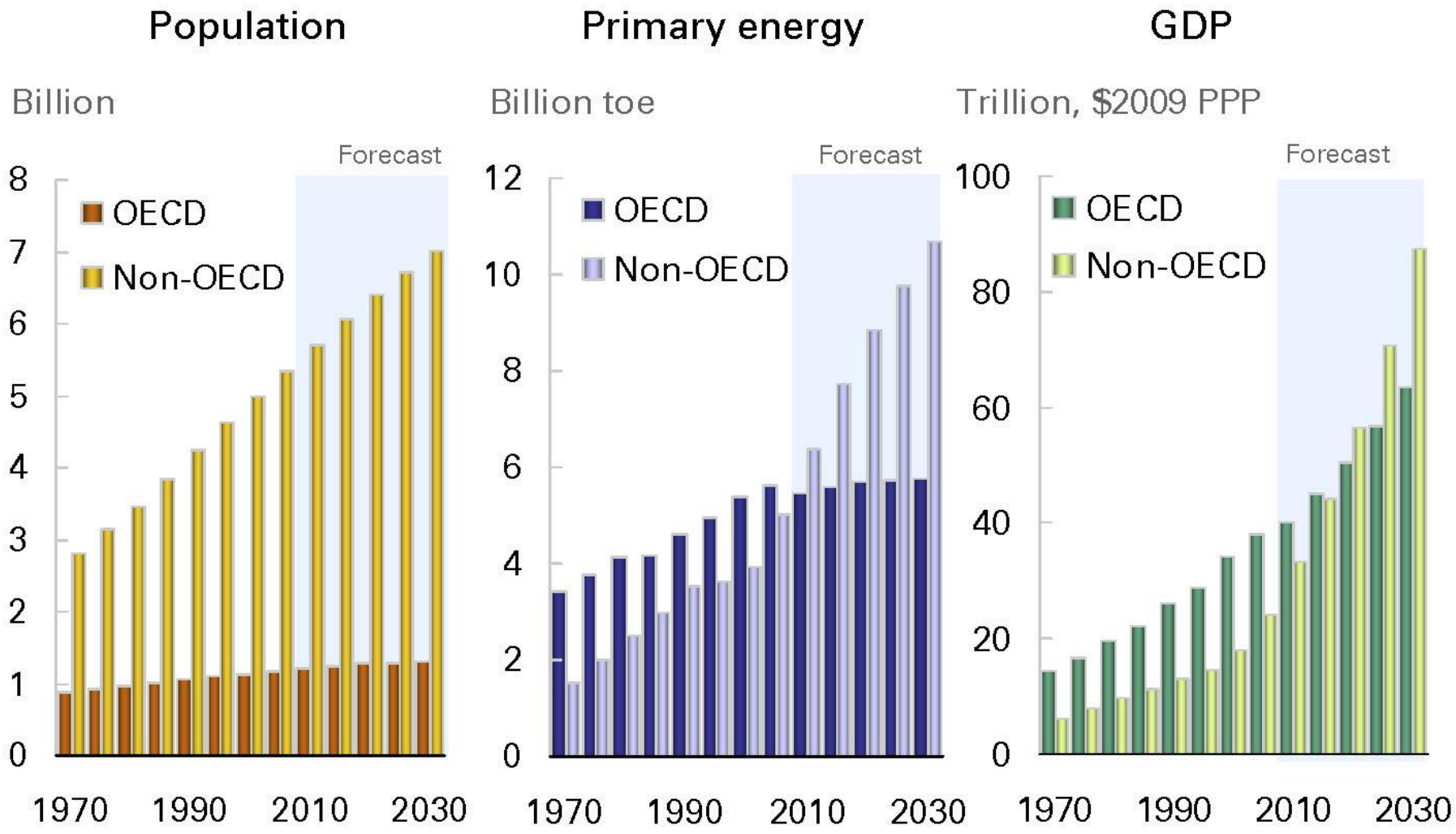
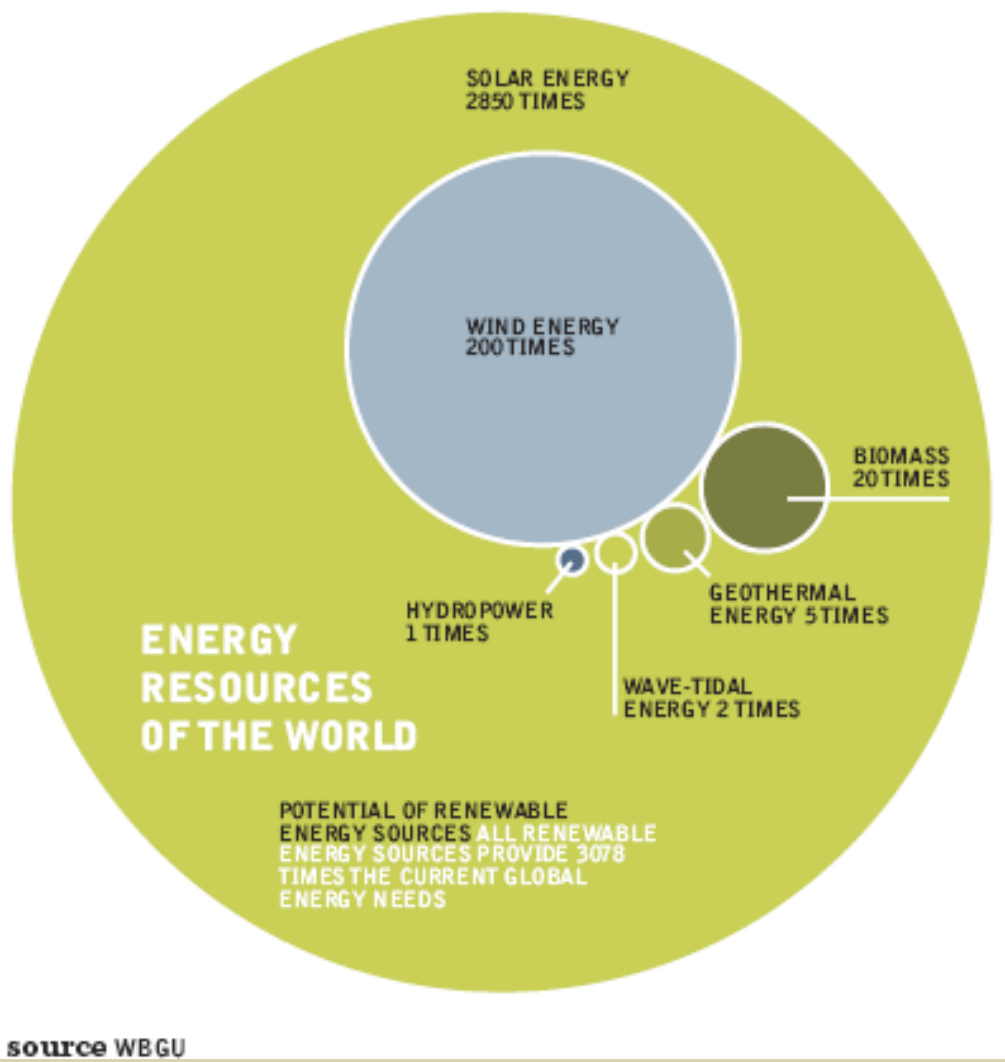
Παγκόσμια Ενεργειακή Ανασκόπηση

The world we live in...



THE AMOUNT OF POWER THAT CAN BE ACCESSED WITH CURRENT TECHNOLOGIES SUPPLIES A TOTAL OF 5.9 TIMES THE GLOBAL DEMAND FOR POWER

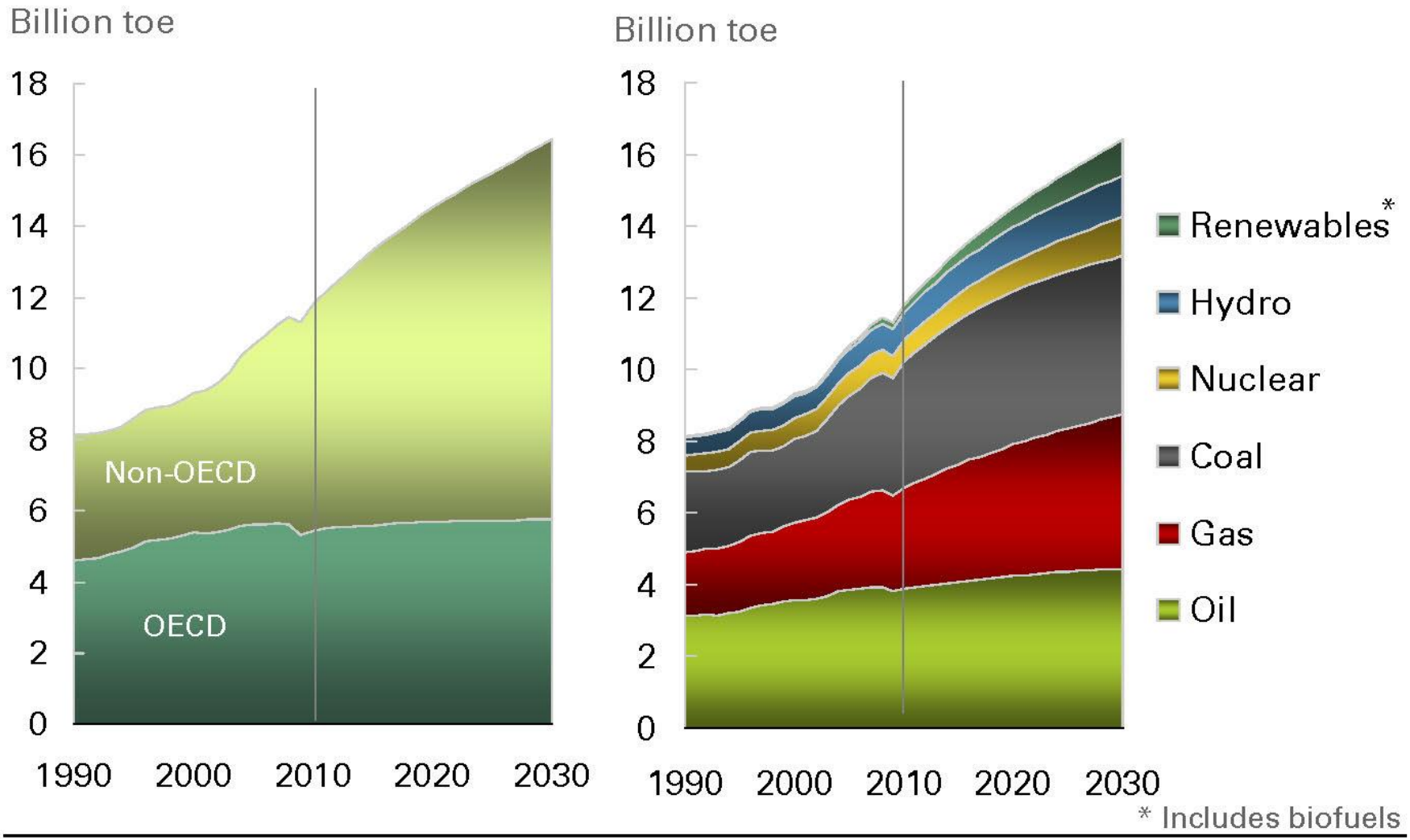


Sun	3.8 times
Geothermal heat	1 time
Wind	0.5 times
Biomass	0.4 times
Hydrodynamic power	0.15 times
Ocean power	0.05 times

source DR. JOACHIM NITSCH

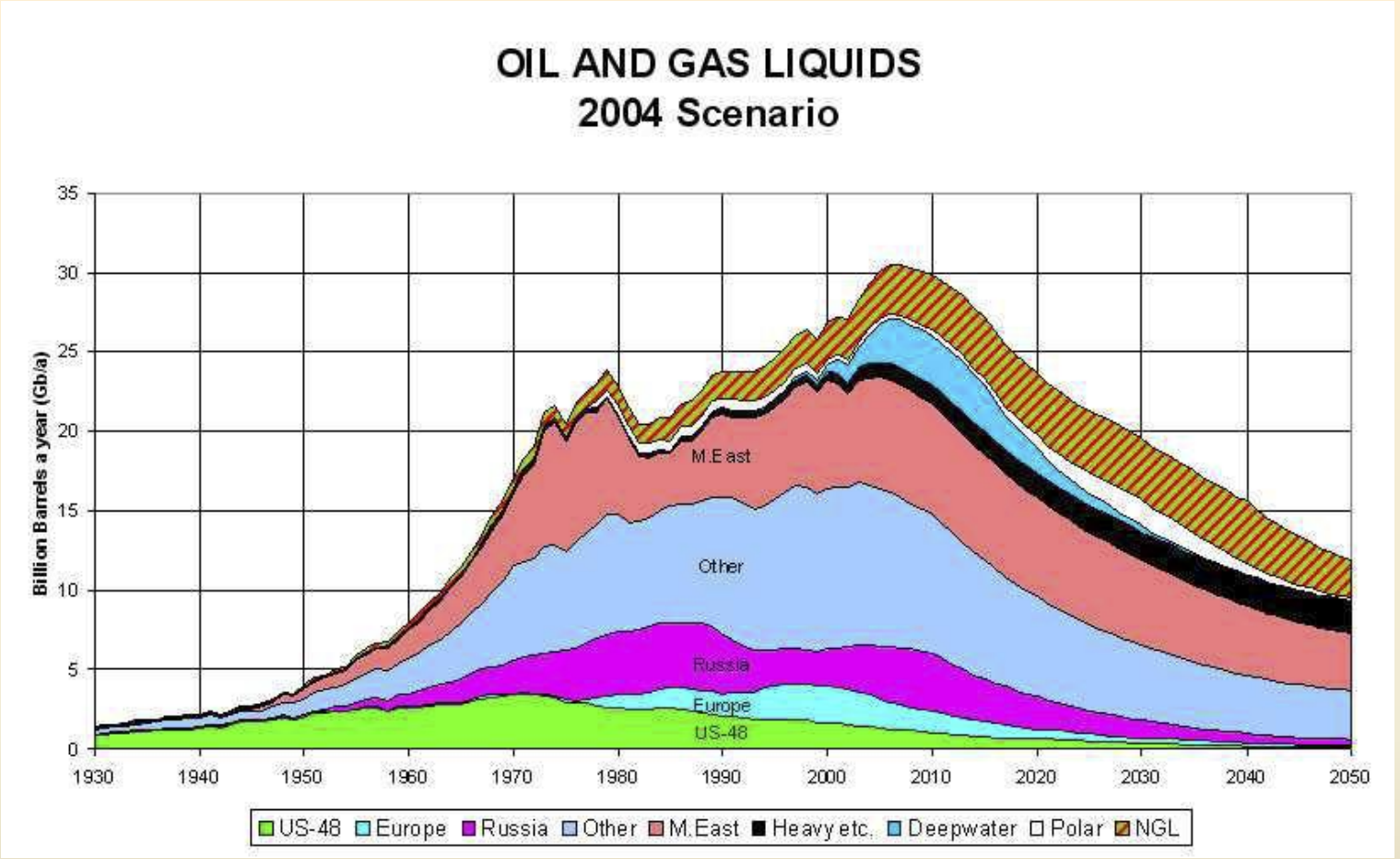
technically accessible today

Non-OECD economies drive consumption growth…



Towards a Long-lasting «sustainable» Energy Crisis

It is certain that the supply of cheap, conventional oil will peak and decline this century, but the argument is about when the peak will come and decline set in.



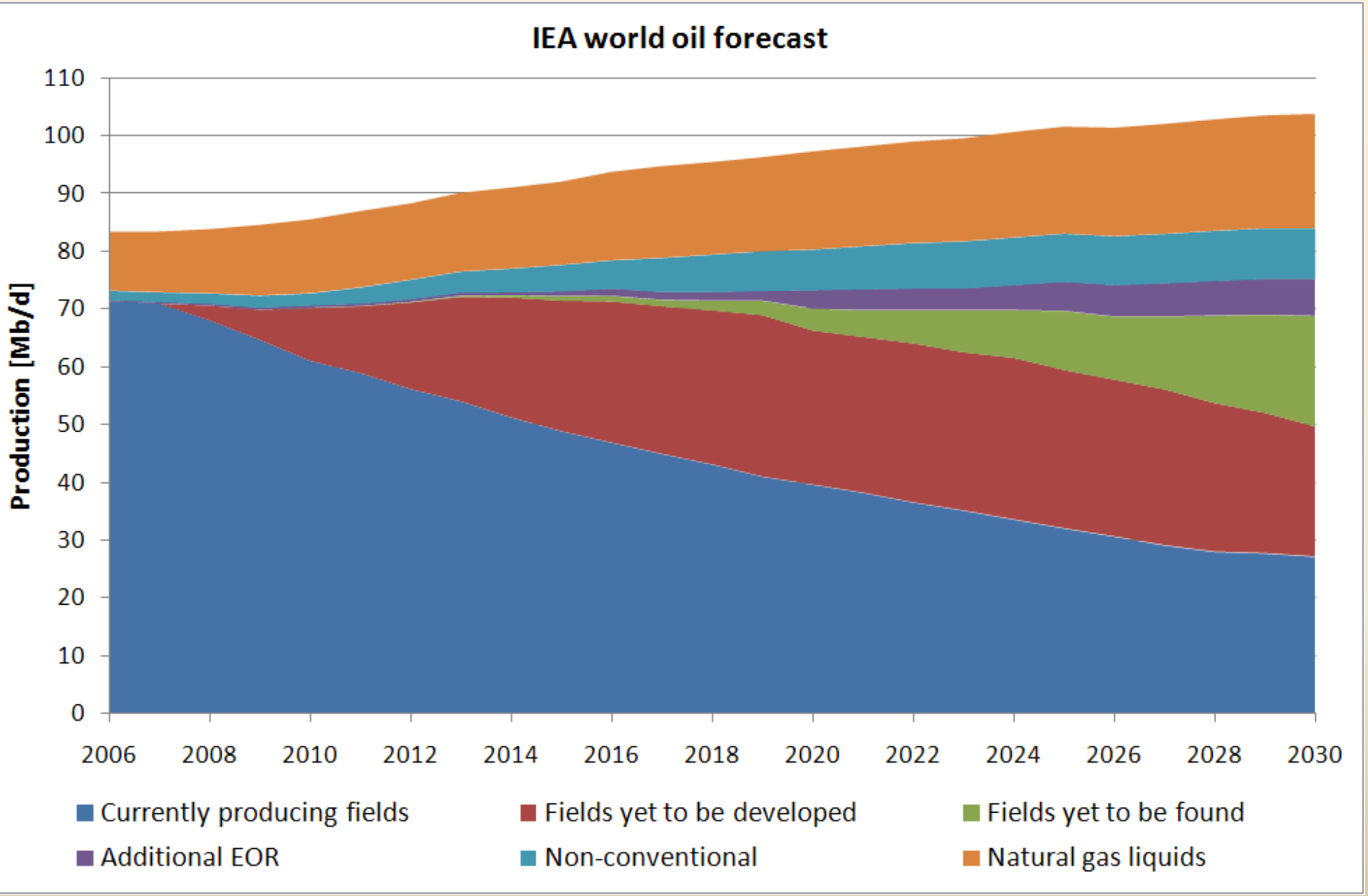
The peak of conventional oil supply was predicted to be at 2008. The US, EU, Indonesia, and many others will be almost out of oil by 2020. Total supply will be less than today by 2020. (ASPO)

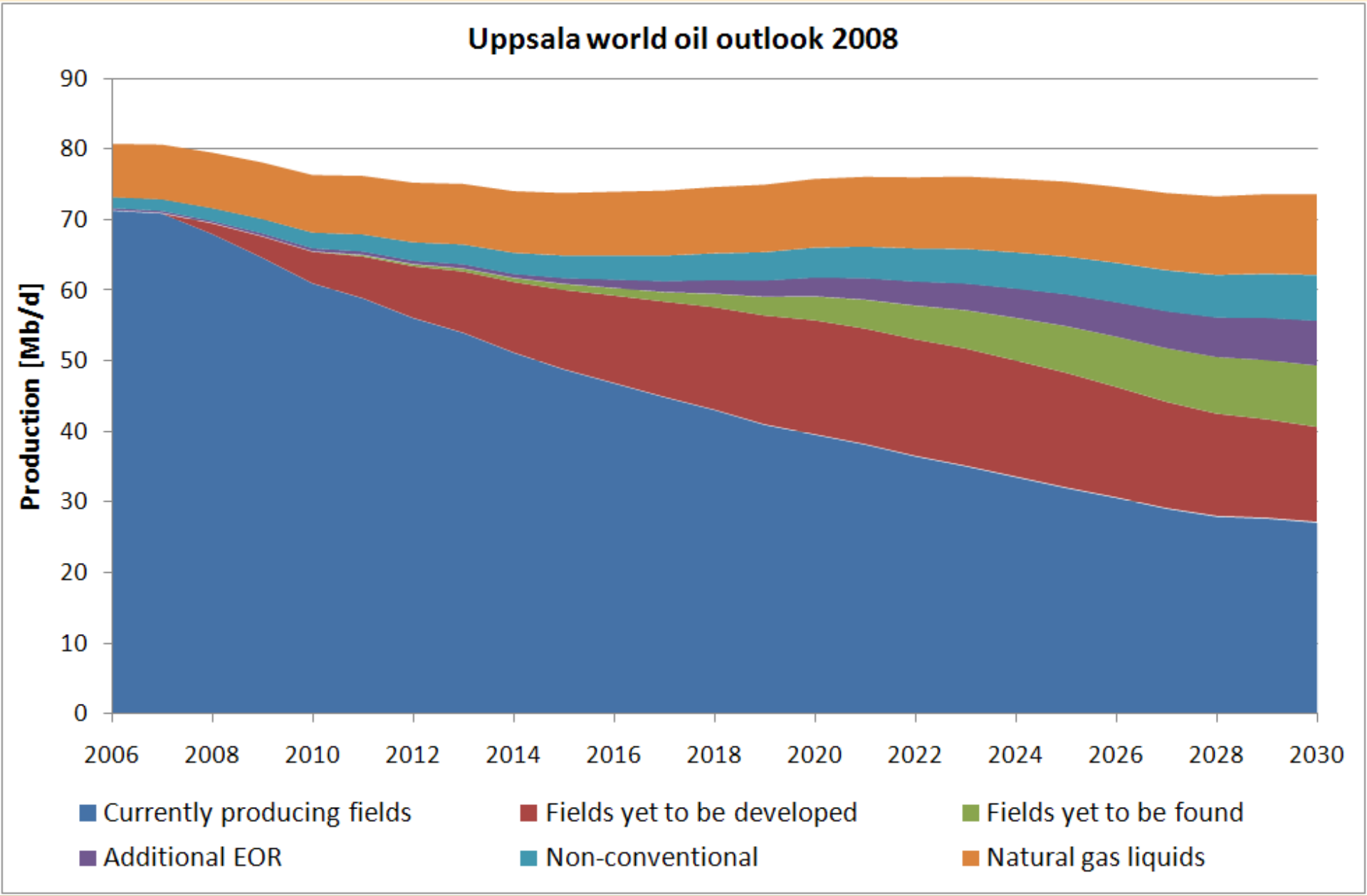
Source: The Coming Energy Winter: II. Resolving Uncertainty about the Oil Peak, Brendan McNamara, Leabrook Computing, Bournemouth, November 15, 2004

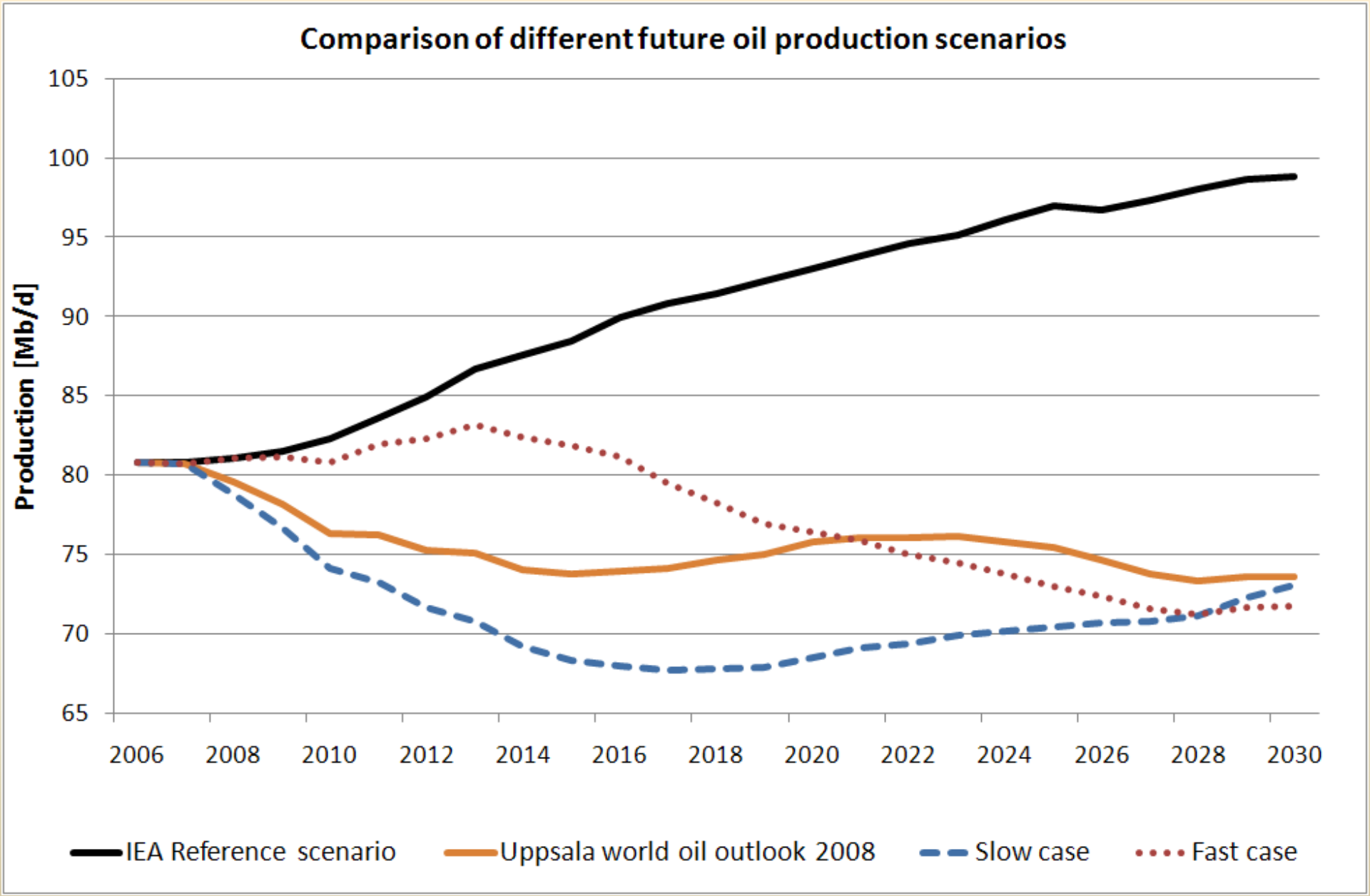
Towards a Long-lasting «sustainable» Energy Crisis

Crude oil prices since 1861

Source: BP Statistical Review of World Energy 2007 Christof Rühl 12 June, 2007

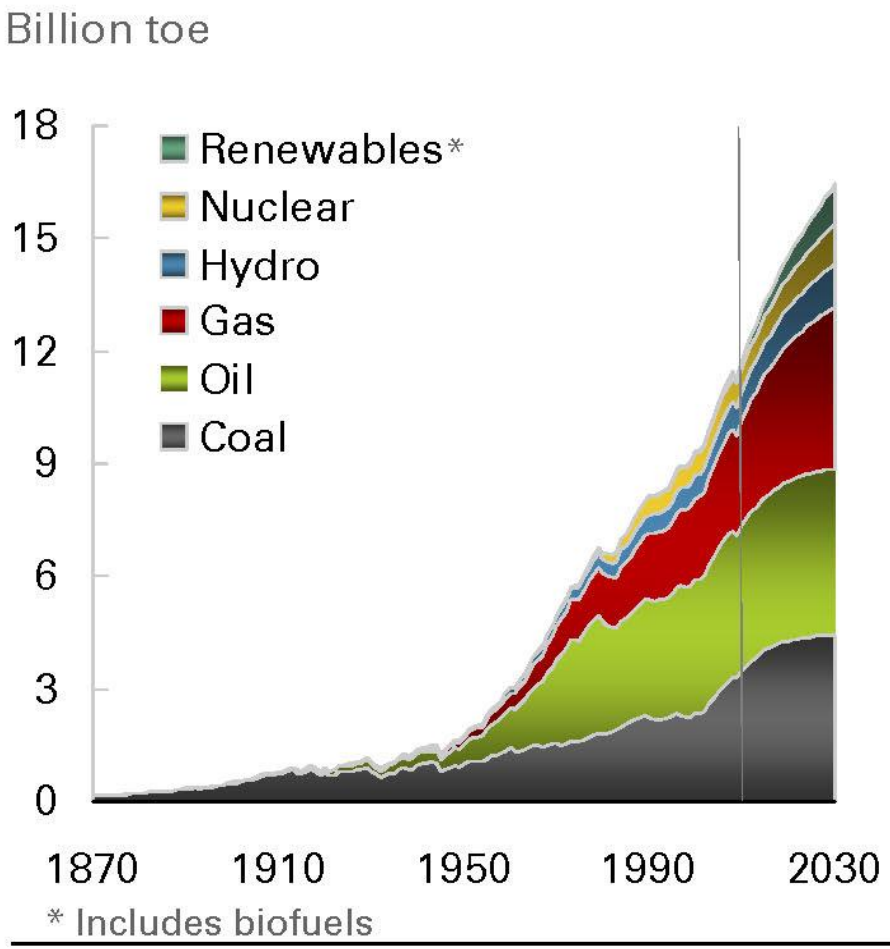

IEA world oil forecast
Production [Mb/d]
110
100
90
80
70
60
50
40
30
20
10
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
Currently producing fields
Fields yet to be developed
Fields yet to be found
Additional EOR
Non-conventional
Natural gas liquids


Uppsala world oil outlook 2008
Production [Mb/d]
90
80
70
60
50
40
30
20
10
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
Currently producing fields
Fields yet to be developed
Fields yet to be found
Additional EOR
Non-conventional
Natural gas liquids


Comparison of different future oil production scenarios
Production [Mb/d]
105
100
95
90
85
80
75
70
65
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
IEA Reference scenario
Uppsala world oil outlook 2008
Slow case
Fast case

The long view: Energy consumption and fuel mix...

World commercial energy use



Contribution to total energy growth

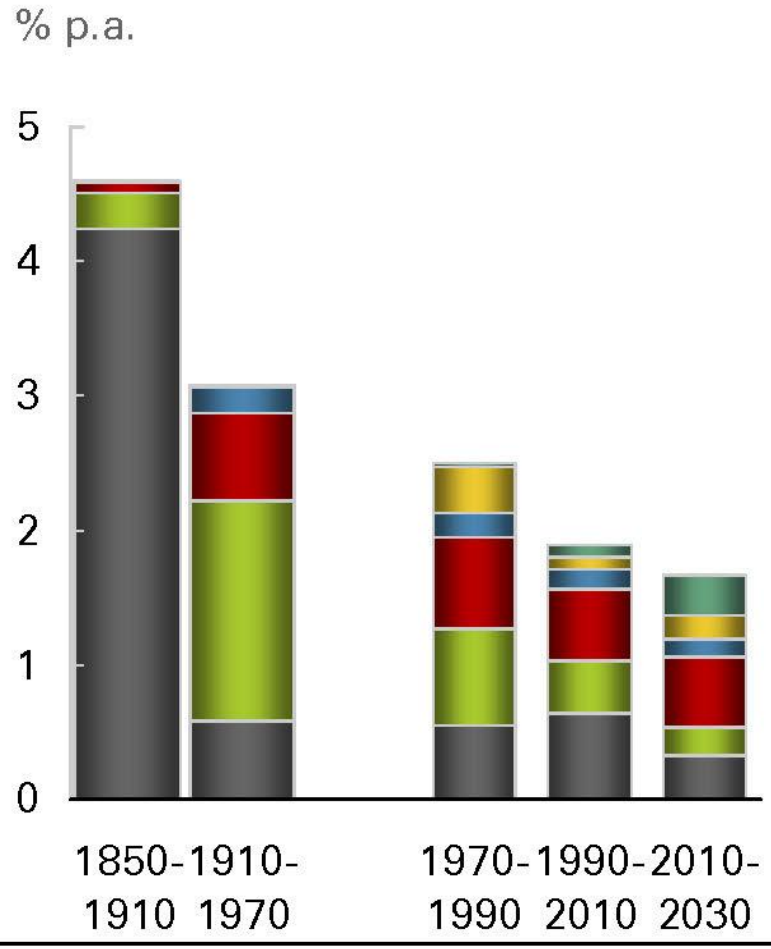
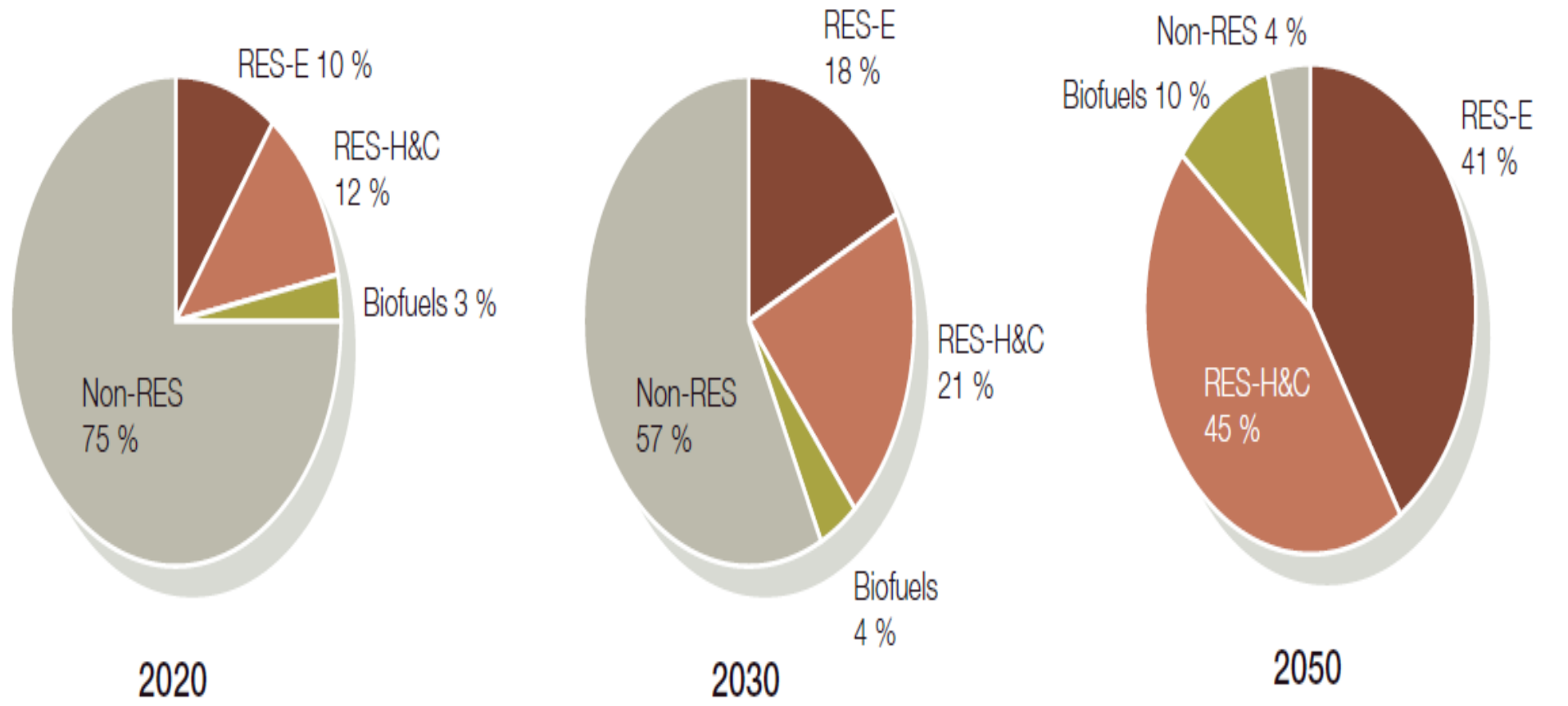


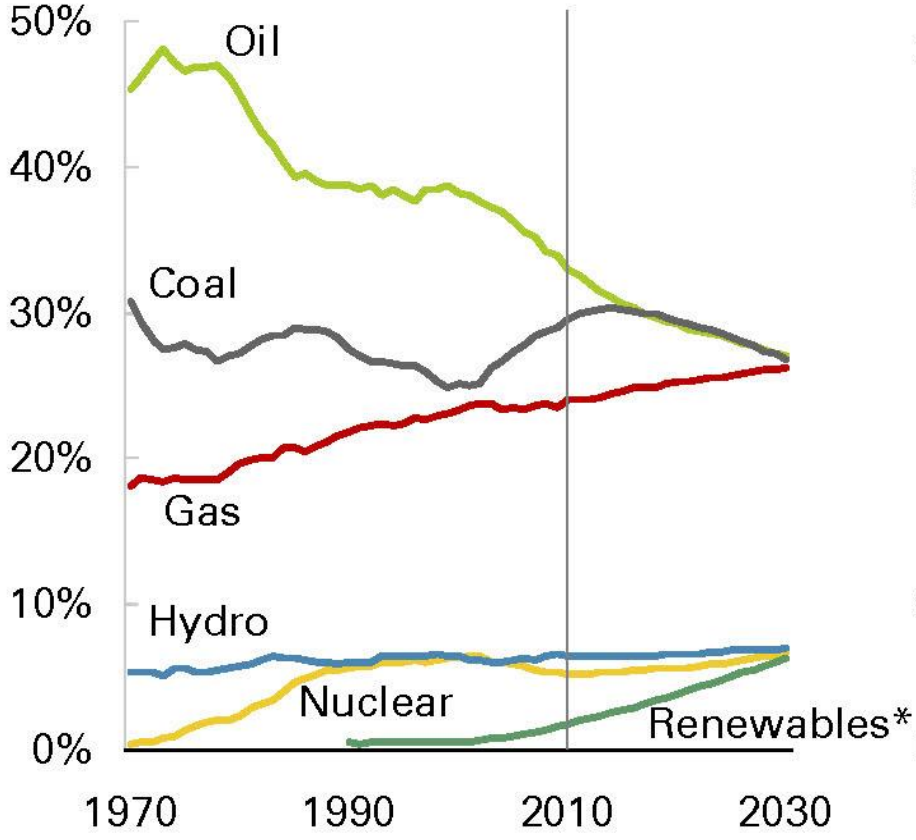
Figure 14 Contribution of Renewable Energy to Final Energy Consumption by Sector (Mtoe)



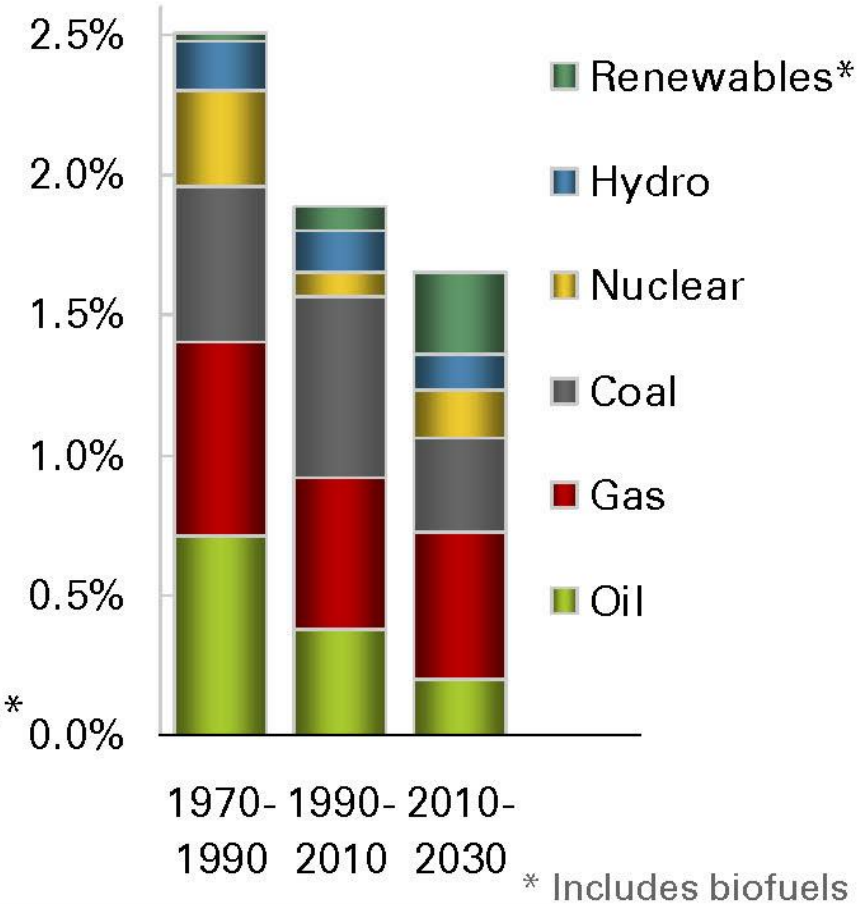
Source: EREC

Gas and renewables win as fuel shares converge...

Shares of world primary energy



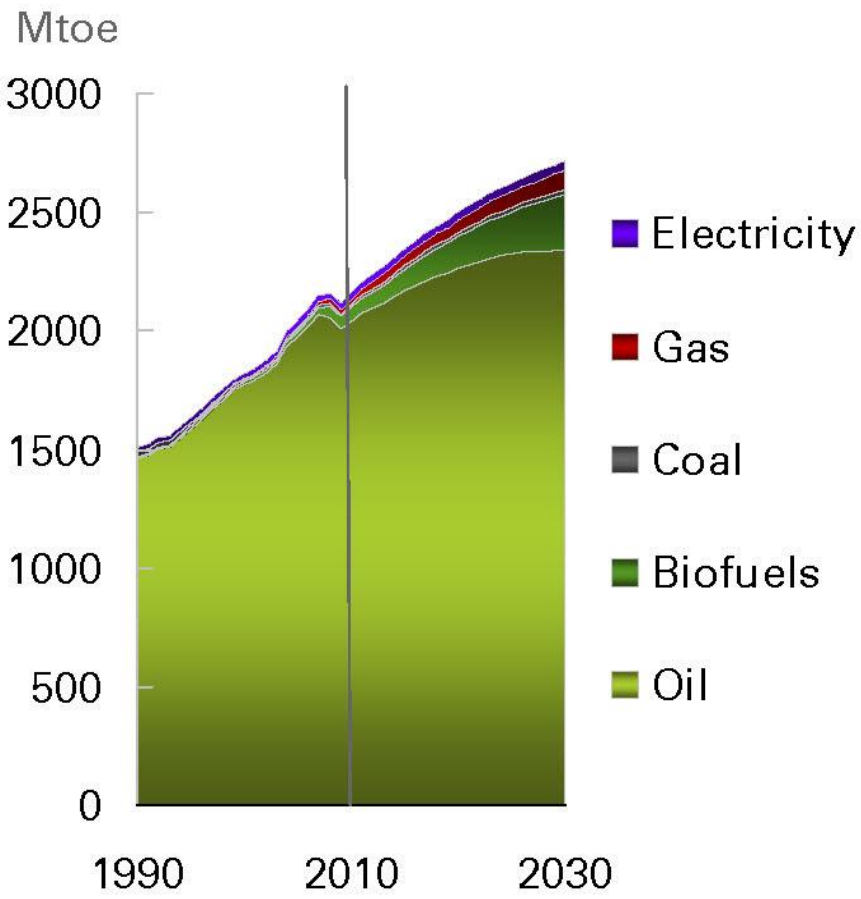
Contributions to growth



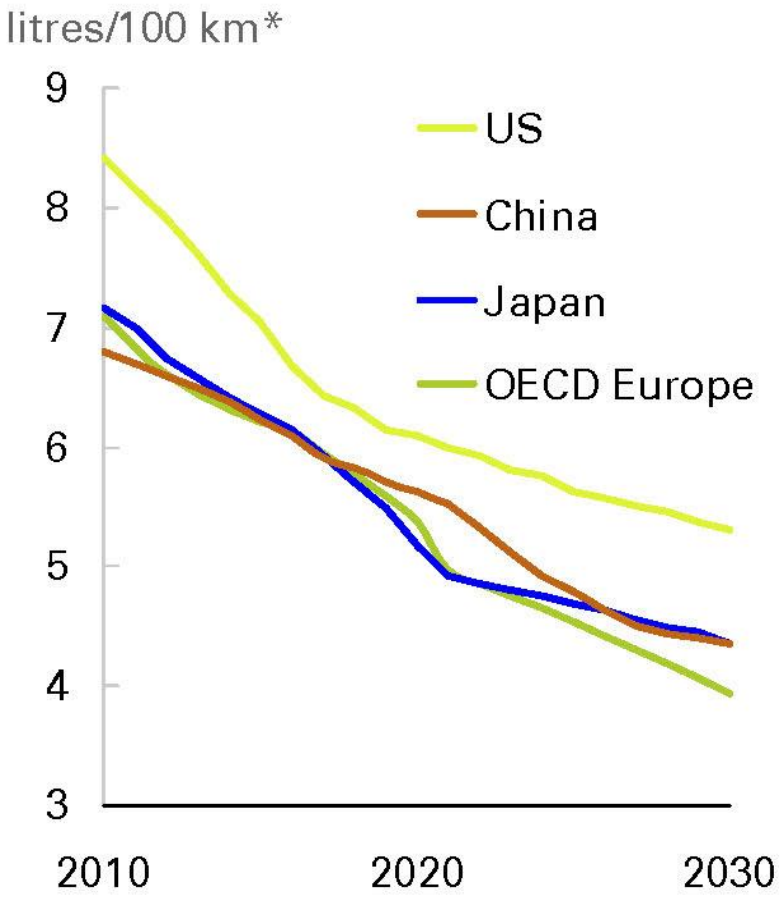
* Includes biofuels

Oil growth in the transport sector slows...

Energy in transport

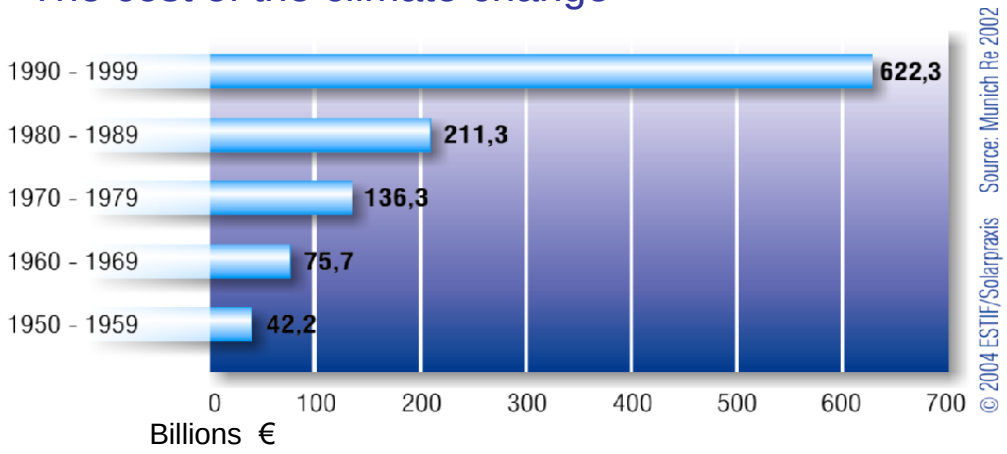


Passenger car fuel economy

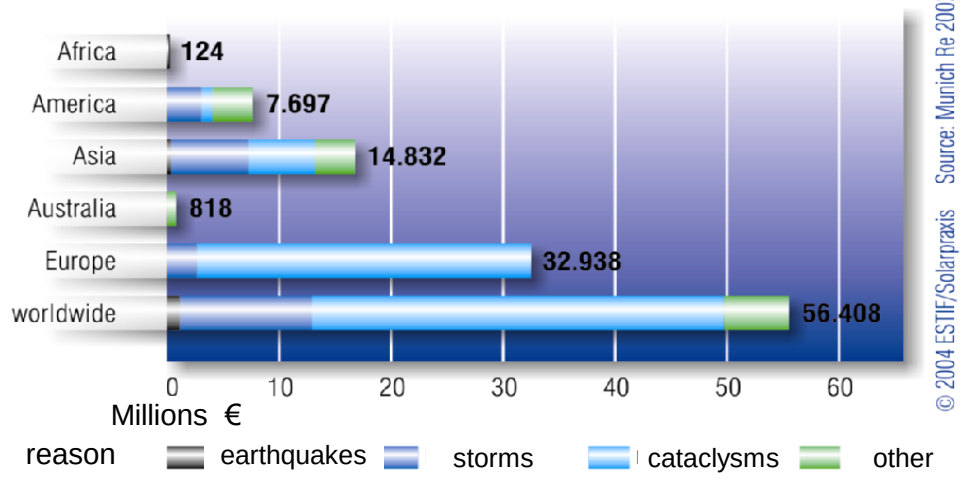


The environmental dimension

The cost of the climate change



Environmental damages (Jan.-Sept. 2002



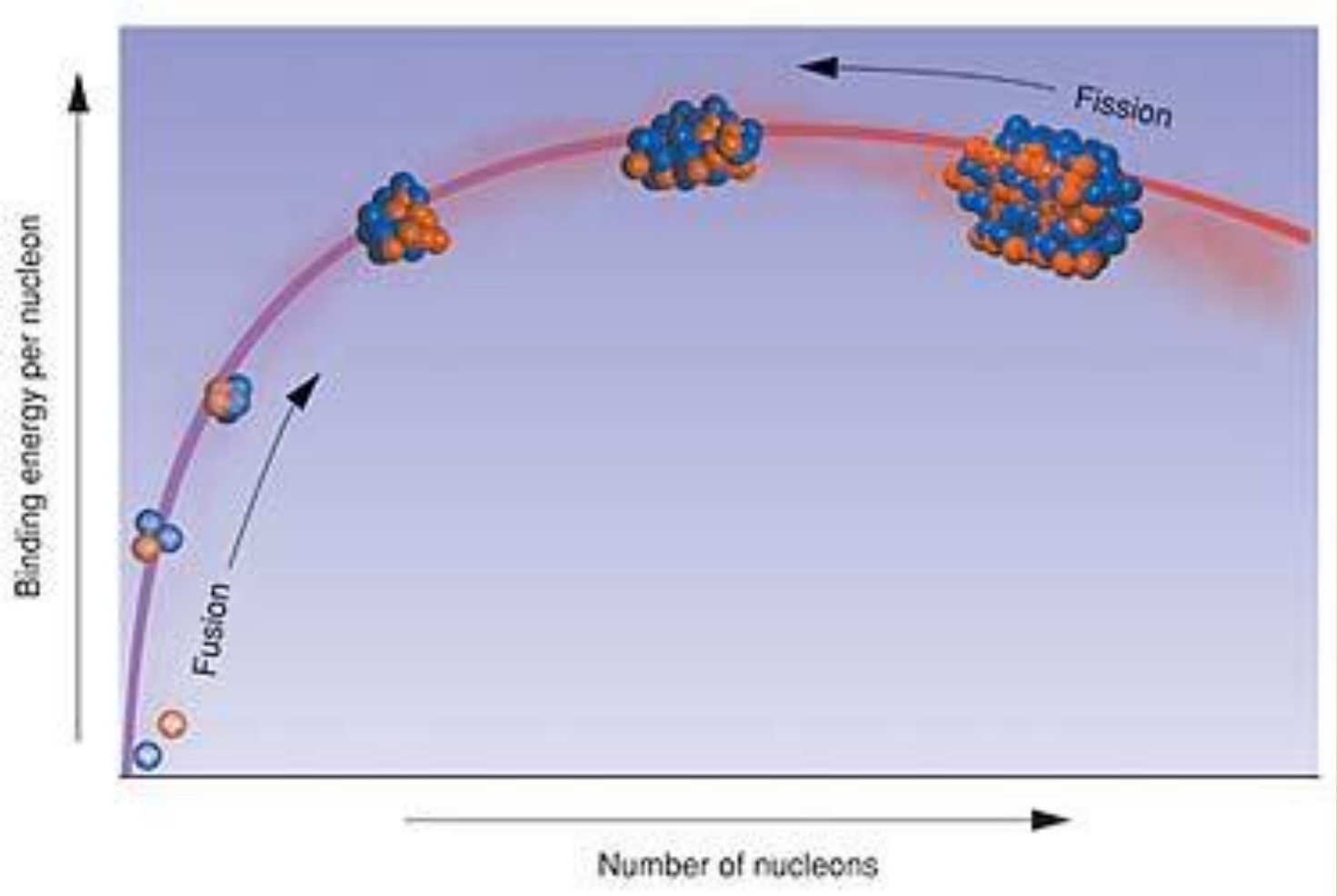
YEAR	GLOBAL TEMPERATURE ANOMALY	RANK
1998, 2005	+0.63°C	1
2003	+0.56°C	2 (tie)
2002	+0.56°C	2 (tie)
2004	+0.54°C	4
2001	+0.51°C	5
1997	+0.47°C	6
1995	+0.40°C	7 (tie)
1990	+0.40°C	7 (tie)
1999	+0.38°C	9
2000	+0.37°C	10

source NATIONAL CLIMATIC DATA CENTER

top 10 warmest years between 1850 and 2005 compared to mean global temperature 1880-2003

Towards a Long-lasting «sustainable» Energy Crisis

IS FISSION OR FUSION OUR FUTURE SOLUTION ?



Towards a Long-lasting «sustainable» Energy Crisis

The current R/P ration for nuclear power is about 15 years if we consider suitable high-grade ores. This would drop to three years if we were able to produce all electricity from nuclear. The only way to avoid this is to use fast-breeder reactors which reprocess spent fuel to create more fuel. Unfortunately this fuel is plutonium, one of the most toxic materials known and a basis for nuclear weapons. Few fast-breeders have been constructed and they have been extremely expensive due to the high safety standards needed. Breeder reactors will not become available for large-scale power generation within the next three decades.

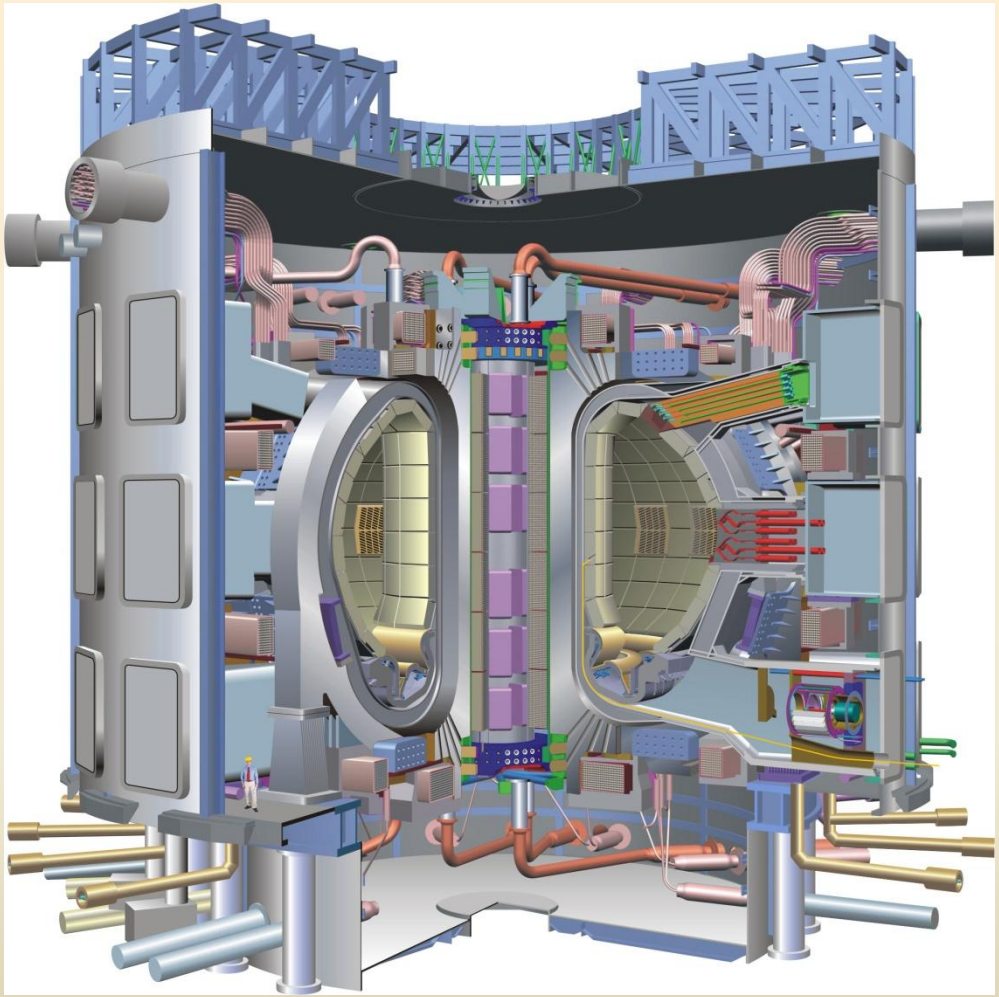
It makes sense for the nuclear plants that are already in existence to be continued and extended if possible, since the cost and pollution from their construction has already occurred. But it would not be wise to go down the road of building new power stations for what can only be a short-term solution (if it is a solution). It would be better to plough the vast costs that would be needed into increasing energy efficiency and renewable sources.

Towards a Long-lasting «sustainable» Energy Crisis

«Prospects for practical applications of fusion power to solve our energy problems appear dubious on engineering grounds.»

«Even, if a practical means of generating a sustained, net power-producing fusion reaction were found, prospects of excessive plant cost per unit of electric output, requirement for reactor vessel replacement, and need for remote maintenance for ensuring vessel vacuum integrity lie ahead. What executive would invest in a fusion power plant if faced with any one of these obstacles? It's time to sell fusion for physics, not power.»

W. E. Parkins, Fusion Power: Will It Ever Come?, SCIENCE VOL 311 (2006) 1380



William E. Parkins worked on uranium separation at the University of California during World War II and later was chief scientist at Rockwell International. This paper was edited to shorter length by the Editor-in-Chief from a manuscript received just before Parkins's death.

Oil Alternatives

Renewable Energy Sources

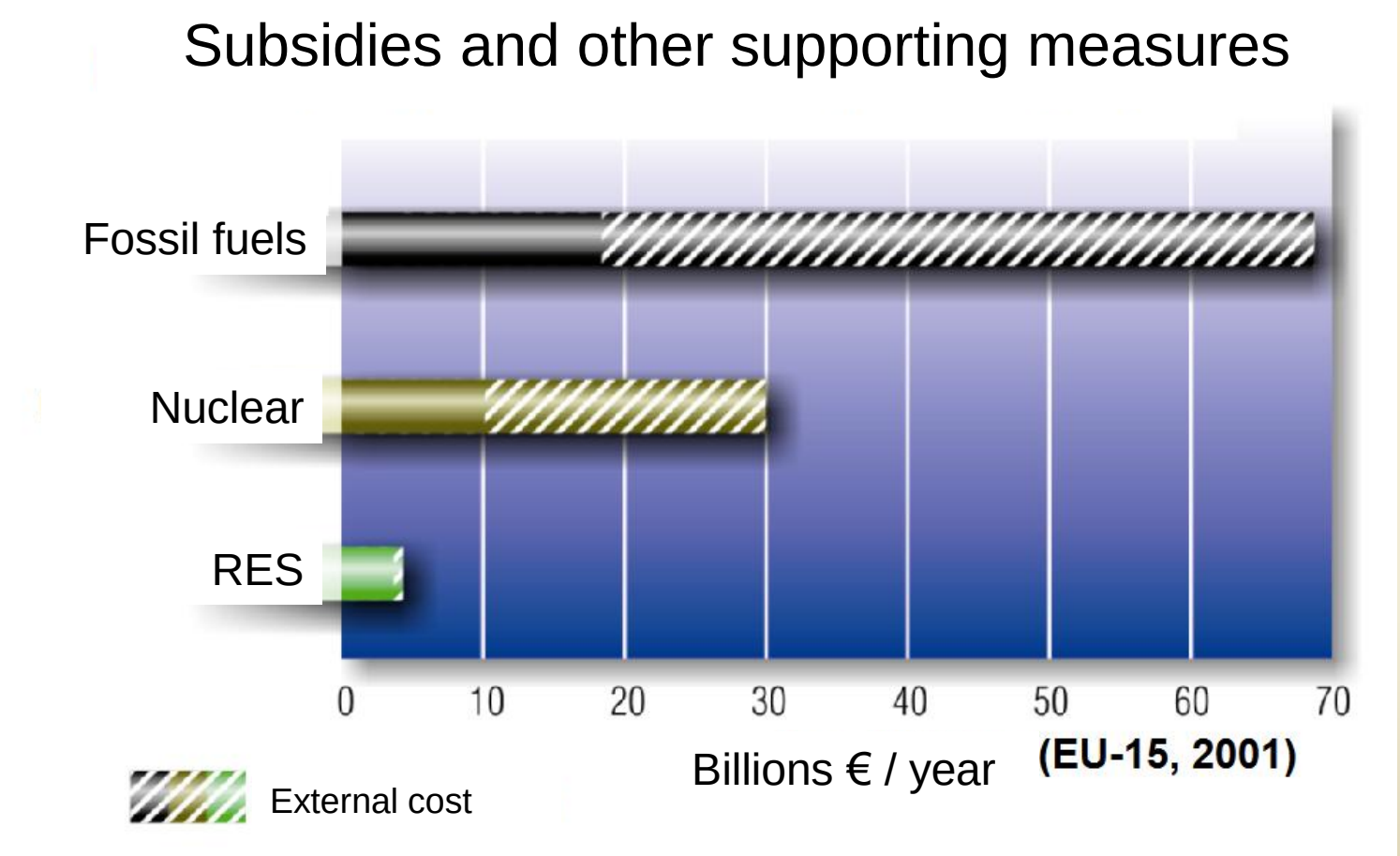
Conservation & Efficiency

BioFuels

Hydrogen Fuel Cells/Electric Cars


Value added services
Forecast information
Off-shore wind
Small hydro power
Solar power plant
Hydro power station
Biomass
Low emission power plant
control
mmunication
HVDC link
Transformer
Microgrid
Wave energy
Residential CHP
Solar
Photovoltaic
Underground info and power transmission
H_2 production and filling station
H_2
Demand side management
HP
Micro storage of electricity
Thermal storage
SMES
Fuel cells
Compressed hydrogen storage

Are R.E.S. over-subsided ?



Sources: - Peter Palinka, Stoa, Directorate A, European Parliament
- F. H. Oosterhuis, "Energy Subsidies in the European Union" Report commissioned by the European Parliament

Figure 1. Renewable Energy Share of Global Final Energy Consumption, 2009

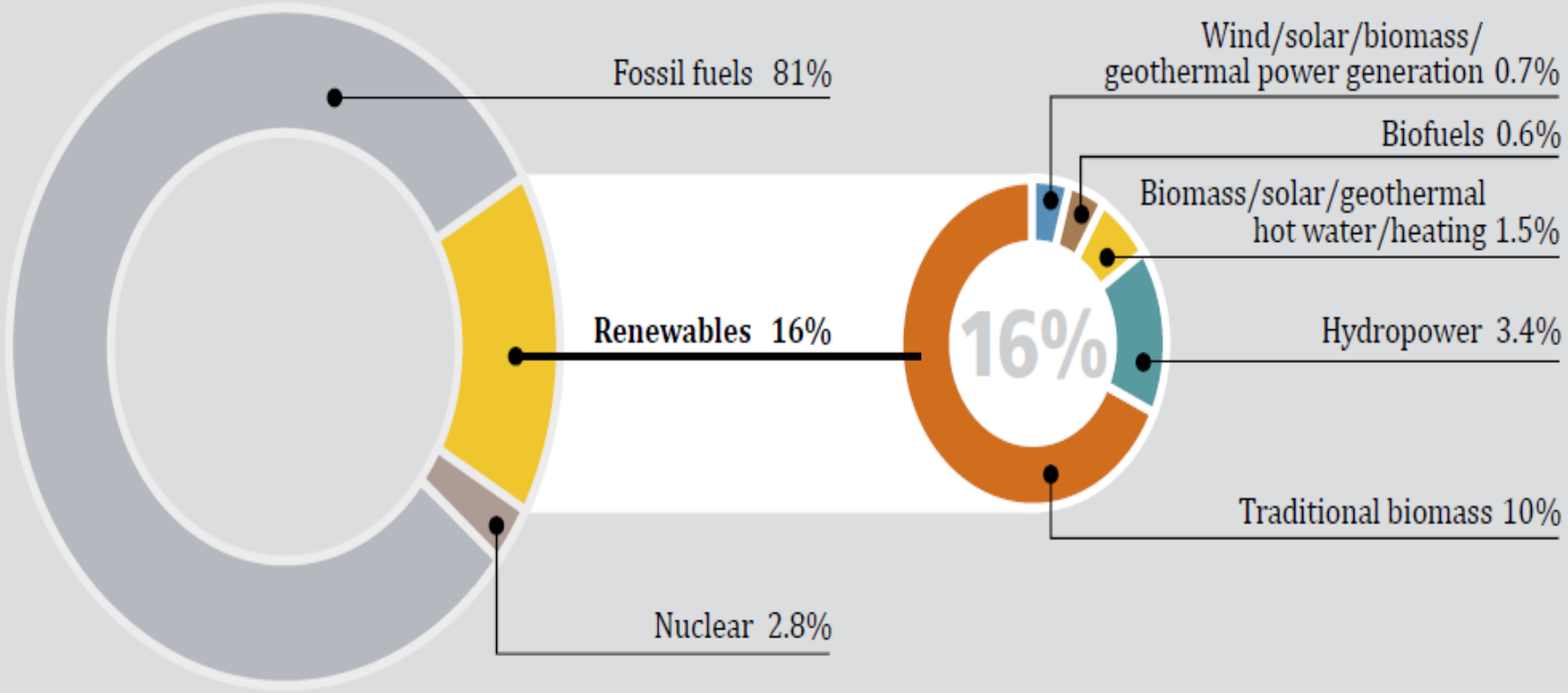


Figure 3. Renewable Energy Share of Global Electricity Production, 2010

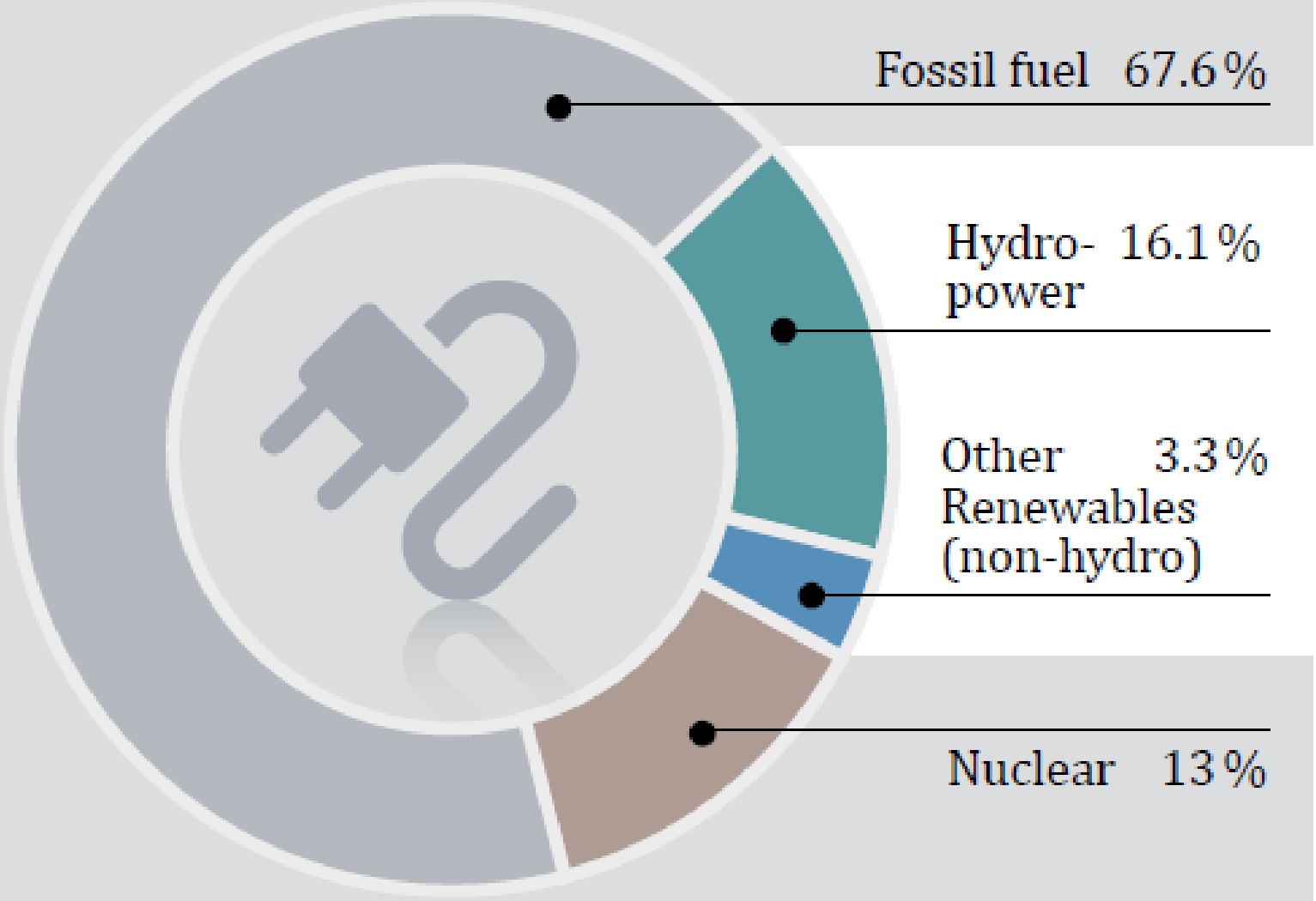


Table 1 Renewable Energy Sources and Technologies

	Electricity	Heating and Cooling	Transport
Wind	Onshore Offshore		
Hydro	Small Hydropower (<10MW) Large Hydropower (>10MW)		
Solar	Photovoltaics (PV) Concentrated Solar Power (CSP)	Solar Thermal	
Ocean	Wave; Tidal; Thermal; Osmotic		
Geothermal	Conventional Geothermal Electricity (hydrothermal); Electricity ORC and Kalina Cycle; Enhanced goethermal systems (EGS); Supercritical fluids	Direct Use Ground Source Heat Pumps	
Bioenergy	Biomass Biogas	Biomass Biogas	Bioethanol Biodiesel Biogas

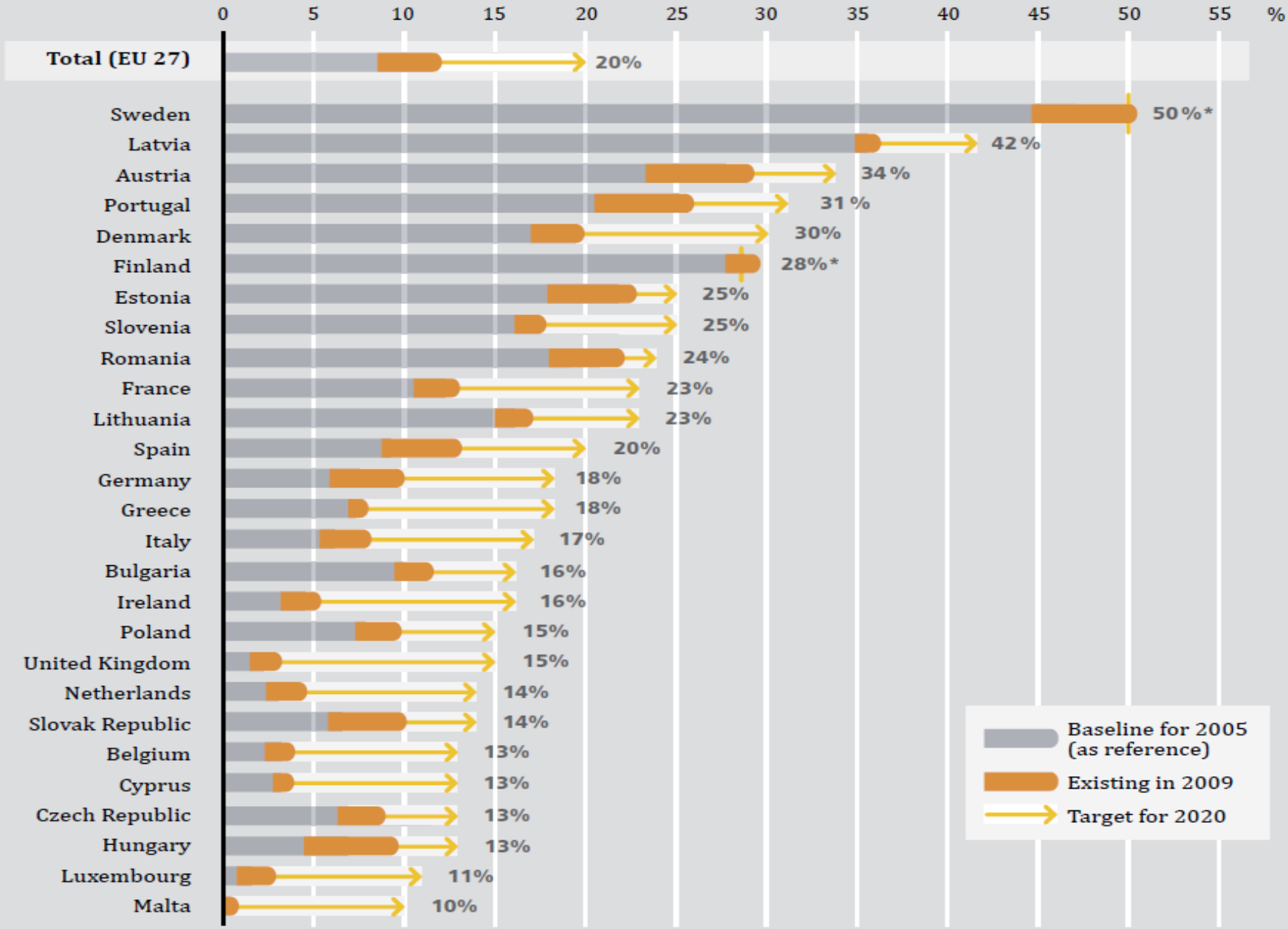


Figure 15. EU Renewable Shares of Final Energy, 2005 and 2009, with Targets for 2020
0
5
10
15
20
25
30
35
40
45
50
55
%
Total (EU 27)
20%
Sweden
50%*
Latvia
42%
Austria
34%
Portugal
31%
Denmark
30%
Finland
28%*
Estonia
25%
Slovenia
25%
Romania
24%
France
23%
Lithuania
23%
Spain
20%
Germany
18%
Greece
18%
Italy
17%
Bulgaria
16%
Ireland
16%
Poland
15%
United Kingdom
15%
Netherlands
14%
Slovak Republic
14%
Belgium
13%
Cyprus
13%
Czech Republic
13%
Hungary
13%
Luxembourg
11%
Malta
10%
Baseline for 2005 (as reference)
Existing in 2009
Target for 2020

Figure 20 Capital Costs of Renewable Energy Technologies Per Unit Installed (2020-2050)

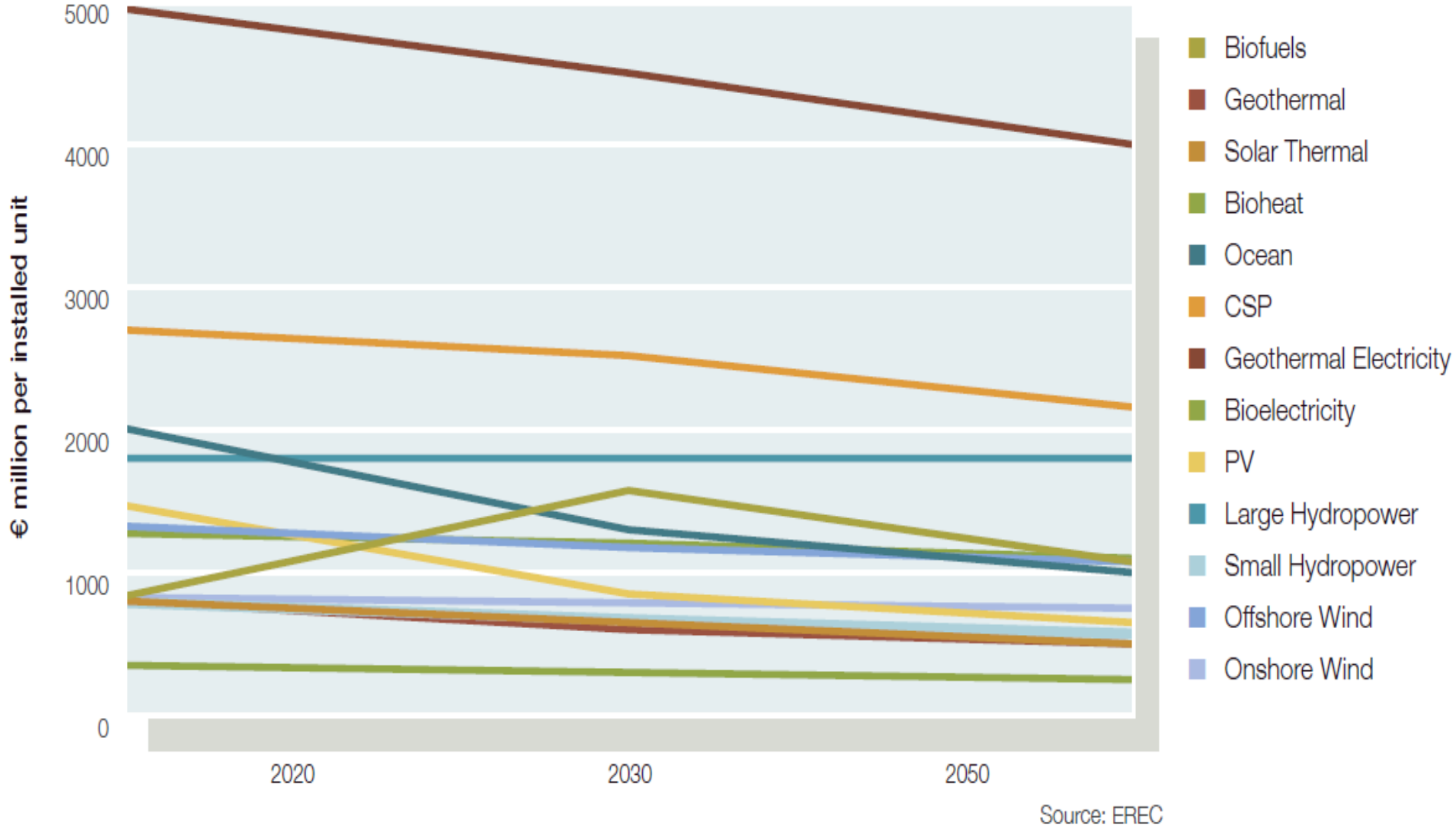
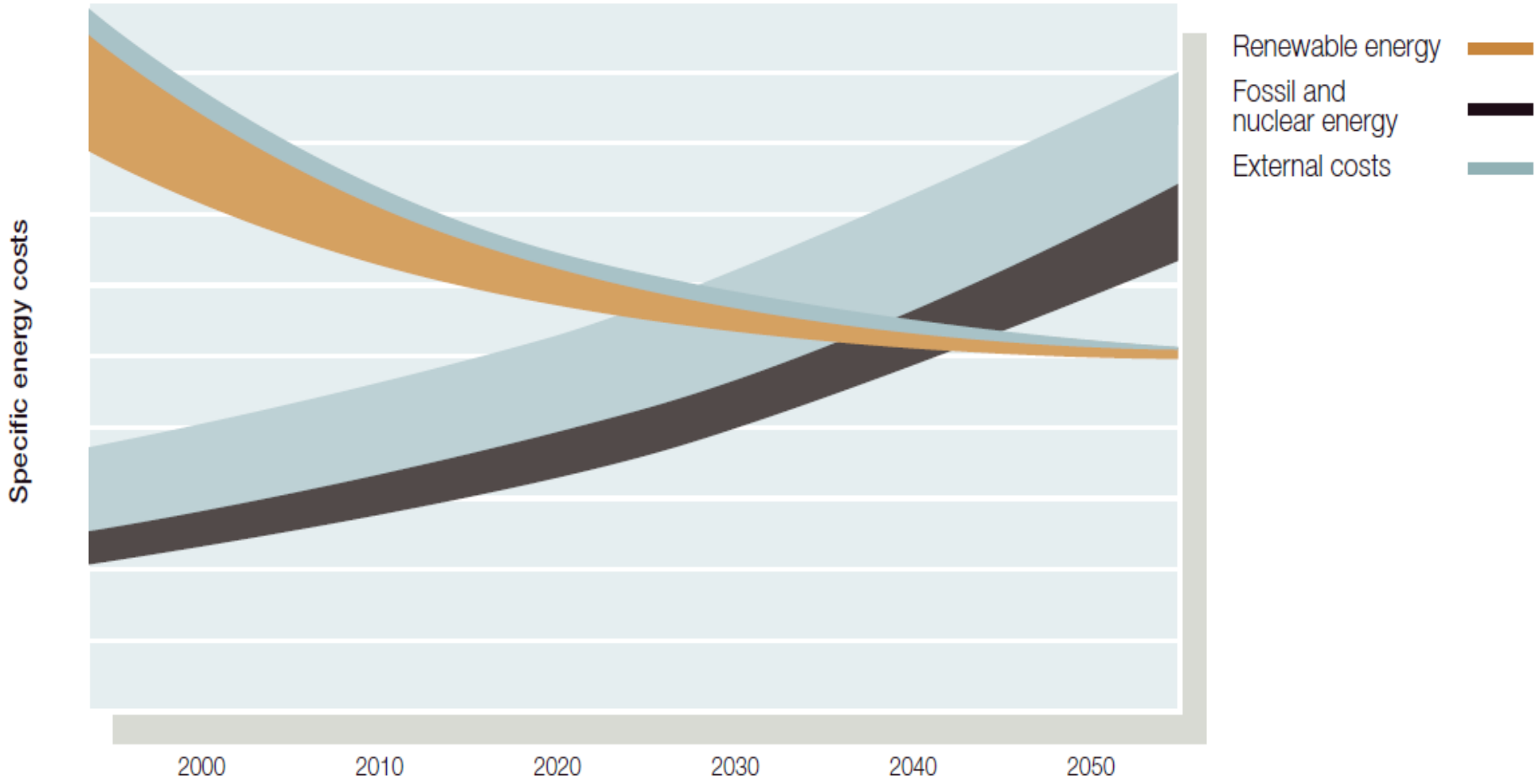


Figure 19 Development of Costs for Renewable and Conventional Energy Sources



Source: DLR

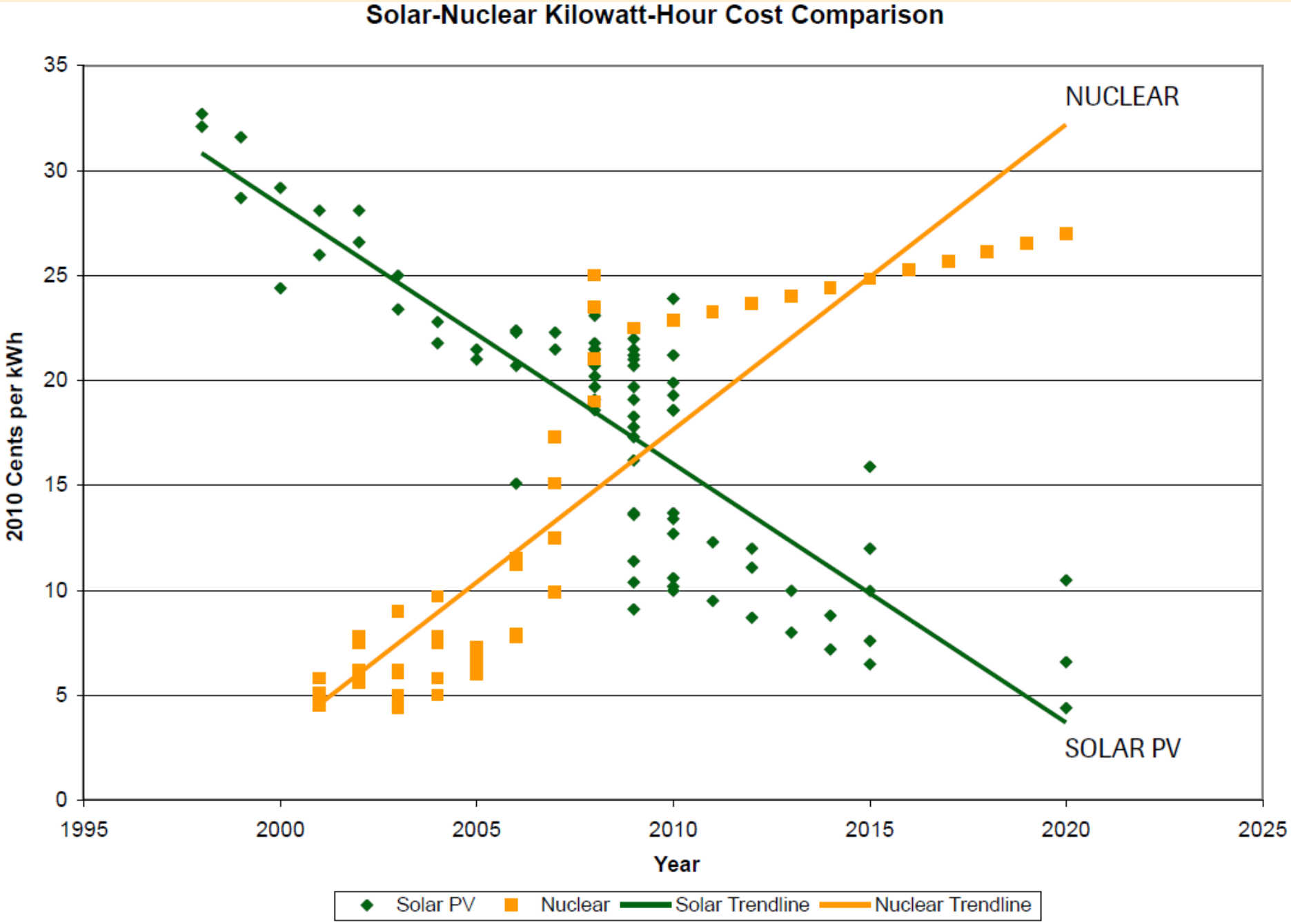

Solar-Nuclear Kilowatt-Hour Cost Comparison
2010 Cents per kWh
35
30
25
20
15
10
5
0
1995
2000
2005
2010
2015
2020
2025
Year
NUCLEAR
SOLAR PV
Solar PV
Nuclear
Solar Trendline
Nuclear Trendline

Figure 4. Renewable Power Capacities*, Developing World, EU, and Top Five Countries, 2010

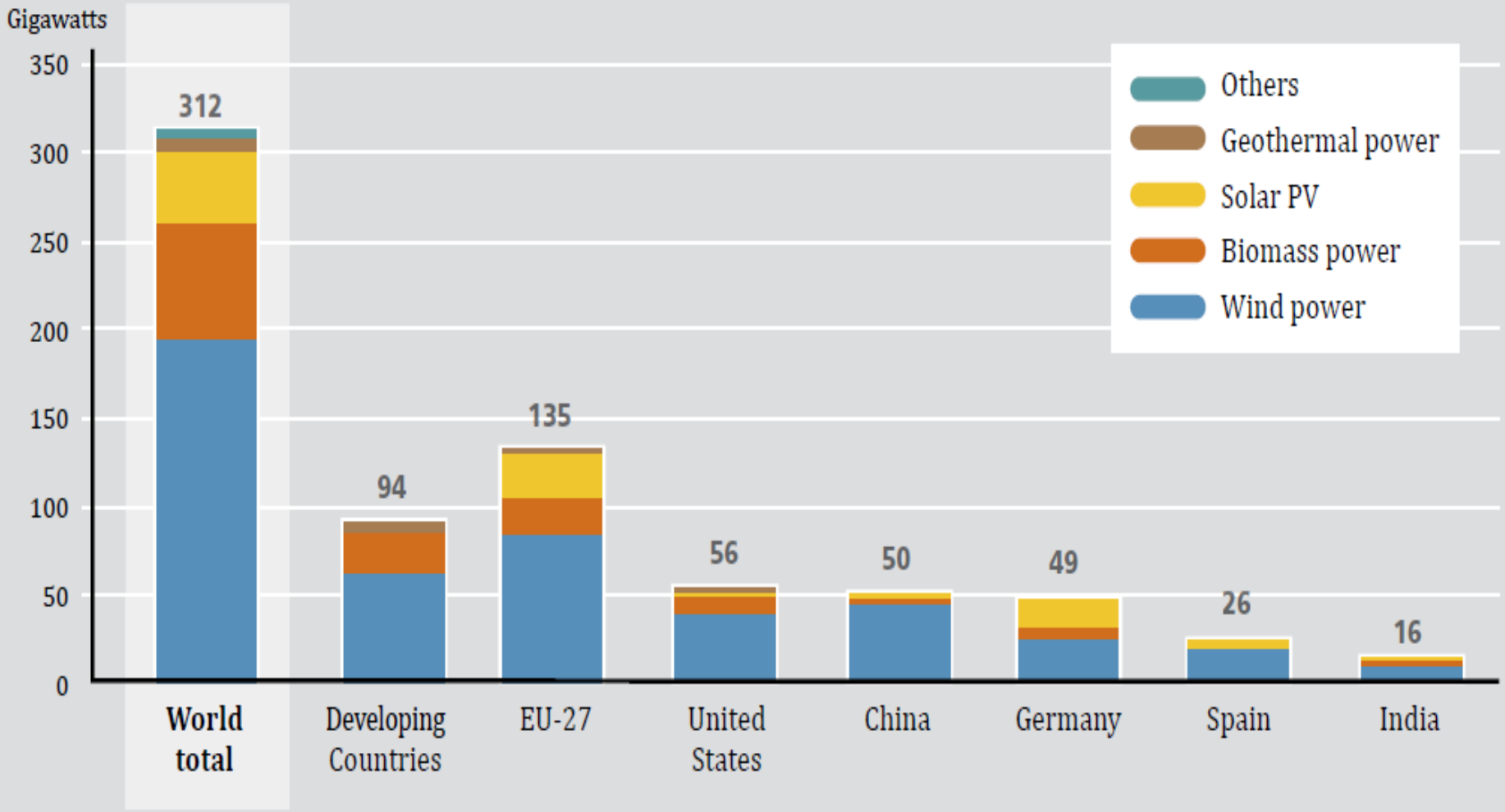
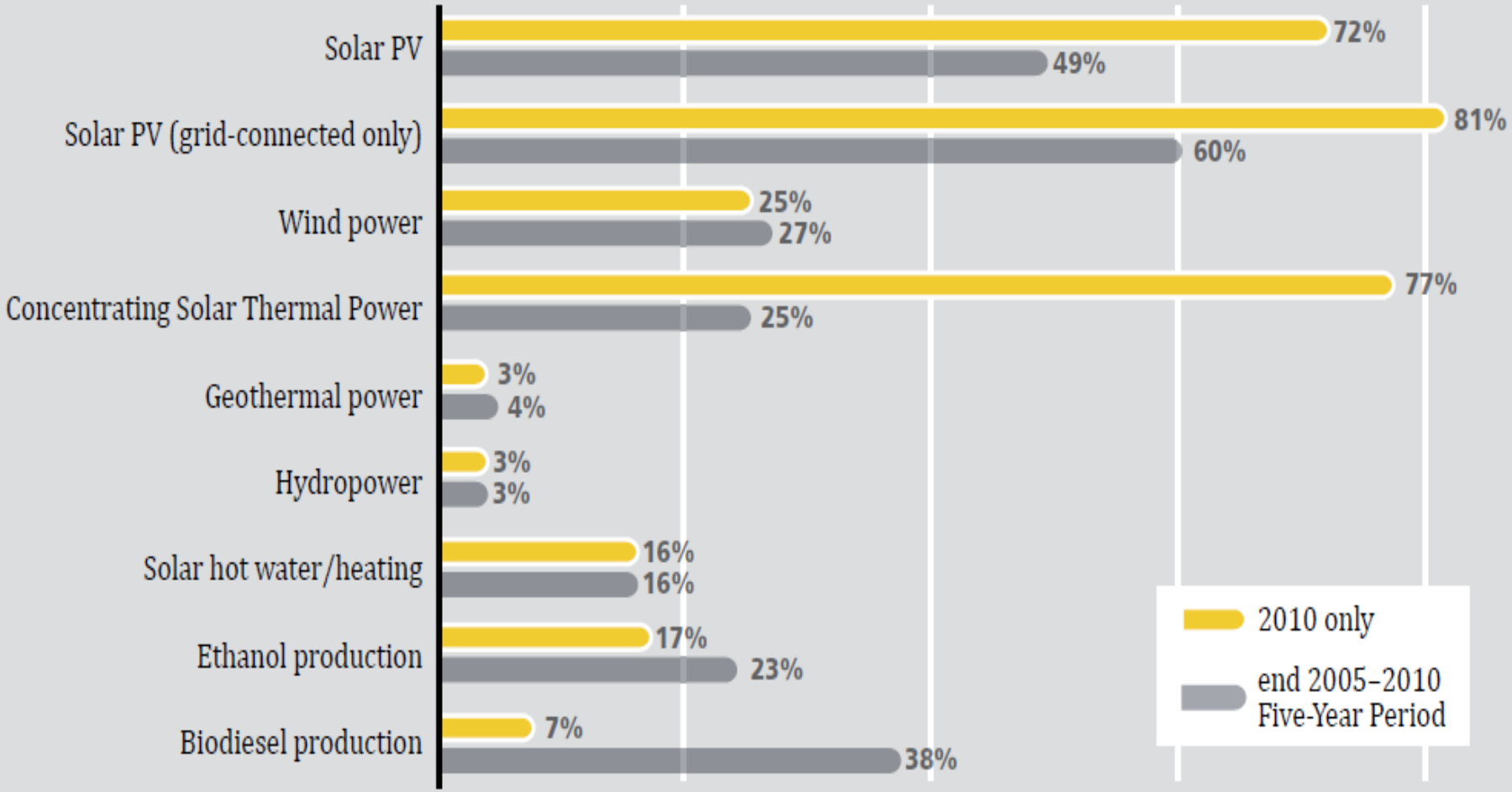


Figure 2. Average Annual Growth Rates of Renewable Energy Capacity and Biofuels Production, 2005–2010



Oil Price Assumption (2010-2050)

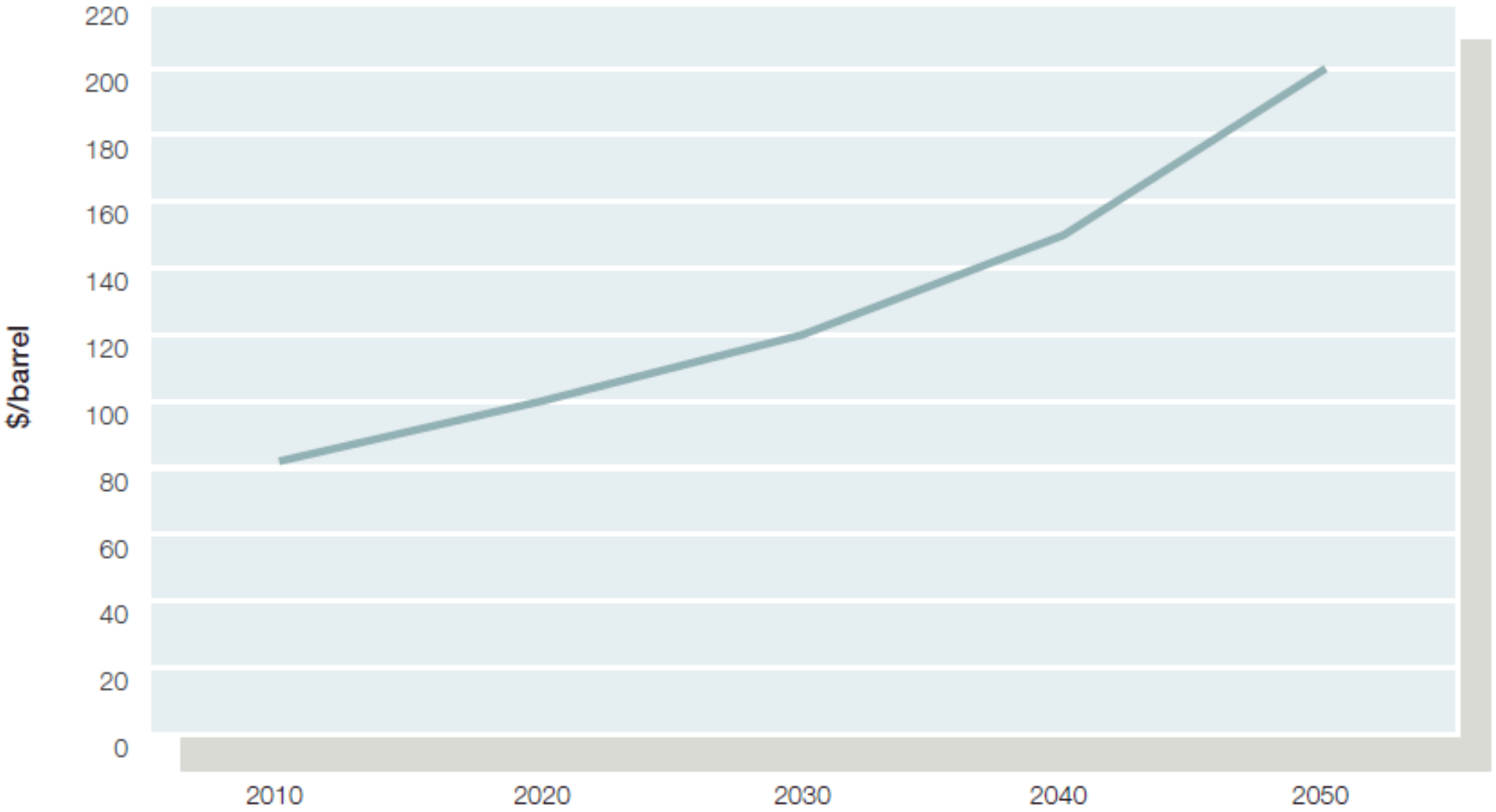


Table 5 Contribution of Renewable Electricity Technologies to Electricity Consumption (TWh)

	2007	2020	2030	2050
Wind	104	477	833	1552
Hydro[1]	325	384	398	448
PV	5.4	180	556	1347
Biomass	102	250	292	496
Geothermal	5.8	31	169	601
CSP	0.8	43	141	385
Ocean	-	5	18	158
Total RES-E (TWh)	543	1,370	2,407	4,987
Total Gross Electricity Consumption				
Eurostat	3,362			
NEP Moderate Price		3,443		
NEP High Price		3,493		
2030 Moderate Price			3,616	
2030 High Price			3,702	
2050 Scenario				4,987*
2050 Aggressive Efficiency				3,491**
Total Share of RES-E (%)	16%	39.2 – 39.8%	65% - 67%	100% - 143%

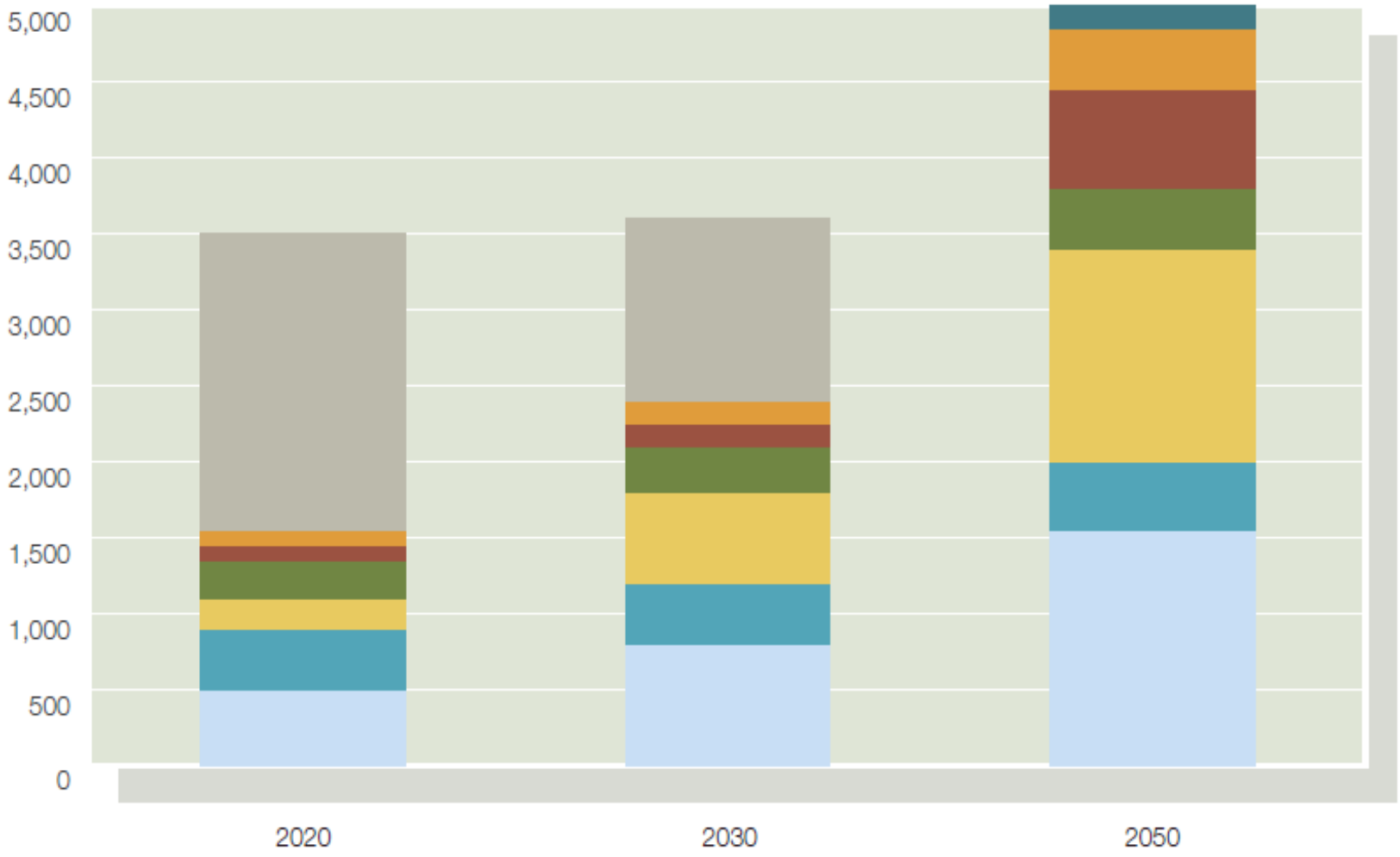
Source: EREC

Table 10 Contribution of Renewable Energy to Final Energy Consumption (Mtoe)

RES Type	2007	2020	2030	2050
Wind	8.9	41	72	133.5
Hydro[1]	27.9	33	34.2	38.5
PV	0.5	15.5	48	116
Bioenergy	77.8	175.5	226	359.1
Geothermal (Electricity and H&C)	1.4	9.7	35.5	188
Solar Thermal	0.9	12	70	122
CSP	0.1	3.7	12.1	33.1
Ocean	-	0.4	1.5	14
TOTAL RES (Mtoe)	118	290.8	499.3	1,004.2
Final Energy Consumption				
Eurostat	1,194.9			
NEP Moderate Price		1,185		
NEP High Price		1,140		
2030 Moderate Price			1,175	
2030 High Price			1,124	
2050 Scenario				1,050
2050 Aggressive Efficiency				735*
Total Share of RES (%)		24.5 – 25.5%	42.4% - 44.4%	96% - 137%

Source: EREC

Figure 8 Contribution of Renewable Electricity Technologies to Electricity Consumption (TWh)



Source: EREC

Table 4 Renewable Electricity Installed Capacity (GW)

	2007	2020	2030	2050
Wind	56	180	288.5	462
Hydro[1]	102	120	148	194
PV	4.9	150	397	962
Biomass	20.5	50	58	100
Geothermal	1.4	4	21.7	77
CSP	0.011	15	43.4	96
Ocean	-	2.5	8.6	65
Total RES-E capacity (GW)	185	521.5	965.2	1,956

Source: EREC

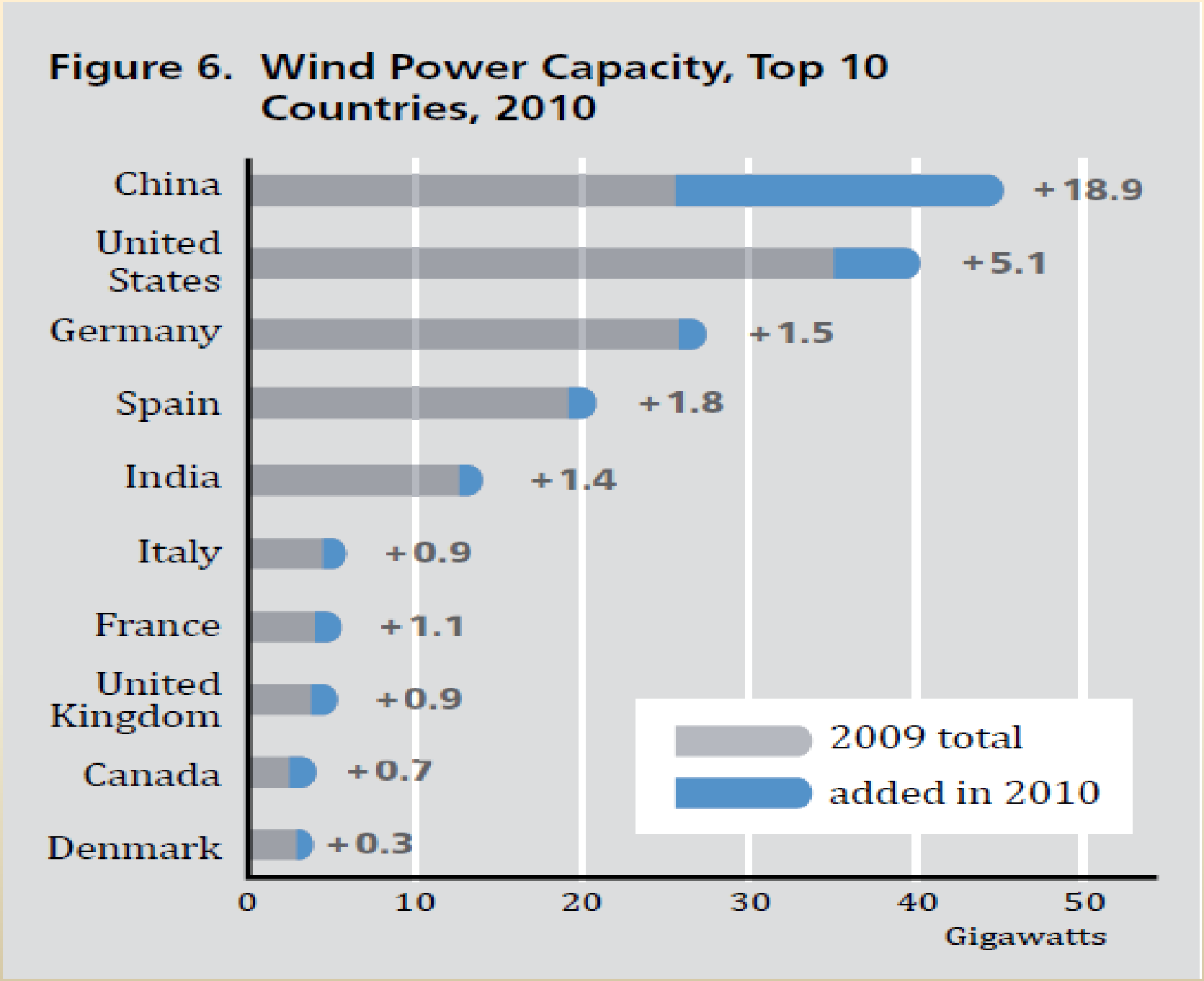
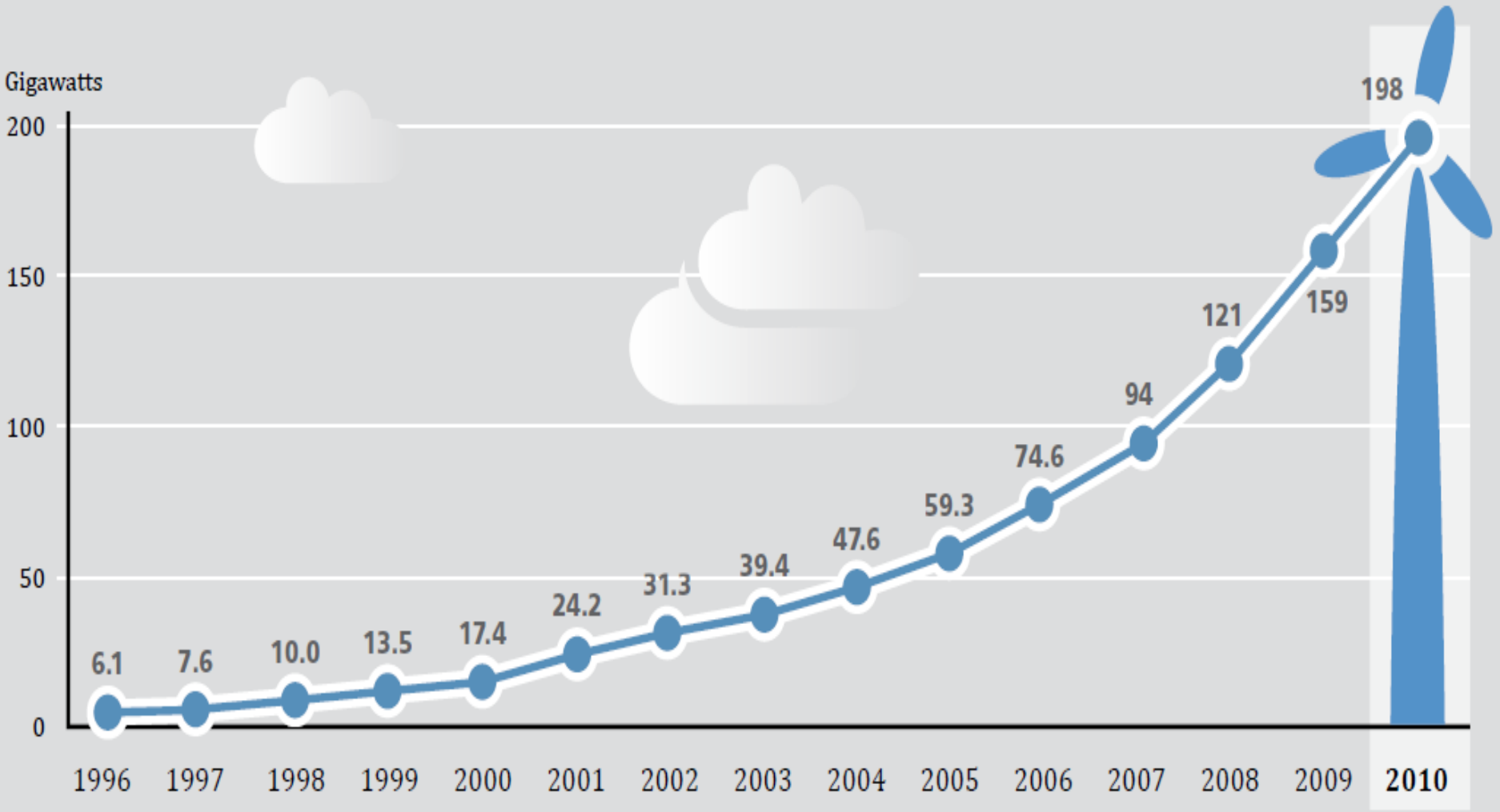


Figure 6. Wind Power Capacity, Top 10 Countries, 2010
China
United States
Germany
Spain
India
Italy
France
United Kingdom
Canada
Denmark
+18.9
+5.1
+1.5
+1.8
+1.4
+0.9
+1.1
+0.9
+0.7
+0.3
2009 total
added in 2010
0
10
20
30
40
50
Gigawatts

Figure 5. Wind Power, Existing World Capacity, 1996–2010



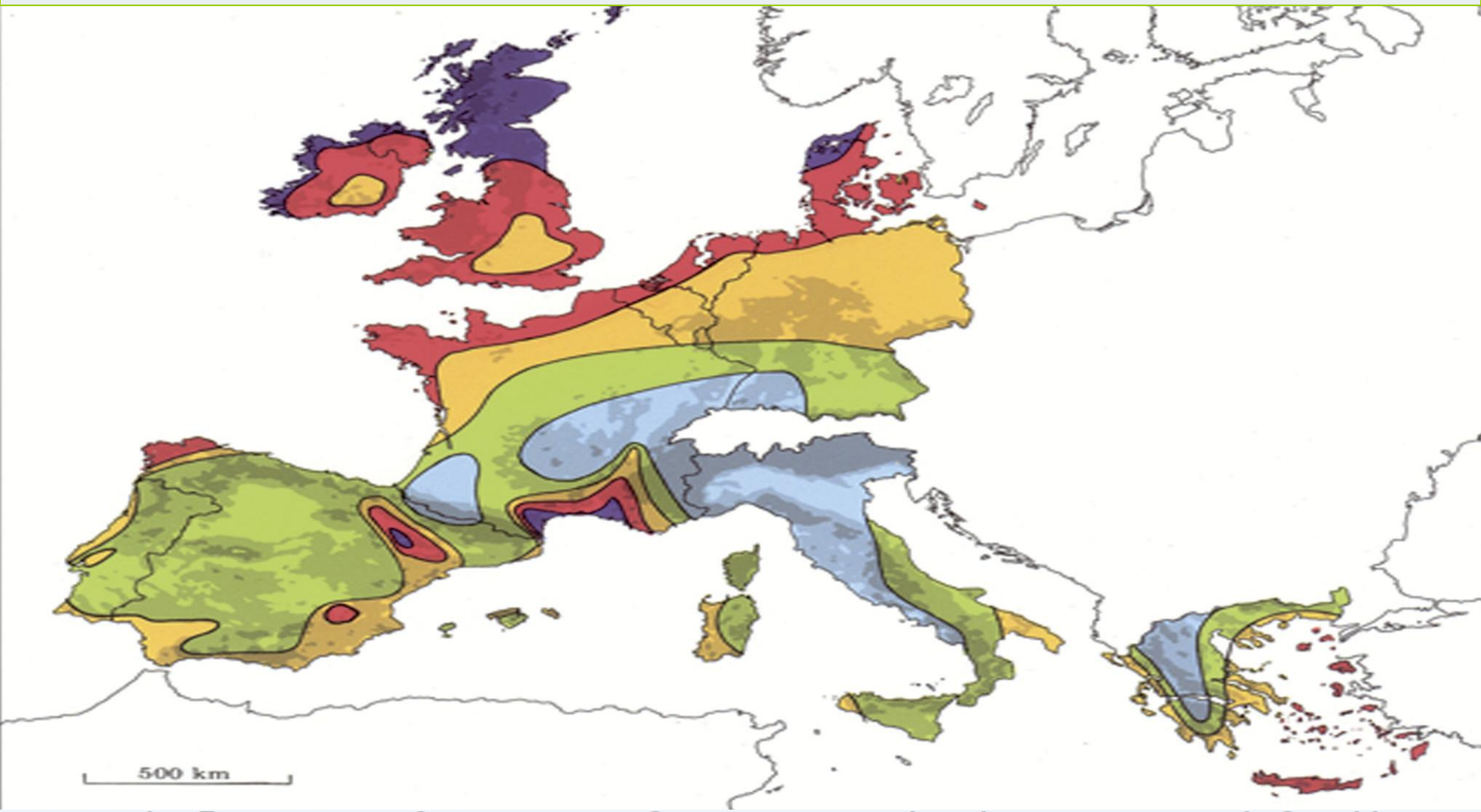


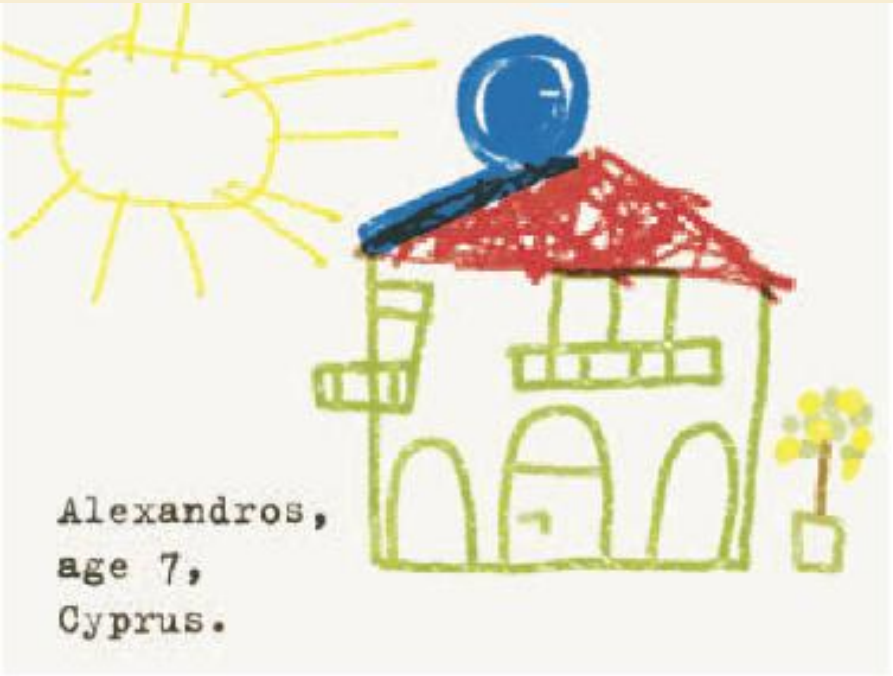
Table 1 Wind Resources at 50 Metres Above Ground Level for Five Different Topographic Conditions

	Sheltered terrain		Open plain		At a sea coast		Open sea		Hills and ridges	
	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}	ms^{-1}	Wm^{-2}
	> 6.0	> 250	> 7.5	> 500	> 8.5	> 700	> 9.0	> 800	> 11.5	> 1800
	5.0-6.0	150-250	6.5-7.5	300-500	7.0-8.5	400-700	8.0-9.0	600-800	10.0-11.5	1200-1800
	4.5-5.0	100-150	5.5-6.5	200-300	6.0-7.0	250-400	7.0-8.0	400-600	8.5-10.0	700-1200
	3.5-4.5	50-100	4.5-5.5	100-200	5.0-6.0	150-250	5.5-7.0	200-400	7.0-8.5	400-700
	< 3.5	< 50	< 4.5	< 100	< 5.0	< 150	< 5.5	< 200	< 7.0	< 400

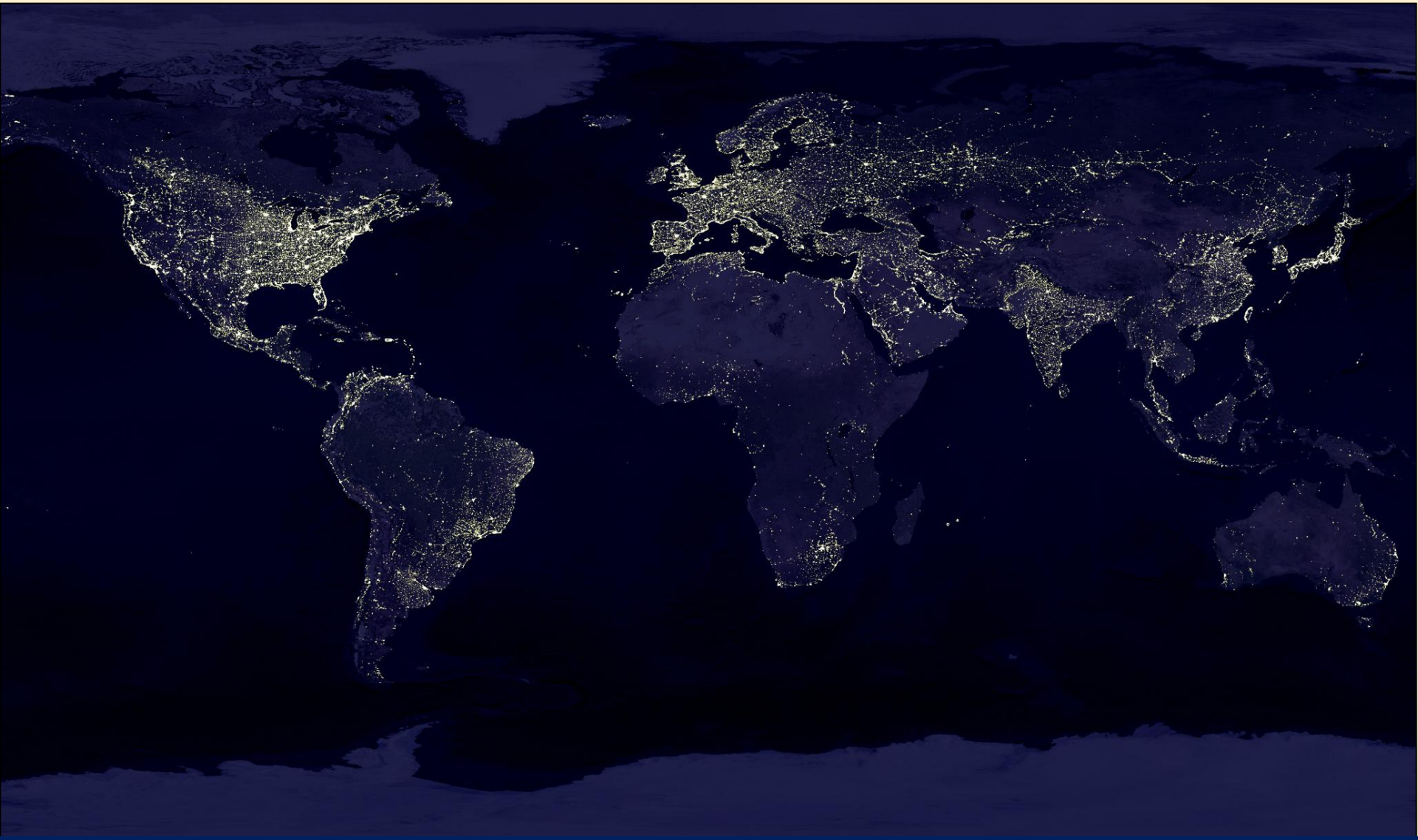
Source: European Wind Atlas, Onshore, Source, Risø National Laboratory, Denmark.

Knowledge is key to renewables acceptance

In regions where solar thermal is already widely used, awareness is very high: Neighbours and friends use solar thermal and everyone knows that hot water is available even during cloudy periods. Lack of knowledge or doubts about solar thermal is the primary reason for not choosing solar energy for heating in regions where solar is still a niche product.



In Cyprus, a solar thermal system belongs to the house just as a chimney belongs to a house in the UK – every child in the relative country "knows" this.



"Our ignorance is not so vast as our failure to use what we know."

M. King Hubbert, geologist for Shell Oil