

Wind Energy: what to expect within the next ten years



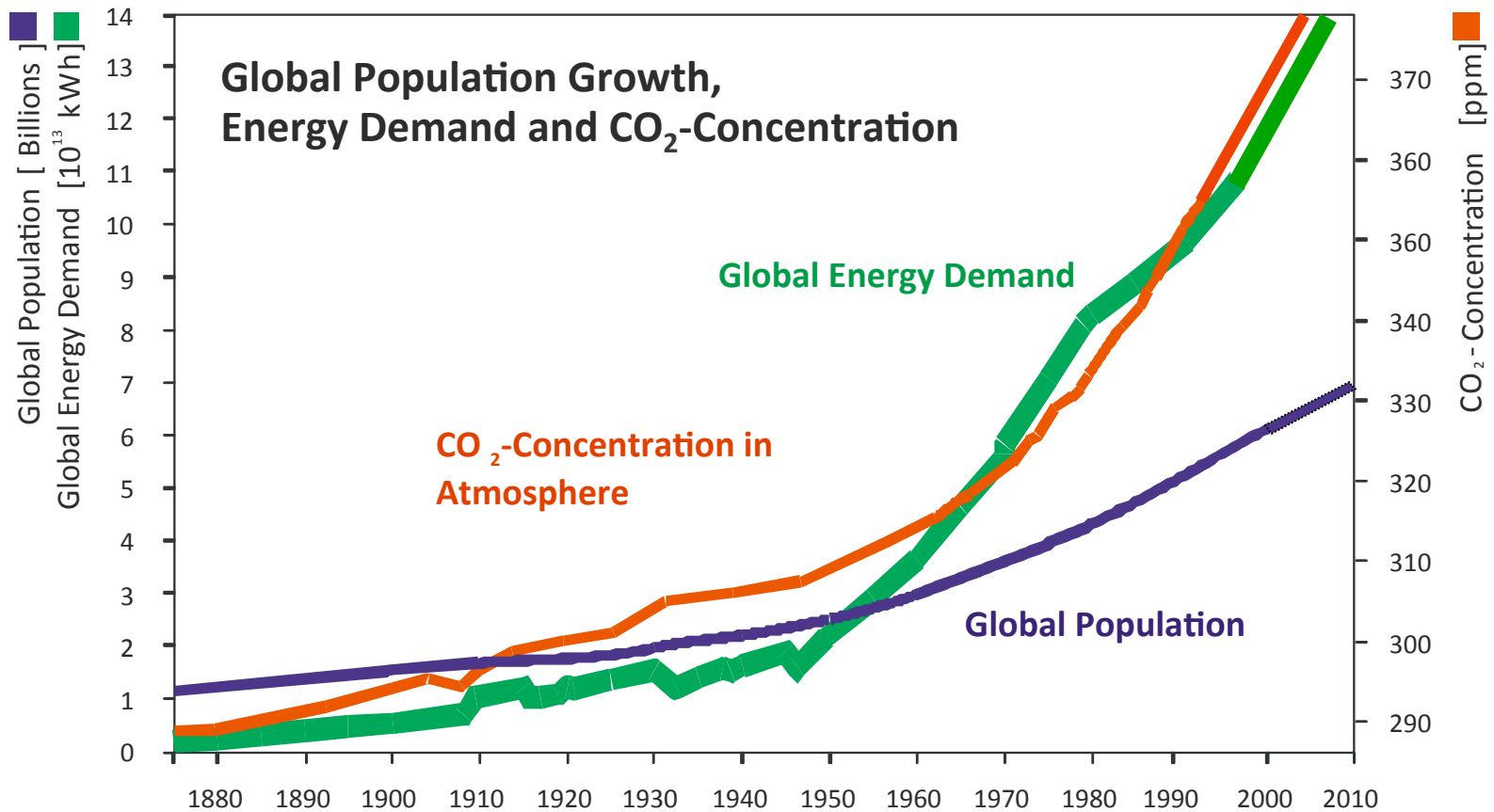
Andreas Reuter DPG-Spring-Meeting 2012

Wind Energy: what to expect within the next ten years

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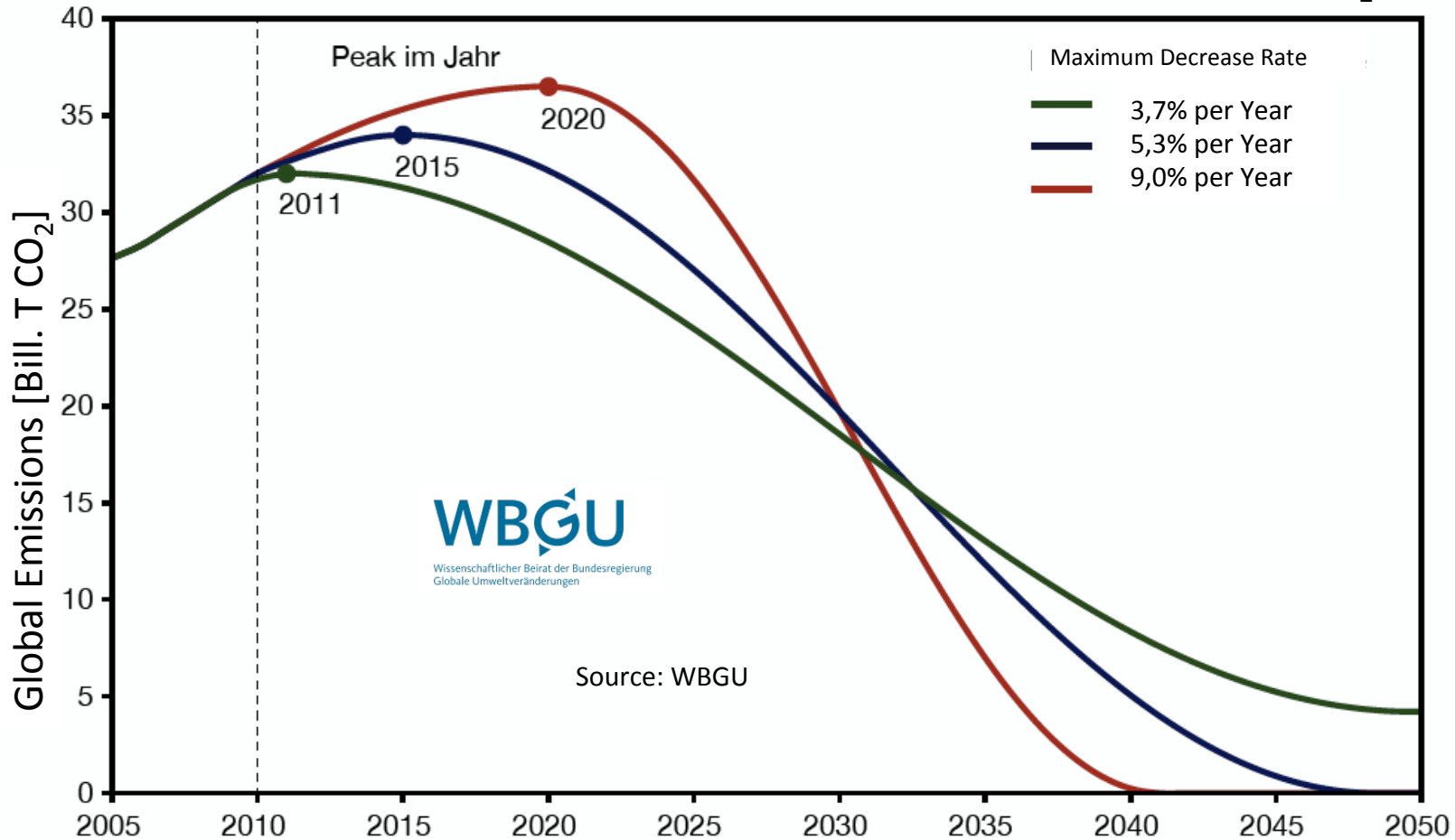
- Climate change and peak oil
- Energy scenarios & the role of wind
- Wind energy potential in Germany
- How to integrate wind into the grid
- Wind technology – the growth story
- Technology challenges onshore and offshore
- The next steps in technology developments

Global situation and future trends



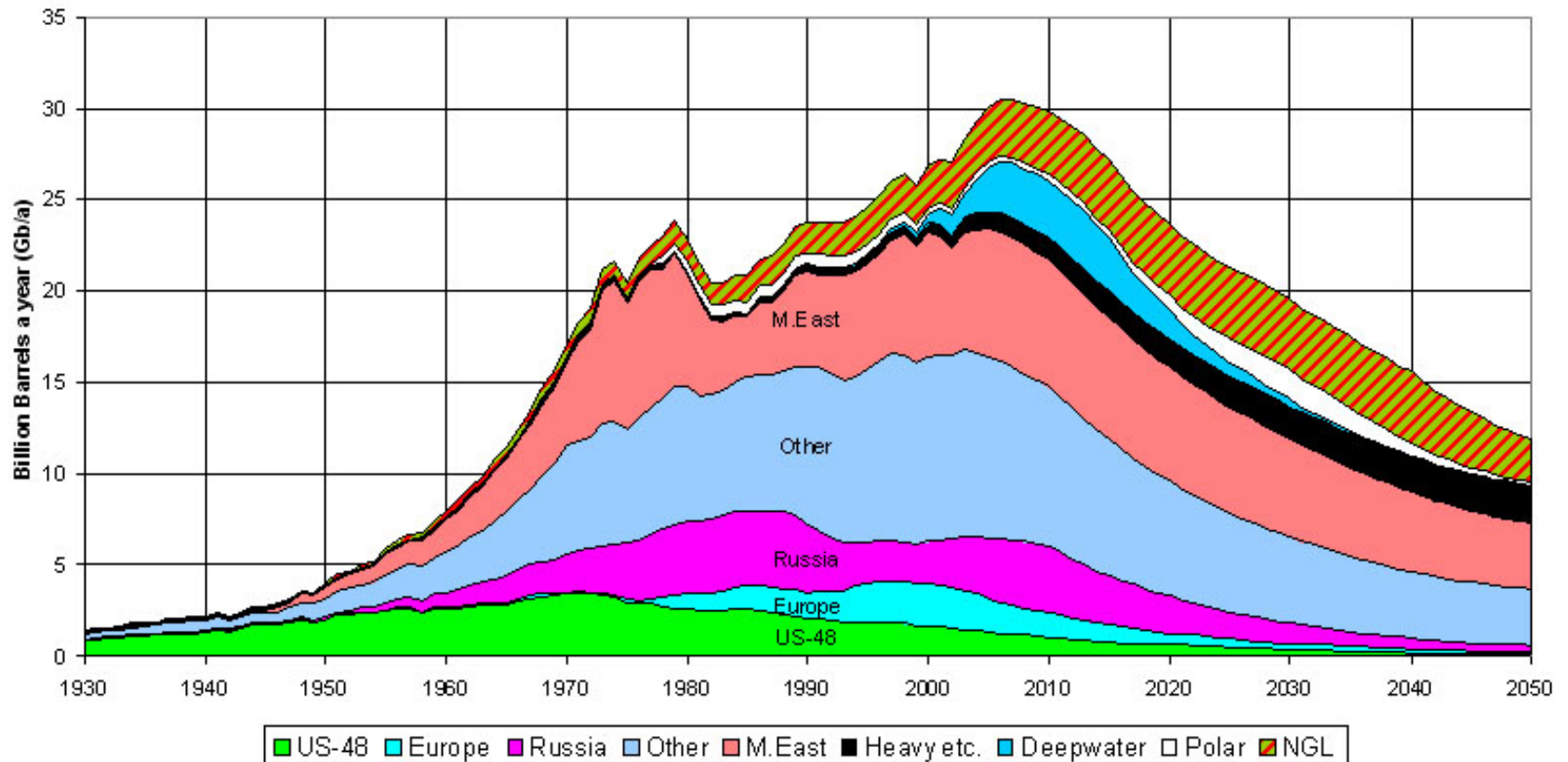
How to keep global warming below 2°C

Maximum Amount of Global Emissions 750 Mrd. t CO₂

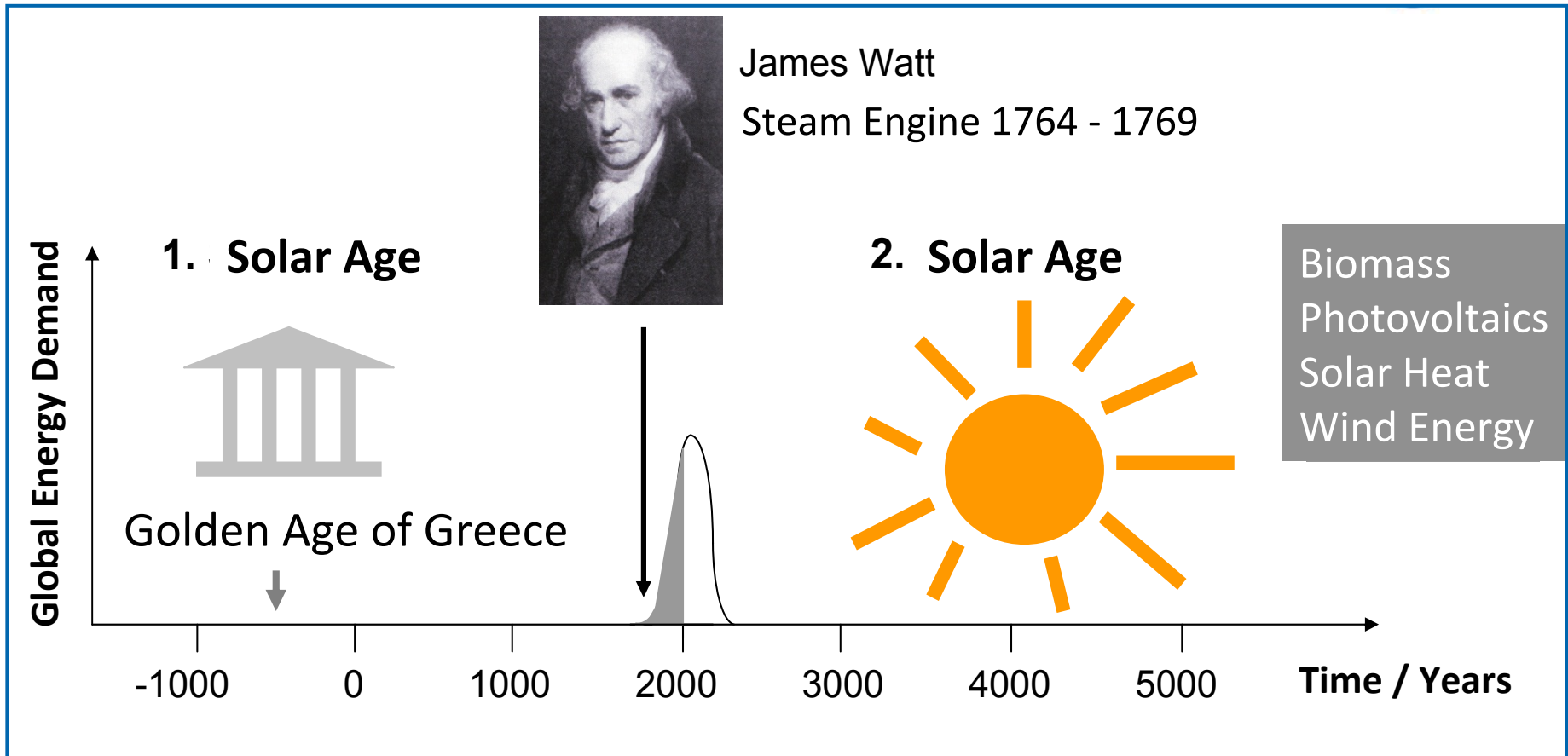




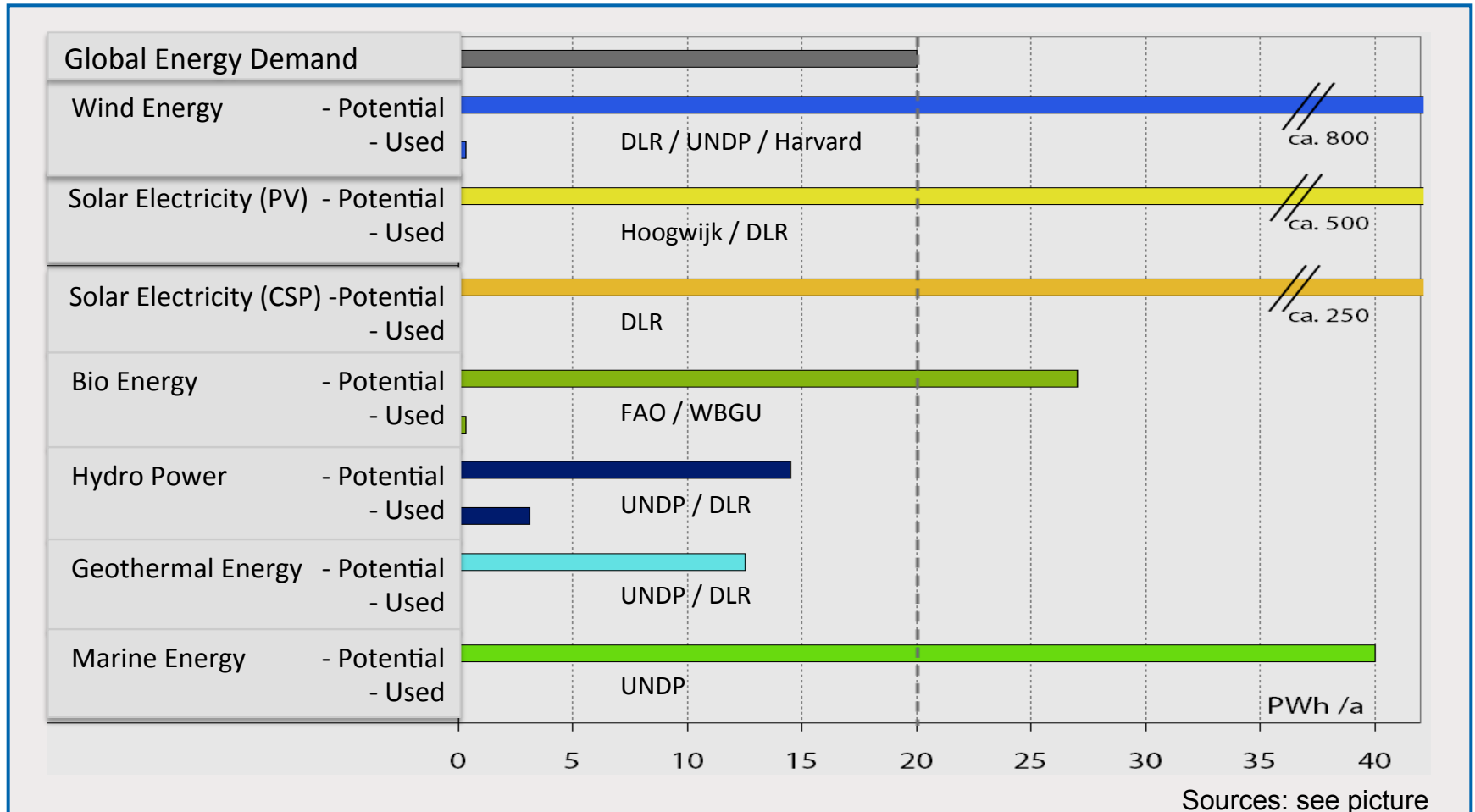
OIL AND GAS LIQUIDS 2004 Scenario



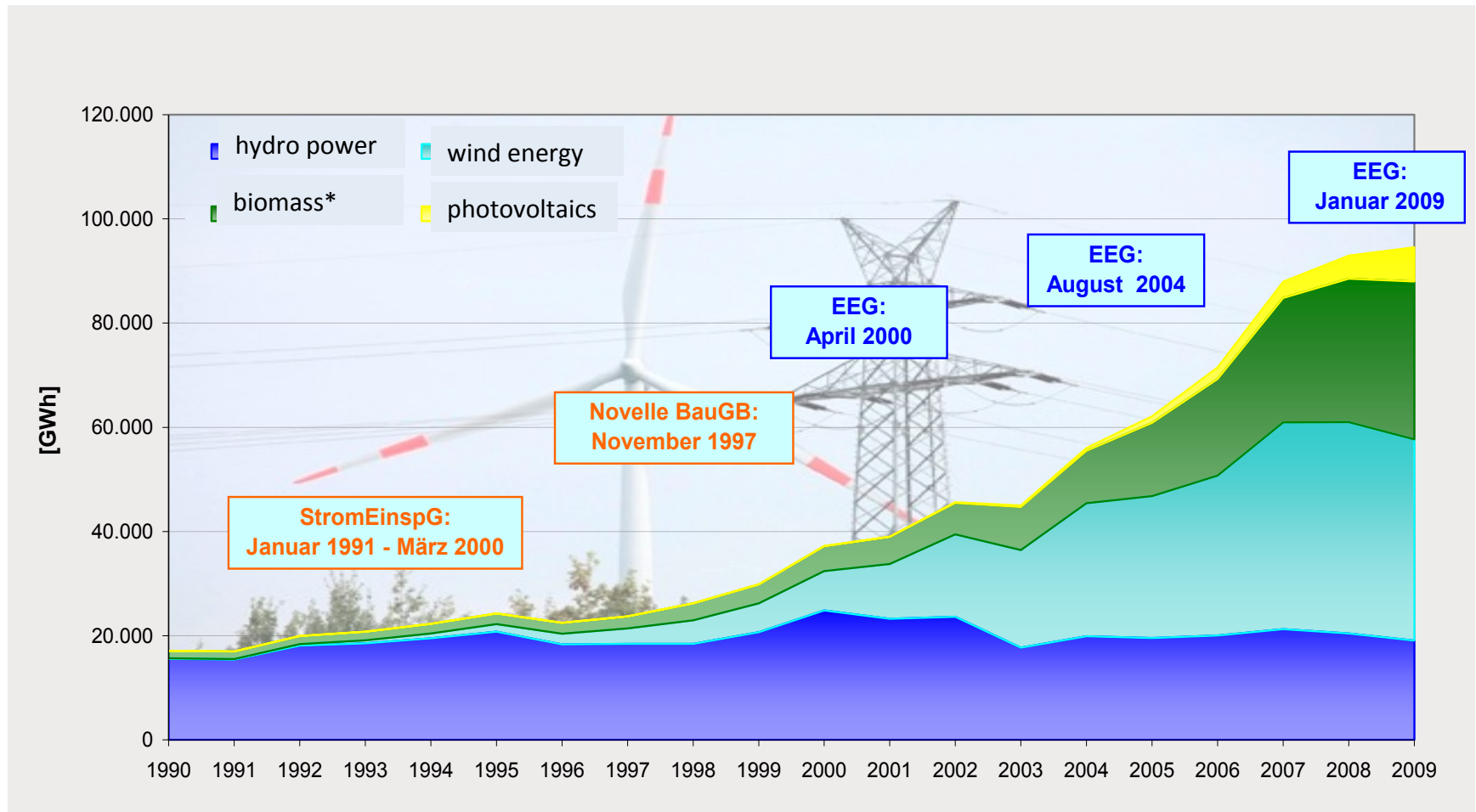
100% Renewables – A historic reality



Global Renewable Energy potential



Renewables in Germany between 1990 and 2009



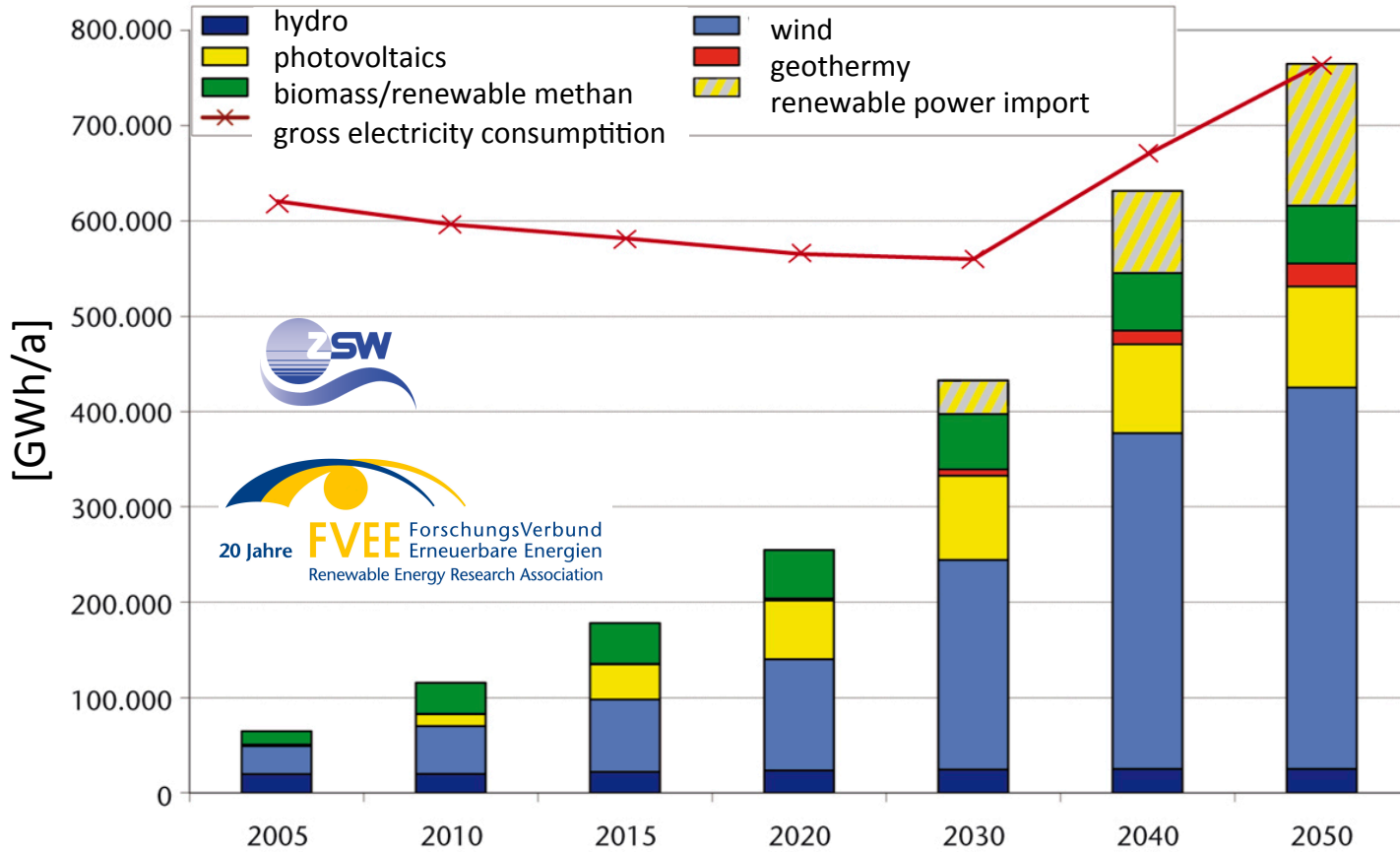
* feste und flüssige Biomasse, Biogas, Deponie- und Klärgas, biogener Anteil des Abfalls;

Strom aus Geothermie aufgrund geringer Strommengen nicht dargestellt; StromEinspG: Stromeinspeisungsgesetz; BauGB: Baugesetzbuch; EEG: Erneuerbare-Energien-Gesetz;

Quelle: BMU-KI III 1 nach Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat); Bild: BMU / Christoph Edelhoff; Stand: Dezember 2010; Angaben vorläufig

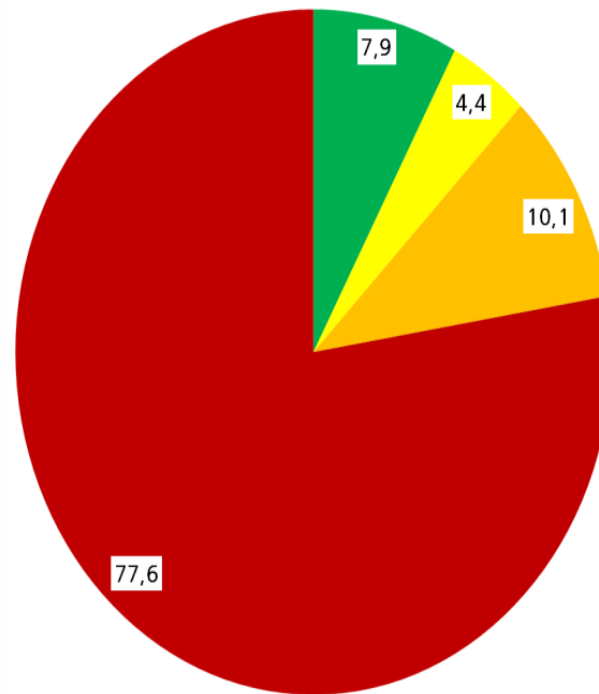
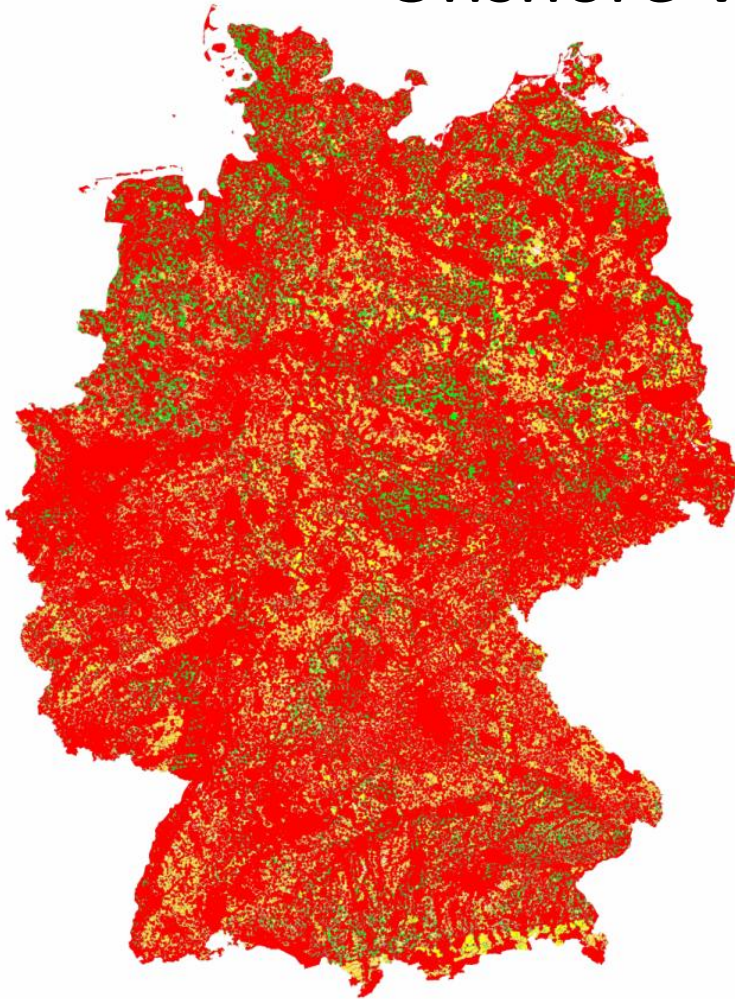
Mix of Renewables in Germany until 2050

gross power generation from renewable energies
[GWh/a]



Onshore Wind – The potential

The 2 % scenario



- Area without restriction
- Forest without nature reserve
- Usable nature reserve
- Unusable area

Onshore Wind – The potential

Energy and power potential by using only 2% of the German land area

	maximum potential (area without restrictions) [GW]	full load hours	using 2% of the area	
			power [GW]	profit [TWh]
Germany	722	2071	189	390

„Based on a new study, onshore wind energy can fulfill 65 percent of the German Energy Demand. But first the declared **height restrictions** for wind turbines have to be removed in order to use the potential of the turbines to its maximum..“

The Renewable Power Plant

Covers 1/10.000 of Germany's load curve at any time – control of real plants

Das Regenerative Kombikraftwerk

Zu jeder Zeit und bei jedem Wetter eine verlässliche Stromversorgung allein mit Erneuerbaren Energien.

- 11 Windenergieanlagen
- 20 Solaranlagen
- 4 Biogasanlagen
- 1 Pumpspeicherkraftwerk

Genauere Prognosen des Stromangebots durch verlässliche Wettervorhersagen

Nutzung von Speichern (Pumpspeicherkraftwerk)

Genauere Prognosen des Strombedarfs

Ausgleich von Schwankungen

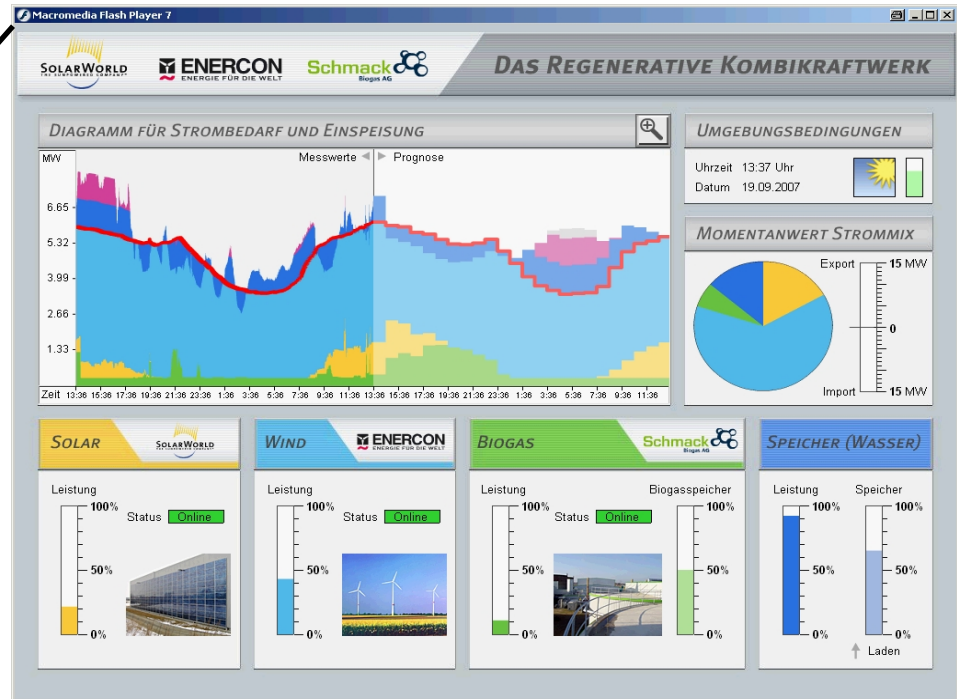
Zentrale Steuerung dezentraler Anlagen

Fahrzeuge als Verbraucher und Speicher

www.kombikraftwerk.de

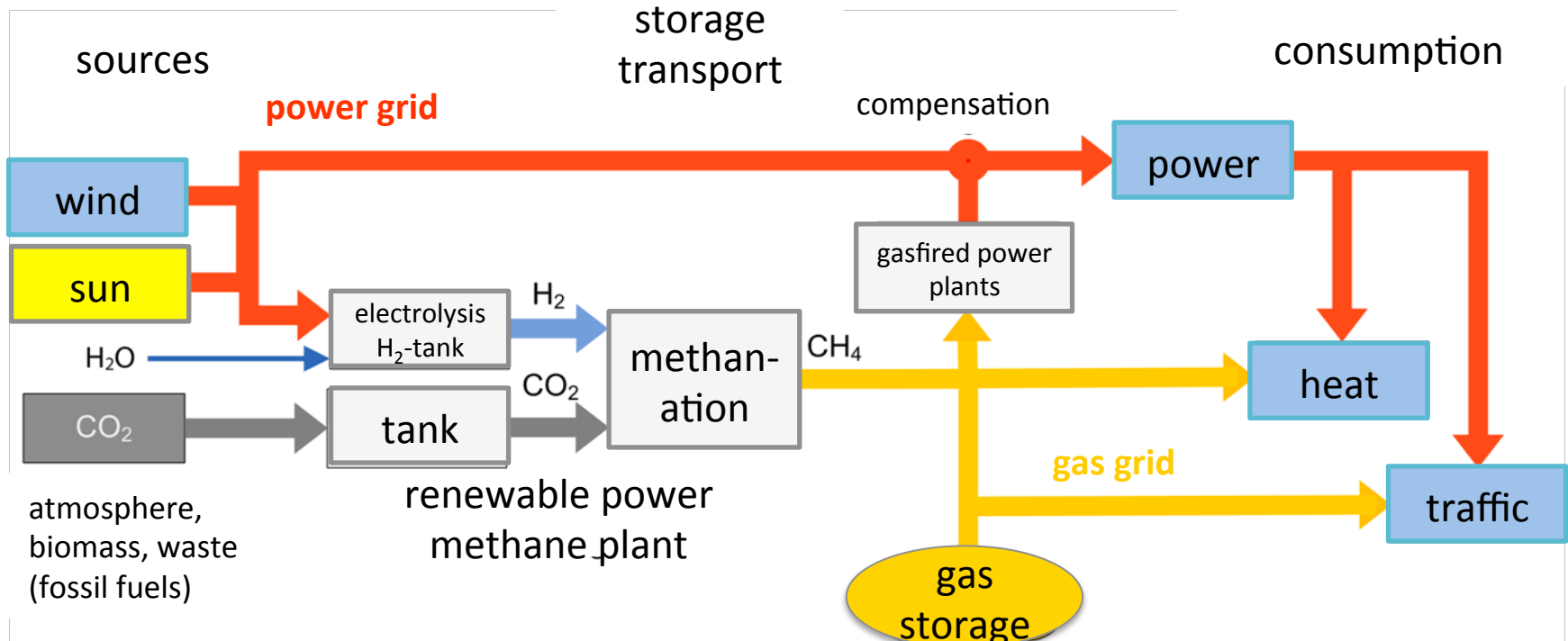
Informationskampagne für Erneuerbare Energien
www.unendlich-viel-energie.de

Das Regenerative Kombikraftwerk deckt im Maßstab 1 zu 10.000 den Strombedarf in Deutschland. Dies entspricht dem Strombedarf von 12.000 Haushalten, also einer Stadt wie Schwäbisch-Hall.



Wind	Solar	Biogas	Hydro	Import/Export
12,6 MW	5,5 MW	4,0 MW	1,0 MW	1,0 MW

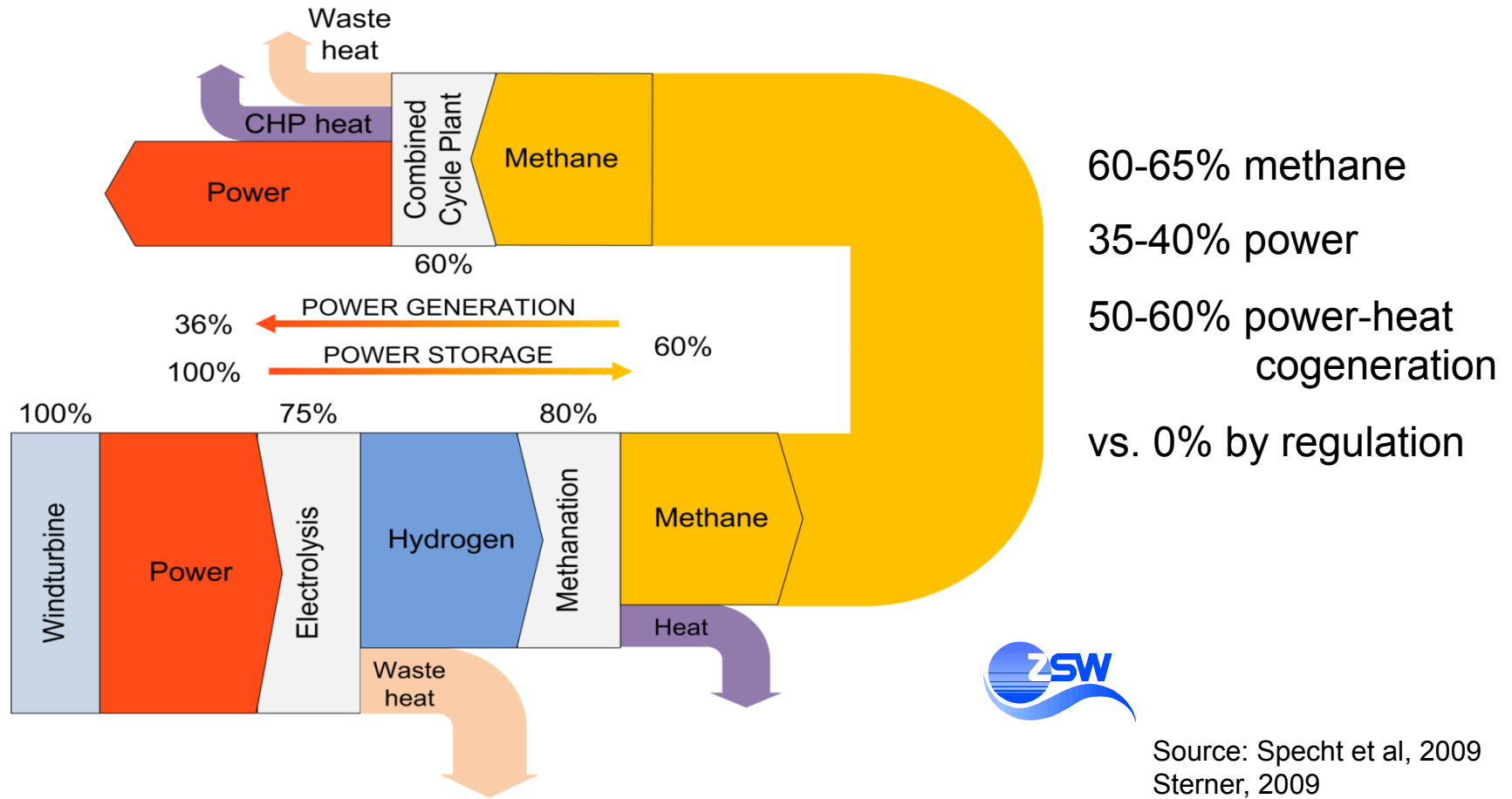
Storage by Linking Power and Gas Grids



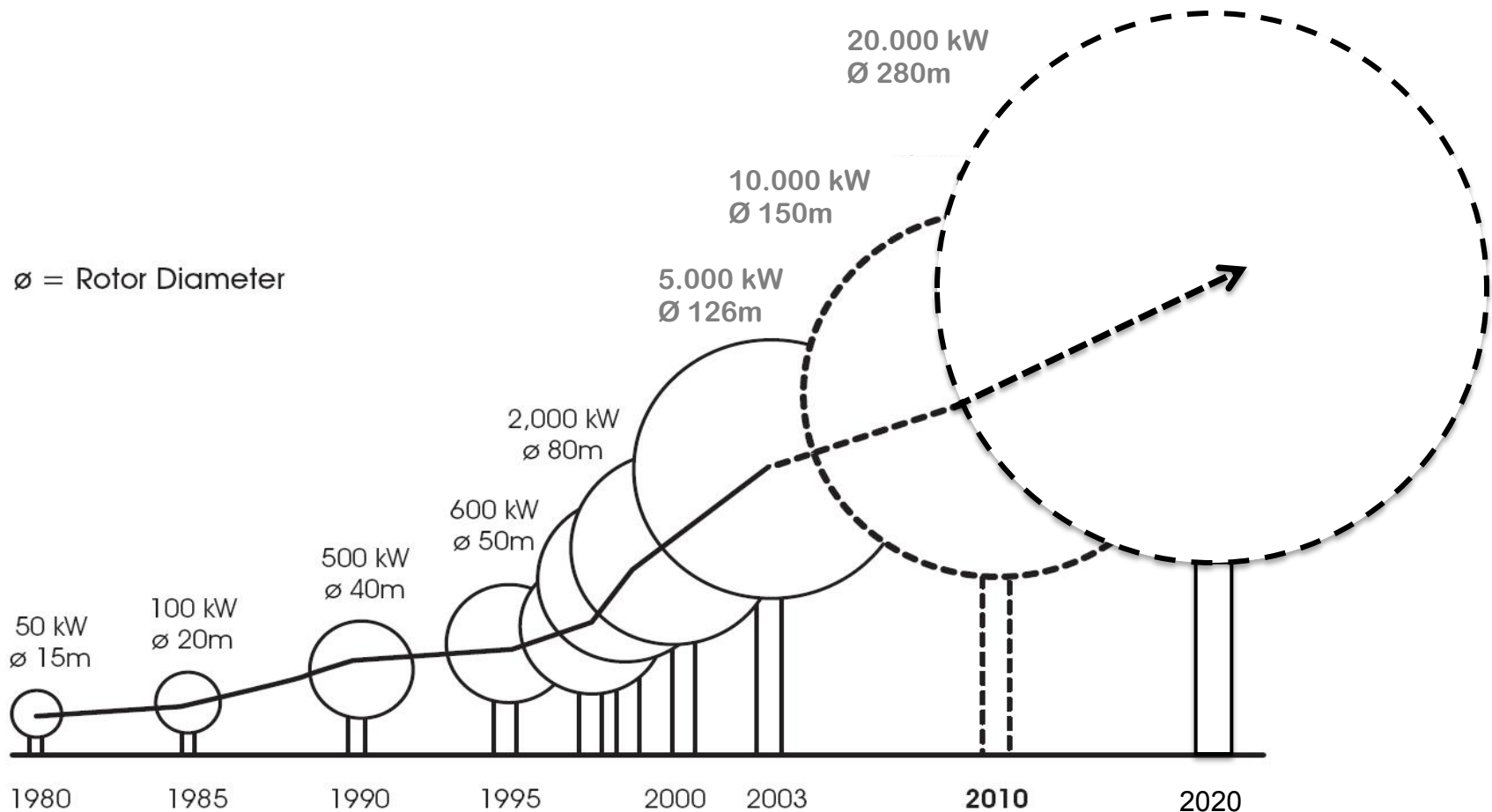
Source: Specht et al, 2009
Sternier, 2009



Renewable Power (to) Methane



The Wind Energy Growth Story



Wind Energy – State of the art

IWES



Wind Energy – State of the art



Growth & Scaling Laws



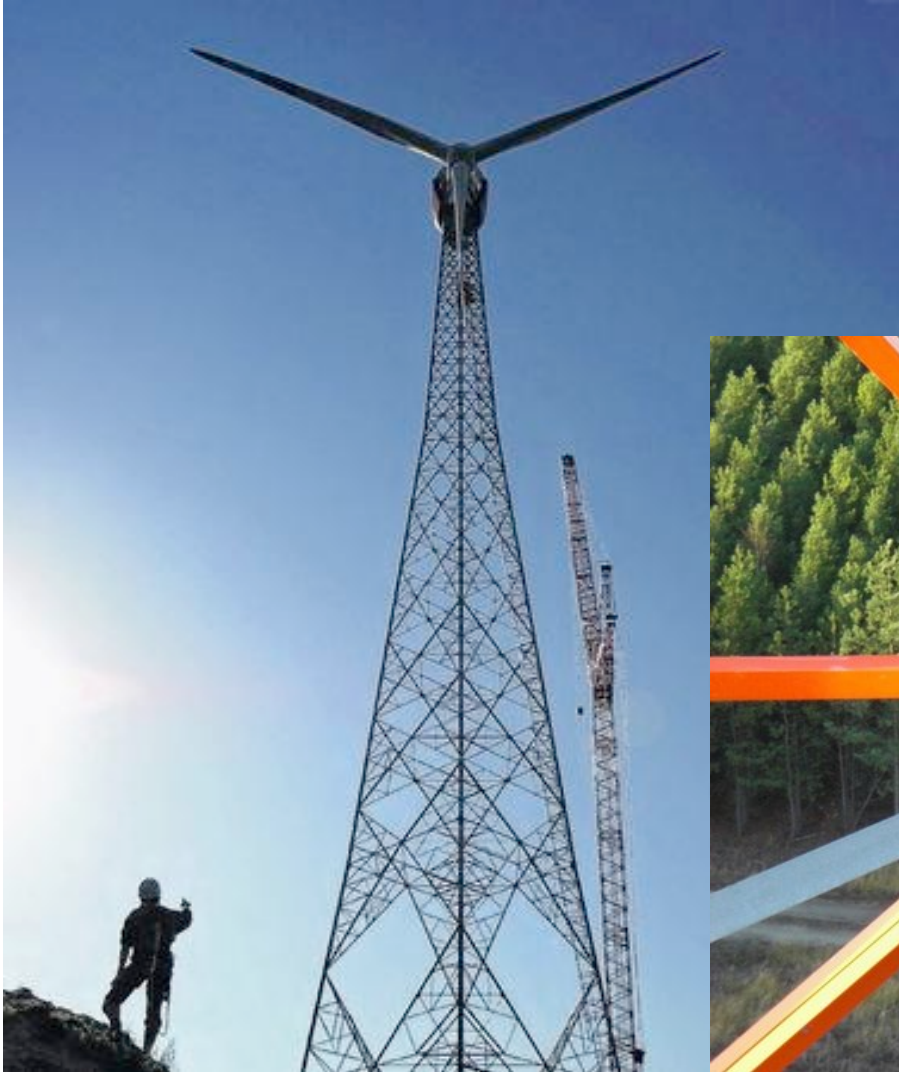
	Absolute Value	Proportionality
Power	$P = \rho/2 c_p(\lambda) v^3 R^2 \pi$	R^2
Speed		R^{-1}
Weight		R^3
Thrust	$S = \rho/2 c_s(\lambda) v^2 R^2 \pi$	R^2
Weight loading		R^1

Going south : wind in forest areas



www.energiwende-sta.de

Old concepts are
back again



...or new are being developed.



Integrated turbine design for next generation ^{IWES}

Especially offshore requires an integrated design approach

-6 MW – 126 m rotor

-Down wind turbine

-2-bladed rotor

-Jacket structure & tower

-DC link

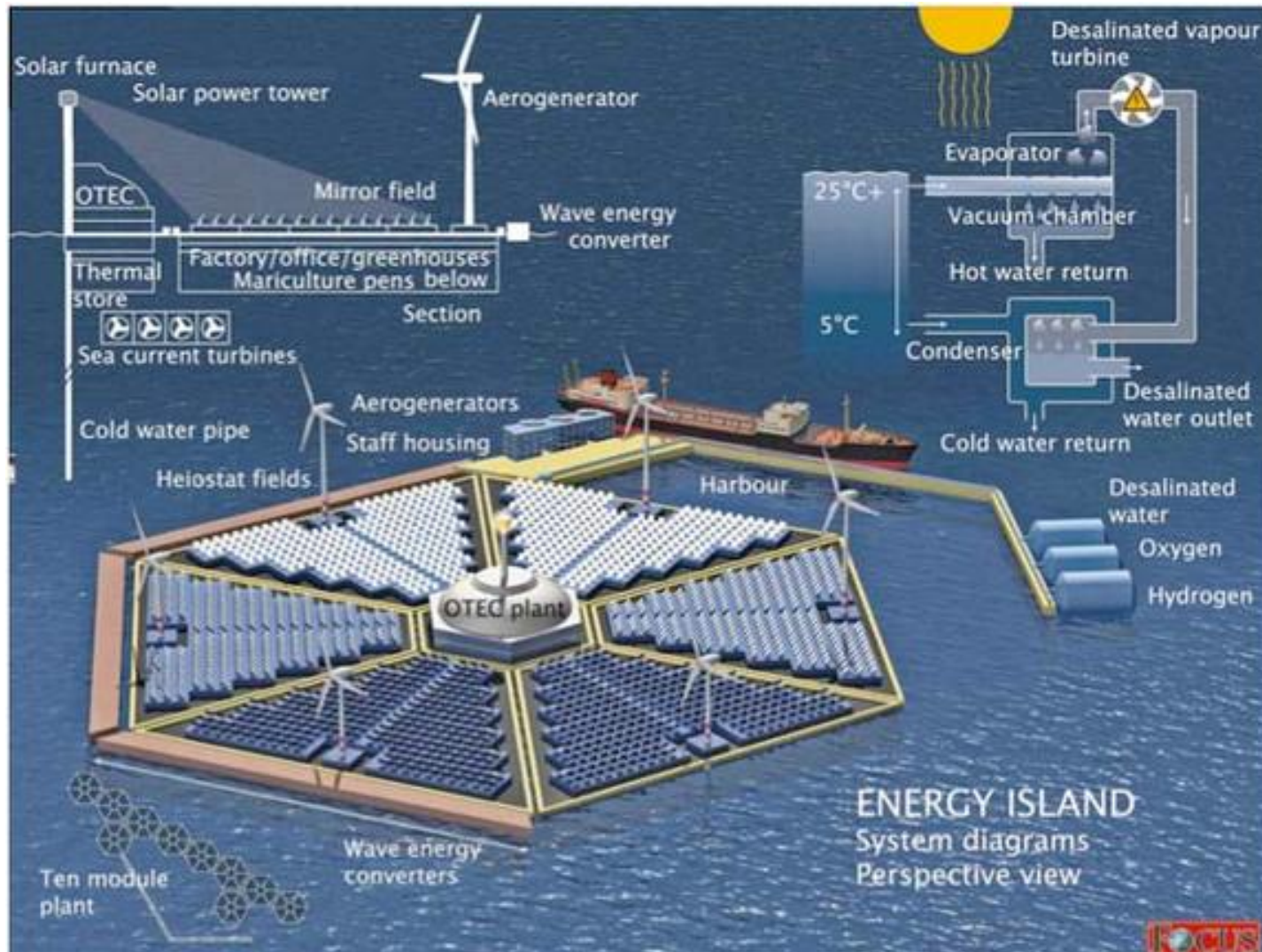
-Weight appr. 250 tons



And the Turbine of the 2020s... Floating?



Energy Islands: a concept of future energy supply



...or completely far out ideas instead of turbines?



Thank you for your kind attention!

