



sgem

Smart Grids and Energy Markets



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Demand of electricity in Finland and EU - Scenarios for 2020...2050 -

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Institute of LUT Energy

Energy Technology | Electrical Engineering | Environment Technology



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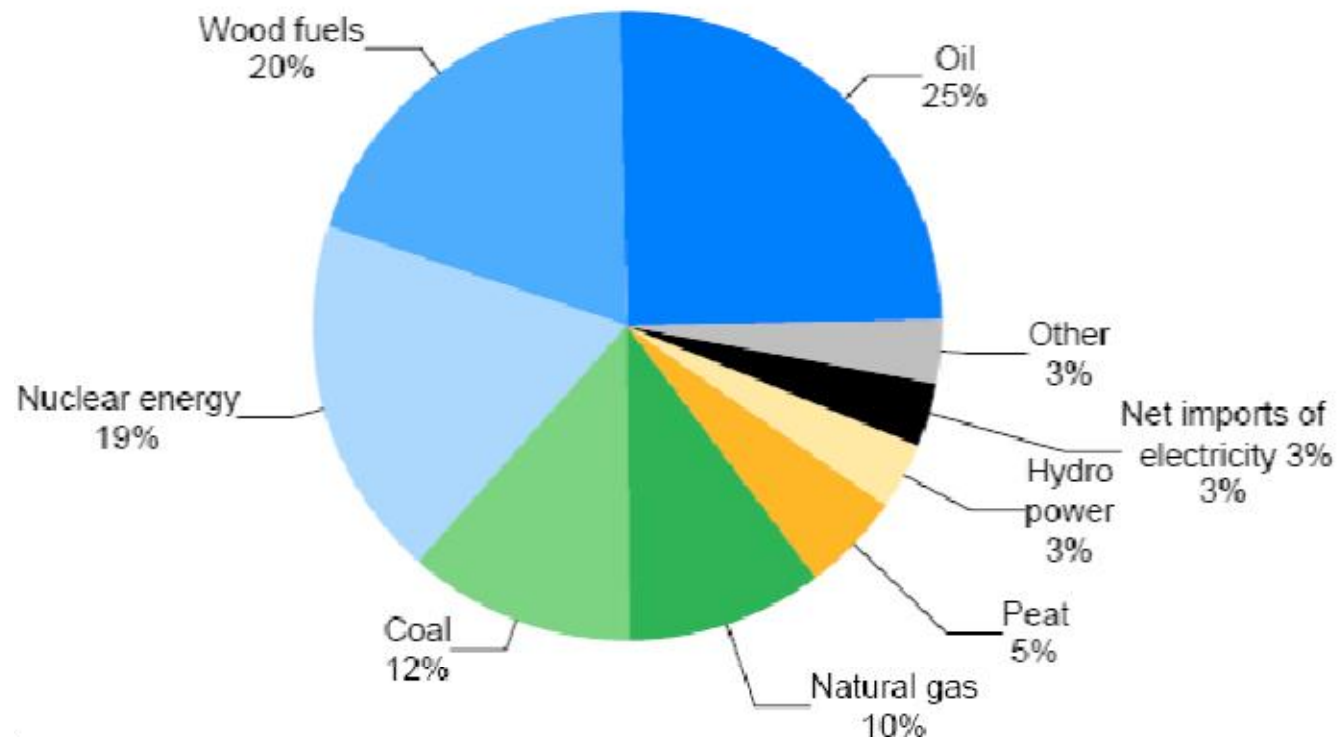
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- Electricity demand in EU
 - Background information
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Total energy consumption in Finland in 2009



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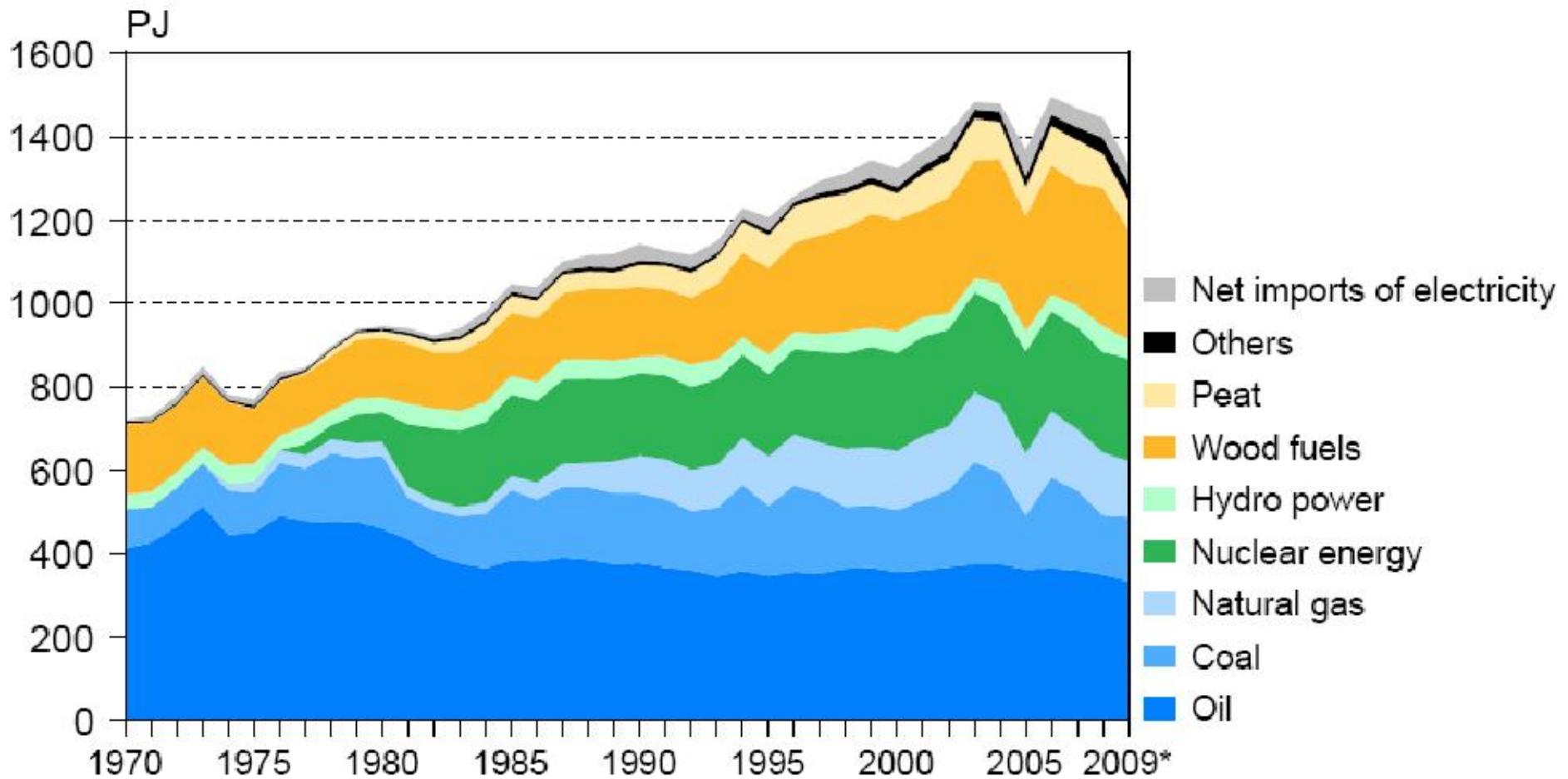


Statistics Finland

Total energy consumption in Finland



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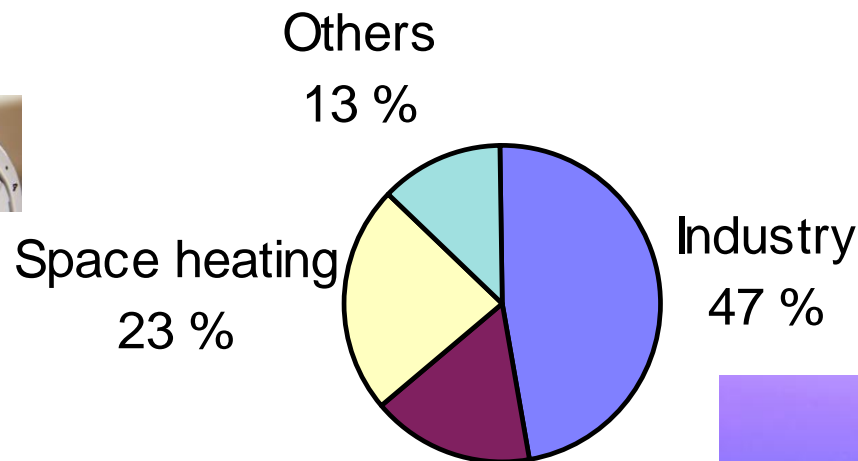


Statistics Finland

Final energy consumption in Finland in 2009



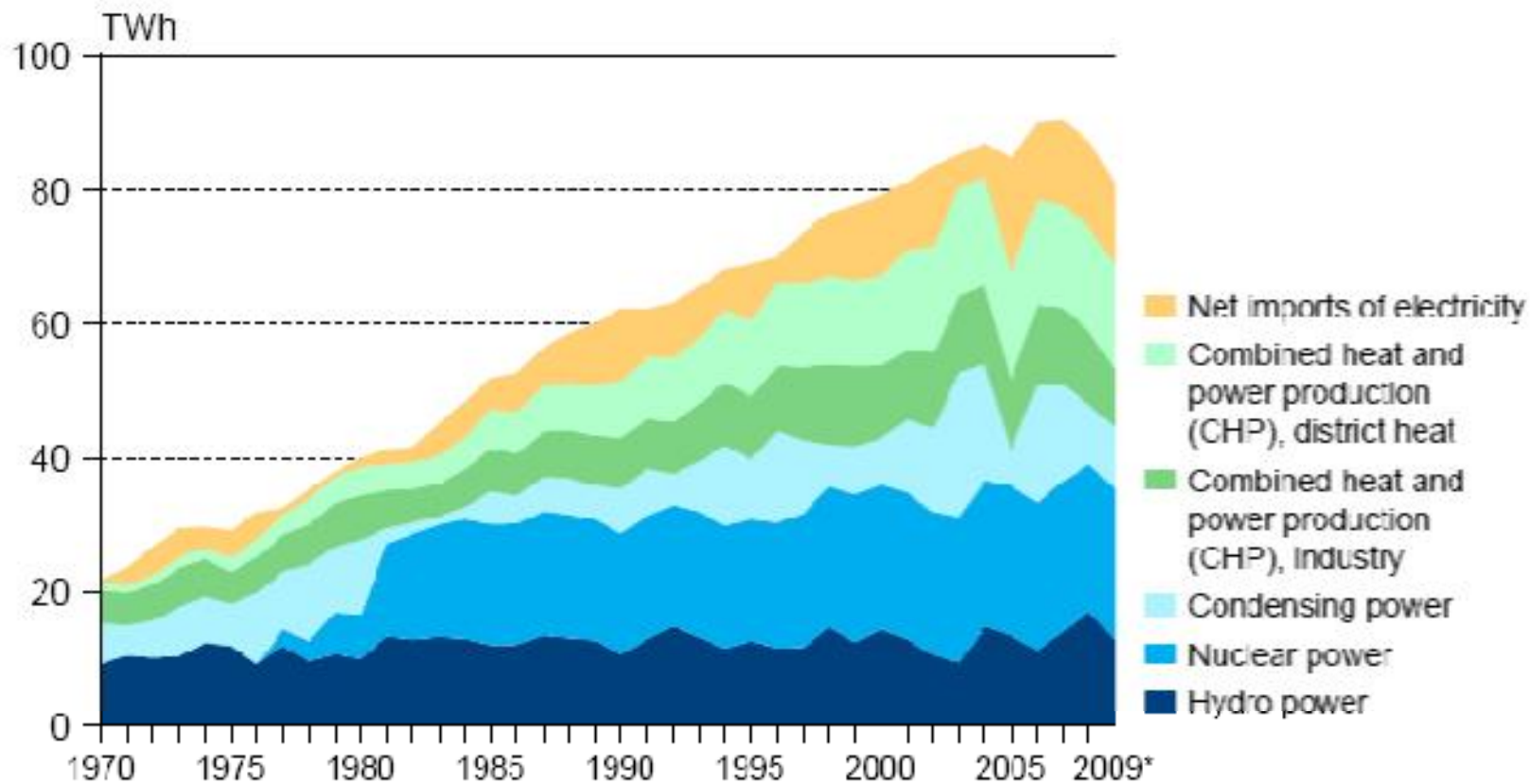
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Electricity supply in Finland 1970...2009



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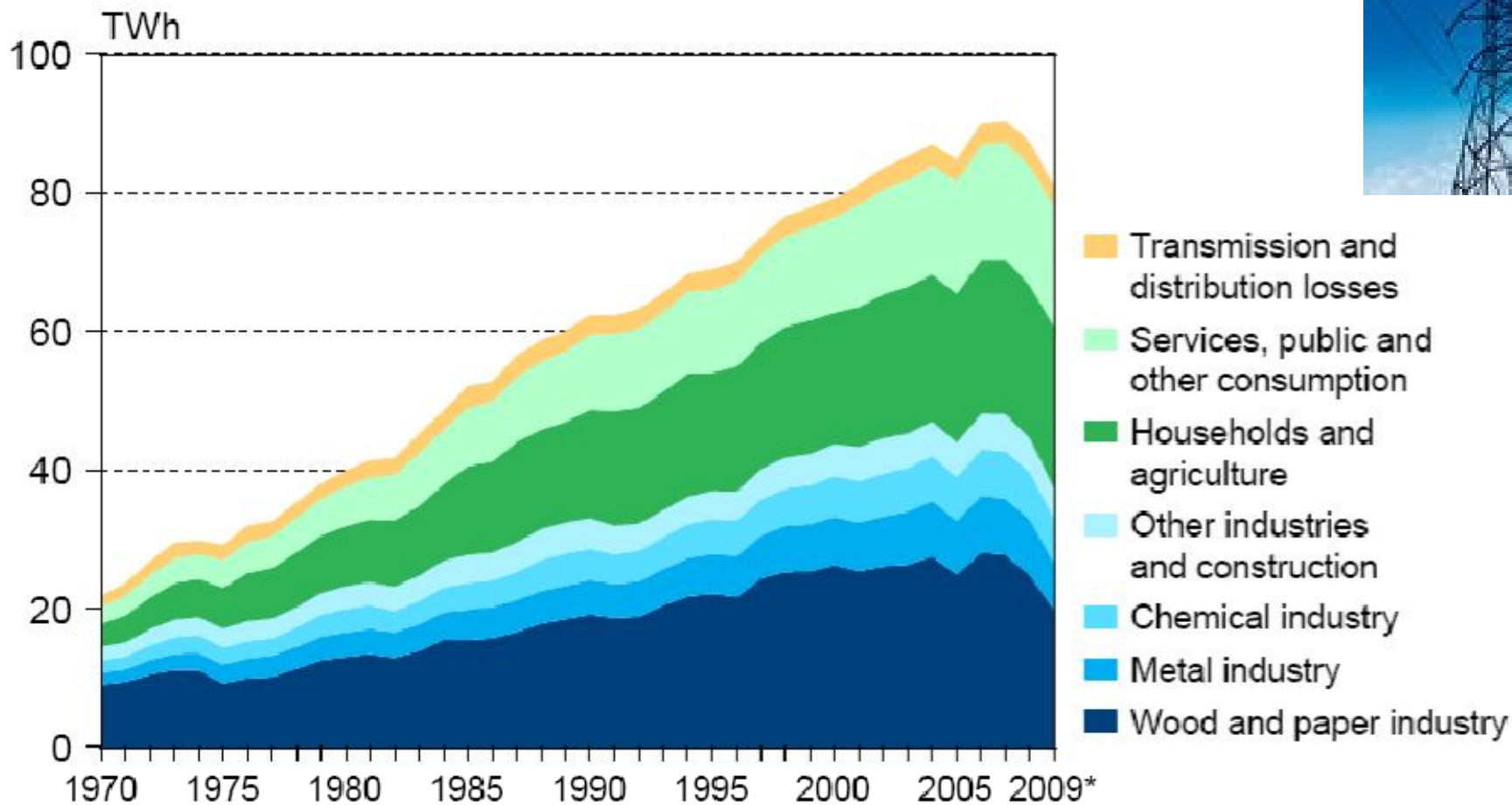


Statistics Finland

Electricity consumption by sector in Finland



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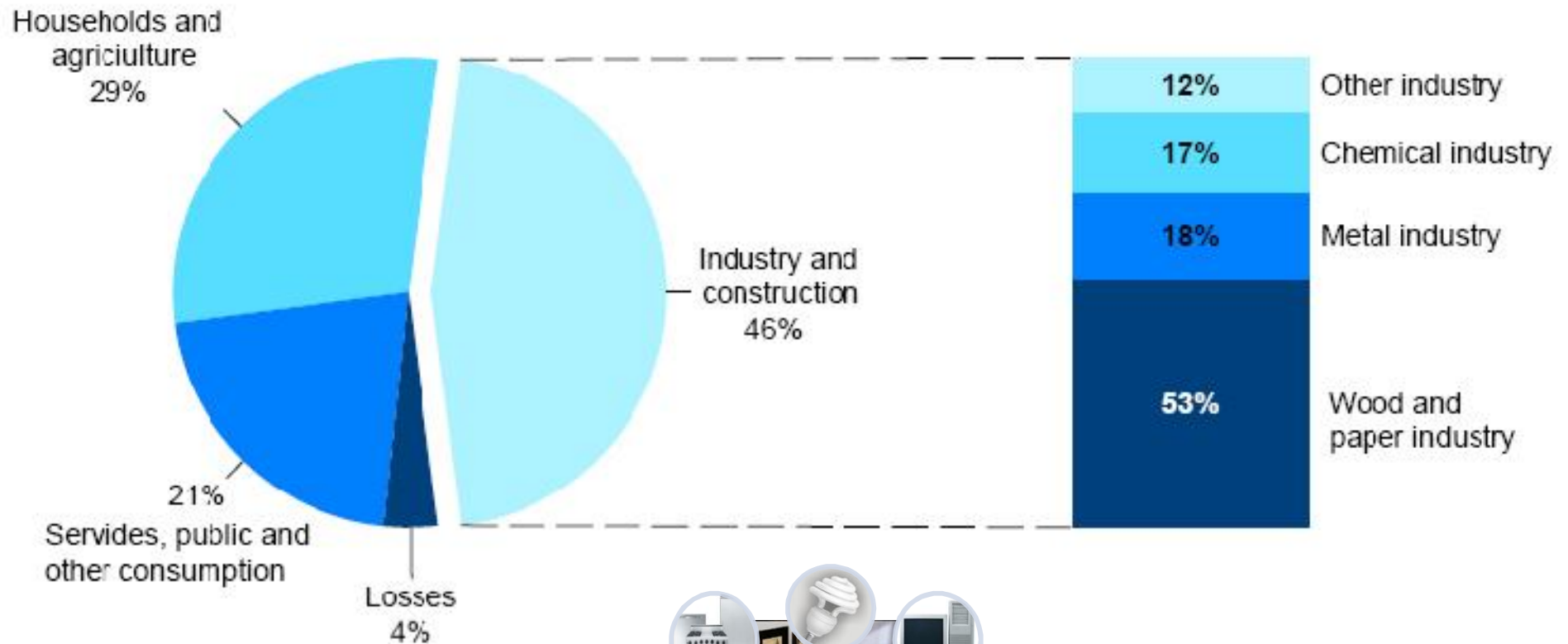


Statistics Finland

Electricity consumption by sector in Finland in 2009



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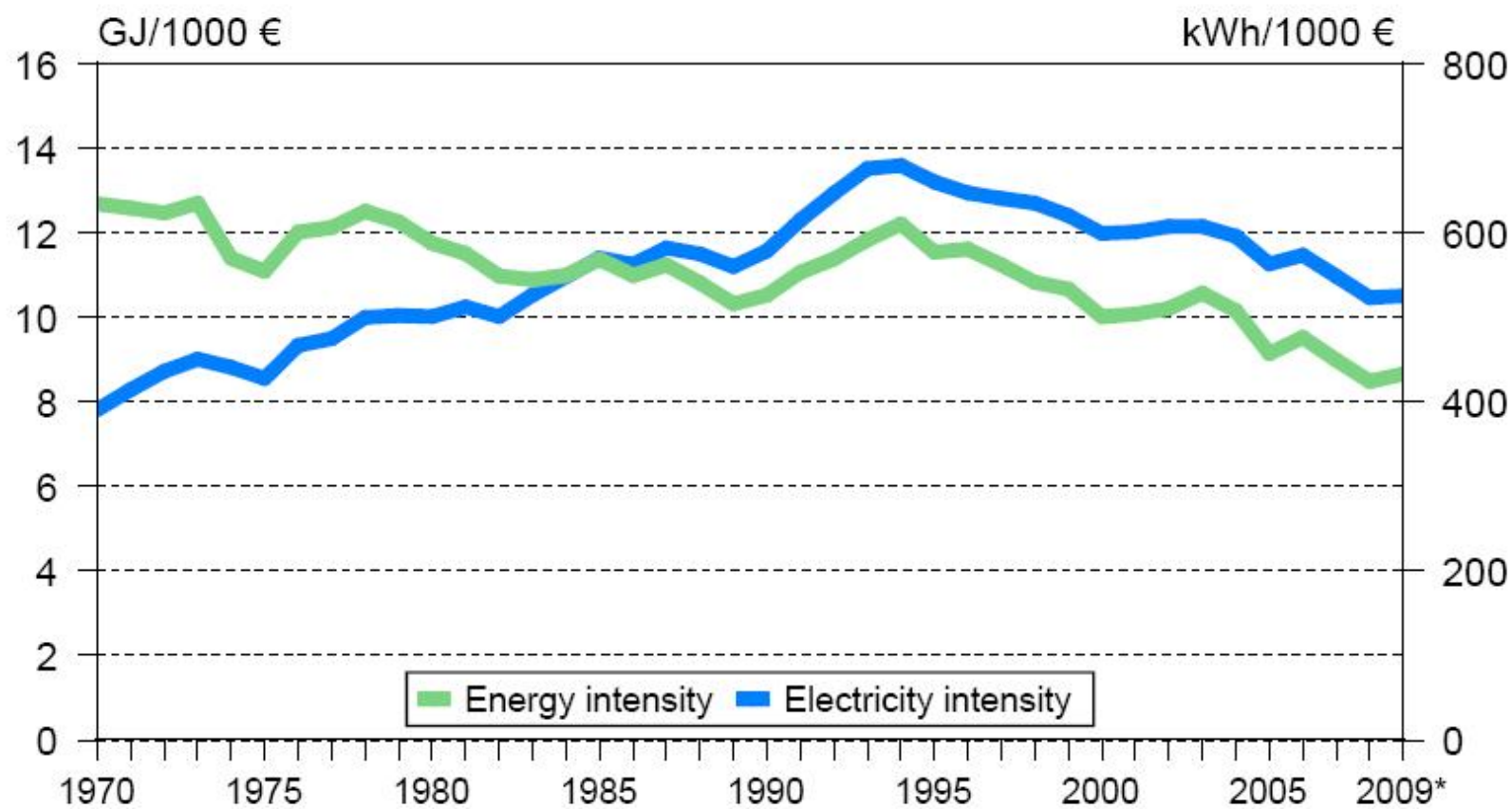
Statistics Finland

Economical background – Finland



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Energy and electricity intensity in Finland

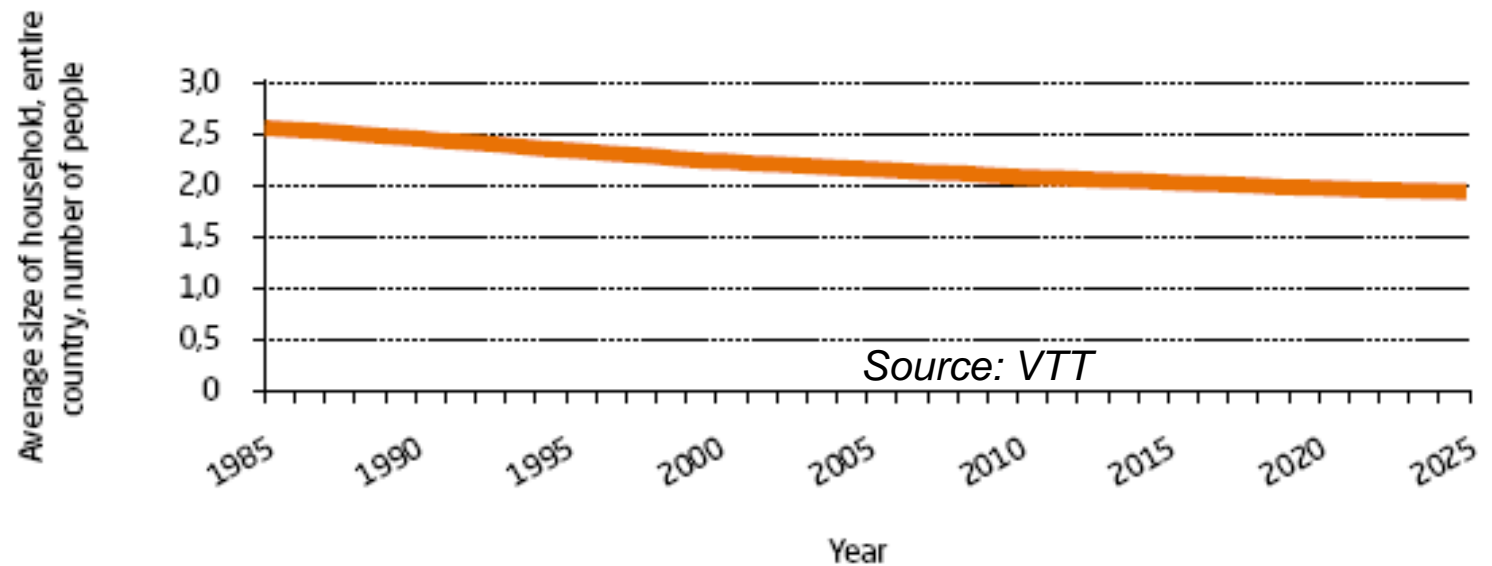
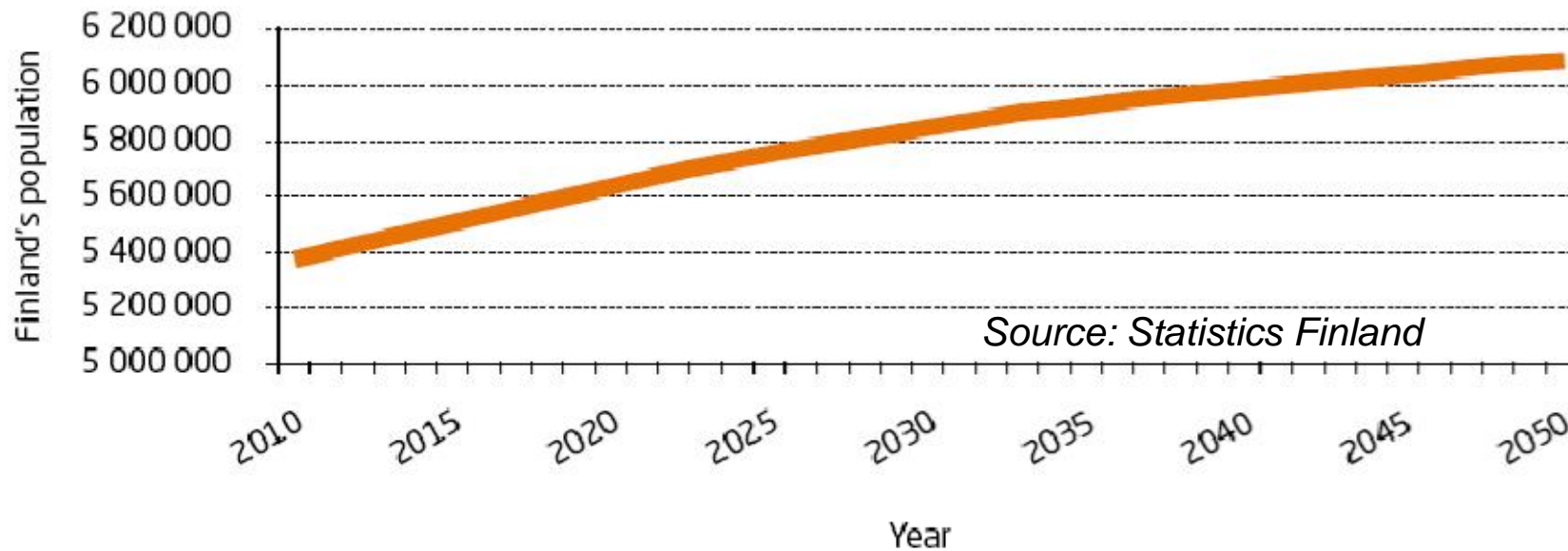


Statistics Finland

Demographical background – Finland



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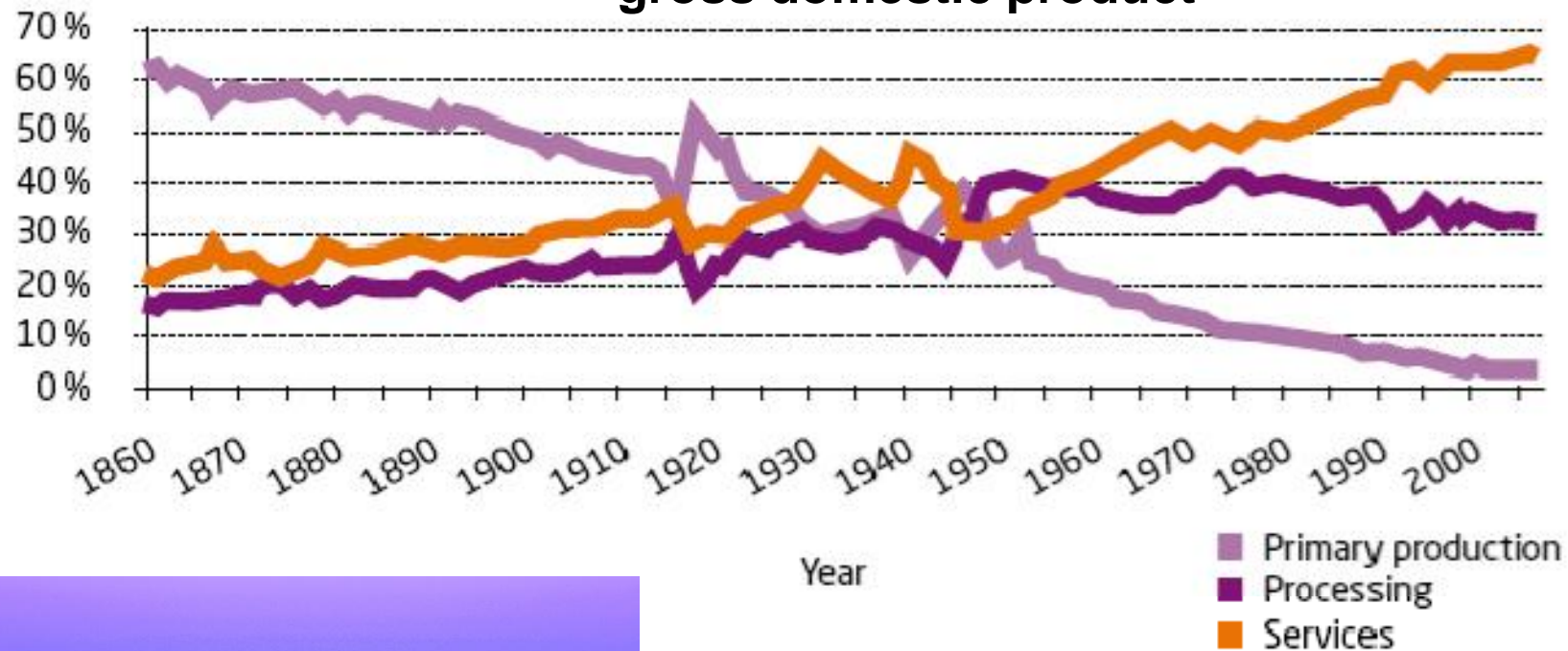


Socio-economical background – Finland



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Share of primary production, processing, and services from gross domestic product



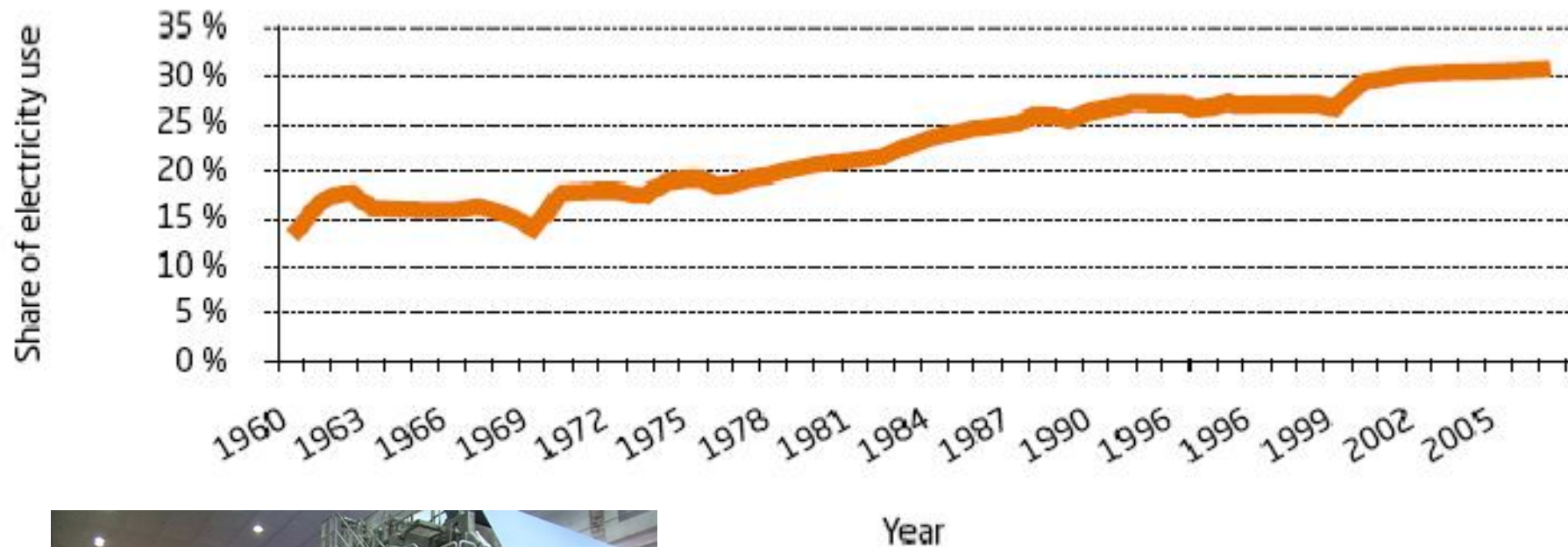
Source: Statistics Finland

Economical background – Finland

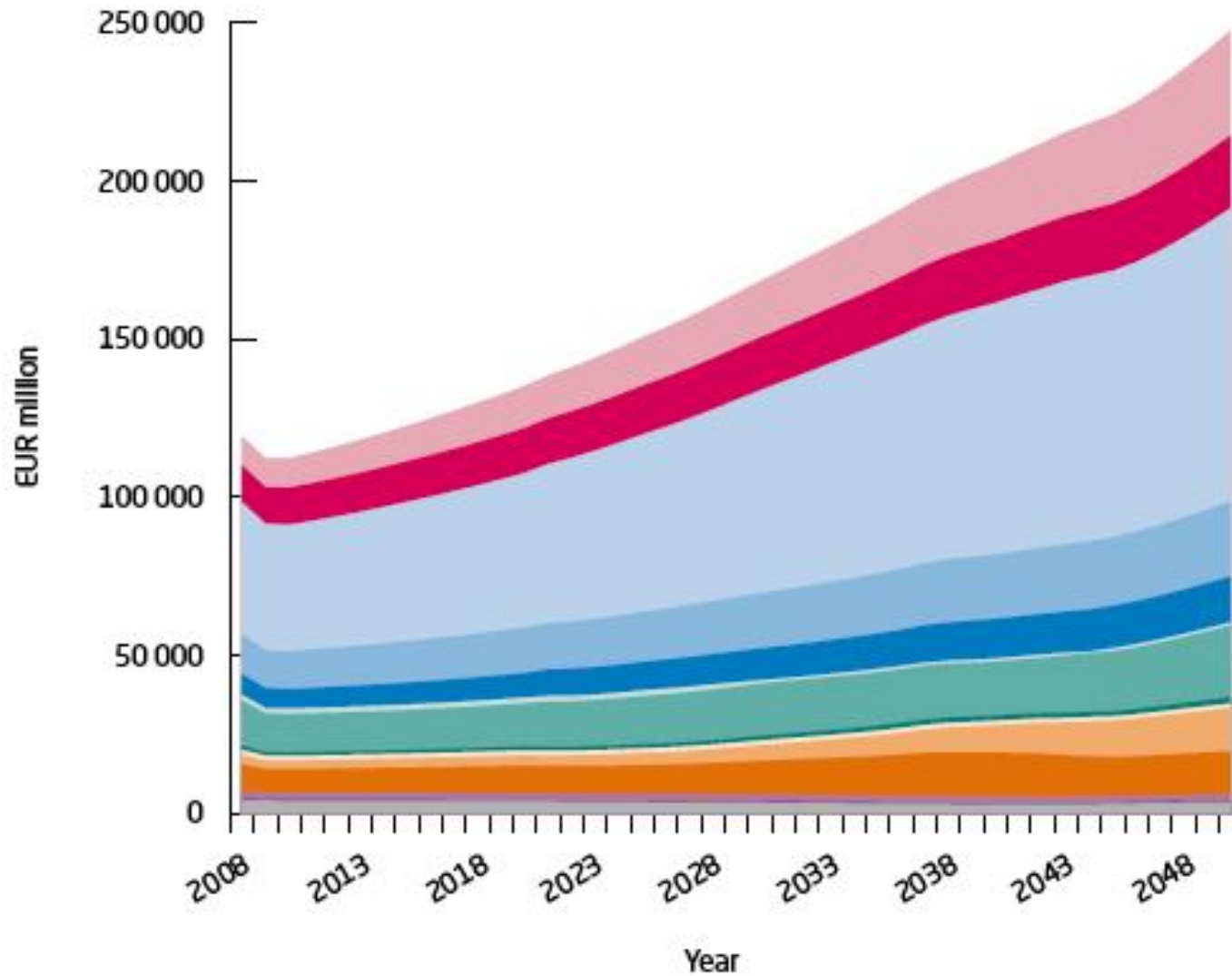


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Share of electricity in industrial energy use in Finland



Economical background – Finland



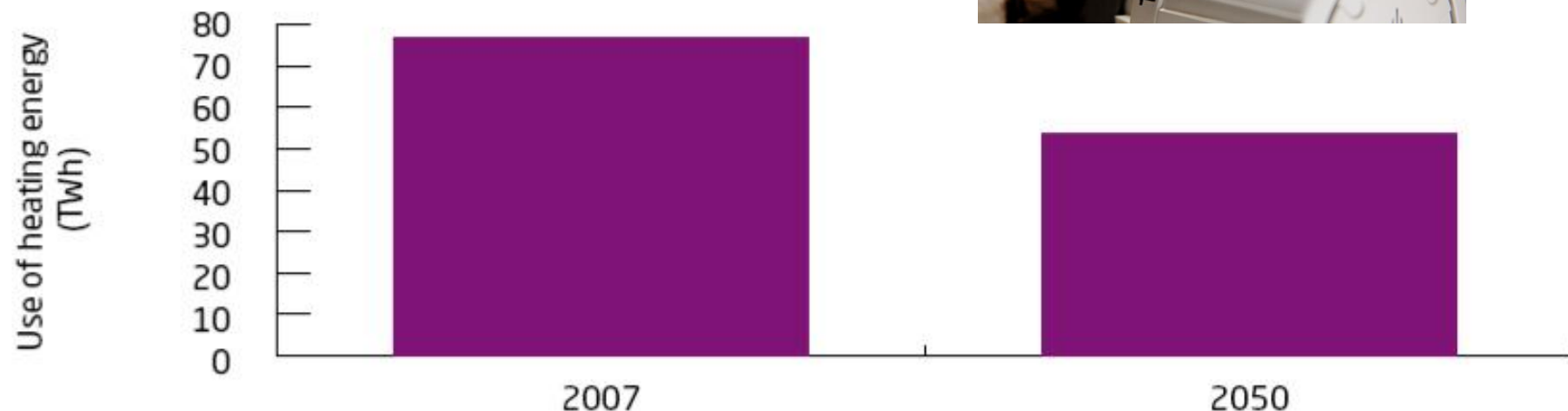
Scenario about growth in added value in different industries

Source: Finnish Energy Industries



Heating of buildings

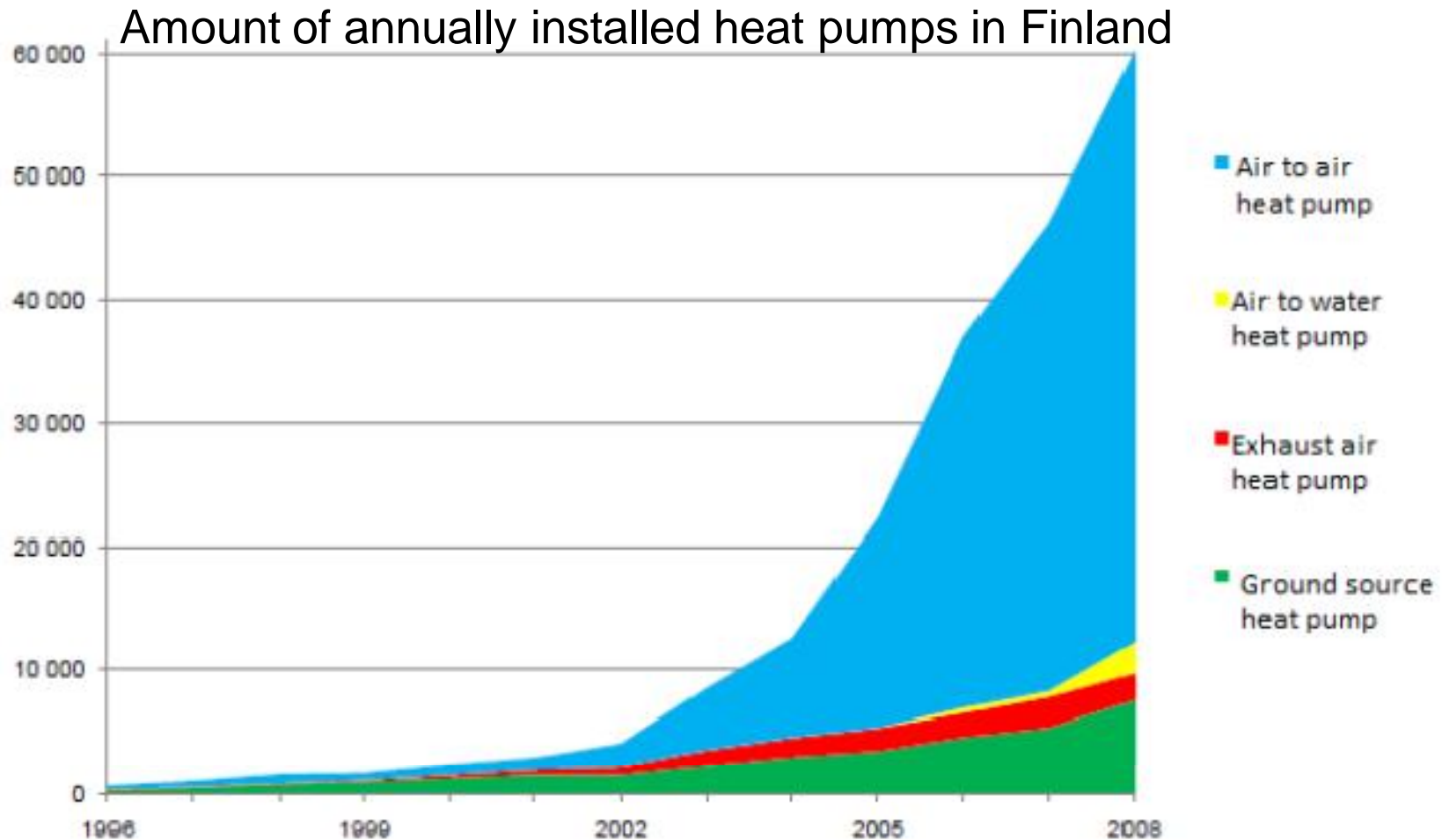
- Estimated increase in the building stock => amount of the heated space will increase
- Increasing energy efficiency of the buildings => specific heat demand is estimated to decrease by 32 % in average by year 2050
- Climate change is estimated to reduce heating demand in Finland by 16 % by year 2050
- In total, 30 % decrease in demand of heating energy is estimated to realize by the year 2050



Heating of buildings



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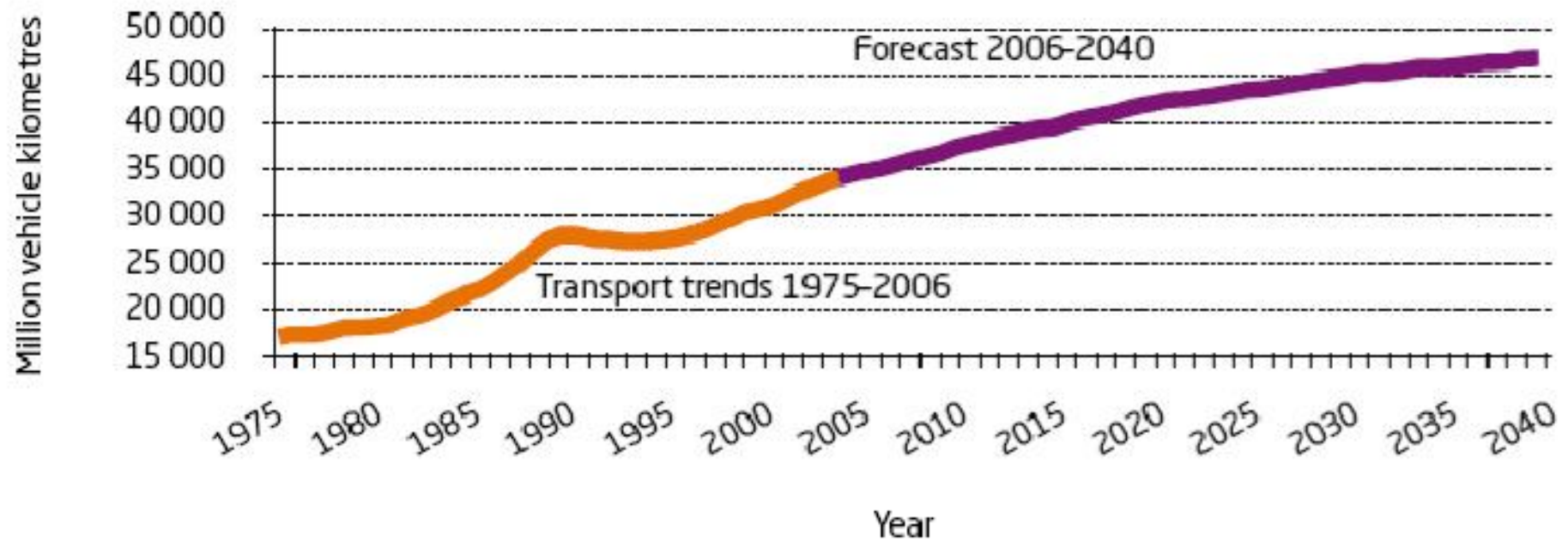
Source: Sulpu

Road traffic in Finland



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Projection of road traffic in Finland



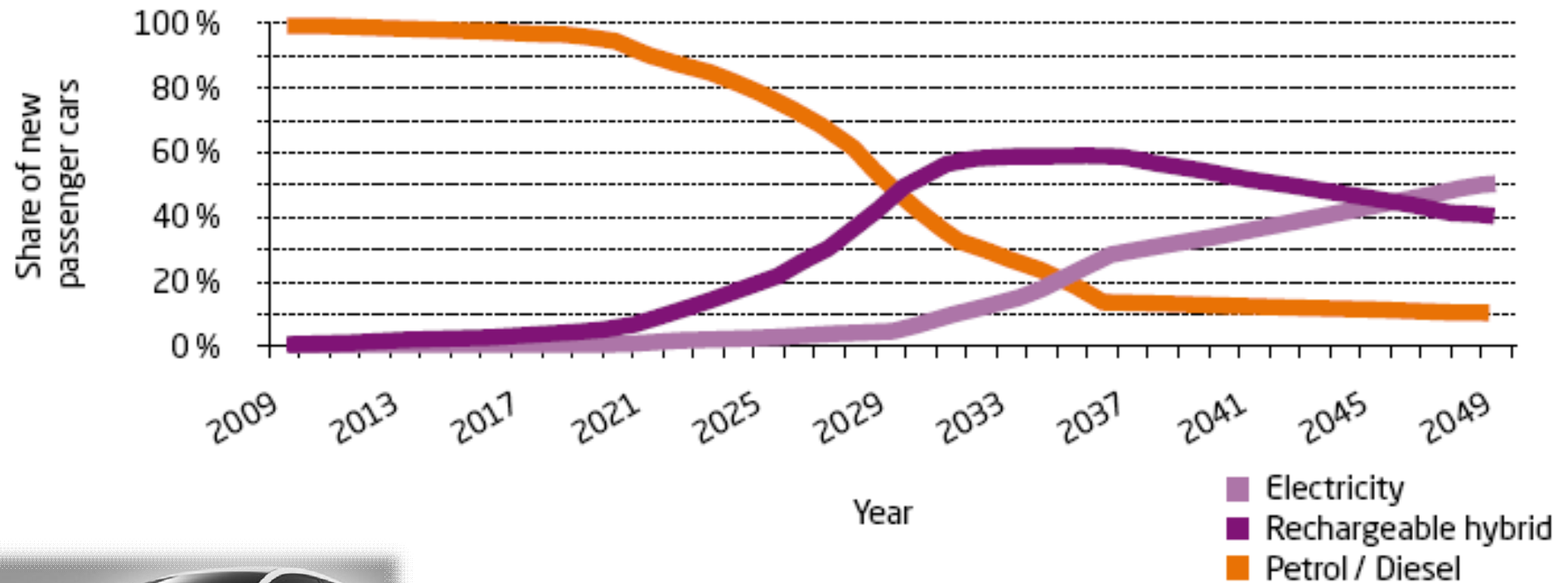
Source: Finnish Road Administration

Penetration scenario for plug-in vehicles



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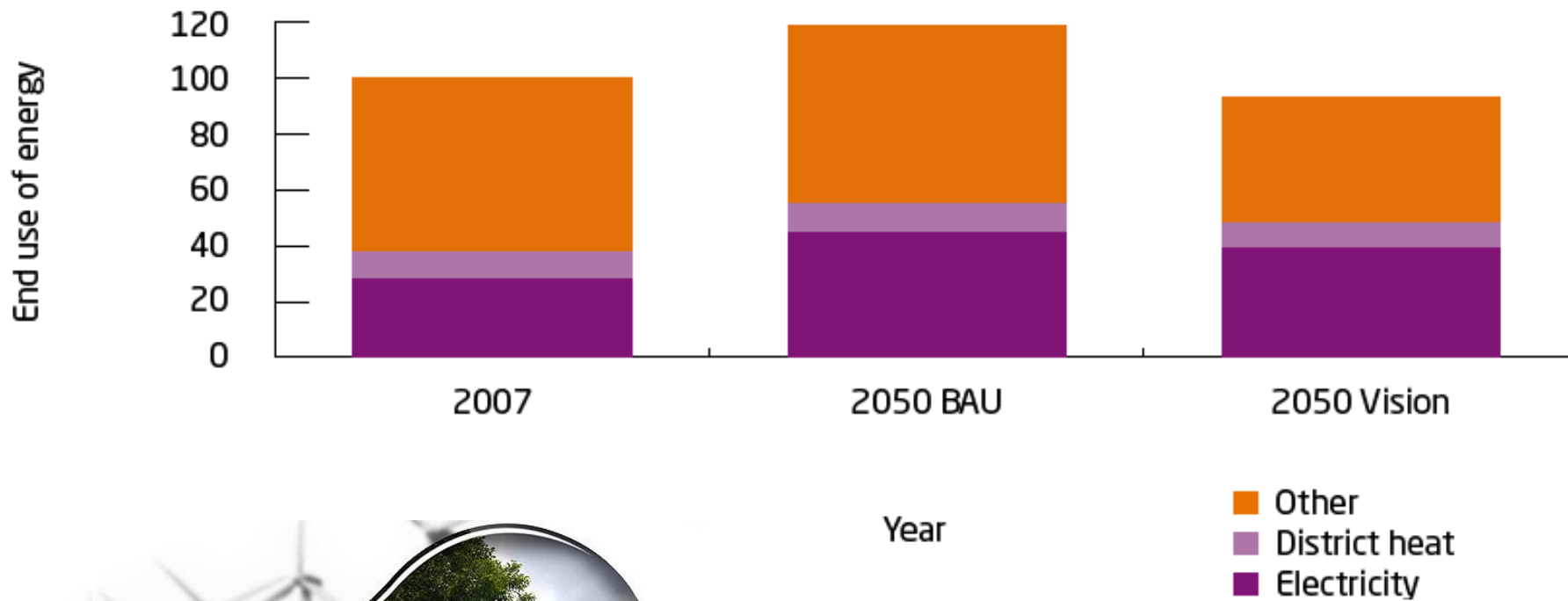
Penetration scenario for EVs and PHEVs



Scenario for energy end-use in Finland



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Source: Finnish Energy Industries

Scenario for electricity use in Finland



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Sector	Electricity use in 2007 (TWh/a)	Electricity use in 2030 (TWh/a)	Electricity use in 2050 (TWh/a)
Households	11	13	13–14
Heating of buildings	12	11	9–11
Cooling of buildings	0,2	1	2
Industry	48	49–56	48–58
Services & Public	15,5	22	30–40
Transport	0,5	3	8–10
Losses	3	3	4
Total	90	100–111	113–138



Source: Finnish Energy Industries



Conclusions about the energy demand in Finland

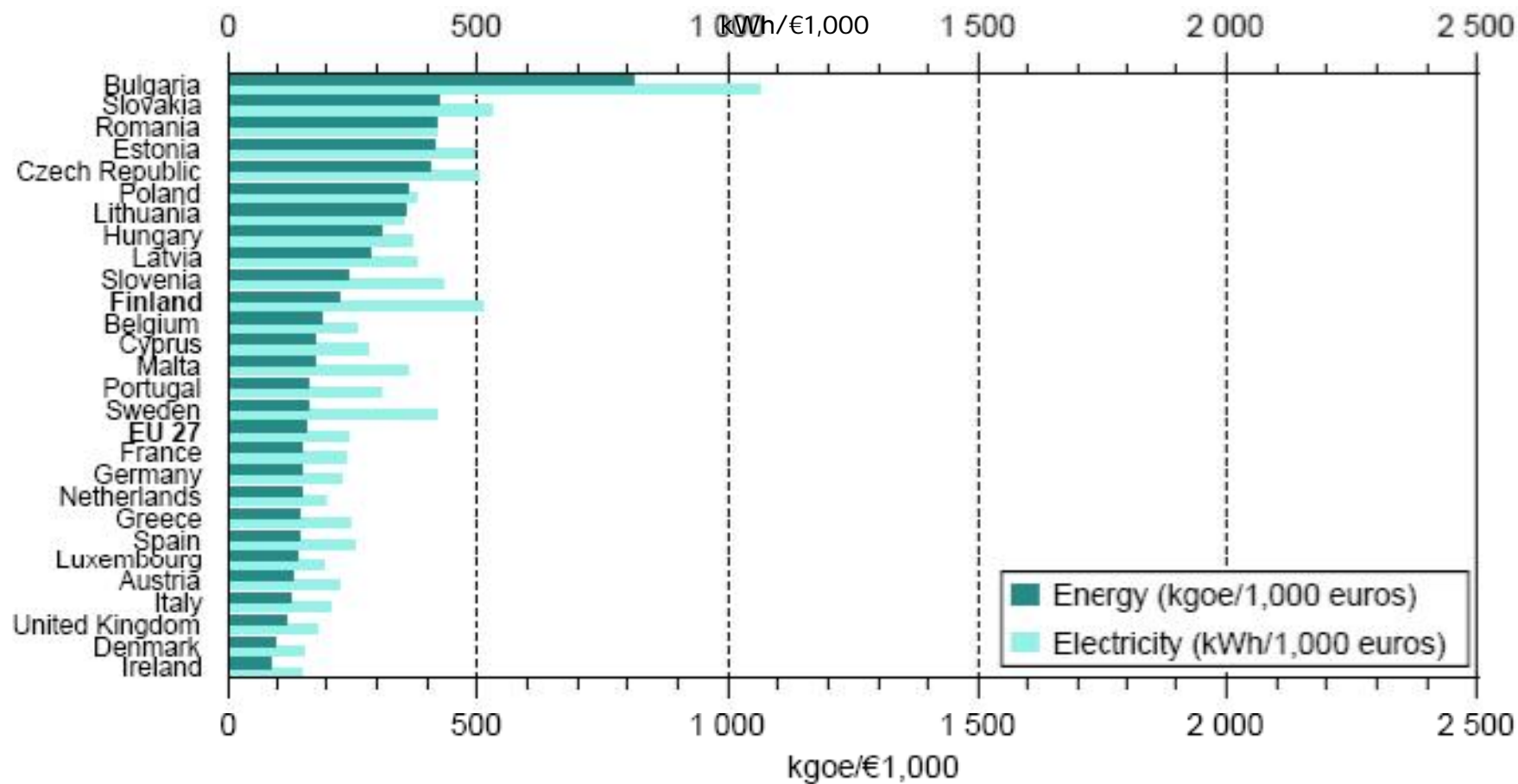
- End use energy efficiency is estimated to improve in every sector
- Heating demand decrease because of increasing energy efficiency in building sector and impact of global warming
 - Role of electricity important especially due to the increasing amount of heat pumps
- Cooling demand is estimated to increase as a consequence of climate warming and increasing amenities of buildings
- Penetration of plug-in vehicles will increase the electricity demand
- The share of service sector in gross domestic production is predicted to grow => changes in the electricity demand of industries
- **Improving energy efficiency, decreasing primary energy demand, increasing role of electricity**



EU's energy intensity



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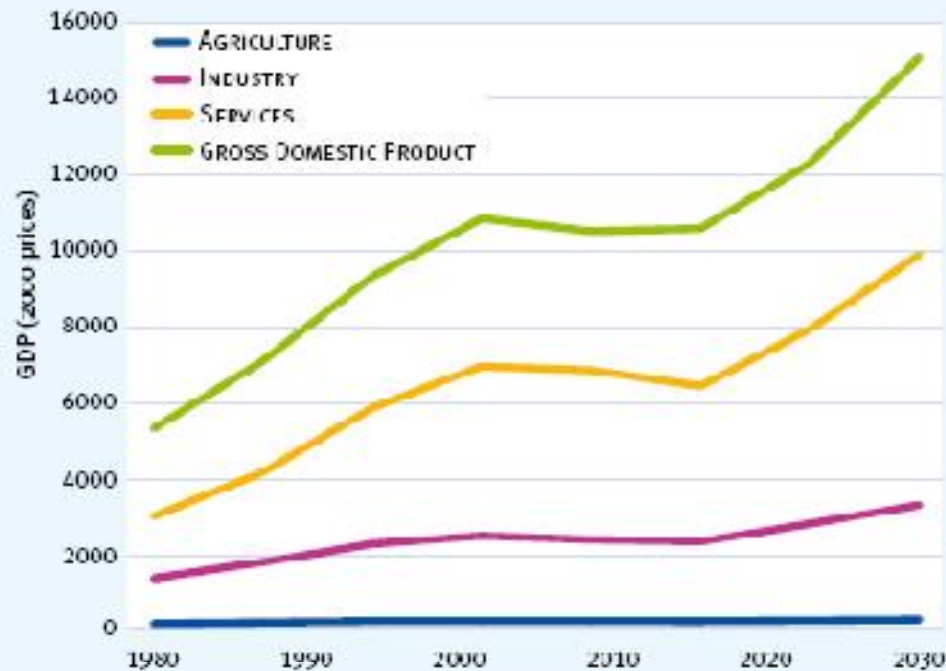
Source: Stastics Finland / Eurostat

EU-27 – economical and demographic development

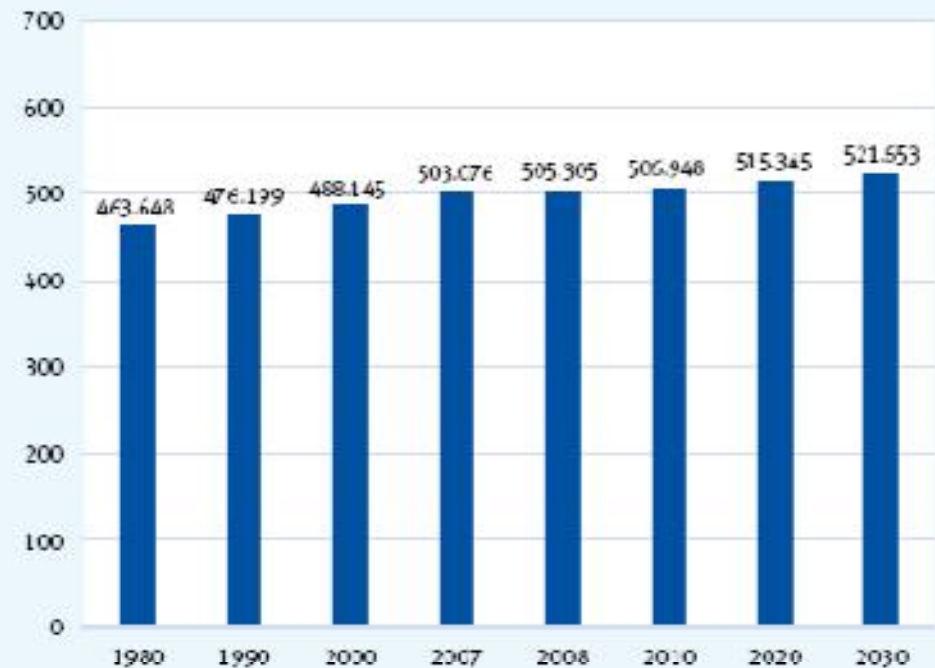


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BREAKDOWN OF GROSS DOMESTIC PRODUCT



DEMOGRAPHIC EVOLUTION OF THE EU POPULATION



Source: Eurelectric

EU-27 – electricity consumption, generation and emissions

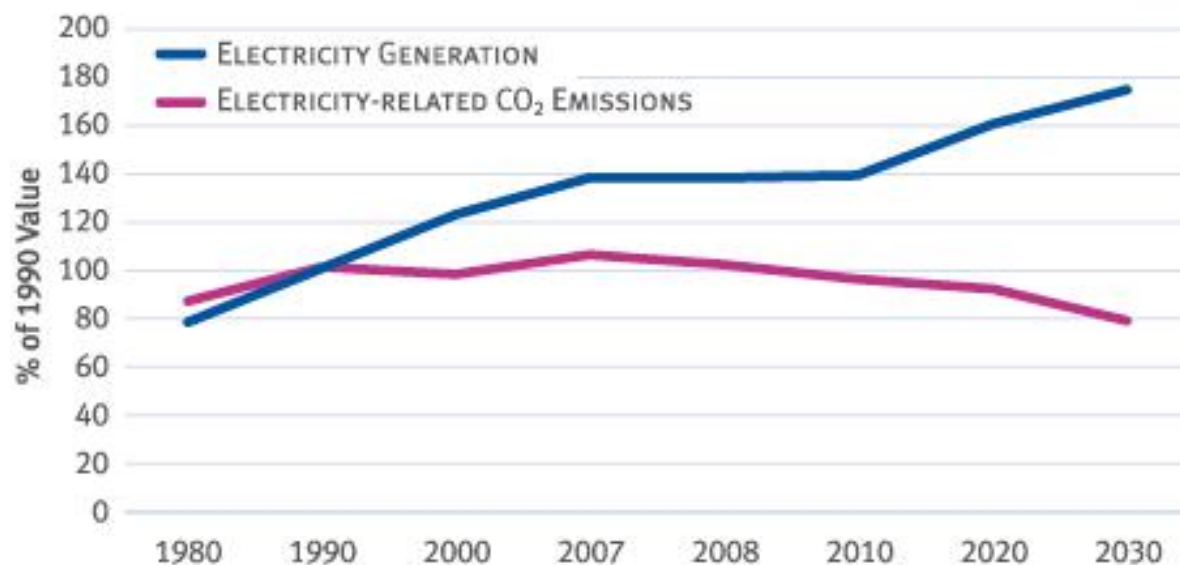


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Annual electricity consumption by sector, TWh

	1980	1990	2000	2007	2008	2010*	2020*
Final Consumption	1,703.6	2,175.4	2,633.0	2,928.0	2,938.9	2,595.0	3,242.2
of which Agriculture	46.2	59.1	60.5	55.9	57.0	52.9	62.6
Industry	892.1	1,060.6	1,180.5	1,235.4	1,226.4	1,059.2	1,288.0
Transport	48.9	61.6	74.6	79.3	76.1	66.0	98.1
Services	262.8	427.2	595.4	607.0	606.4	660.6	838.9
Households	405.5	562.6	716.2	655.3	653.7	745.9	904.6

ELECTRICITY GENERATION & CO₂ EMISSIONS (1990 BASELINE)

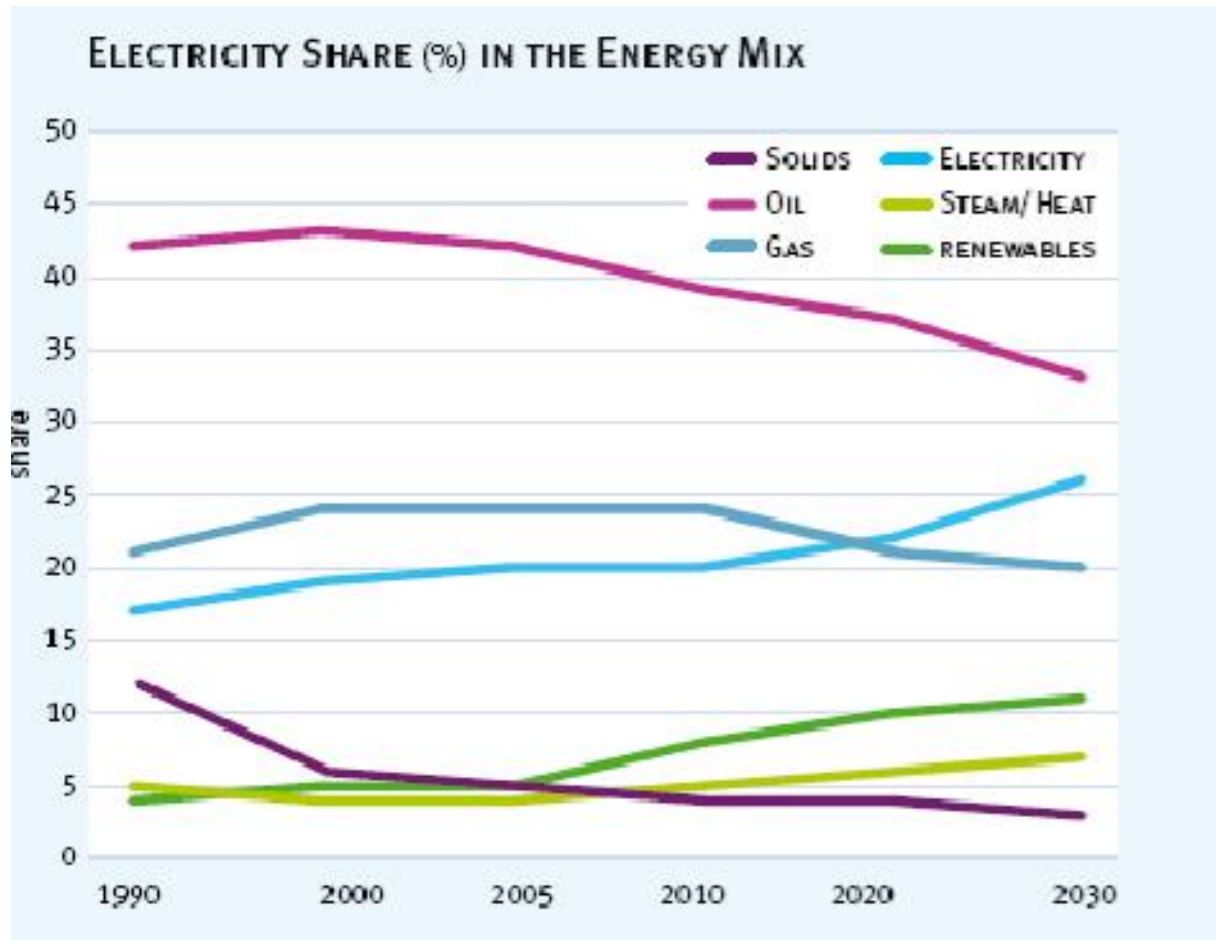


Source: Eurelectric

EU-27 – electricity share in the energy mix



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Source: Eurelectric

EU-25 – electricity consumption scenarios



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Four scenarios:

- The Baseline scenario, which includes ongoing current policies on energy efficiency and support for renewable energy sources (RES), but does not expand them, nor does it foresee any change in the current constraints on the development of nuclear energy or envisage the emergence of carbon capture and storage (CCS) technology
- An Efficiency & RES scenario, which centers on energy efficiency and renewables, with the same constraints for nuclear energy as under Baseline, and without the emergence of CCS
- A Supply scenario based on a nuclear renaissance and CCS technology
- A Role of Electricity scenario, which envisages the use of all options towards a low-carbon energy system - energy efficiency, renewables, nuclear energy and CCS. The scenario exploits the synergy between a low-carbon electricity supply system and efficient electro-technologies, including in areas traditionally largely limited to direct combustion of oil and gas - namely road transport (through the introduction of plug-in hybrid cars) and heating & cooling (through heat pumps)

Source: Eurelectric

EU-25 – electricity consumption scenarios



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The Baseline scenario is a projection of future evolution of the European energy demand and supply system reflecting business-as-usual trends. The dynamic trends and changes are reflected in this scenario. The evolution is considered to be an outcome of market forces without taking into account external or societal costs, such as for example environmental impacts and possible threats to security of energy supply. For the Baseline scenario, future changes are assumed to result from existing policies and measures. No additional policy instruments or policy targets are assumed for this scenario.

The Efficiency & RES scenario assumes that policy focuses on energy efficiency and renewables and involves a package of measures promoting energy savings and highly efficient appliances, plus policies facilitating further deployment of renewables, including support for biomass. This scenario does not involve any revision of nuclear policy as compared with baseline and excludes the development of carbon capture and storage (CCS) technology.

The Supply scenario assumes that policy focusses mainly on power generation in order to obtain a low carbon energy system and meet the emissions cap. The scenario does not foresee any additional efforts to promote energy efficiency or renewables over and above the Baseline scenario. It also assumes that a new nuclear policy is adopted and put in place, and that CCS is facilitated and successfully developed.

The Role of Electricity scenario does not exclude any means or options towards a low carbon energy system in Europe. It involves policies promoting energy efficiency on the demand side and policies supportive to renewables as envisaged in the Baseline scenario, but without incorporating any additional policies for renewables or biomass. In addition, this scenario assumes that new demand-side electro-technologies will successfully develop. Some of these technologies improve energy efficiency in specific electrical uses, such as efficient lighting and motor drives, while others facilitate higher penetration of electricity in substitutable energy uses, including heat pumps and plug-in hybrid vehicles. On the supply side, the Role of Electricity scenario mobilizes, alongside renewables, both the new nuclear policy and CCS technology, as specified for the Supply scenario.

Source: Eurelectric

EU-25 – electricity consumption scenarios – role of electricity



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TABLE 8: FINAL ENERGY DEMAND – EU 25

	BASELINE		EFFICIENCY & RES		SUPPLY SCENARIO		ROLE OF ELECTRICITY	
	2030	2050	2030	2050	2030	2050	2030	2050
Consumption of energy (Index 2005=100)	117.6	109.0	102.1	85.5	113.3	101.1	105.6	96.8
End-use Sectors, except transport	120.3	115.7	105.3	93.0	115.0	109.5	110.4	109.8
Transport Sector	111.5	93.9	95.0	68.7	109.6	82.2	94.9	67.7
Electricity Consumption	144.5	160.3	126.8	138.1	142.8	162.8	172.1	211.5
	05-2030	05-2050	05-2030	05-2050	05-2030	05-2050	05-2030	05-2050
Energy Efficiency (annual average rate, %)	-1.35	-1.46	-1.90	-1.99	-1.50	-1.62	-1.77	-1.72
End-use Sectors, except transport	-1.26	-1.33	-1.78	-1.81	-1.44	-1.45	-1.60	-1.44
Transport Sector	-1.56	-1.78	-2.19	-2.47	-1.63	-2.08	-2.19	-2.50
	2030	2050	2030	2050	2030	2050	2030	2050
Share of Electricity in Final Energy	24.6	29.4	24.8	32.3	25.2	32.2	32.6	43.7
End-use Sectors, except transport	34.1	39.1	34.1	42.2	35.3	42.2	40.8	50.6
Transport Sector	1.5	2.8	1.8	2.5	1.5	2.3	11.3	18.7



Source: Eurelectric

EU-25 – electricity consumption scenarios – role of electricity



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RESULTS FOR 2030	BASELINE	EFFICIENCY & RES	SUPPLY SCENARIO	ROLE OF ELECTRICITY
Final Energy Demand (2005=100)	118	102	113	106
Electricity Consumption (2005=100)	145	127	143	172
Electricity from Nuclear (TWh)	654	852	1535	1643
Electricity from Renewables (TWh)	1092	1675	1267	1359
CO ₂ Stored (cumul. Bill. tCO ₂)	0	0	4.8	3.6
Power Investment (cumul GW)	928	984	950	1050
Net Imports of Gas (2005=100)	188	179	174	164
Net Imports of Oil (2005=100)	116	97	108	93
Electricity Price (2005=100)	111	122	132	120
Total Energy Cost as % of GDP	9.57	10.27	10.61	9.64
CO ₂ Emissions (1990=100)	110	70	70	70



Source: Eurelectric

EU-25 – electricity consumption scenarios – role of electricity



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RESULTS FOR 2050	BASELINE	EFFICIENCY & RES	SUPPLY SCENARIO	ROLE OF ELECTRICITY
Final Energy Demand (2005=100)	109	85	101	97
Electricity Consumption (2005=100)	160	138	163	212
Electricity from Nuclear (TWh)	654	852	2077	1262
Electricity from Renewables (TWh)	1437	2097	1558	1729
CO ₂ Stored (cumul. Bill. tCO ₂)	0	0	19.5	19.1
Power Investment (cumul. GW)	1533	1781	1609	1979
Net Imports of Gas (2005=100)	205	180	174	165
Net Imports of Oil (2005=100)	88	66	75	63
Electricity Price (2005=100)	121	128	139	134
Total Energy Cost as % of GDP	8.83	9.28	9.59	8.59
CO ₂ Emissions (1990=100)	95	50	50	50

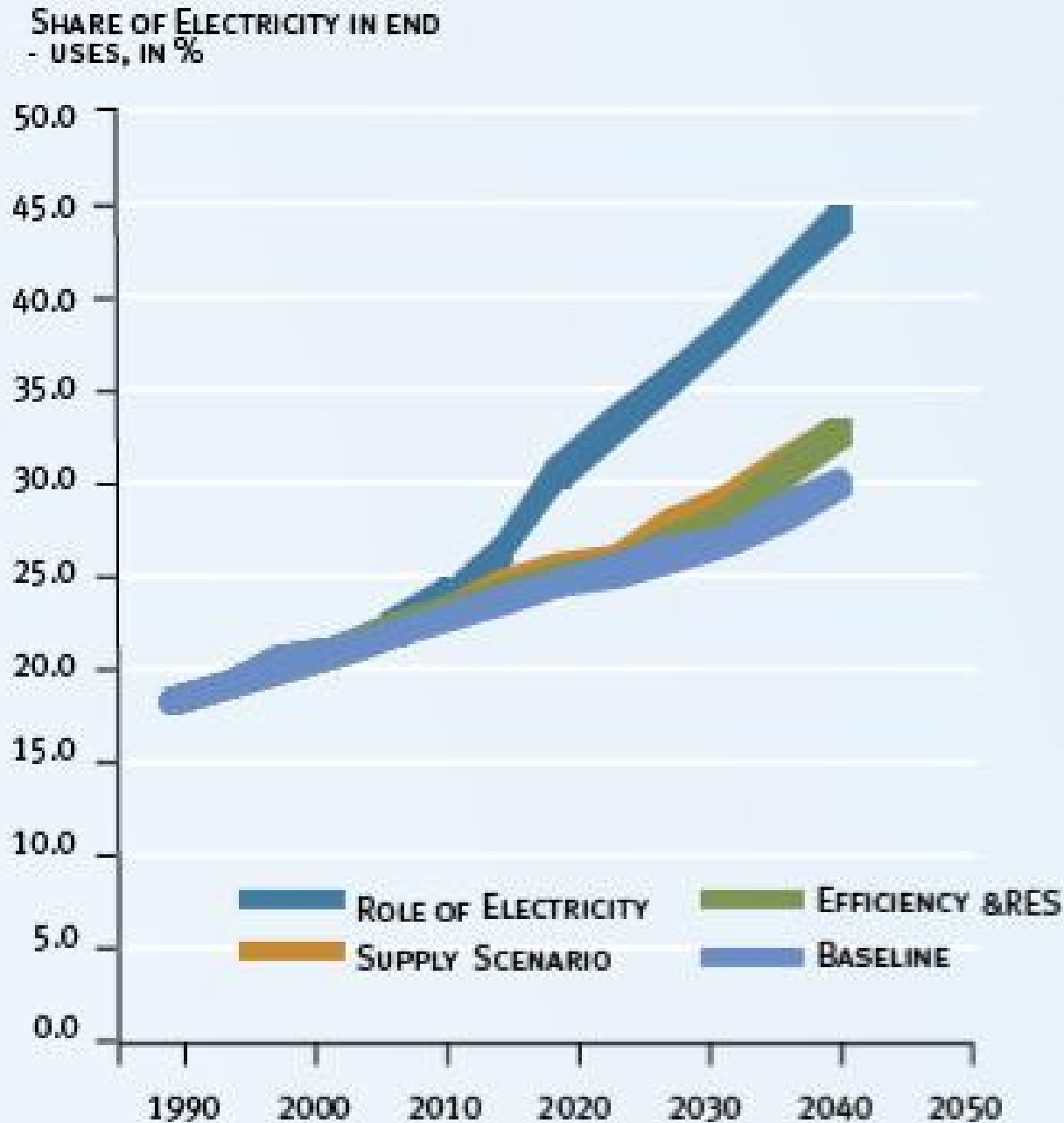


Source: Eurelectric

EU-25 – electricity consumption scenarios – role of electricity



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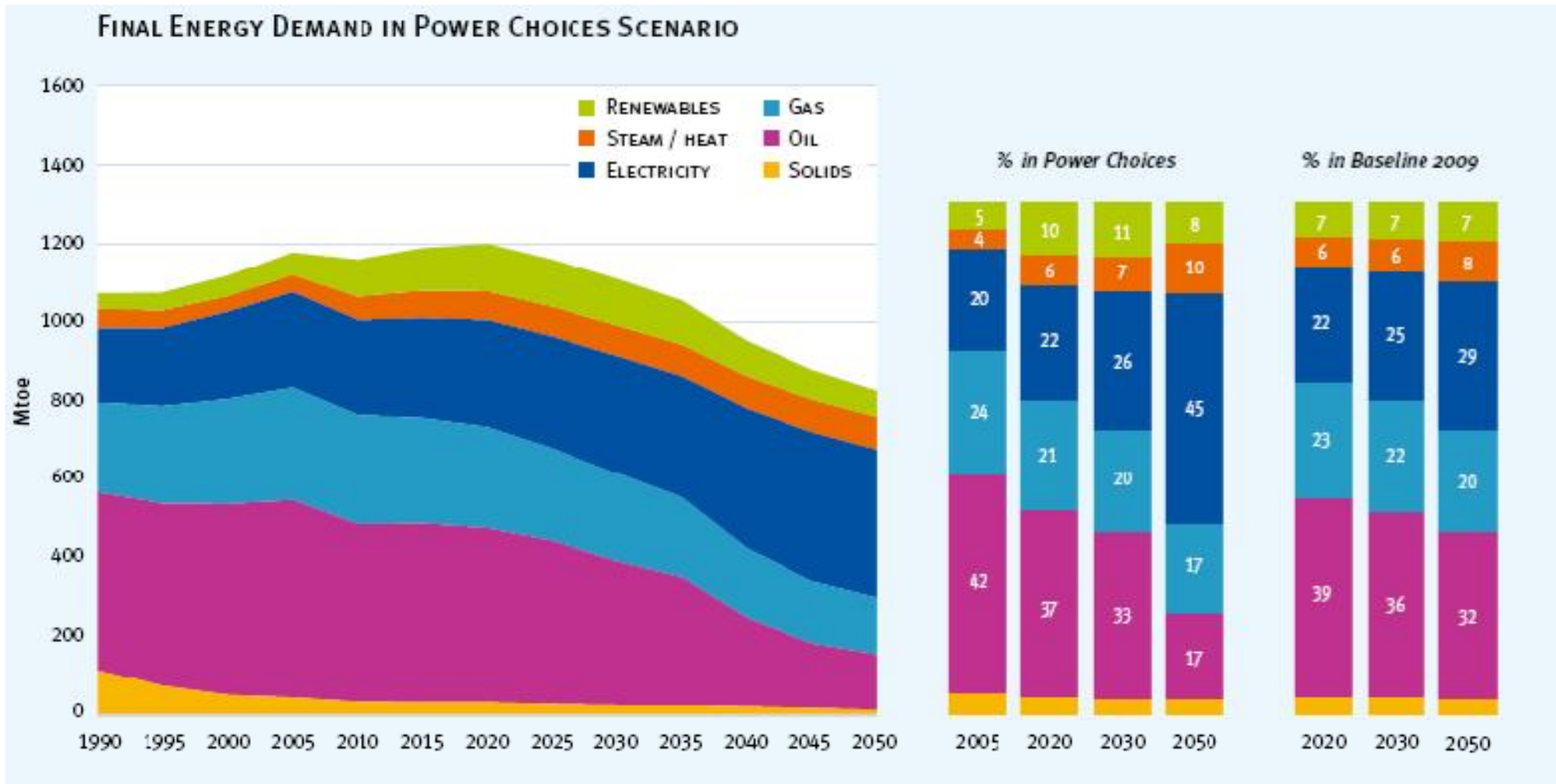


Source: Eurelectric

EU-25 – Final energy consumption scenarios – power choices



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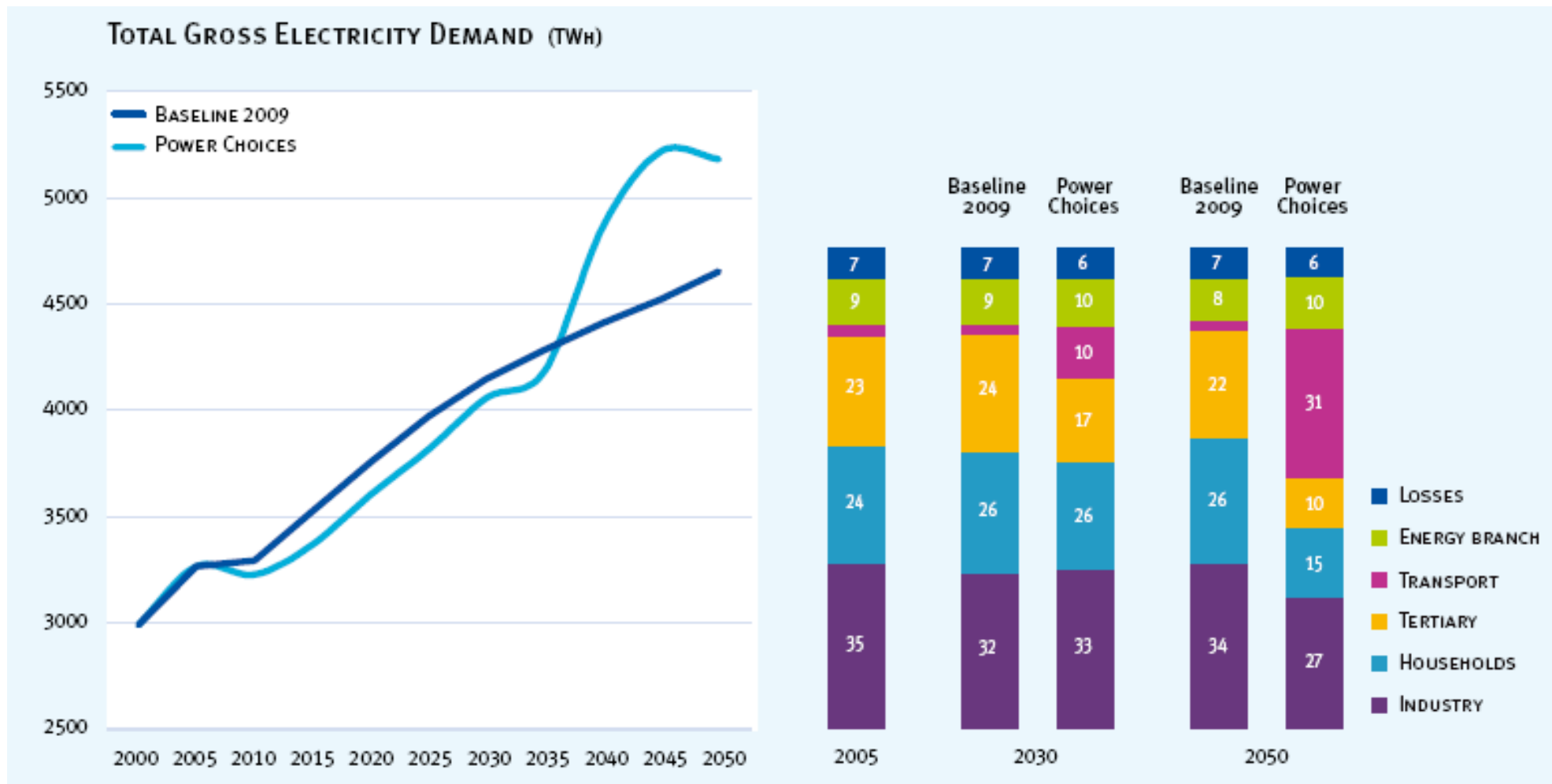


Source: Eurelectric

EU-25 – electricity consumption scenarios – power choices



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Source: Eurelectric

EU-25 – shares in passenger vehicle stock – power choices



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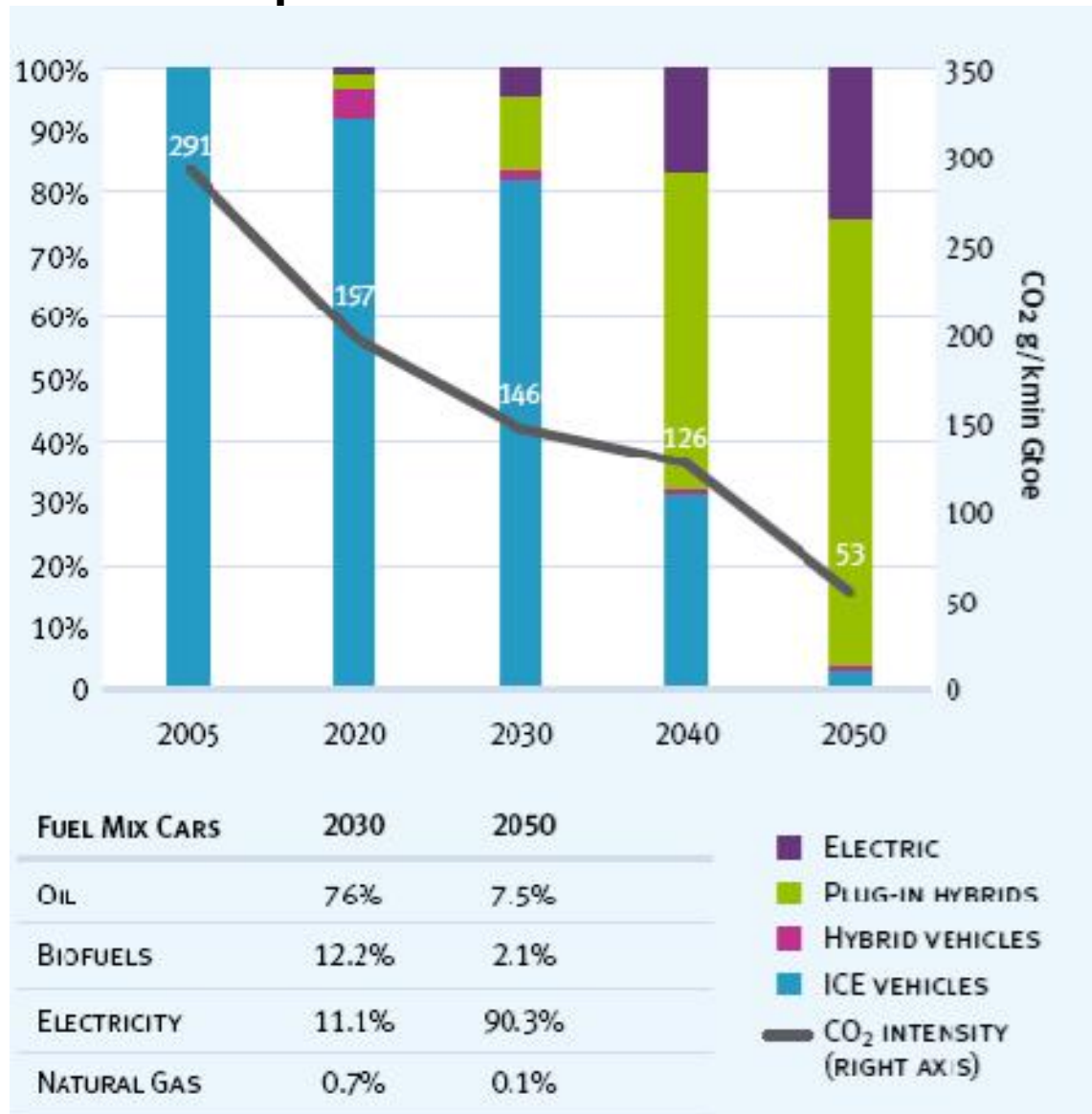
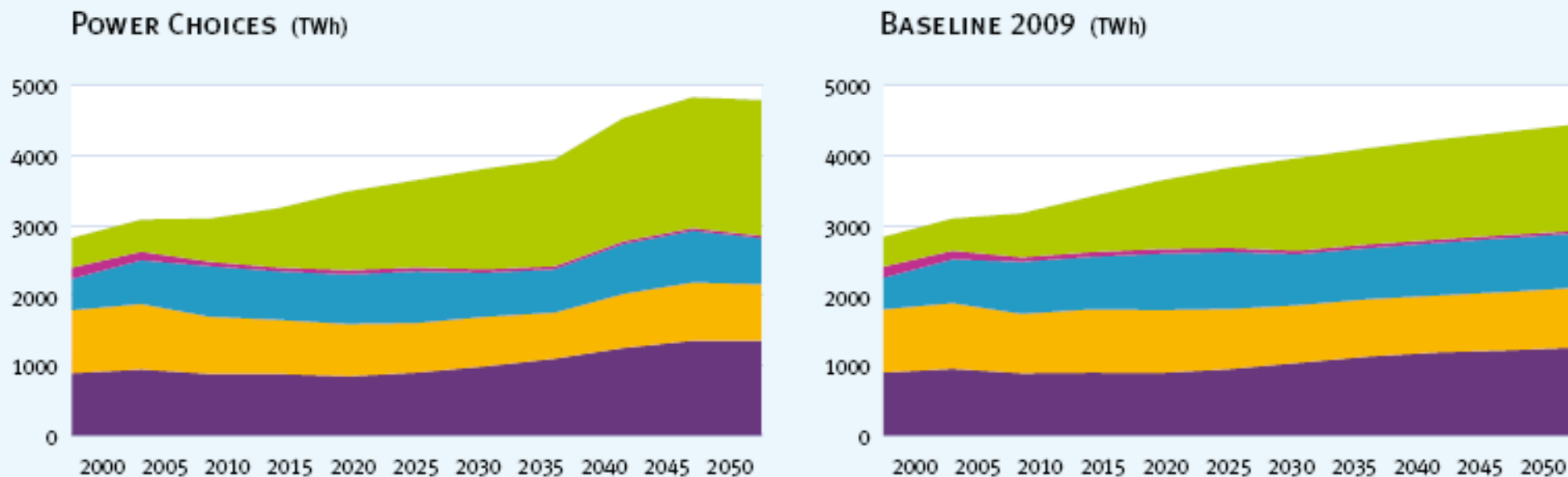


Figure 18: Shares in Passenger Vehicles Stock

Source: Eurelectric

EU-25 – Power generation structure – power choices



%	POWER CHOICES				BASELINE 2009		
	2005	2020	2030	2050	2020	2030	2050
RES	14.8	32.0	37.7	40.4	26.7	33.3	34.2
OIL	5.6	1.8	1.2	0.7	1.9	1.2	0.9
GAS	16.0	20.3	16.5	13.6	22.2	18.5	17.3
SOLIDS	31.9	21.4	18.5	16.9	24.7	20.8	19.3
NUCLEAR	31.7	24.5	26.1	28.4	24.5	26.2	28.3

Figure 22: Summary of Power Generation Structure



Conclusions about the electricity demand in EU

- Increasing energy efficiency in end-use
- Electrification of the transport sector
- Role of electricity is estimated to increase
 - From 20 % to 30...45 % by the year 2050
- Total energy consumption is estimated to decrease by 2050, while slight increase is still anticipated until 2020
- Electricity demand is estimated to increase constantly in EU-25
 - ~ 4 000 TWh in year 2030 (~3 300 TWh in year 2006)
 - ~ 4 600 – 5 200 TWh in year 2050

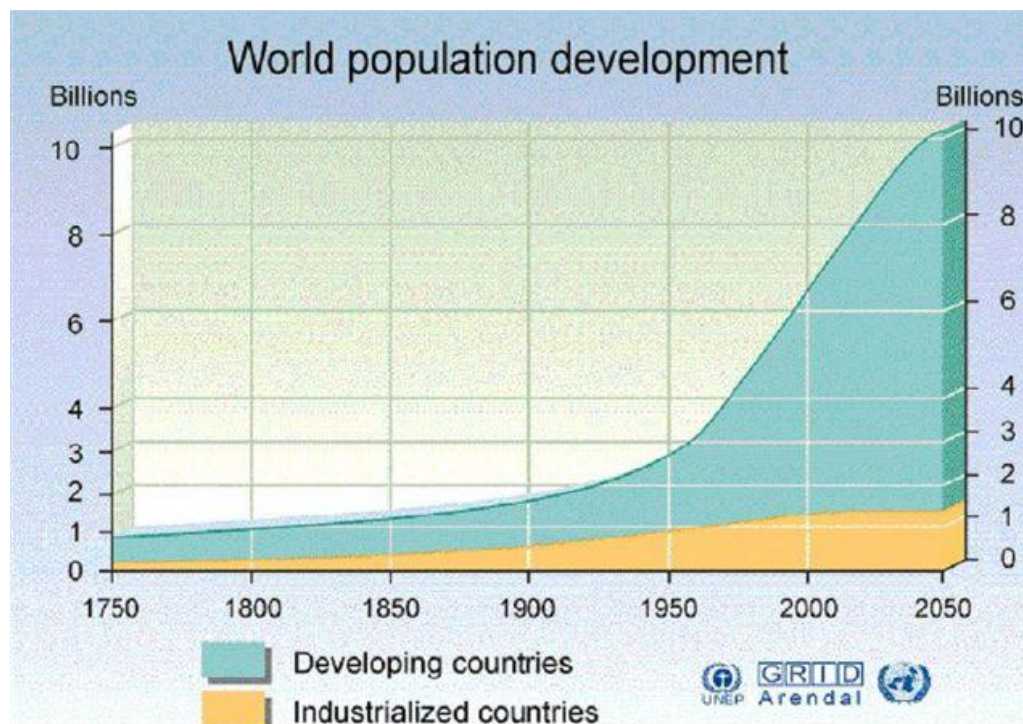


Global development to 2050



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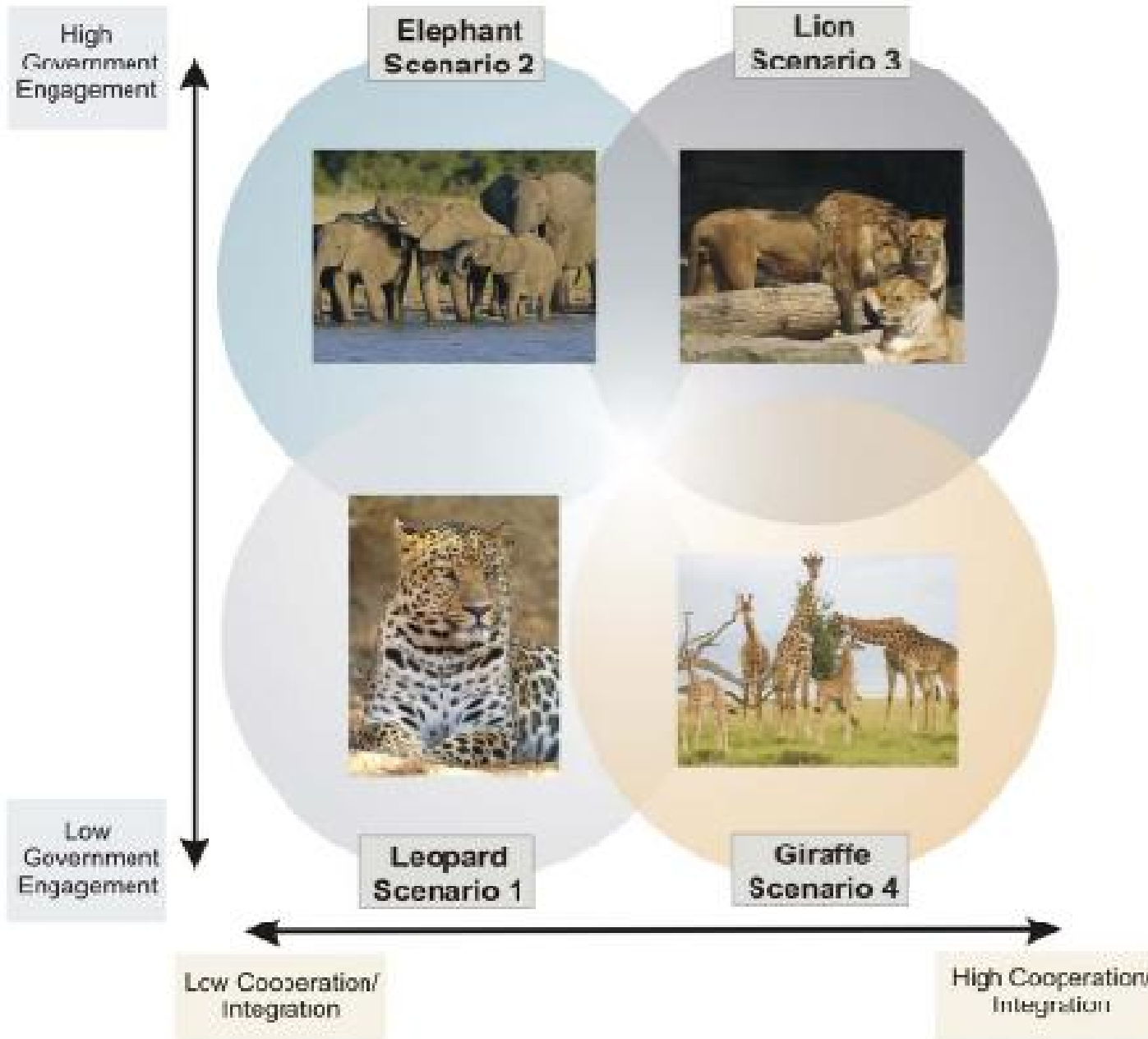
- The global population is estimated to increase annually by 1 % to about 8 billion by 2030 and to 9-10 billion by the year 2050
- It is estimated that energy supplies must double by the year 2050, in order to meet the energy demand



Global development to 2050 – WEC scenarios



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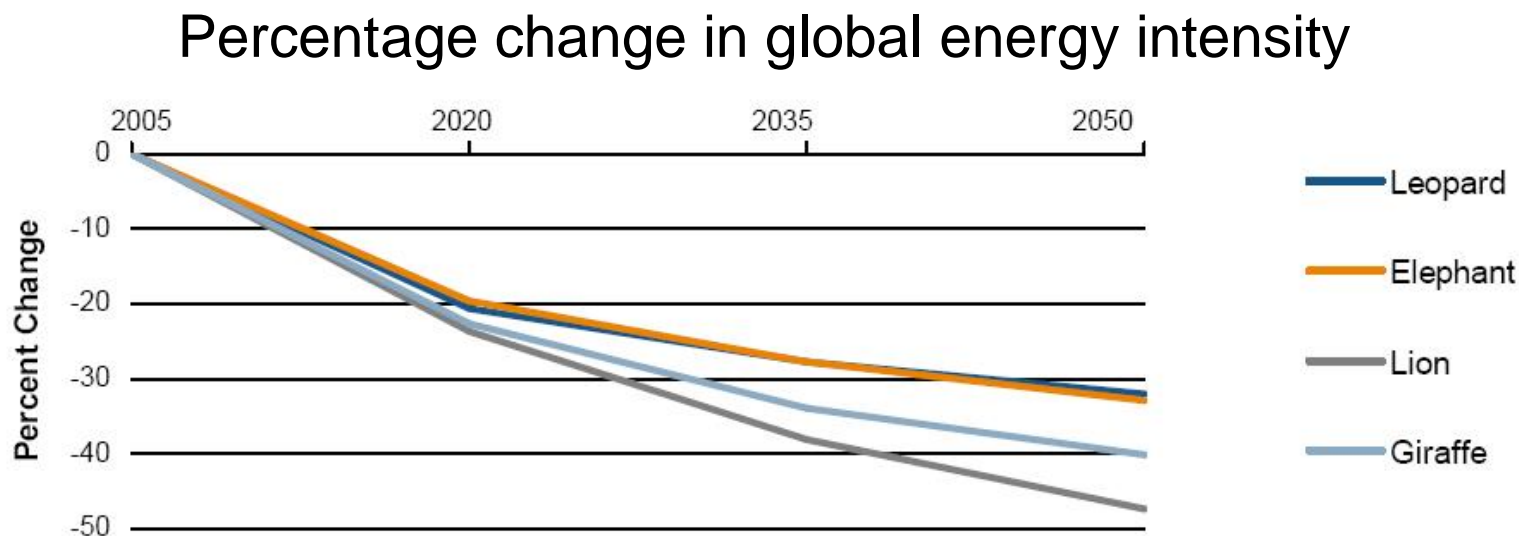
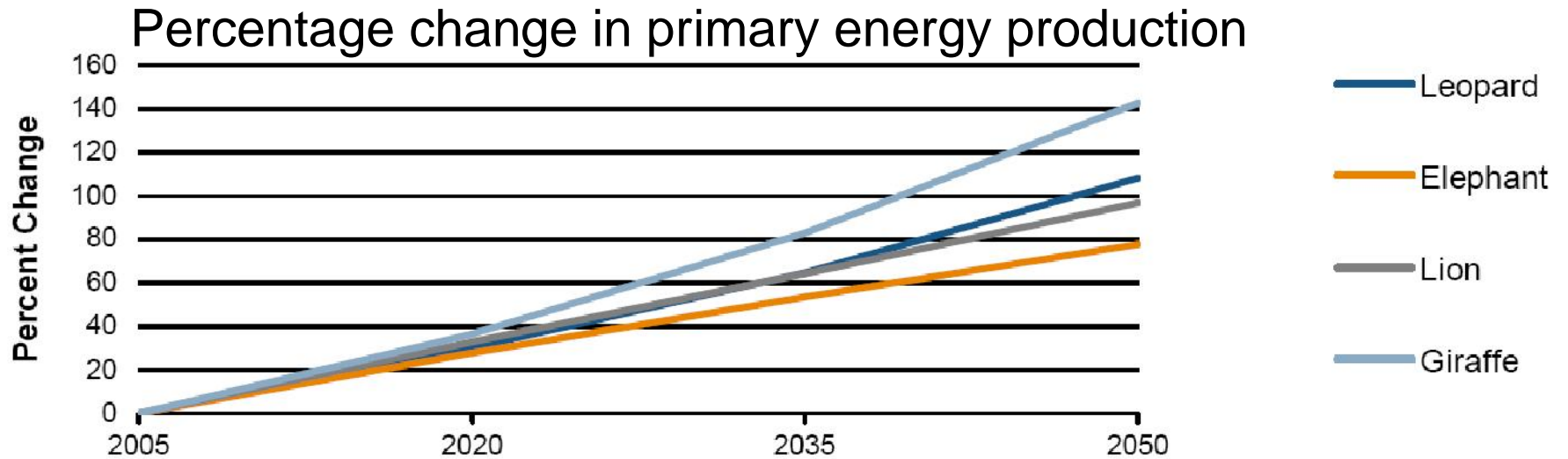


Source: WEC 2007

Global development to 2050 – WEC scenarios



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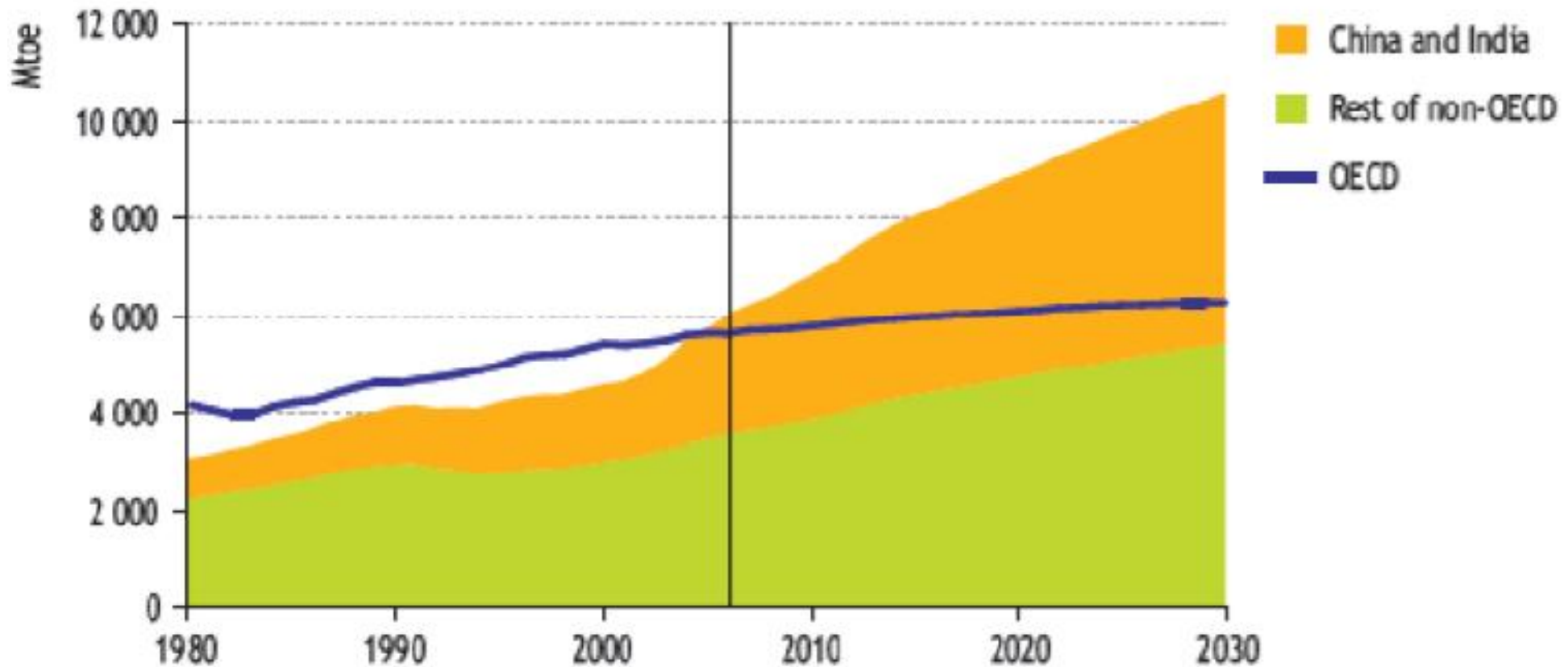
Source: WEC 2007

Global development – IEA scenarios



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World primary energy demand by region in reference scenario



Source: IEA 2008

Global development – IEA scenarios



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World final energy demand (Mtoe) by sector in reference scenario

scenario	1980	2000	2006	2015	2030	2006-2030*
Industry	1 779	1 879	2 181	2 735	3 322	1.8%
Coal	421	405	550	713	838	1.8%
Oil	474	325	329	366	385	0.7%
Gas	422	422	434	508	604	1.4%
Electricity	297	455	560	789	1 060	2.7%
Other	165	272	307	359	436	1.5%
Transport	1 245	1 936	2 227	2 637	3 171	1.5%
Oil	1 187	1 844	2 105	2 450	2 915	1.4%
Biofuels	2	10	24	74	118	6.8%
Other	57	82	98	113	137	1.4%
Residential, services and agriculture	2 006	2 635	2 937	3 310	3 918	1.2%
Coal	244	108	114	118	100	-0.5%
Oil	481	462	472	493	560	0.7%
Gas	346	542	592	660	791	1.2%
Electricity	273	613	764	967	1 322	2.3%
Other	661	910	995	1 073	1 144	0.6%
Non-energy use	348	598	740	876	994	1.2%
Total	5 378	7 048	8 086	9 560	11 405	1.4%

Source: IEA 2008

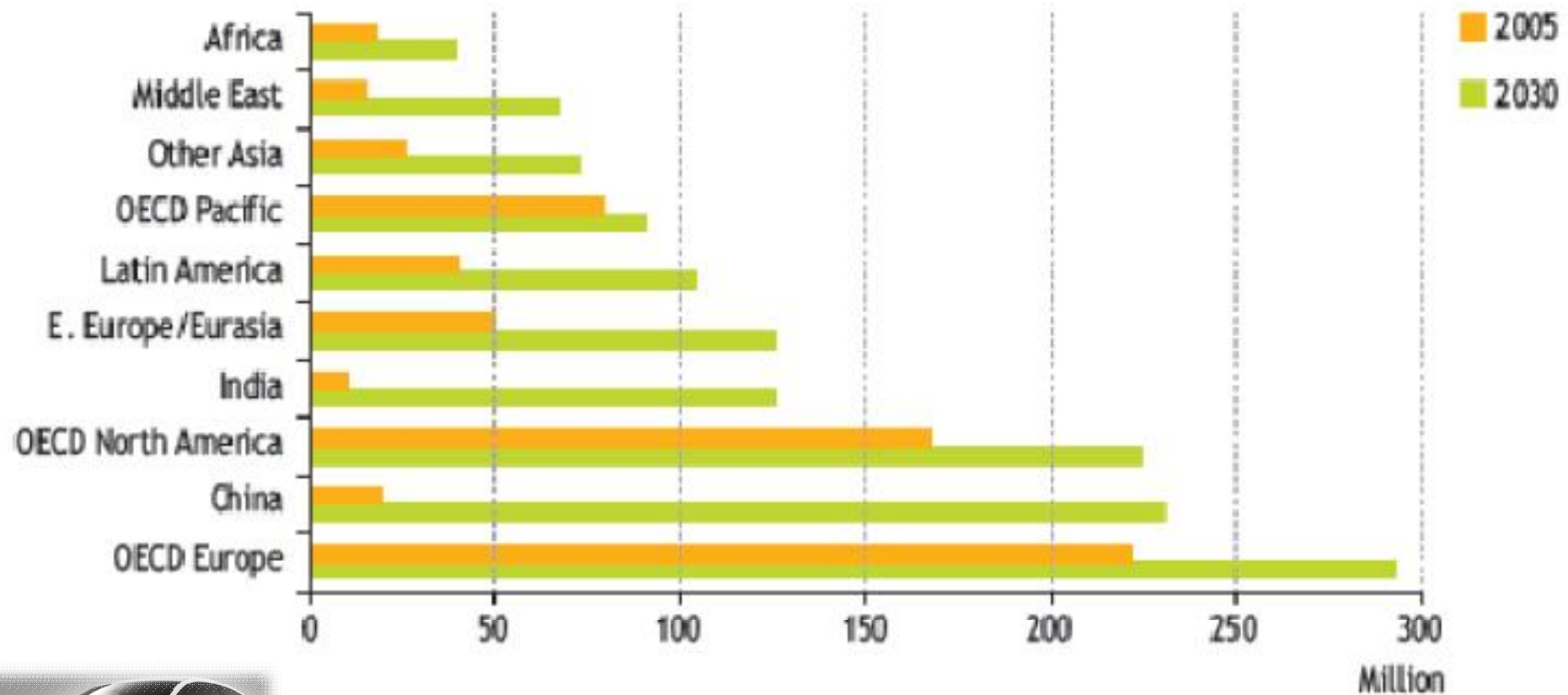
* Average annual rate of growth.

Global development – IEA scenarios



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Light-duty vehicle stock by region in reference scenario



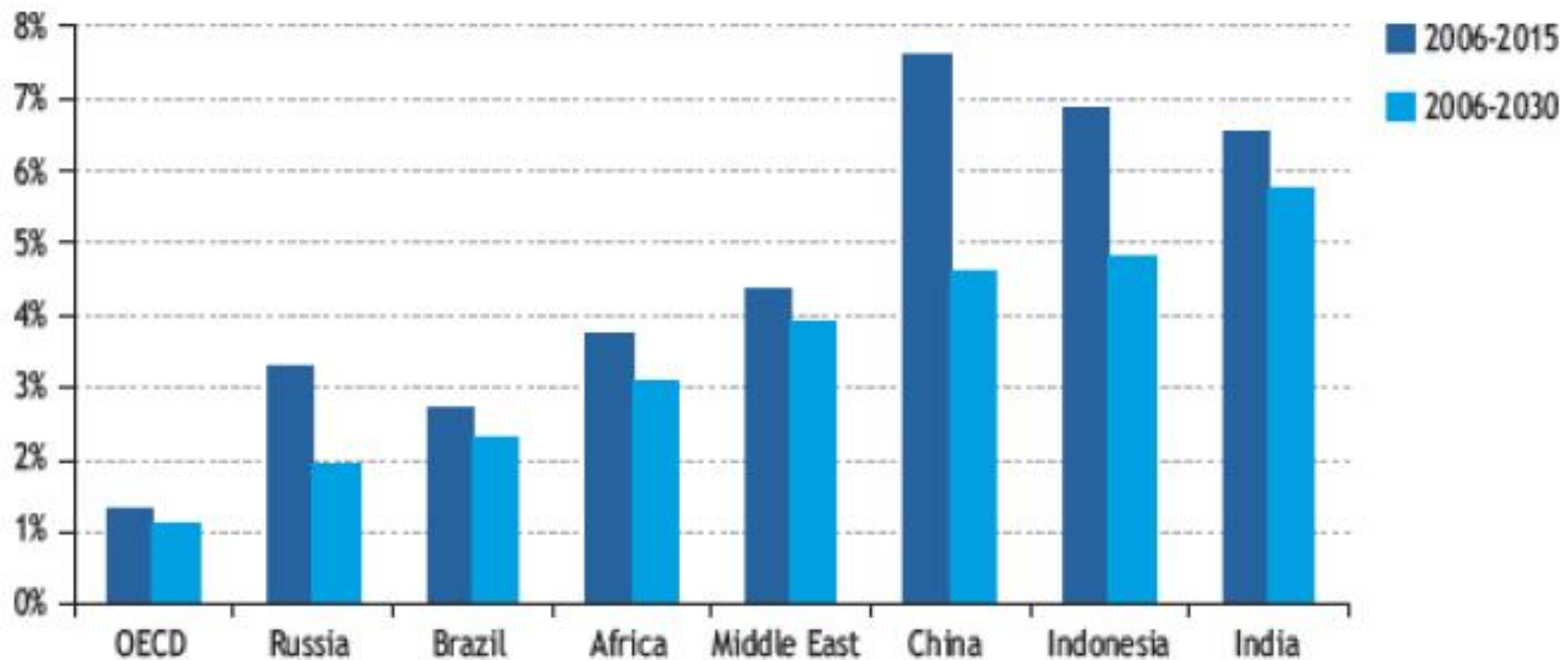
Source: IEA 2008

Global development – IEA scenarios



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Electricity demand growth rate by region in reference scenario

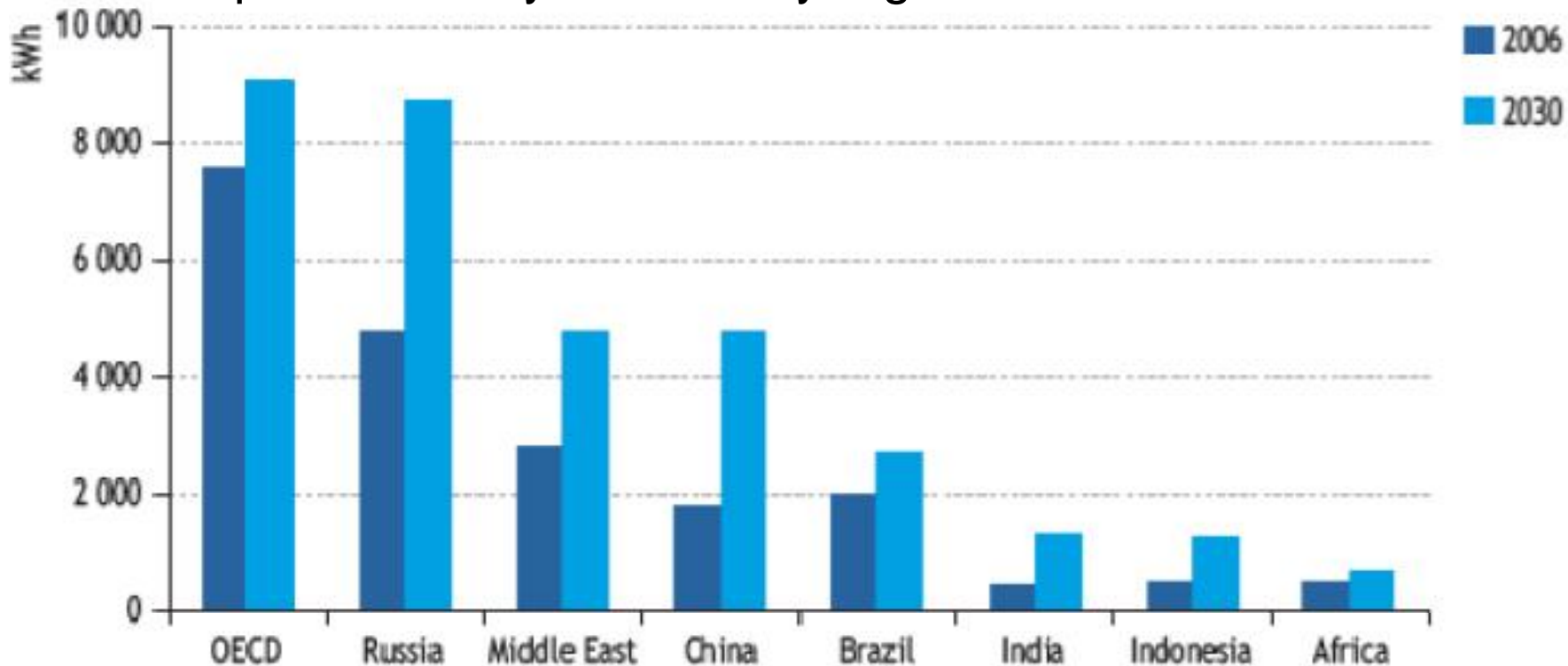


Global development – IEA scenarios



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Per capita electricity demand by region in reference scenario



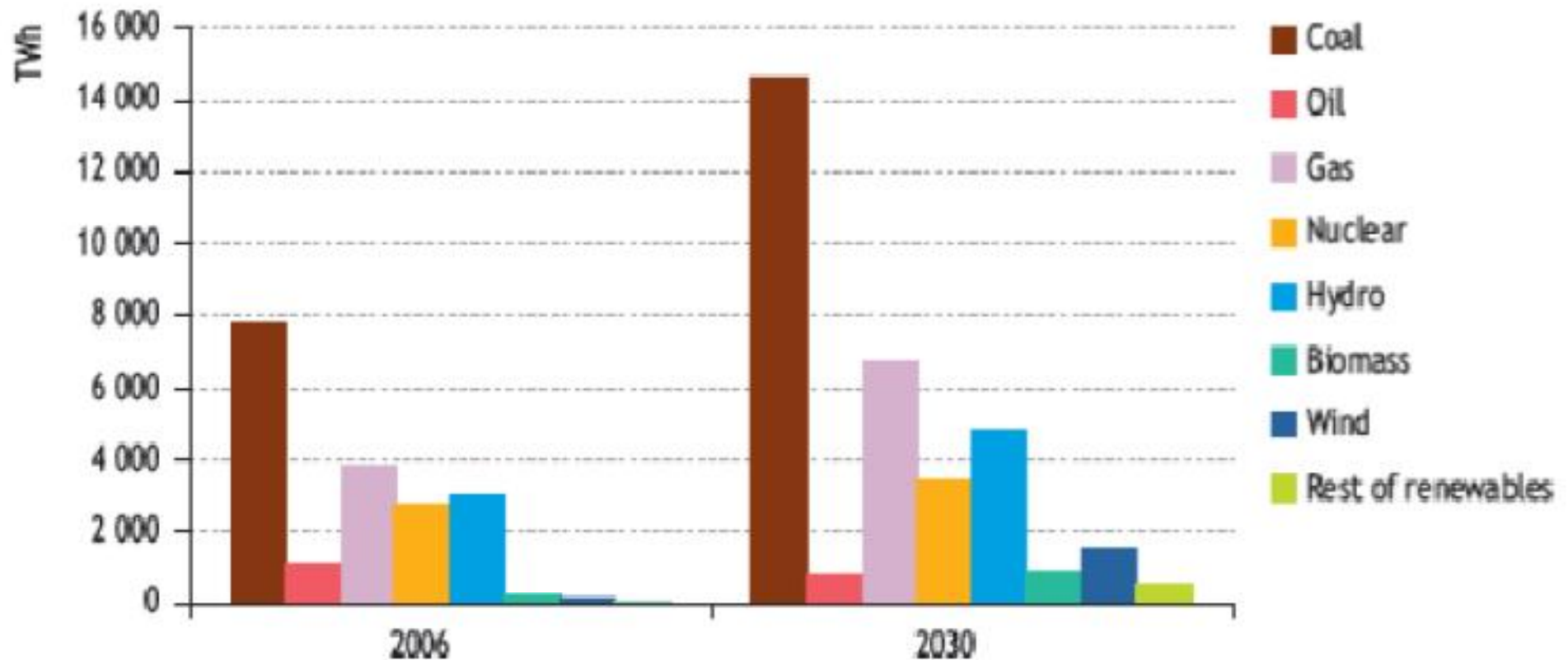
Source: IEA 2008

Global development – IEA scenarios



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World electricity generation by fuel in reference scenario



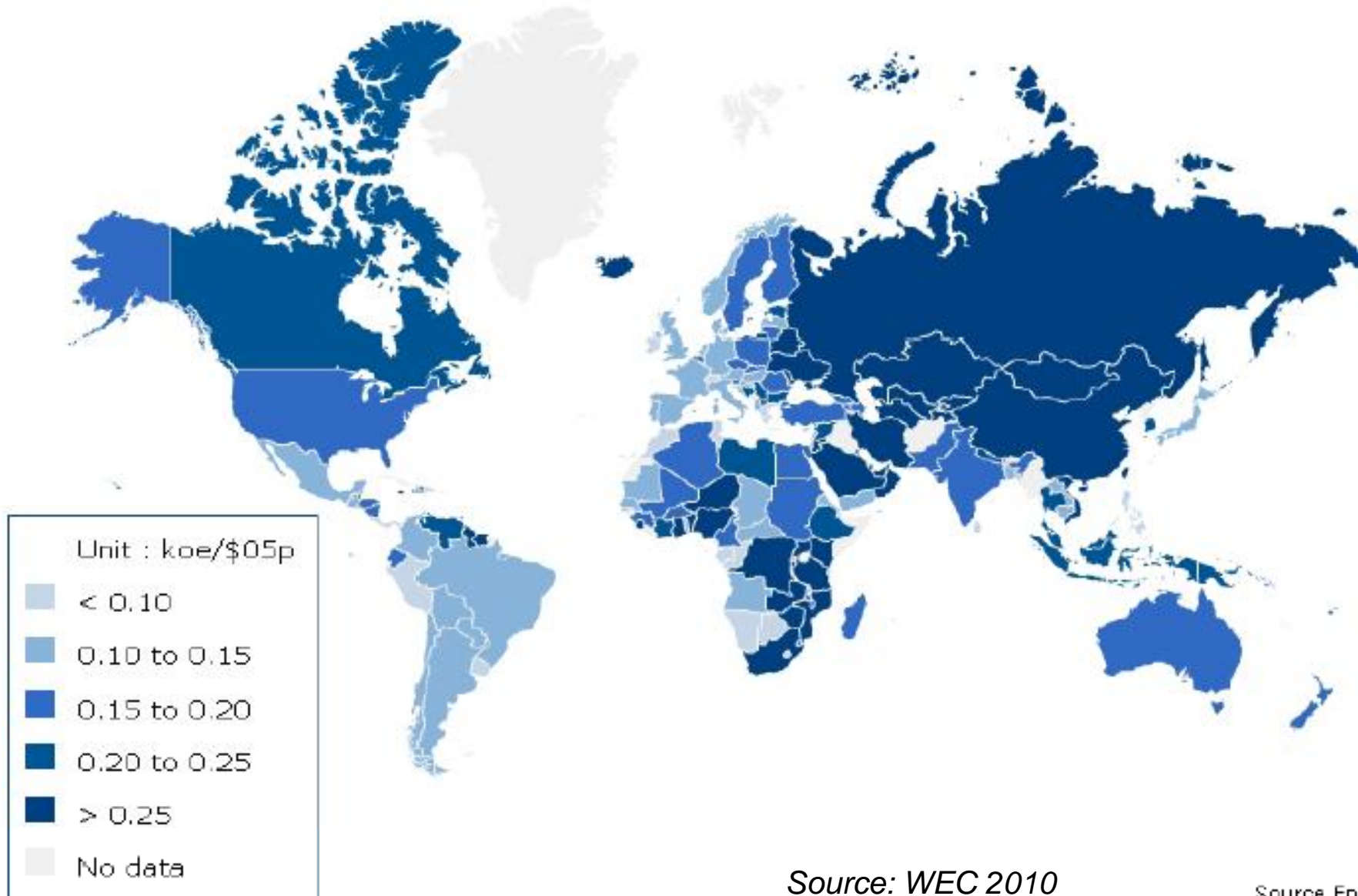
Source: IEA 2008

Global trends



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Primary energy intensity by country in 2008



Source: WEC 2010

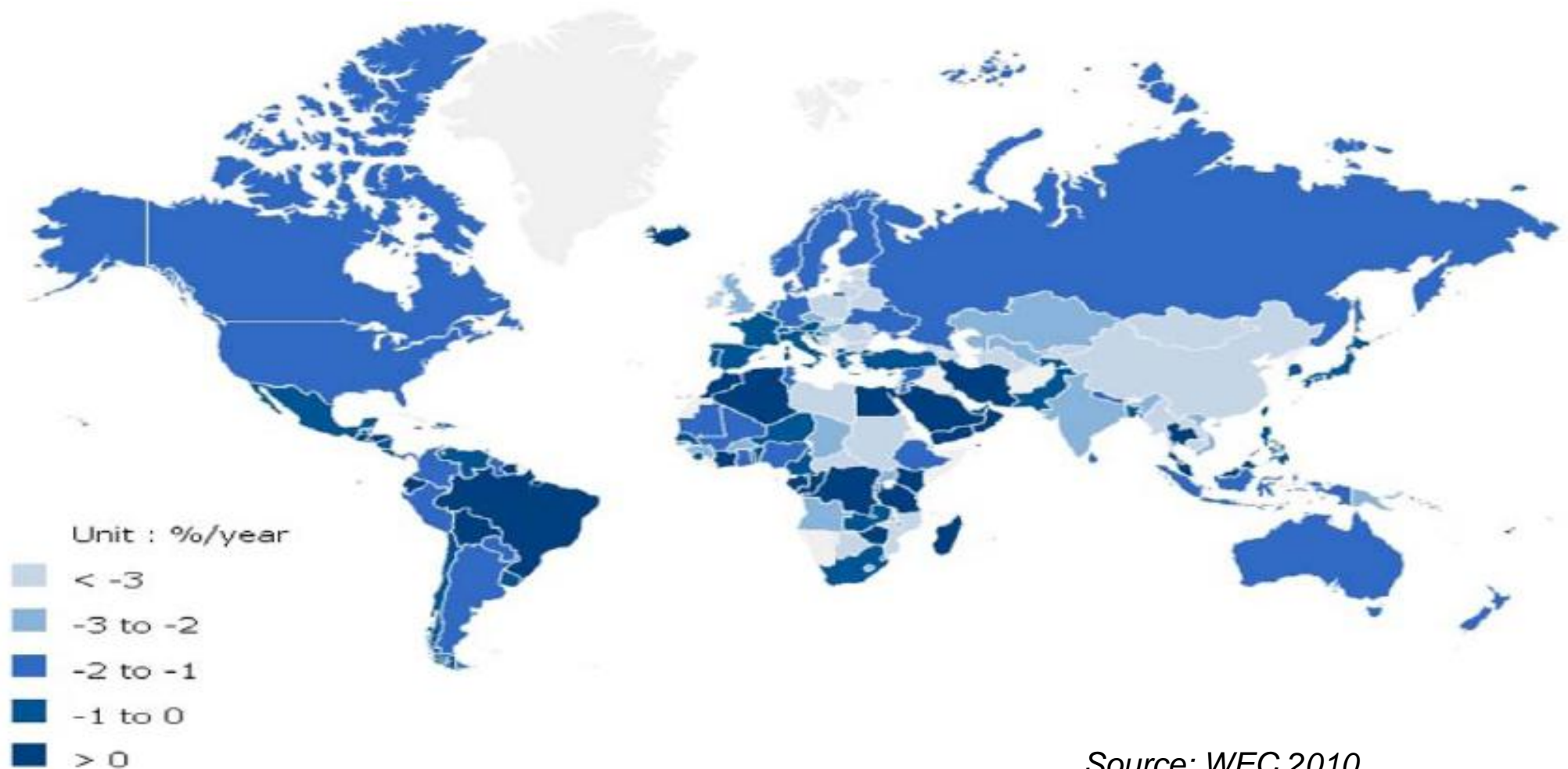
Source Enerdata

Global development



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Primary energy intensity trends by country 1990-2008

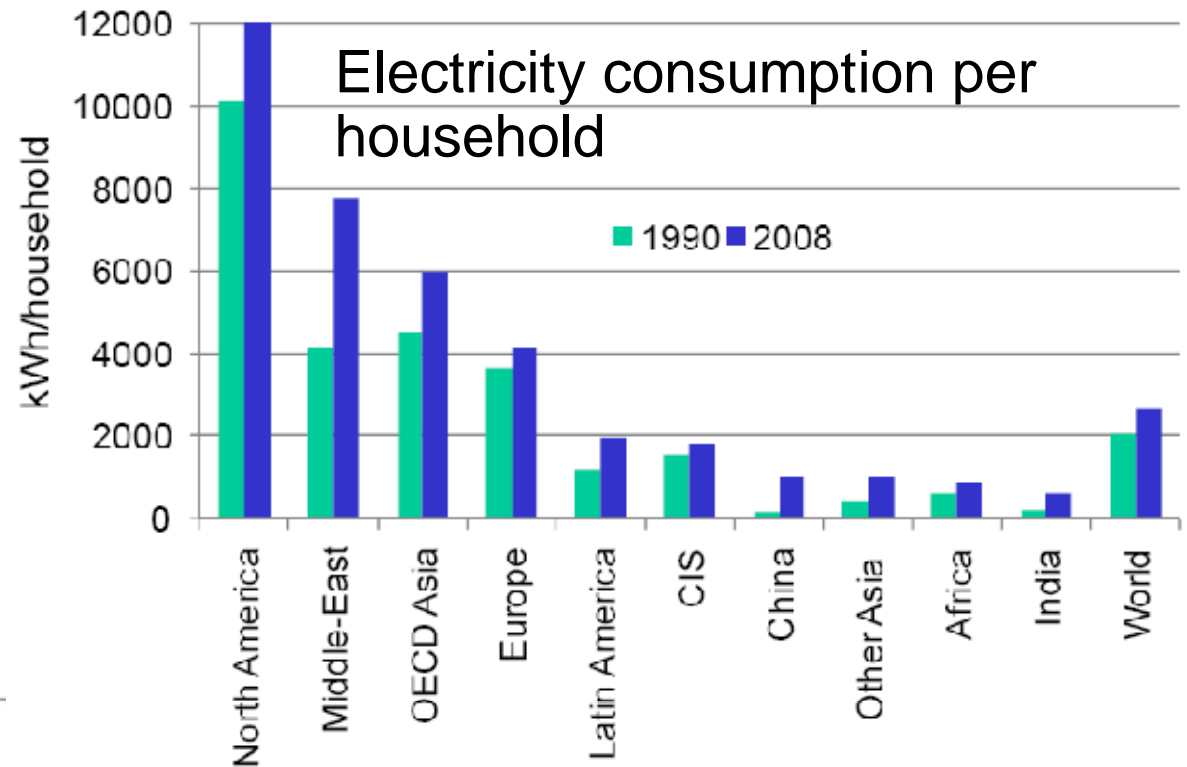
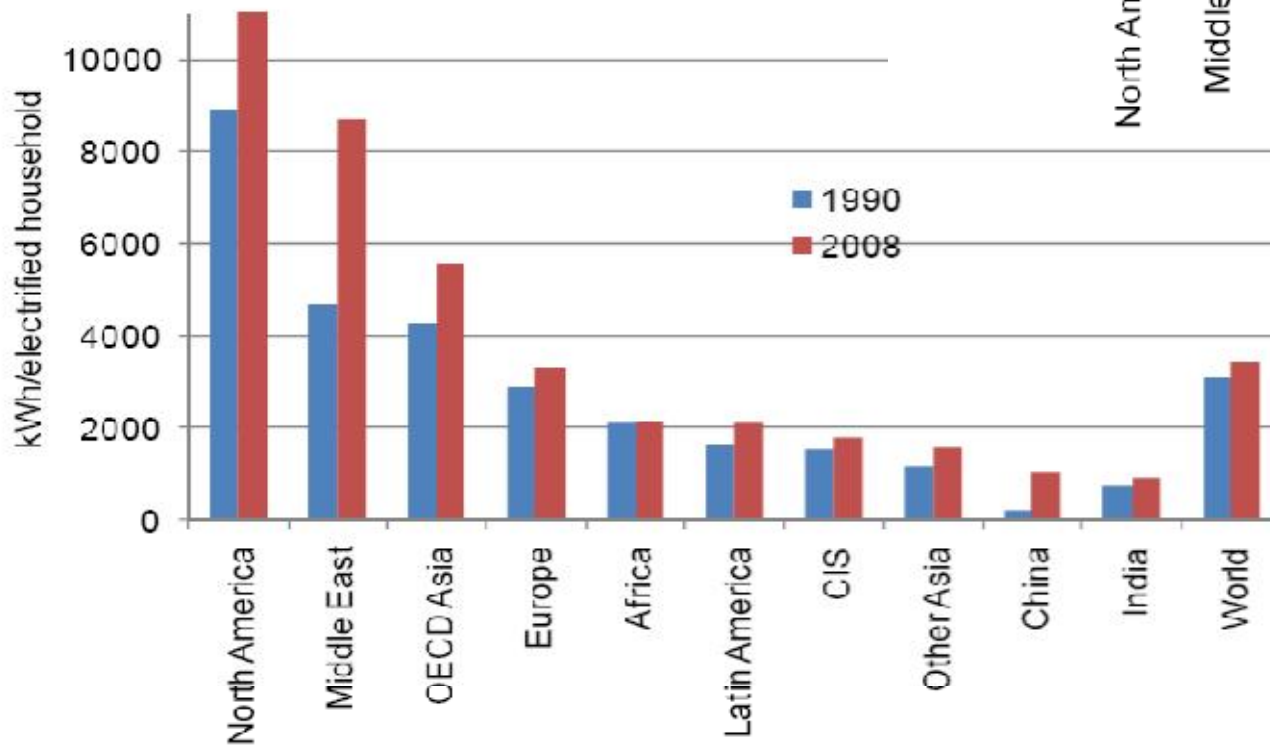


Source: WEC 2010

Global development



Electricity consumption per electrified household



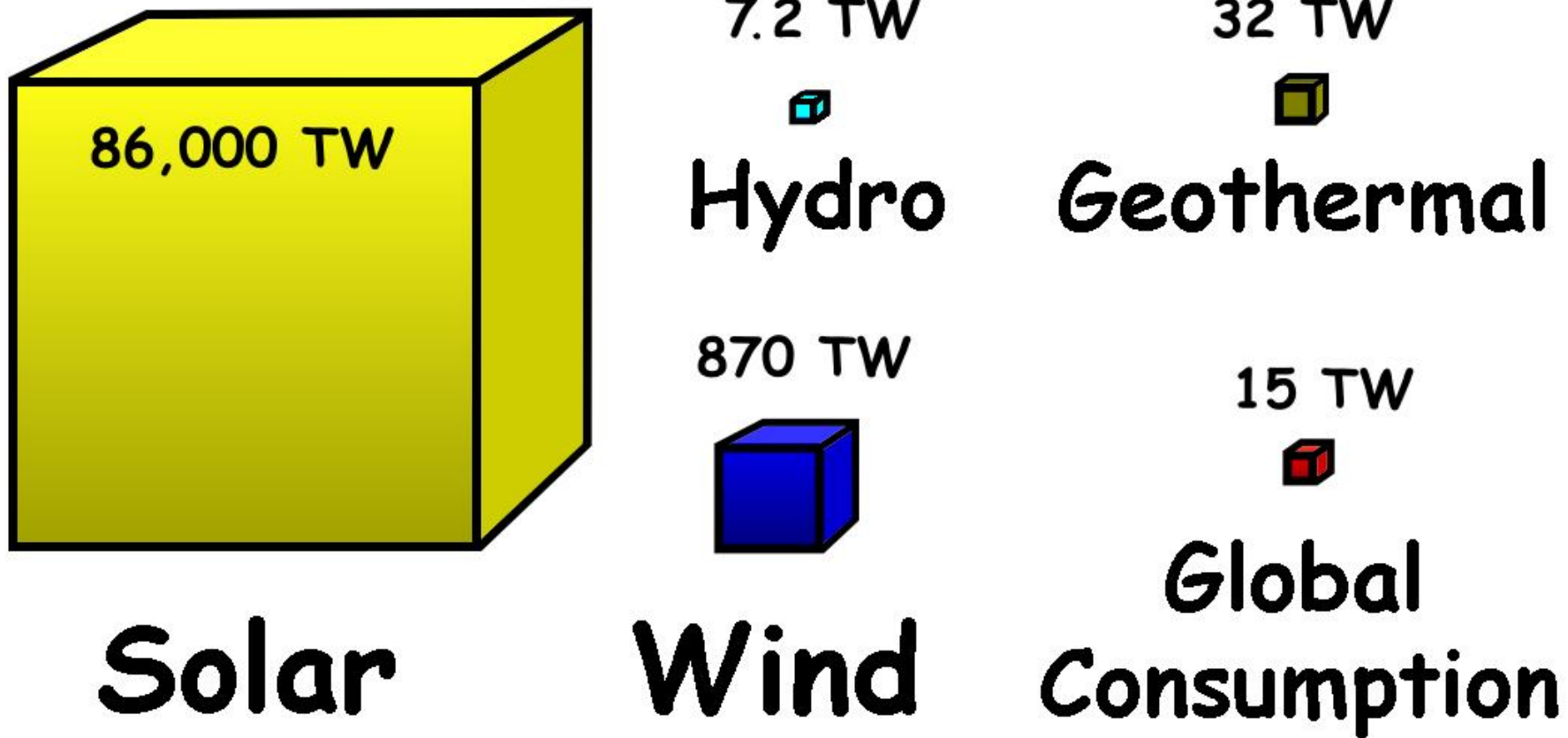
Source: WEC 2010

Is there enough energy?



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Available renewable power and total global power consumption



Source: Wikipedia



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