

New Energy Technologies and Major Industry Trends

Population Demographics

- Increase of Welfare
- Megacities
- Mobility, Global Trade



Demand Growth

- Energy/Electricity
- Clean Water
- Food

Decreasing Natural Resources

- Decreasing Reserves of Conventional Oil/Gas
- Geopolitical tension between energy producers and consumers



Search for Alternatives

- Exploration of non-conventional Reserves and Resources
- Increasing Role of renewables
- Reassessing Nuclear

Environmental Awareness

- Increasing Emissions of SO₂, NO_x, particulates, heavy metals
- CO₂ issue and Climate change



Demand for Equipment

- Emission Control Systems
- Renewables + Nuclear
- High Tech for Energy Efficiency

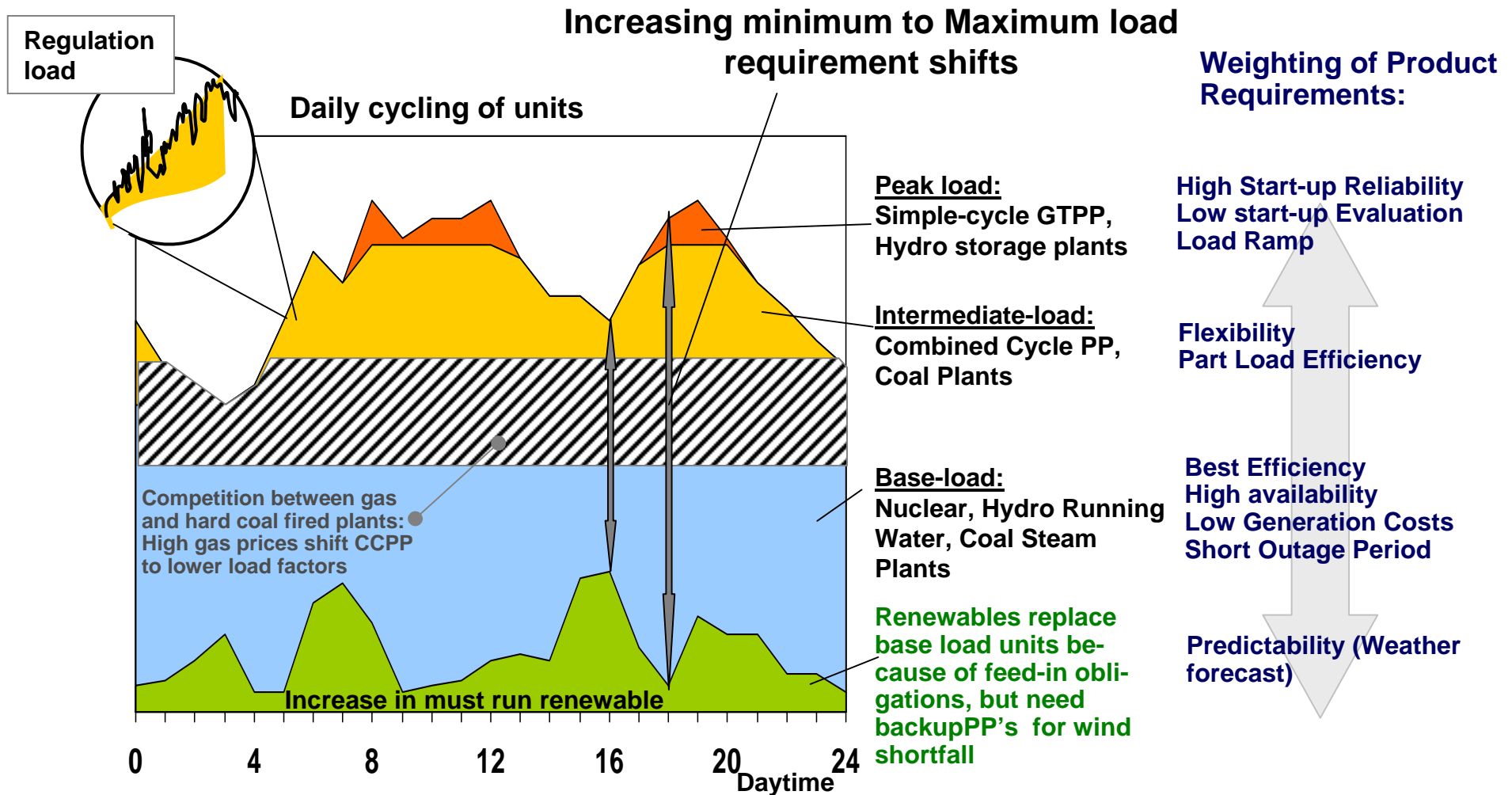
Increasing Demand for Investment in the Full Chain of Energy Supply Systems



Up to 2020: Financing of ~ 9 Trillion € in the Energy Industry

Typical Areas of Requirements and Different Power Plants Types

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Operational Flexibility: Increasing Challenges for Base Load Plants

Power Production Costs by Plant Types






















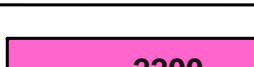



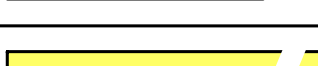

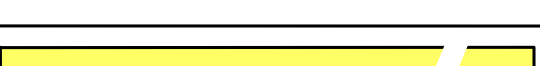
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Power Plant Type	Average Annual Full Load Hours (h/a)	Specific Investment (EUR/kW)	Production Costs (EURct/kWh) *) Variable Share / Total Costs
Nuclear Power (1600 MW, 36%)	8000	1700	0.8 3.5
Lignite (900 MW, 43%)	7000	1100	1.5 3.2
Hard Coal (700 MW, 45%)	7000	850	1.9 3.4
Combined Cycle (Gas) (450 MW, 58%)	7000	400	3.4 4.2
IGCC Coal (700 MW, 47%)	7000	1300	1.6 3.9
Combined Cycle / CO ₂ –Sequestr./Liquific. (380 MW, 50%)	7000	580	3.1 4.3
IGCC Coal / CO ₂ –Sequestr./Liquific. (630 MW, 43%)	7000	1750	1.8 4.8

*) Variable costs include fuel costs and O&M costs, while total costs include additionally capital costs
 Production costs averaged over plant operation time (Nuclear 45 years, Coal 35 years, CCPP 25 years, IGCC 30 years)
 Financing conditions: in general share of loans 70 %, interest on loan 6%, interest on equity 12%, discount rate 8%;
 for Nuclear EPR Finland interest on loan 4.5%, interest on equity 8%, discount rate 6%)
 Fuel prices: Hard coal: 2.00 EUR/GJ, Natural gas: 5.50 EUR/GJ, Nuclear fuel: 0.70 EUR/GJ (no price escalations)

Power Production Costs of Renewables by Plant Types

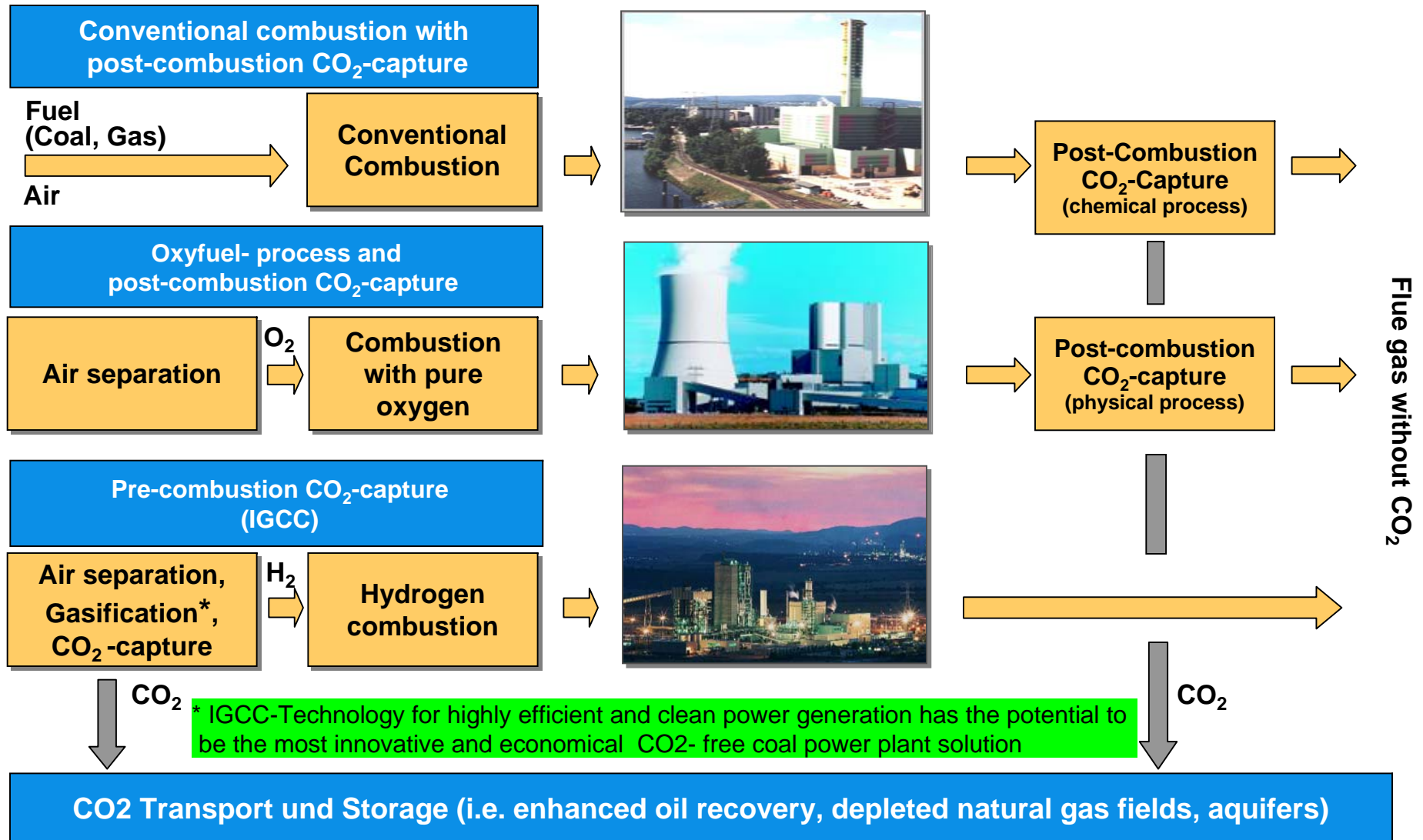
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Power Plant Type	Average Annual Full Load Hours (h/a)	Specific Investment (EUR/kW)	Production Costs (EURct/kWh) *) Variable Share / Total Costs
Hydro (Reservoir) (400 MW)	 5000	 1800	 0.1  5.2
Hydro (Running Water) (30 MW)	 5000	 1800	 0.1  7.0
Wind Power (Onshore) (1,5 MW)	 1900	 900	 0.7  6.6
Wind power (Offshore) (3 MW)	 3600	 1500	 0.9  6.0
Biomass (30 MW, 38%)	 4500	 2700	 1.7  8.0
Geothermal (30 MW, 25%)	 5000	 2200	 1.6  6.9
Photovoltaic (1 MW)	 2400	 6000	 0.4  40.0

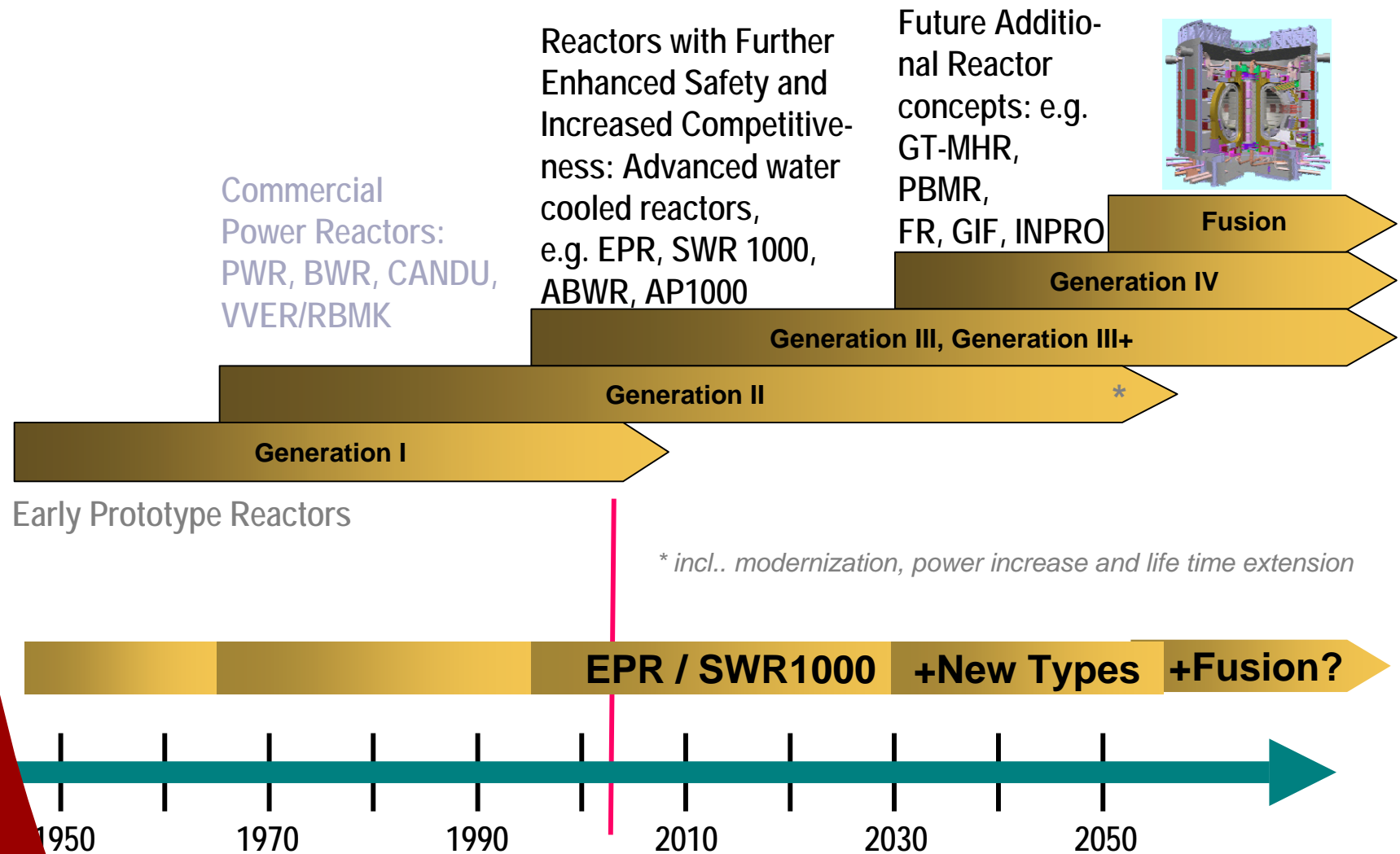
*) Variable costs include fuel costs and O&M costs, while total costs include additionally capital costs
 Production costs averaged over plant operation time (Hydro 45 years, Wind power 25 years, Biomass/Geothermal 30 years, Photovoltaic 25 years)
 Financing conditions: share of loans 70 %, interest on loan 6%, interest on equity 12%, discount rate 8%,
 Fuel prices: Biomass 1.30 EUR/GJ

Upcoming Technological Trends Towards CO₂ Free Fossil Power Plants

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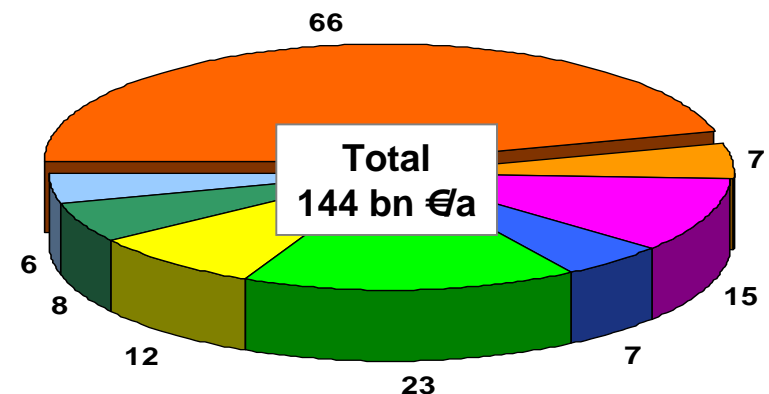


Reactor Generations



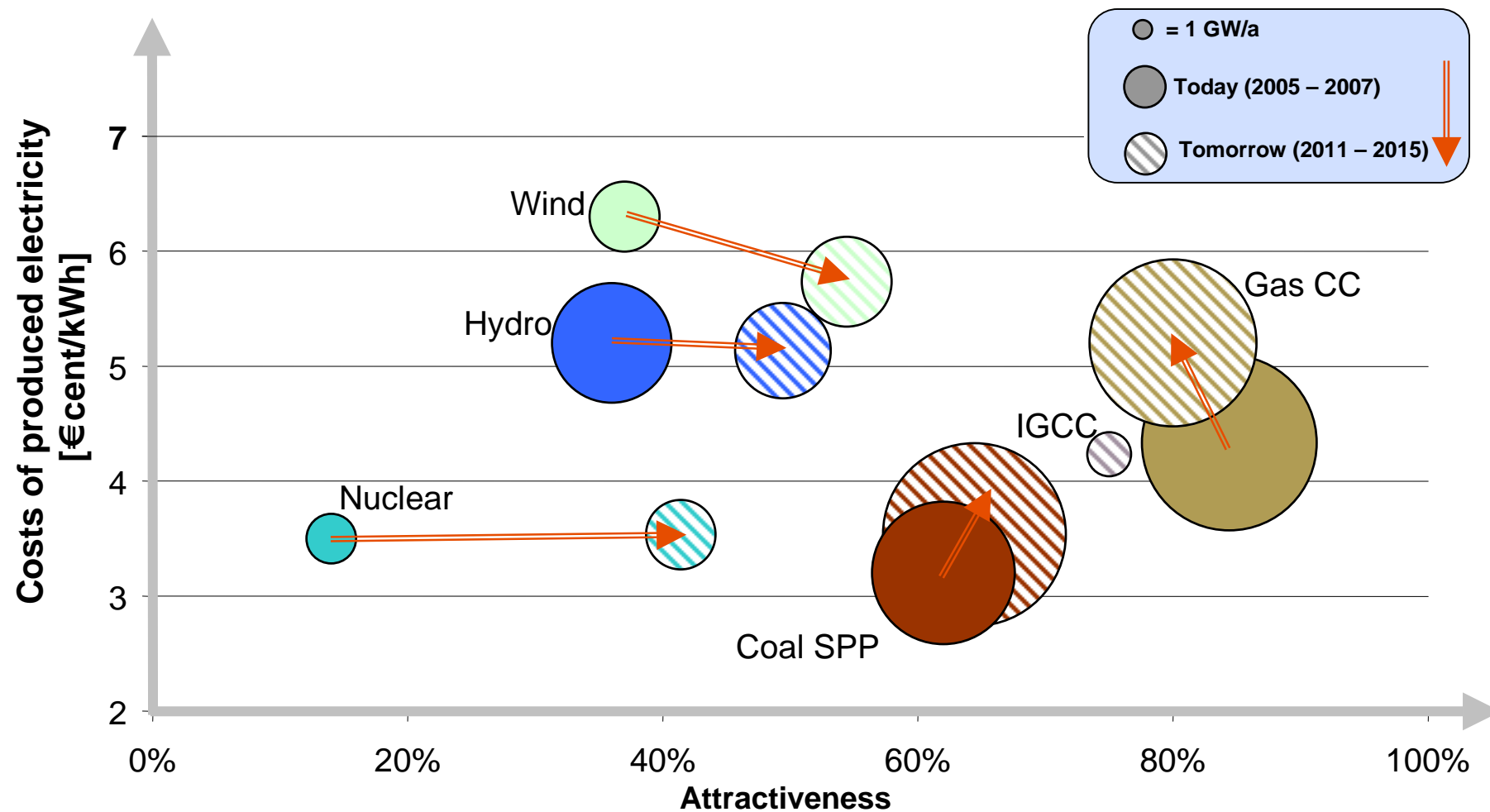
- All available technologies always are analyzed and checked to cohere with changing trends
- No primary energy but energy carrier suitable for every use (motion, heat, light, signal transmission, ...)
- Practically all primary energy sources („clean“ or „dirty“) can be used for transformation into electricity
- When used environmentally friendly without CO₂
- No significant storage possible: Supply according to demand (time + amount; backup power)
- Power plant installations driven by consumption growth, aging fleets and environmental concerns
- Power generation business impacted by energy policies (e.g. liberalization) and strategies of utilities
- Potentials of renewable energy are much higher than world electricity demand. Improvement of their economics is the key driver for further market penetration
- In each scenario renewable power will play a larger role. Wind power (+biomass) has the best short term chances
- Environmental awareness: CO₂ becomes a driver; high efficient technologies needed to limit the CO₂ emissions
- Significant regional differences in growth, with worldwide shift to gas utilization
- Reassessment of nuclear energy

- Capital Investments:
Annual Average Capital Investment in Energy Sector 2005 – 2020 (bn EUR)
Total 566 bn €/a;
Out of this Annual Average Capital Investment in Power Generation 2005 - 2020 (bn EUR) Total 144 bn €/a



Energy Landscape: Today & Tomorrow

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Conventional Wisdom is Changing

Thank you very much for your attention !

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