UNIVERSITÄT LEIPZIG

Energiemanagement und Nachhaltigkeit

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Integrating renewable energies in future energy systems - opportunities and challenges

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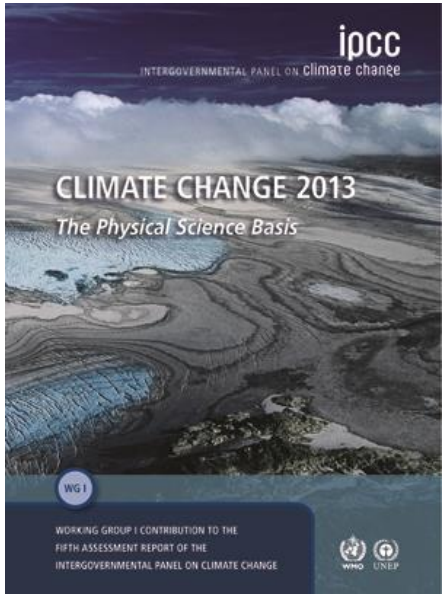
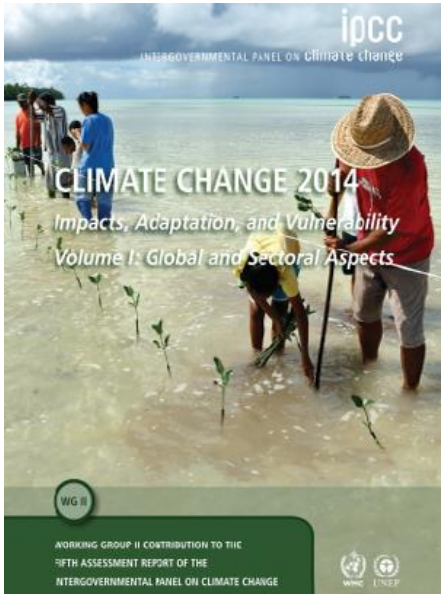
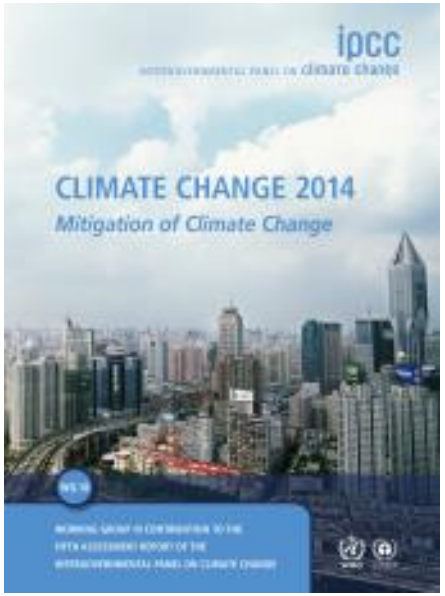
The 5th IPCC Assessment Report: the threat of climate change and options to mitigate it



Working Group I:
Science of Climate Change

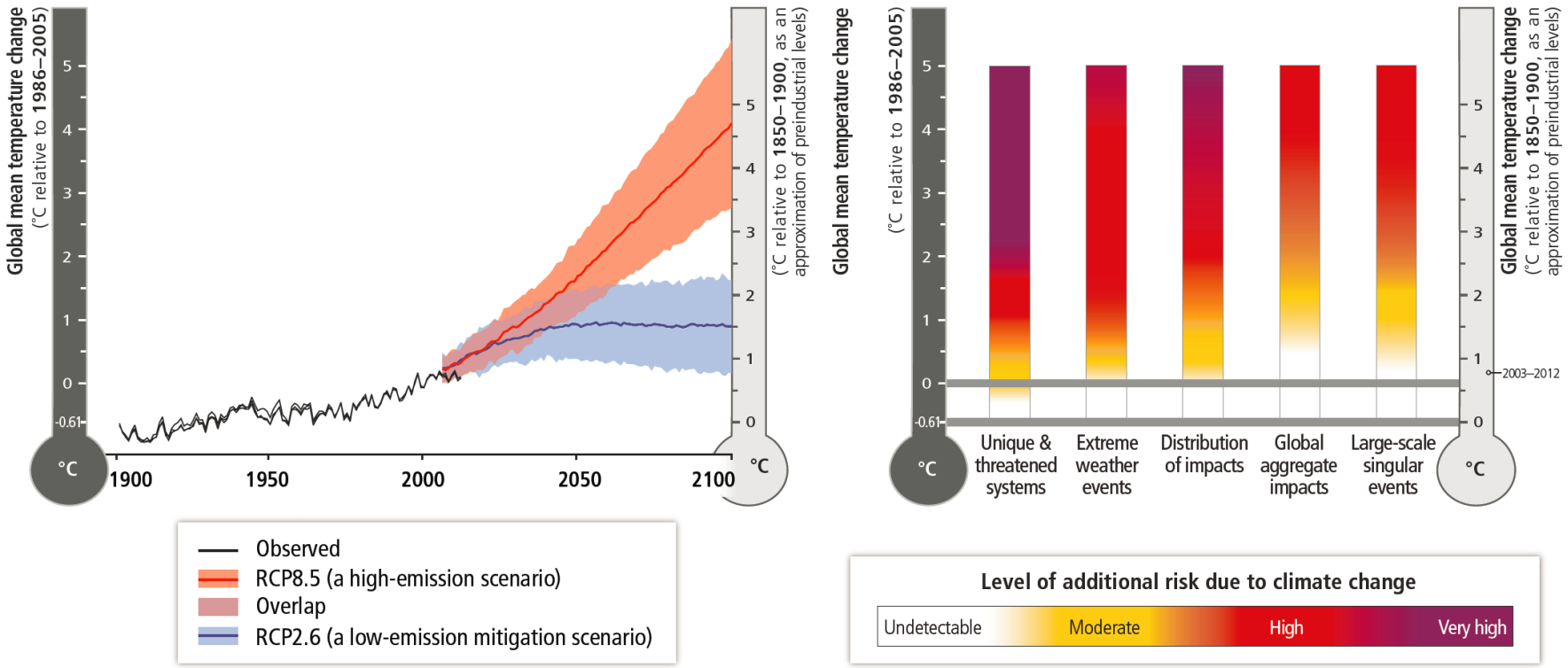


Working Group II:
Climate Impacts



Working Group III:
Mitigation

„The 5 Reasons for Concern“



Assessment Box WG2 SPM.1 Figure 1: A global perspective on climate-related risks. Risks associated with reasons for concern are shown at right for increasing levels of climate change. The color shading indicates the additional risk due to climate change when a temperature level is reached and then sustained or exceeded. Undetectable risk (white) indicates no associated impacts are detectable and attributable to climate change. Moderate risk (yellow) indicates that associated impacts are both detectable and attributable to climate change with at least medium confidence, also accounting for the other specific criteria for key risks. High risk (red) indicates severe and widespread impacts, also accounting for the other specific criteria for key risks. Purple, introduced in this assessment, shows that very high risk is indicated by all specific criteria for key risks.

Mitigating climate change: cost-effective stabilization pathways

ipcc
INTERGOVERNMENTAL PANEL ON climate change

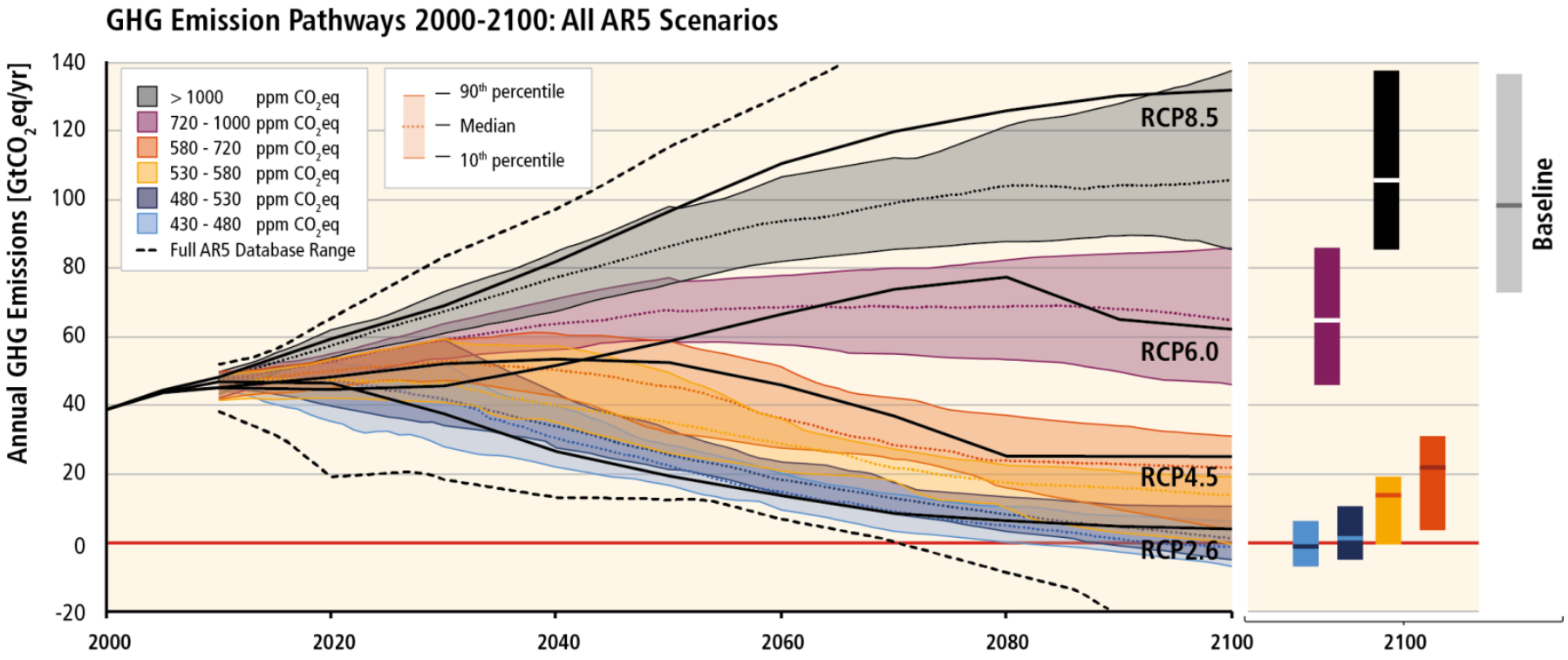


Figure WG3 SPM.4

Sectoral challenges and mitigation opportunities

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INTERGOVERNMENTAL PANEL ON climate change

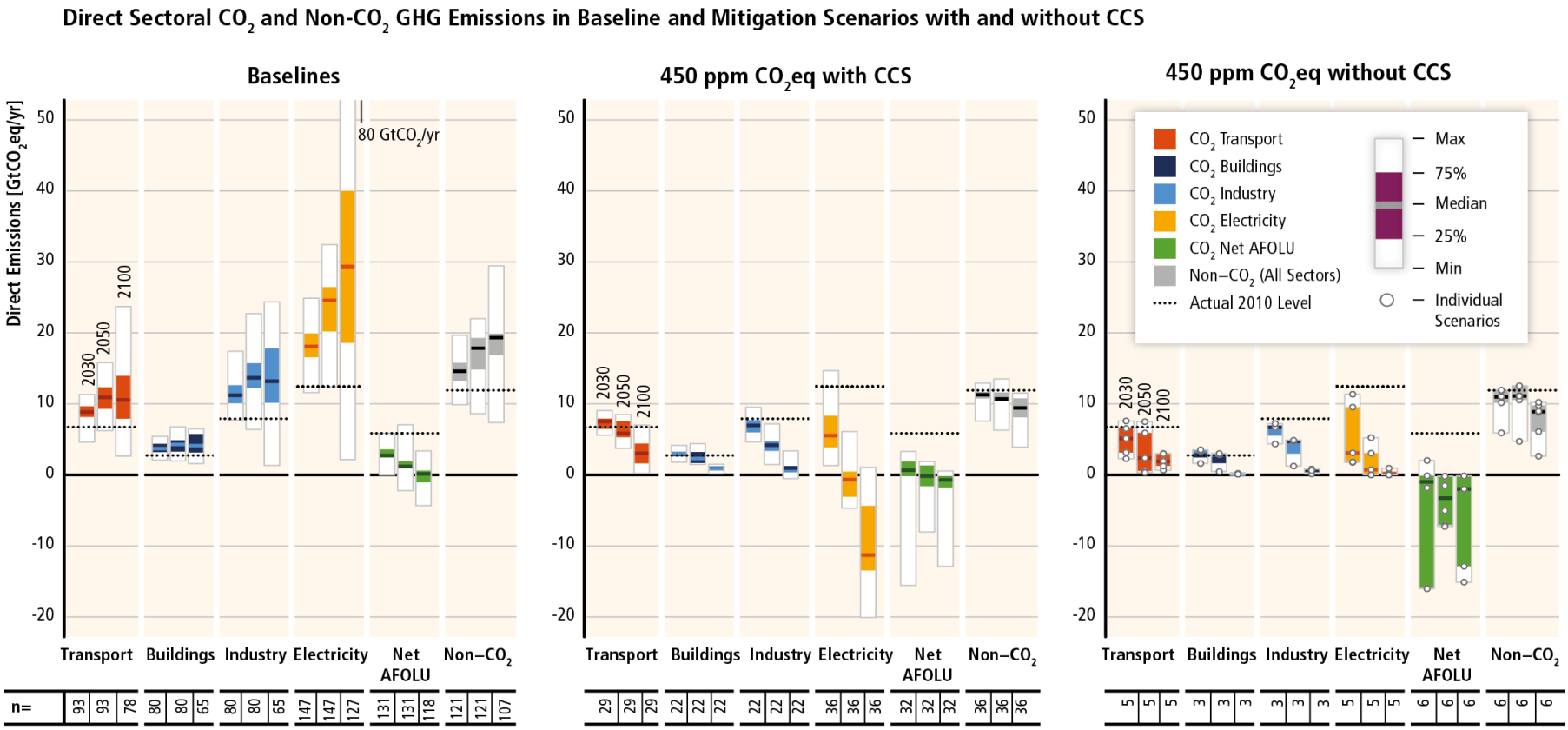
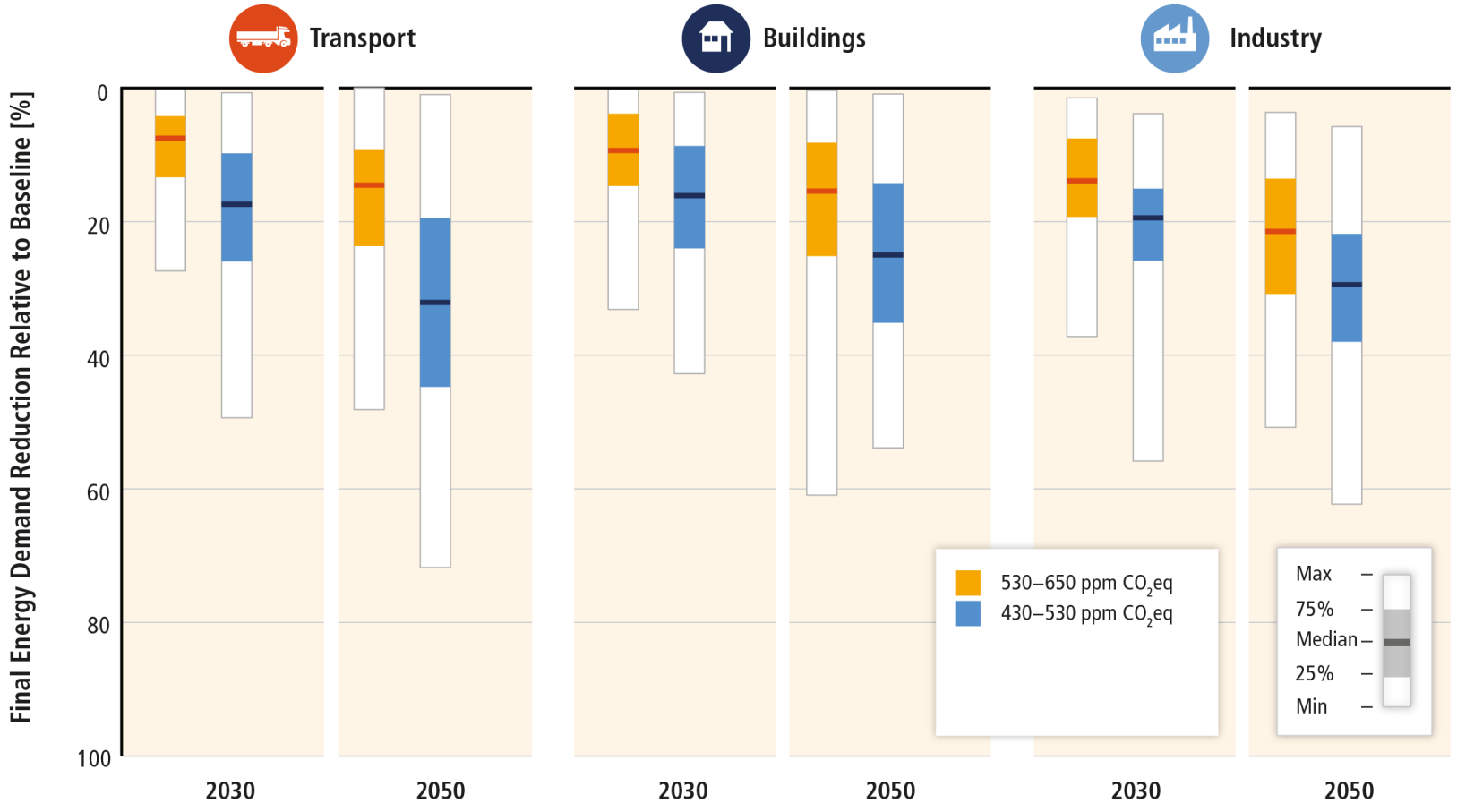


Figure WG3 SPM.7

1st Pillar: final energy demand reduction (energy efficiency improvements)



2nd Pillar: upscaling of low-carbon technologies

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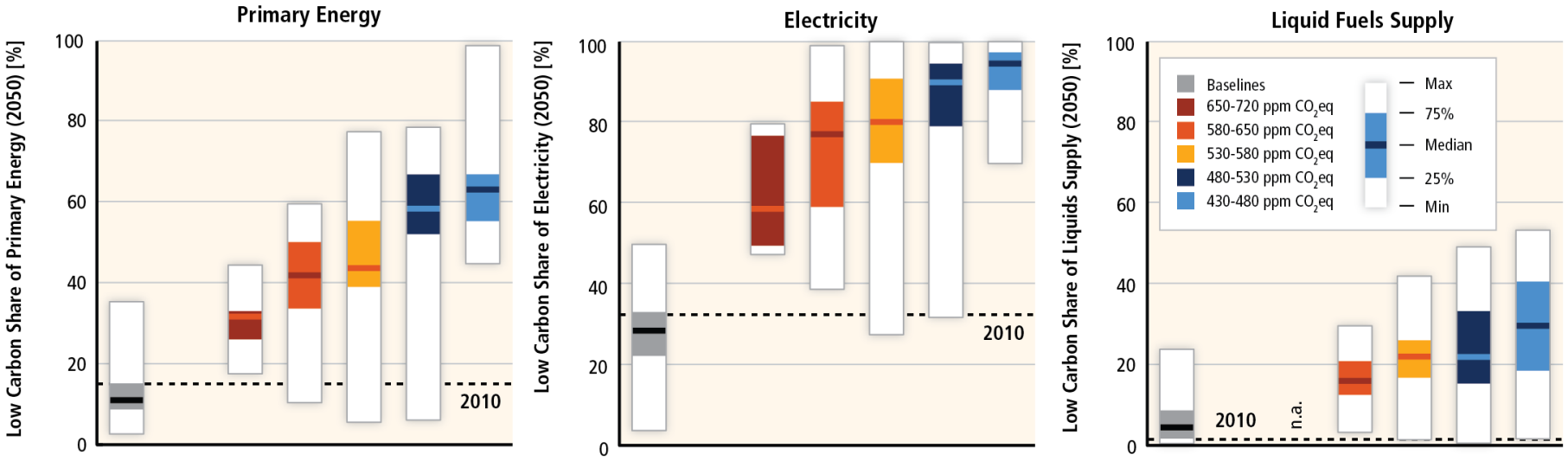
INTERGOVERNMENTAL PANEL ON climate change



Share of low-carbon energy in total primary energy, electricity and liquid supply sectors for the year 2050.

Investment needs and associated market opportunities

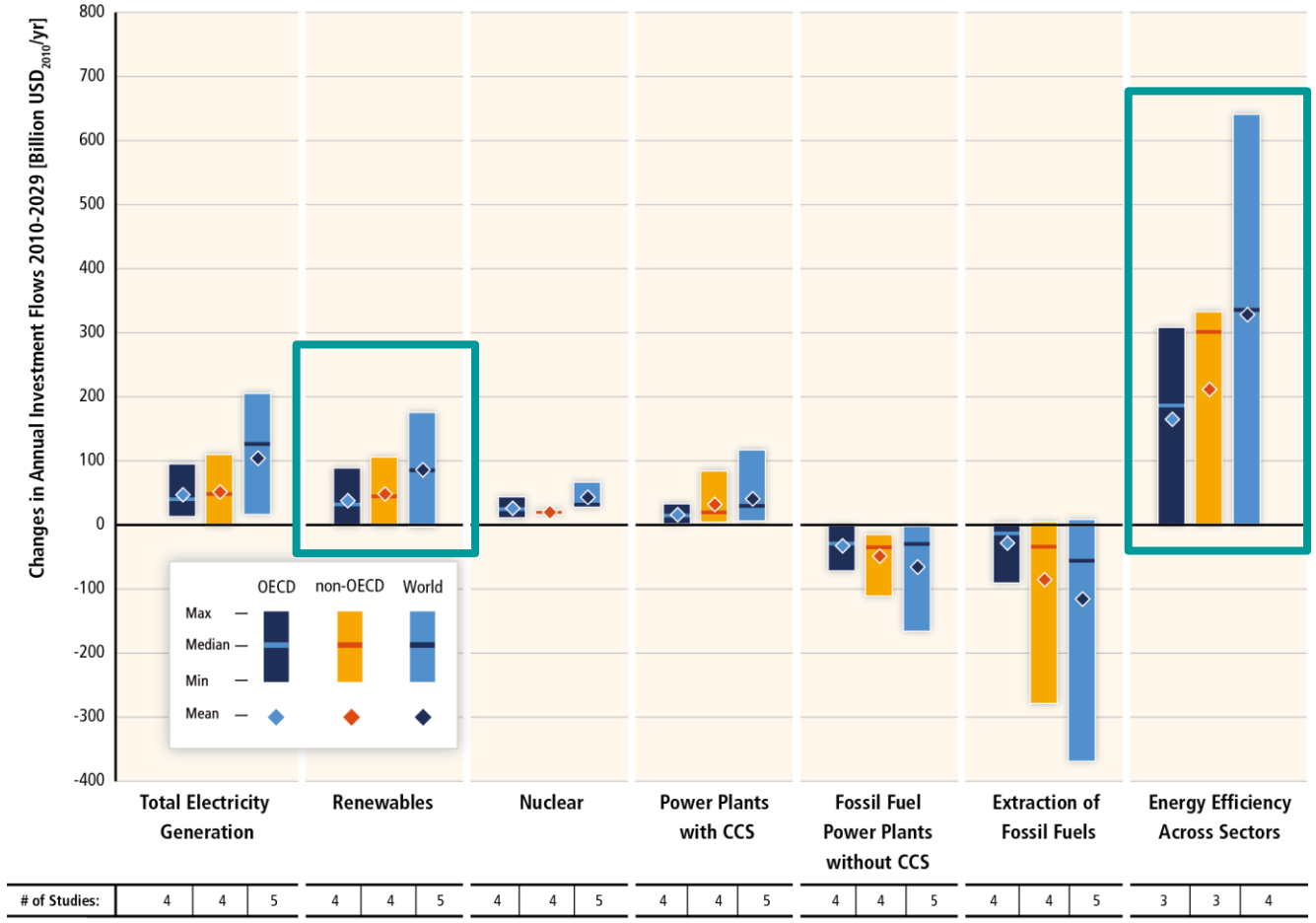
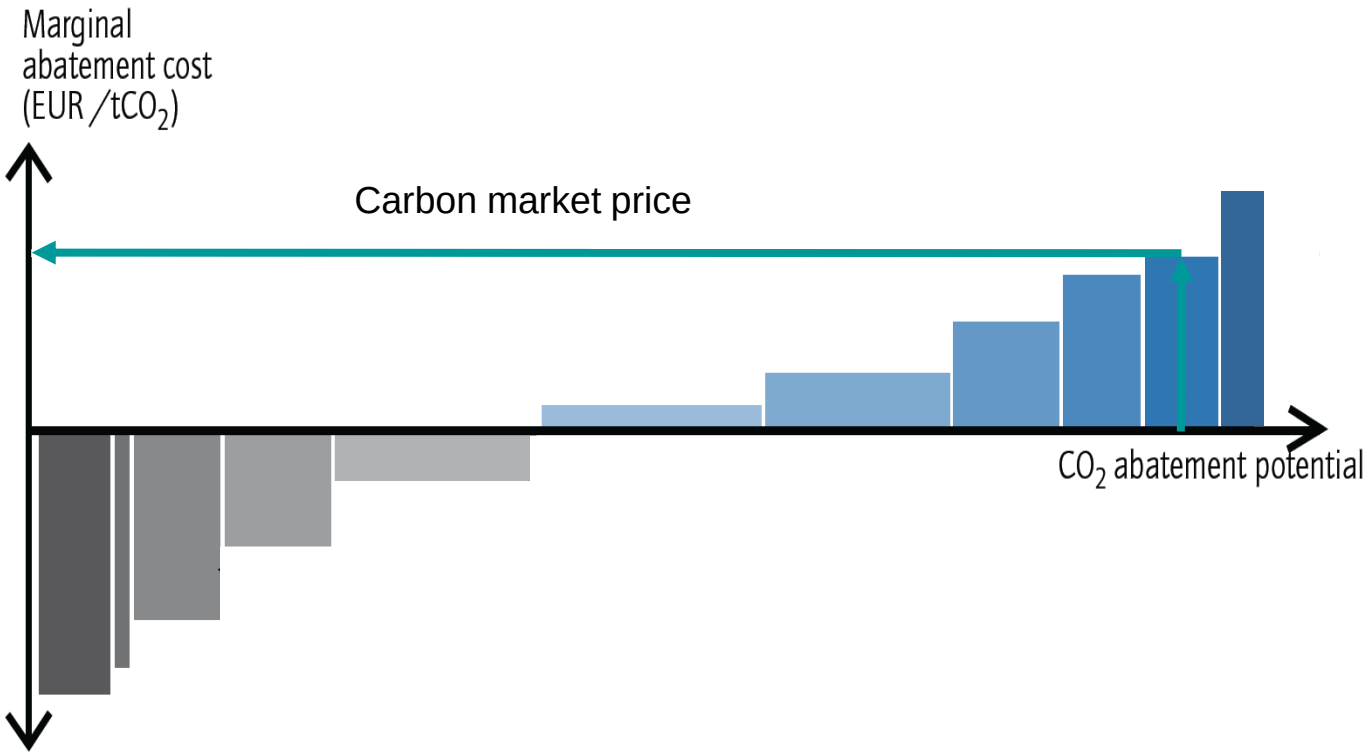


Figure WG3 SPM.9

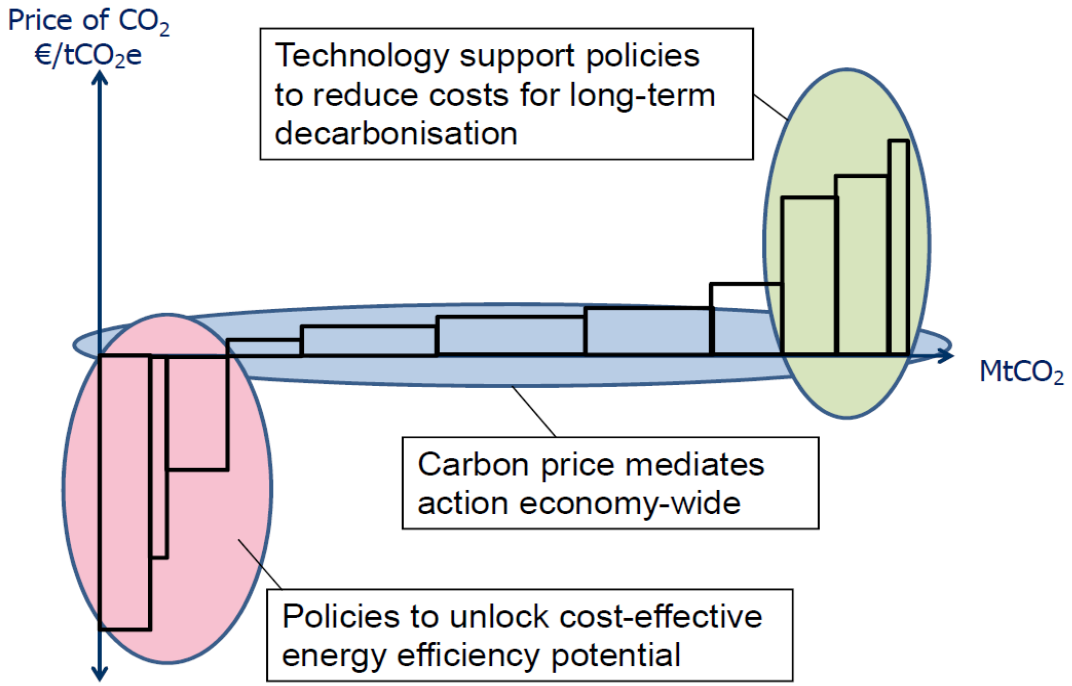
Designing a climate policy framework allowing for deep emissions reductions



Source: International Energy Agency, OECD/IEA, Paris, 2009.

The core policy mix:

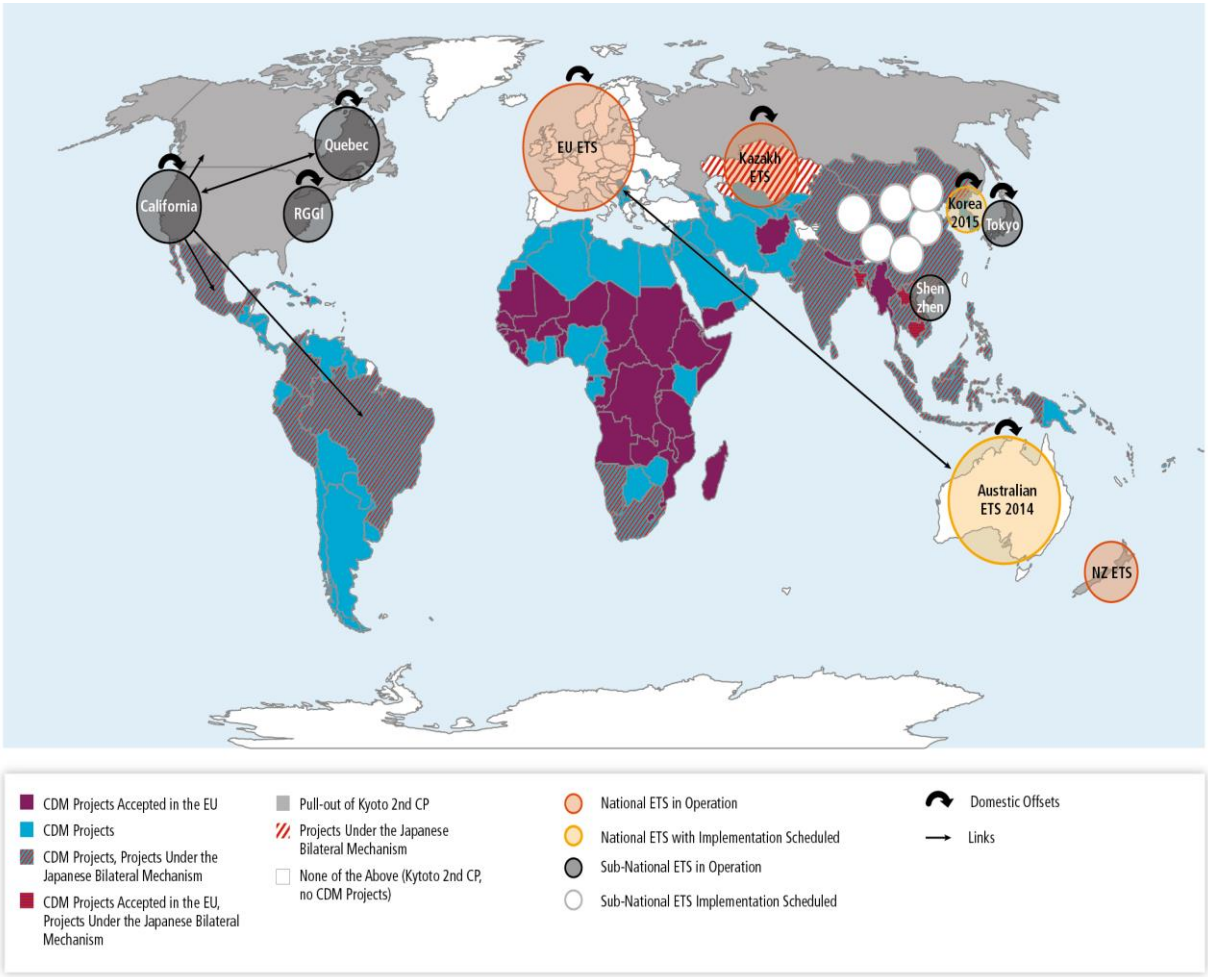
Figure 1 The core policy mix: a carbon price, energy efficiency and technology policies



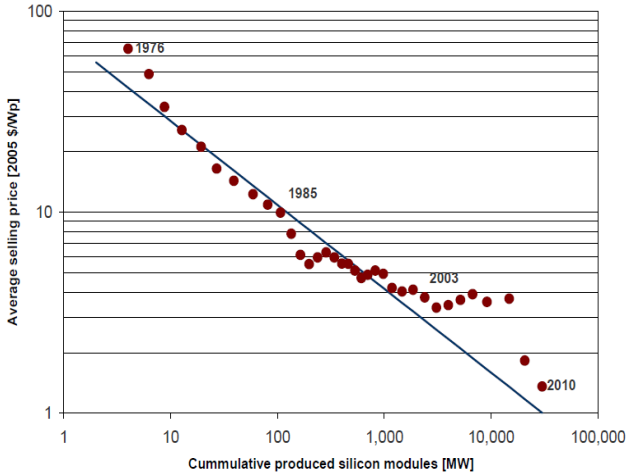
[2] Policies such as feed-in-tariffs or tradeable obligations that drive a significant scale-up of technology deployment to further lower costs.

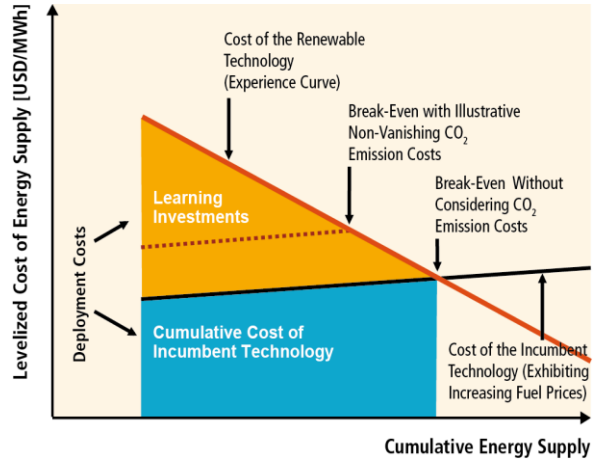
Source: International Energy Agency: Summing up the parts, OECD/IEA, Paris, 2011.

Emission Trading



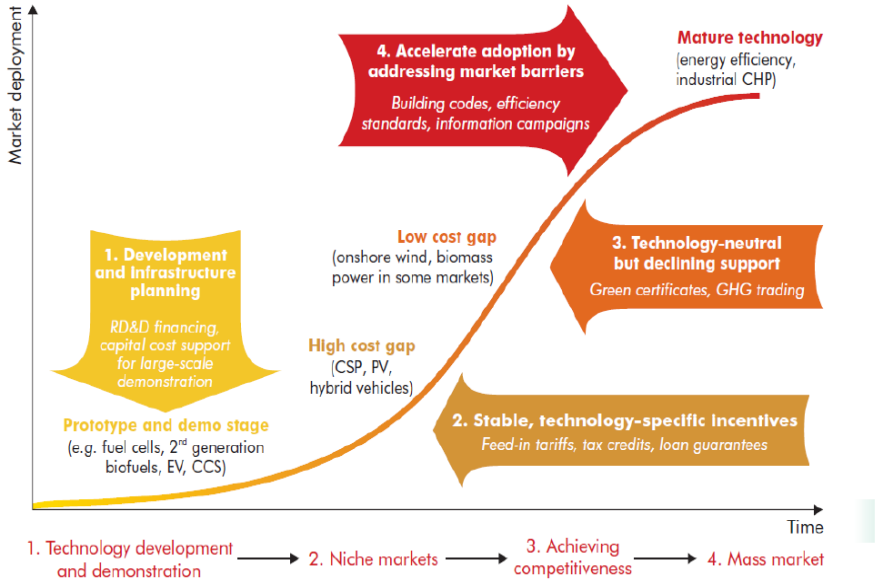
Support for learning technologies





Source:IPCC, SRREN, 2011.

Figure 3.3 Policy support appropriate to different stages in technology development



Source: International Energy Agency, OECD/IEA, Paris, 2009.

The German "Energiewende"

Table 1: Status quo and quantitative Energiewende targets

Category	2011	2012	2020	2050		
				2030	2040	2050
Greenhouse gas emissions						
Greenhouse gas emissions (compared to 1990)	-25.6%	-24.7%	at least -40%	at least -55%	at least -70%	at least -80% to -95%
Renewable energies						
Share in gross electricity consumption	20.4%	23.6%	at least 35%	at least 50% (2025: 40 to 45%)	at least 65% (2035: 55 to 60%)	at least 80%
Share in gross final energy consumption	11.5%	12.4%	18%	30%	45%	60%
Efficiency						
Primary energy consumption (compared to 2008)	-5.4%	-4.3%	-20%		-50%	
Gross electricity consumption (compared to 2008)	-1.8%	-1.9%	-10%		-25%	
Share of electricity generation from combined heat and power plants	17.0%	17.3%	25%			
Final energy productivity	1.7% per annum (2008–2011)	1.1% per annum (2008–2012)	2.1% per annum (2008–2050)			
Buildings						
Primary energy requirement	–	–	–		around -80%	
Heat requirement	–	–	-20%		–	
Rate of modernisation	approx. 1%	approx. 1%	doubling of levels to 2% per annum			
Transport						
Final energy consumption (compared to 2005)	-0.7%	-0.6%	-10%		-40%	
Number of electric vehicles	6,547	10,078	1 million	6 million		–

Source: BMWI, Monitoring Report, 2014.

Renewable energies and integration challenges

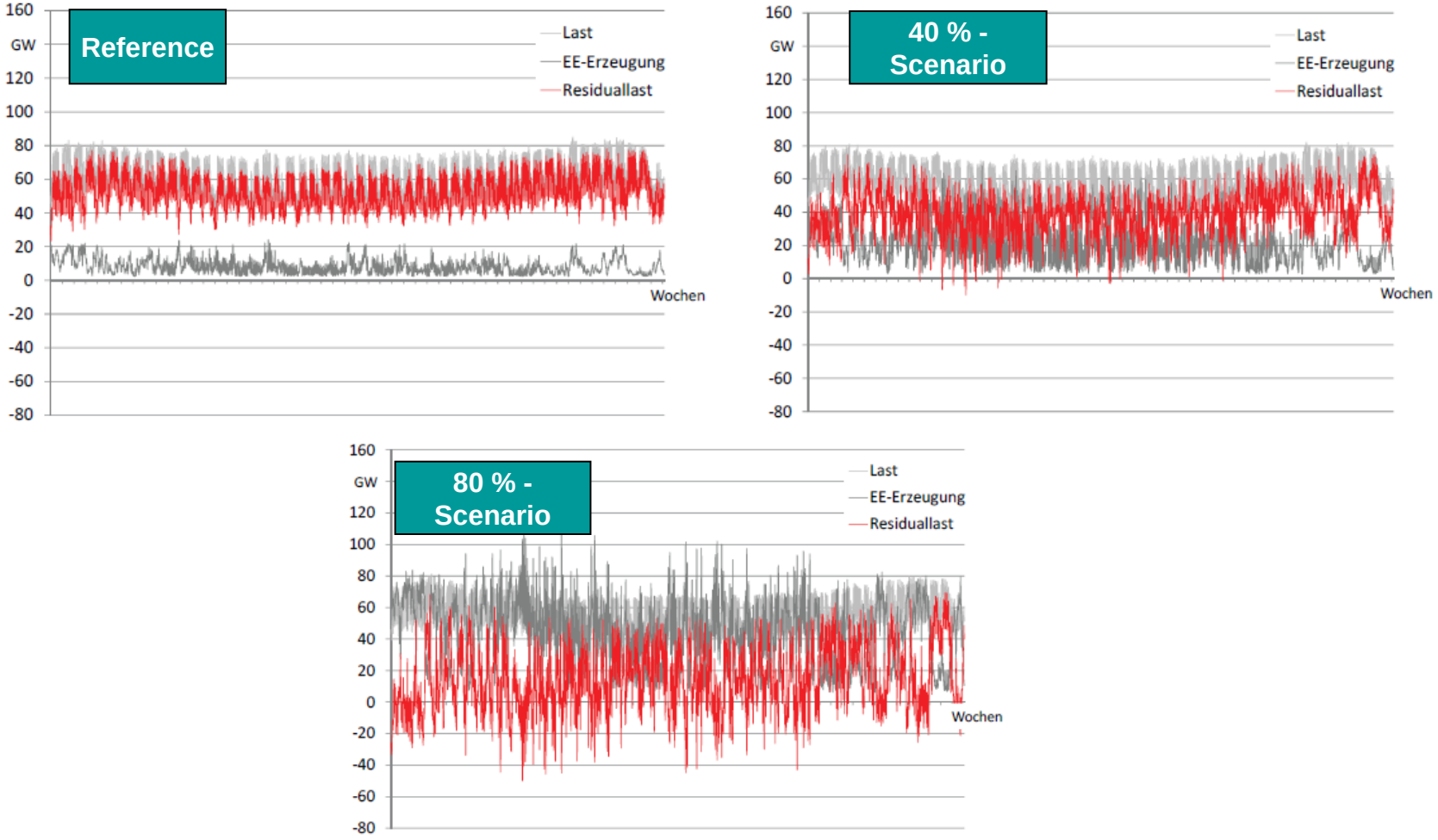


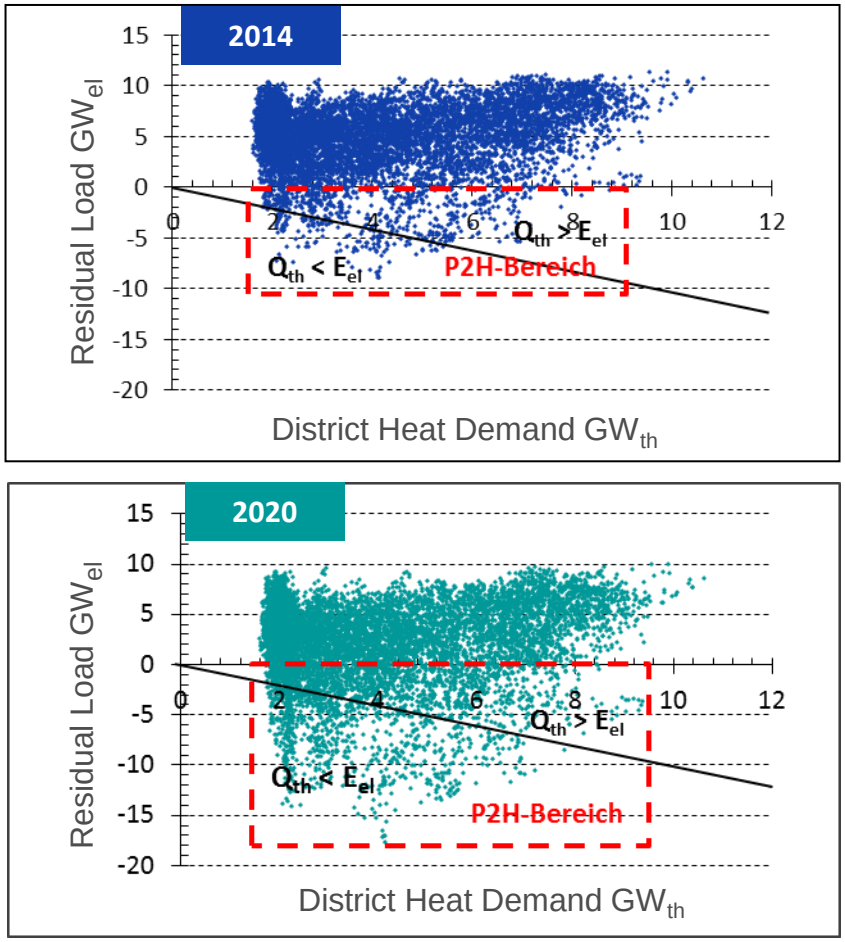
Abbildung 3-3: Jahresganglinie von Last, EE-Erzeugung und Residuallast im 80%-Szenario

Source: VDE, Energiespeicher für die Energiewende, 2012

Mitigating the regional and temporal variability: „flexibility options“

- Extension of transmission grids (➔ European super grid)
- Energy storage
  (pump hydro storages, batteries, compressed air energy storage)
- Curtailment of renewable energies
- Demand response (load management)
- Flexible generation using fossil fuels
  (central CCGT, decentral cogeneration units, …)
- Cross-energy management:
  Power-to-Heat (P2H), Power-to-Gas (P2G)
- Extension of distribution grids (➔ smart grids)

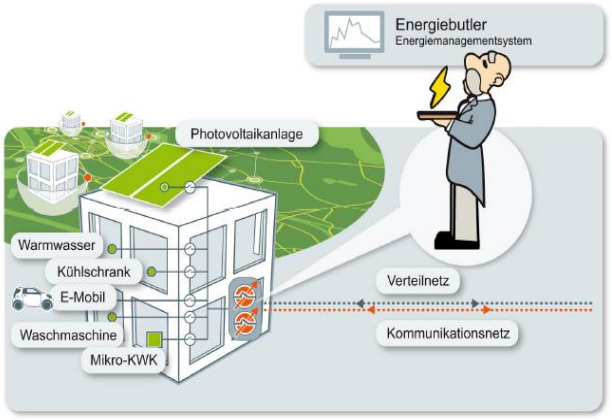
Technical Potential of Power-to-Heat (P2H)



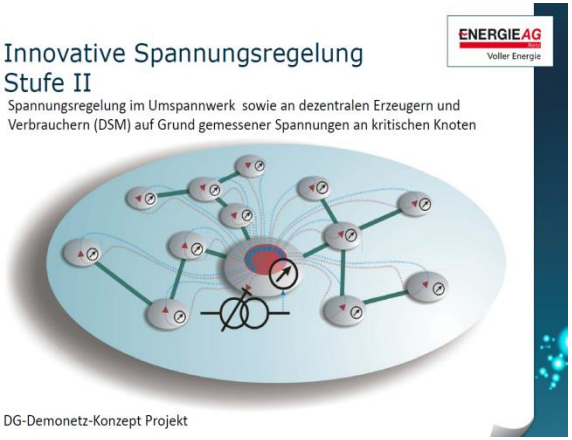
Technical Potential of Power to Heat in the 50Hertz Control Area

Source: own calculations, IIRM, Universität Leipzig, 2012

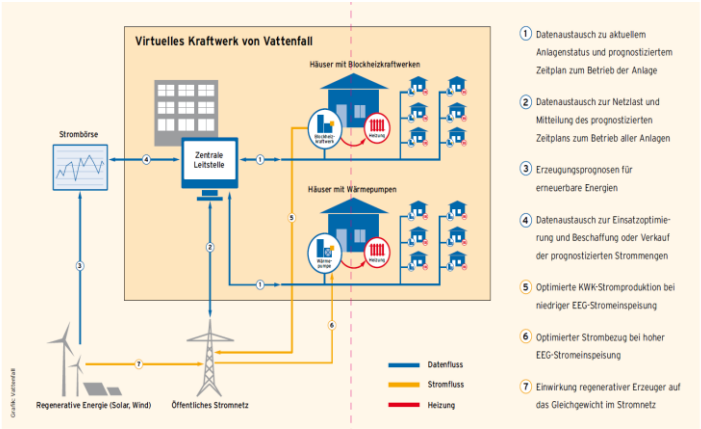
Smart grids: one word - (at least) 4 concepts



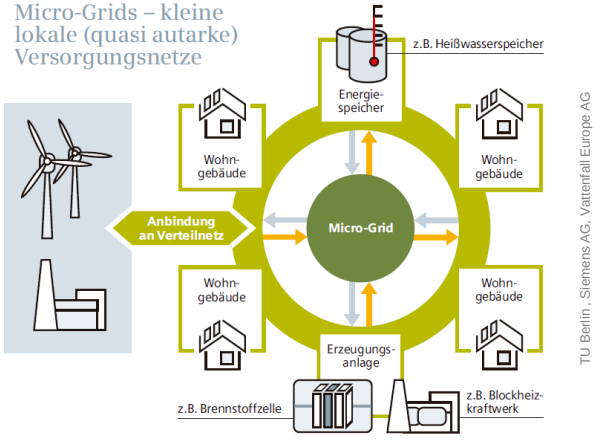
Energy data management (Smart metering and smart home)



Adaptive grid management



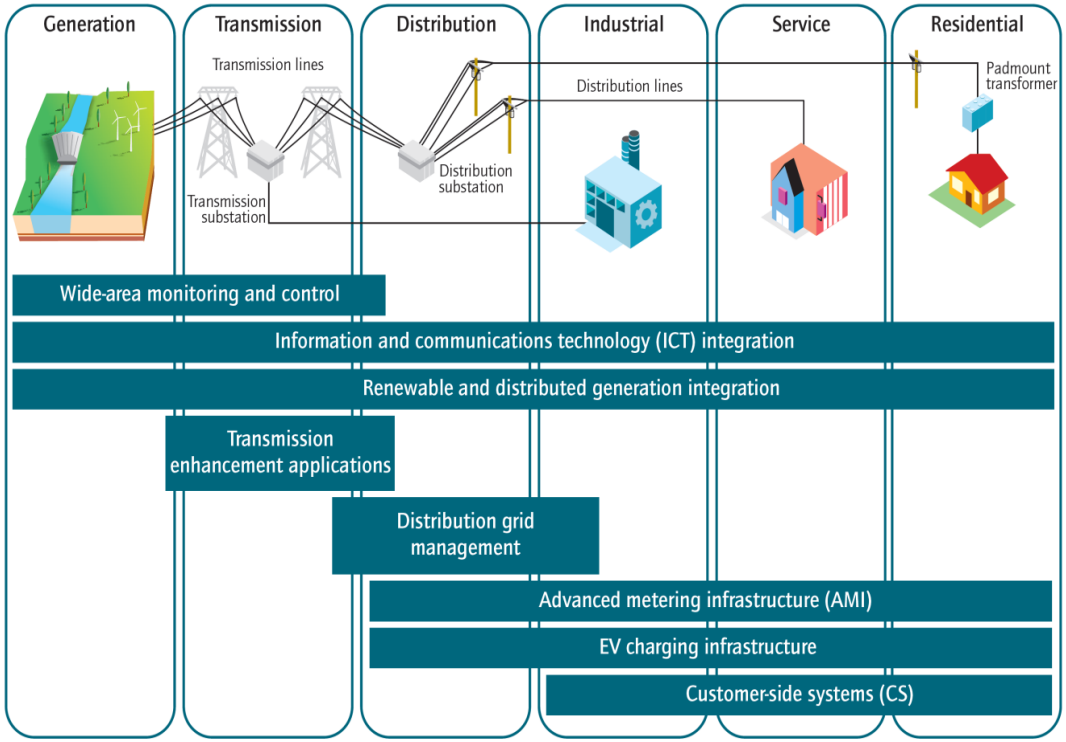
Virtual power plants



Micro-Grids

Smart Grid – not constrained to decentral applications

Figure 8. Smart grid technology areas



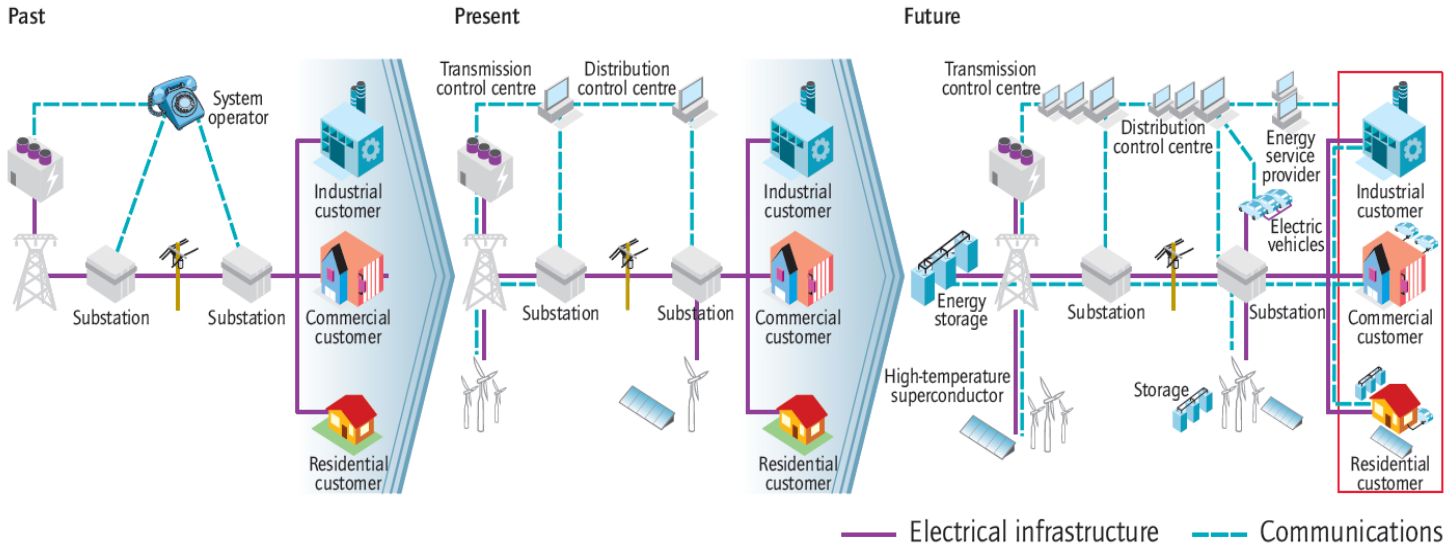
Source: Technology categories and descriptions adapted from NETL, 2010 and NIST, 2010.

KEY POINT: Smart grids encompass a variety of technologies that span the electricity system.

IEA, Technology Roadmap, Smart Grids, 2010

"Smartening" of the energy system

Figure 1. Smarter electricity systems



Source: Unless otherwise indicated, all material derives from IEA data and analysis.

KEY POINT: The "smartening" of the electricity system is an evolutionary process, not a one-time event.

IEA, Technology Roadmap, Smart Grids, 2010

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