Policy Approaches for Climate Technologies

Dr. Harald Kohl
BMUB, Head of Division
„Climate Technologies“

German Climate Action Plan 2050

- Global Target: Greenhouse Gas Neutrality in the Second Half of this Century
- German Long-Term Target: Reducing Greenhouse Gas emissions in Germany by 80 to 95 percent
- Requires Structural Changes in nearly all relevantSectors
- Supply an Use of Energy in the Power Sector, Industry and Buildings, Industrial Processes, Agriculture, Land-Use
- German Government will agree on the Climate Action Plan 2050 by summer and will outline the Overall Strategy of the necessary Transition Processes in Germany
- Climate Policy is like a Large Scale Innovation Agenda including Smart Technological Solutions

Energy Generation, Energy Efficiency

- Climate Policy: Sustainable Energy Generation (Power, Heat/Cold, Mobility) vs. Efficiency in Use and Consumption
- Combined Heat and Power Generation (Cogeneration, Trigeneration), Renewable Energies, Decarbonisation
- Energy Efficiency Targets (2020/2050): Primary Energy Consumption (10/25%), Electricity Consumption (10/25%), near climate neutral Building stock in 2050, Energy Productivity average increase rate of 2.1 percent up to 2050.

Federal Ministry
for Economic Affairs
and Energy

Energie wende
Switch to the Future

2050 *Energiewende* targets

		Achieved 2014	2020	2025	2030	2035	2040	2050
Climate	% greenhouse gas reduction (vs. 1990)	-27%	-40		-55		-70	-80 to -95
Renewable Energies	% gross electricity consumption	32.6% (2015)	35	40 to 45	50	55 to 60	65	80
	% gross final energy consumption	13,7%	18		30		45	60
Energy Efficiency	% primary energy consumption (vs. 2008)	- 7.3 % (2015)	-20					-50
	final energy productivity (vs. 2008)	1.7% p.a.	+2.1% p.a. (2008-2050)					
	building renovation	~1% p.a.	doubling of renovation rate: 1% → 2% p.a.					
	% transport energy consumption (vs. 2008)	1.7%	-10					-40

Source: Federal Government 2010, BMU/BMWi 2014, BMWi 2015, AGEE-Stat 2014, AGEB 2015, BMWi 2016

The energy transition follows a transparent, long-term strategy with specific targets.

Main federal-level **energy efficiency** measures

taxation – regulation – financial incentives – information & consultation

Buildings

- Energy saving legislation
- KfW progammes for construction

Products & appliances

- Energy Efficiency Labelling Ordinance
- National Top Runner Initiative

Industry and business

- Obligatory energy audits
- KfW credits and loans
- Energy consulting services

Transport

- Motor vehicle taxation
- Regulation of consumption

Source: Ecofys 2015

Energy efficiency policies find a balance between consultation, information, incentives and regulation.

Federal Ministry
for Economic Affairs
and Energy

Energiewende
Switch to the Future

NAPE: Efficiency measures and their expected savings

32-76.5 PJ savings

Quality assurance and optimising of energy consulting	4.0 PJ
Incentive programme for energy-efficient renovation	up to 40 PJ
Continuation and increased funding of the CO_2 building modernisation programme	12.5 PJ
Promoting "energy performance contracting"	5.5-10 PJ
National energy-efficiency label for old heating installations	10.0 PJ

85 PJ savings

National top runner initiative	85.0 PJ
Pilot programme for energy savings meters	-

180.5-206 PJ savings

Introduction of a competitive tendering scheme for energy efficiency	26-51.5 PJ
Upgrading the KfW energy efficiency programmes	29.5 PJ
Energy efficiency networks initiative	74.5 PJ
Obligation to perform energy audits for non-SMEs	50.5 PJ

Source: Ecofys 2015 based on BMWi 2014

A balance of information, support and regulation.

The Role of Climate Technologies

- Important Role of Climate Technologies in all Sectors, in particular in the Energy Sector
- Technology Openness
- Avoiding counterproductive effects for the environment, nature and health
- High Tech Solutions as well as Simple but Effective Solutions (i.e. in the Buildung Sector)
- „Low Hanging Fruits“ as well as Advanced Technologies and „Cleaning the Floor“ Measures
- Technologically Learning Process (like the Action Plan)
- Cross Sectoral Solutions, System Flexibility

Climate Technologies: Two Examples

- **Waste Heat an Waste Cold**

  Utilisation of Waste Thermal Energy from Energy Production / Industrial Processes. Large Potential for Heat and Cold Grids Technologies (including Low Temperature Grids) and for Storage Systems

- **Power To X**

  Cross Sectoral Systems, Power to Heat, Power to Gas, Hydrogen for Storing and Distributing Energy, Smart Energy Systems, Fuel Cell Technology

Funding (administrated by BMUB)

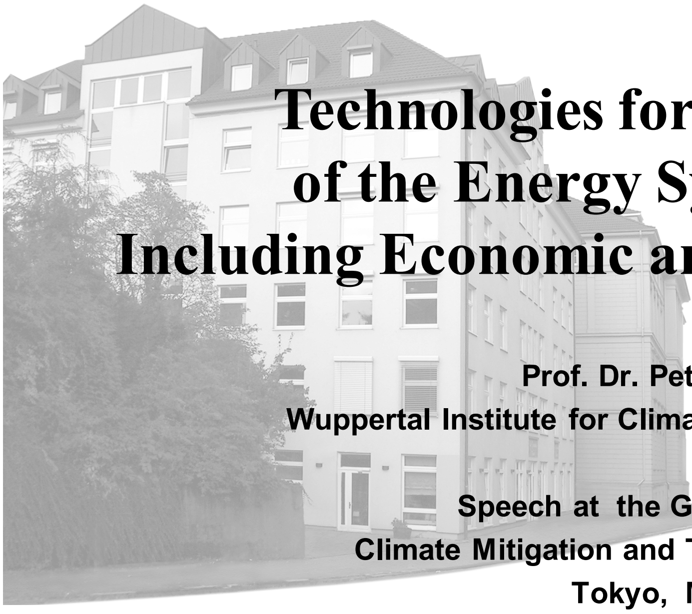
National Climate Initiative

- Programmes and projects covering a broad spectrum of climate-related activities, Including climate technologies
- financial support and funding for projects in municipalities, consumption, companies and industry as well as education and training
- Examples: Energy-efficient LED Lighting, Electrical Appliances, Energy-Efficiency in Production
- Innovation Prize for Climate and Environment
- International Climate Initiative with regard to Technology Transfer (speech by Harald Neitzel this afternoon)

Environmental Innovation Programme

- for projects that are well suited for demonstration purposes and for replication
- further refinement both of the technologies involved and of the environmental regulatory framework
- Small and medium-sized businesses receive priority funding, loan or investment grant from KfW
- Federal Environment Agency manages environment technology issues

Wuppertal Institut



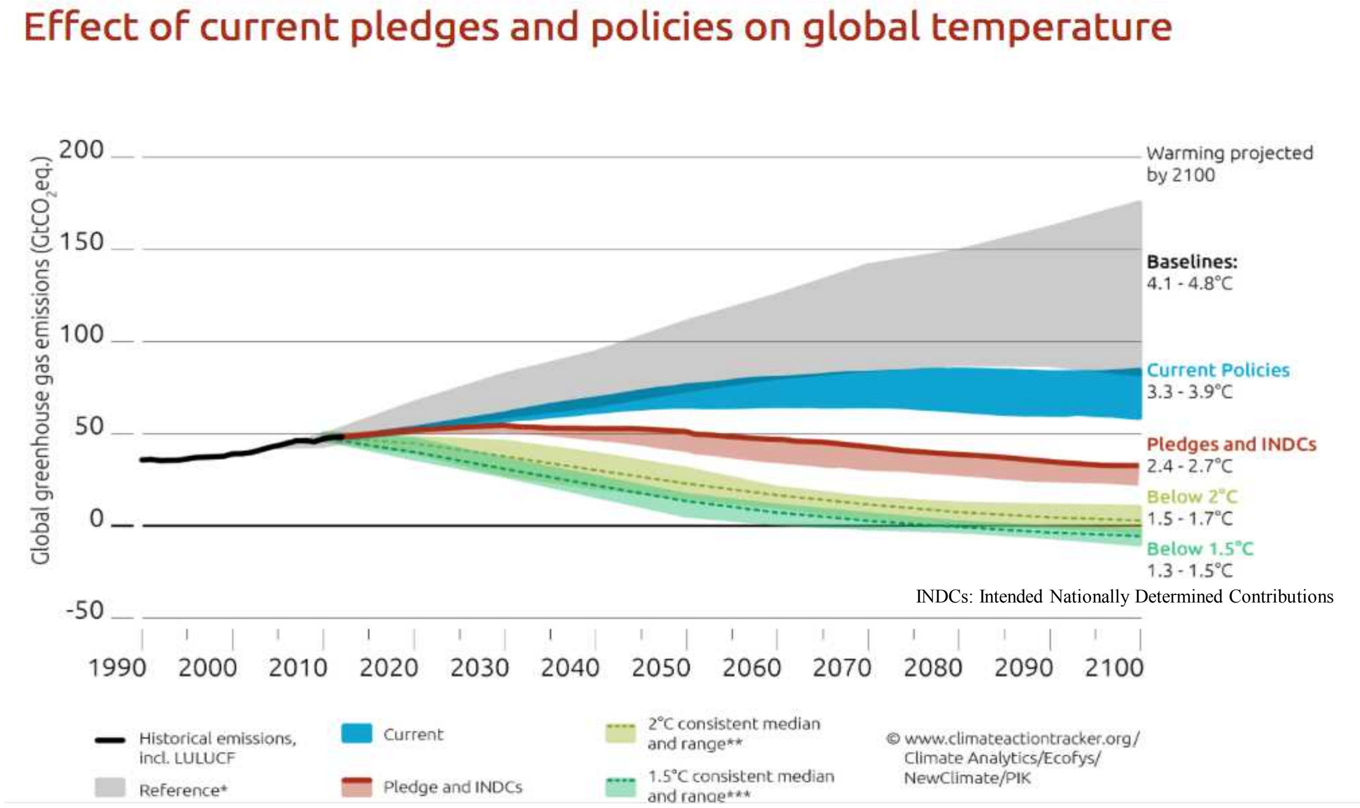
Technologies for Decarbonisation of the Energy System until 2050 Including Economic and Social Compatibility

Prof. Dr. Peter Hennicke
Wuppertal Institute for Climate, Environment and Energy

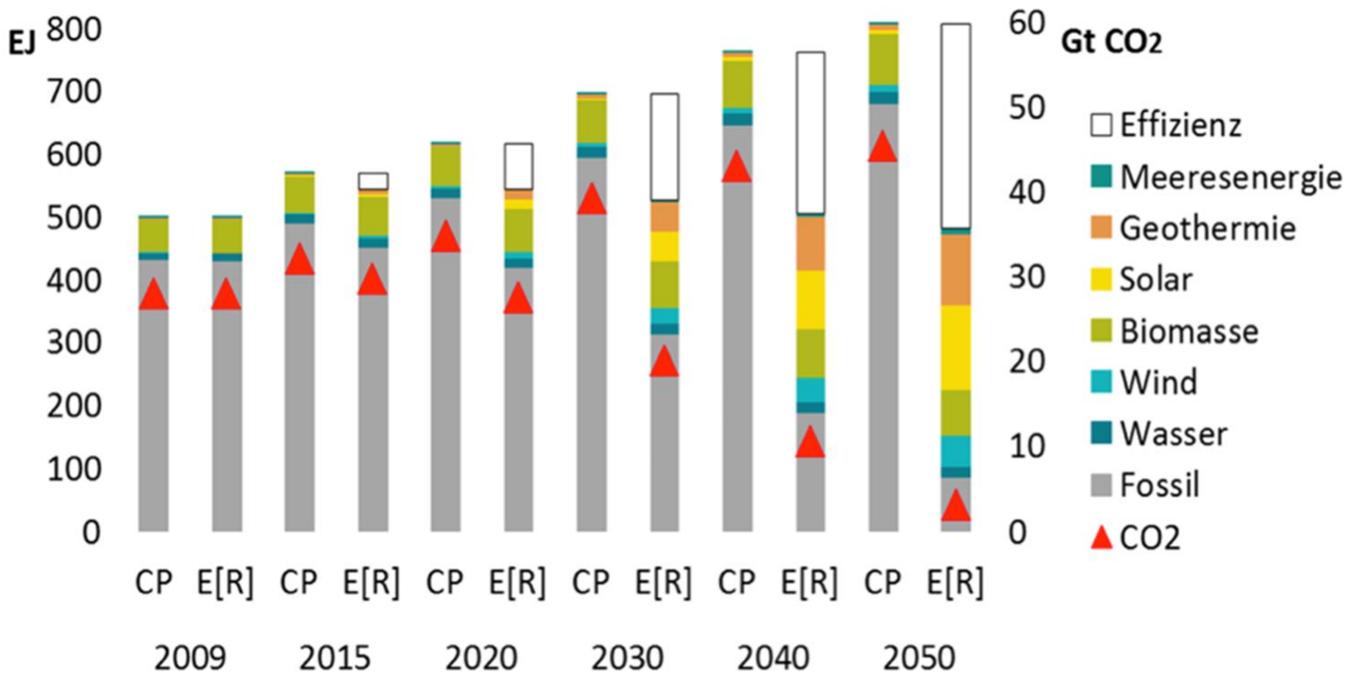
Speech at the German-Japanese Climate Mitigation and Technology Symposium
Tokyo, May 18th

1.5° - 2° C target means: Reduction of GHG to zero until 2080!

->„Negative“ emissions (BECCS) -> Complete decarbonisation of the energy sector

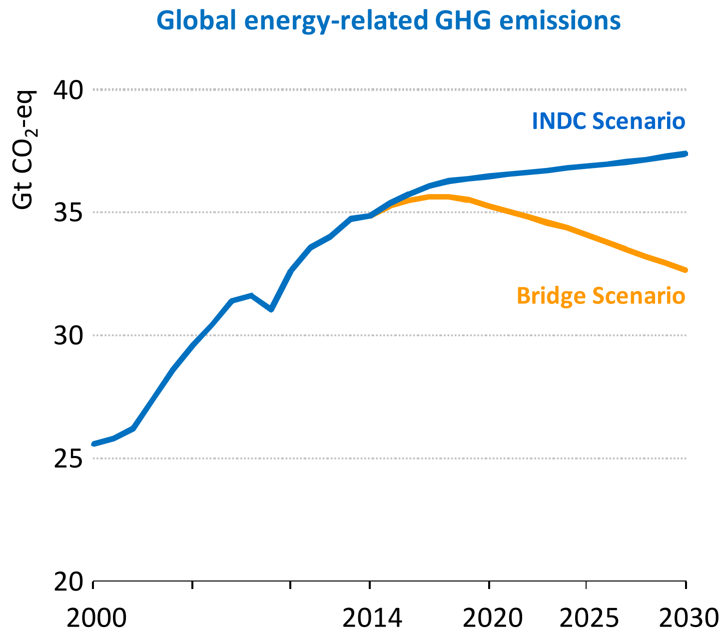


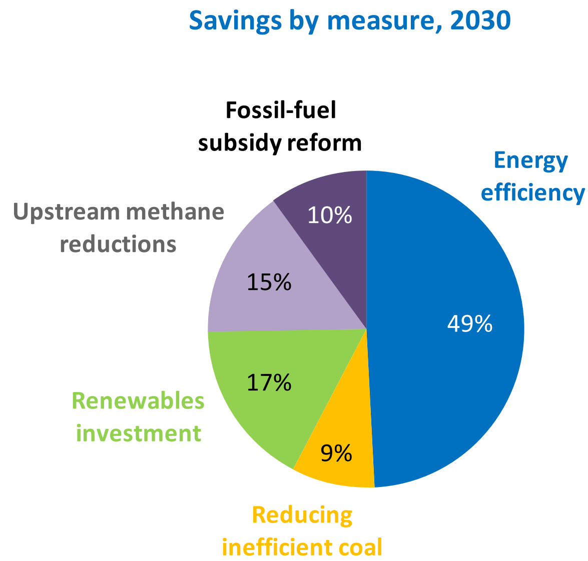
Global pathway to zero emissions: Efficiency + Renewables
Comparison: IEA Current Policy (CP) vs. Energy (r)evolution (E (R))



Source: DLR 2015

A robust "technology bridge" to climate mitigation
IEA-Bridge Scenario (2015) -> Peak of CO2- emissions around 2020



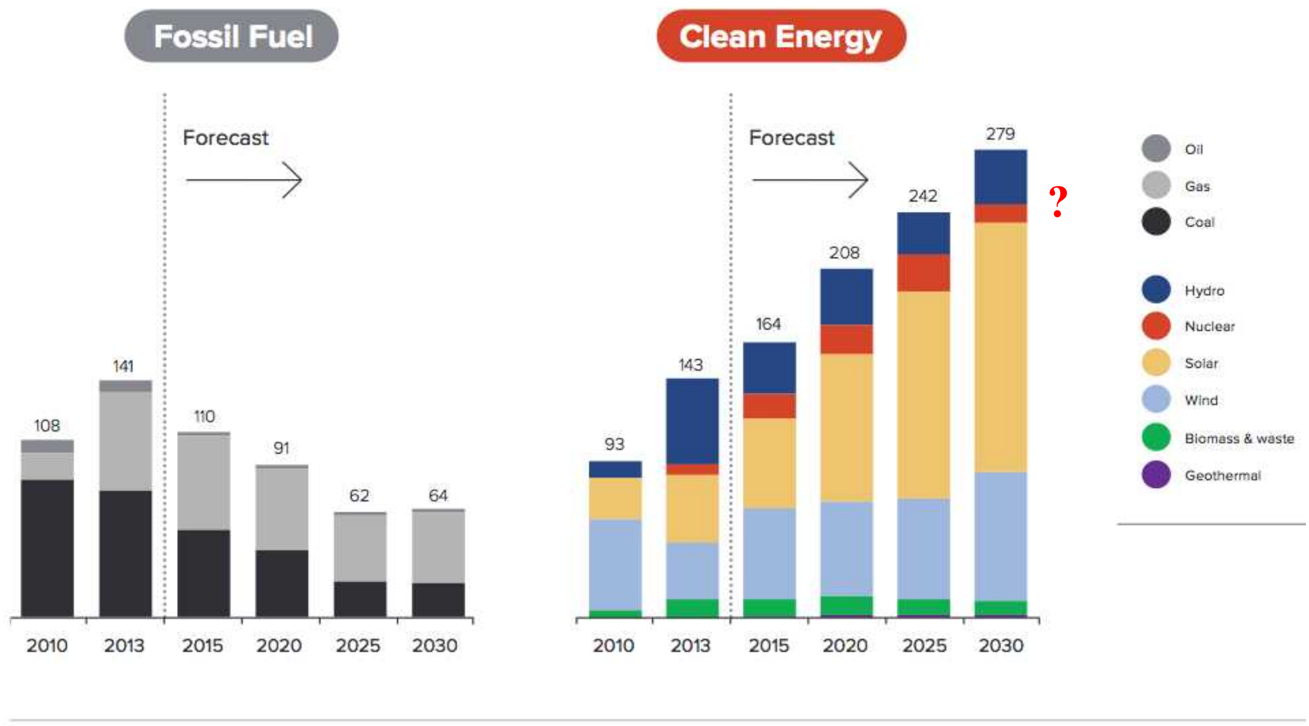


INDCs: Intended Nationally Determined Contributions

Source: IEA, Energy and Climate 2015

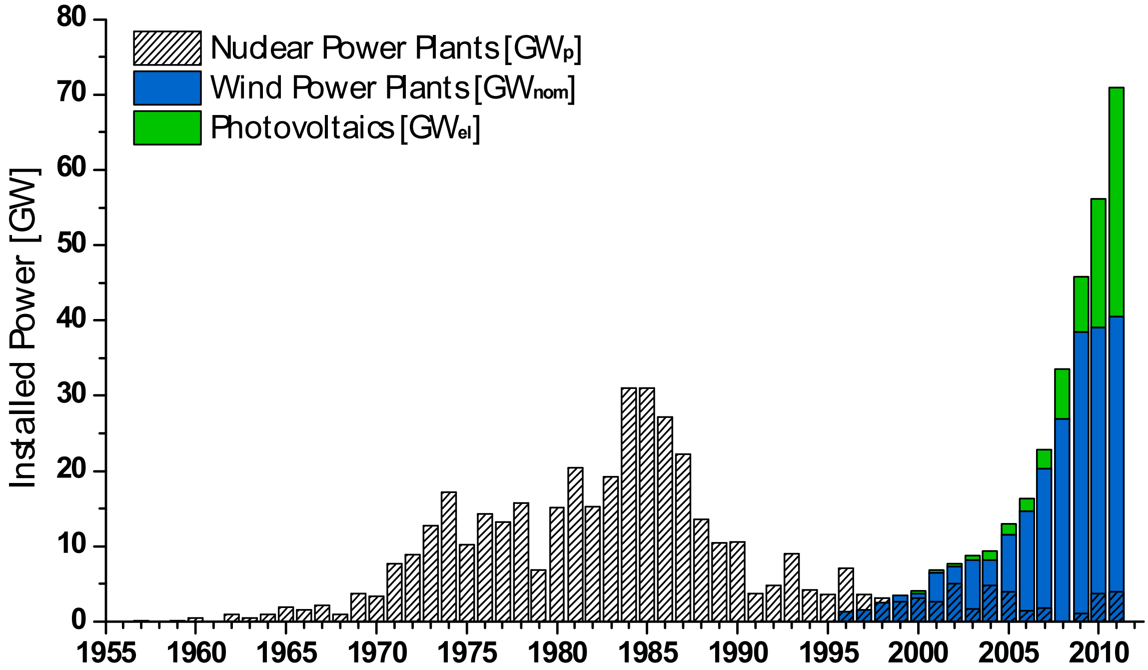
Five measures – shown in a "Bridge Scenario" – achieve a peak in emissions around 2020, using only proven technologies & without harming economic growth

Bright global perspectives of renewable electricity
A factor of four more additional power than fossil fuels



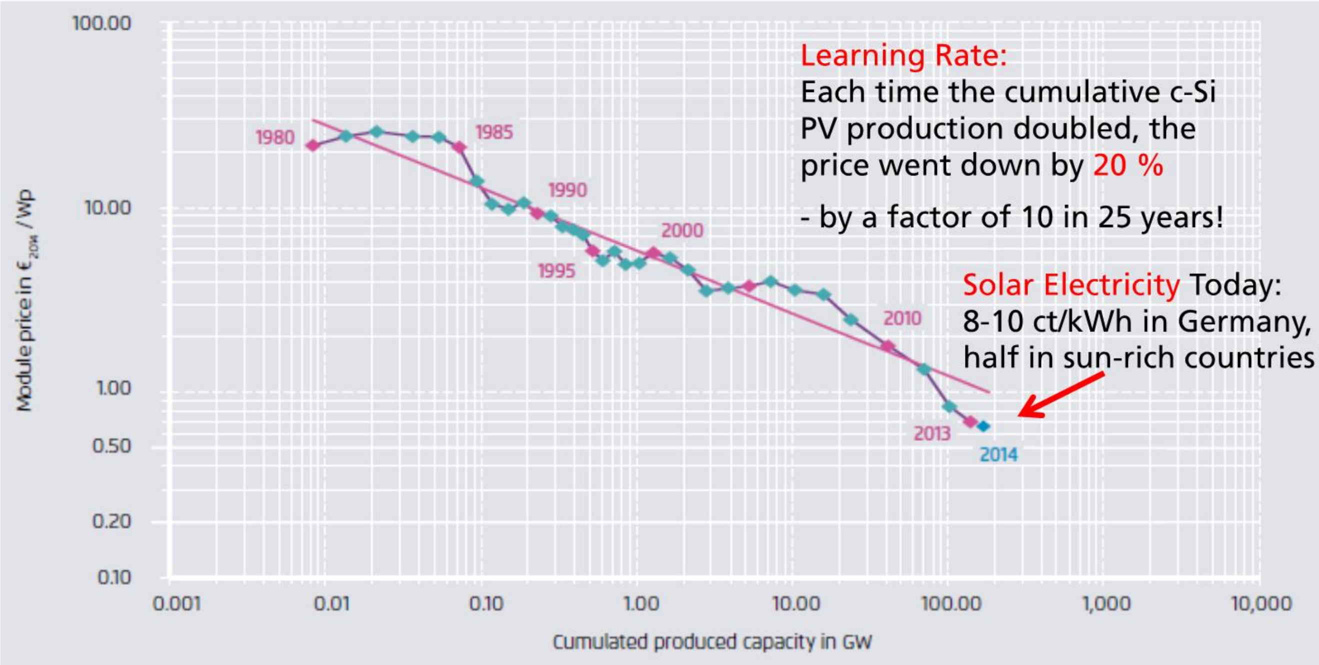
Source: Bloomberg New Energy Finance, 2015.[13]

Newly installed power -> renewables vs. nuclear power
-> Market perspectives: disruptive innovation vs. high risk perception



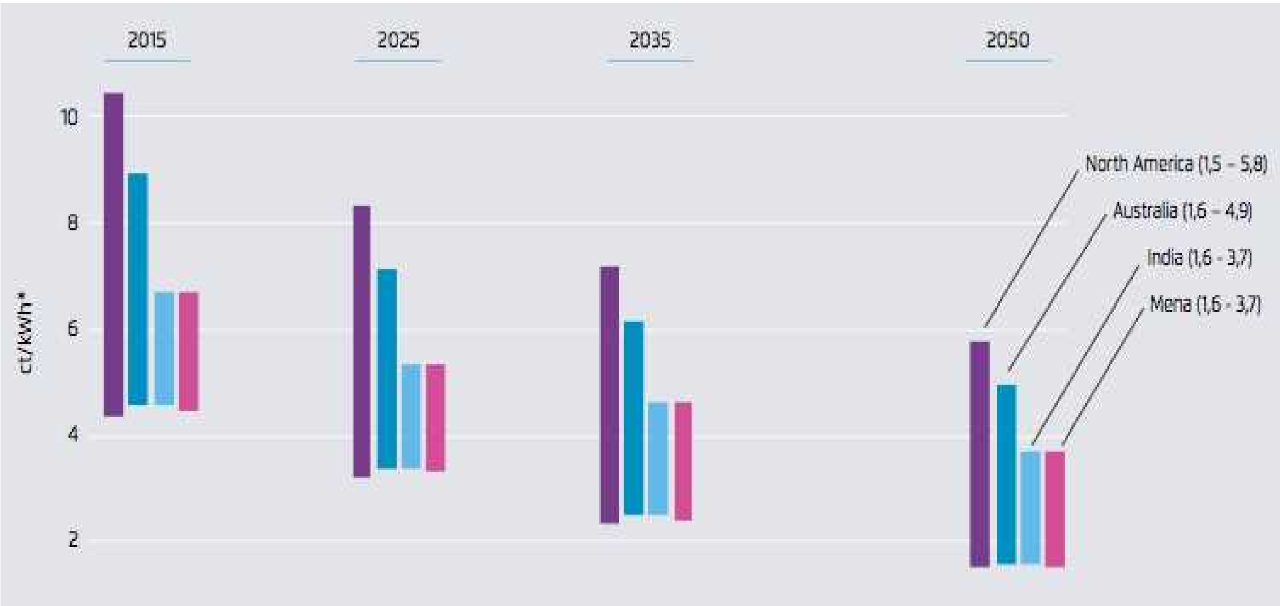
Quelle: IAEA, GEWC, EPIA

Past learning curves and cost degression for green power
Unexpected steep cost degression of PV power



Source: Navigant Consulting; EUPD PV module prices (since 2006), Graph: ISE 2014

Forcasted cost degression of new PV power
- in North America, Australia, India and Mena region (in cts/kWh)



Breaking news: „Today, wind power costs only 3cts/kWh“ (Siemens)

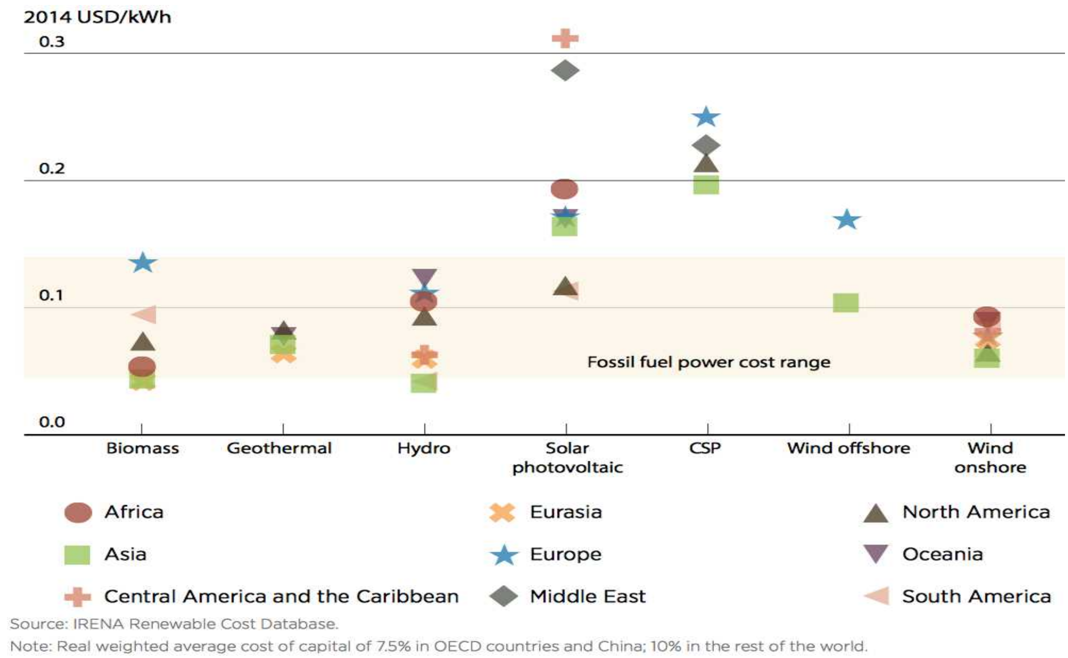
* Real values EUR 2014; full load hours based on [27], investment cost bandwidth based on different scenarios of market, technology and cost development; assuming 5% (real) weighted average cost of capital.

Source: Agora, Current and Future Cost of PV, 2015

Weighted average cost of electricity by region

for utility scale renewable technologies, comp. with fossil fuel power (2013/2014)

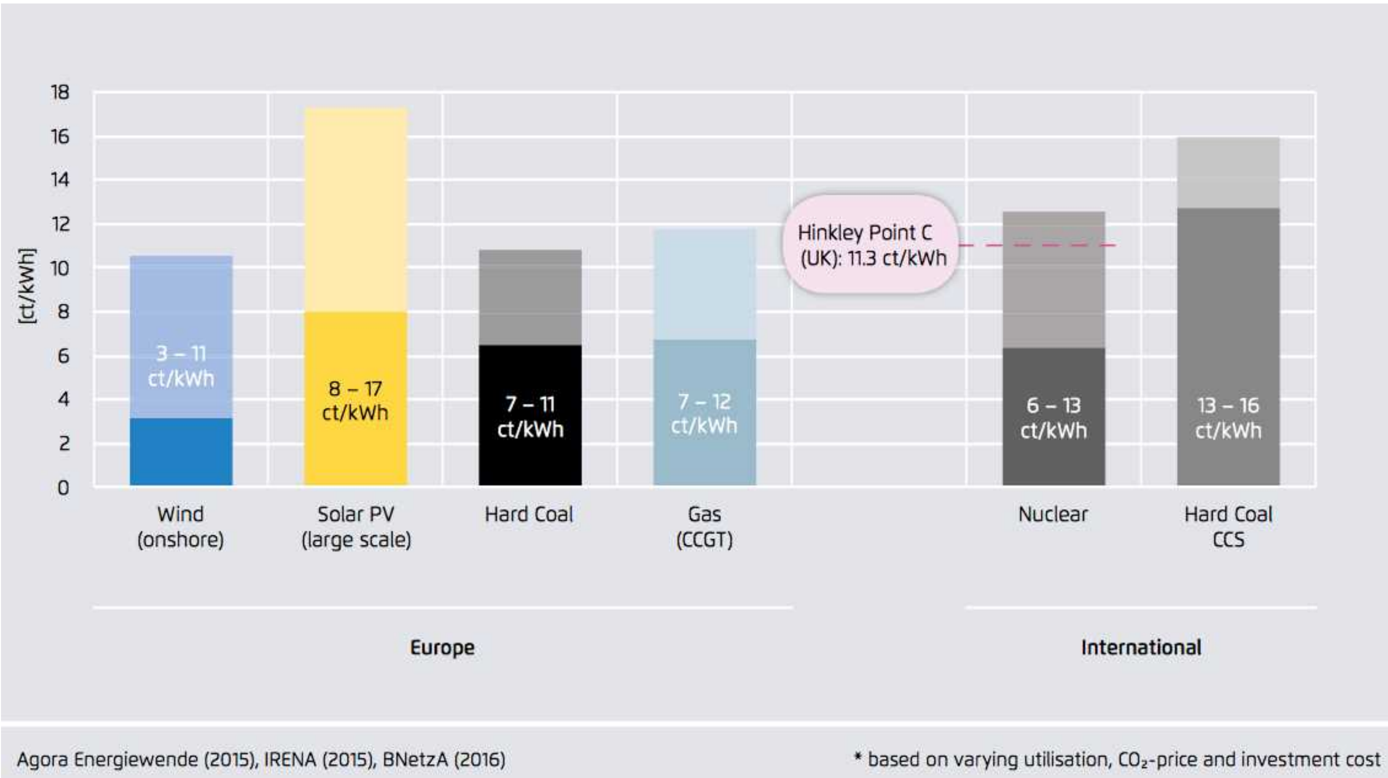
„Regional, weighted average costs of electricity from biomass for power, geothermal, hydropower and onshore wind are all now in the range, or even span a lower range, than estimated fossil fuel-fired electricity generation costs. Because of striking LCOE reductions, solar PV costs also increasingly fall within that range" ***(IRENA, 2015)***



Source: IRENA 2015

Current costs of PV and wind in Europe

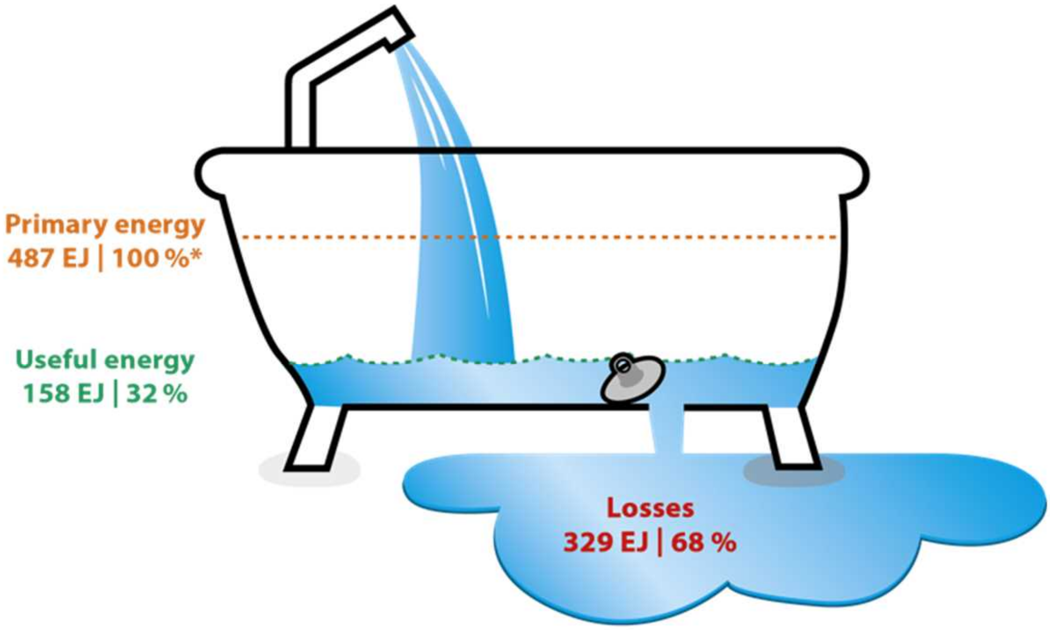
Compared with levelized costs of nuclear (UK) and gas/coal (incl.CCS)



Source: Agora/ Prognos 2016

Efficiency first:Reduce losses of the global energy system!

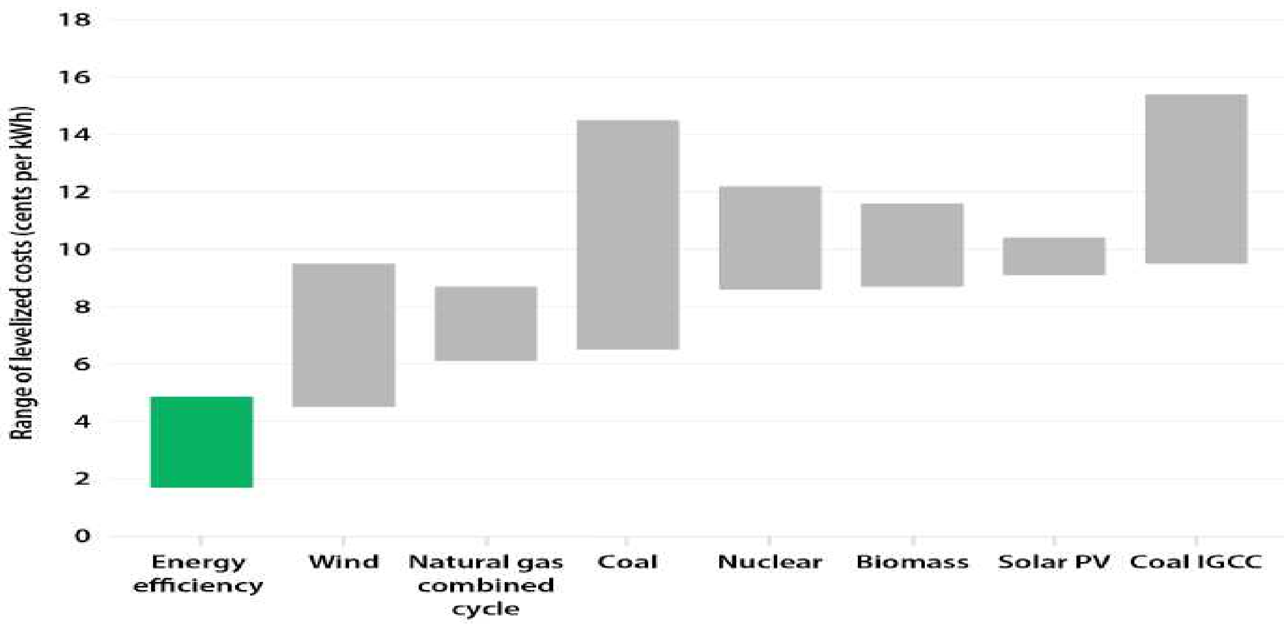
Energy efficiency revolution (= end use + decentralised power) needed



*Total primary Energy 519 EJ less 32 EJ non energetic consumption
Source: Hennicke/Grasekamp 2014; based on Jochem/Reize 2013; figures from IEA/OECD/IREES

US: Cost of utility efficiency programs (average: 2.8 cents per kWh)

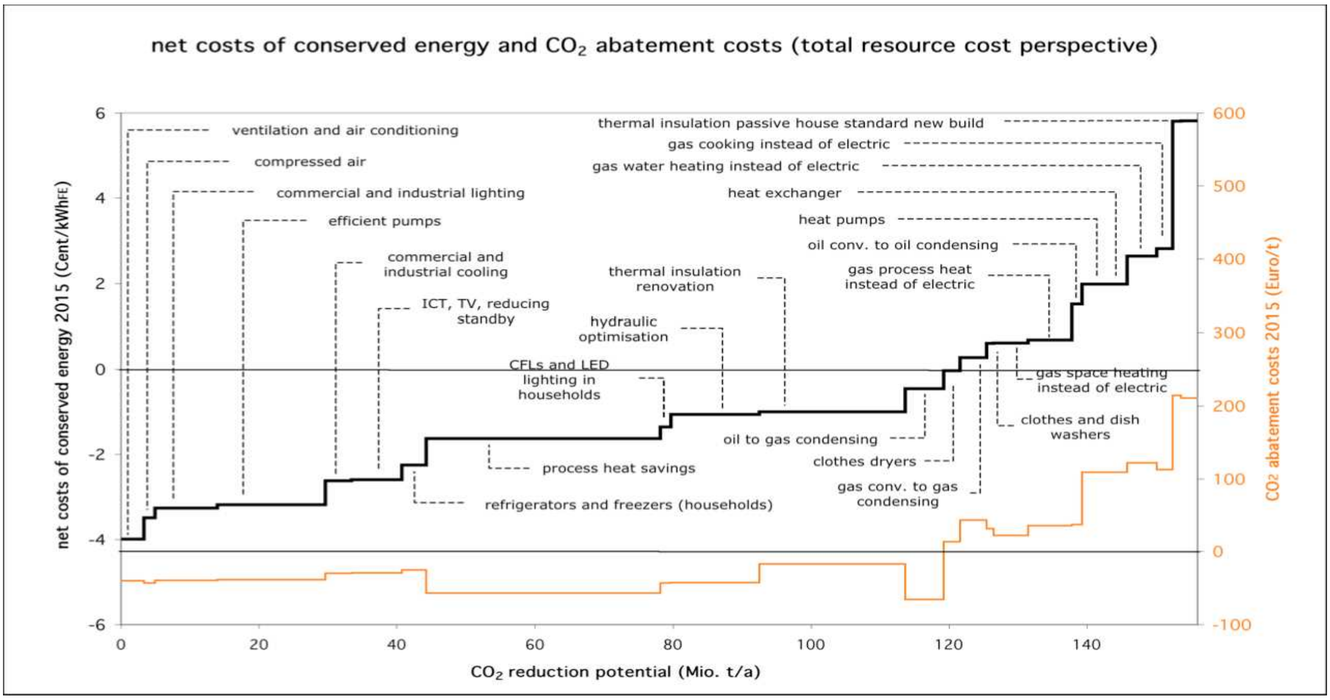
A factor of 50- 75% less than levelized cost of new electricity resource options



The high-end range of coal includes 90 percent carbon capture and ompression. PV stands for photovoltaics. IGCC stands for integrated gasification combined cycle, a technology that converts coal into a synthesis gas and produces steam.
Source:ACEE 2014. Energy efficiency portfolio data from Molina 2014; all other data from Lazard 2013.

The economics of „Negawatts“ compared to „Megawatts“
140 TWh can be saved with a profit – when barriers are removed!

Example for Germany



Source: Wuppertal Institute 2006

State of the art: Buildings used as power plants
„Plus-Energy-Houses“ in Freiburg/Germany: supply more energy than they use!

Caption: Plus energy houses are designed to produce more energy than they consume in the course of the year.

Subsidies for retrofitting the building stock are necessary
- but the macroeconomic multiplier and self-financing effects are promising!

Promotional effects — kfw BANKENGRUPPE

	2009	2010	2011
Commitments (in millions of EUR)	8,863	8,746	6,510
housing units (in 1.000)	617	953	282
reduction of CO_2 (in 1,000 Tonnen p.a.)	1,452	1,049	567
jobs * (in 1.000)	292	342	247
investments (in millions of EUR)	18,335	21,330	18,427
federal budget (in millions of EUR)	2,033	1,337	934
leverage	9.0	16.0	19.7

* safeguarded employment for one year

Effects of promotion

- Increase of retrofitting ratio
- Sustainable reduction of CO_2-emissions
- Promotion for SMEs and creation of employment
- Substantial investments in buildings be triggered

Budget funds being recovered by additional revenues of taxes

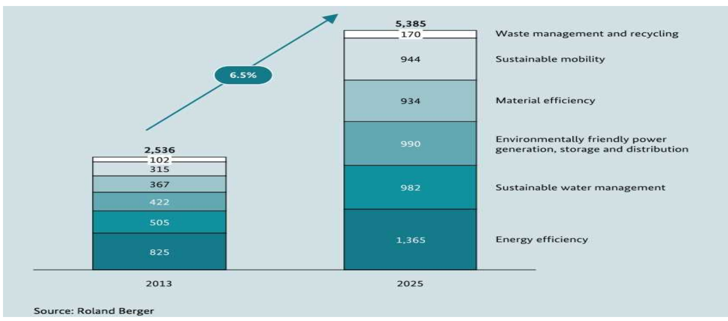
Integrated business fields of „GreenTech Lead Markets“ ->
driving the transition to low carbon, green and circular economies!

Key for international competitiveness: Technologies to foster energy and resource productivity!

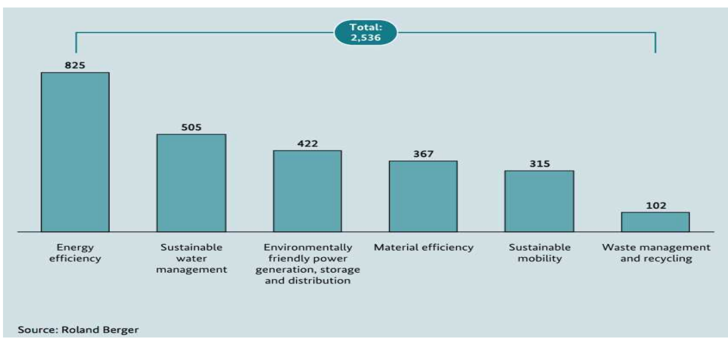
Lead markets	Market segments	
Environmentally friendly power generation, storage and distribution	• Renewable energy • Ecofriendly use of fossil fuels • Storage technologies	• Efficient grids
Energy efficiency	• Energy-efficient production processes • Energy-efficient buildings • Energy-efficient appliances	• Cross-sector components
Material efficiency	• Material-efficient processes • Cross-application technologies • Renewable resources	• Protection of environmental goods • Climate-adapted infrastructure
Sustainable mobility	• Alternative drive technologies • Renewable fuels • Technologies to increase efficiency	• Transportation infrastructure and traffic management
Waste management and recycling	• Waste collection, transportation and separation • Material recovery • Energy recovery	• Landfill technologies
Sustainable water management	• Water production and treatment • Water system • Wastewater cleaning	• Increasing the efficiency of water usage

Source: Roland Berger

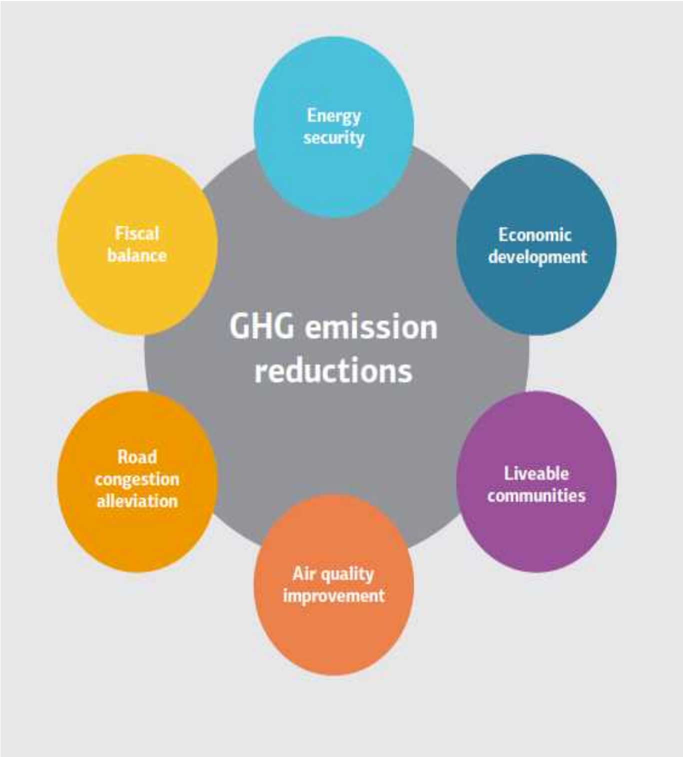
Doubling of „GreenTech Lead Markets“ (in bn€)



Most attractive „GreenTech Lead Market“ (in bn €): Energy efficiency

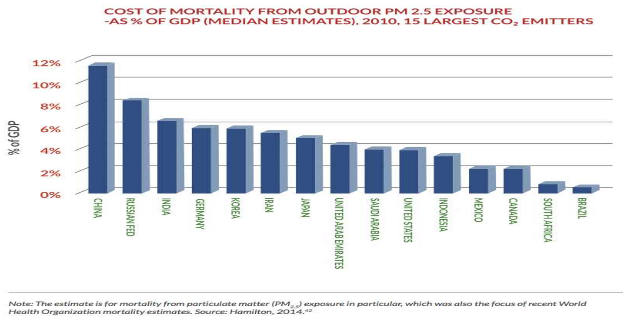


Recognize the „Non-climate drivers“ (IEA) of GHG reductions
-> even without climate change we should invest in decarbonisation technologies!



Quelle: IEA 2014

„Between 350,000 and 500,000 Chinese die prematurely each year because of the country's disastrous air pollution, says China's former health minister“. The Telegraph, 9. 3. 2015



First conclusion: *Global* decarbonization is feasible

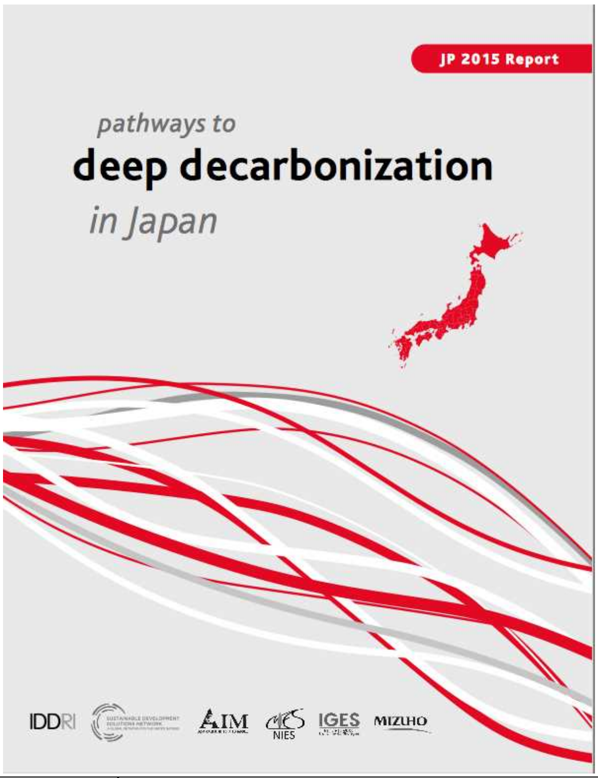
1. Higher ambition level of major emitting countries are needed (US, China, EU/Germany, Japan...) to stay within the 2° C boundary

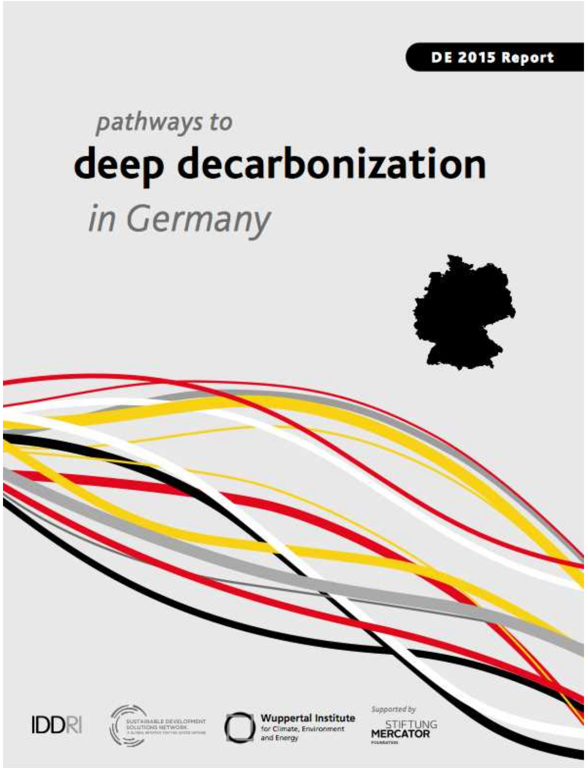
1. Deep decarbonization strategies must be based on three pillars:„efficiency first fuel“ (IEA), renewables cost decrease and GreenTech integration

2. Decarbonization strategies are cost effective, when co-benefits and avoided damage costs are considered

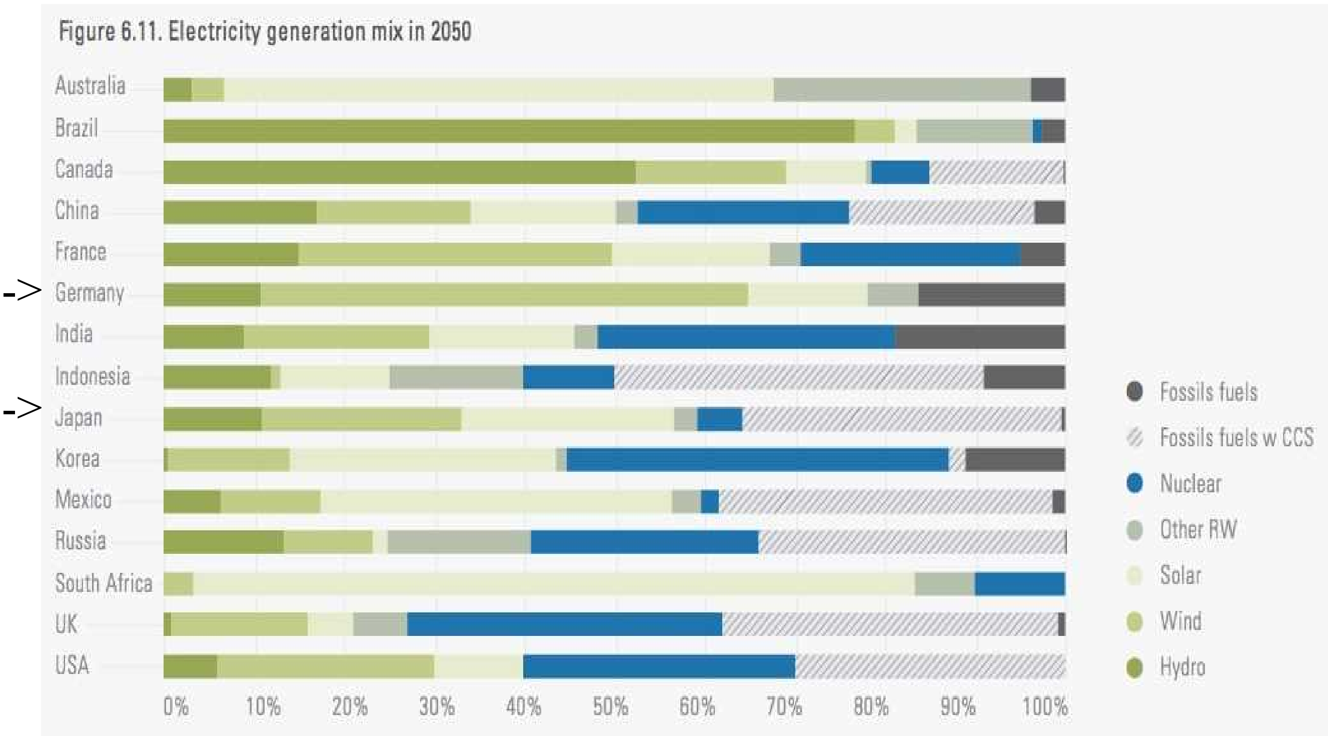
3. But: *National* decarbonization analysis is necessary (back-casting approach) -> dialog on roadmaps with all stakeholders needed!

Japan and Germany: Case studies of the DDPP-Project
DDPP = Deep Decarbonisation Pathway Project (16 countries are included)



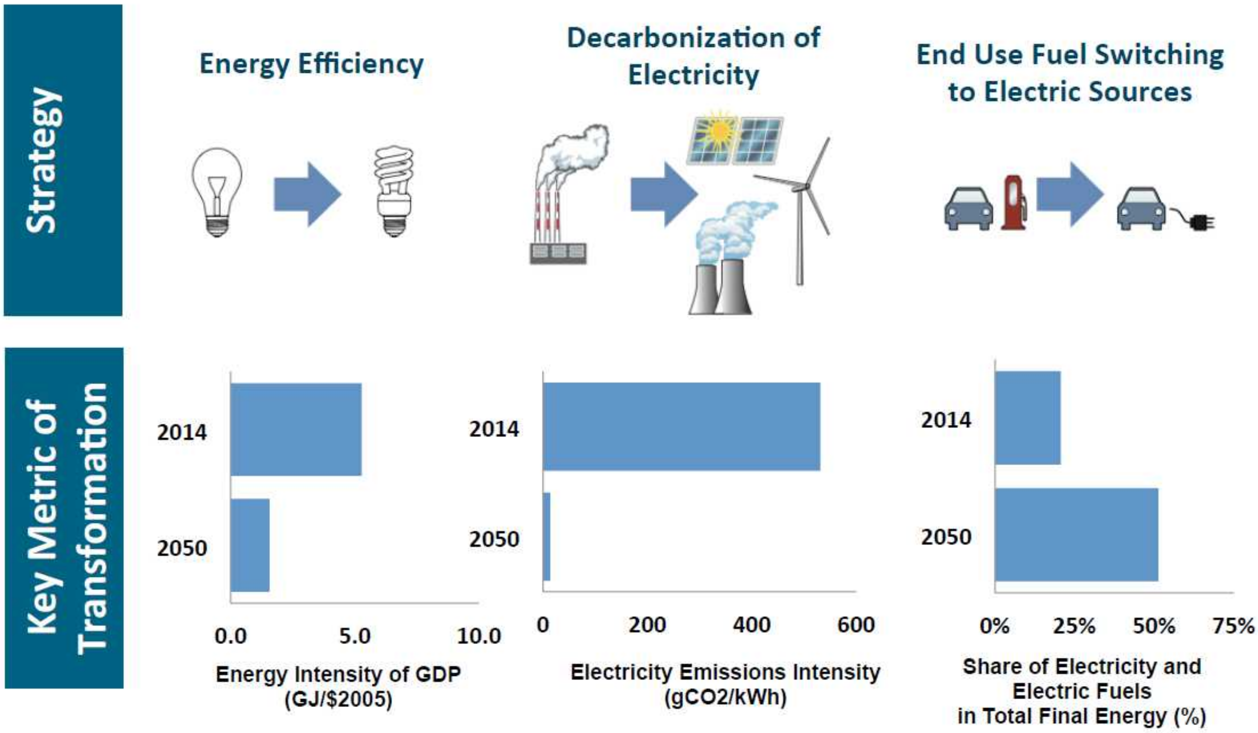


Different ways towards decarbonized electricity in DDPP
-> reduce uncertainty and foster implementation by knowledge exchange



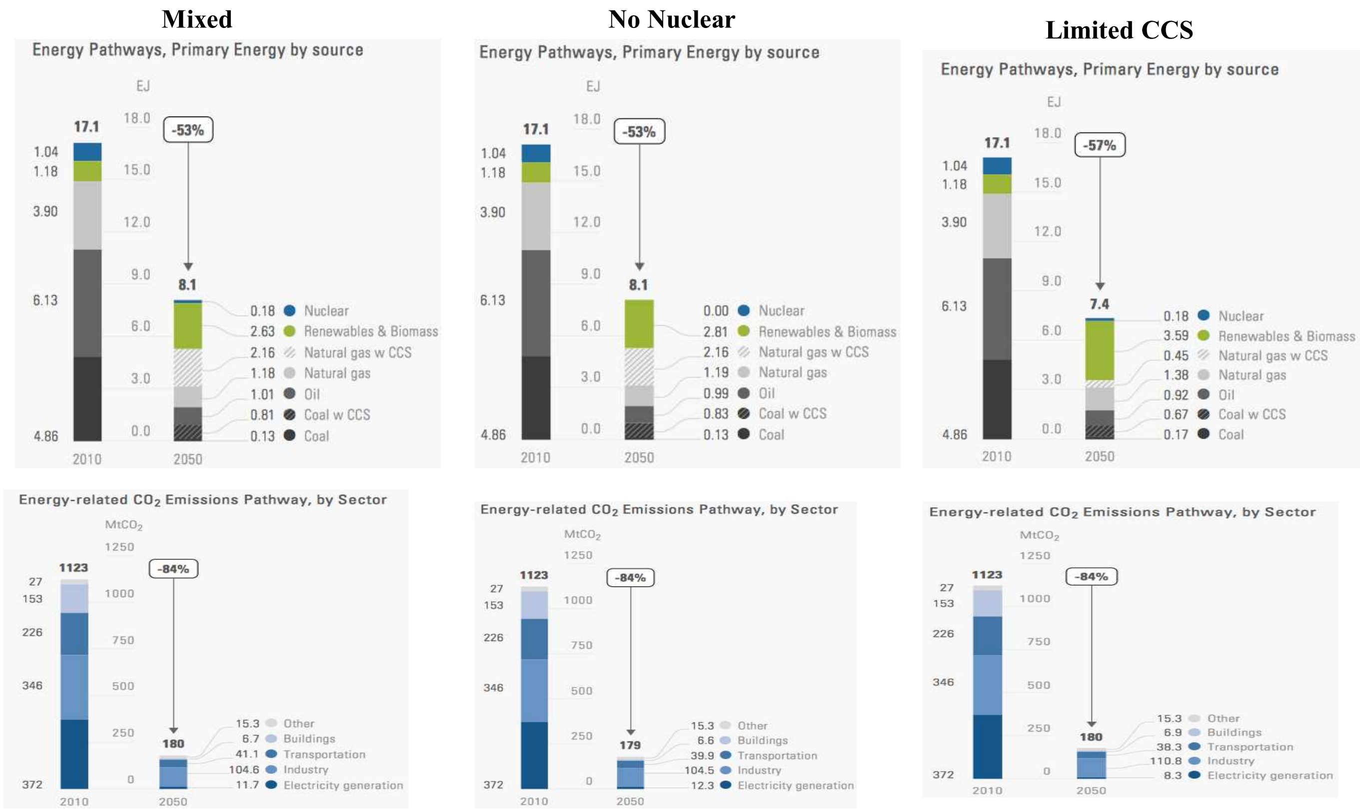
Source: DDPP 2015

Common key strategies of all 16 DDPP Case Studies
Most of the required technologies have become cost effective



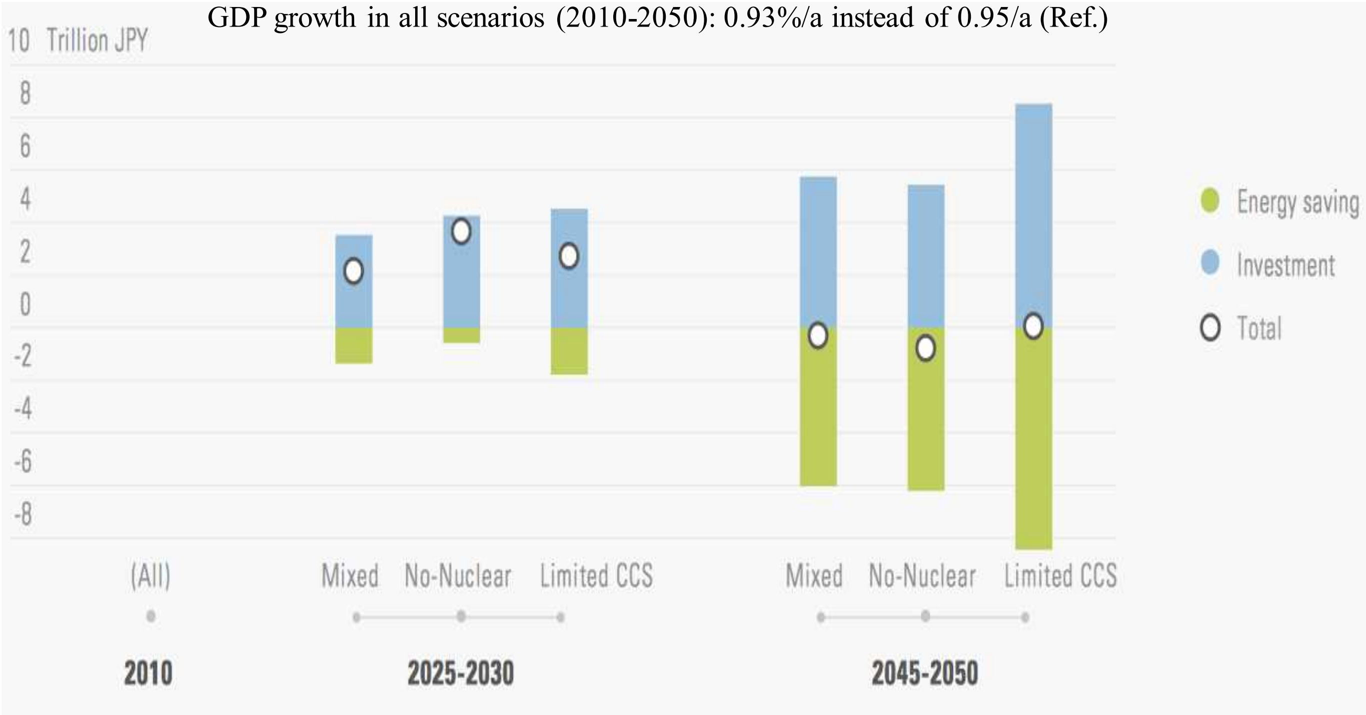
Source: DDPP 2015

Three typical strategies for Deep Decarbonisation in Japan
DDPP-Scenarios (2015) demonstrate a broad range



Comparable total costs (investments - energy cost savings)
in the DDPP scenarios for Japan

GDP growth in all scenarios (2010-2050): 0.93%/a instead of 0.95/a (Ref.)



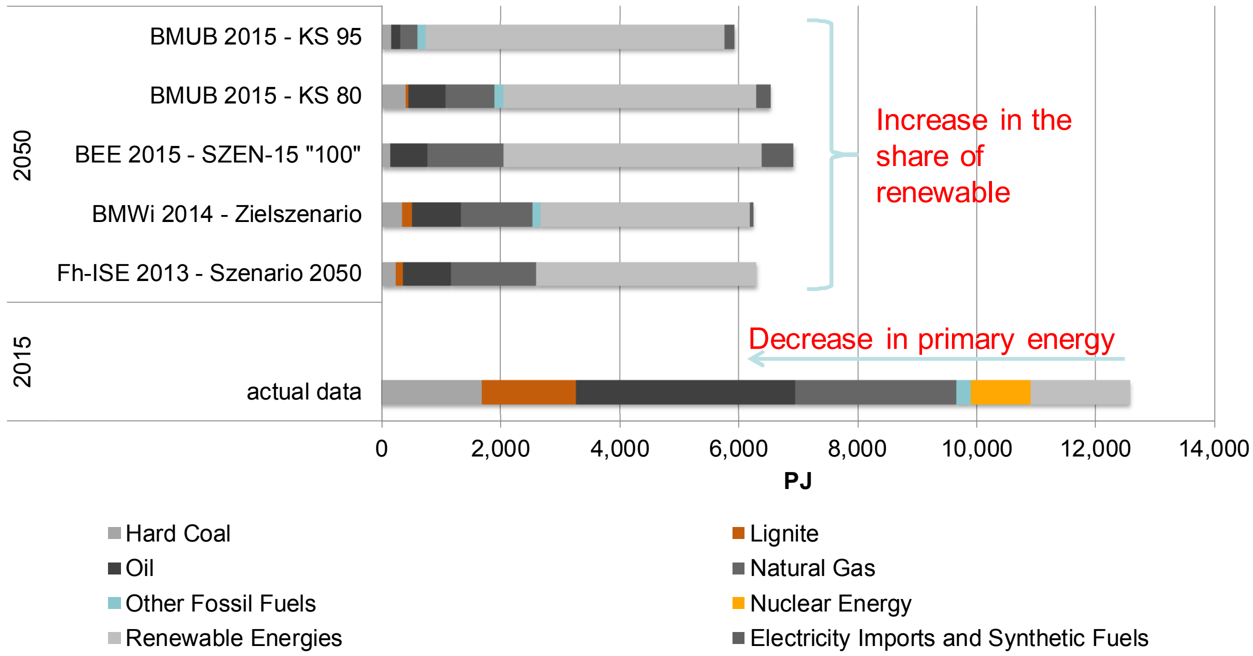
Source: DDPP, JP 2015 Report, 2015

"Revolutionary Targets" (Chancellor Merkel)
Energy Concept, Federal German Government, 28 September 2010

Development Path	2020	2030	2040	2050
Greenhouse Gas Emissions	- 40%	- 55%	-70%	- 80 bis 95%
Share of renewable energies in relation to the gross final energy consumption	18%	30%	45%	60%
Electricity generated from Renewable Energy Sources in relation to gross final energy consumption	35%	50%	65%	80%
Primary Energy Consumption [base year 2008] / annual average gain in energy productivity of 2.1 %, based on final energy consumption.	-20%			-50%
Electricity Consumption [base year 2008]	-10%			-25%
Doubling the Building Renovation Rate from the current figure of less than 1 % a year to 2% of the current building stock ; reduction				-80%
Reduction of the **Final Energy Consumption** in the **Transport Sector** [base year 2005]	-10%			-40%

Research consensus: “Energiewende” is technically feasible

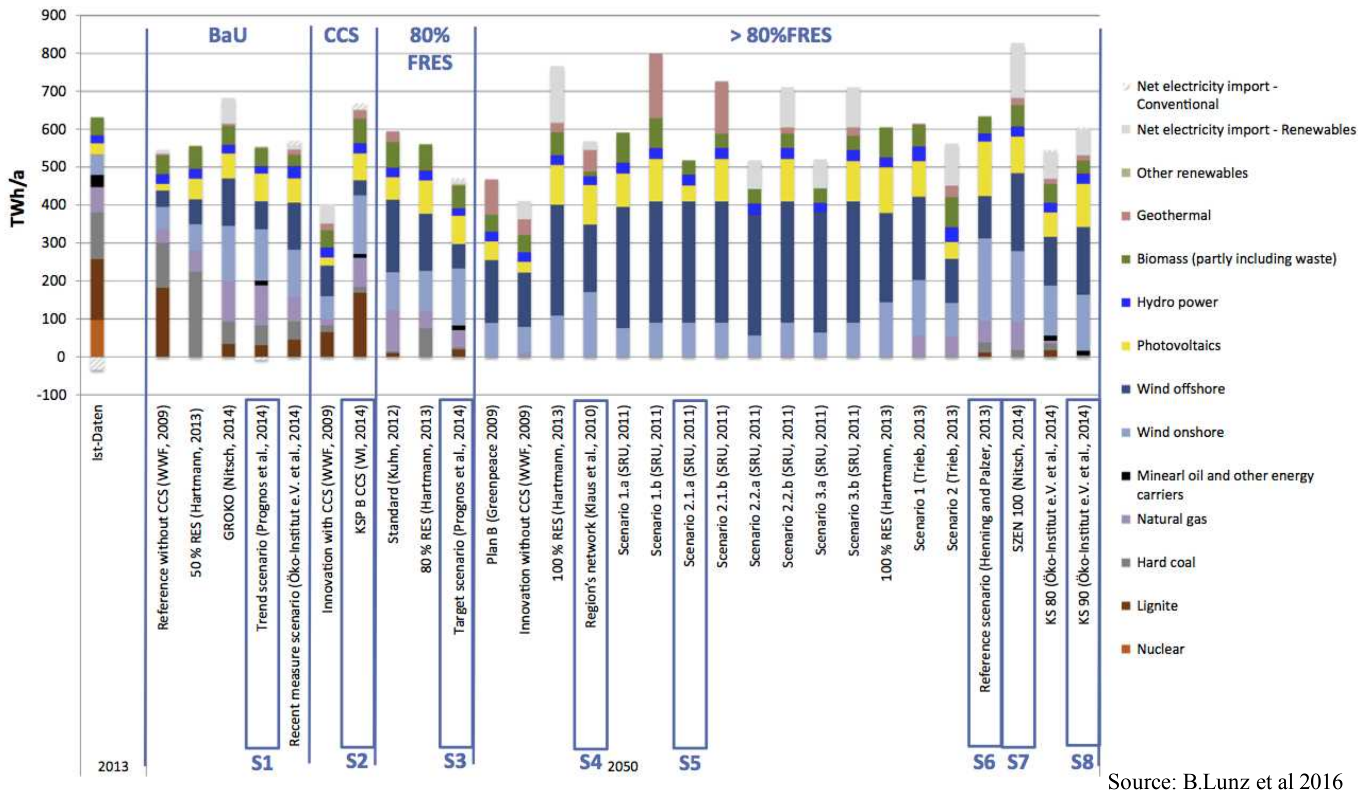
Decoupling GDP from quality of life plus ecological modernisation in Germany



Source: Particular scenario studies and AG Energiebilanzen (2015).

Typical scenarios of future German electricity production

Many options, but uncertainty on final electricity demand and energy mix in 2050

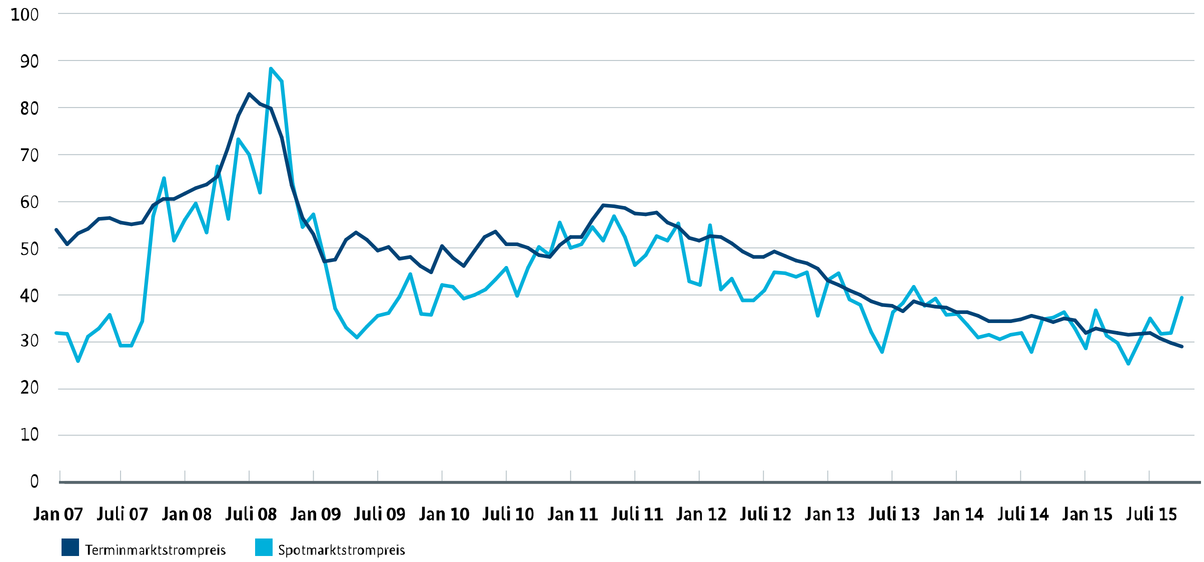


Source: B.Lunz et al 2016

Decrease of Stock Exchange Prices: Avantage for industry

due to learning effects/EEG -> power intensive industry profits by direct purchase

Trading price of electricity in the spot market and futures trading in Euro/MWh

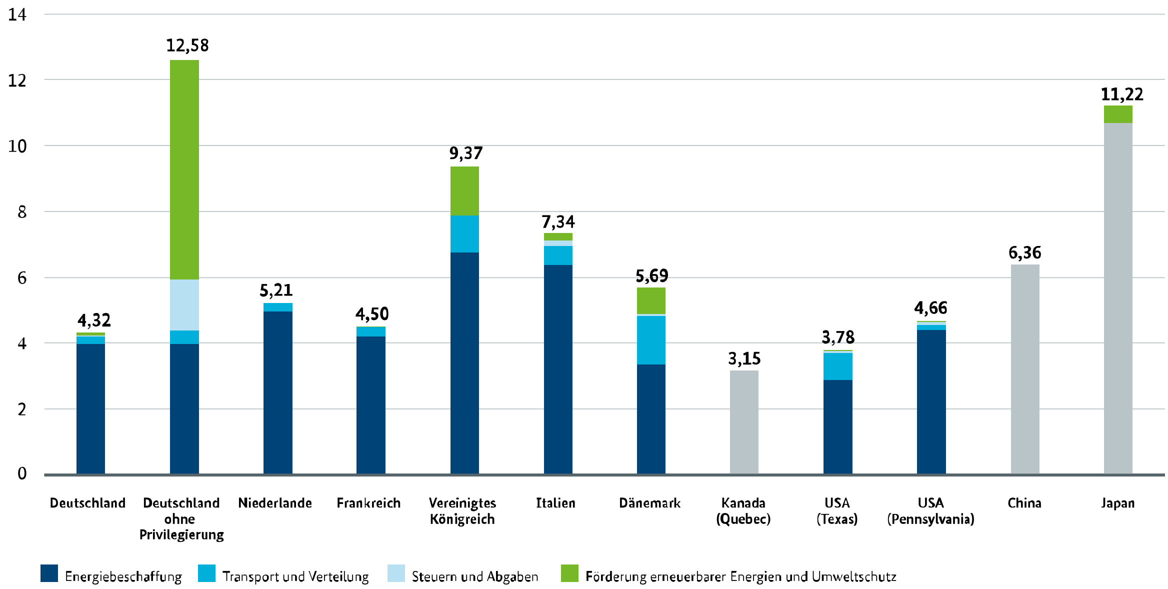


Quelle: European Energy Exchange 10/2015
Monatsmittelwerte für Produkte Day Base (Stundenkontrakte) und Phelix-Futures (Baseload, Year Future)

Comparison of electr. prices for power intensive industries

When considering the excemption clauses, the electricity prices are competitive

Electricity prices for electricity intensive companies in international comparison ct/kWh



Quelle: Ecofys, ISI 2015. Grau gekennzeichnet, wo keine Aufteilung in Preiskomponenten möglich war

Key technologies of the German energy transition
Electricity production

Renewables

- Wind onshore

- Wind offshore

- Photo-voltaics

- Hydropower

Complementary electricity production

- Conventional power plants

- Combined heat and power (different sizes)

- Combined cycle power plants

Key technologies of the German energy transition
Heat supply

Using electricity

- Electric heat pumps
- Direct heating (only surplus electricity)

Solar thermal (decentralized or disctrict heating grids)

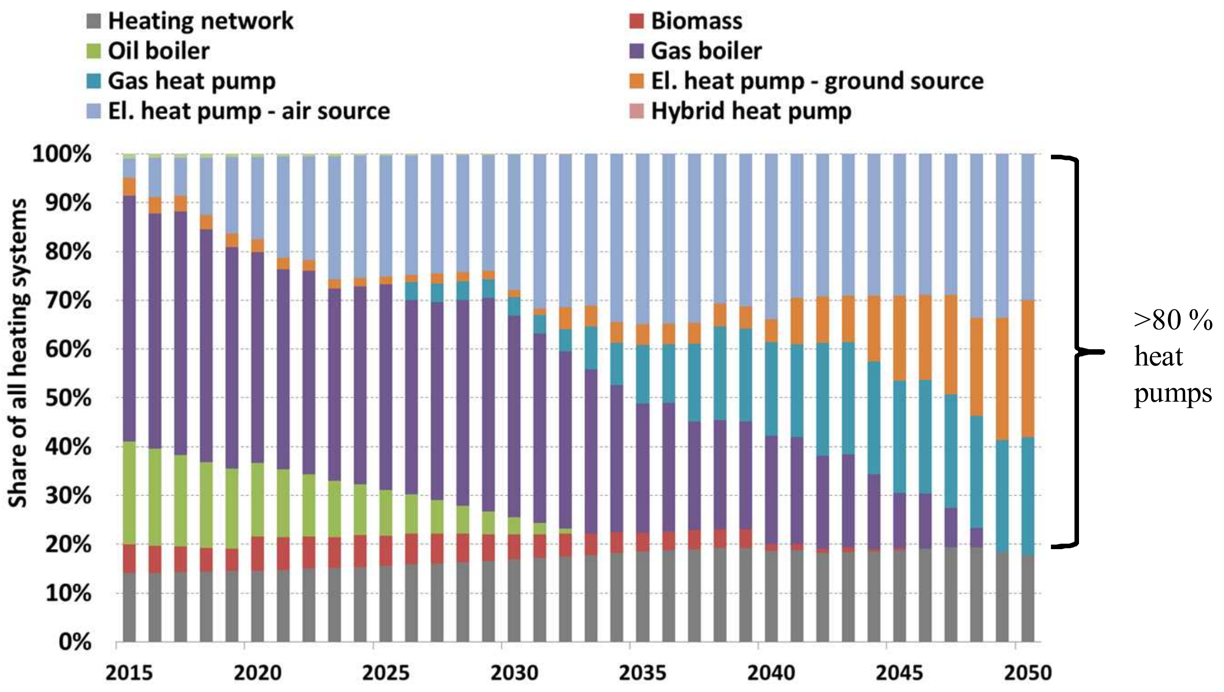
Using fuel

- (Condensing) boilers

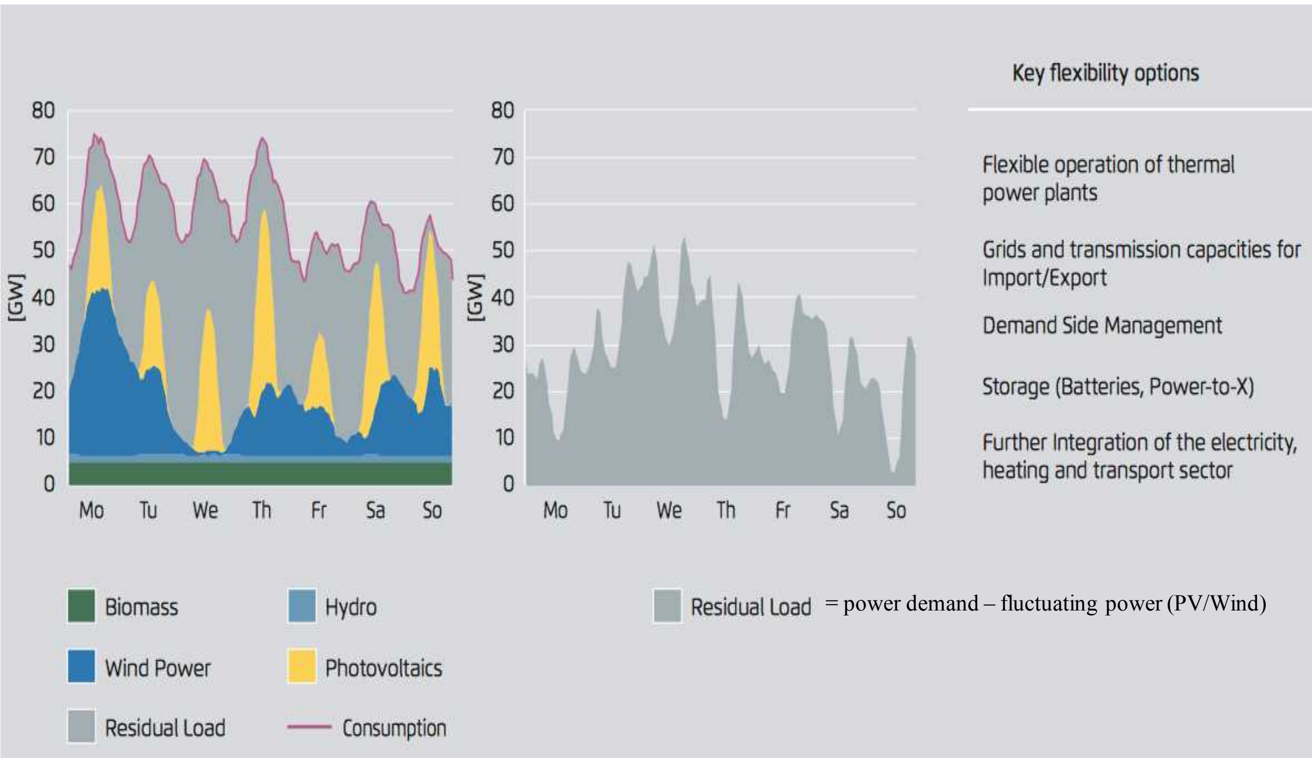
- Gas heat pumps

- Combined heat and power (different sizes)

Heating technologies-> interlinked with the power market
85% CO_2 - Reduction Scenario



Gross electricity generation and residual load in Germany
Simulated for one typical week in April 2022 with 50% renewables



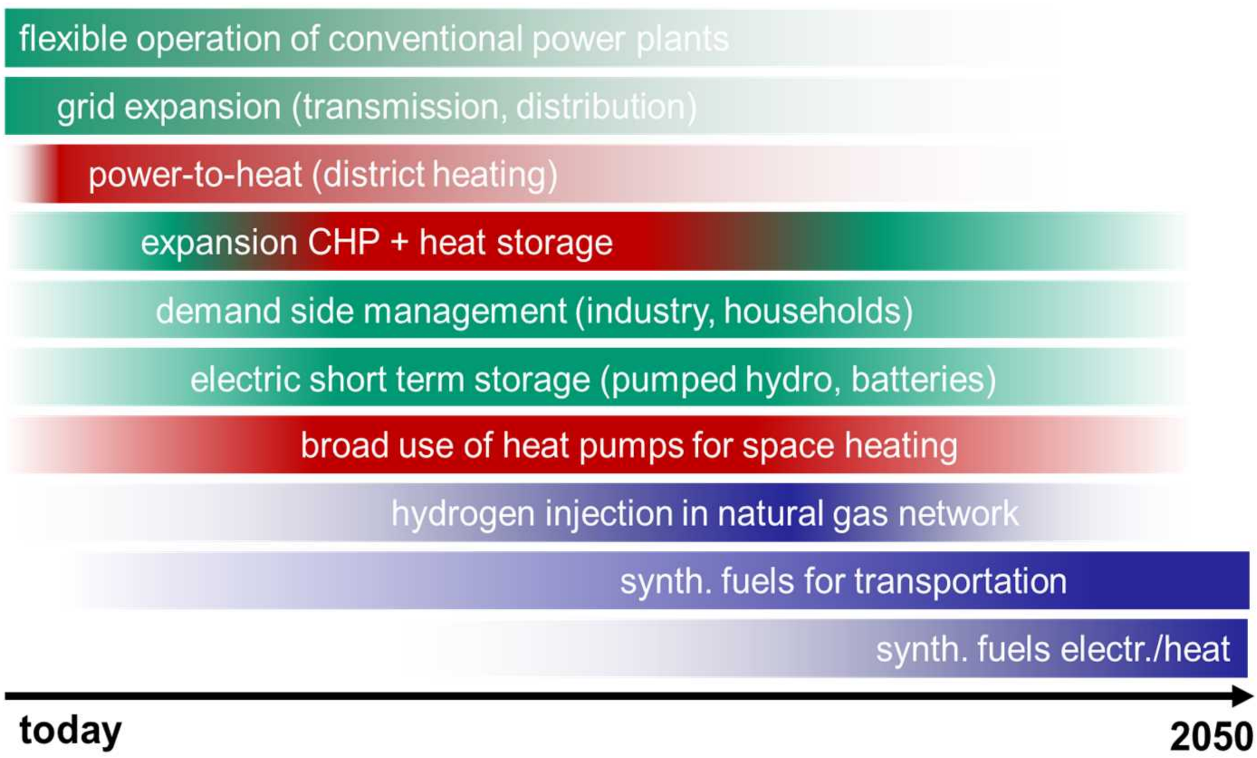
Source: Agora 2016

Connecting wind (north) and PV (south) by transmission lines
one cost-effective way to raise security of power supply

Monthly power production from PV and Wind in Germany (2012 and 2013)

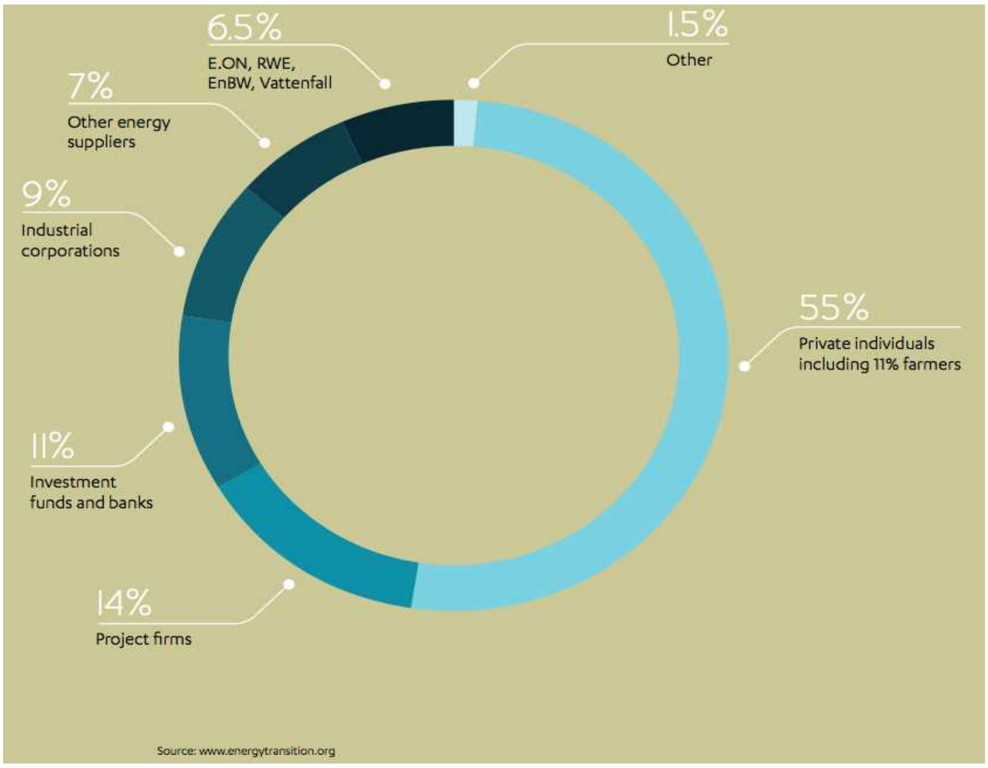
Quelle: Fraunhofer ISE (2015); Samadi 2016

Major flexibility options on the transition timeline to 2050
Enough potential to manage fluctuating power (PV; Wind) in Germany

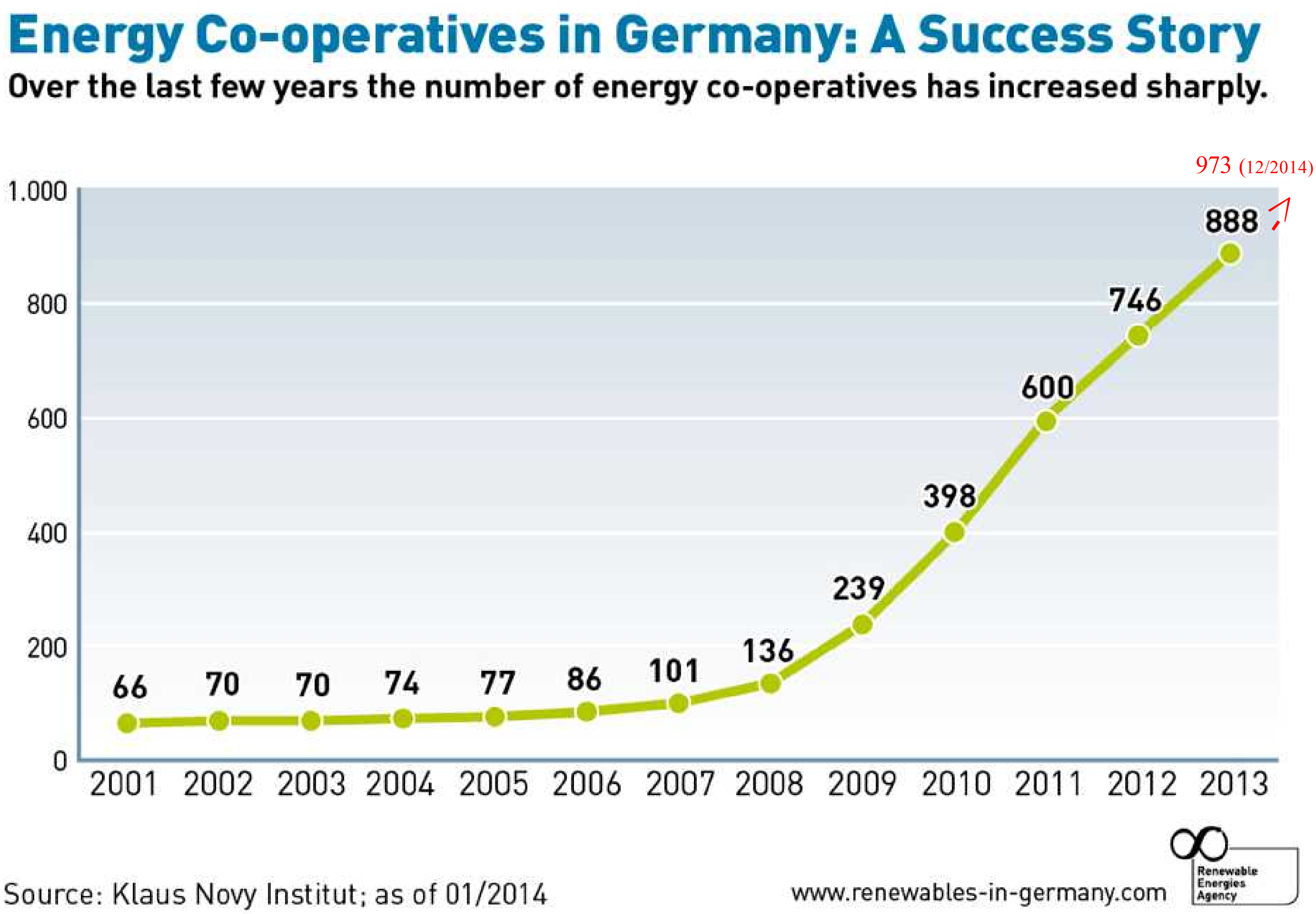


Source: Henning 2016

Decarbonisation technologies are dezentralized:
Ownership of installed renewable power capacities in Germany 2010



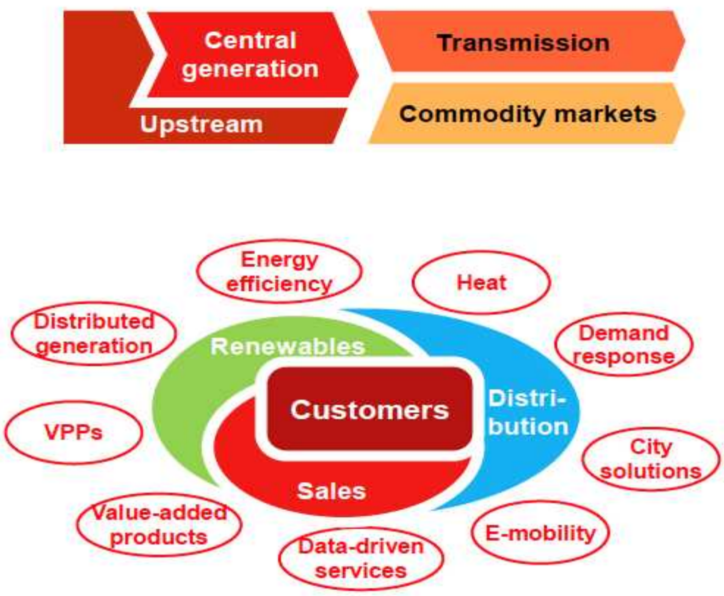
Source: Greenpeace International 2013



The split of E.ON : „A matter of survival“.

FR 12.3.2015: „Tottering giants. Billons of losses for RWE and E.ON“!

Two very different energy worlds emerging



Conventional energy world

- System-centric
- Security of supply
- Global/regional perspective
- Large scale, central
- Conventional technologies

New energy world

- Customer-centric
- Sustainability
- Local proximity
- Small scale, distributed
- Clean technologies

e·on

German-Japanese Energy Transition Council (GJETC)

on behalf of the German Federal Environmental Foundation (DBU)

Main results of feasibility study

- Stakeholder support in both countries
- Positive signals/decisions for funding
- Structure of the Council clarified
- Study and work program identified

Vorstudie zur Einrichtung eines „Deutsch-Japanischen Kooperationsrats zur Energiewende“

DBU-Az.: 32756/01-4

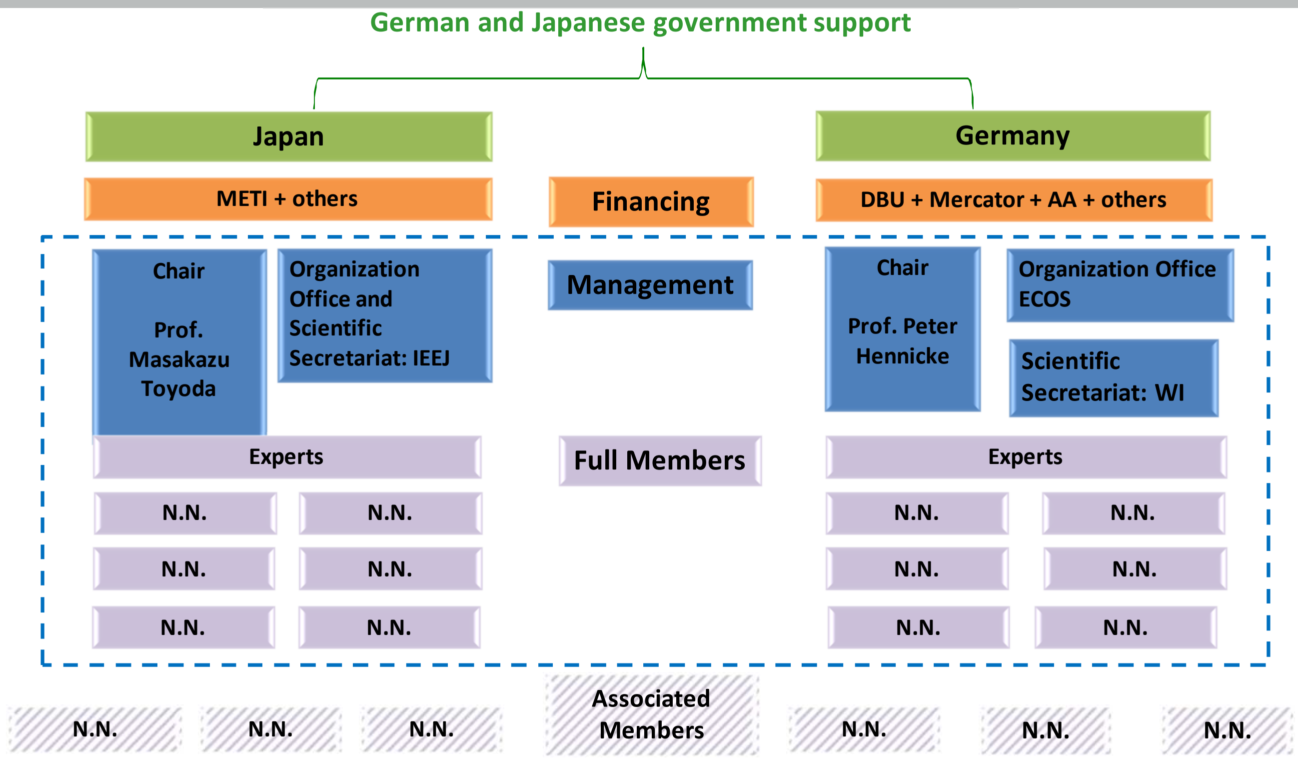
Prof. Dr. Peter Hennicke
Dr. Stefan Thomas
Dr. Dagmar Kiyar
Dorothea Hauptstock
Wilhelm Meemken
Johanna Schilling

Wuppertal und Osnabrück, 30.9.2015

Abschlussbericht

Structure of the Expert Council (GJETC)

First meeting in Tokyo 28./29. September 2016



Final conclusions

1. We need a new governance structure for „speeding up, scaling up and tightening up“ the energy system transition

2. International cooperation is key: Demonstrating a sussessful energy transition in Japan and Germany could be a global game changer

1. Identify and maximize the „Non climate benefits“: Ecological modernisation, longterm competitiveness, supply security, risk minimisation...

2. „Green technological progress“ required –> avoid path dependencies and lock-in effects -> learn from good practices

Thank you for your attention!

New publication:

The Energiewende
On the WI- website:
http://wupperinst.org/info/details/wi/a/s/ad/3319/