Wuppertal Institute
for Climate, Environment
and Energy

Phasing out nuclear energy and mitigating climate change – how Germany evaluates the chances to achieve both

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Wuppertal Institute

Presentation at the
International Energy Programm Evaluation Conference (IEPEC)
in Rome, 12 June 2012

Thesis

The Challenge: Decoupling well being from the use of nature by fostering resource efficiency

- Limited „relative“ decoupling in the past, „absolute“ decoupling is necessary in the future
- Decoupling depends on “Lead markets for GreenTech”, energy efficiency being the greatest
- “Lock in” effects must be avoided by ambitious targets for “efficiency + renewables”

The “Energiewende”: Germany on the way to sustainable energy?

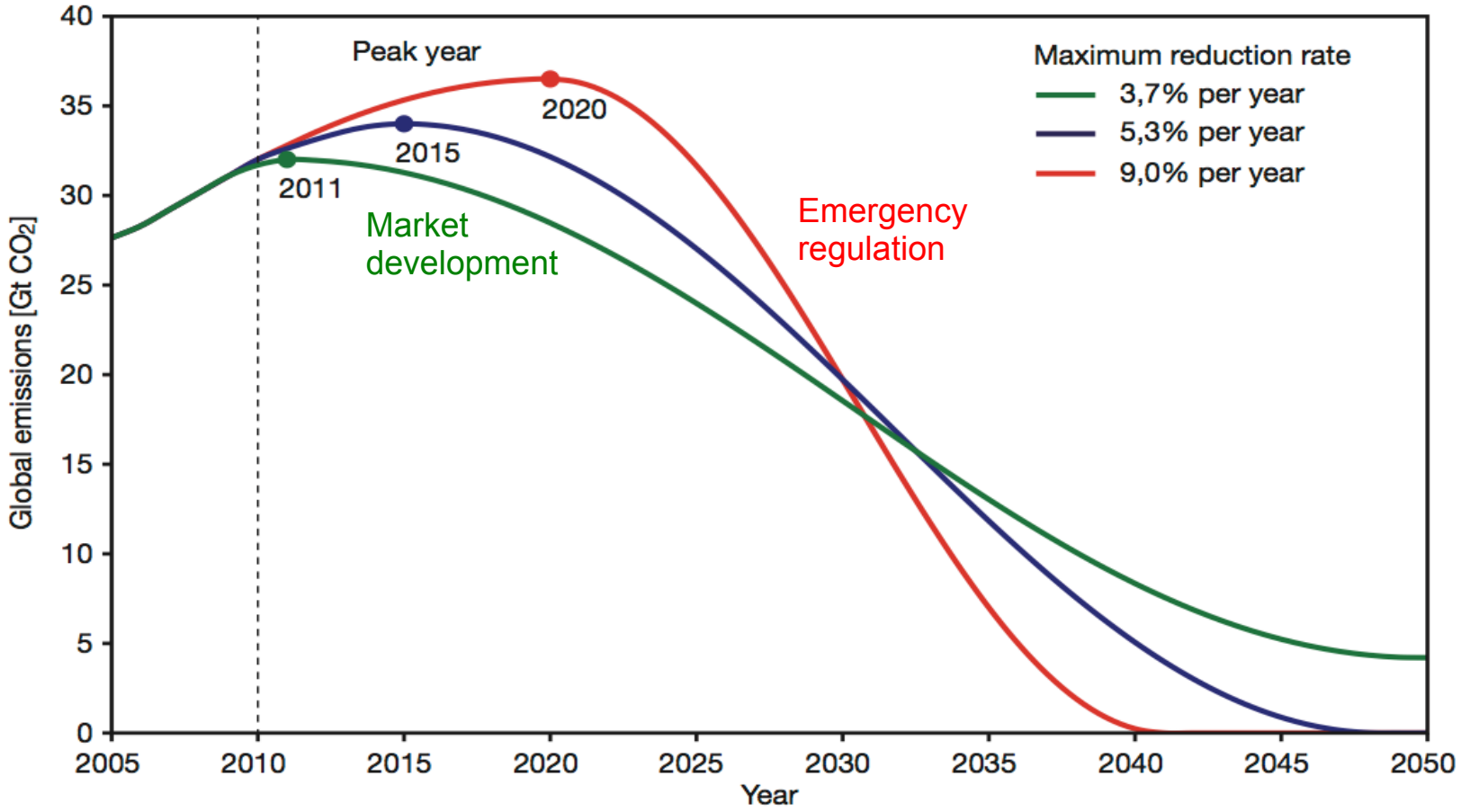
- Very ambitious government targets for 2020/ 2050 based on expert consensus
- Pioneering work for systems/grid integration of solar and wind needed
- Social acceptance depends on costs distribution (sectors; time scale)
- Renewables on track, but efficiency is lacking behind
- New supportive framework for the „resource efficiency revolution“ necessary

The “Great Transformation”: Is decoupling possible? Which life style changes are needed?

- Too much efficiency gains are “eaten up” by rebound effects and consumerism
- A global dialog on “New models of wealth” is needed

We are running out of time!

If GHG-emissions don‘t peak soon
an emergency program will be necessary to stay below the 2°-goal



Source: WBGU 2010

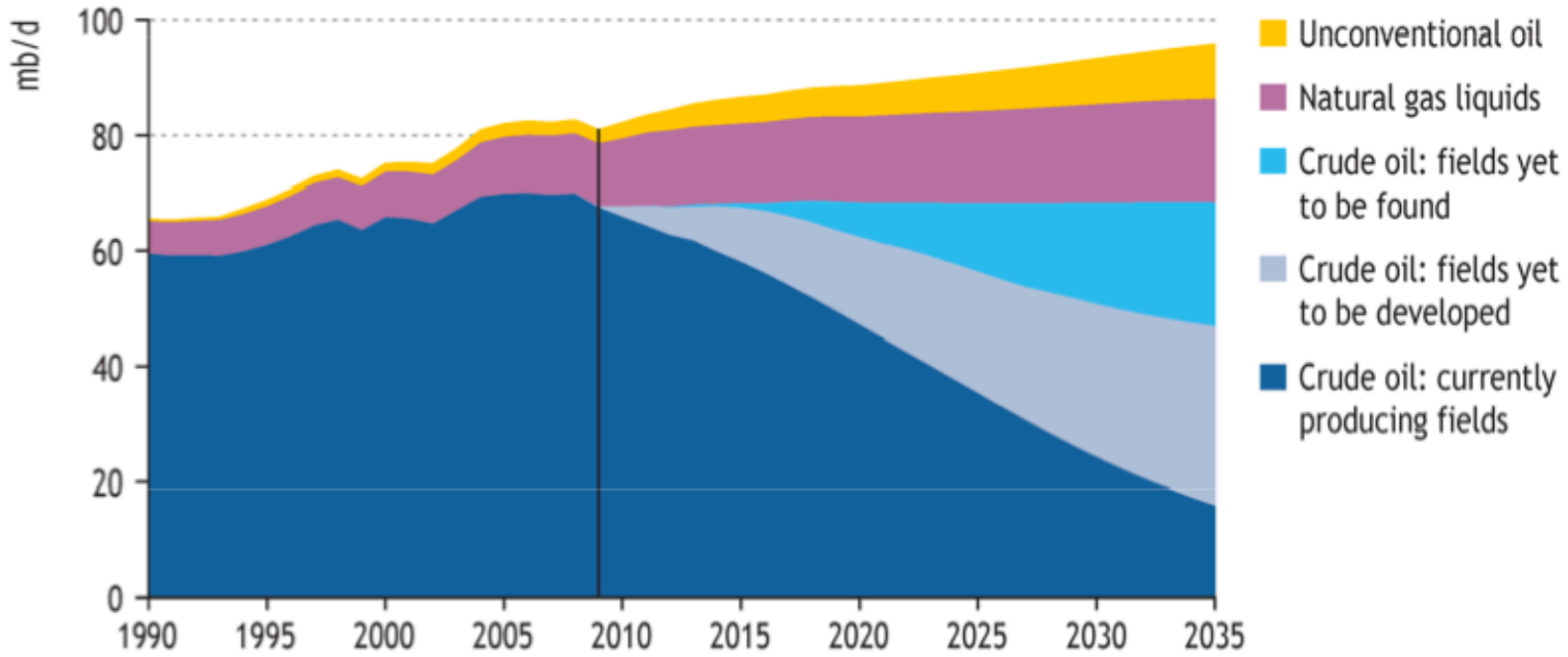
IEA: „Peak oil“ in „currently producing fields“ (2008)

But many risky, dirty and (still) profitable resources are available

Oil production becomes less crude

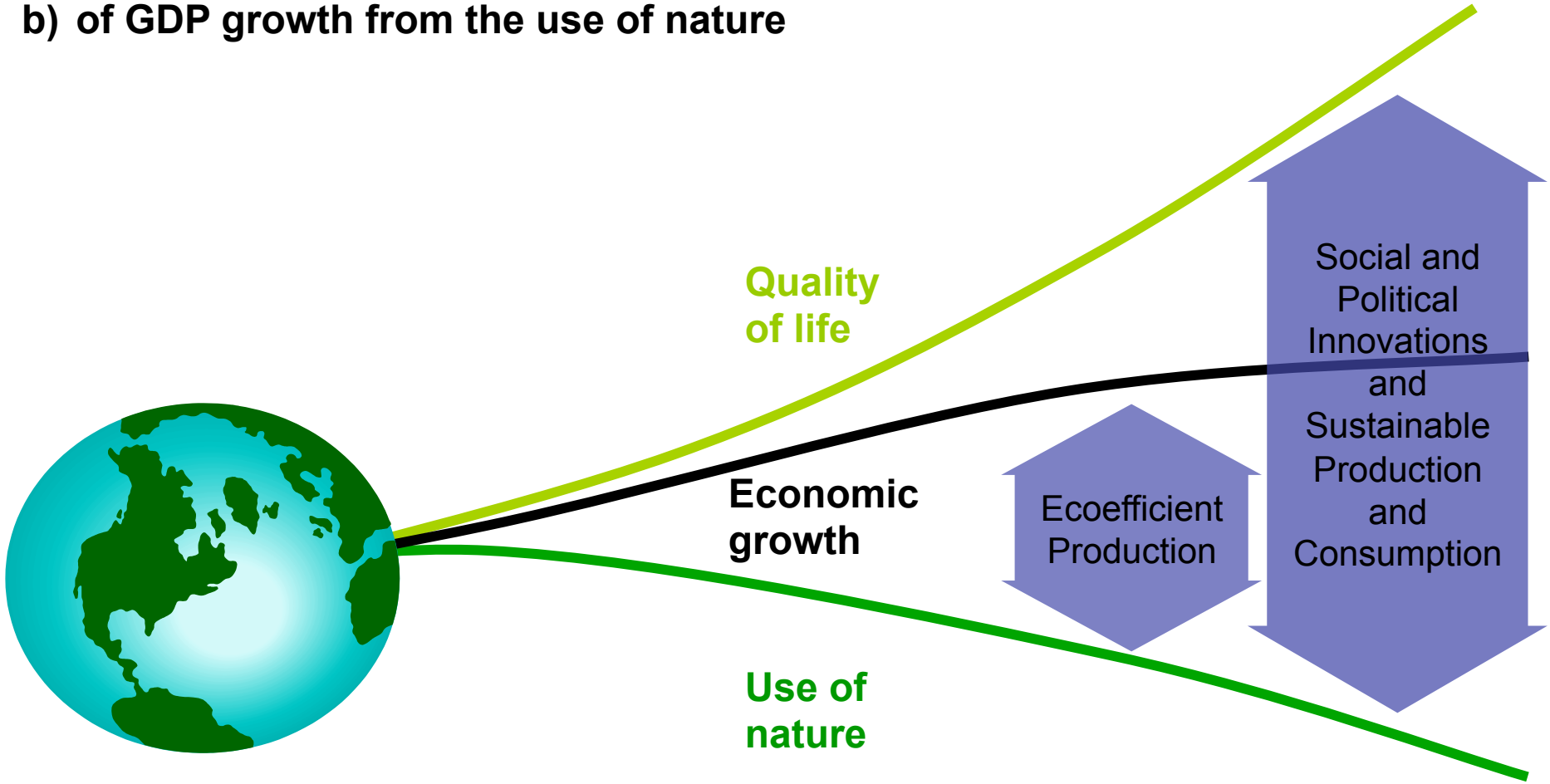
World Energy Outlook 2010

World oil production by type in the New Policies Scenario



The Challenge: *Double* Decoupling

a) of the quality of life from GDP growth and
b) of GDP growth from the use of nature



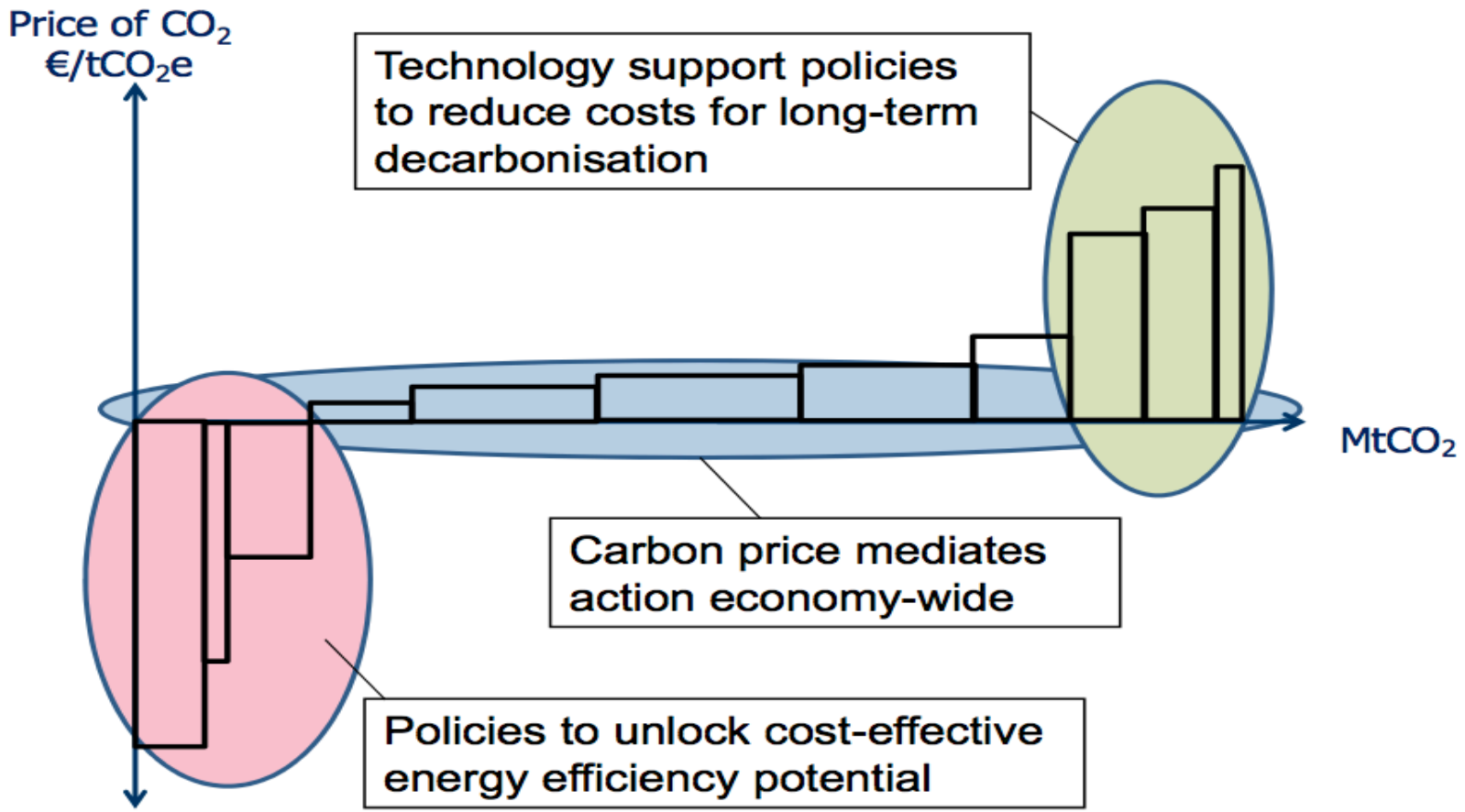
Source: Wuppertal Institute 2009

Economics of climate mitigation and resource protection

Internalisation of external costs + Cost reduction of renewables + Rapid deployment of efficiency + R&D&D + life style changes

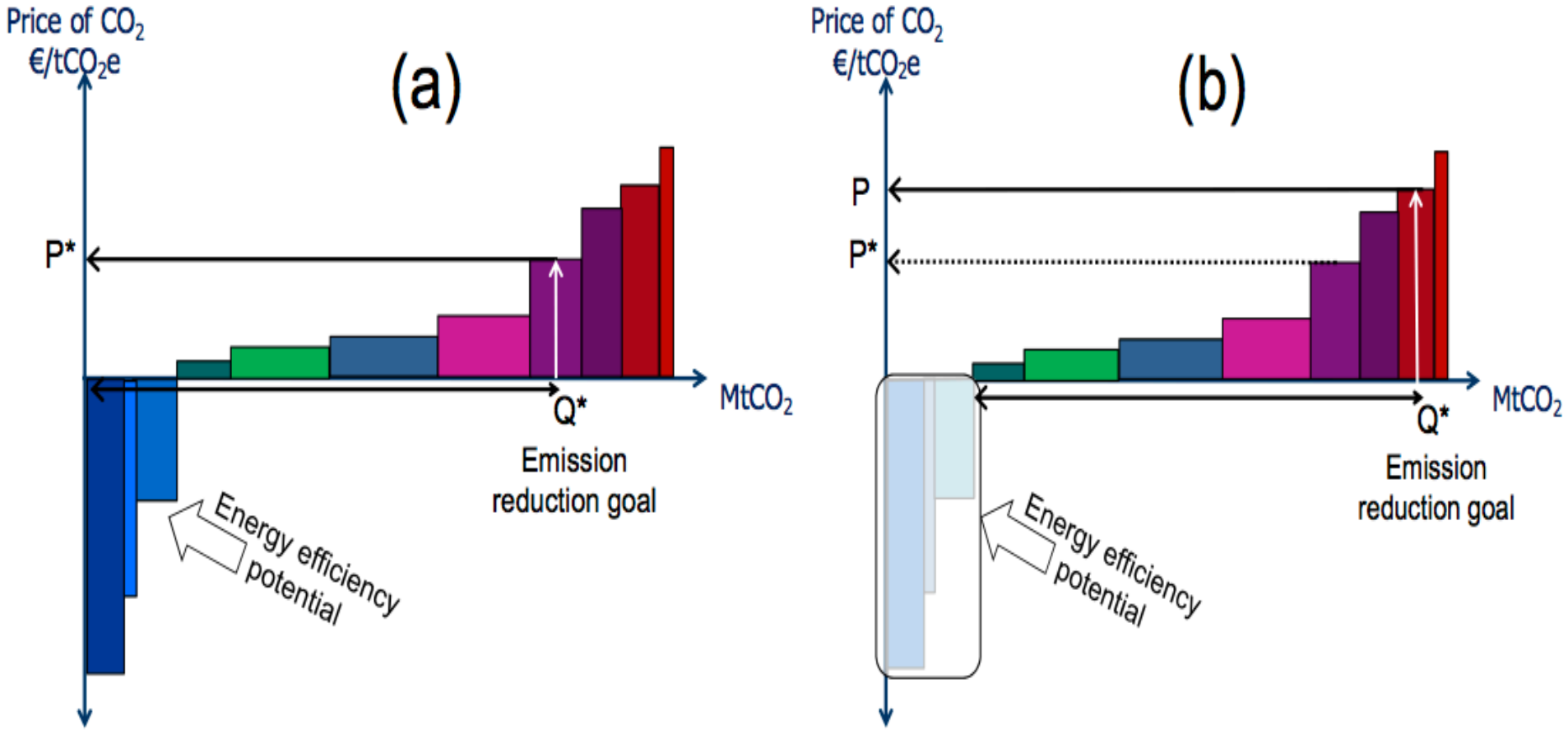
Integrated core strategies for climate mitigation

Efficiency policy + Price on $C0_2$ + Feed in Law + R&D&D-policies



Source: IEA/OECD 9/2011

The impact of less ambitious efficiency policies:
Costs of climate mitigation will increase



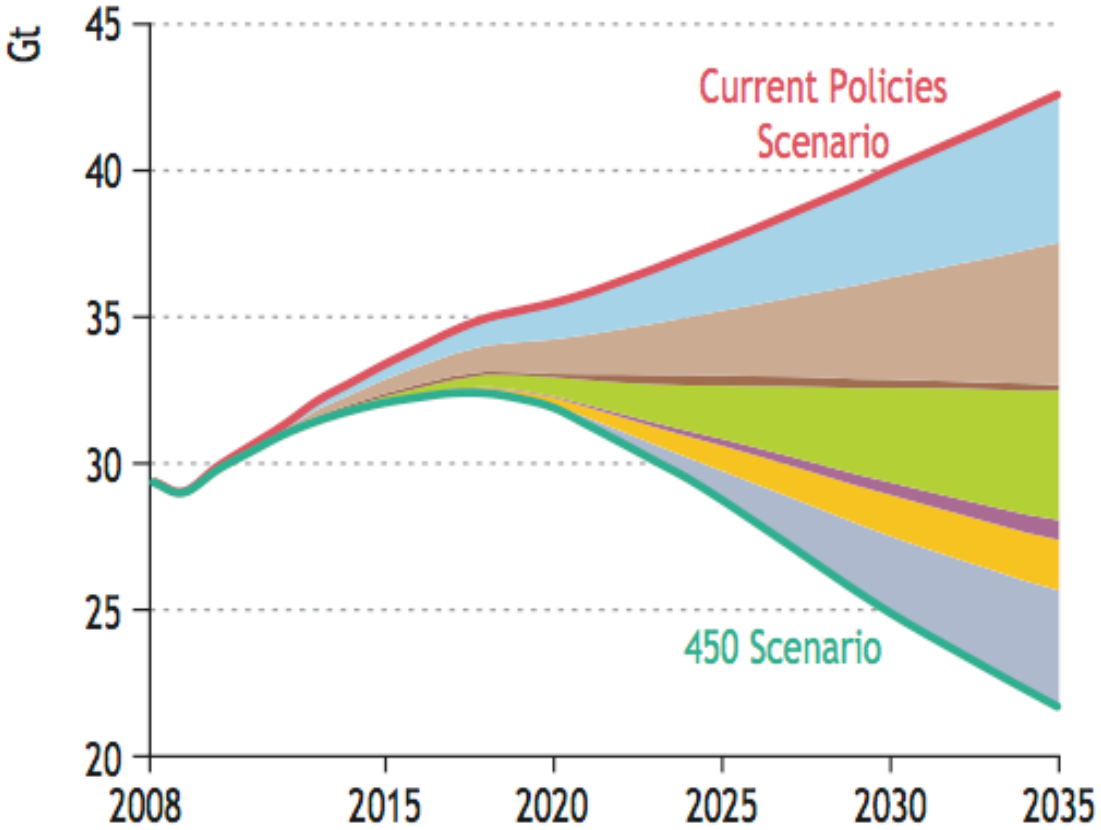
Source: IEA/OECD 9/2011

Technologies are available - optimistic perspectives for sustainable energy

„Humanity can solve the carbon and climate problem in the first half of this century simply by scaling up what we already know to do“
(Pacala / Socolow 2004, Princeton University, USA**).**

World Energy Outlook 2010: Efficiency = 50% of the solution, but …

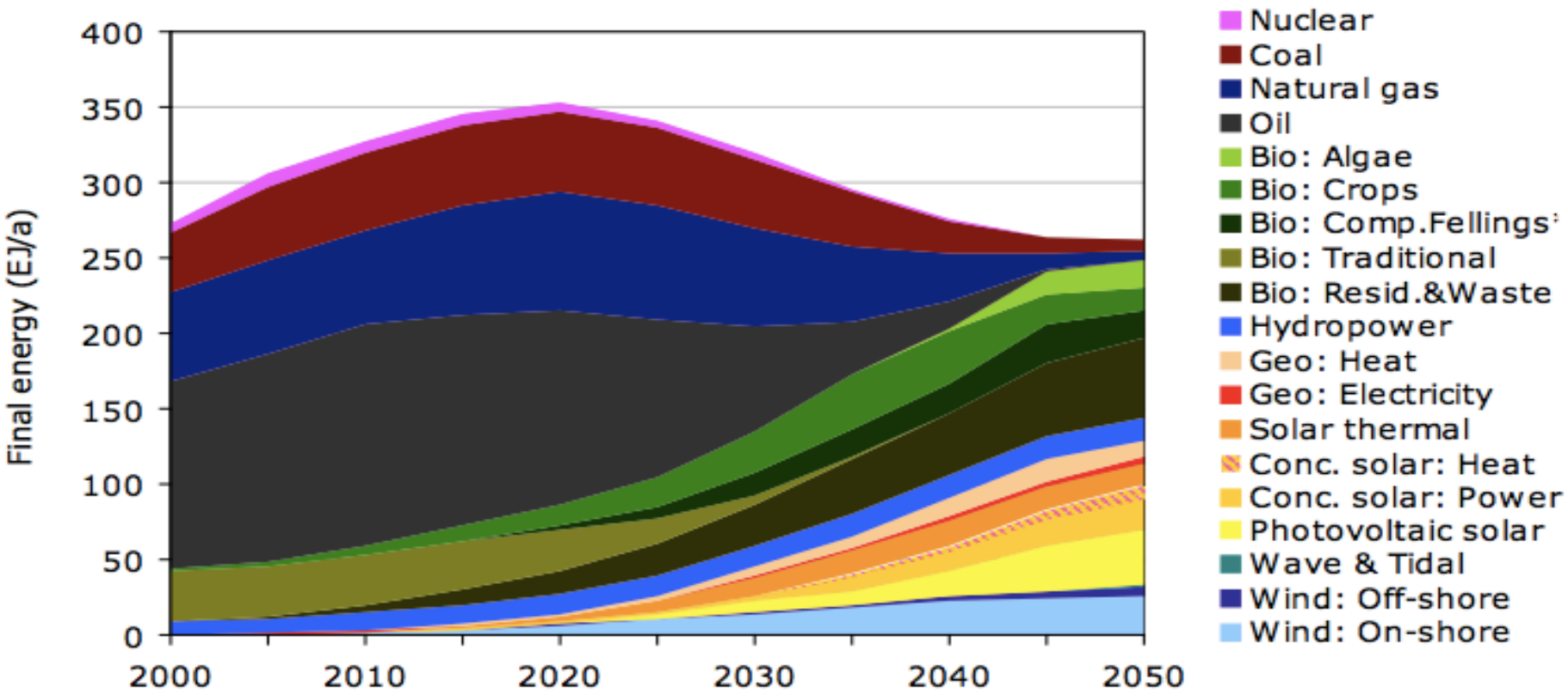
…what about the social embeddedness of technologies?



	Abatement		
	2020	2030	2035
Efficiency	71%	49%	48%
End-use (direct)	*34%*	*24%*	*24%*
End-use (indirect)	*33%*	*23%*	*23%*
Power plants	*3%*	*2%*	*1%*
Renewables	18%	21%	21%
Biofuels	1%	3%	3%
Nuclear	7%	9%	8%
CCS	2%	17%	19%
Total (Gt CO_2)	3.5	15.1	20.9

Source: IEA/OECD, 450 ppm CO2eq scenario to achieve 2° target, 2010

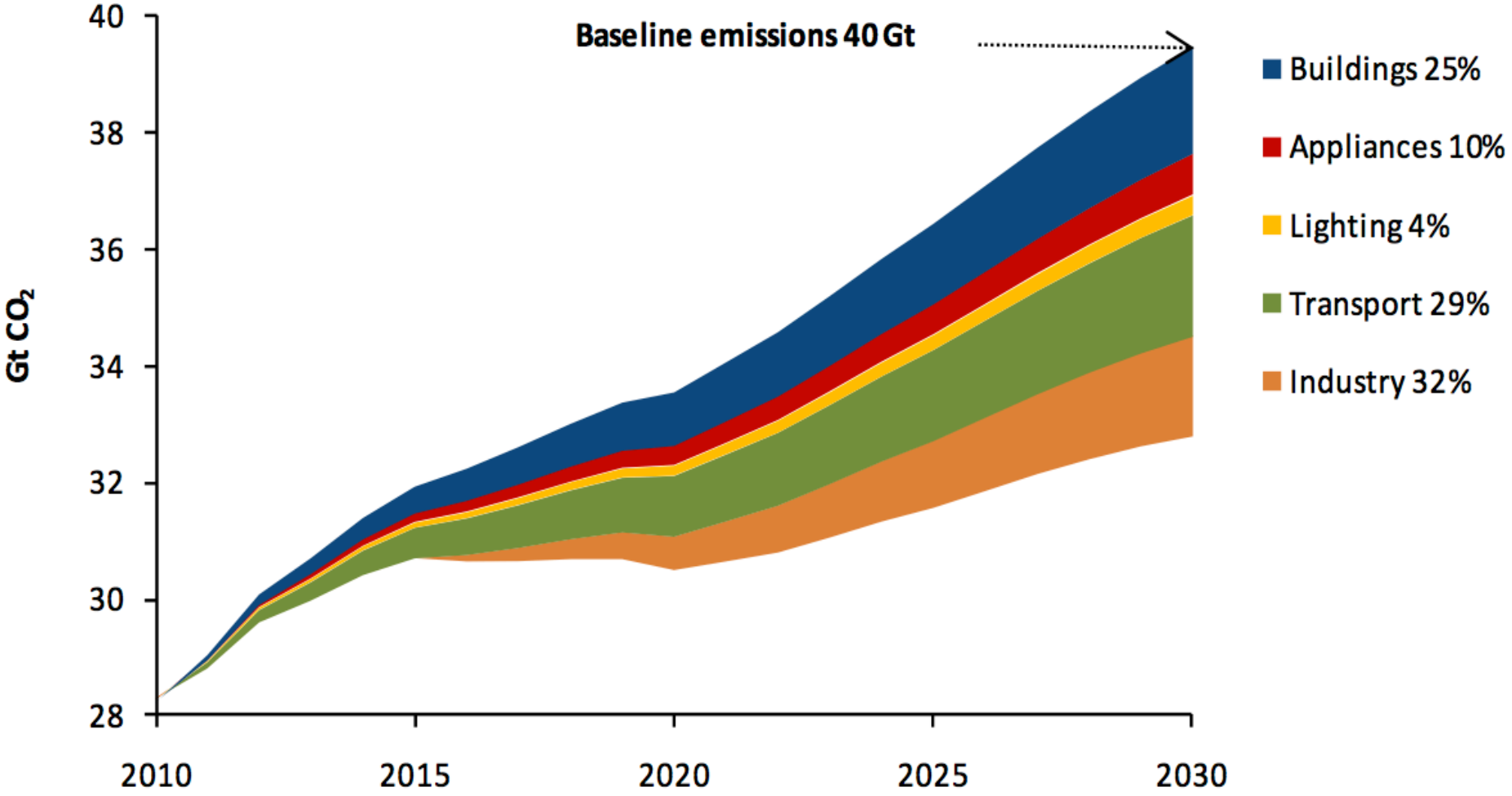
100% renewable global energy in 2050
according to the WWF/Ecofys Scenario



- In 2050, energy demand is 15 % less then in 2005; nuclear phase out; CCS after 2025/30 only marginal
- As far as possible electrical energy is used; bioenergy for trucks, ships, aeroplanes, industrial processes
- By 2050 €4 trillion/a saved compared to BAU; around 2050 savings outweigh investments

Source: WWF/Ecofys 2011

Estimate of potential $C0_2$ emissions savings
through implementation of IEA energy efficiency policy recommendations

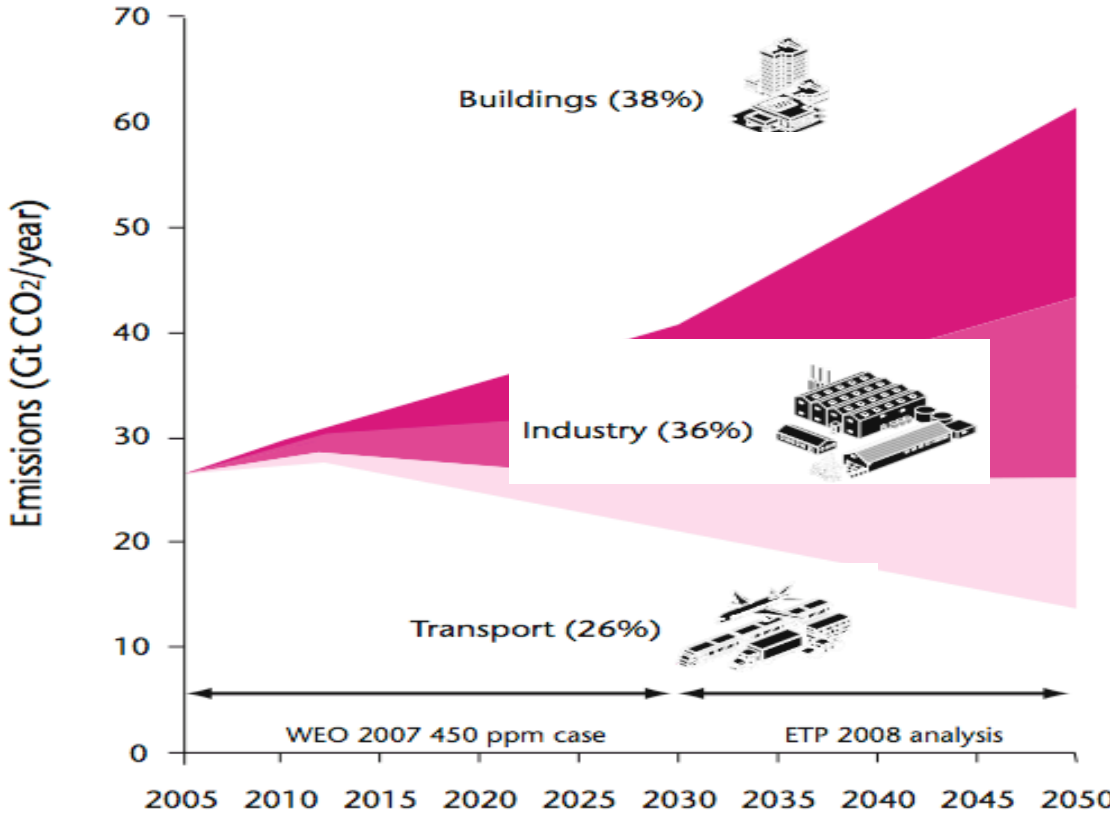


Source: IEA, Clean energy. Progress Report, 2011

Buildings have the largest CO_2-reduction potential, but the implementation gap is huge

The implementation gap

Buildings have to contribute 38% of CO_2 reduction in 2050



- **This will only happen, if innovative policies and measures are used**. ***Because:*** the sector has complex structures and lots of barriers.

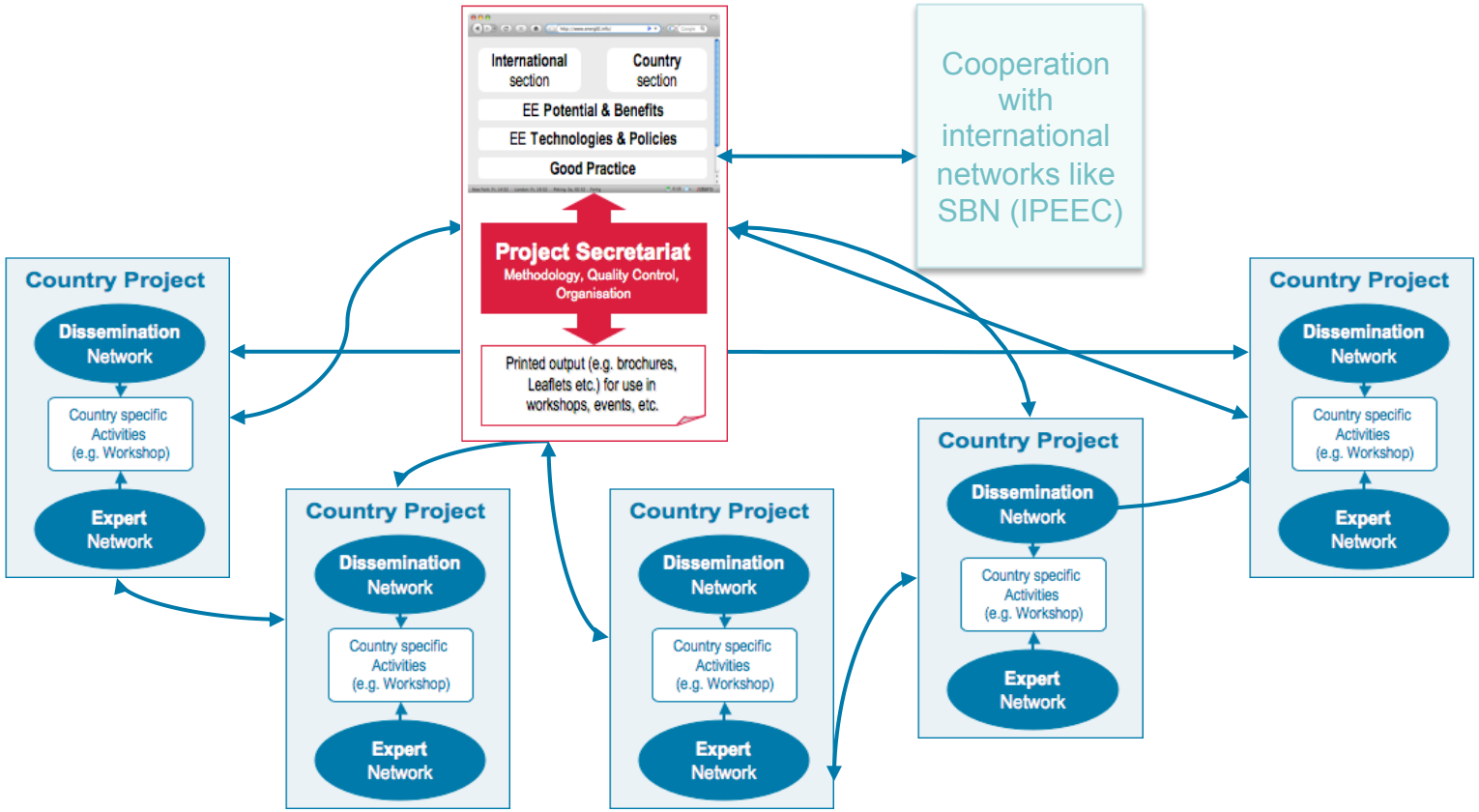
- **Knowledge exists but is not easily available ("closing the knowledge gap")** ***In particular:*** for emerging economies and developing countries

Source: IEA 2008

International bigEE network
A Web Portal to close the knowledge gap!

bigEE

Starting with China, India, South Africa …..Brasil or Mexico next?



Source: Wuppertal Institute, bigEE 2011

bigEE – range of topics

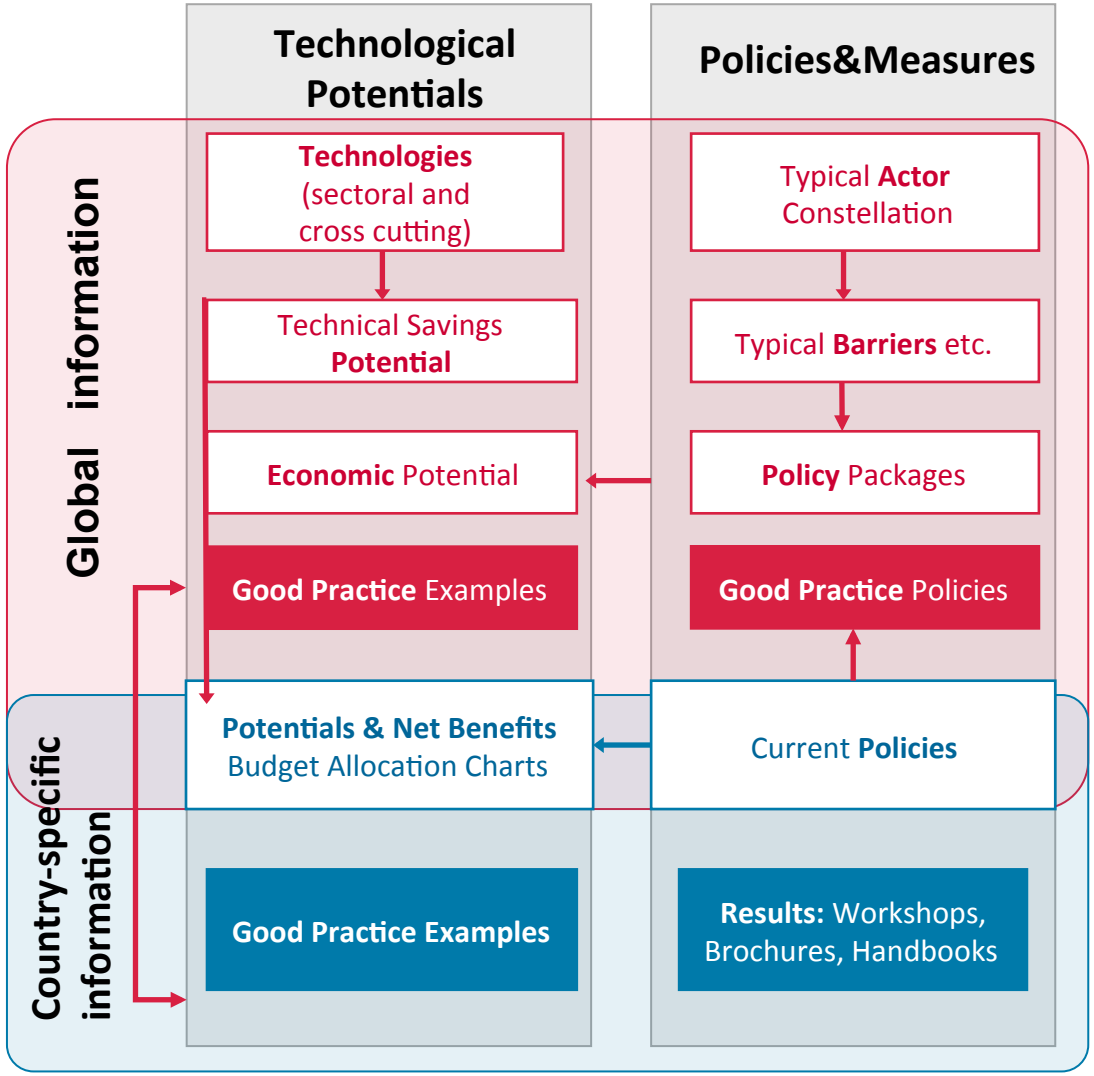
The bigEE web portal covers
- residential buildings
- commercial / public buildings
- industry sector related buildings
- appliances

in four main climate zones:

Including information on
- technologies
- saving options and potentials
- actor constellations
- policies and measures
- good practices

at
- international and
- national levels.

Source: Wuppertal Institute, bigEE 2011



How to build a “lean, green, clean” energy system? Germany as an example?

“Revolutionary Targets” (Chancellor Merkel) of the German Energy Concept

How will it be implemented? Is it transferable to other countries ?

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				-80%
Reduction of the **Final Energy Consumption** in the **Transport Sector** [base year 2005]	-10%			-40%

Source: Federal German Government 9/2010

Pre-Fukushima: No political consensus on phase-out

Key nuclear phase-out policy decisions between 1998 and 2010

- **2000:** Agreement of SPD/Green government with owners of nuclear power plants about a phase-out until early 2020s
- **2003/2005:** Two nuclear power plants shut down as a result of law
- **Fall 2010:** New government (CDU/Liberals) decides to extend the use of nuclear plants by an average of 12 years against strong protests

Post-Fukushima: Political consensus forming

Key political decisions in 2011 concerning nuclear phase-out

- **March 2011**: Chancellor Merkel states that a re-evaluation of nuclear power after Fukushima accident is needed worldwide

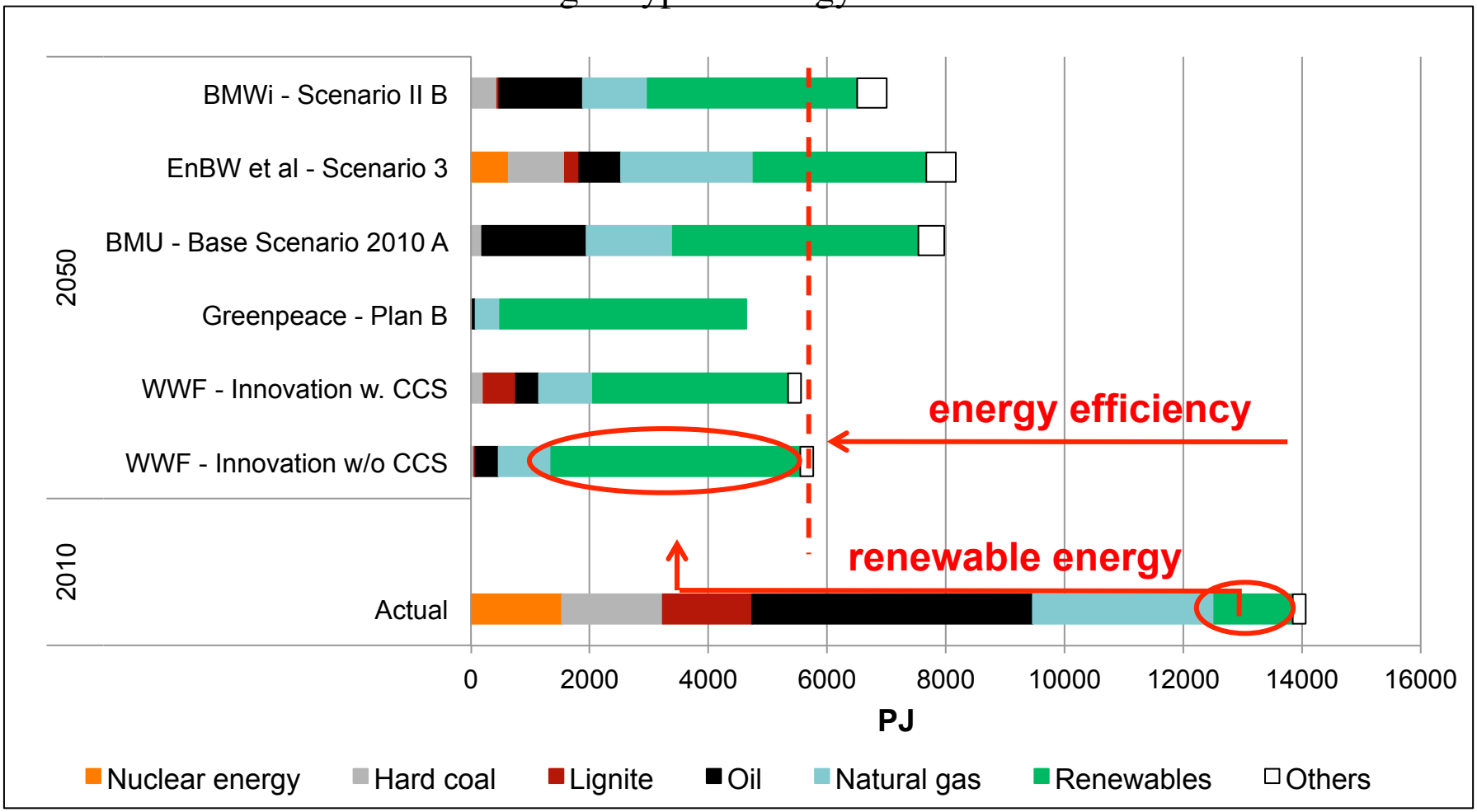
- **June 2011:** Government announces new nuclear phase-out plans
  - Seven oldest reactors shut down
  - One reactor to be shut down each by 2015, 2017 and 2019
  - Three reactors to be shut down by 2021
  - Last (and newest) three reactors to be shut down by end of 2022

- **End of June 2011:** Parliament endorses phase-out law; Social Democrats and Greens support the law →first German nuclear phase-out consensus

Germany on the way to sustainable energy and decoupling?

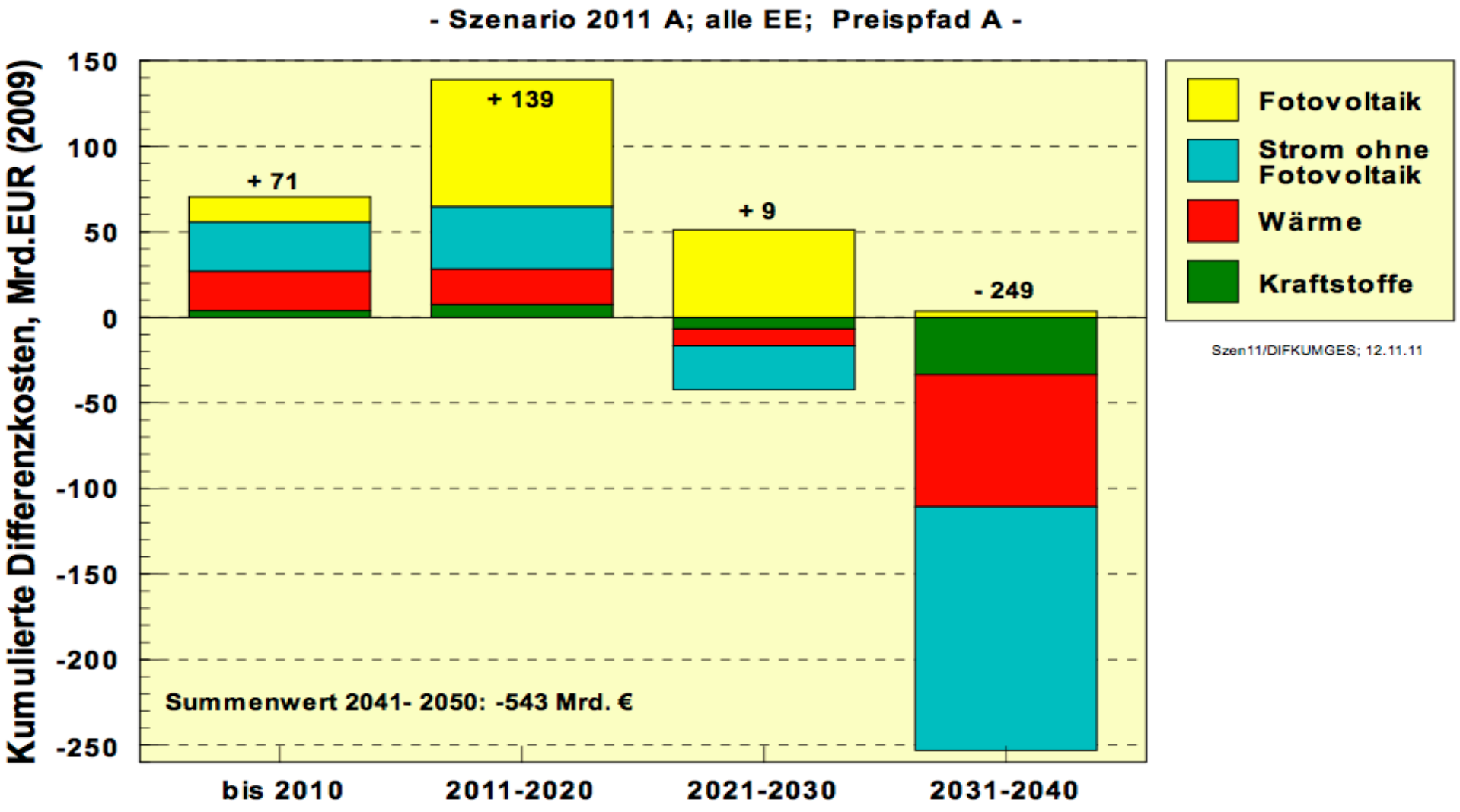
The Integration of renewables and efficiency is the key to sustainable energy!

Primary energy supply and mix in Germany in 2010 (actual) and in 2050 according to typical energy scenarios



Source: Samadi 2011, based on data from AG Energiebilanzen 2011 and scenario studies cited

Typical dynamics of the differential costs of the „Energiewende“
All sectors; according to German BMU „Lead Scenario 2011“



European and German climate mitigation studies
Economic benefits due to efficiency and renewables integration

UBA (Hrsg.) 2009

ISI/ Roland Berger (2009)

McKinsey (2009)

PIK et al (2009)

WWF/Prognos/Öko/Ziesing (2009)

ADAM (EU27, 2009)

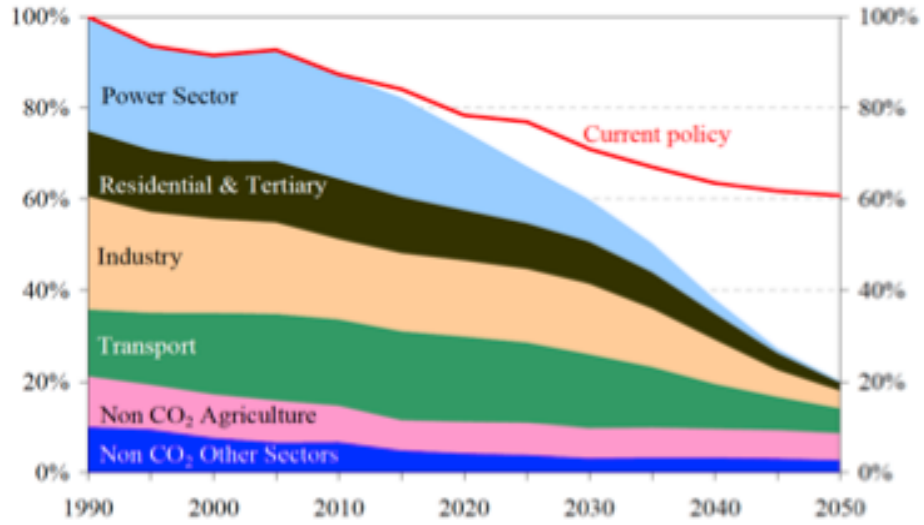
FVEE (2010)

SRU/Hohmeyer (2010)

PIK et al (2011)

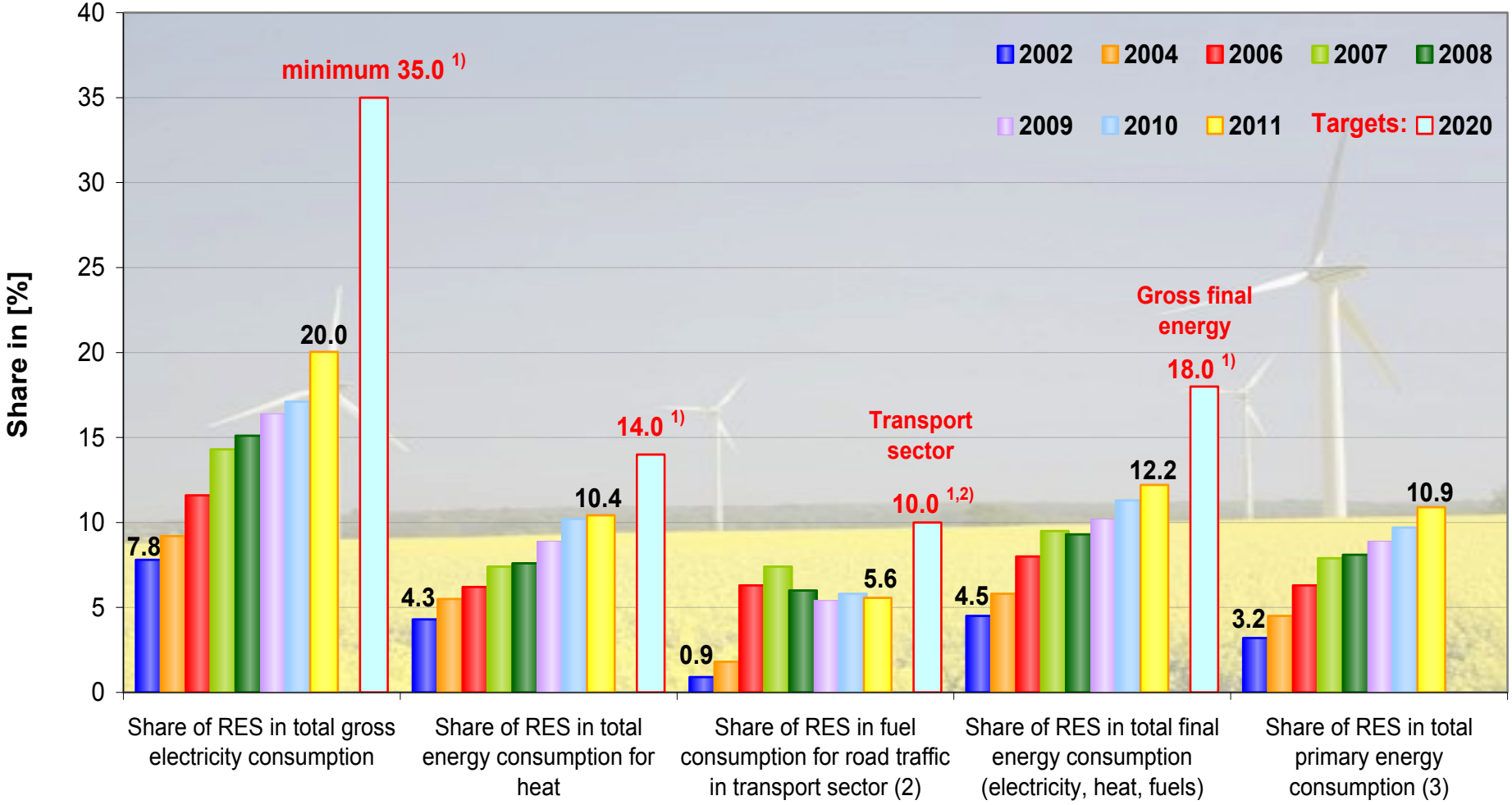
A Roadmap for moving to a competitive low carbon economy in 2050 (European Commission, March 2011)
"This analysis of different scenarios shows that domestic emission reductions of the order of 40% and 60% below 1990 levels would be the cost-effective pathways by 2030 and 2040, respectively"

Figure 1: EU GHG emissions towards an 80% domestic reduction (100% =1990)



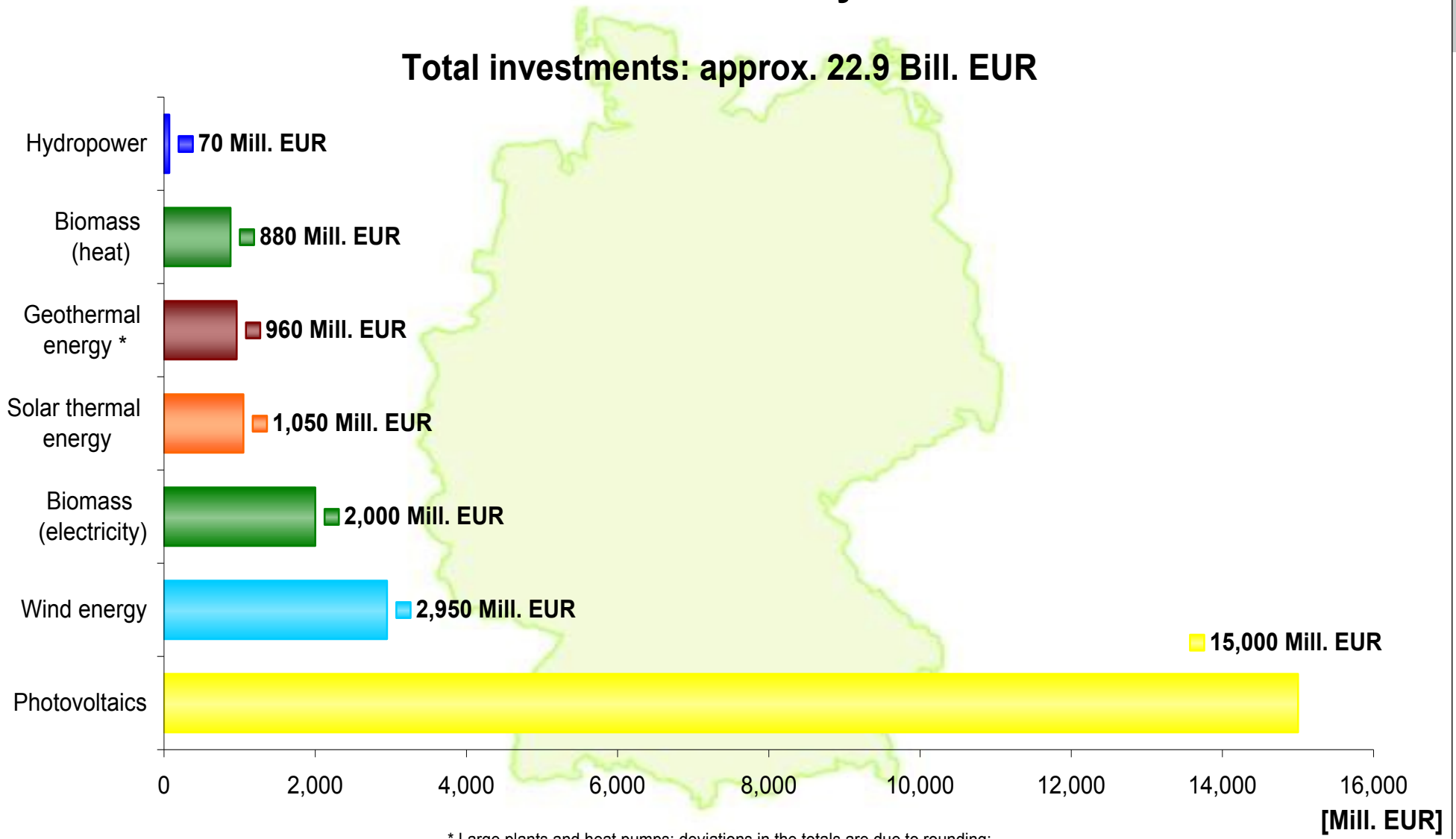
Current role of renewables and efficiency in German energy system

Renewable energy sources as a share of energy supply in Germany



1) Sources: Targets of the German Government, Renewable Energy Sources Act (EEG); Renewable Energy Sources Heat Act (EEWärmeG), EU-Directive 2009/28/EC;
2) total consumption of engine fuels, excluding fuel in air traffic; 3) calculated using efficiency method; source: Working Group on Energy Balances e.V. (AGEB); RES: Renewable Energy Sources;
source: BMU-KI III 1 according to Working Group on Renewable Energy-Statistics (AGEE-Stat); image: BMU / Brigitte Hiss; as at: March 2012; all figures provisional

Investments in the construction of renewable energy facilities in Germany 2011

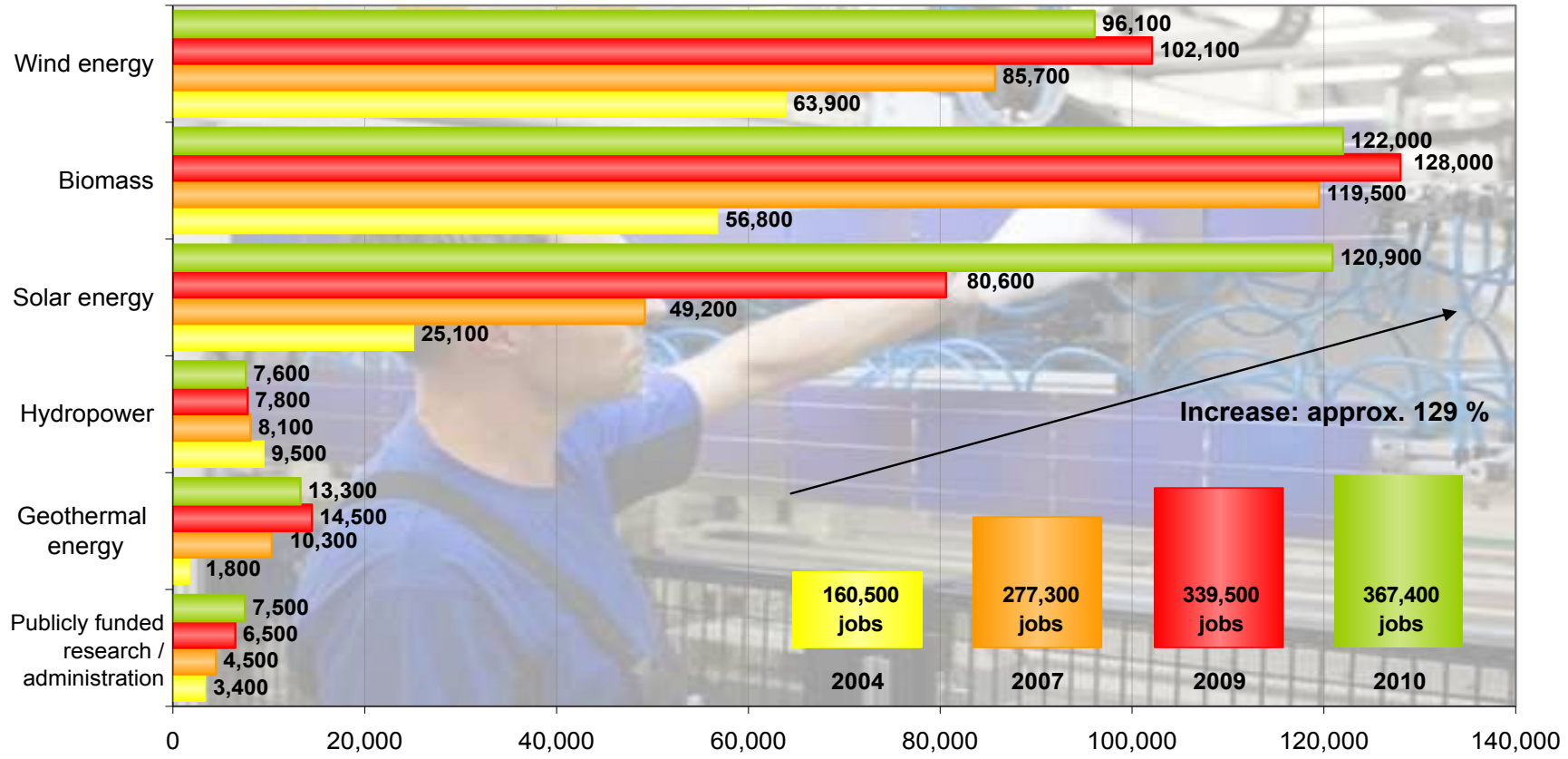


* Large plants and heat pumps; deviations in the totals are due to rounding;
source: BMU-KI III 1 according to the Centre for Solar Energy and Hydrogen Research Baden-Wuerttemberg (ZSW); as at: March 2012; all figures provisional

Renewable energy policy in Germany

Considerable number of people working for renewable energy sector

Jobs in the renewable energy sources sector in Germany

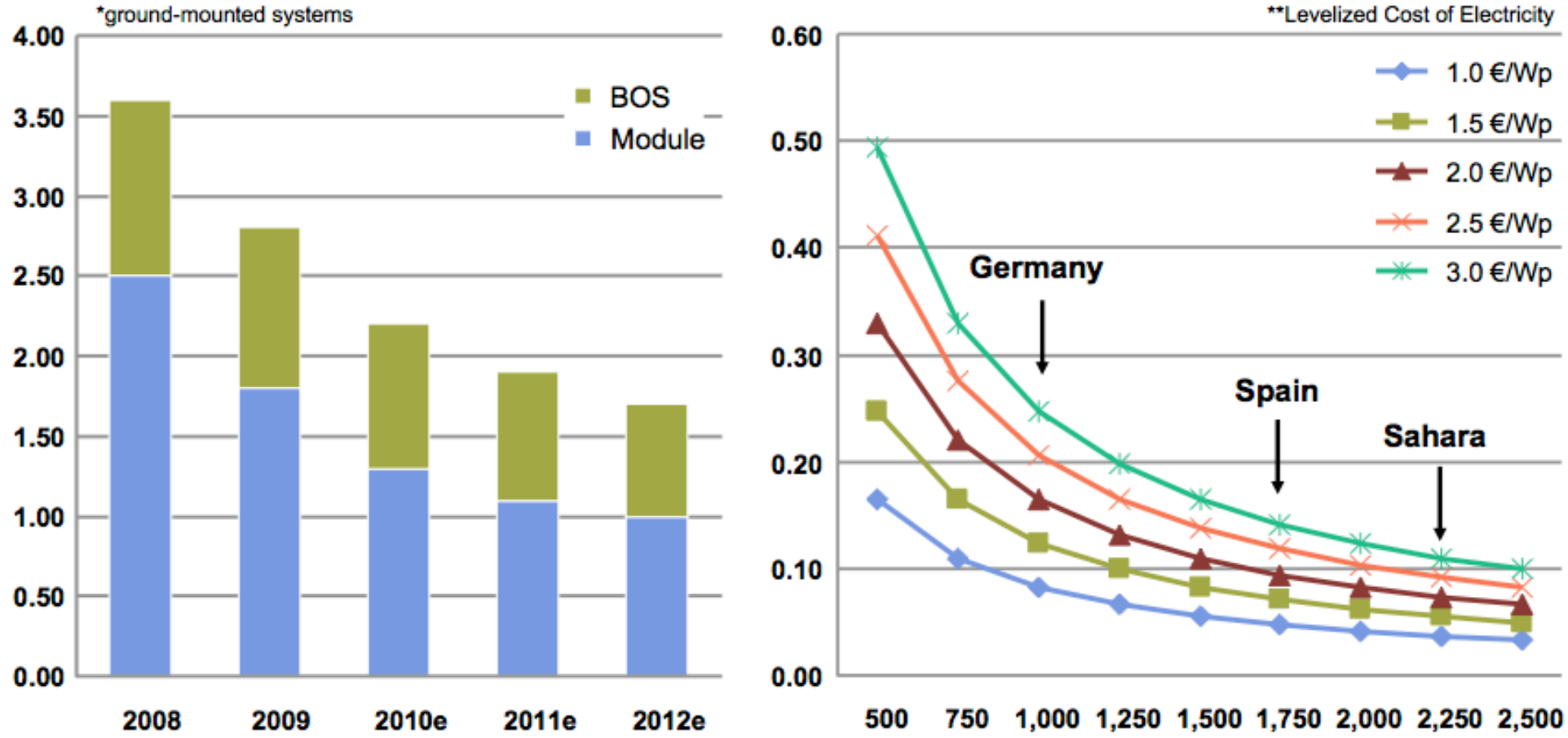


Figures for 2009 and 2010 are provisional estimate; deviations in totals are due to rounding;
Source: O'Sullivan/Edler/van Mark/Nieder/Lehr: "Bruttobeschäftigung durch erneuerbare Energien im Jahr 20010 – eine erste Abschätzung", as at: March 2011; interim report of research project „Kurz- und langfristige Auswirkungen des Ausbaus erneuerbarer Energien auf den deutschen Arbeitsmarkt"; image: BMU / Christoph Busse / transit

Source: BMU (Federal Ministry for the Environment) 2011

DECLINING SYSTEM PRICES WILL BRING DOWN TOTAL COST OF PV ELECTRICITY

PV System Price Development* (€/Wp) and corresponding LCOE** (€/kWh)

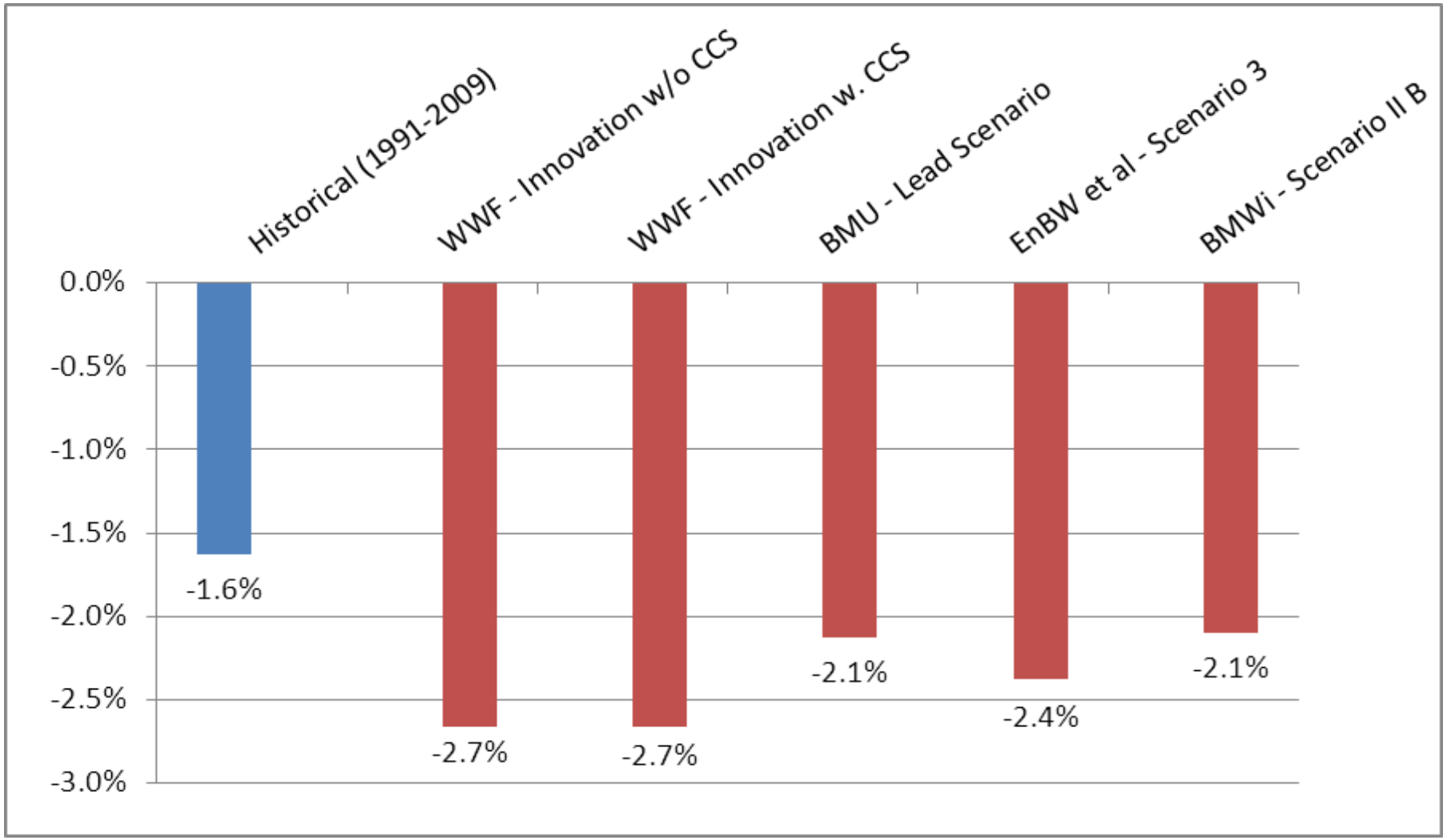


Sources: LBBW 02/2009, industry announcements, WACKER estimates

Focus on energy efficiency makes the transition to sustainable energy quicker and cheaper

Fostering energy efficiency is the bridge to the solar age

energy intensity (1991-2009) and until 2050 according to German scenarios

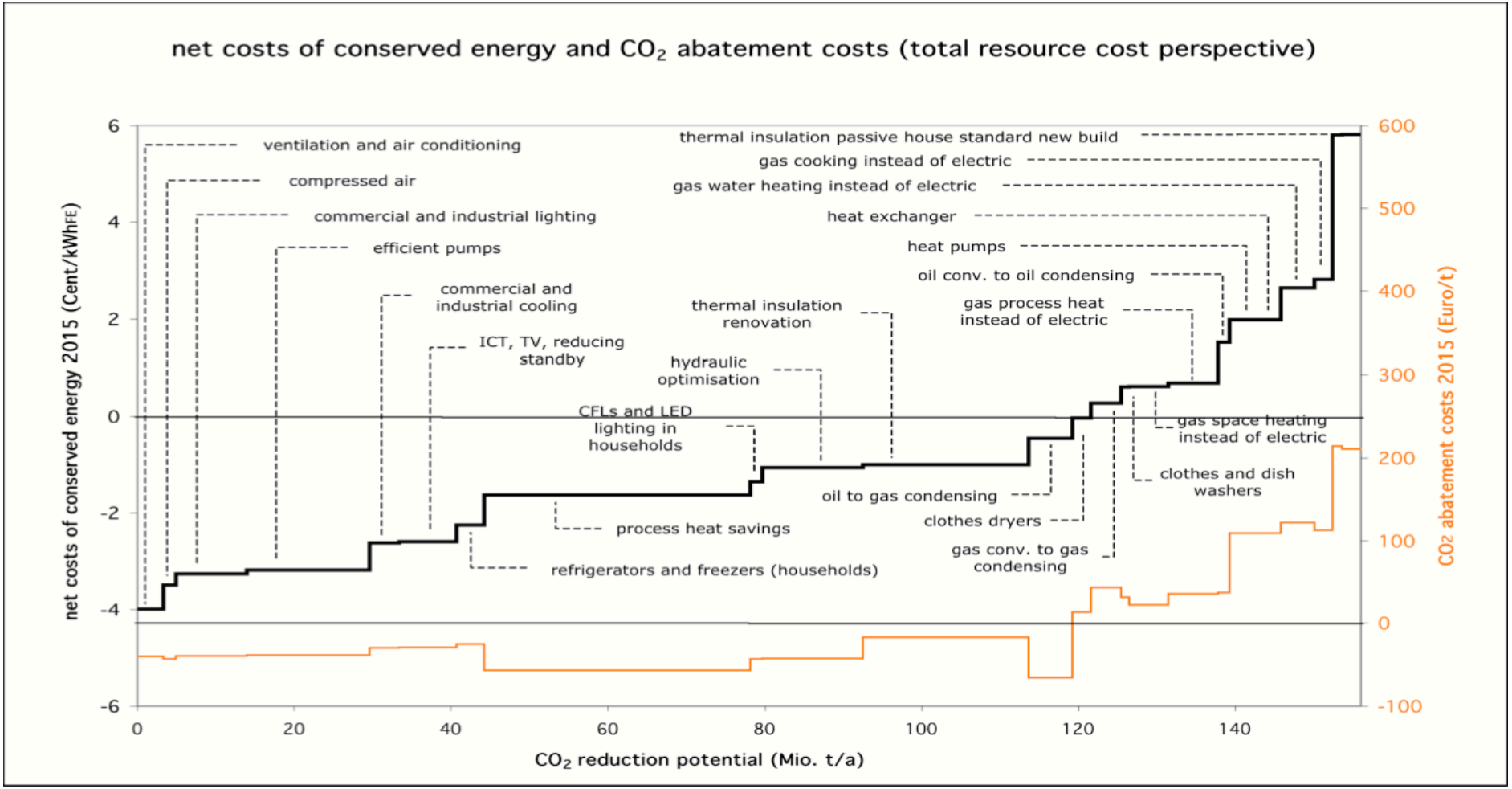


(Sources: AG Energiebilanzen 2010, Federal Statistical Office 2010, Samadi 2011)

The economics of „Negawatts“ compared to „Megawatts“

Motivate and prioritize by using „Budget Allocation Charts (BAC)“

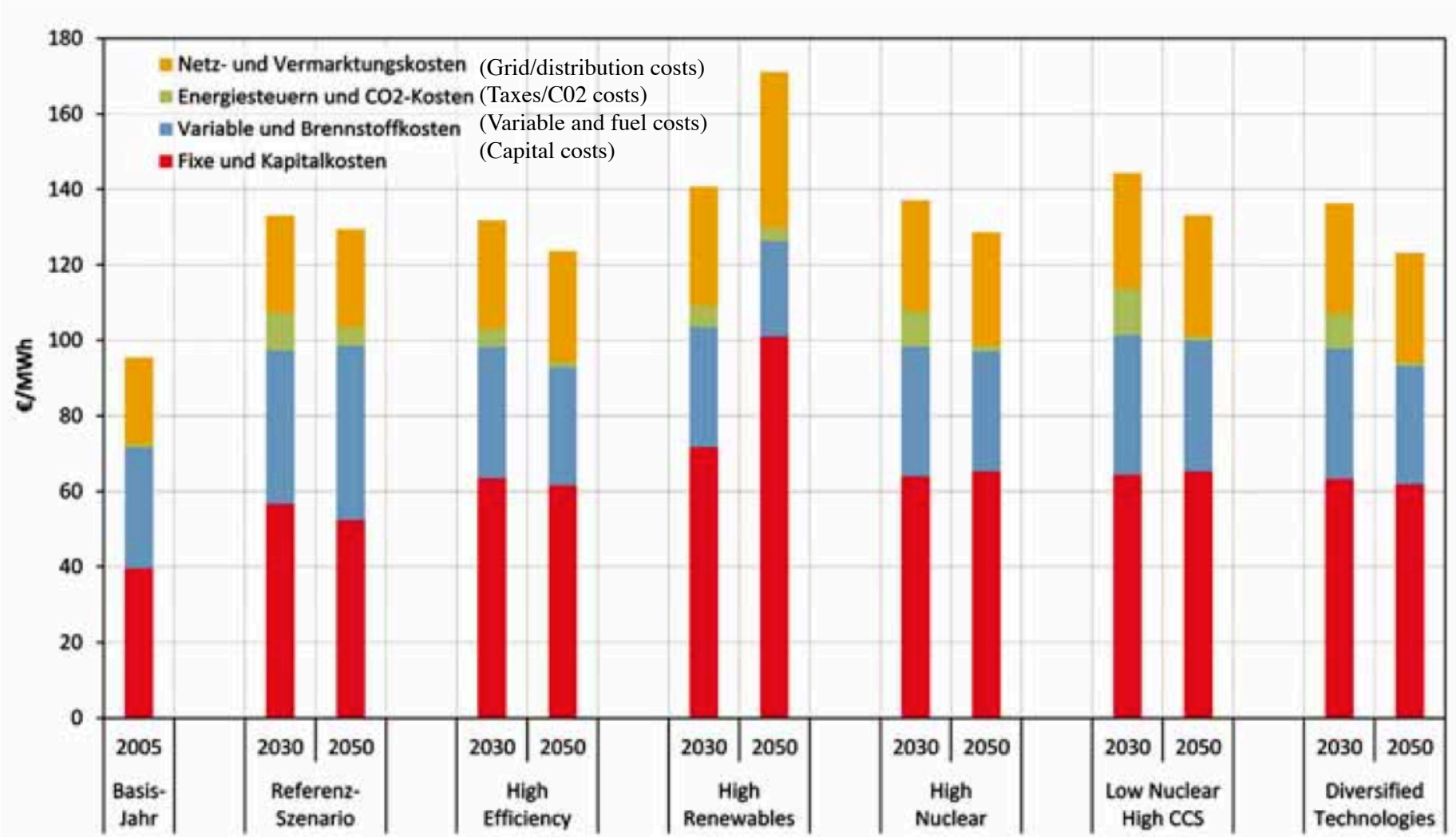
Example for Germany



Source: Wuppertal Institute 2006

Longterm electricity system costs for EU27 -

a factor x higher than for „Negawatts“ (2-8 cts/kWh); EU Roadmap 2050 scenarios



Source: Matthes 2012

Markets for energy services need regulation:
Market failures are not the exception, but the rule!

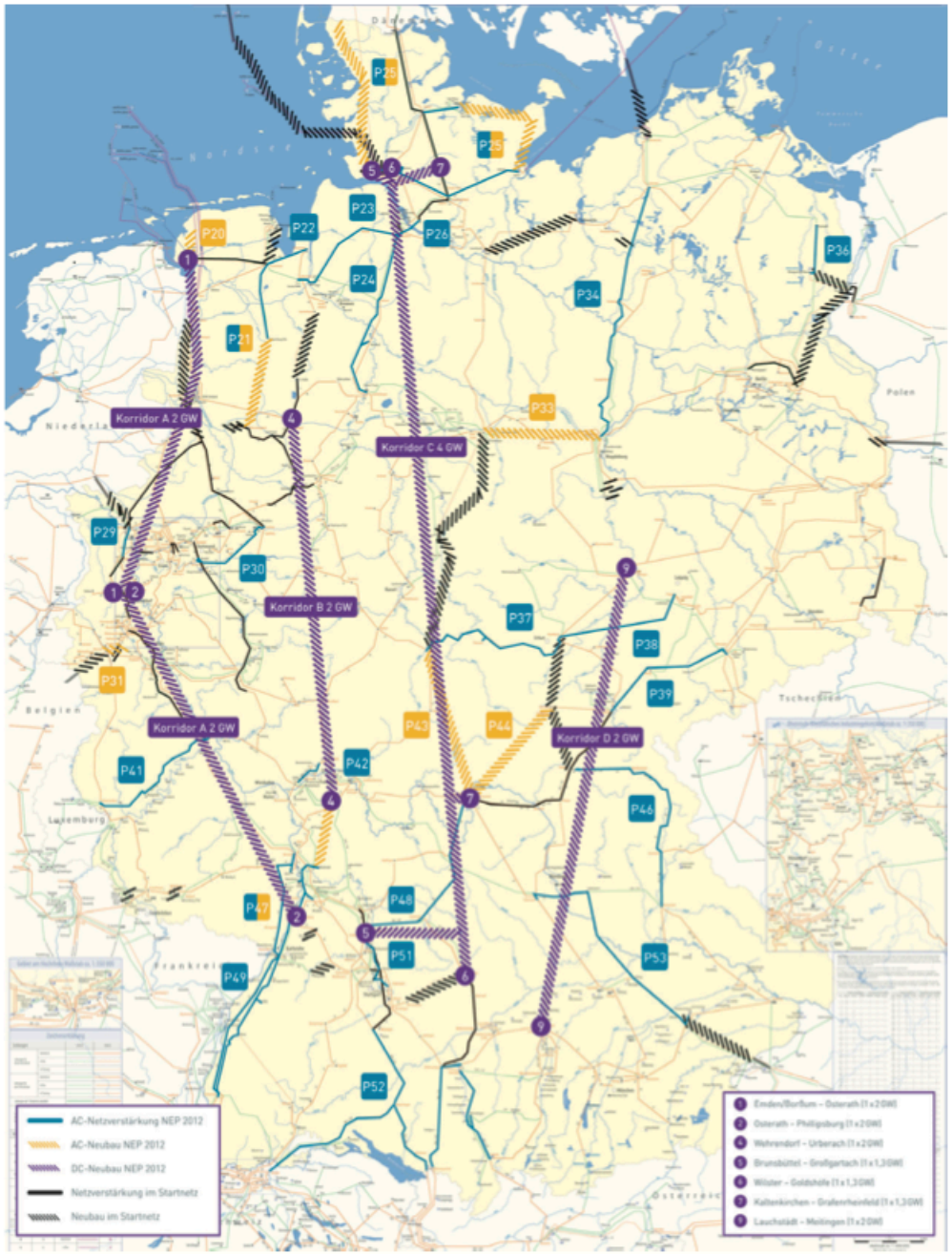
- **Energy efficiency fund** financed by the budget (e.g. DK, NO)
- Financing program costs by **transmission fees** (e.g. BE, DK)
- Financing program costs by **tax reliefs** for utilities (NL, 1999-2003)
- **„White certificates“** by cap/trade system (IT, FR)
- **Obligation for utilities** (EU-Efficiency Directive; German Env.Adv.Council))
- **„NEGAWatt Delivery Law“** by fixed renumeration (like German EEG)
- Additionally possible: **Regional** Efficiency Fund (e.g. Hannover)

Quelle: WI / Infrafutur 2007/SRU 2011

Decentralized power options and new actors (e.g. regional utilities, citizens cooperatives, prosumer) drive the “Energiewende”

Four new transmission lines?
German „Energiewende“ 2032

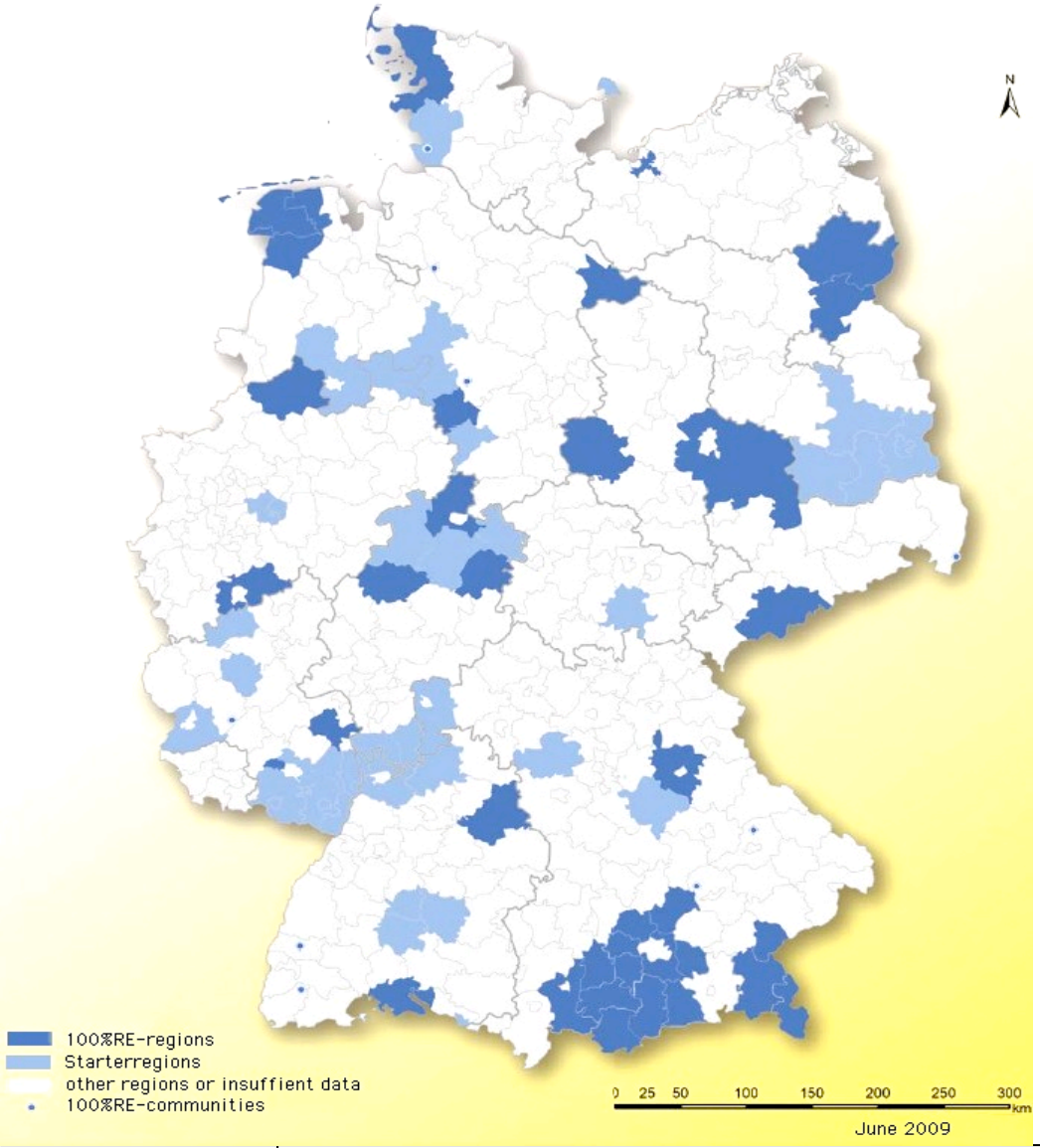
- **Four new power lines in 2020 (north/ south)**
- **Affordable amount of total costs (20bn)**
- **Decentralized options underestimated?**
- **All energy efficiency potentials used?**

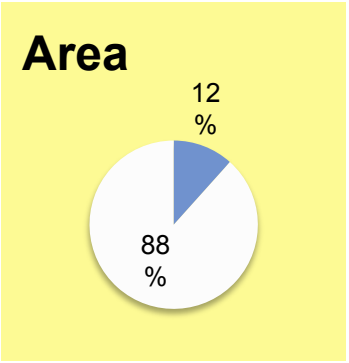


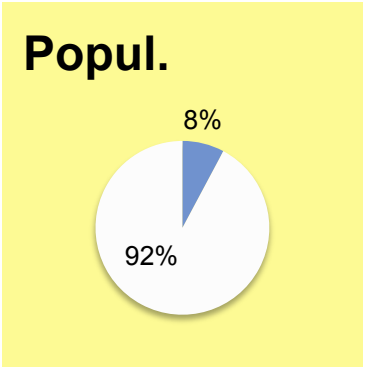
Quelle: VDE Verband der Elektrotechnik Elektronik Informationstechnik e.V./Übertragungsnetzbetreiber

Decentralized options support large scale implementation

100%-Renewable-Energy-Regions in Germany





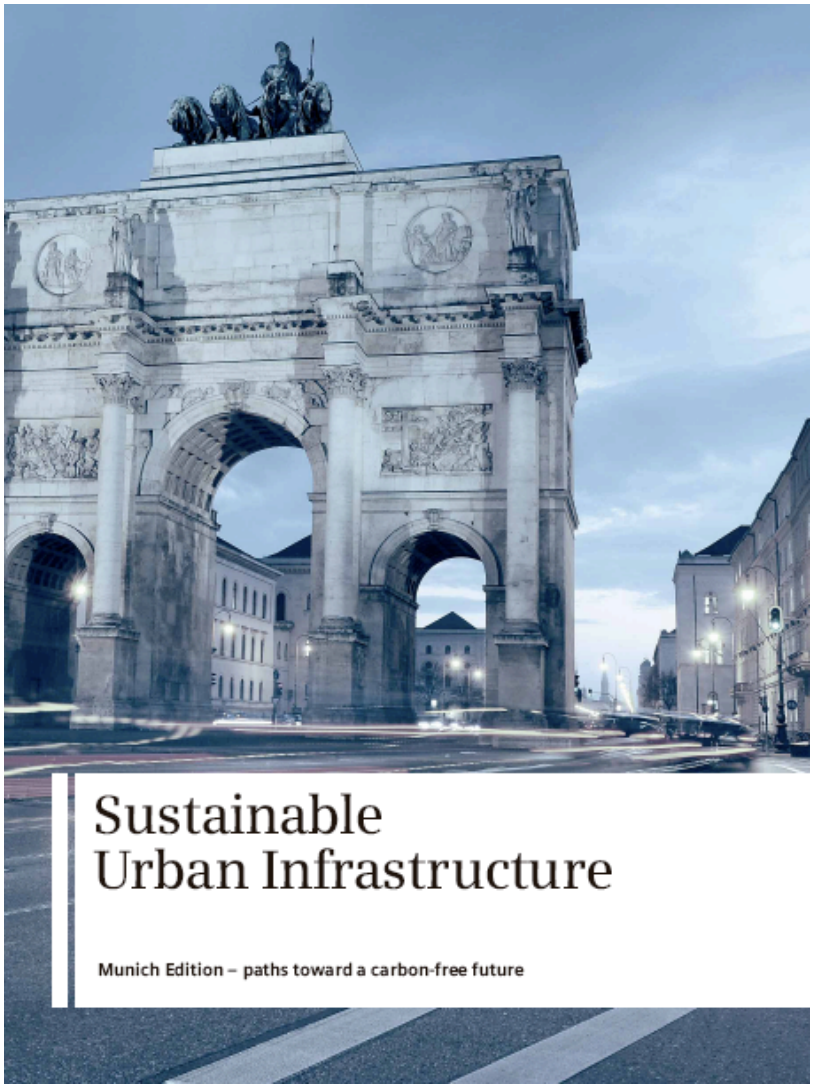


- Political decision towards 100% renewable energy in more than 100 cities or regions
- Aim: Complete change towards renewable energy as well as reducing energy use
- Using regional sustainable energy sources to create regional welfare (income effects)
- Main barriers: co-ordination, local acceptance, lack of funds
- Innovative financing (citizen companies, cooperatives, local funds)

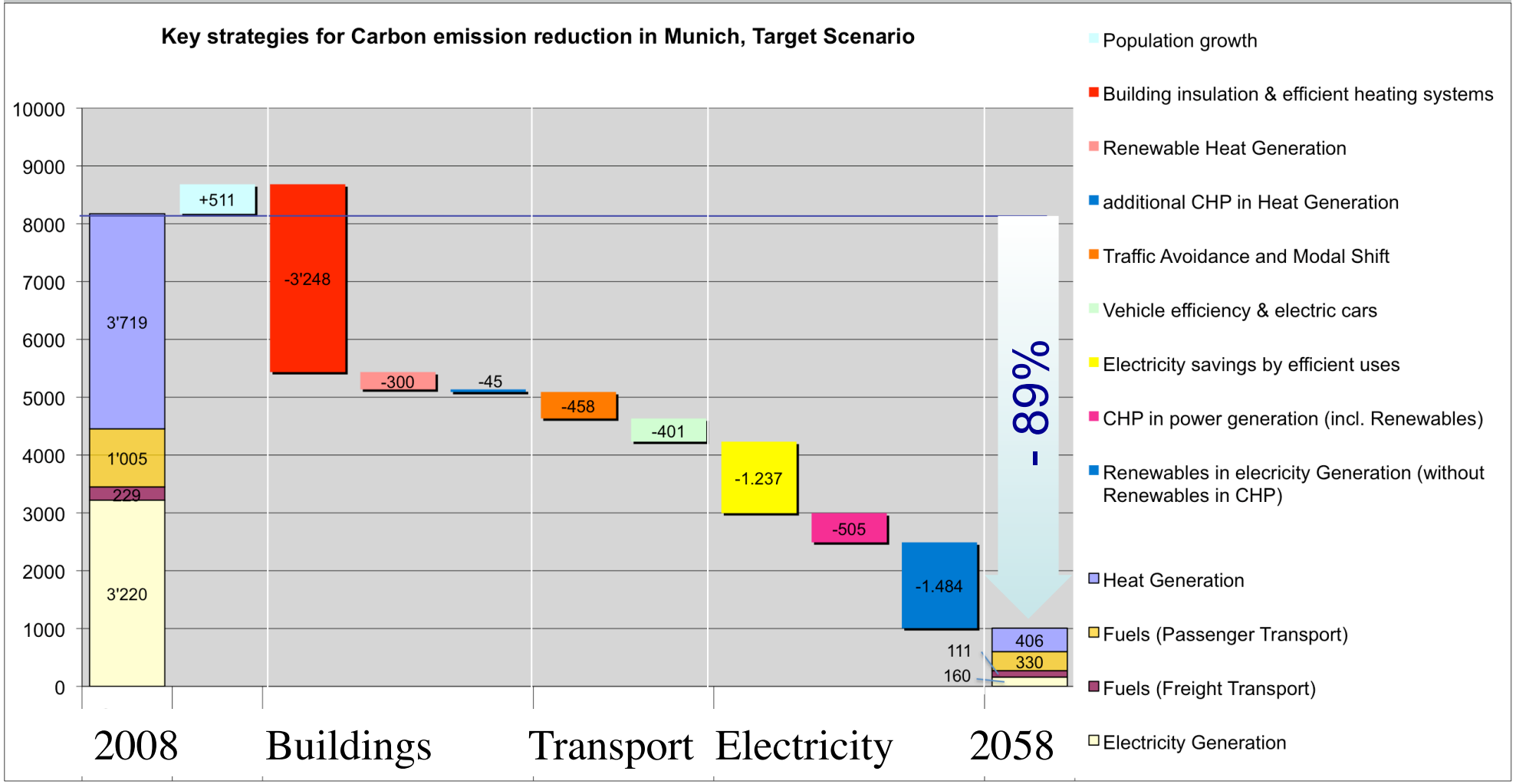
Map: http://www.100-ee.de/. Graphics: Katrin Erfkamp, Wuppertal Institut

Pathway to Carbon Free Cities – The Example of Munich 2058

- **Blueprint for the restructuring of cities**
  - **50% of the worlds population live in cities consuming more than 70% of the energy**
  - **50% of cities in the year 2050 are still to be built**
  - **50% have been already built (including infrastructure)**
- **The „Munich Vision“: Reducing CO_2 at least by 80% (2058)**
- **Study on behalf of Siemens AG**



Key options to reduce CO_2 by 90% in Munich



Source: Wuppertal Institute 2009

Retrofitting existing buildings to nearly „passive houses“

passive house standard = 15 kWh/qm/a

dena
German Energy Agency

High-Performance-Retrofitting: more than 400 high efficient buildings all over Germany.

All building types and construction periods included

Multi family dwelling
Pforzheim
Year of construction 1951

before: 358 kWh/m²a
after: 31 kWh/m²a
reduction of 92% primary energy

Single-family home
Oldenburg
Year of construction 1890

before: 462 kWh/m²a
after: 21 kWh/m²a
reduction of 95% primary energy

heritage building in
Eichstetten
Year of construction 1750

before: 202 kWh/m²a
after: 22 kWh/m²a
reduction 89% primary energy

State of the art: Buildings used as power plants

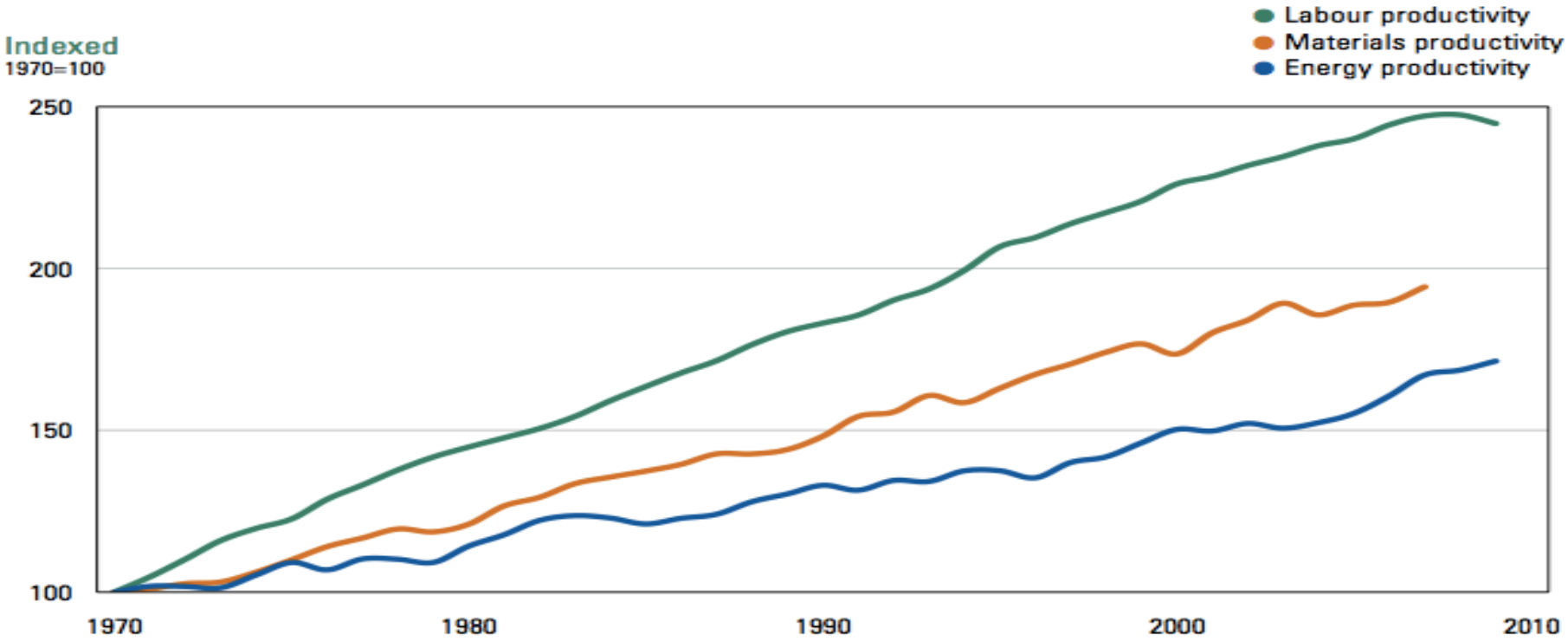
„Plus-Energy“ houses in Freiburg/Germany

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

The benefits of integrated resource and energy efficiency strategies

Material- and energy productivity lacks behind labour productivity

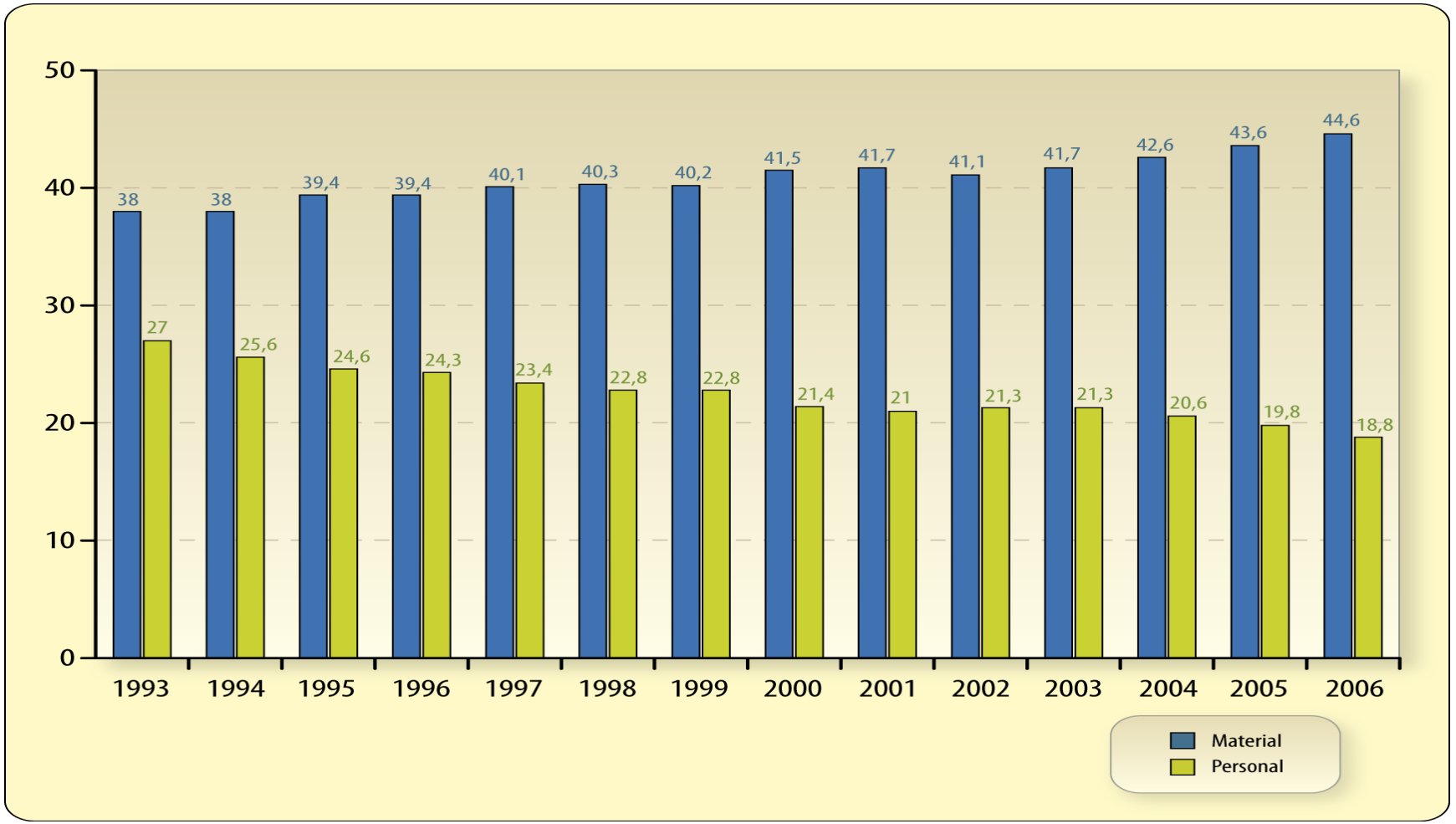
„Green technical progress“ makes tons and kilowatt-hours redundant not people!



Note: Labour productivity in GDP per annual working hours; material productivity in GDP per domestic consumption (DMC) and energy productivity in GDP per total primary energy supply (TPES).

Source: EEA 2011

High shares of material costs (45%: blue)
compared to energy (2-3%) **and wages** (19%: yellow) **for German industry**

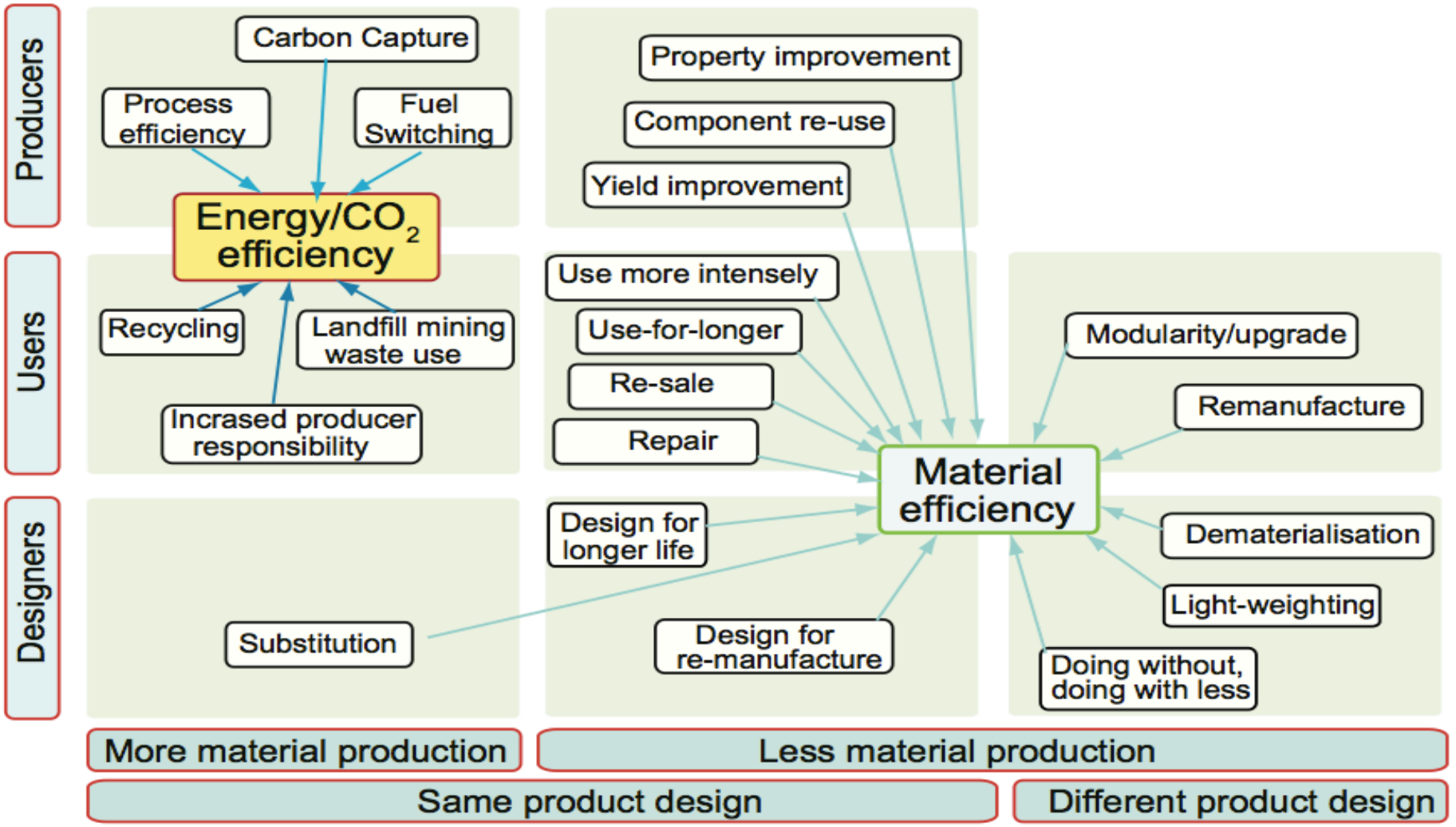


Materialkosten = Rohstoffe und sonstige frendbezogene Vorprodukte, Hilfs- und Betriebsstoffe incl. Fremdbauteile, Energie und Wasser, Brenn- und Treibstoffe, Büro- und Werbematerial sowie nichtaktivierte geringwertige Wirtschaftsgüter

Source: Dörner / Hennicke 2009

On the road to integrated „resource policy“?

Combining P&M for energy and material efficiency creates many synergies



Source: Allwood et al, 2011

Modelling a “Resource Efficient Germany”:

Integrated climate and resource protection is a win-win-strategy!

The following effects result of a forced resource efficiency strategy for 2030 in relation to a reference scenario of active climate protection (GHG reduction: 54 %):

- Absolute reduction of material consumption of about – 20 %
- Increase of GDP of about + 14,1 %
- Increase in Employment of 1,9 %
- Reduction of Public Dept of 11,7% (- 251 bn €)
- Conclusion: 1. Absolute decoupling of TMR/GDP is possible

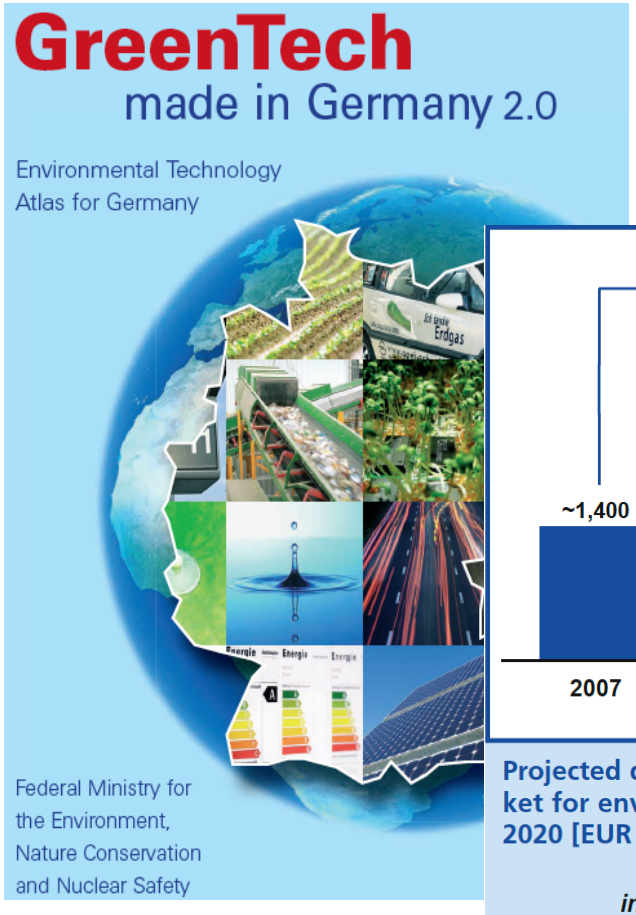
  2. “Industrial ecological policy” must drive innovation

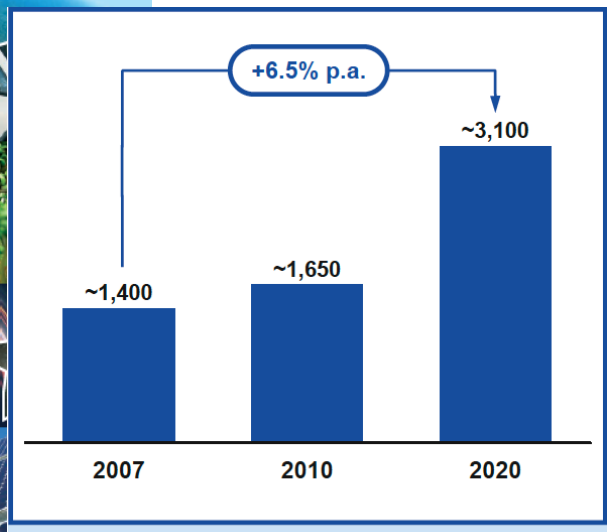
  3. Reduction of resource costs increase competitiveness

Source: Distelkamp / Meyer / Meyer 2010

GreenTech: System solutions to foster resource productivity and to reduce costs

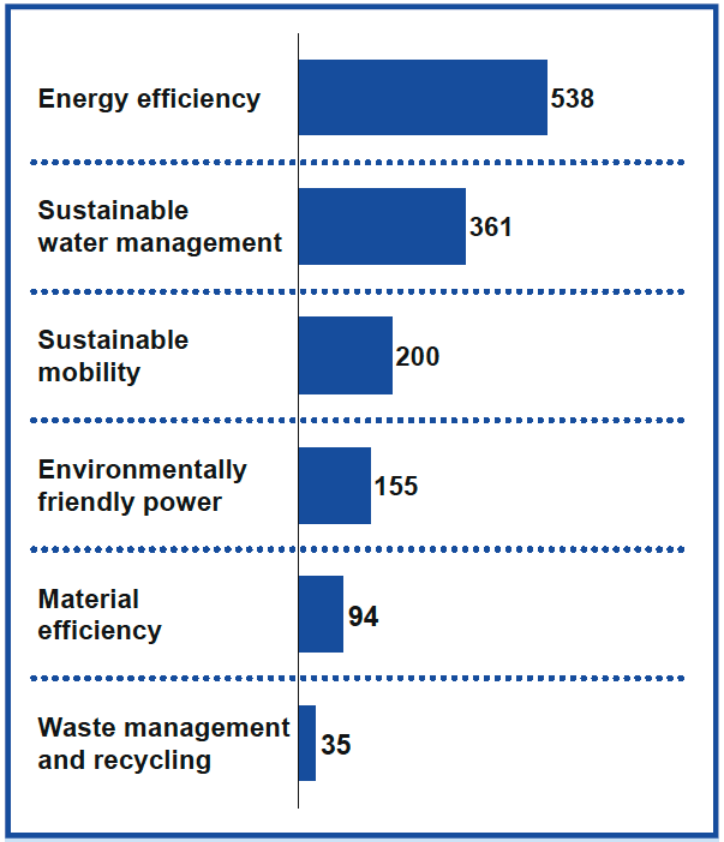
Six selected Lead Markets





Projected development in the global market for environmental technology, 2007–2020 [EUR bn]

Source: Market studies, interviews with experts, Roland Berger



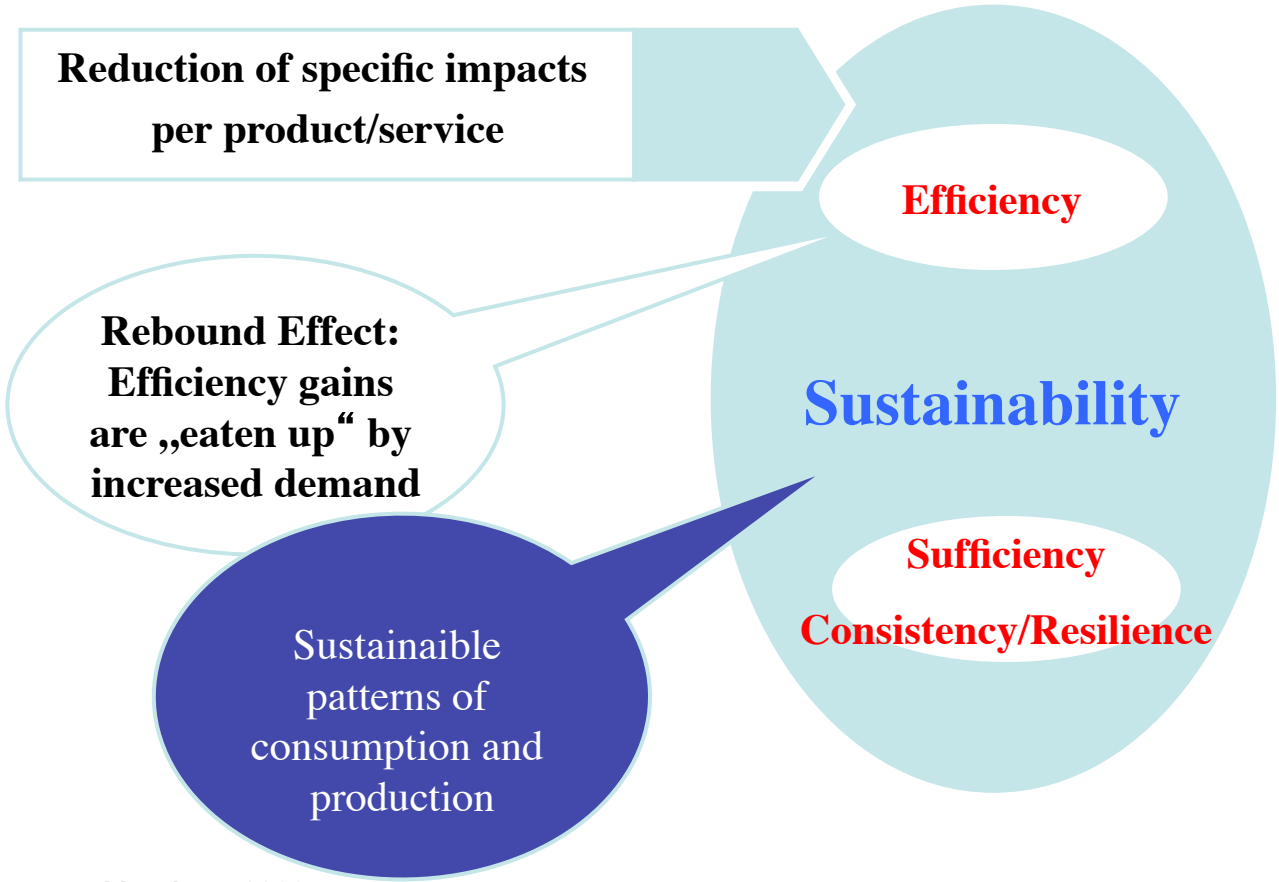
Global market volume for environmental technologies in 2007 [EUR bn]

Source: Market studies, interviews with experts, Roland Berger

Is efficient sufficient?

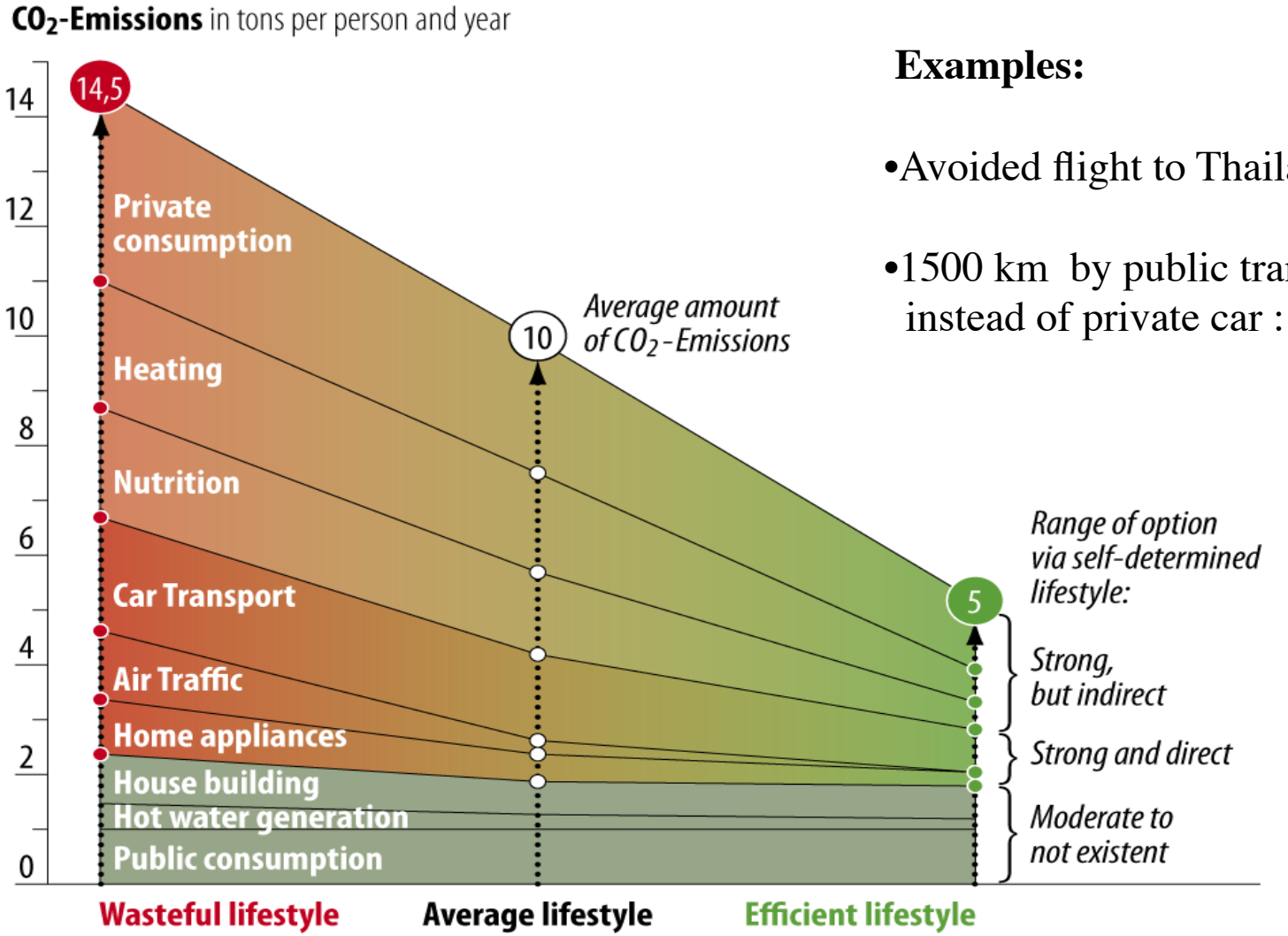
1980-2000: 25% less energy/raw materials per $ GDP – “eaten up” by 82% global economic growth!

The combination “efficiency + sufficiency + consistency” leads to sustainability



Source: Wuppertal Institute 2009

“European Lifestyle”:The scope for different consumption patterns to reduce $C0_2$ in EU 25



Source: Wupperal Institute 2007

Examples:

- Avoided flight to Thailand : - 5t/C02
- 1500 km by public transport instead of private car : - 1.5 t/C02

Policies to reduce rebound effects

- System adjustments
  - Direct:
    - Binding energy saving targets (EU 2011, SRU 2011, Linz/ Scherhorn 2011)
    - Reduction of subsidies for conventional energy
    - Caps, e.g. dynamic standard for fleet consumption (EU car)
    - Cap and trade
    - Progressive standards (e.g. ICT)
    - Electricity customer accounts (SRU)
    - Bonus/malus regulations („feebates“)
    - Ecotax
  - Indirect:
    - Structural change to less resource intensive sectors (i.e. services)
    - Promotion of renewable energy in complementarity with energy efficiency
- Behavioral change
    - Sustainable consumption, promotion of common goods
    - Reducing societal disparities (e.g. income, wealth, access)

Wuppertal Institute
for Climate, Environment
and Energy

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