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Prof. Dr. Peter Hennicke

Possible longterm energy futures and impulses for the energy transition in Germany

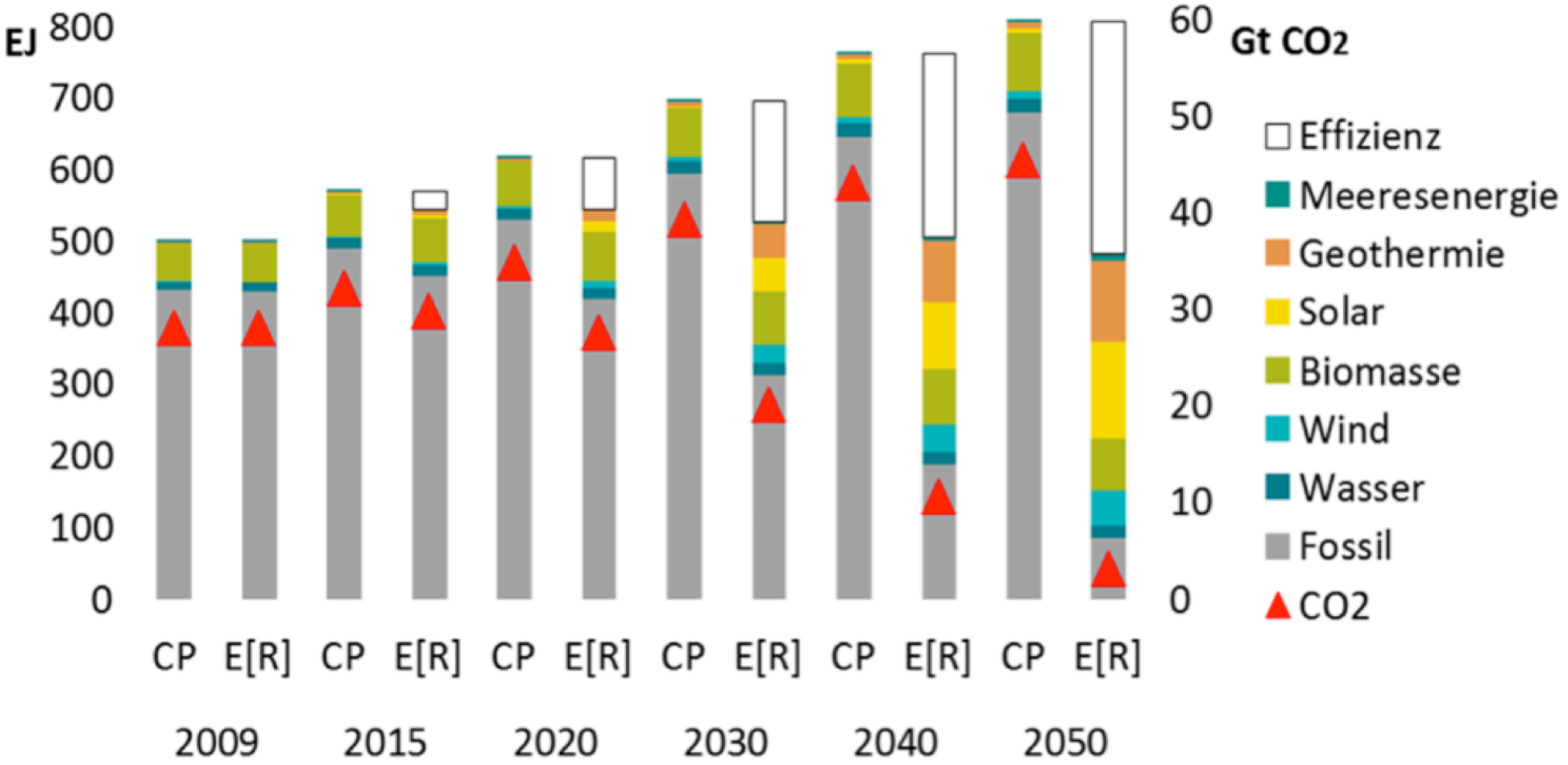
Impulse for the outreach session of the GJETC,

6th September, 2017

At IEEJ, Tokyo

Global pathway to zero emissions: Efficiency + Renewables

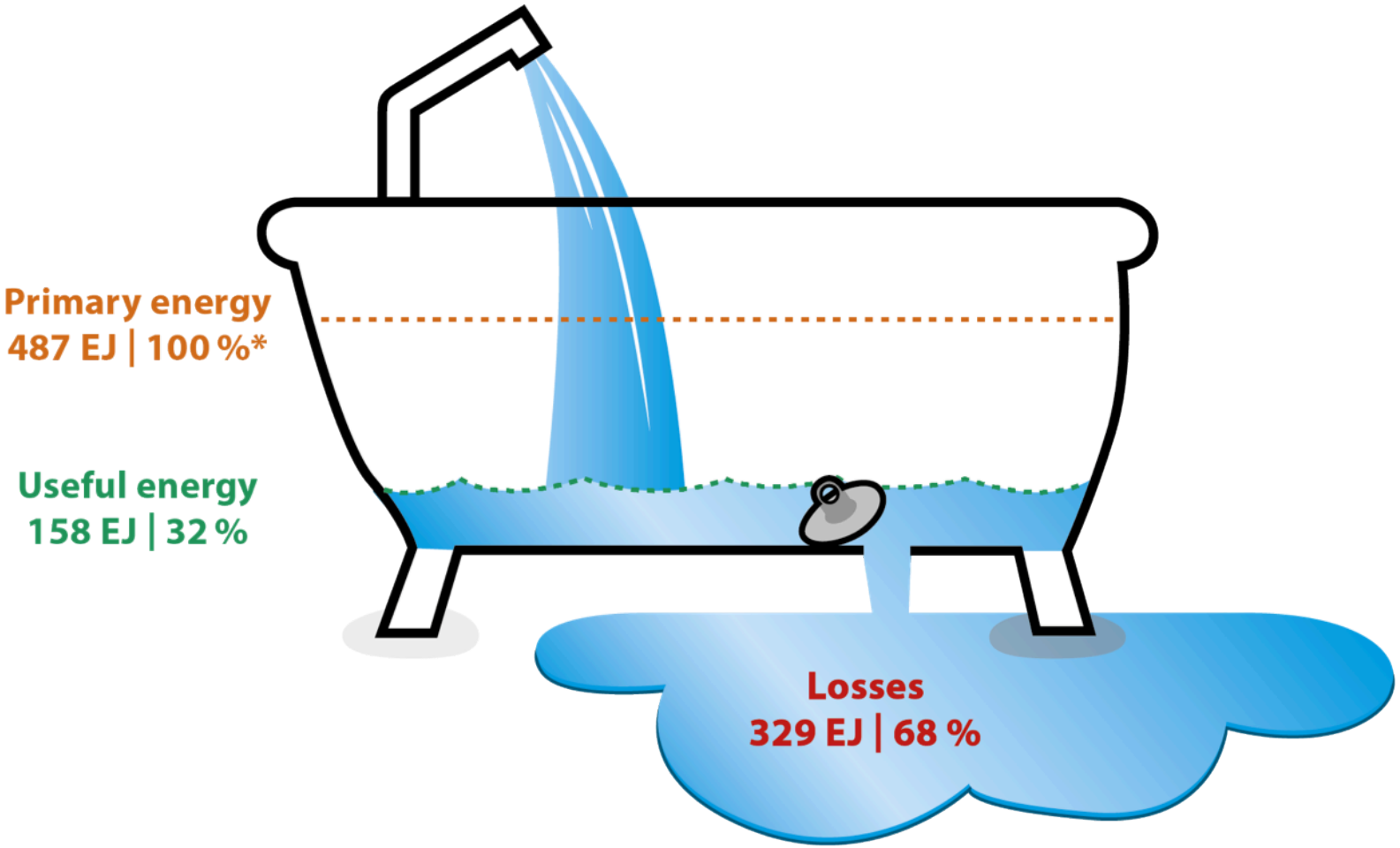
IEA Current Policy (CP) vs. Energy (r)evolution (E(R))



Source: DLR 2015

"Efficiency first" (IEA): Reduce losses of the global energy system….

…by the "energy efficiency revolution" and decentralized power

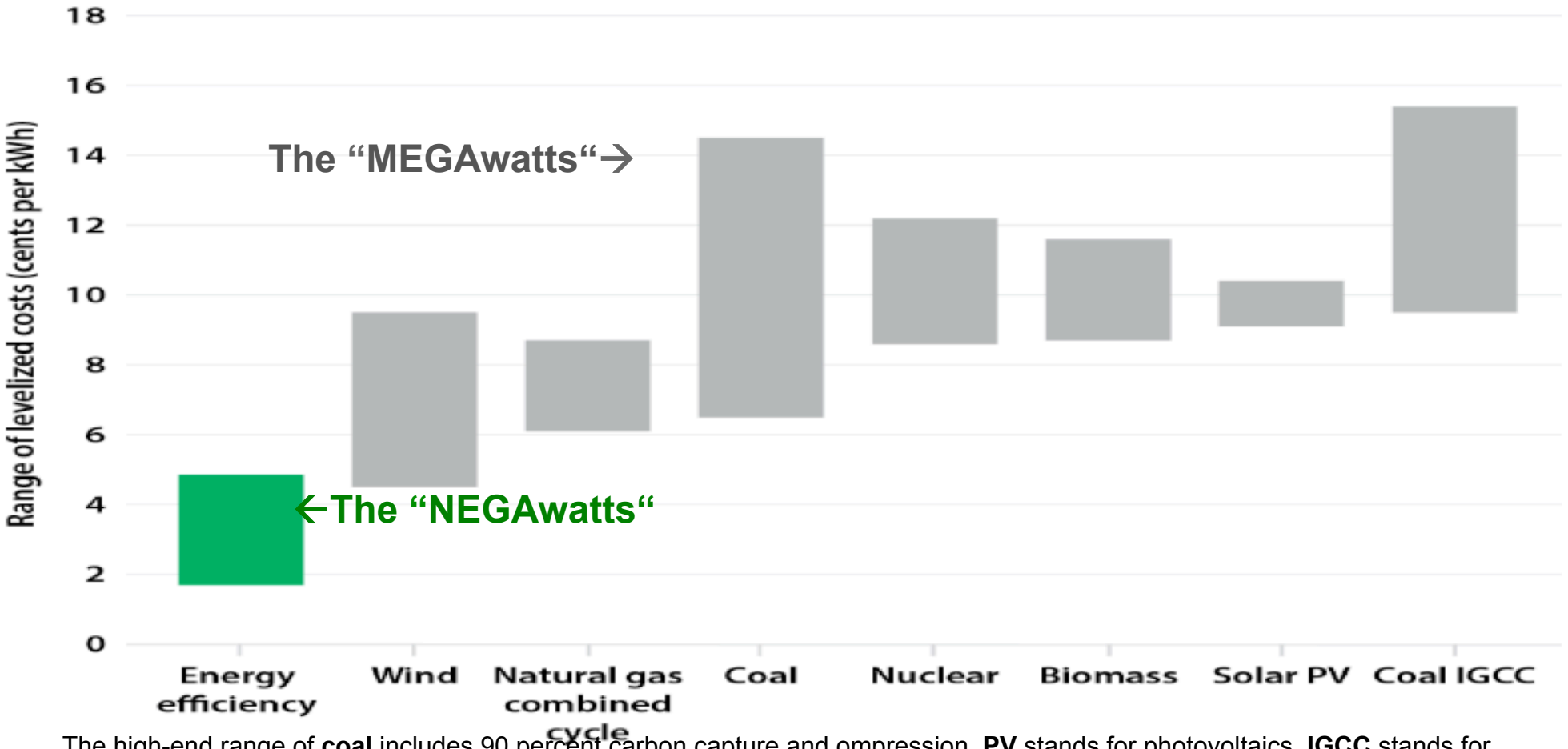


*Total primary Energy 519 EJ less 32 EJ non energetic consumption

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 costs of new power supply



The high-end range of **coal** includes 90 percent carbon capture and ompression. **PV** stands for photovoltaics. **IGCC** stands for integrated gesification 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.

Cost reductions of key technologies

for decentralized supply and use of energy

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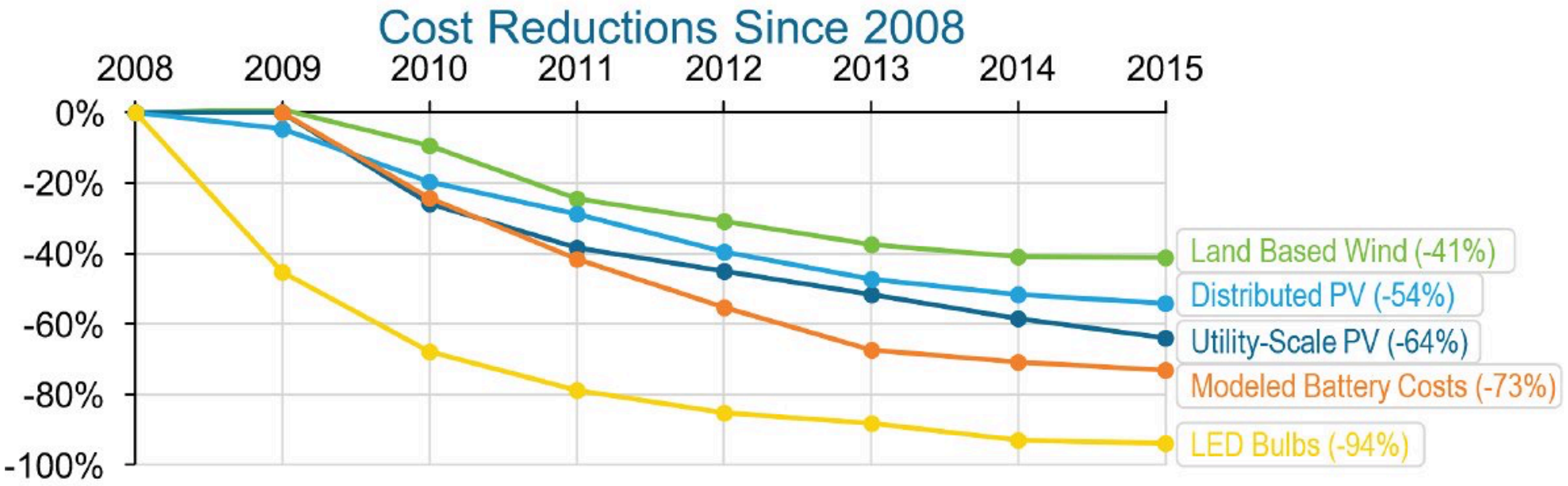

Notes: Land based wind costs derived from levelized cost of energy from representative wind sites from references [1] and [2]. Distributed PV is average residential installed cost from reference [3]. Utility-Scale PV is median installed cost for utility-scale PV systems from reference [4]. Modeled battery costs are at high-volume production of battery systems, derived from DOE/UIS Advanced Battery Consortium PHEV Battery development projects. LED bulbs are for A-type bulbs from reference [5].

Source: US Department of Energy 2016

“Revolutionary Targets” (Chancellor Merkel)

Energy Concept, Federal German Government, 09/2010

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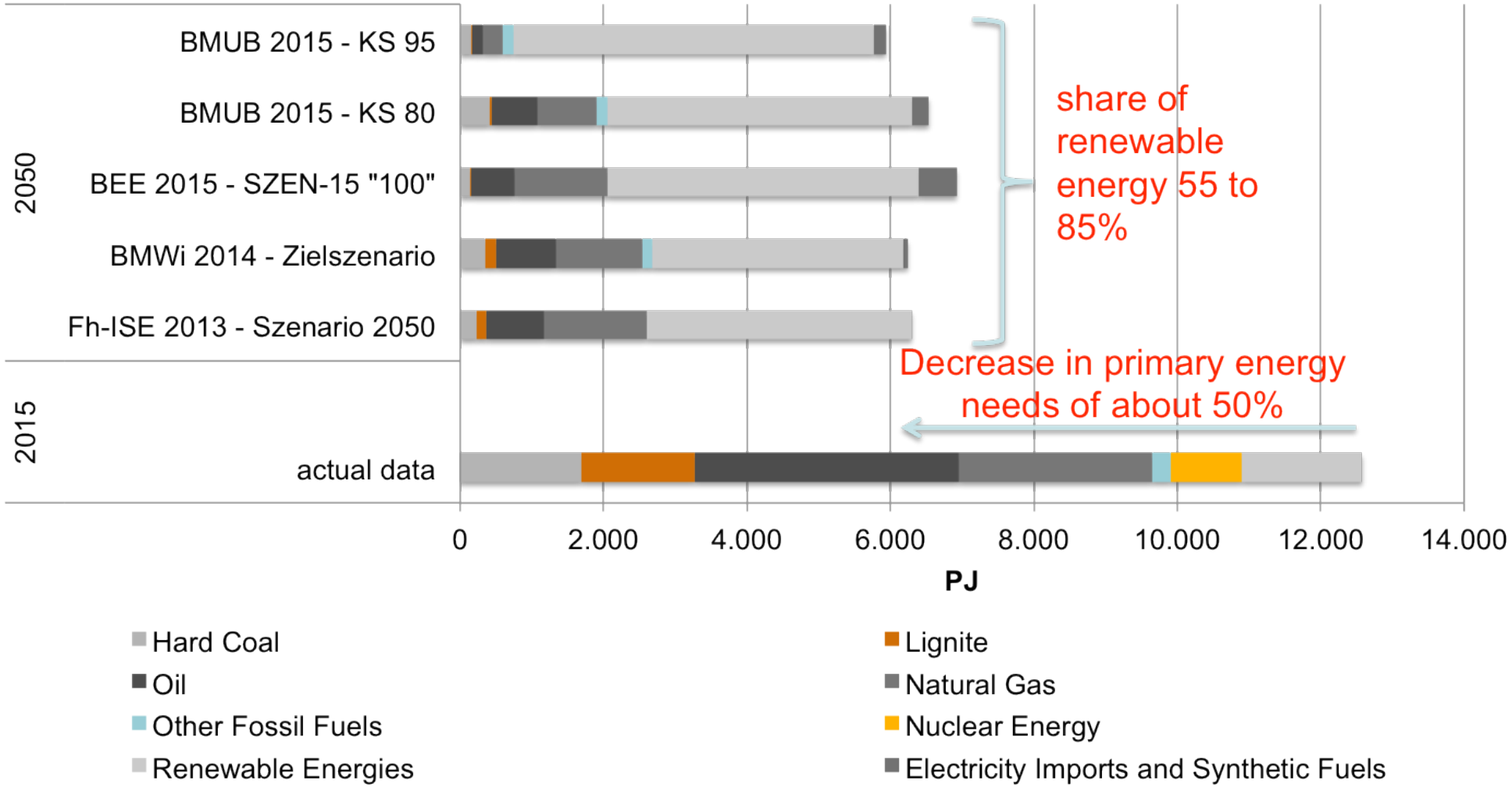
	2014	2015	2020	2030	2040	2050
Greenhouse gas emissions						
Greenhouse gas emissions (compared to 1990)	-27.7 %	-27.2 %	minimum -40 %	min -55 %	min -70 %	min -80 to 95 %
Increase in share of renewable energy in final energy consumption						
Share in gross final energy consumption	13.6 %	14.9 %	18 %	30 %	45 %	60 %
Share in gross power consumption	27.3 %	31.6 %	min 35 %	min 50 % (2025: 40-45 %)	min 65 % (2035: 55-60 %)	min 80 %
Share in heat consumption	12.5 %	13.2 %	14 %			
Share in transport sector	5.6 %	5.2 %	10 % (EU goal)			
Reduction of energy consumption and increase in energy efficiency						
Primary energy consumption (compared to 2008)	-8.3 %	-7.6 %	-20 %			-50 %
Final energy productivity	1.6 % per year (2008-2014)	1.3 % per year (2008-2015)	2.1 % per year (2008-2050)			
Gross electricity consumption (compared to 2008)	-4.2 %	-4 %	-10 %			-25 %
Primary energy demand buildings (compared to 2008)	-19.2 %	-15.9 %				around -80 %
Heat demand buildings (compared to 2008)	-14.7 %	-11.1 %	-20 %			
Final energy consumption transport (compared to 2005)	1.1 %	1.3 %	-10 %			-40 %

Research consensus in Germany:
The Energiewende is feasible and attractive!

→ absolute decoupling of GDP (quality of life) and energy is possible



Source: Particular scenario studies and AG Energiebilanzen 2015

Questions on different views in Germany and Japan:

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- Ambitious climate mitigation: cost or benefit for the economy?
- Costs of PV and wind power?
- More base load or more flexibility options?
- Perception of decentralisation and ownership?
- Potentials and policies on energy efficiency?
- Future role of incumbent power suppliers?
- Public acceptance of the energy transition?
- Perception of economic growth, lifestyles and sufficiency?

Additional investments in climate and resource protection –

A core strategy to foster innovations and green growth

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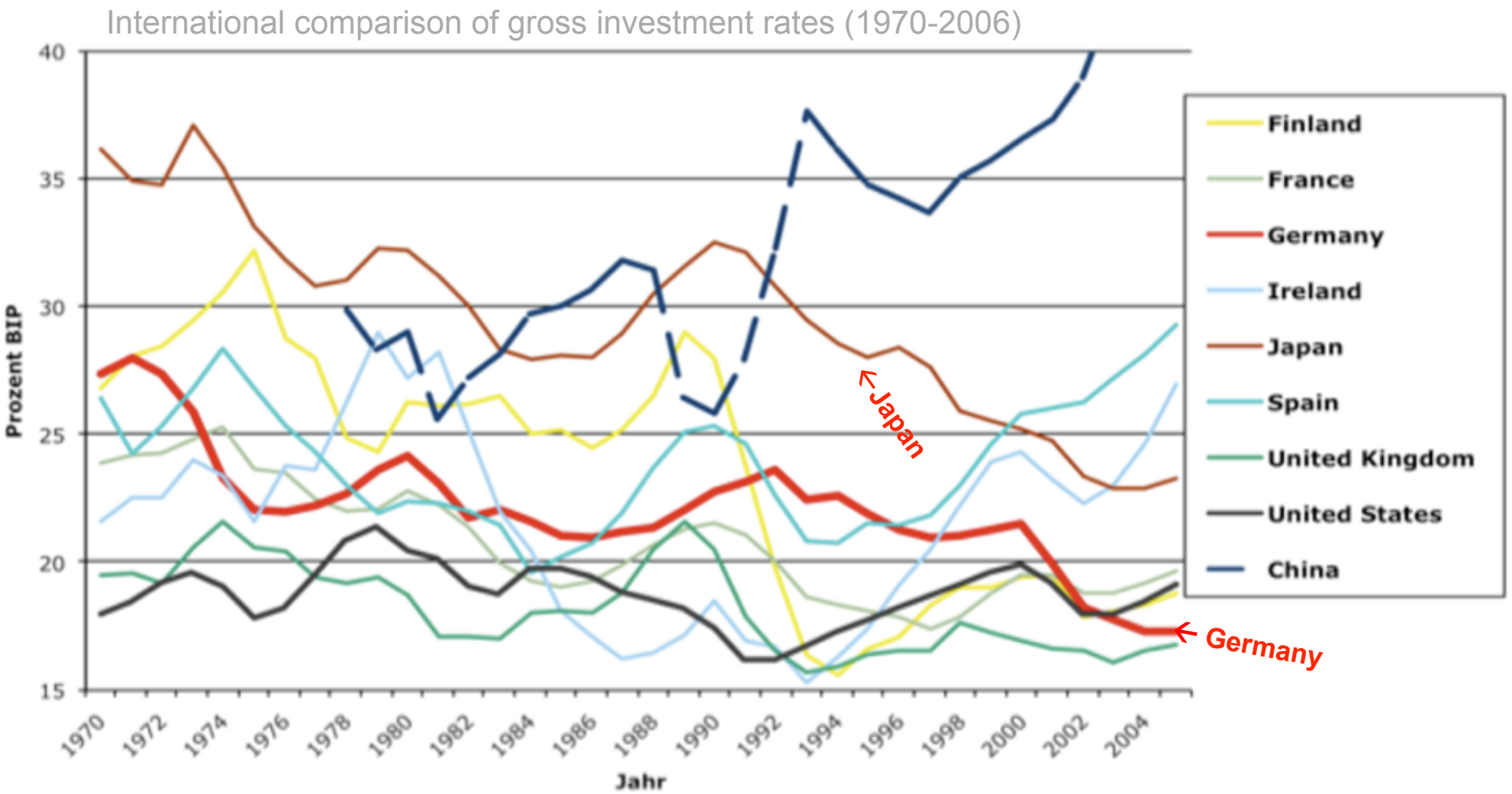

Source: C. Jäger, PIK, 2009.

Astonishing global differences of PV costs (2015)

= great cost reduction potential in Japan

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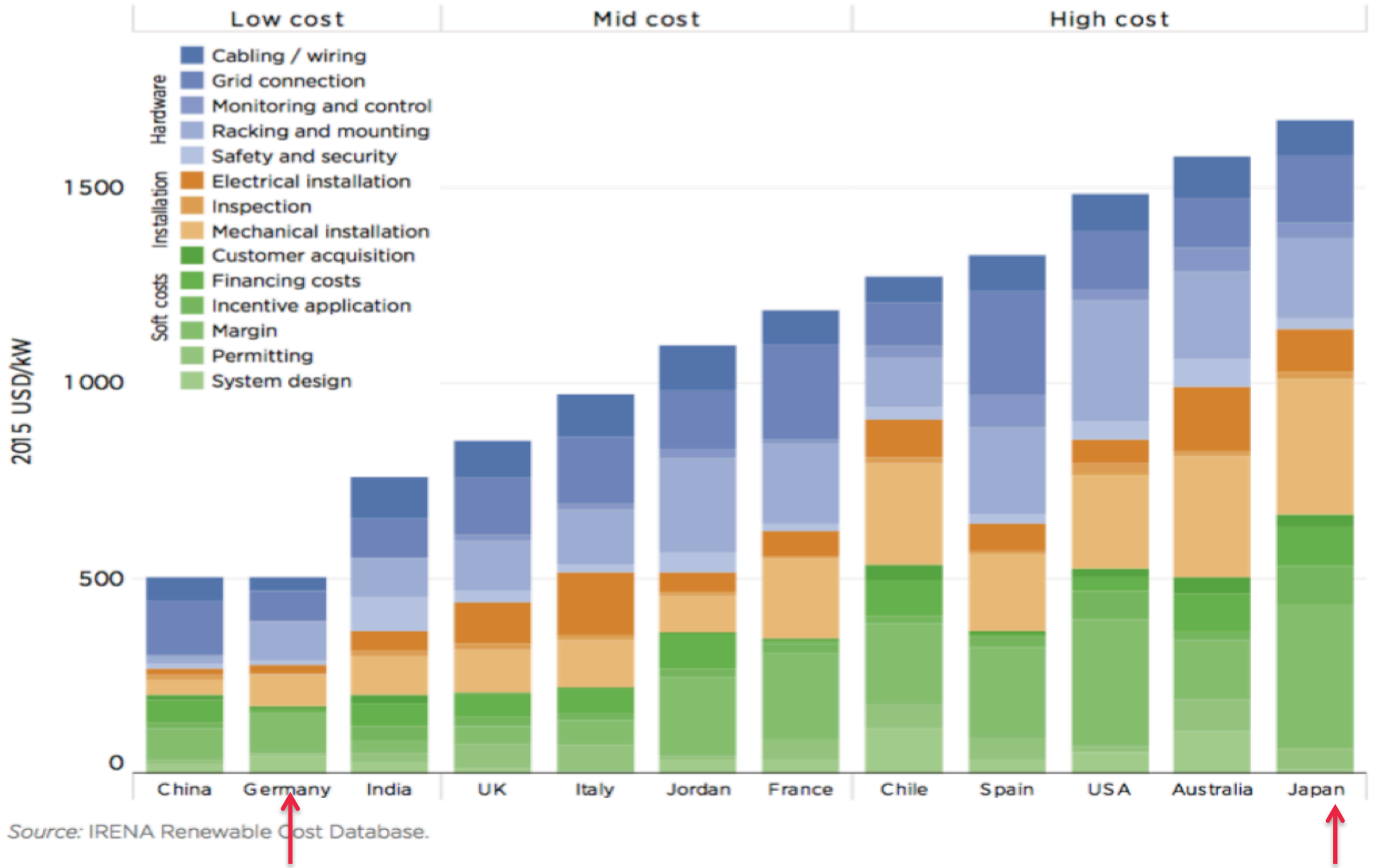

Source: IRENA 2016

Range of current green power costs in Germany

→ in comparison to new nuclear and coal/CCS (UK)

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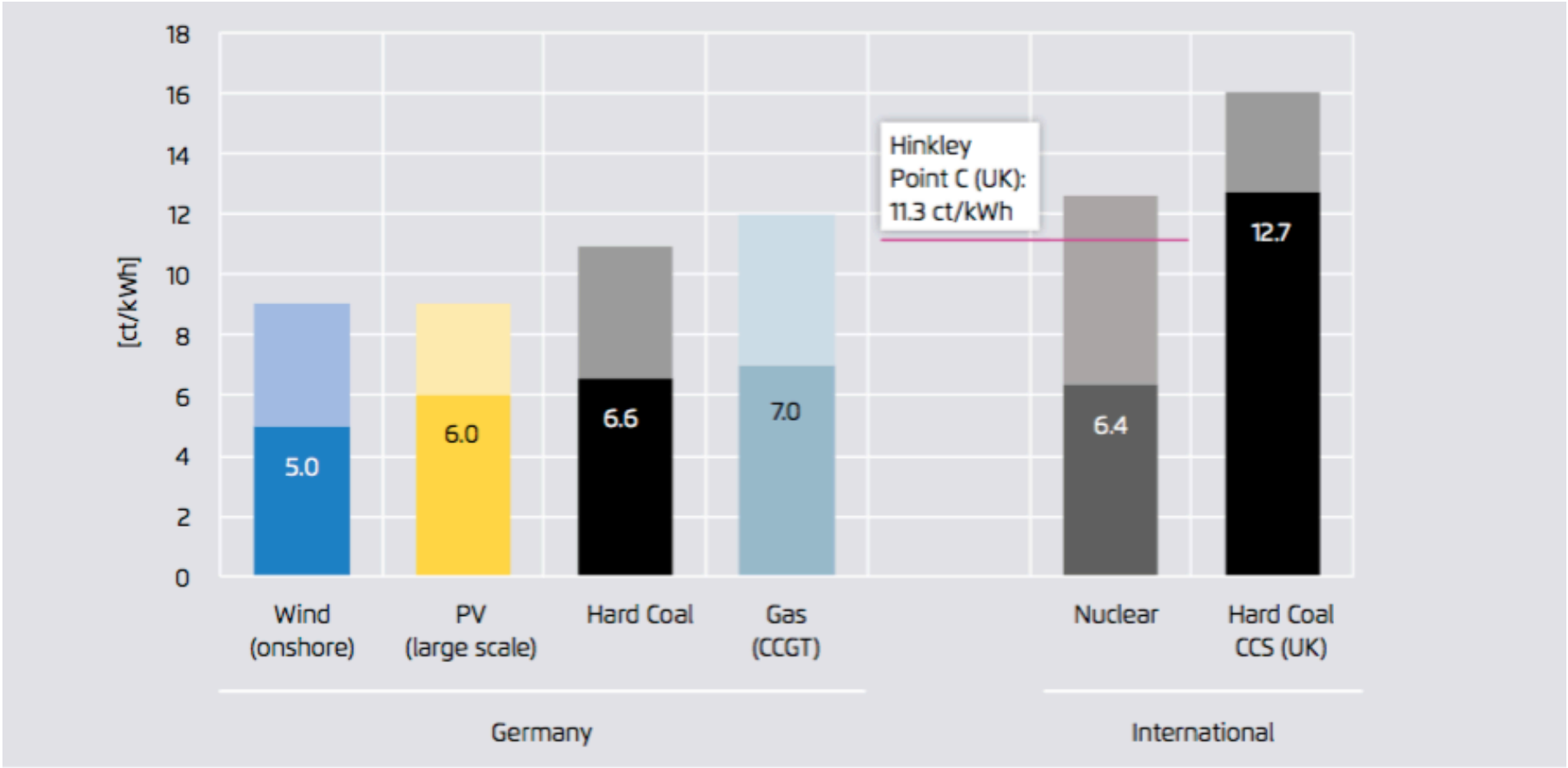

Agora Energiewende (2014), DECC (2013), enervis (2015), EDF, own calculations. The LCOE is a metric used to compare the generation costs (EUR/kWh) of different technologies, taking into account fixed and variable costs, as well as cost of capital (WACC). In general, feed-in tariffs are slightly higher than the LCOE, as energy producers usually include revenue margins in their calculations.

The challenge: Gross electricity generation and fluctuating residual load in Germany

Forget base load – raise flexibility for security of supply!

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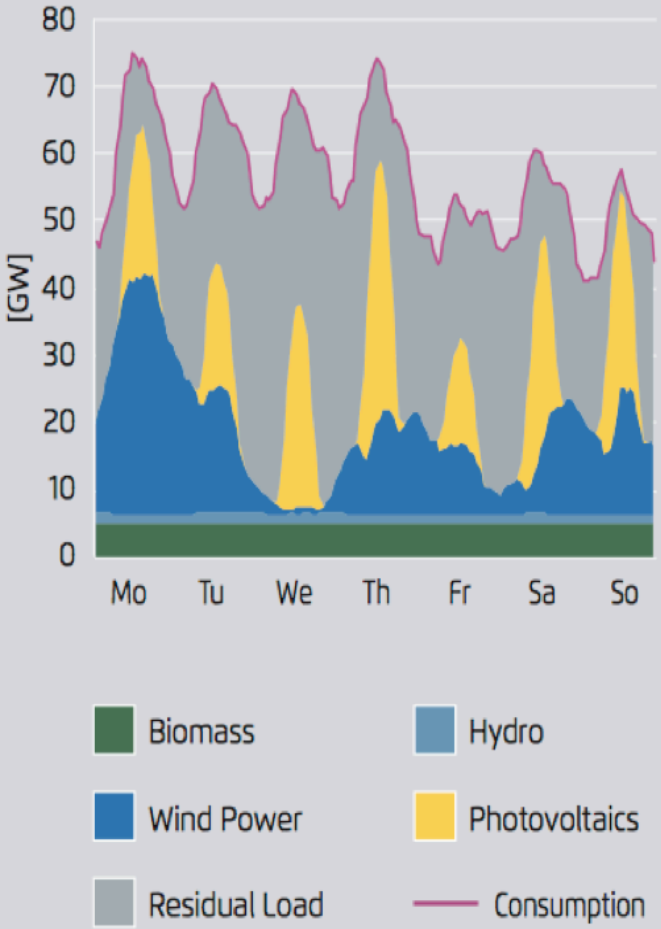
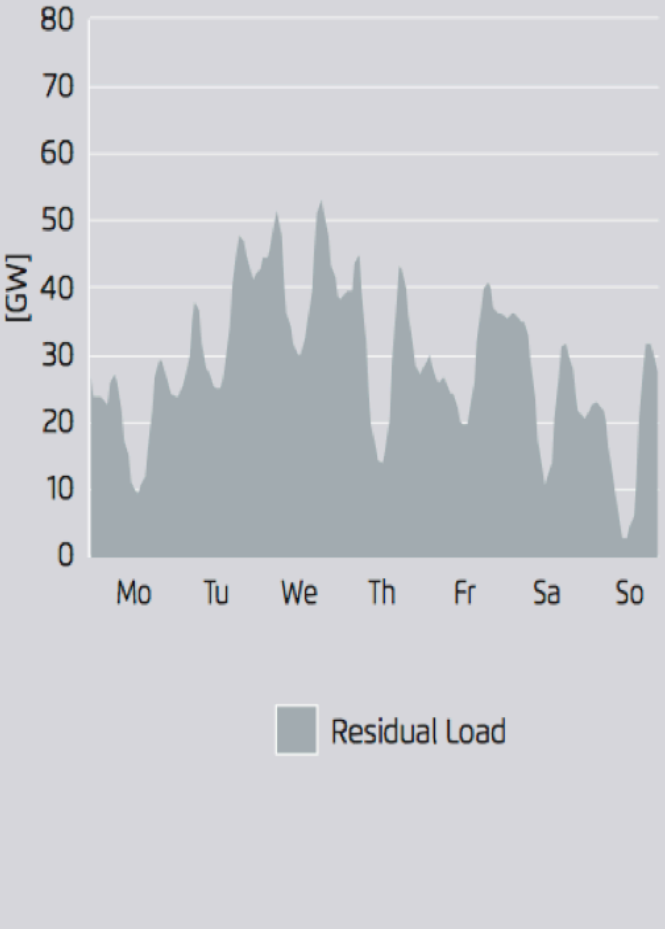
One typical week in April 2022 with 50% renewables:





Key flexibility options

- Flexible operation of thermal power plants
- Grids and transmission capacities for Import/Export
- Demand Side Management
- Storage (Batteries, Power-to-X)
- Further Integration of the electricity, heating and transport sector

Source: Agora 2016

Decarbonization technologies are decentralized:

Ownership of installed renewables power in Germany 2010

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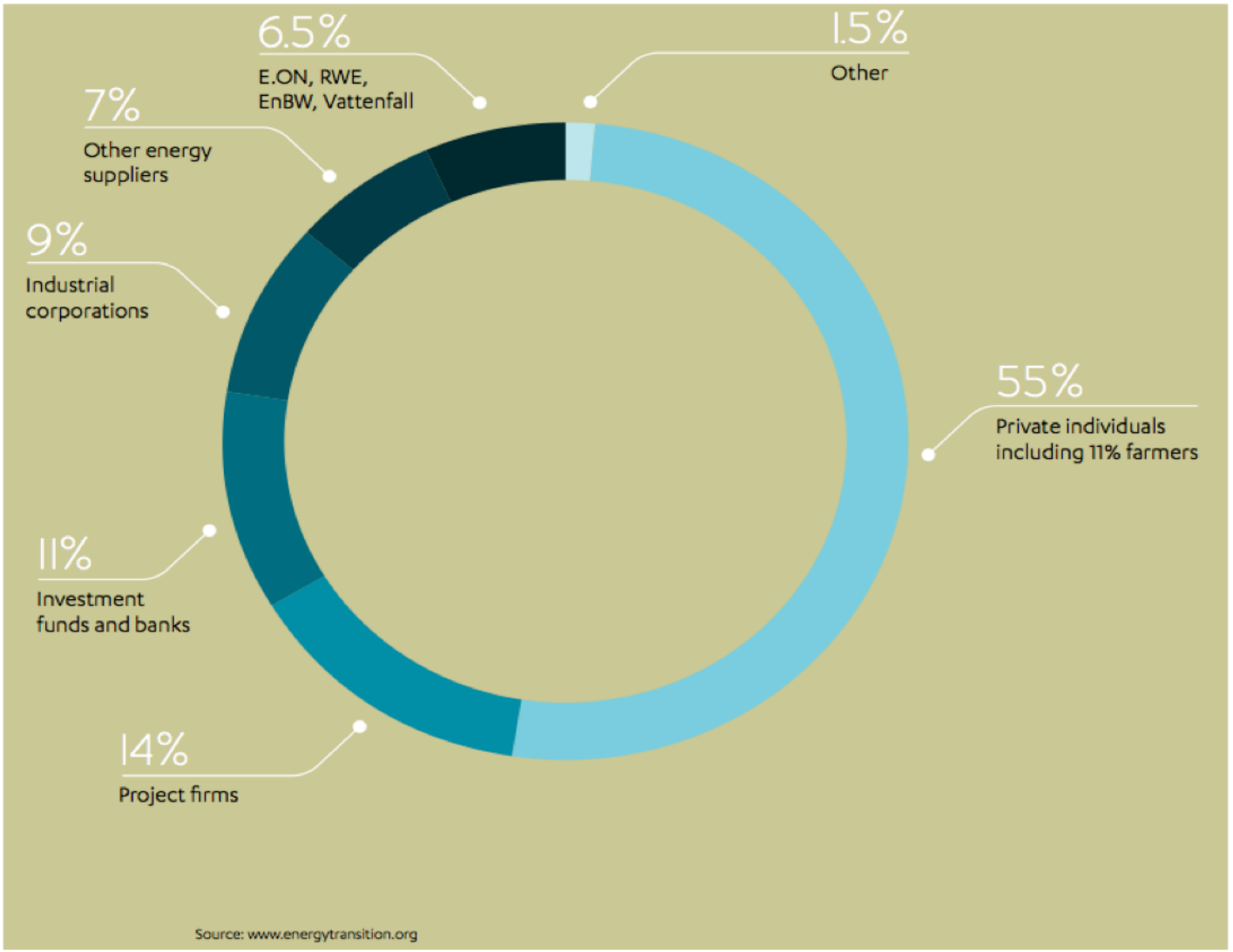

Source: Greenpeace International 2013

Citizen financed energy cooperatives

Status and development of an unexpected surprise!

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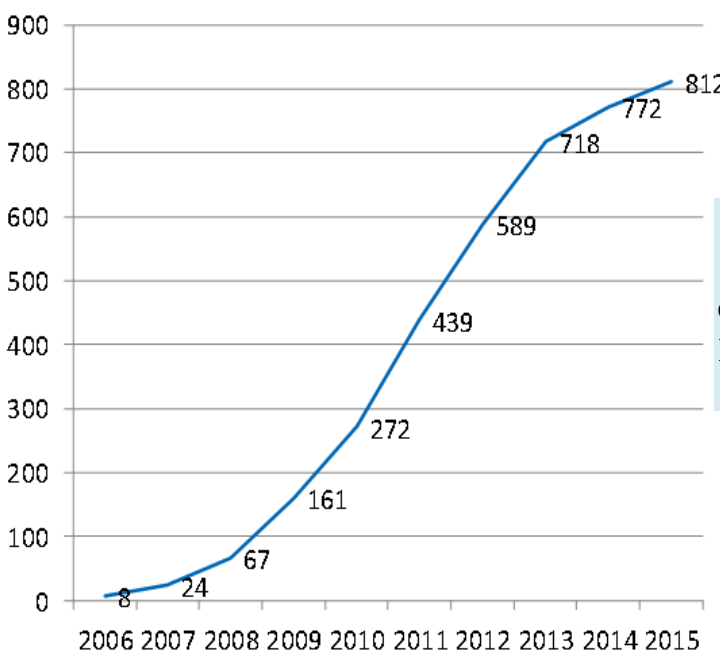
- **Overall: 812 cooperatives have been founded since 2006**
  - with 165 000 citizens
  - 655 million Euro member‘s capital
  - 1,8 billion investments in renewable energies



Foundations of energy cooperatives in the DGRV, cumulated, since 2006

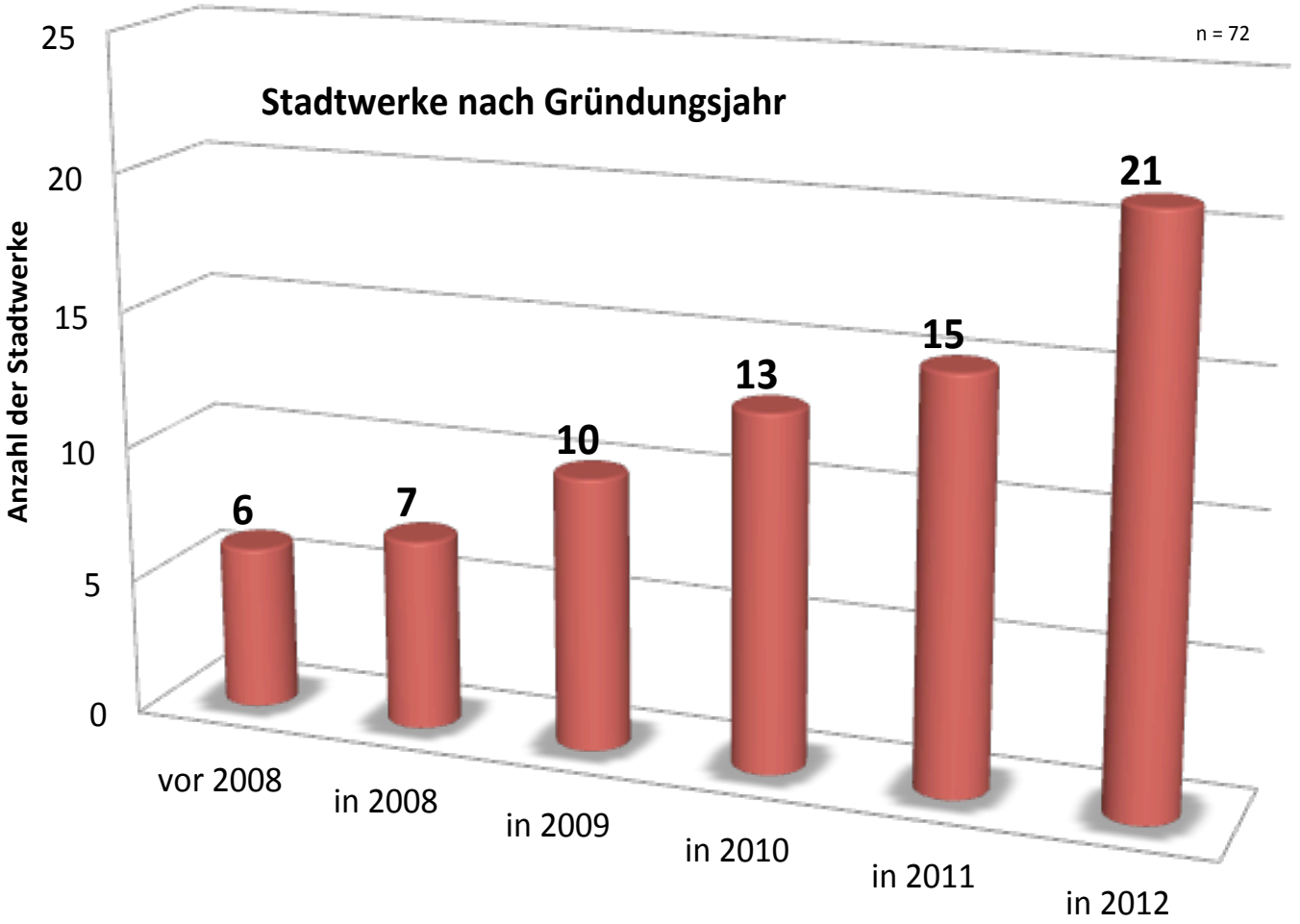
- **Survey 2015: Slower development due to EEG-reform**
  - In 2015 40 energy cooperatives have been founded. With that decreases the number of newly established cooperatives by 25% compared to the previous year.
  - Reasons: “Economic limits for new photovoltaic projects (…) with the introduction of a tendering procedure a further impediment for “citizen-produced energy” has been established” (Press release, DGRV annual survey 2015)

Source: Results of the DGRV annual survey 31.12.2015

“Stadtwerke”- 72 new foundations (2005-2012)

Total amount in Germany: more than 1000!

- Trend towards a continuous foundation of municipal energy suppliers? („Stadtwerke“):
- Between 2005 and 2012 72 municipal energy suppliers have been established



Source: Stadtwerke-Neugründungen und Rekommunalisierungen, Energieversorgung in kommunaler Verantwortung; Kurt Berlo, Oliver Wagner; 2013

Ranking list of new electricity providers (PPS)

by sales volumes in the household segment (April-Nov. 2016)

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	Sales volume	Share under PPS	Sector / Category
Tokyo Gas	1.057.522 MWh	31,8%	Gas
Osaka Gas	441.092 MWh	13,3%	Gas
KDDI	299.796 MWh	9,0%	Mobile communication
JX Energy	271.114 MWh	8,2%	Oil
Saisan	101.485 MWh	3,1%	Gas
Tokyu Power Supply	89.090 MWh	2,7%	Railway company
K-opticom	72.872 MWh	2,2%	Subsidiary company of Kansai EPCO
J:COM West	71.515 MWh	2,2%	Cable television
Tonen General Sekiyu	55.697 MWh	1,7%	Oil
SB Power (Softbank)	50.139 MWh	1,5%	Mobile communication
Restliche Stromanbieter	812.680 MWh	~24,5%	-

Source: Eigene Darstellung von Robin Goeßmann; Die Liberalisierung des japanischen Strommarktes nach dem Atomunfall von Fukushima/ Hintergründe, Auswirkungen/ Rahmenbedingungen; Masterarbeit 2017; Daten entnommen aus: METI (2017b: Internet)

„After the Fukushima Daiichi nuclear disaster, nearly **800 PPS** companies filed documentation required by law, but only 135 have actually supplied any electricity, and they held only about 9 percent of the market share at the end of fiscal 2015 (i.e., March 31, 2016)“.
Source: Japan For Sustainability”, No. 171, Nov. 2016); PPS = Power producer and supplier

“Life punishes those who come to late”
(Mikhail Gorbachev)

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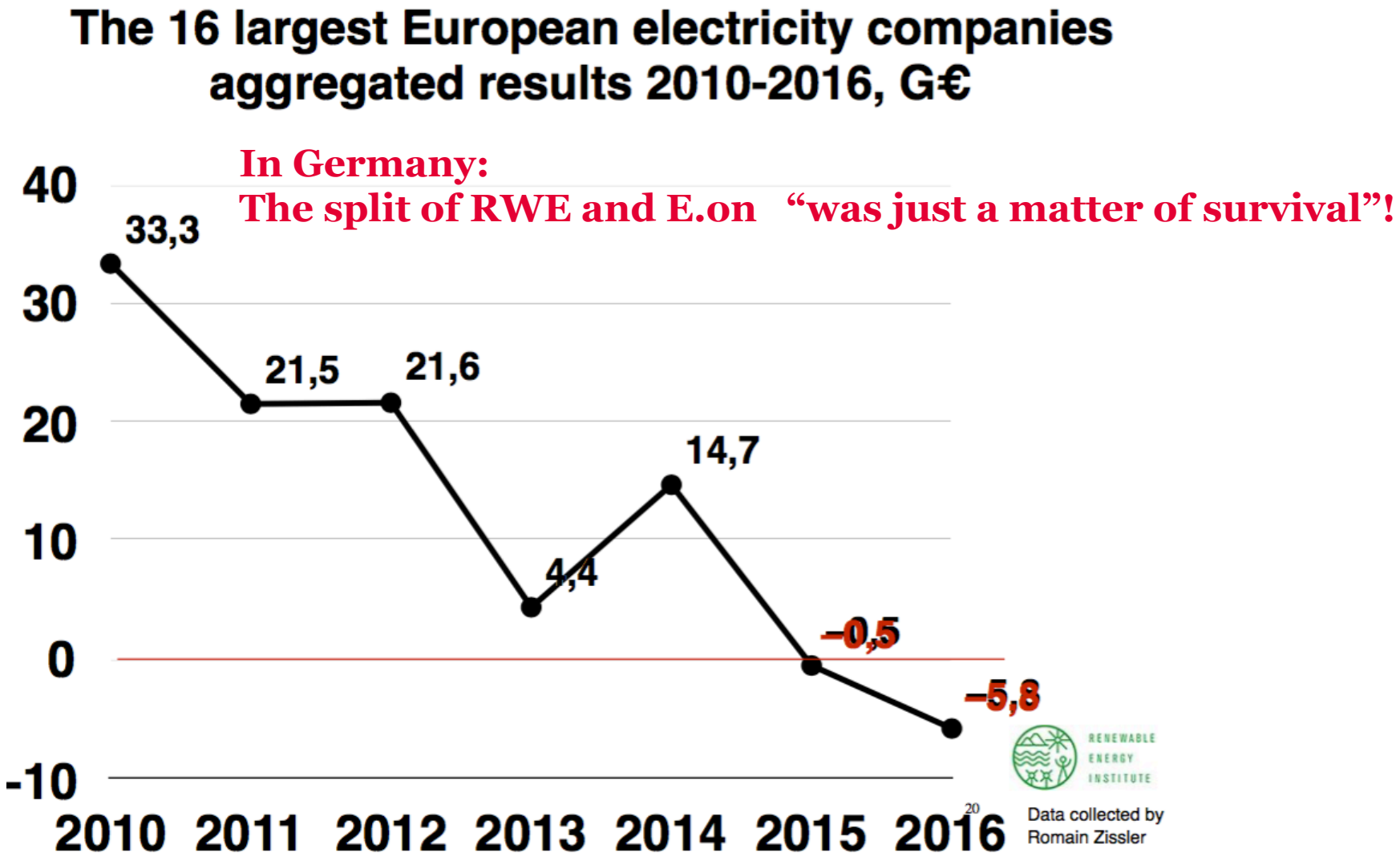
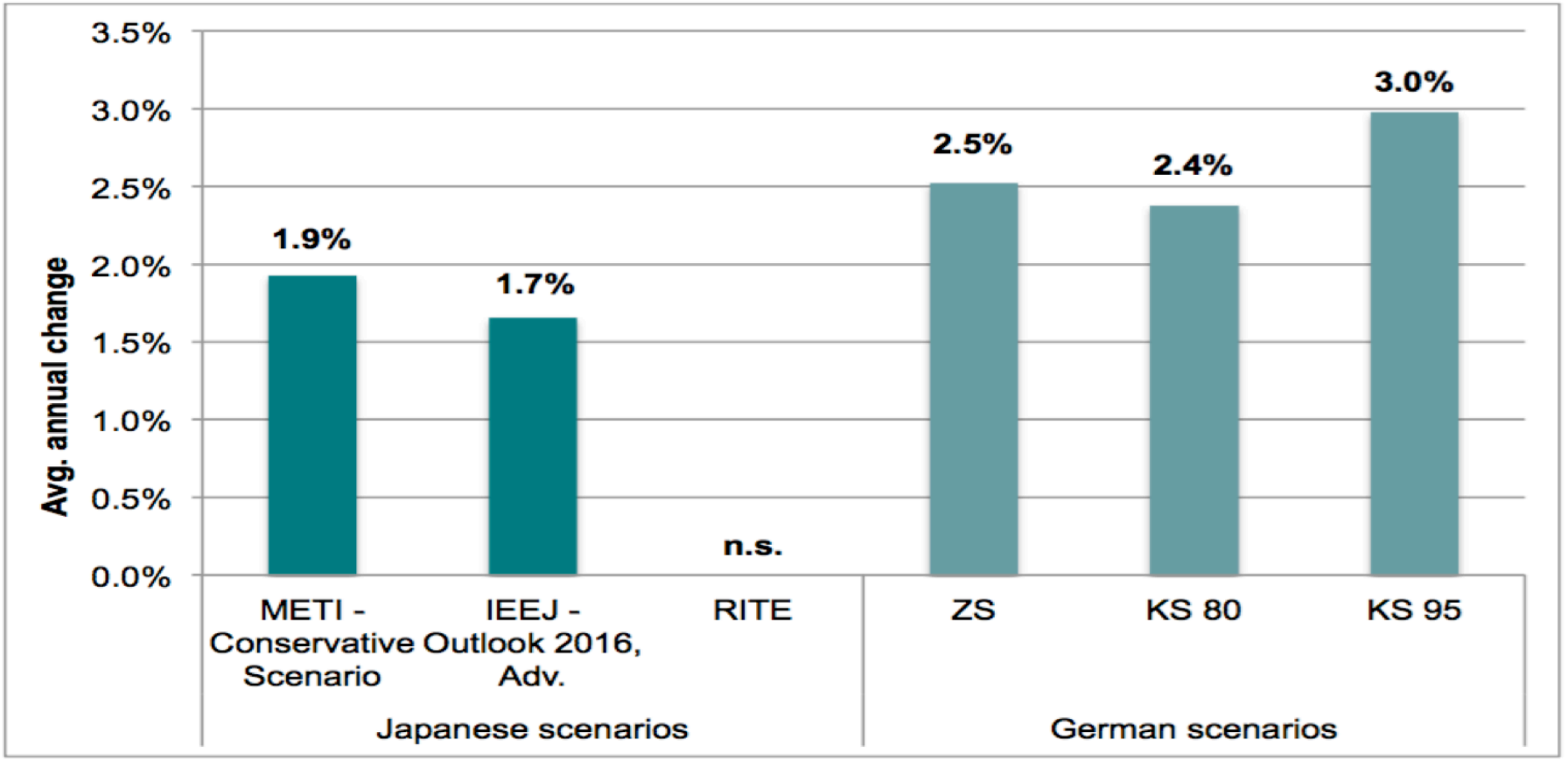


Different potentials for the increase of energy productivity?

(2010-2013) in selected scenarios for Japan and Germany



Sources: Own figure and calculations based on the data found in the cited scenarios and studies.

Source: GJETC (ed.): Energy transition as a central building block of future industrial policy, 2017.

State of the art: Buildings as power plants

"Plus-energy-houses" in Freiburg/Germany

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

Public opinion about the Energiewende

90%: important! But 50%: proceeds not well!

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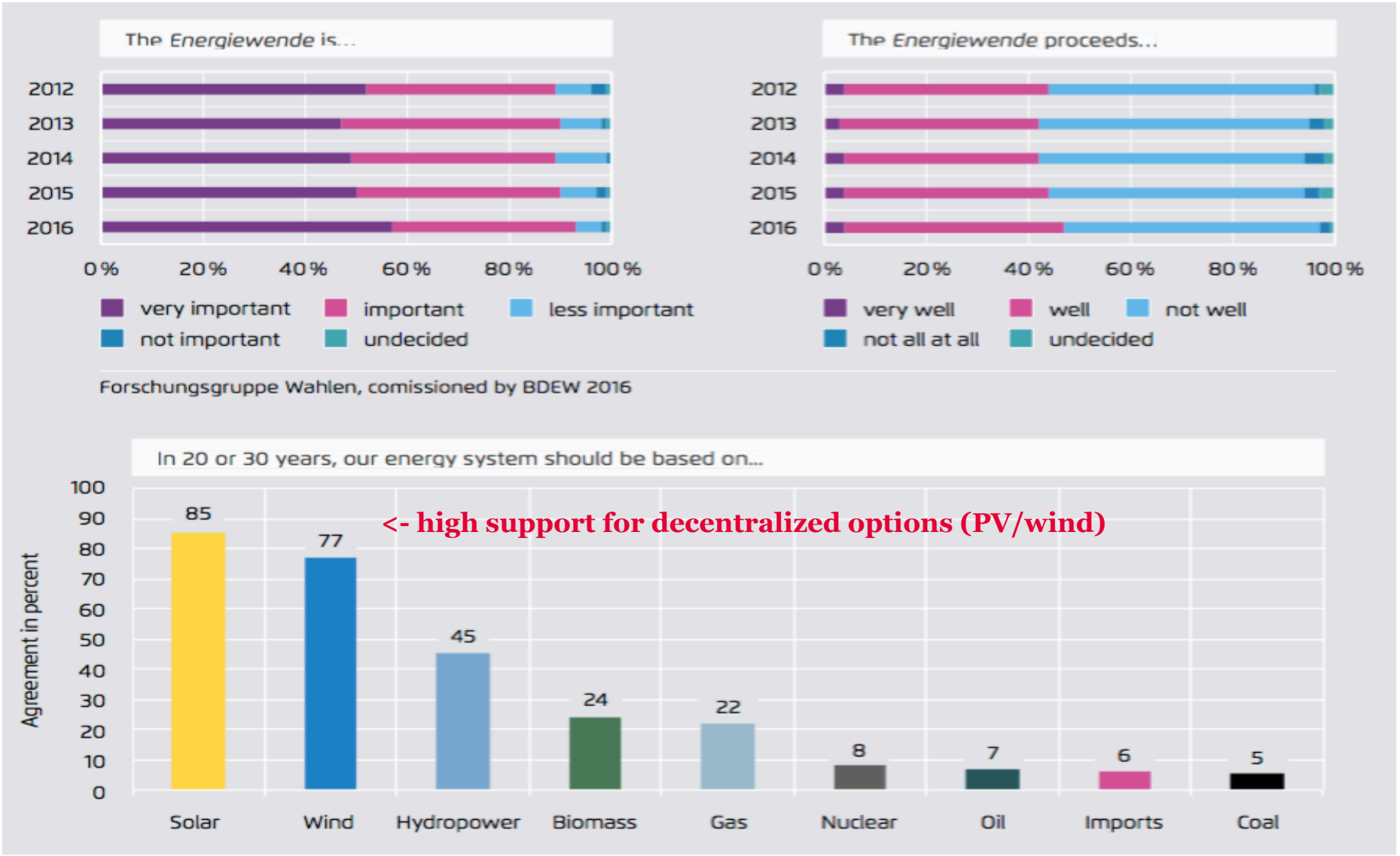

Average electricity prices

→ expensive: households/SME – cheap: industry

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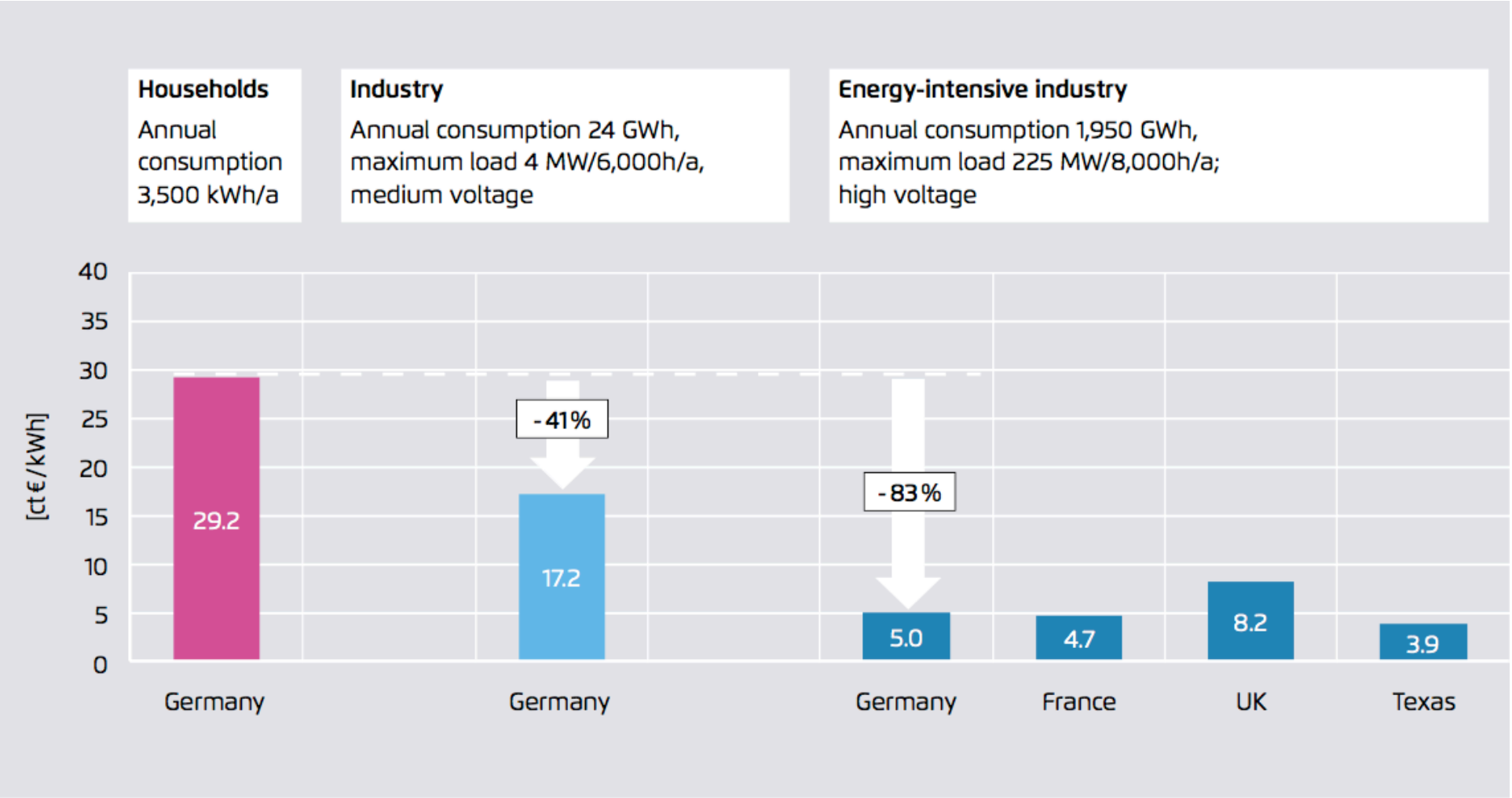

BNetzA (2014), Ecofys/ISI (2014)

Electricity prices and consumption

- higher prices can be compensated by more efficient use!

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	Annual household consumption in kWh	Electricity price in EURct/kWh	Annual electricity bill in EUR
Denmark	3,820	29.4	1,121
US	12,294	9.0	1,110
Germany ←	3,362	29.1	978
Japan ←	5,373	18.1	971
Spain	4,038	22.6	912
Canada	11,303	7.5	851
France	5,830	14.3	834
UK	4,143	17.3	717
Italy	2,485	23.3	580
Poland	1,935	15.1	291

Enerdata (2015), World Energy Council (2015), own calculations

* consumption data from 2013; electricity prices data from 2014

Growing GDP – constant life satisfaction!

A challenge for Germany and most OECD countries as well!

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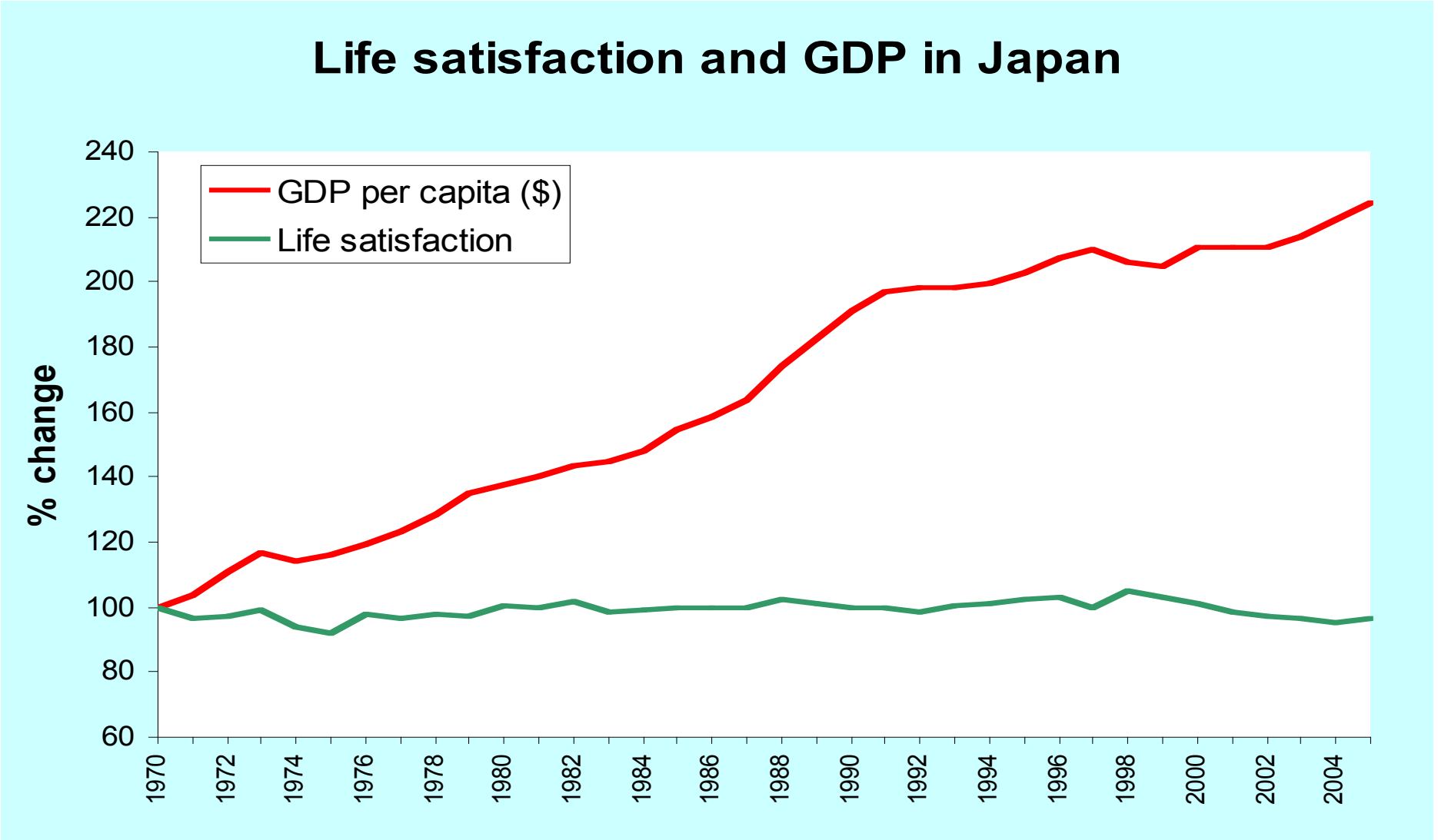

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Thank you for your attention!

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Available under www.wupperinst.org/info/details/wi/a/ad/3319/

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