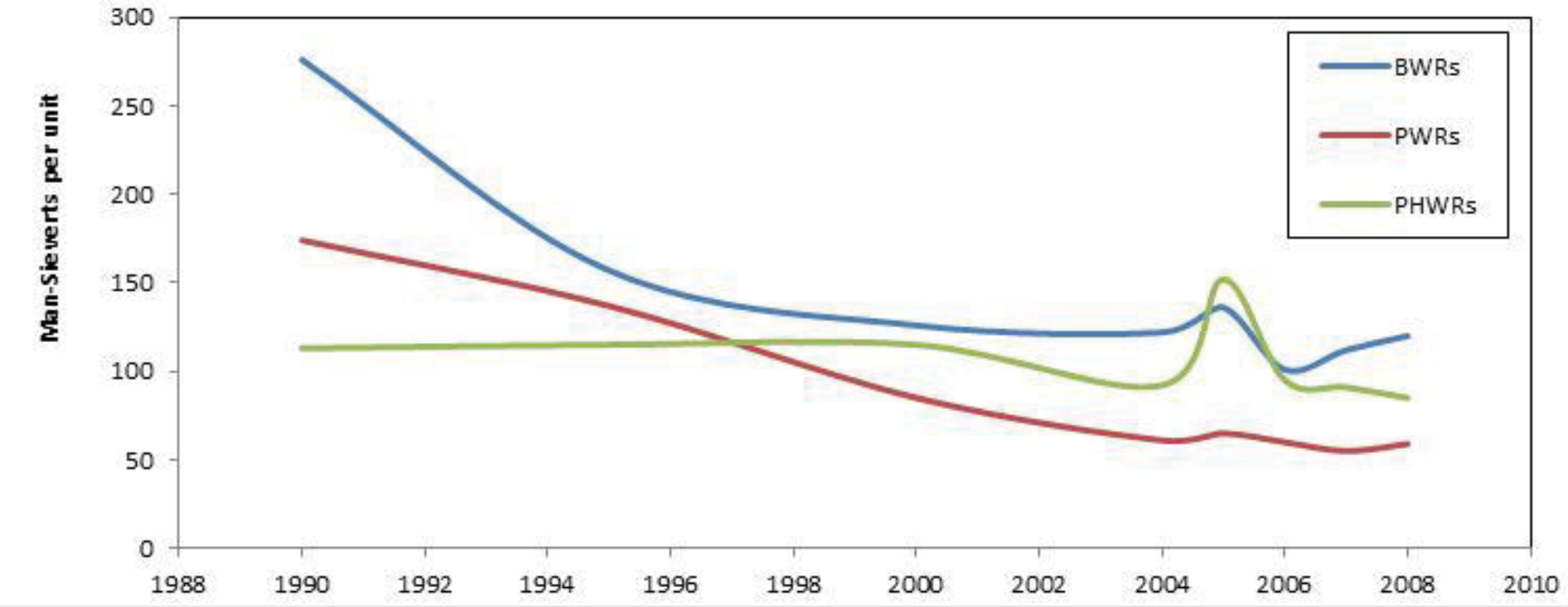
4. NE is GE: Environmental criteria

Air pollutant emissions – selected power technologies



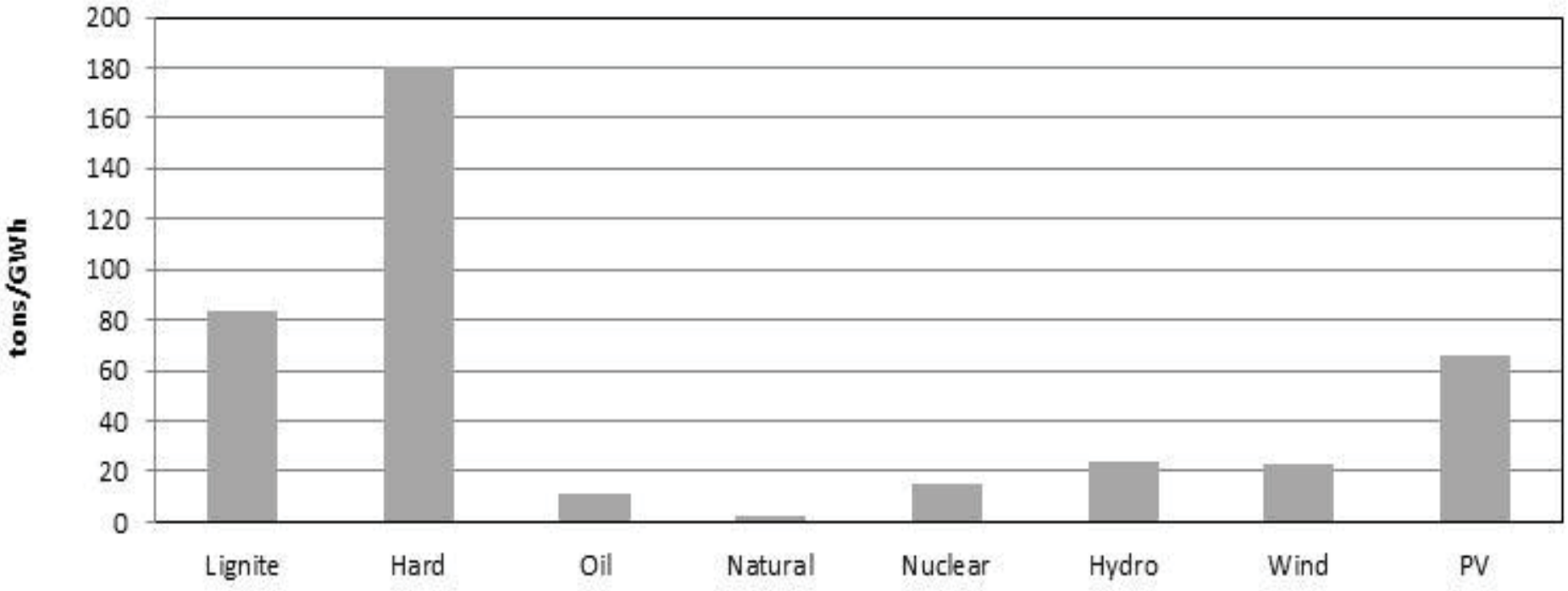
4. NE is GE: Environmental criteria

Health risks – collective radiation exposure - low



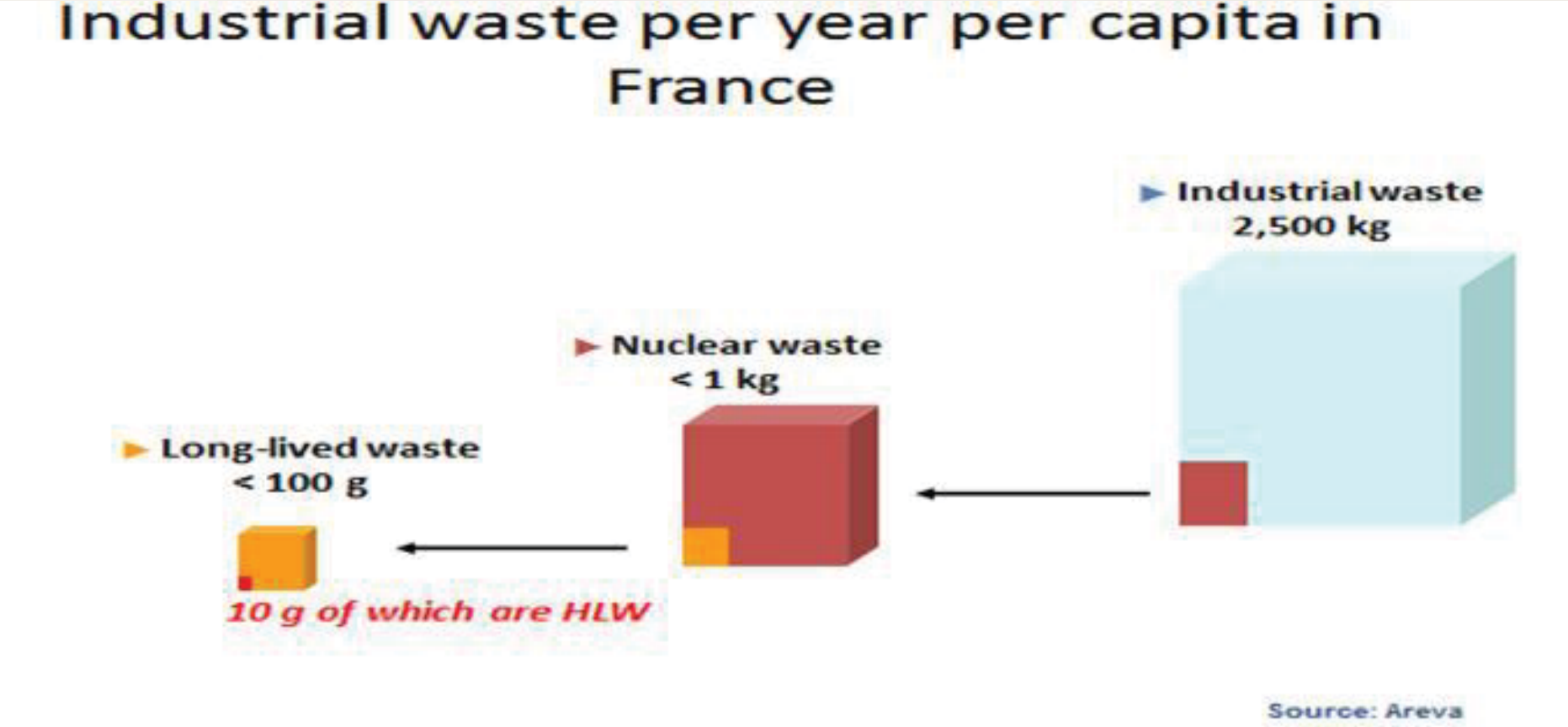
4. NE is GE: Environmental criteria

Total waste volumes from generation technologies



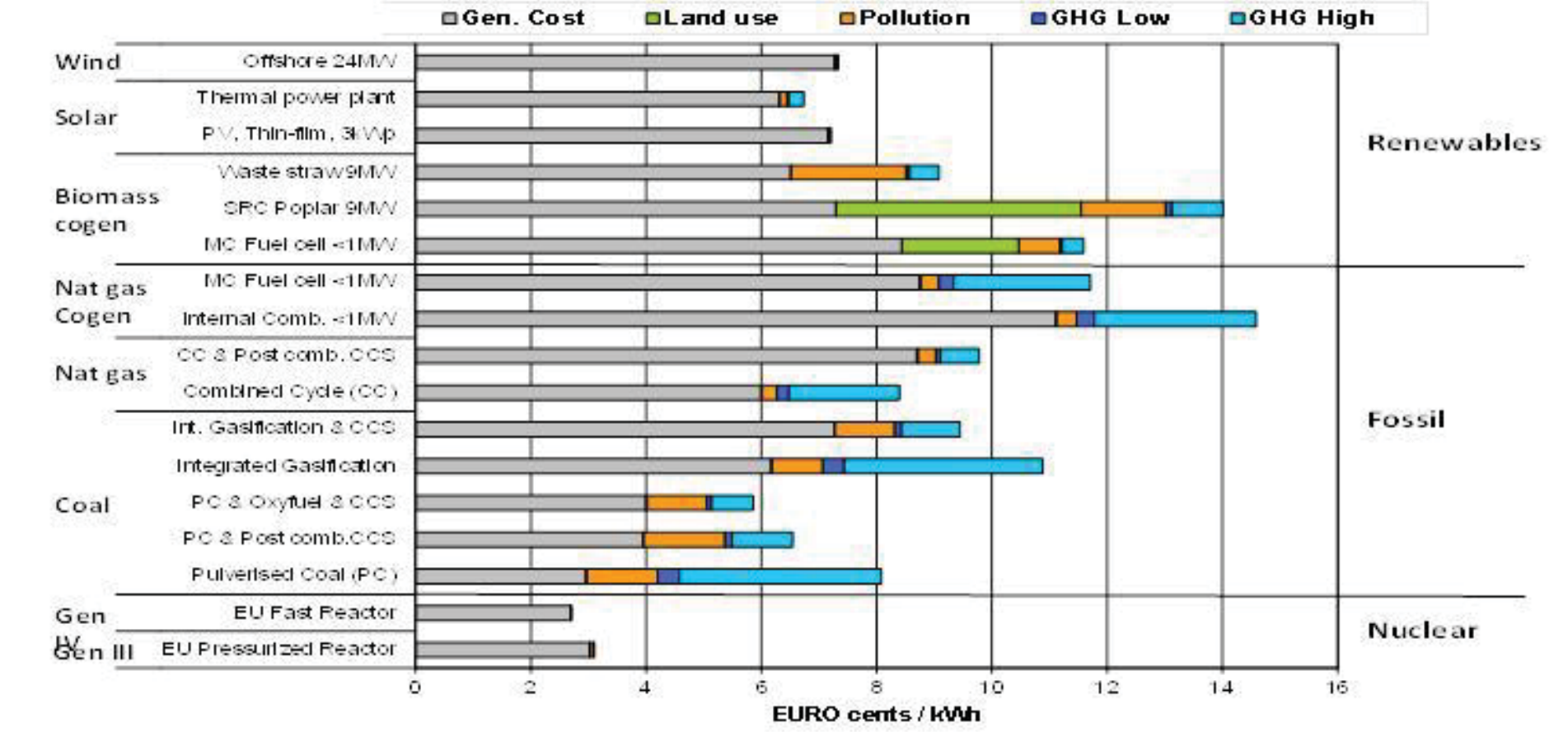
4. NE is GE: Environmental criteria

Share of RW in total industrial waste - France



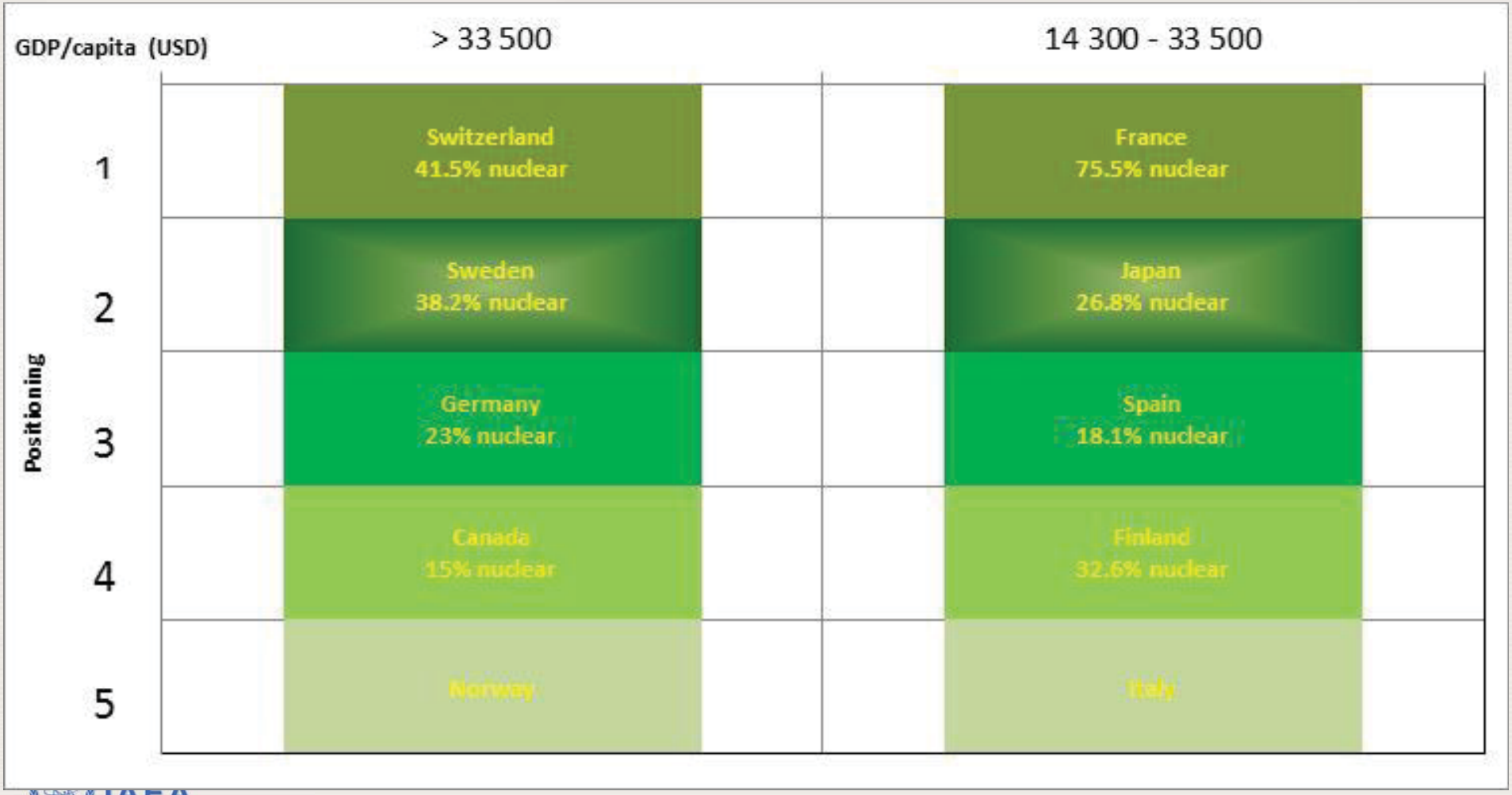
4. NE is GE: Environmental criteria

Total = private + external (social) costs – 2 GHG cases



4. NE is GE: Environmental criteria

Energy sustainability index, 2 economic groups



5. Main messages

Objective way to assess NE as a GE:
evaluate and compare to others against same criteria
Exact scores depend on national/regional conditions:
geography, resource endowments, climate,
social, economic, political conditions, etc.
Nuclear tends to perform well against GE criteria:
- economic
- resource efficiency
- environmental impacts

➔ Nuclear energy is a green energy source
not denying some risks

5. Main messages

Green economy, green growth, green energy aspirations and targets:

Nuclear energy is *not the panacea*

but:

it could be *part of the solution.*

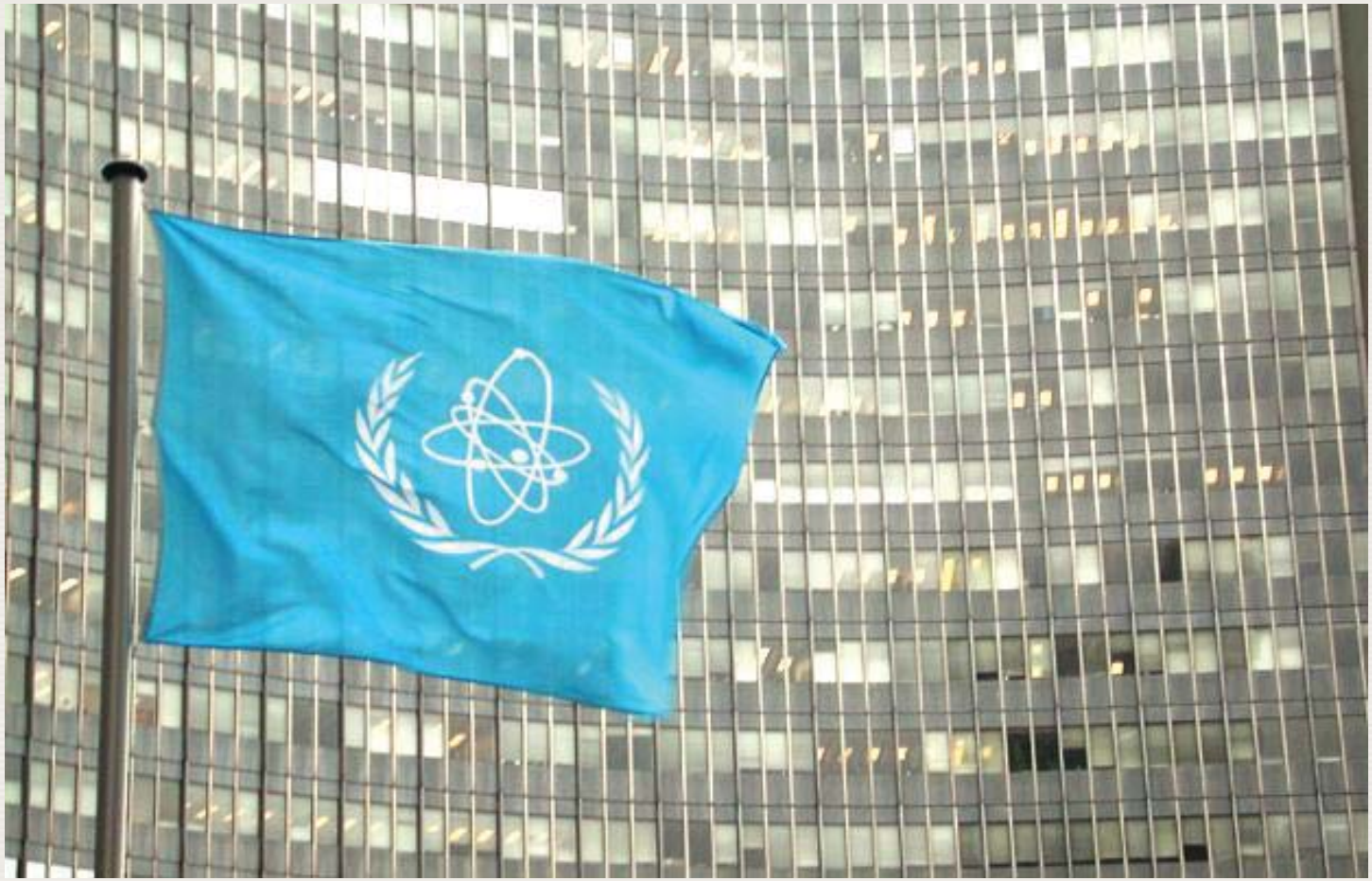
Where, when, how much, what arrangements:

depends on *national* circumstances and

priorities → *decision of sovereign states*

IAEA mandate: support, tools, capacity building, expertise, analysis, publications

IAEA - http://www.iaea.org/OurWork/ST/NE/index.html



…atoms for peace.