Wuppertal Institute
for Climate, Environment
and Energy

Transitions towards sustainable energy systems: Development of visions, goals and strategies

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Outline

- The Wuppertal Institute
- Motivations. Why are Energy Transitions needed?
- One ‘real experiment’: the German ‘Energiewende’
- The role of scenario techniques in Energy Transitions

Mission of the Wuppertal Institute
Inter- and transdisciplinary Sustainability Research

- The WI explores and develops models, strategies and instruments to support a sustainable development at local, national and international levels.
- Sustainability research at the WI focuses on ecology and its relation to economy and society.
- Our research analyses and initiates technological and social innovations that decouple economic growth from nature use.

➡ **Scientific policy consulting (think tank): no university**

➡ **Independent connecting point between basic science (universities) and policy/business**

Science Company Wuppertal Institute
Locations

Where we are?

Wuppertal headquarter

Berlin Office

Integrated perspective requires interdisciplinary staff
The Team in 2014

ca. 200 Staff members

President Prof. Dr. Uwe Schneidewind

Scientific Disciplines
- Natural sciences
- Environmental sciences
- Geography
- Systems sciences
- Engineering sciences
- Planning sciences
- Economics
- Political science and law
- Social sciences

Further team members
- Scientific Services
- Administrative Services
- Ph.D. students
- Research students and trainees

Research Topics and Organisation
Research Groups, Focus Subjects, Cross Cutting Subjects

Future Energy and Mobility Structures

Focus subjects:

- New energy carriers and fuels
- Technologies and systems integration

RG1

Energy, Transport and Climate Policy

Focus subjects:

- Policy instruments especially for climate protection and energy efficiency
- Future energy and mobility services

RG2

Cross Cutting Subjects

- Transition research as a reference frame
- Focus on urban transitions & industry transitions

Material Flows and Resource Management

Focus subjects:

- Increasing resource productivity without problem shifting
- Integrated assessment of resources and land use

RG3

Sustainable Production and Consumption

Focus subjects:

- Resources and sustainability management
- Changing patterns of action in production and consumption

RG4

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Motivations to Energy Transitions [towards low-carbon energy systems] – Globally

- Climate change
  - Energy sector responsible for ca. 30% of total global GHG emissions by 2010 [IPCC report 2014]

- Energy poverty
  - 0.9 billion people lack access to reliable electricity
  - 2.4 billion people relies on non-solid fuels as main source of energy [SE4All tracking framework 2013]

- Geopolitical stability
  - A significant part of the global supply of fossil energy carriers is coming from political instable regions

Motivations to Energy Transition – in the EU Context

Commitment to the 2°-target of the EU

„In order to be in line with the 80 to 95% overall GHG reduction objective by 2050, the Roadmap indicates that a cost effective and gradual transition would require a 40% domestic reduction of greenhouse gas emissions compared to 1990 as a milestone for 2030, and 80% for 2050."

[EU Roadmap towards low carbon economy 2050]

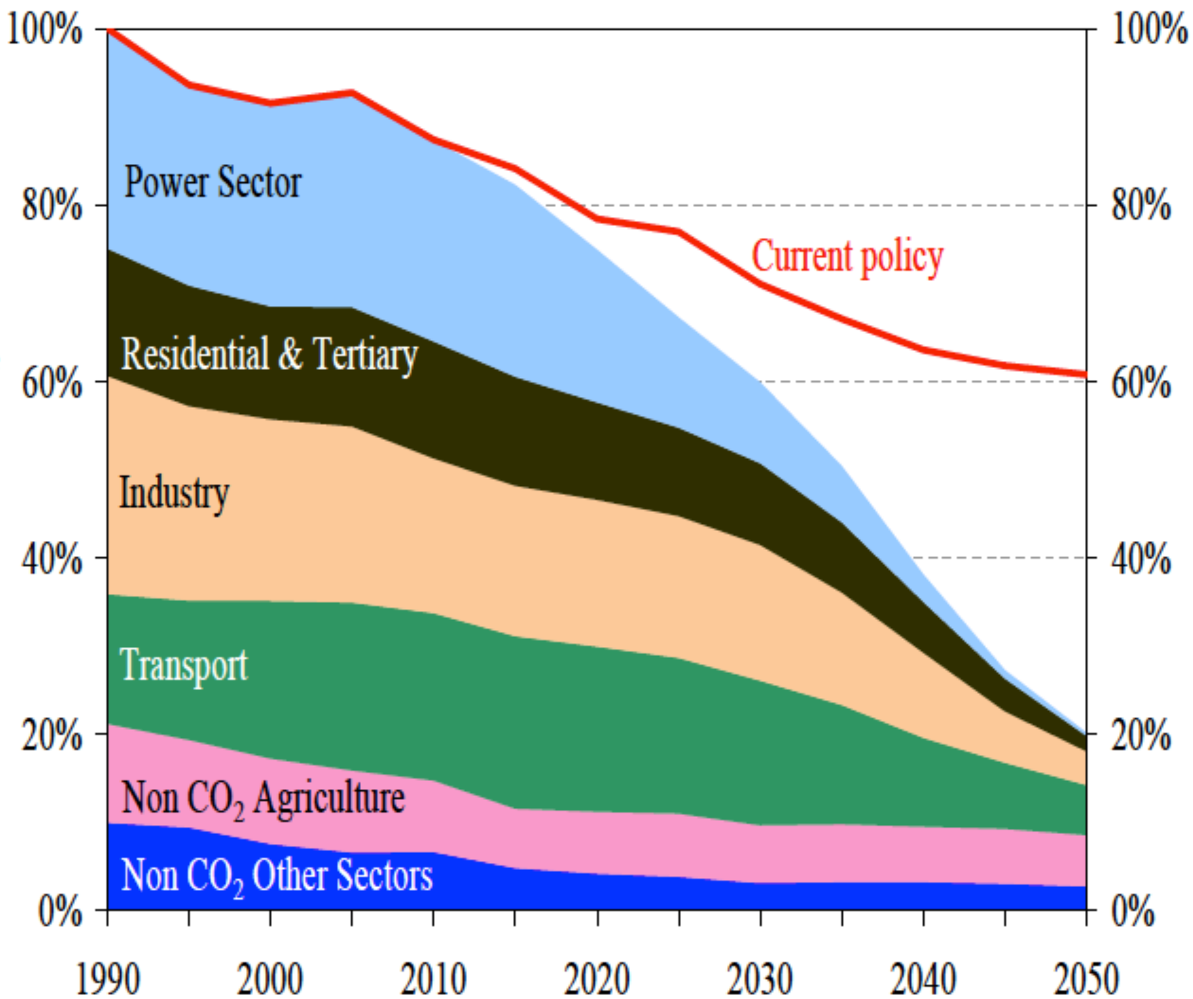
A cost-efficient pathway towards 2050

80% domestic reduction in 2050 is feasible

- with currently available technologies,
- with behavioural change only induced through prices
- If all economic sectors contribute to a varying degree & pace.

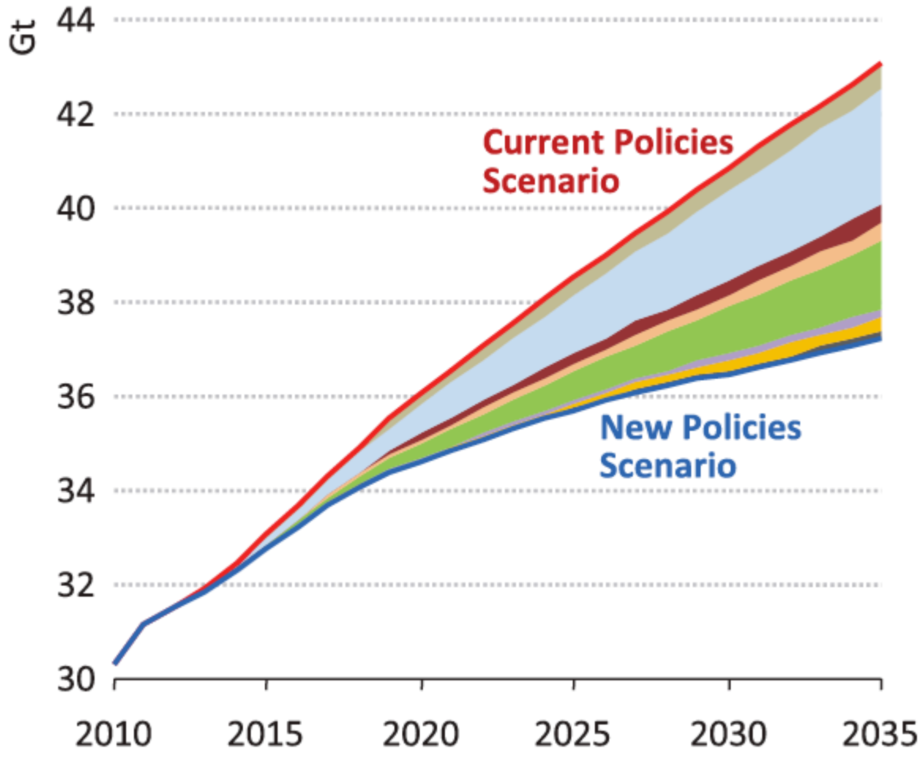
Efficient pathway:

-25% in 2020
-40% in 2030
-60% in 2040



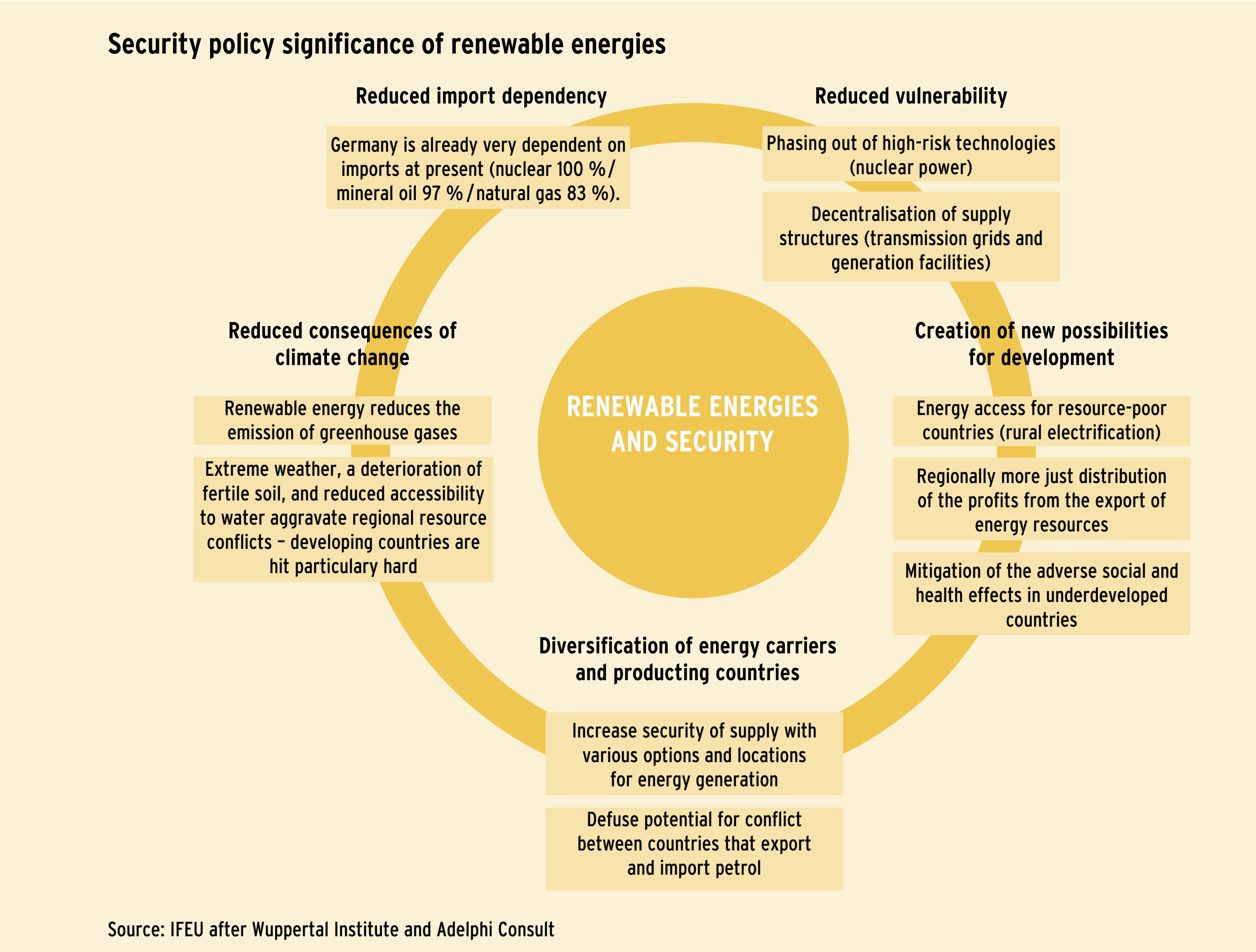
Energy efficiency and renewables: The main keys for Energy Transitions

Figure 7.16 ▷ World energy-related CO_2 emissions abatement in the New Policies Scenario relative to the Current Policies Scenario



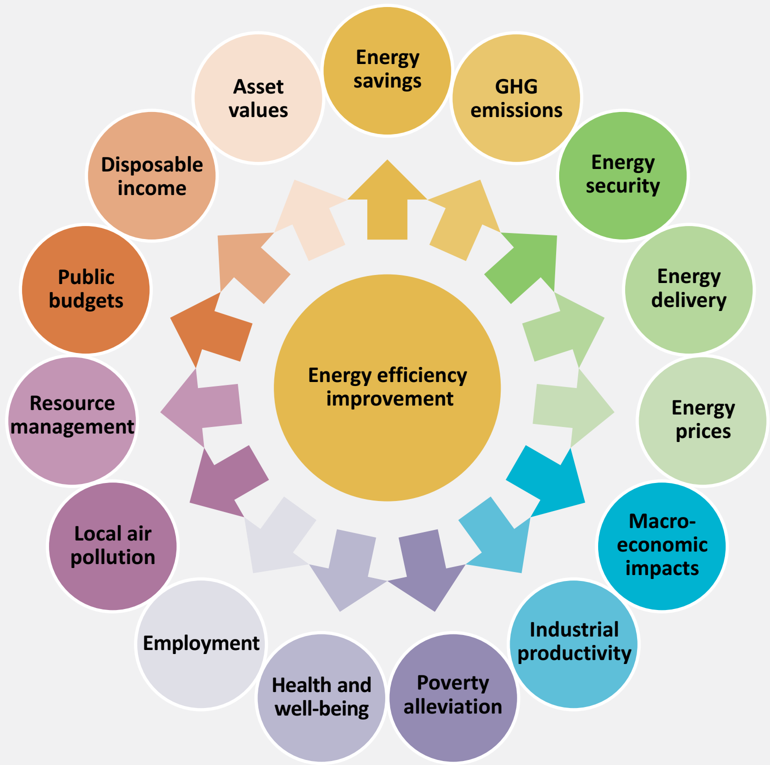
CO_2 abatement	2020	2035
Energy service demand	16%	9%
End-use efficiency	42%	42%
Supply efficiency	8%	7%
Fuel and technology switching in end-uses	6%	6%
Renewables	21%	25%
Biofuels	3%	3%
Nuclear	3%	5%
CCS	1%	2%
Total (Gt CO_2)	**1.5**	**5.9**

Co-benefits from increasing share of renewable energy in the system



Co-benefits from energy efficient measures

Figure ES.2 The multiple benefits of energy efficiency improvements



Note: This list is not exhaustive, but represents some of the most prominent benefits of energy efficiency identified to date.
Source: Unless otherwise noted, all material in figures and tables in this chapter derives from IEA data and analysis.

Key point A multiple benefits approach to energy efficiency reveals a broad range of potential positive impacts.

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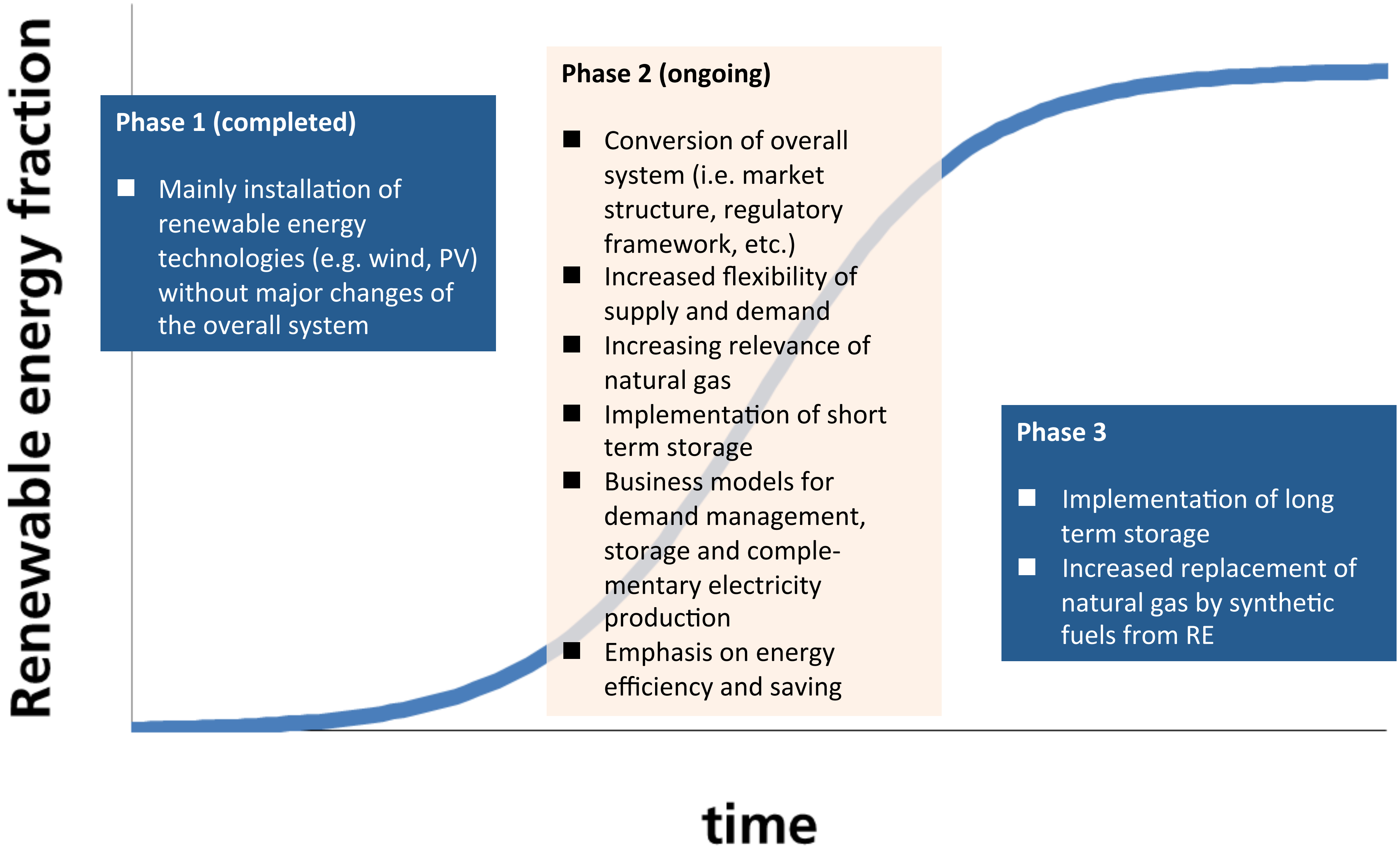
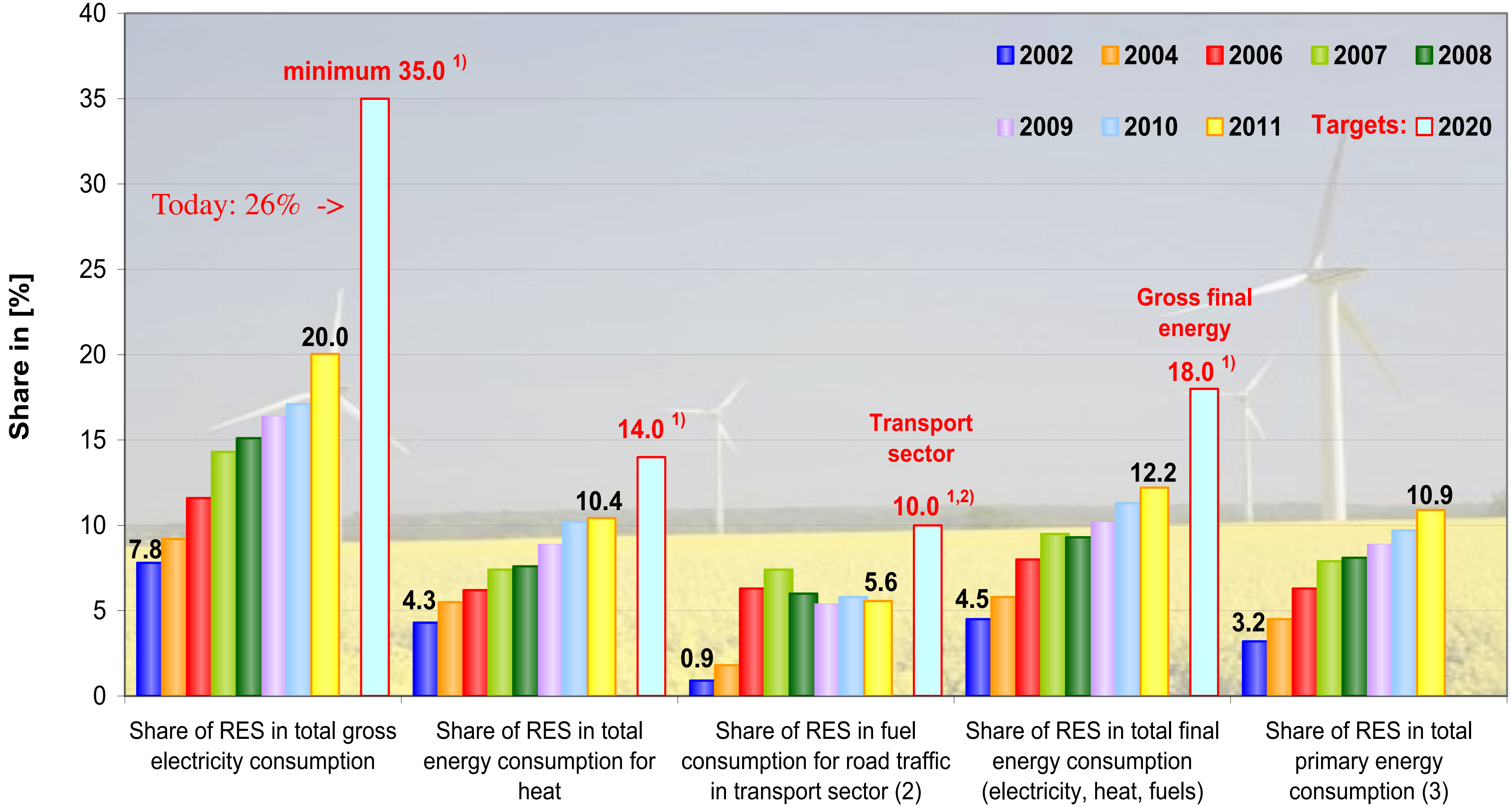
Energy system transition is a complex and multi-step process which ends up in fully renewable energy dominated system

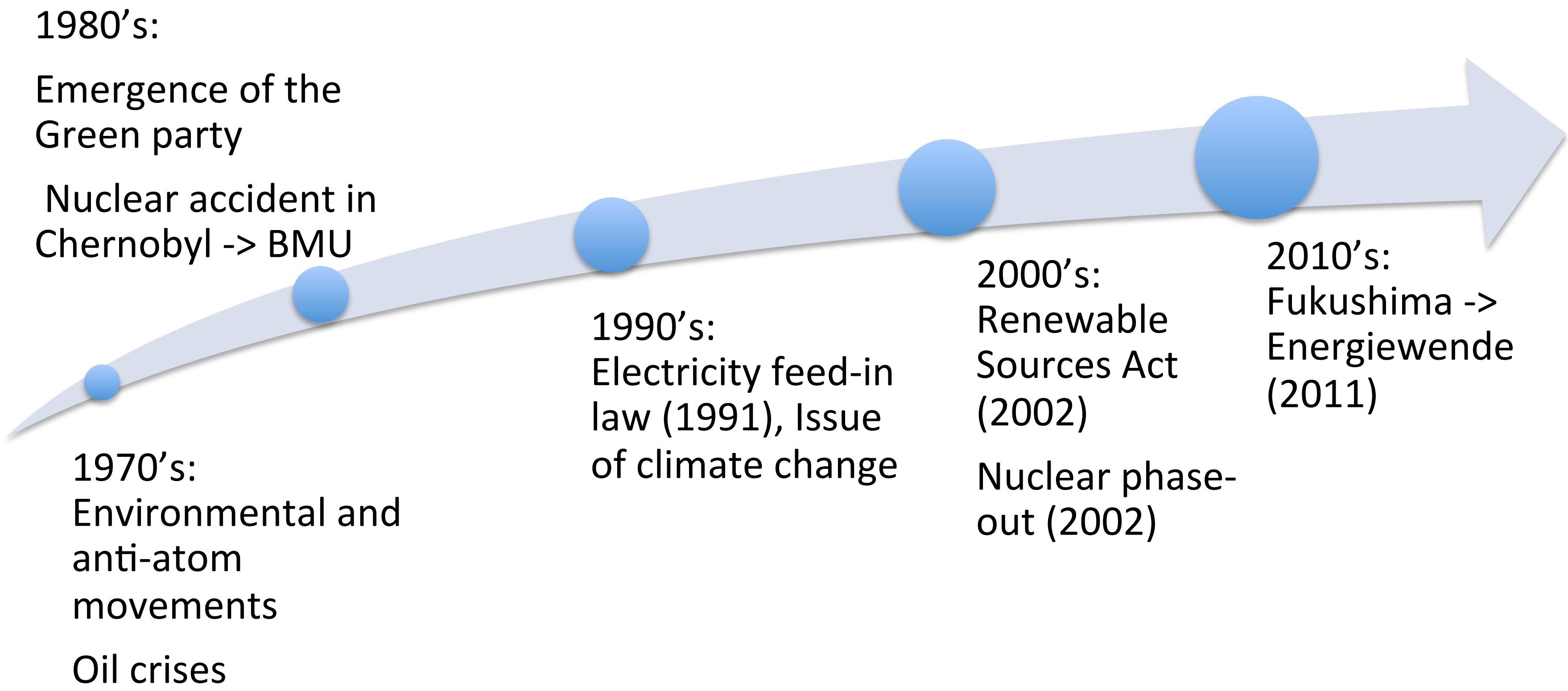


Renewable energy sources as a share of energy supply in Germany



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

From environmental movements to “Energiewende”



The role of science in the transition process:

Four "Enquete-Commisions" of the German Bundestag

A long history of (controversial) scientific and political discussions

Features of Enquete-Commissions: about 24 members (50%MPs; 50% experts; public hearings; scientific assessments and reports; more or less impact on public opinion)

- **1981 to 1983: Enquete Commission on "The Future of Nuclear Energy"**
- **1987 to 1995: Two Enquete Commissions on "Preventive Measures to Protect the Earth's Atmosphere" and on "Protecting the Earth's Atmosphere"**
- **2000 to 2002: Enquete Commission on "Sustainable Energy in the Context of Liberalisation and Globalisation"**
- **A shift of scientific and public opinion:**

➢ **1981 to 1987: nuclear phase advocated only by a small minority (Öko-Institute/ Freiburg)**
➢ **1987 to 1995: heated debates within the research and political community**
➢ **2002 ff: a majority of researchers support the "Energiewende" driven by public protests**

Participation of research and the civil society

Fostering the "Energiewende" by four national dialogs and moderated processes

Ethic-Commission 2011:
"Energiewende Deutschlands – Ein Gemeinschaftswerk für die Zukunft"
→ public participation is key!

- **Trialogue Energiewende (**Humboldt Viadrina School of Governance**)** since March 2012 / time frame: 1,5 years
- **Platform Energiewende** (Trans-disciplinary Panel on Energy Change; Institute for Advanced Sustainability Studies) since March 2012
- **Agora Energiewende** (Mercator Foundation and European Climate Foundation) since June 2012 / time frame: 4 years
- **Helmholtz-Dialogue** (Helmholtz-Allianz – ENERGY-TRANS-Future Infrastructure of the energy supply) since June 2012 / time frame Helmholtz-Allianz: 5 years
- **Climate protection plan North Rhine-Westphalia** (NRW, Wuppertal Institute), since August 2011 to February 2012

  - General goals: Dissemination, participation, conflict mediation
  - Similar target groups: civil society, industry, policy makers, media
  - Partly including research activities with high budgets
  - Public access/participation differs

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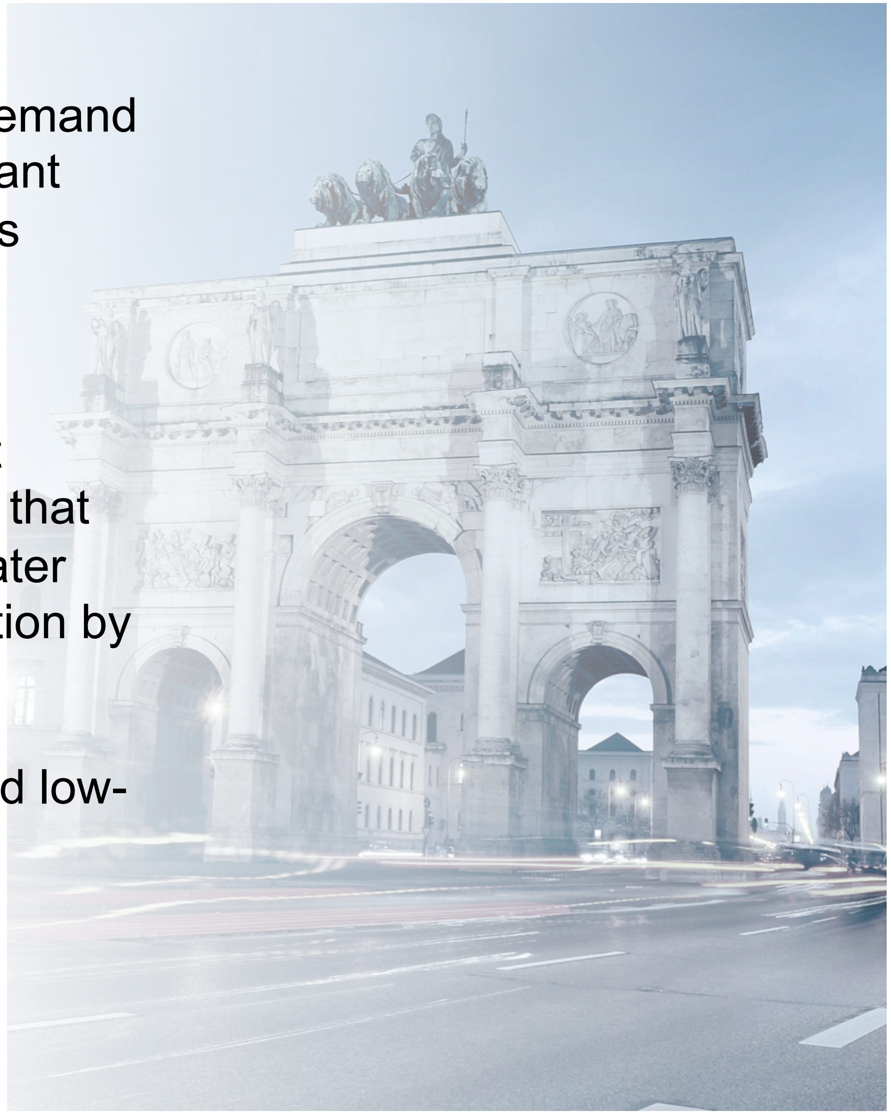
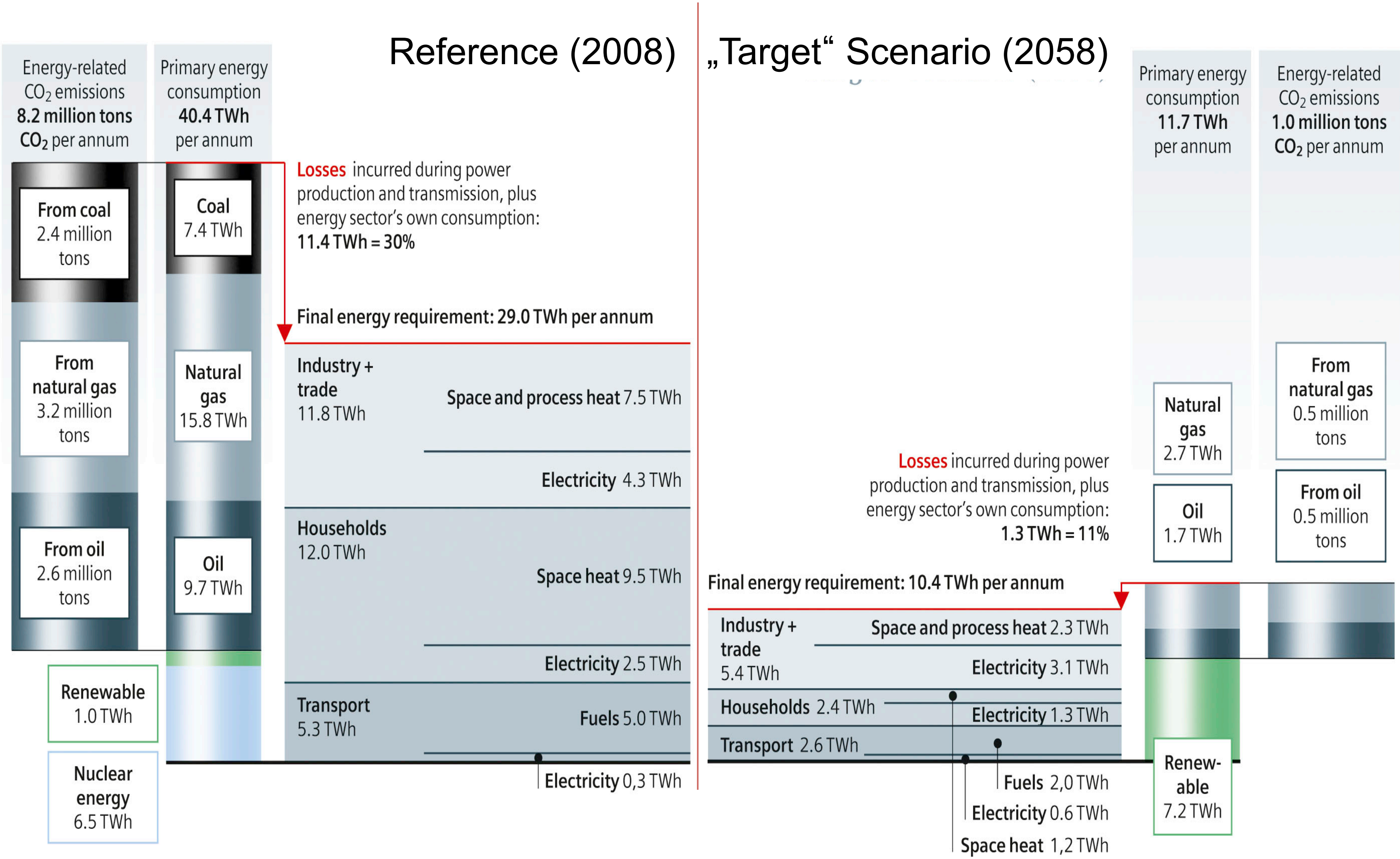
Concepts and visions - Sustainable Urban Infrastructure Munich
Three Guiding Principles for redesigning Urban Infrastructures

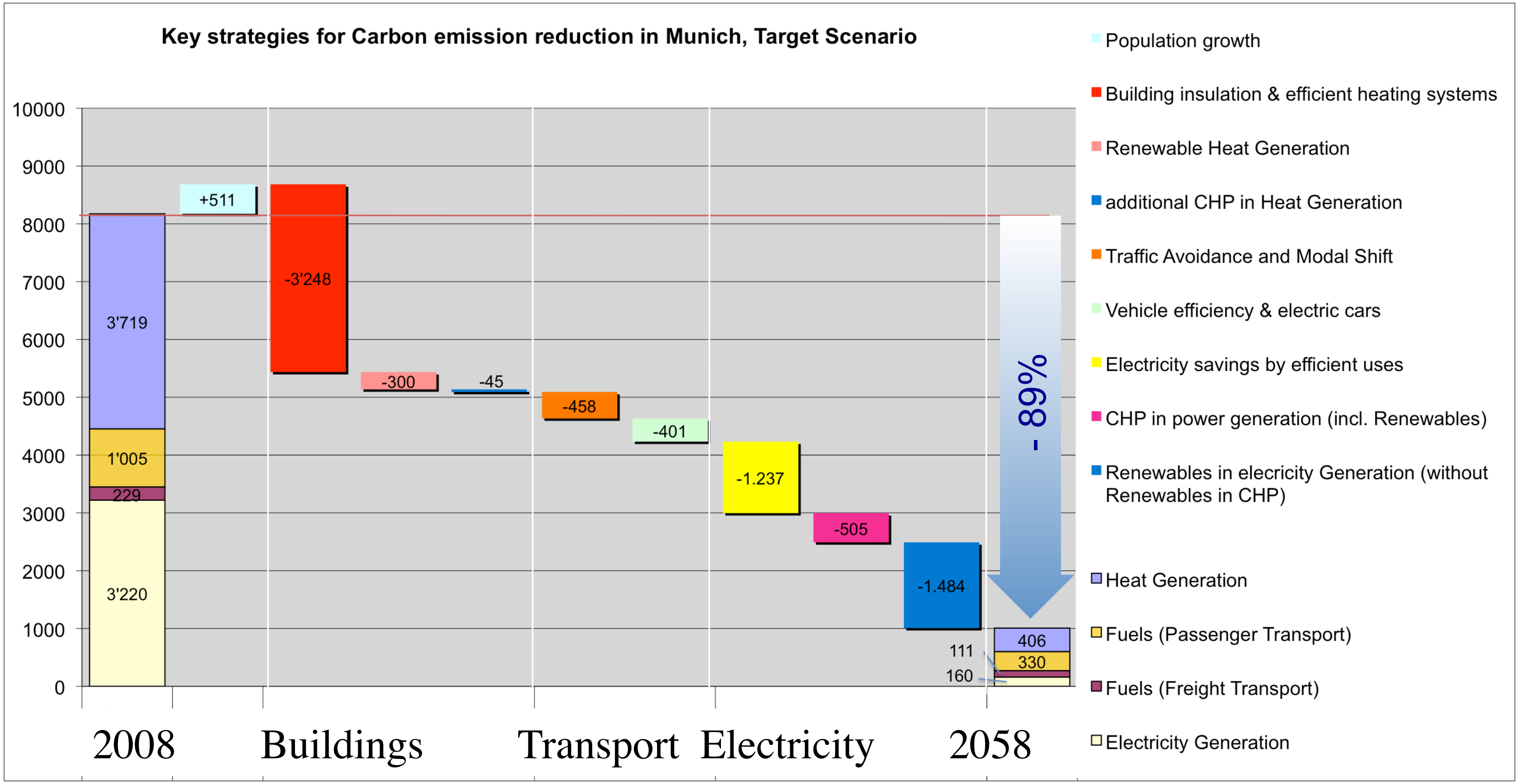


- Become **highly efficient in all sectors** of demand (households, service sector, industry if relevant and transport); i.e. significantly less energy is consumed to achieve the same level of convenience and utility.
- **Adapt** their heating, electrical, and transport **infrastructures** to accommodate a demand that has been substantially reduced through greater efficiency and to support this demand reduction by appropriate infrastructure solutions.
- **Convert** their **energy base** to renewable and low-carbon energy sources.

Energy demand and related CO_2 emissions Target scenario

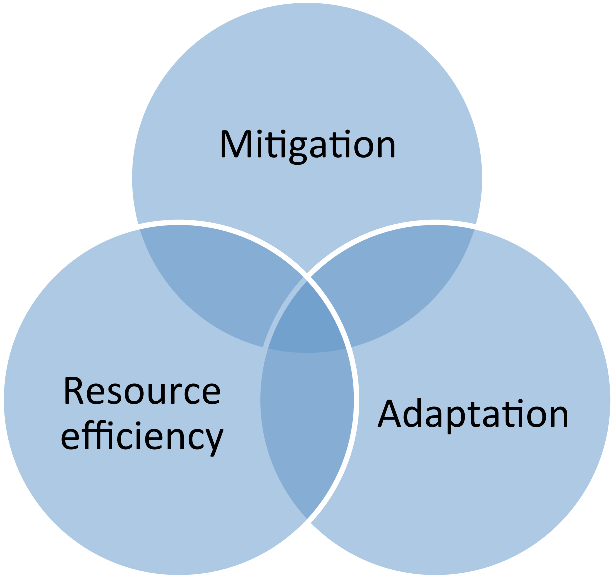


Contribution of main strategies for reaching the target goal



Source: Wuppertal Institute 2009

Sino-German Low Carbon Future Cities (LCFC) 2011-2014:



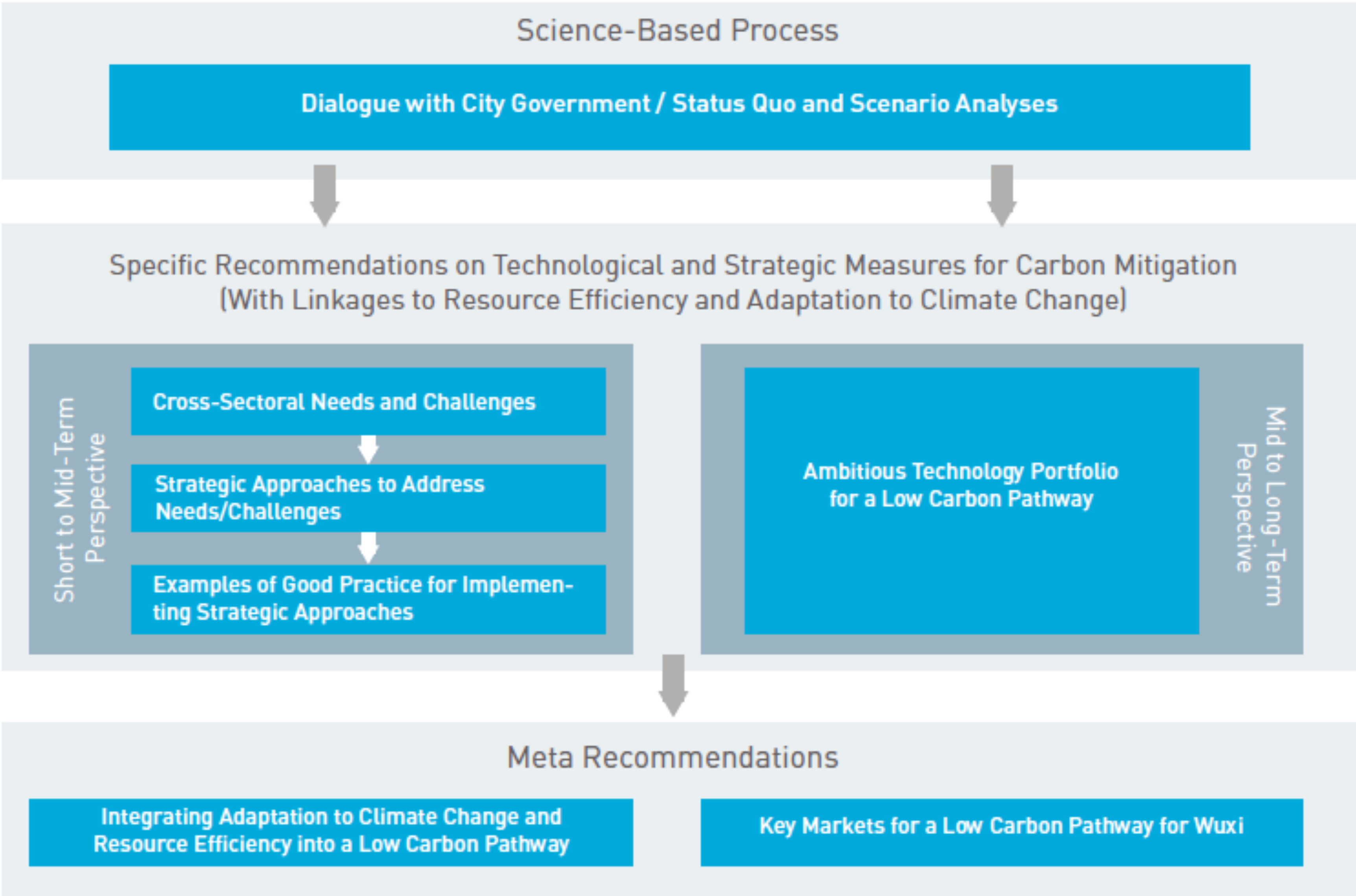
Main goal:
to develop an integrated **low carbon, resource efficiency and adaptation** strategy for two pilot regions, i.e. Wuxi in China and Duesseldorf+ region in Germany.

Scientific Analysis

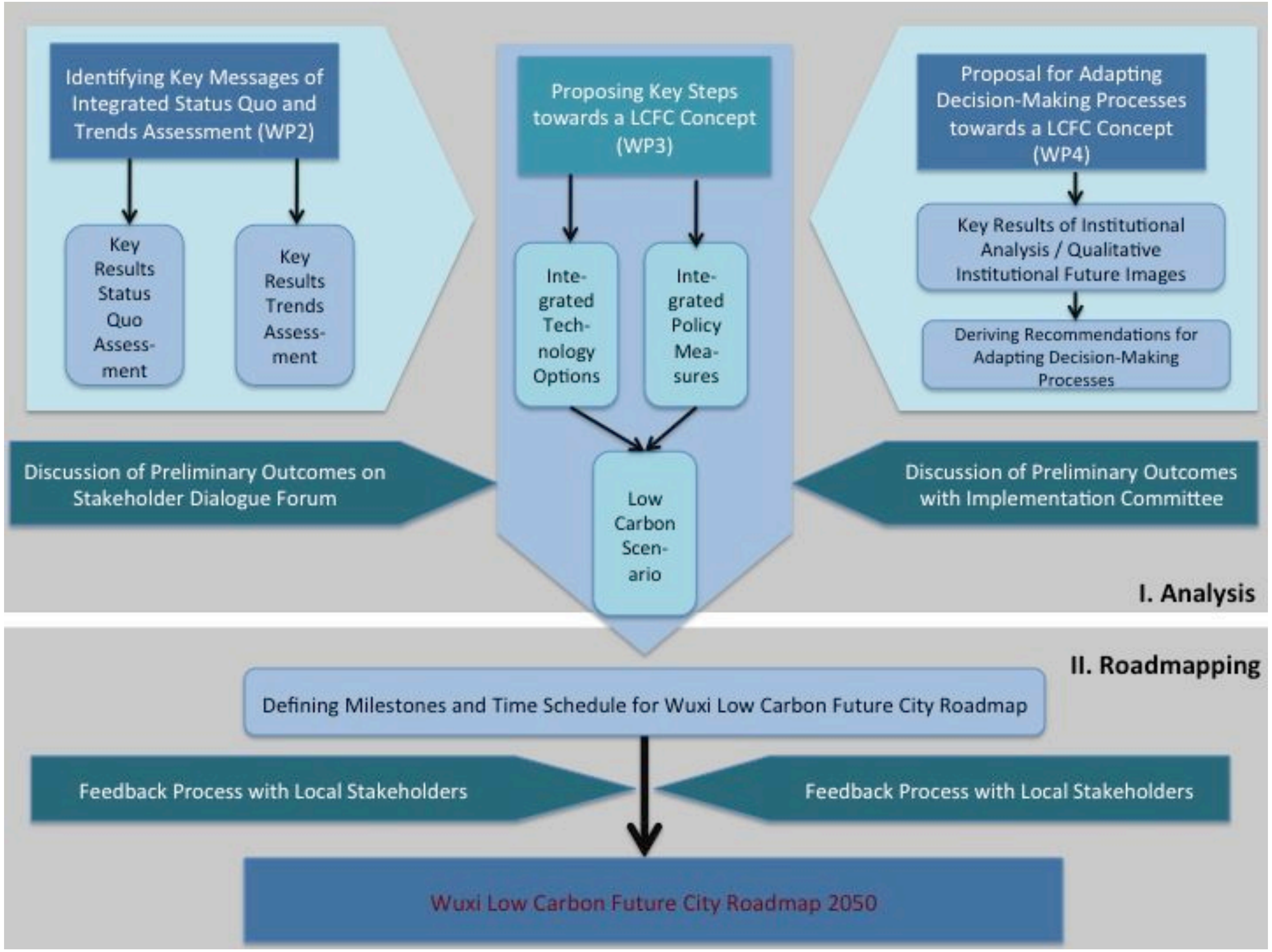
Stakeholder Dialogue

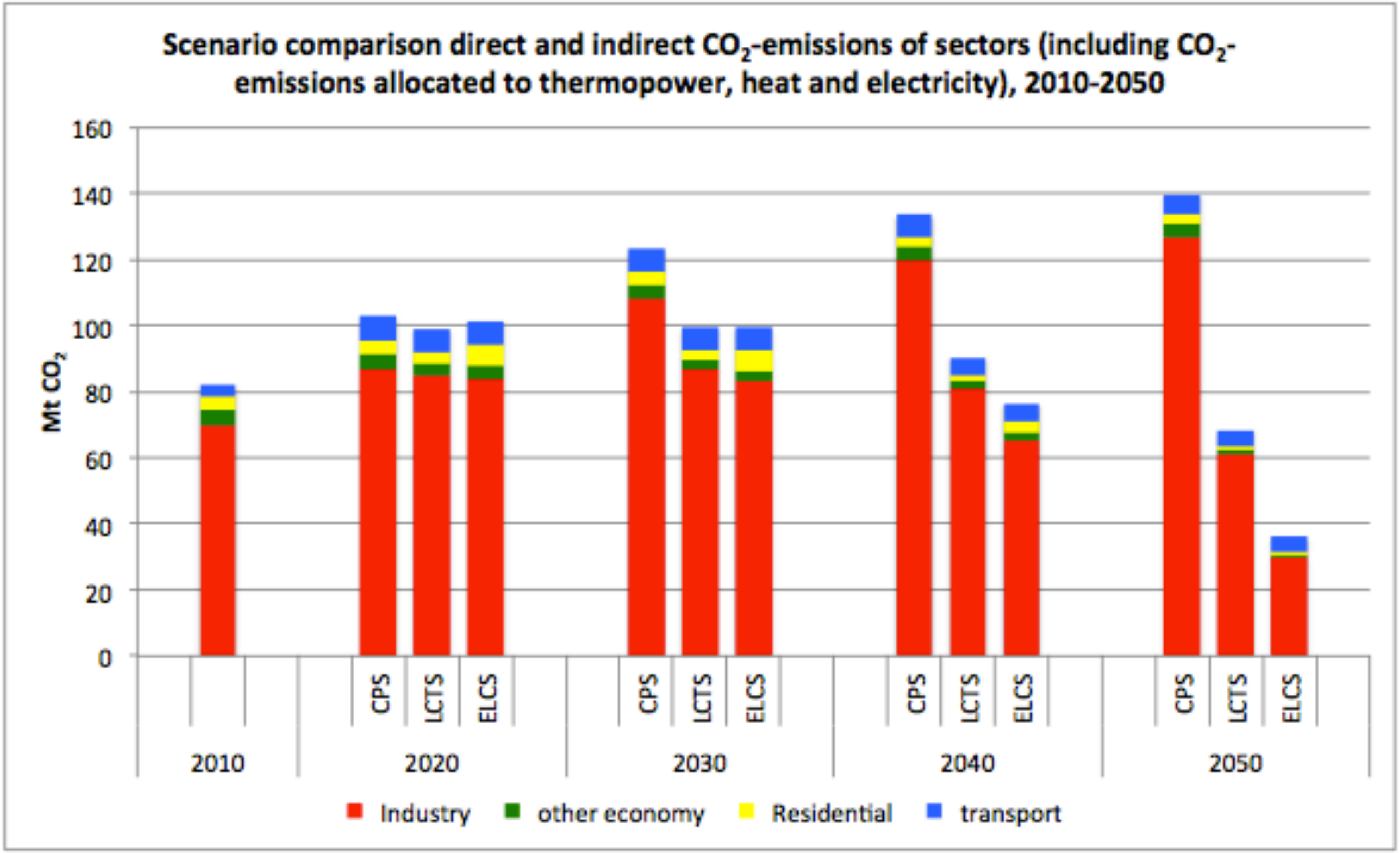
Low Carbon Business Model

Process of Developing the Integrated Strategy for Wuxi



Conceptual overview
Development of Low Carbon Future Scenario in a systematic and particpatory process





Scenario comparison direct and indirect CO_2-emissions of sectors (including CO_2-emissions allocated to thermopower, heat and electricity), 2010-2050
Mt CO_2
160
140
120
100
80
60
40
20
0
CPS
LCTS
ELCS
2010
2020
2030
2040
2050
Industry
other economy
Residential
transport

Manual: Lessons learnt from low carbon city project
低碳城市行动指南

LESSONS LEARNT
FROM A SINO - GERMAN LOW CARBON CITY PROJECT:

A MANUAL

LOW CARBON FUTURE CITIES
A Sino-German Cooperation on an Integrated Climate and Resource Proof Urban Development
www.lowcarbonfuture.net

Funded by
Stiftung Mercator

Philosophy of Wuppertal Institute Scenario Work

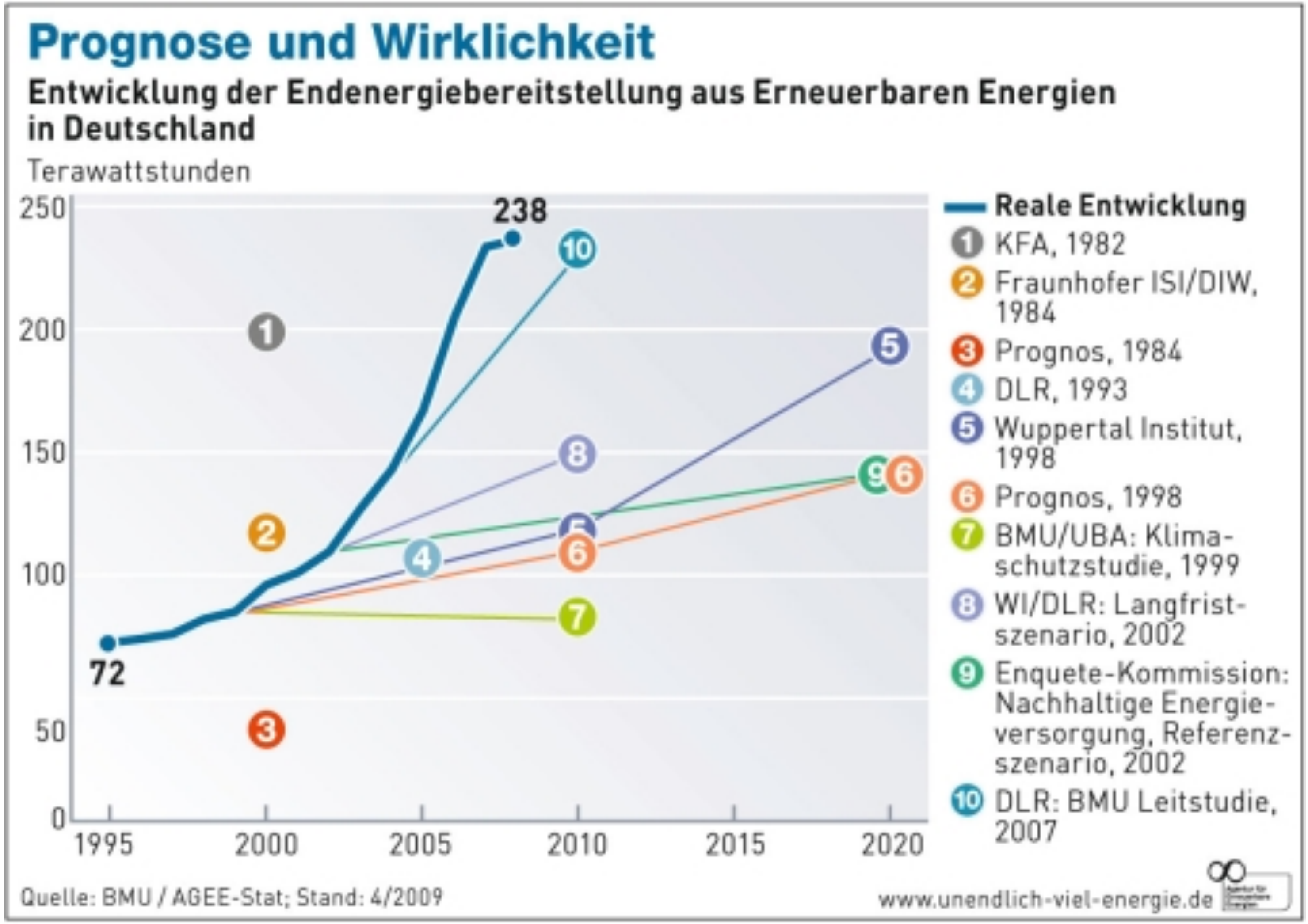
- Scenarios are quite different from predictions
- Scenarios are asking “what happens if ….”
- Scenarios are based on a consistent set of assumptions which should be outlined transparently
- Scenarios are necessary
  - to pick up future uncertainties
  - to identify the corresponding range of possible future paths (including the branching points)
  - to describe the major impacts and dangers of those paths
  - to deal with new challenges and significant changes of crucial frame conditions
  - to gain more experience about the manifold interactions in the system
  - to enable an elaborate discussion about suitable policy and technology strategies following defined targets
- Scenarios should include a broad spectrum of opinions and expert views from different stakeholders (e.g. via interviews)

Scenario analysis – how to approach

- Determination of technical potentials
  - Dynamic instead of status Quo potential analysis: Potentials are changing within the time frame and depending from ecological restrictions
- Learning curves are crucial for long term scenarios
  - Consideration of learning curves due to decreasing CO2-avoidment cost
- Comparison of technological options on the time frame taking policy instruments and changing frame conditions into consideration (Promotion of technological innovations, subsidies for fossil energies)
- Assessement of the efficiency of limited ressources taking an integrated perspective into consideration
- Looking behind the border - global link and international cooperation (e.g. the regional utilization of renewables has to be integrated timely in supraregional and trans-European utilization systems)

Scenarios and reality

As a result of policy measures and unexpected technology developments reality can be faster than scenarios expect



Energy transition is not an autonomous process

Complex challenges at the implementation of the transformation processes

- **Technical challenges:** further development of technologies (e.g. storage and hybrid systems, forecast...)
- **Compatibility challenges:** Cooperation between conventional and new technologies and business models.
- **Investment challenges:** New financing mechanisms, early investment: pay now – earn back money later
- **Infrastructural challenges:** further development of infrastructures (e.g. smart and super smart grid)
- **Ressource challenges:** avoidance of negative ressource effects (critical ressources, toxic materials)
- **Stakeholder challenges:** change of existing stakeholder structures
- **Social challenges:** Social acceptance, participation, sustainable lifestyle and avoidance of rebound effects
- **Political challenges:** Integration of regional, national and international political initiatives (multi-level approach)
- **Innovation challenges:** System innovations instead of mere technical orientation

Source: Fischedick 2014

Conclusion

The possible role of scenarios in the context of scientific based policy consulting

- Identify robust technology and infrastructure paths
- Clarify the meaning of distinct technologies and strategies on the time scale (e.g. alternative fuels, efficiency improvements, renewable energies)
- Efficiency of distinguished renewable energy applications competing with each other (e.g. biomass, wind electricity)
- Impact of crucial elements on energy and transport system and infrastructures (e.g. fuel costs, learning curves)
- Assessment and analysis of “visions” (e.g. carbon free fossil energy future, hydrogen economy)
- Application of new scenario methodologies (e.g. online conduction of scenario based stakeholder dialogues) to embed politicians directly in the scenario process

Development of suitable energy and climate policies

Scenarios for the region

Source: http://en.wikipedia.org/wiki/Danube

What do we know about the RE potentials in the Danube region (theoretical, technical, economic potentials)?

Which scenarios are already existing?

What are robust findings and what are major uncertainties?

What are relevant questions which can and may be addressed by energy scenario analysis?

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Thanks for your attention!