Nuclear power as a solution to climate change? Potential consequences of global up-scaling

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Some notes on my perspective and background

I am not a nuclear engineer

I will not focus on waste

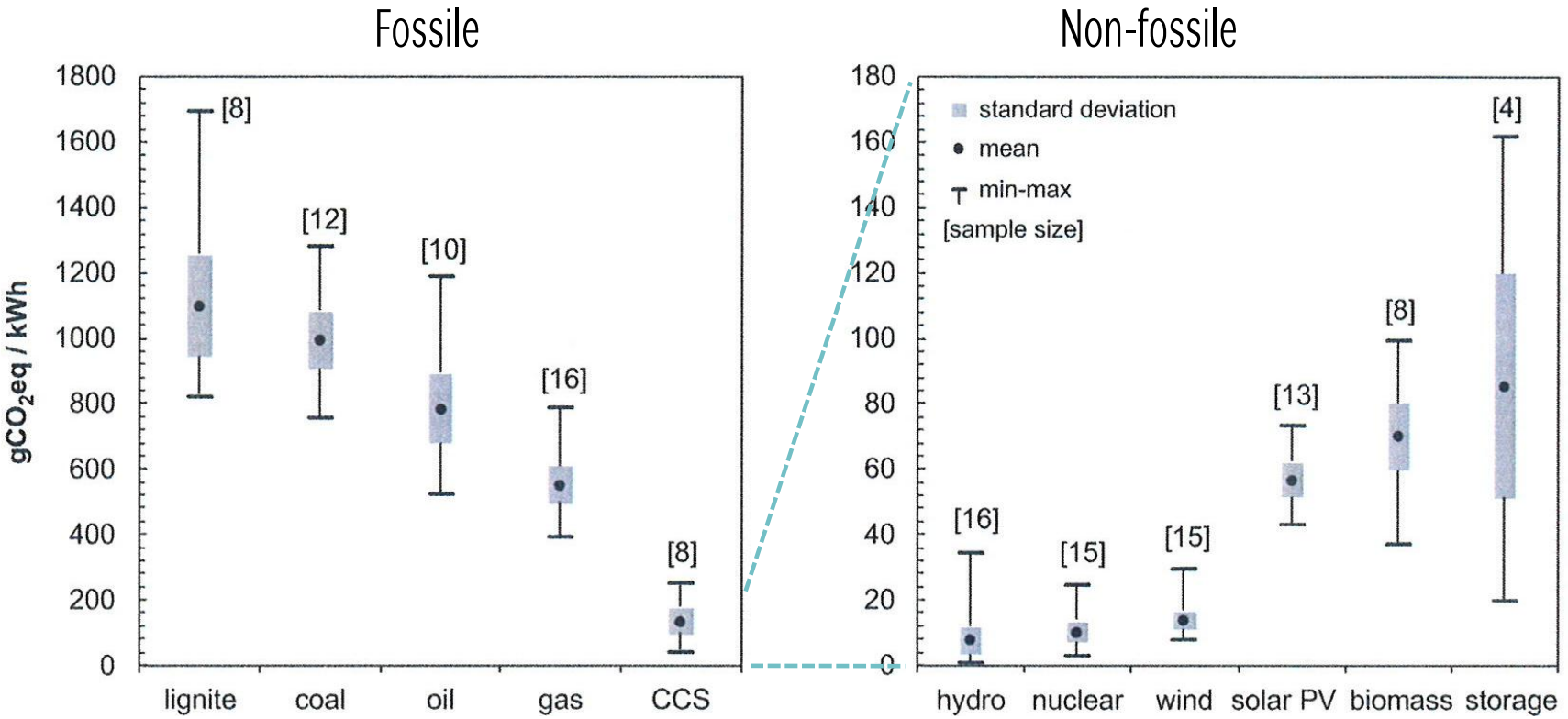
Climate mitigation perspective

An energy system perspective

A global perspective

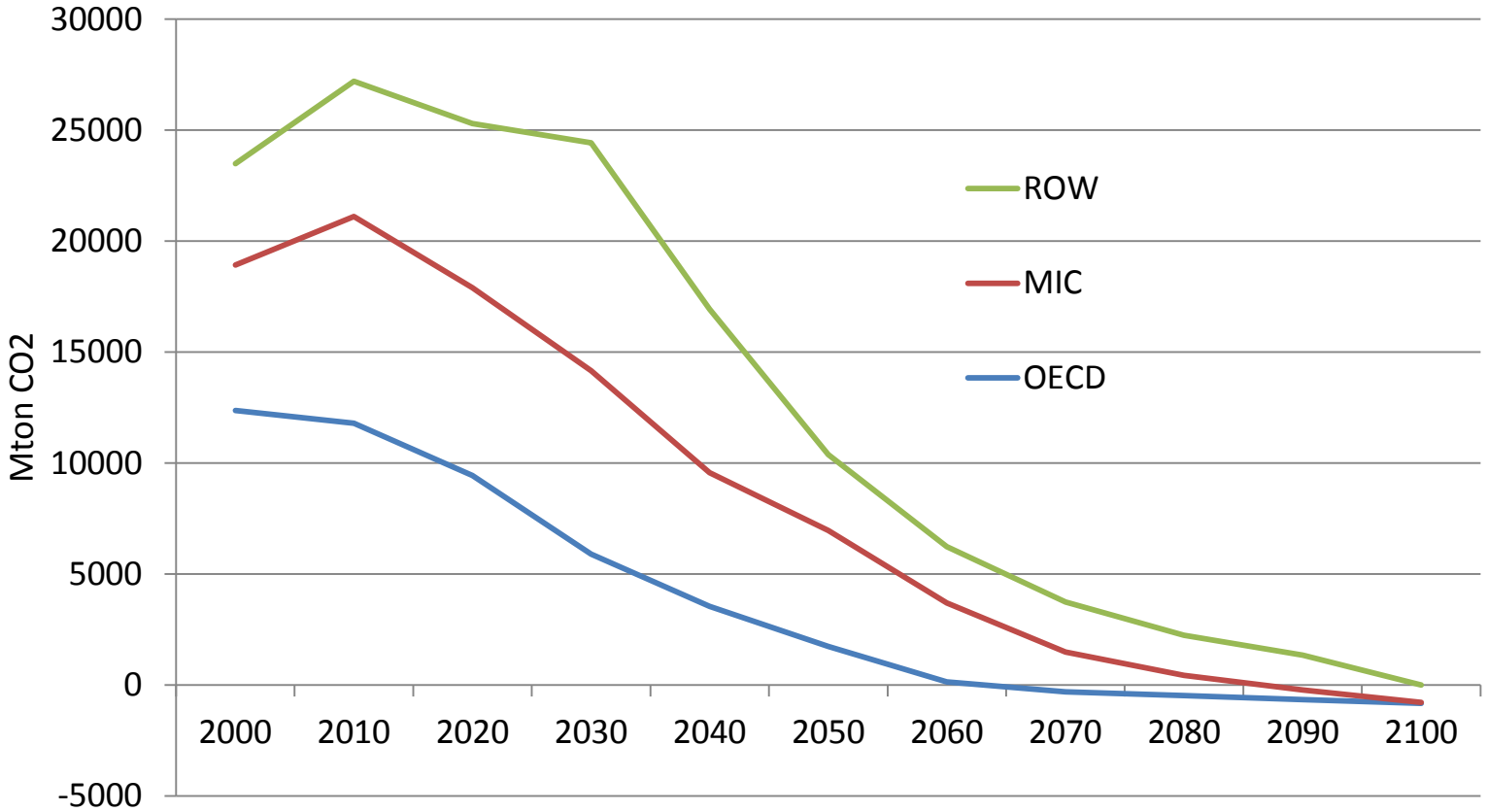
Main focus on nuclear proliferation and resource base

Nuclear energy as climate mitigation option

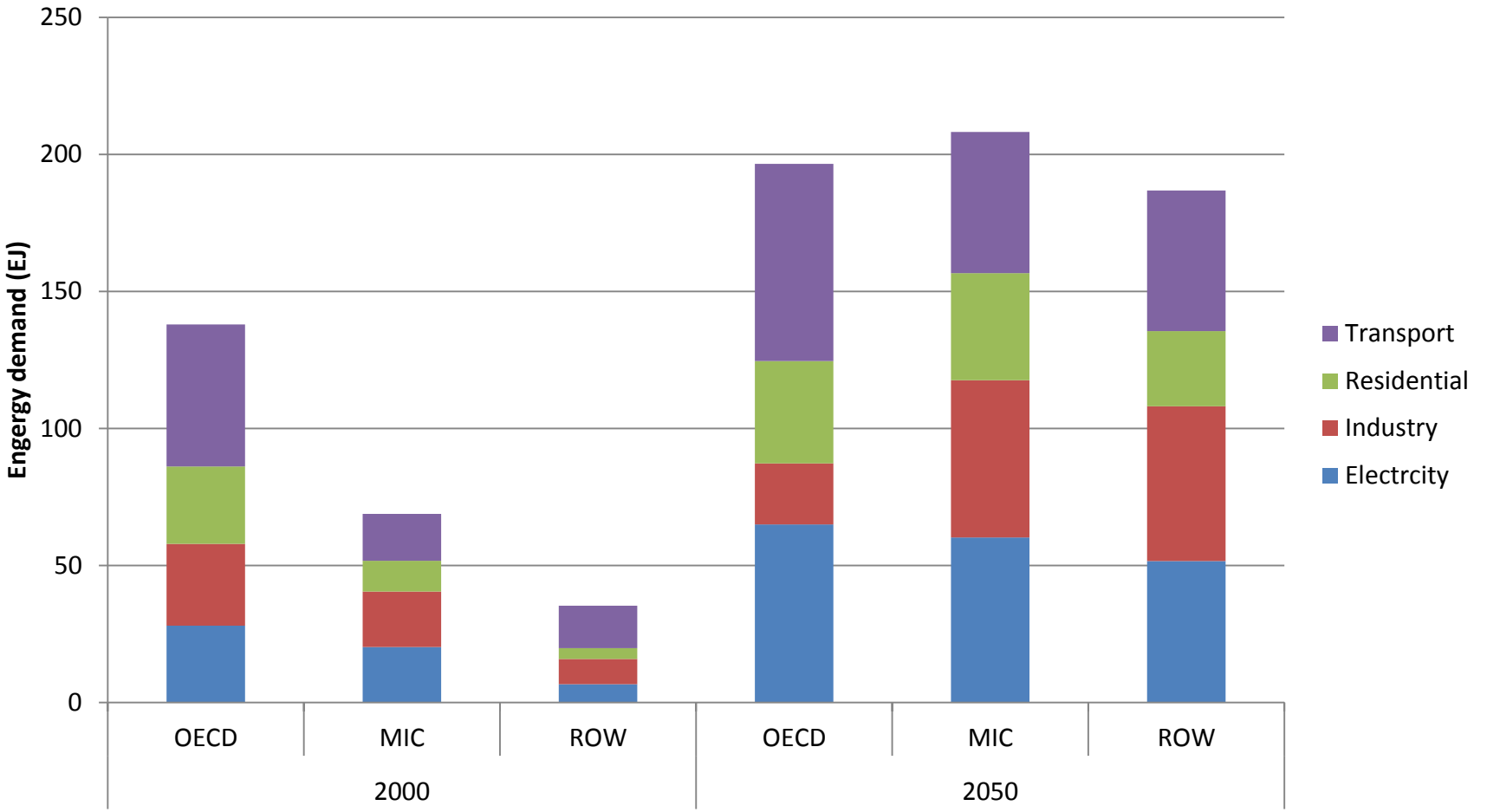


Weisser, 2007

Meeting the 2 degree target with 70% probability

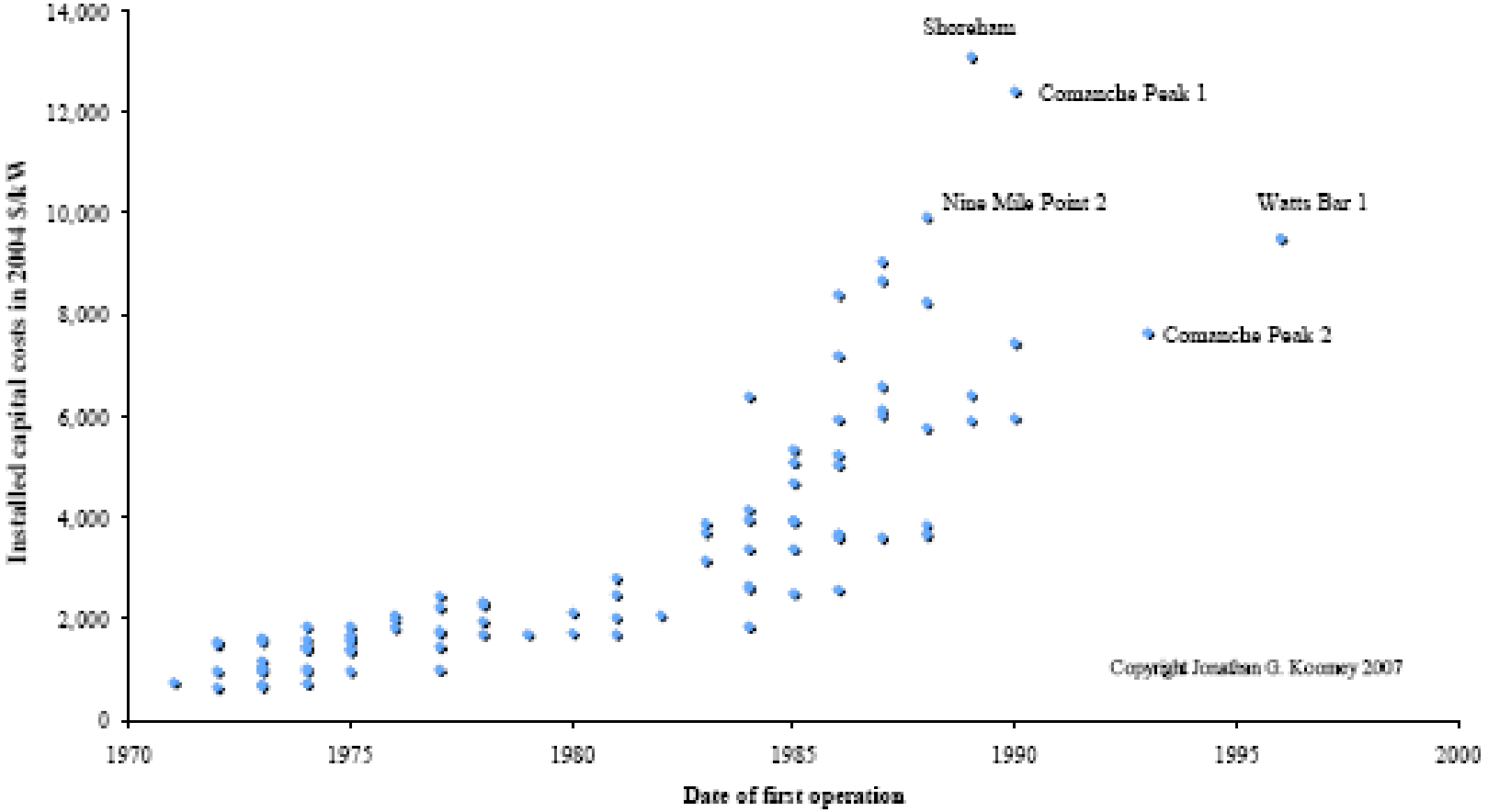


Final energy demand

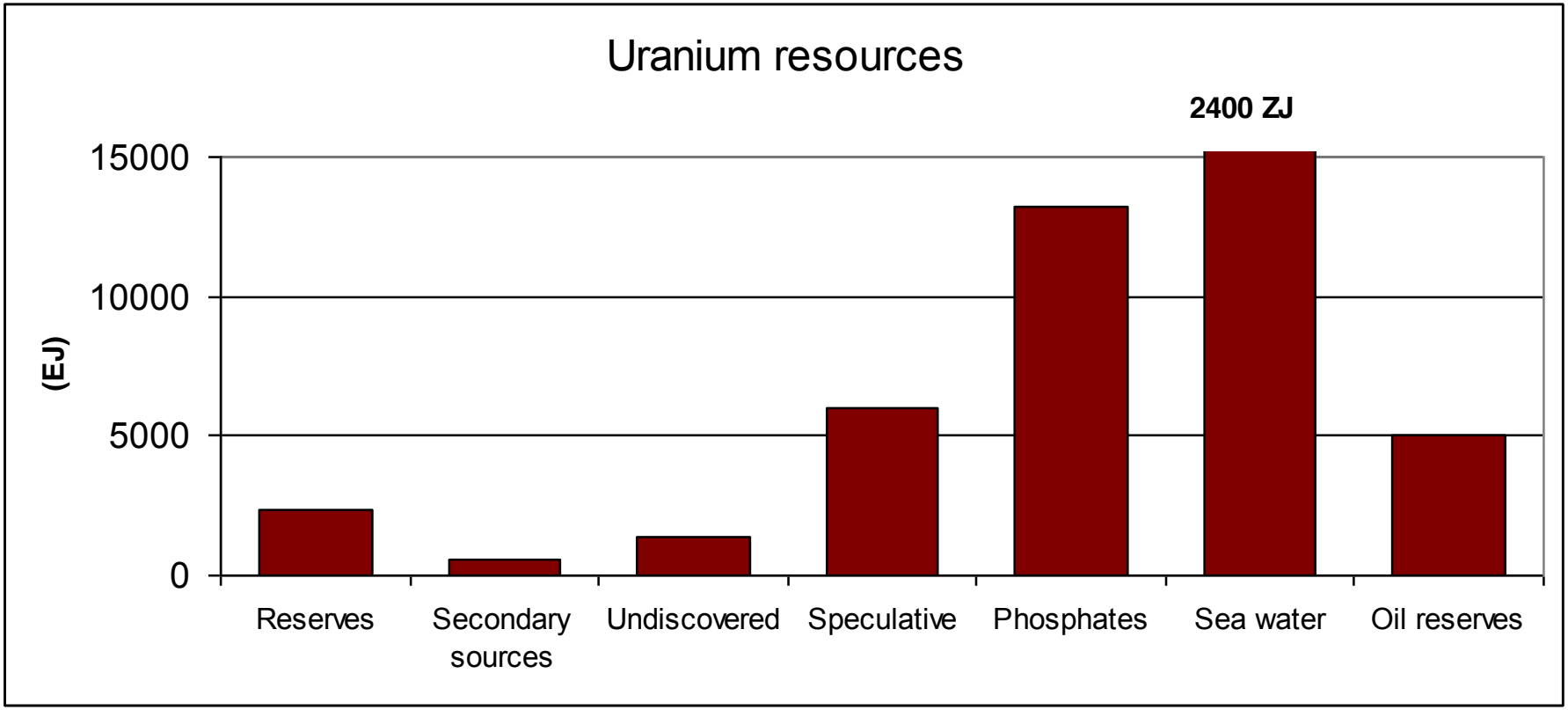


Energy technology	Developed	Main advantages	Main problems
Nuclear	Yes	Base load	Waste, proliferation, public acceptance
Coal with CCS	Demonstration level	Base load, can be applied to many emissions sources	Public acceptance, storage capacity
Bioenergy	Yes	Fuel, cheap	Land scarcity
Wind and solar PV	Yes	Large resource base, renewable	Intermittency
Concentrated solar power	Demonstration level	Large resource base, renewable	Only in sunny regions, costly

Cost of nuclear energy



Resources



Price and Blaise, 2002

The GET model

Cost-minimizing model

Covers the global energy system

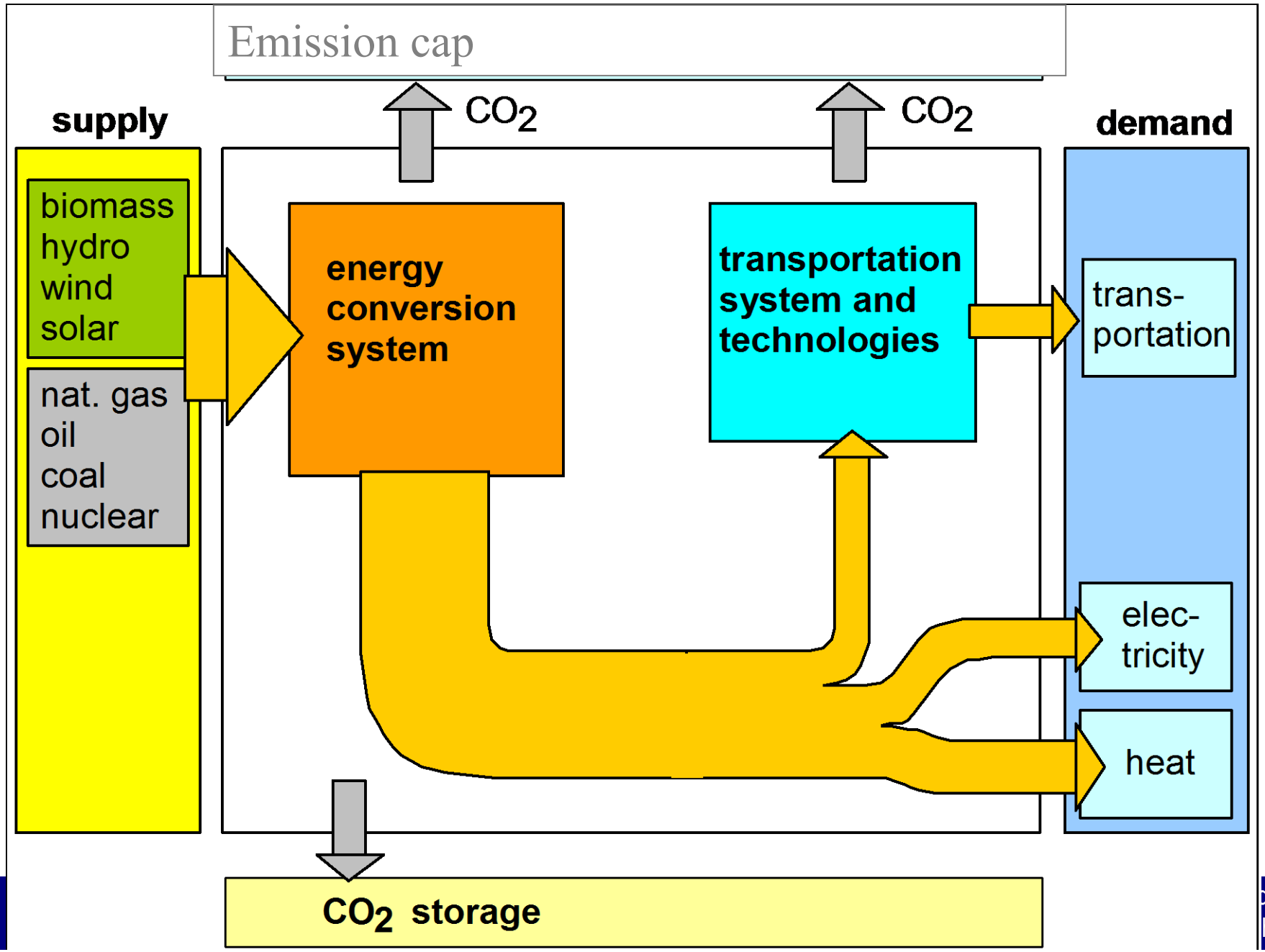
3 regions – OECD

- Middle income countries (MIC)

- Rest of the world (ROW)

Time-perspective 2000-2100

Technology costs and resource constraints


Emission cap
supply
CO_2
CO_2
demand
biomass
hydro
wind
solar
nat. gas
oil
coal
nuclear
energy conversion system
transportation system and technologies
trans-portation
elec-tricity
heat
CO_2 storage

Nuclear options in GET

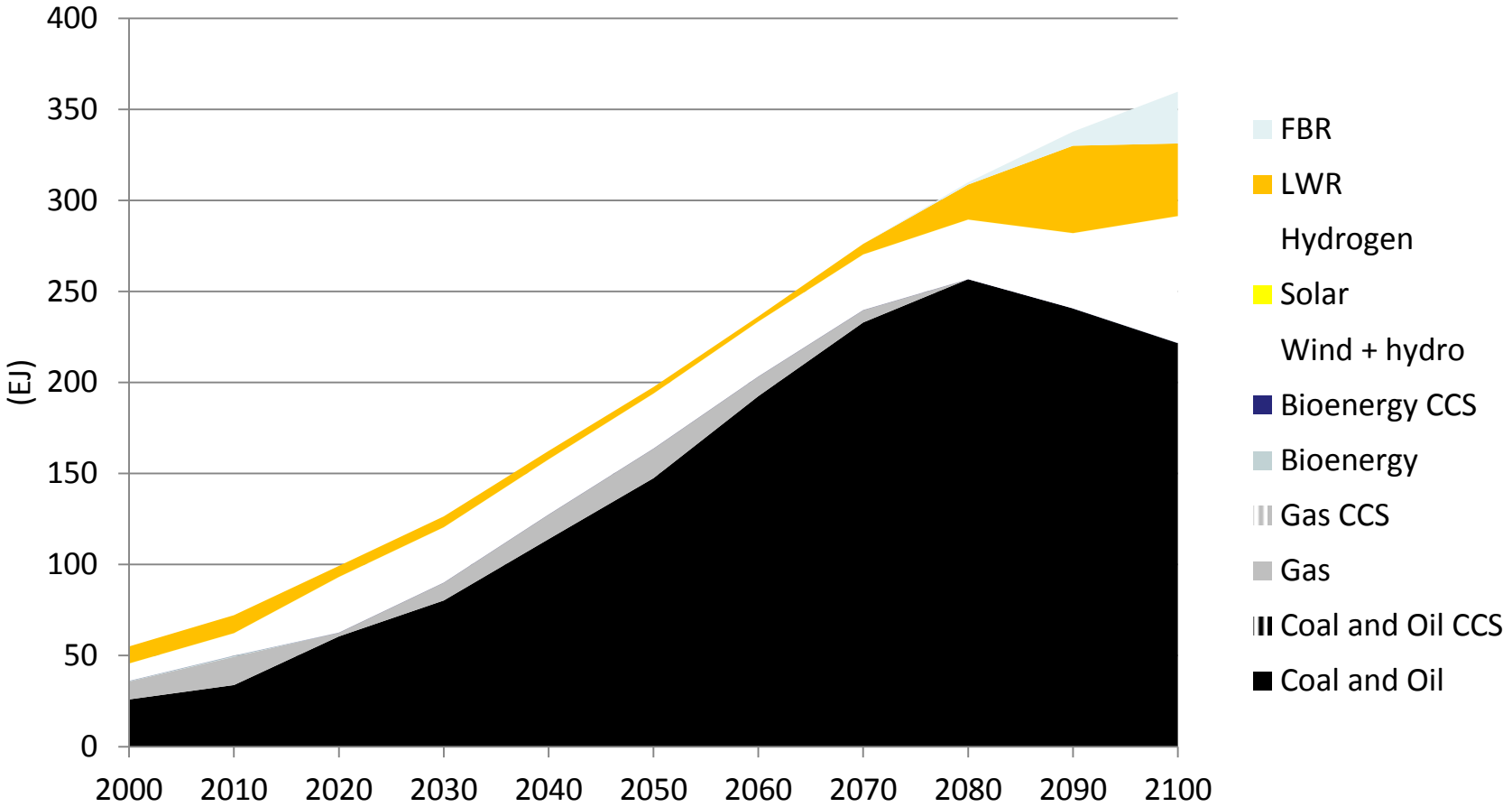
LWR

LWR with MOX fuel

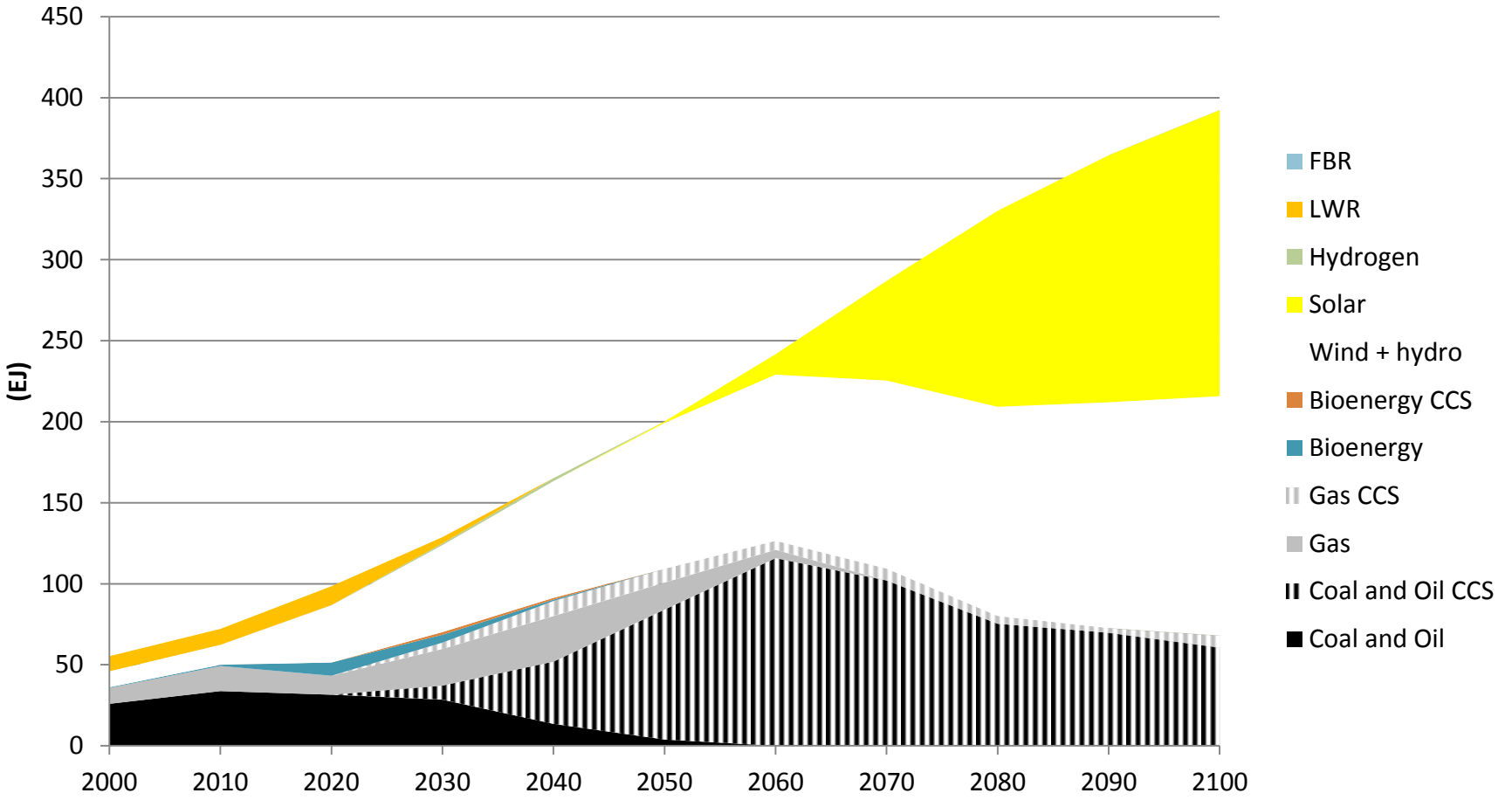
FBR from 2030.

Helium cooled reactors that could produce H2 with high efficiency

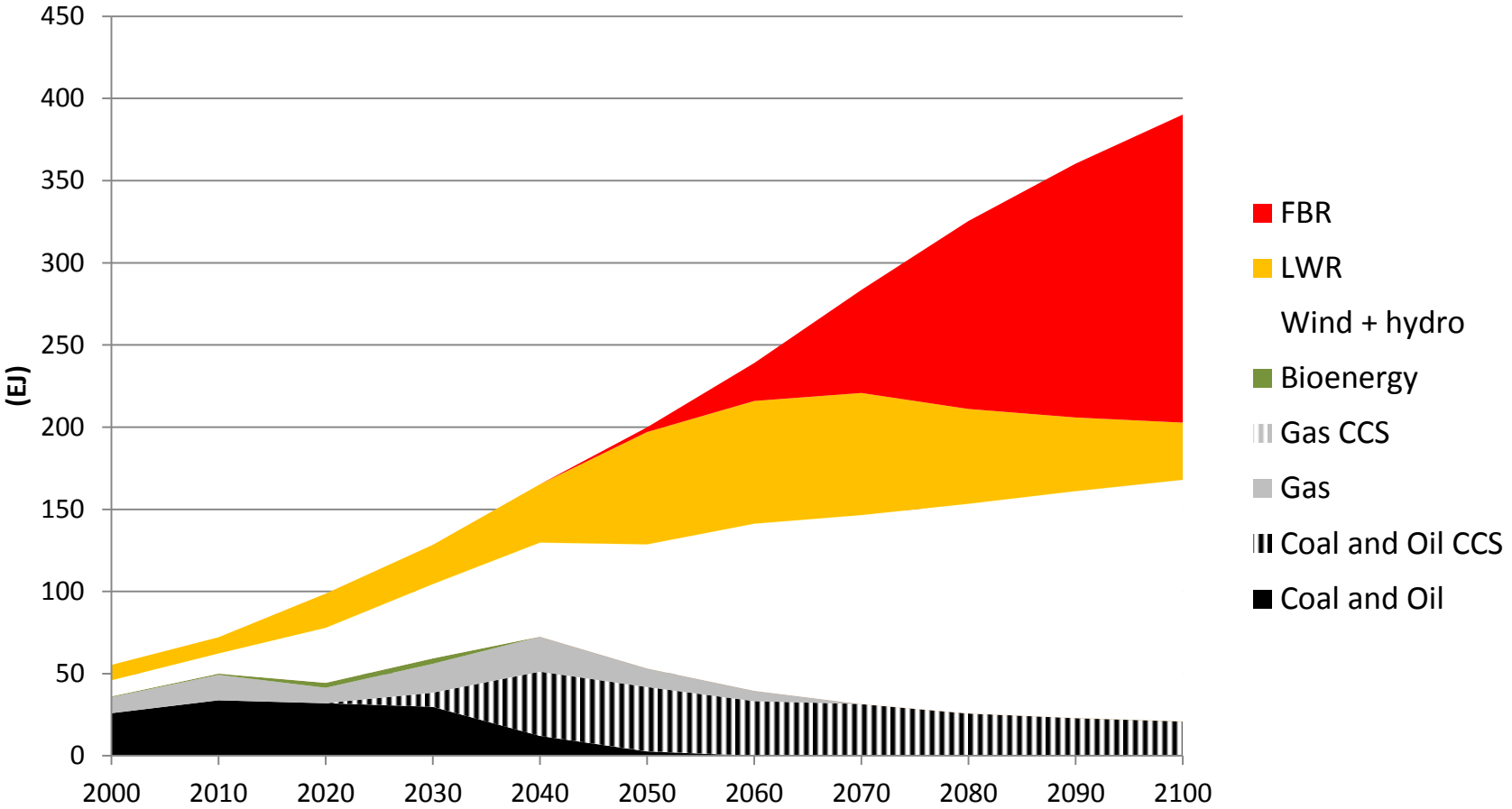
Electricity generation, without carbon constraint



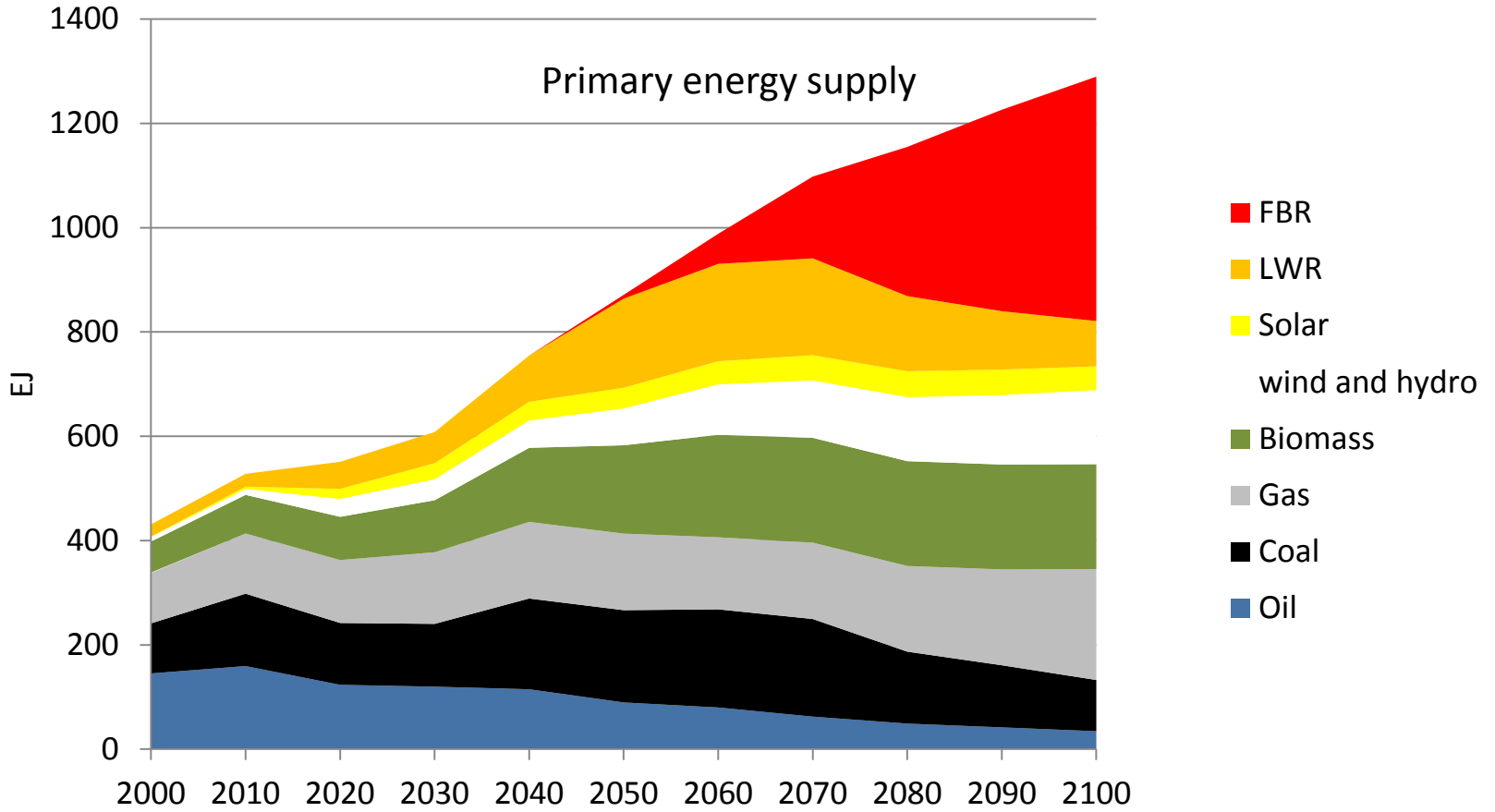
Electricity supply, 400 ppm CO2, no nuclear



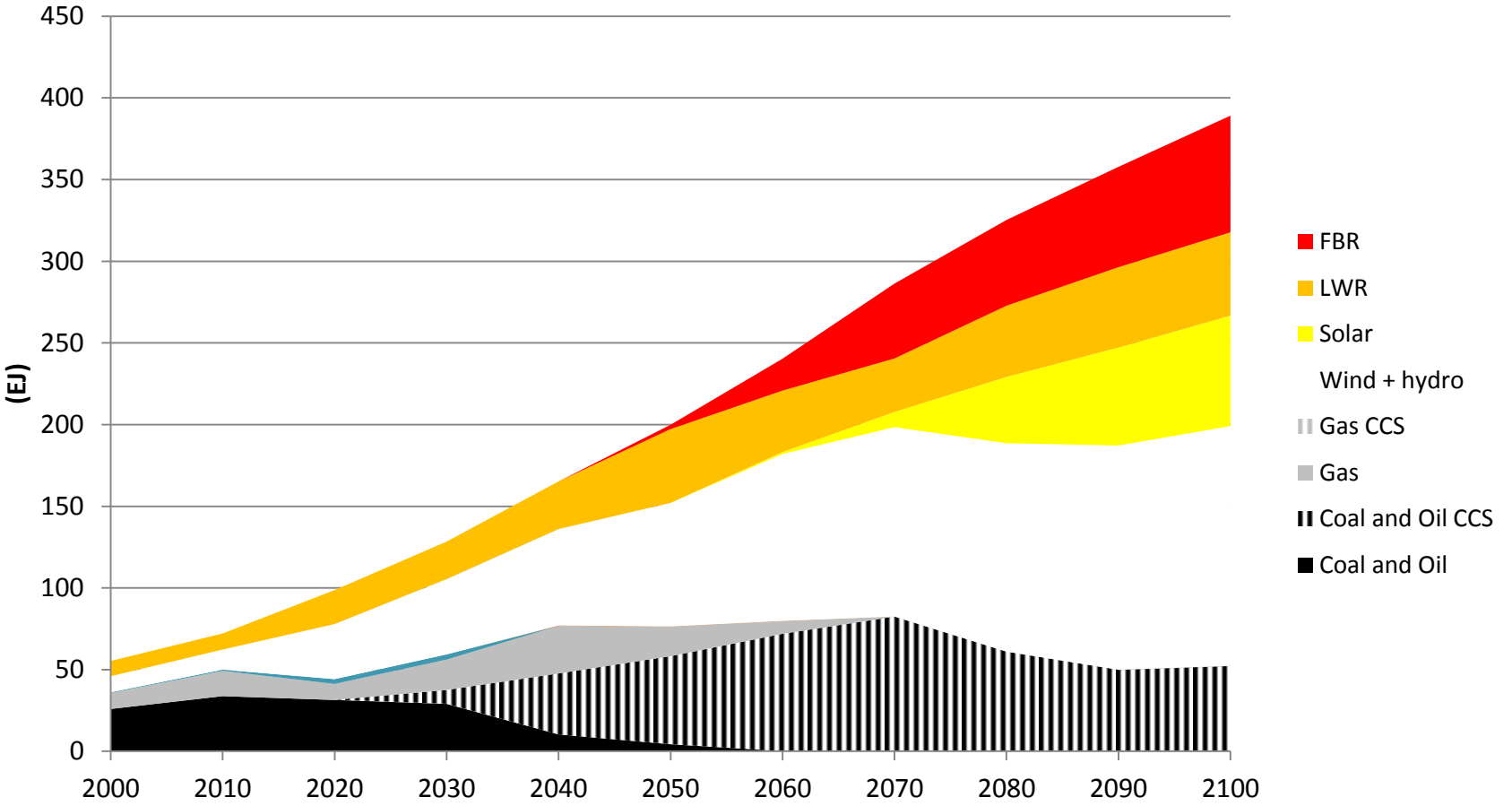
Electricity supply, 400 ppm, all nuclear



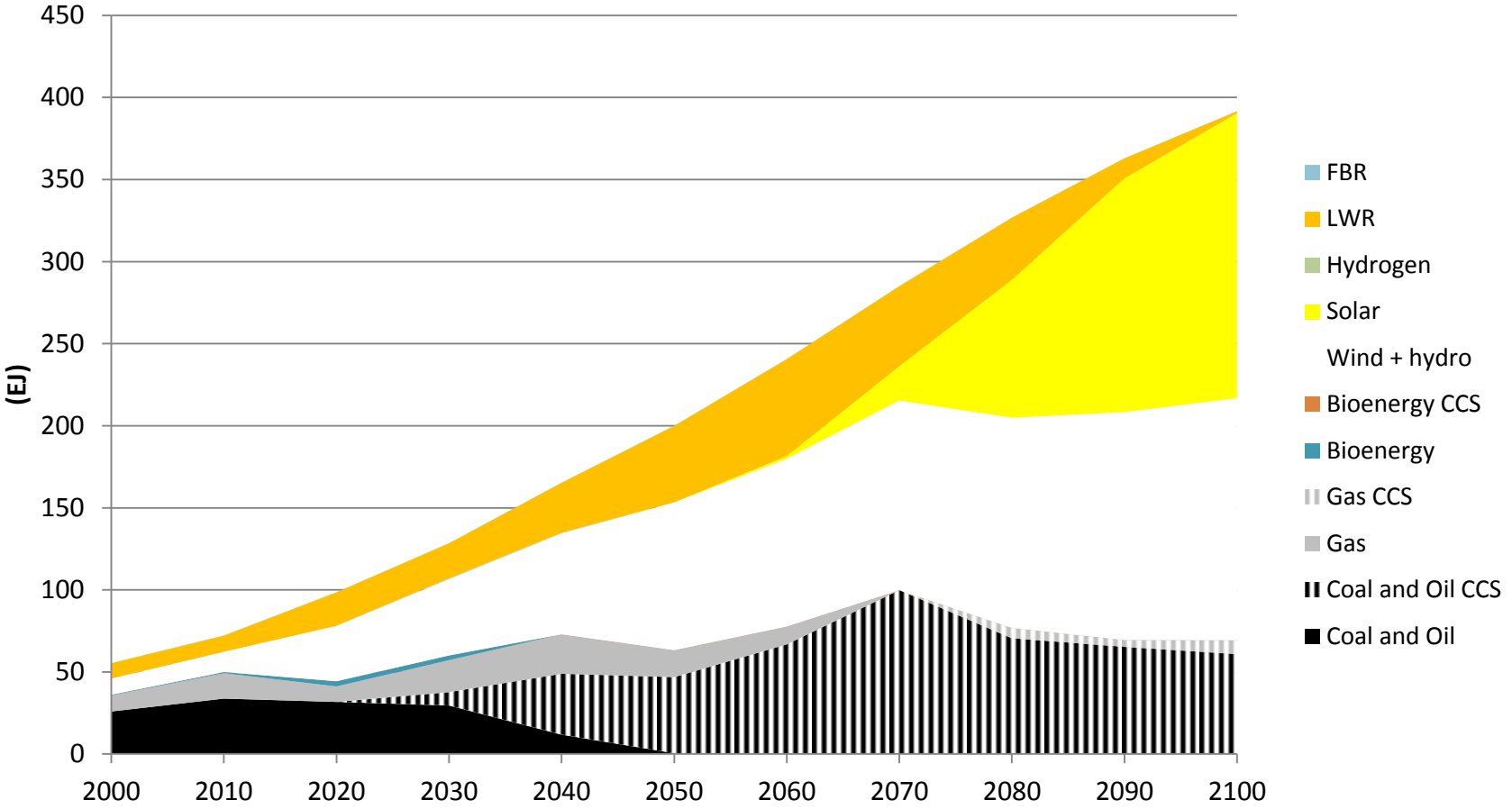
400 ppm, all nuclear

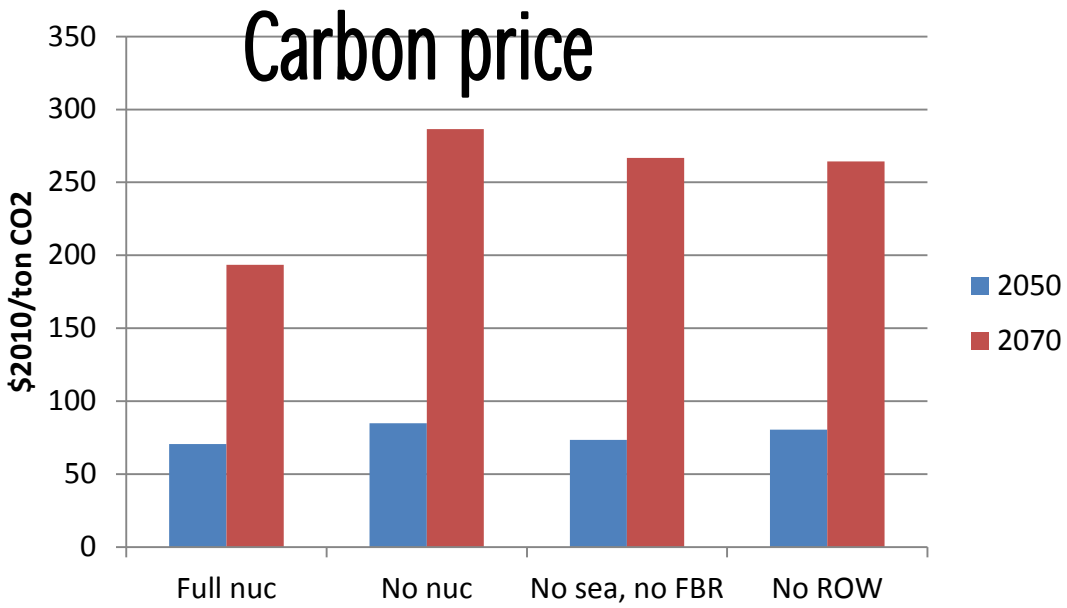


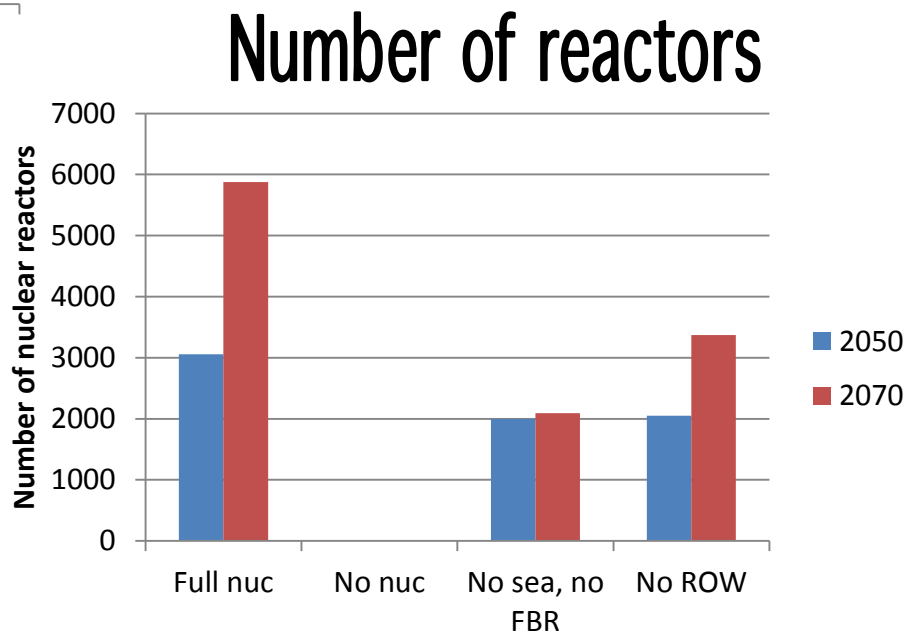
Electricity supply, 400 ppm, no nuc in ROW



Electricity supply, 400 ppm, no sea water uranium and no FBR




Carbon price
$2010/ton CO2
350
300
250
200
150
100
50
0
Full nuc
No nuc
No sea, no FBR
No ROW
2050
2070


Number of reactors
Number of nuclear reactors
7000
6000
5000
4000
3000
2000
1000
0
Full nuc
No nuc
No sea, no FBR
No ROW
2050
2070

Climate mitigation and nuclear energy

A 2 degree target is technically feasible also without nuclear energy

A full nuclear scenario reduces the cost of reaching stringent targets, and about ten-fold the number of reactors by 2050

Breeders or sea water uranium is required for nuclear to make large scale climate mitigation effort

Risk of nuclear proliferation

For the mitigation effort to be large scale, nuclear knowledge and technology must be spread globally

Proliferation risk will depend on

– Diffusion of enrichment and reprocessing among states with weak institution and/or nuclear weapon ambitions.

- Demand for nuclear knowledge

- Level of international safeguards

Even if breeders are proliferation resistant, LWR and enrichment will be present in a long transient phase (50 years)