Influence of the Increasing Renewable Energy Production on Instrumentation and Metrology for Oil and Gas

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Outline:

- The „Energy turnaround“ in Germany
- Renewable Energy sources in Germany
- Instrumentation and Metrology for Biofuels
- Summary and conclusion

1. The „Energy turnaround“ in Germany

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Autumn 2010:

Decision of the German government

„Withdrawal from the nuclear phase out“

1. The „Energy turnaround“ in Germany

***Fukushima* power-plant desaster 11 March 2011**

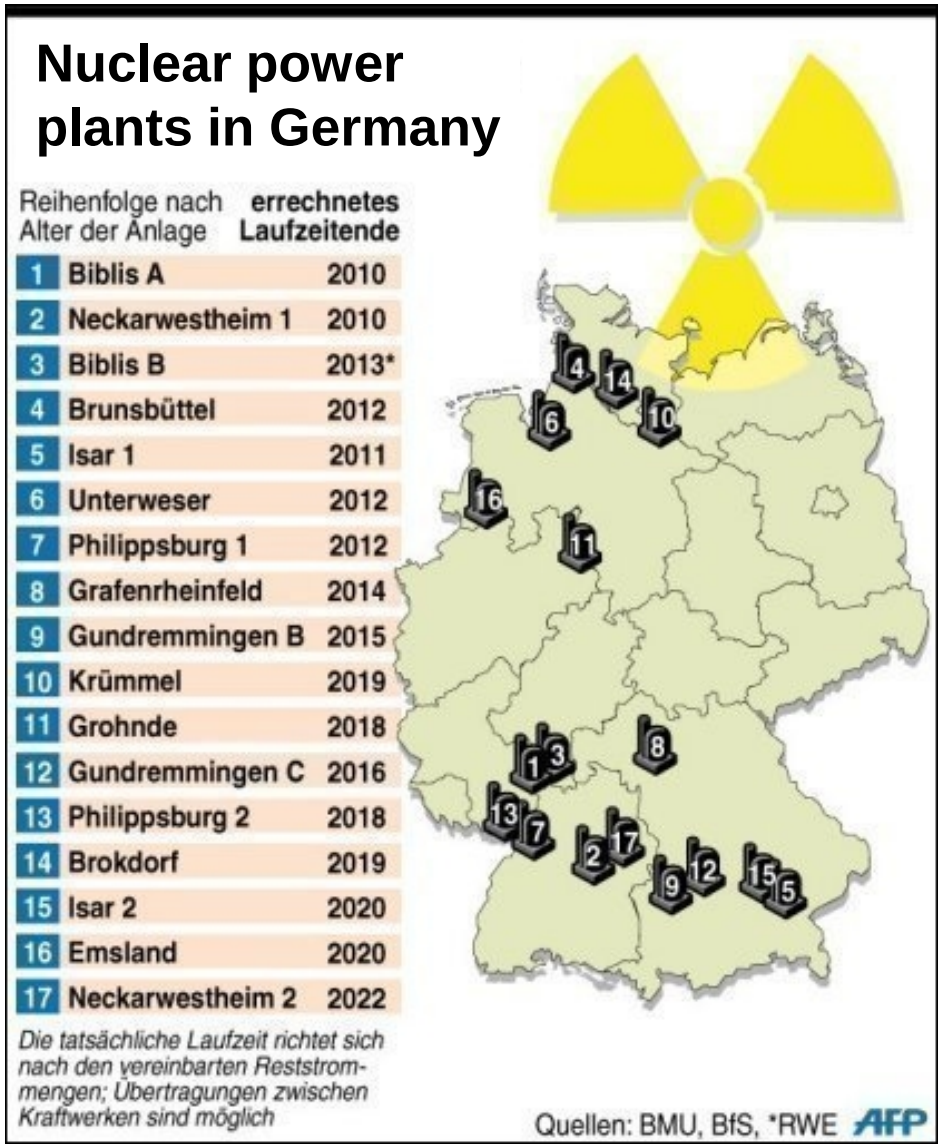
1. The „Energy turnaround“ in Germany

1. Three-months moratorium for discussions with experts
2. Stress tests of all 17 German nuclear power plants showed bad results (13 had to be modified)
3. 80% of the German population were in favor of nuclear phase out, 8 % against (opinion poll in June 2011)

1. The „Energy turnaround“ in Germany

Nuclear phase out until 2022 in Germany

- ⇨ **How to close the gap?**
- ⇨ **Need for more renewable energy**
- ⇨ **Need for a fast development**



Nuclear power plants in Germany

Reihenfolge nach Alter der Anlage		errechnetes Laufzeitende
1	Biblis A	2010
2	Neckarwestheim 1	2010
3	Biblis B	2013*
4	Brunsbüttel	2012
5	Isar 1	2011
6	Unterweser	2012
7	Philippsburg 1	2012
8	Grafenrheinfeld	2014
9	Gundremmingen B	2015
10	Krümmel	2019
11	Grohnde	2018
12	Gundremmingen C	2016
13	Philippsburg 2	2018
14	Brokdorf	2019
15	Isar 2	2020
16	Emsland	2020
17	Neckarwestheim 2	2022

Die tatsächliche Laufzeit richtet sich nach den vereinbarten Reststrommengen; Übertragungen zwischen Kraftwerken sind möglich

Quellen: BMU, BfS, *RWE AFP

1. The „Energy turnaround“ in Germany

(Publication from the German ministry for econ.)

= „Energy turnaround“ started in June 2011

(Progress? For sure.)

KEY FIGURES

7. EU ENERGY TARGETS: 20-20-20 BY 2020

20 - Reduction of the greenhous gas emissions by 20 % compared to 1990

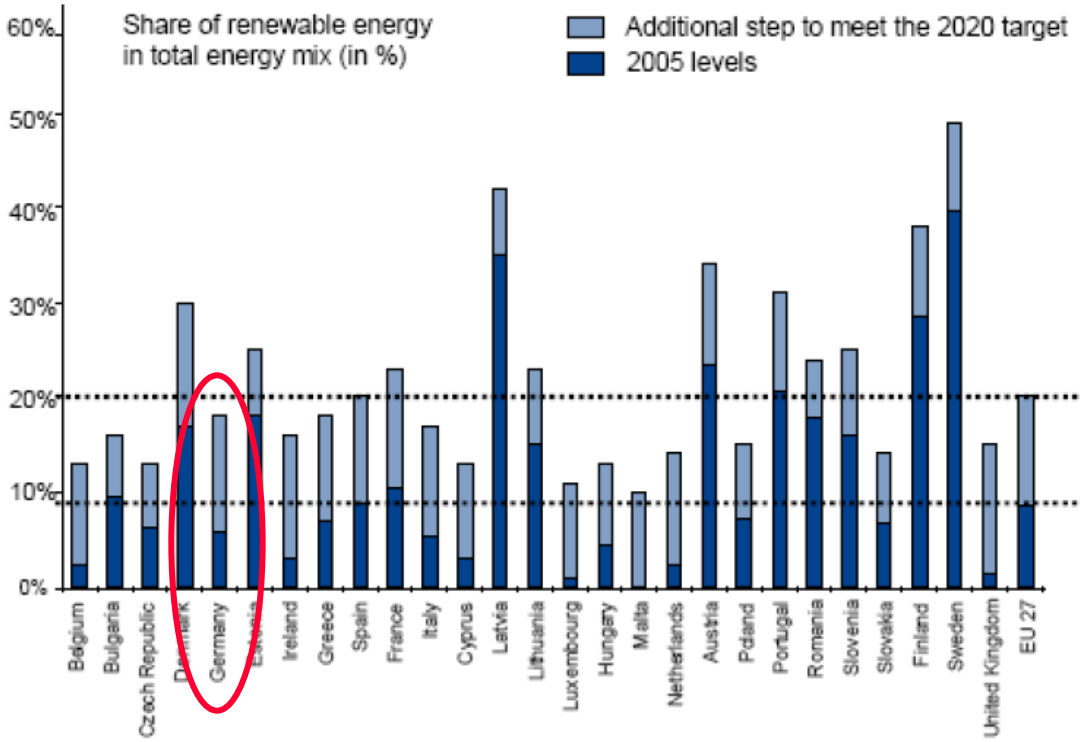
20 - 20 % increase in energy efficiency

20 - Increase the share of renewable energy sources in energy consumption by 20 % (as an average)

1. The „Energy turnaround“ in Germany

7. EU Energy targets 20-20-20 by 2020

✓ Increase the share of renewable energy sources in energy consumption to 20%



Germany:

increase from 10.9 % (2010) to 18 % (2020)

EU 2020

EU 2005

Source: Eurostat and European Commission

3. Renewable Energy sources in Germany

Renewable energies: goals of the German government

	RE share in electricity
At the latest	[%]
2020	at least 35
2030	at least 50
2040	at least 65
2050	at least 80

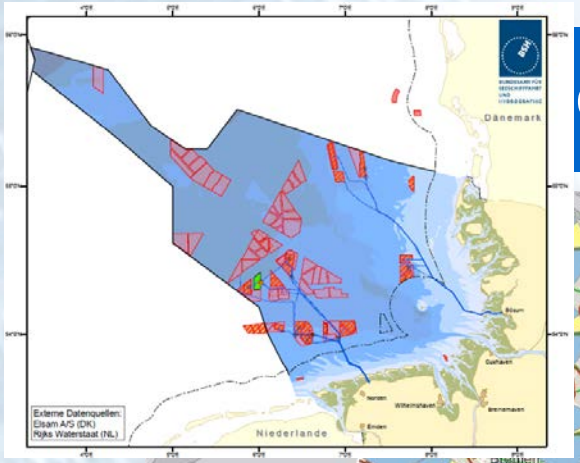
	RE share in gross final energy consumption
	[%]
2020	18
2030	30
2040	45
2050	60

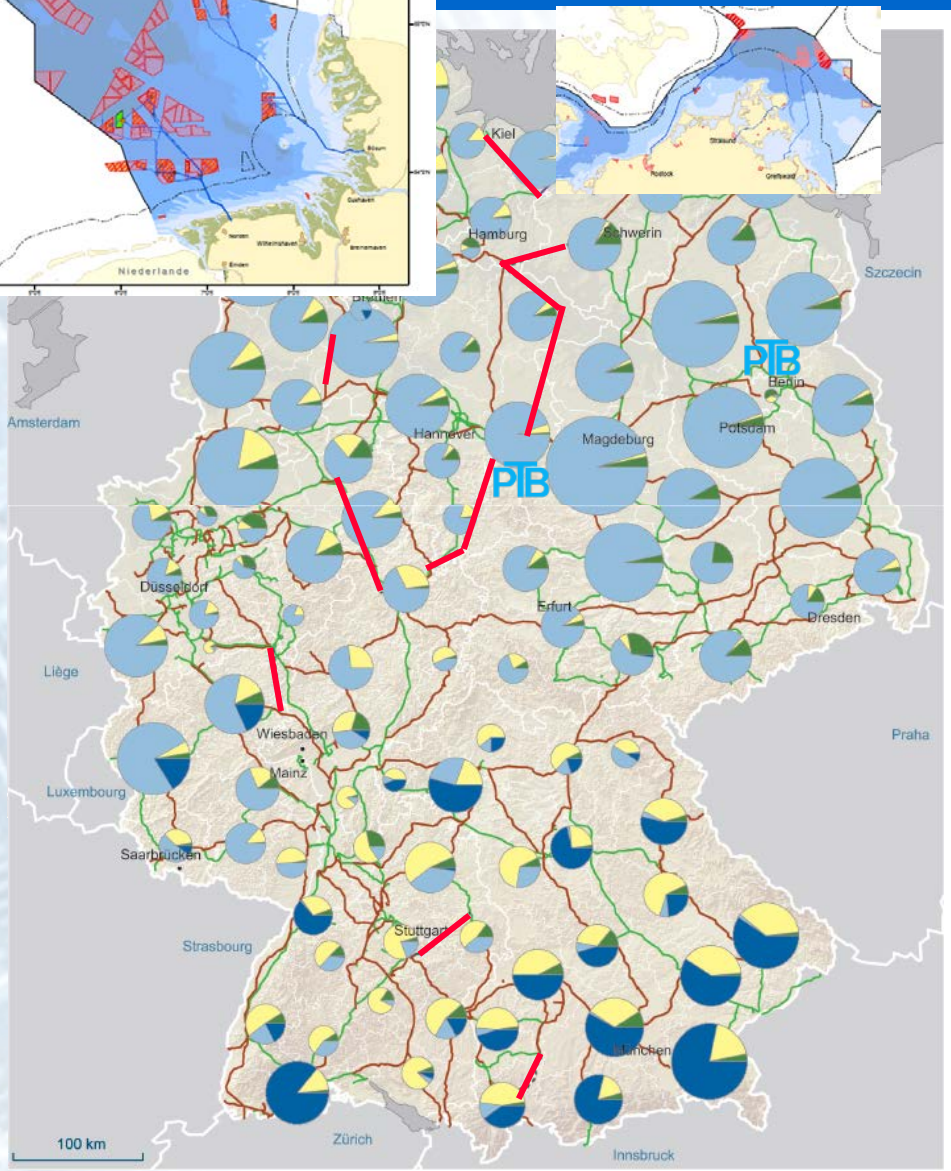
By 2020 the German government aims to raise the renewables' share in total heat supply to 14 percent, and to 10 percent in final energy consumption in the transport sector.

These targets will also help to lower greenhouse gas emissions in Germany by 40 percent by 2020 and by 80 to 95 percent by 2050 (compared to 1990). To this end, the government aims to reduce electricity consumption by 10 percent by 2020 and by 25 percent by 2050, while primary energy consumption is to fall by 20 percent by 2020 and 50 percent by 2050.

http://www.erneuerbare-energien.de/english/renewable_energy/downloads/doc/44744.php

e Energy sources in Germany





Installed electrical power: (renewable)

- Biomass
- Photovoltaics
- Wind
- Hydro

380 kV power line planned

(due to missing power lines sometimes wind mills have to be switched off!)

2. Renewable Energy sources in Germany

Study on long-term sustainable use potential of renewable energies:

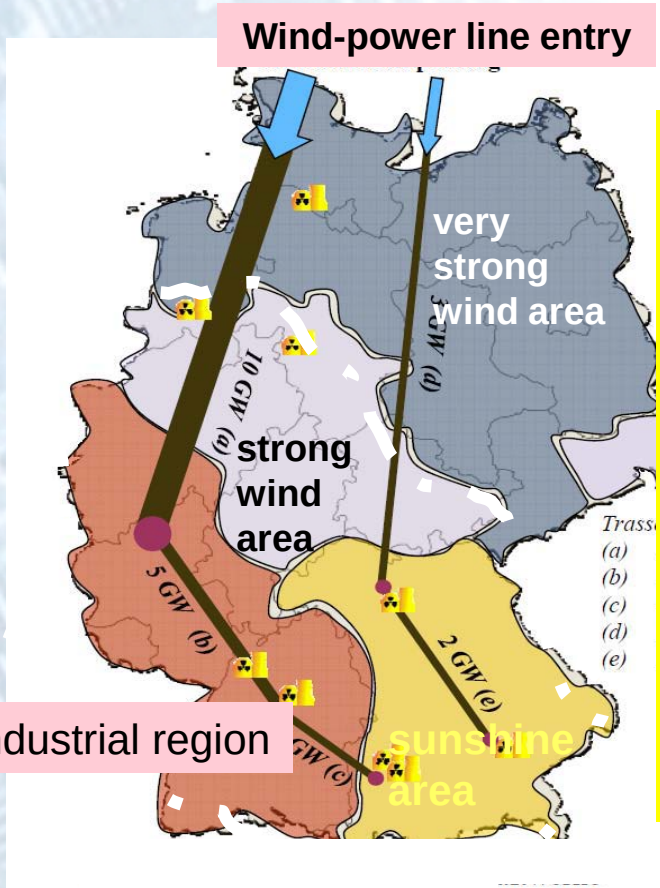
	2010:	Potential:
Electricity generation*:	17.0 %	128.3 %
Heat generation*:	9.5 %	61.1 %
Fuel generation*:	**5.8 %**	**14.5 %**
total energy generation*:	10.9 %	69.1 %

power to fuel?

⇨ **increase of efficiency necessary by > 30 %**

*share with respect to corresponding consumption in 2010

3. Instrumentation and metrology for biofuels



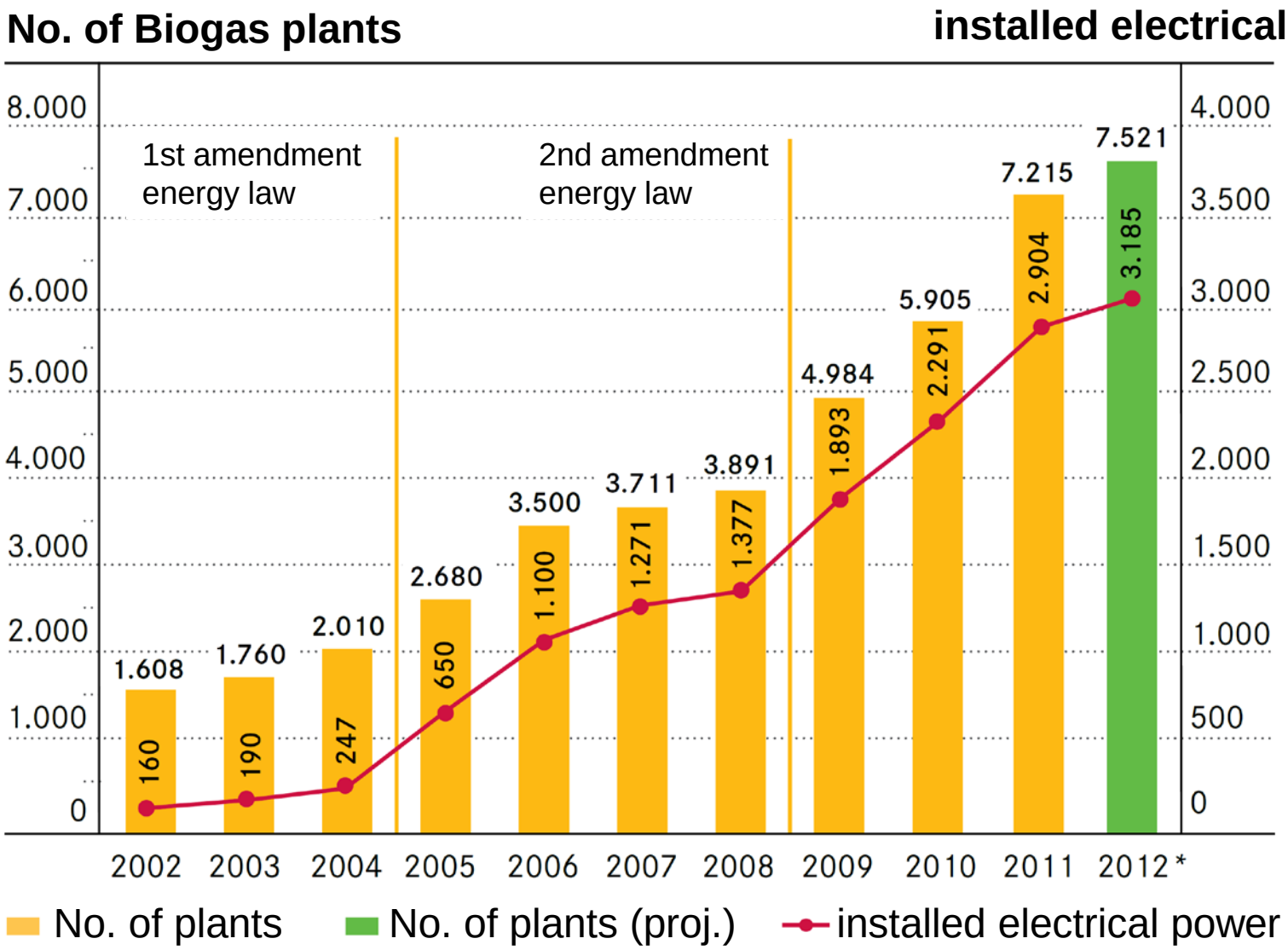
Source: Beck, EFZN

(German) gas grid can store chemical gas energy for some months; Grids cover Mid-Europe very well.

… and natural gas can be blended with up to 20% H_2

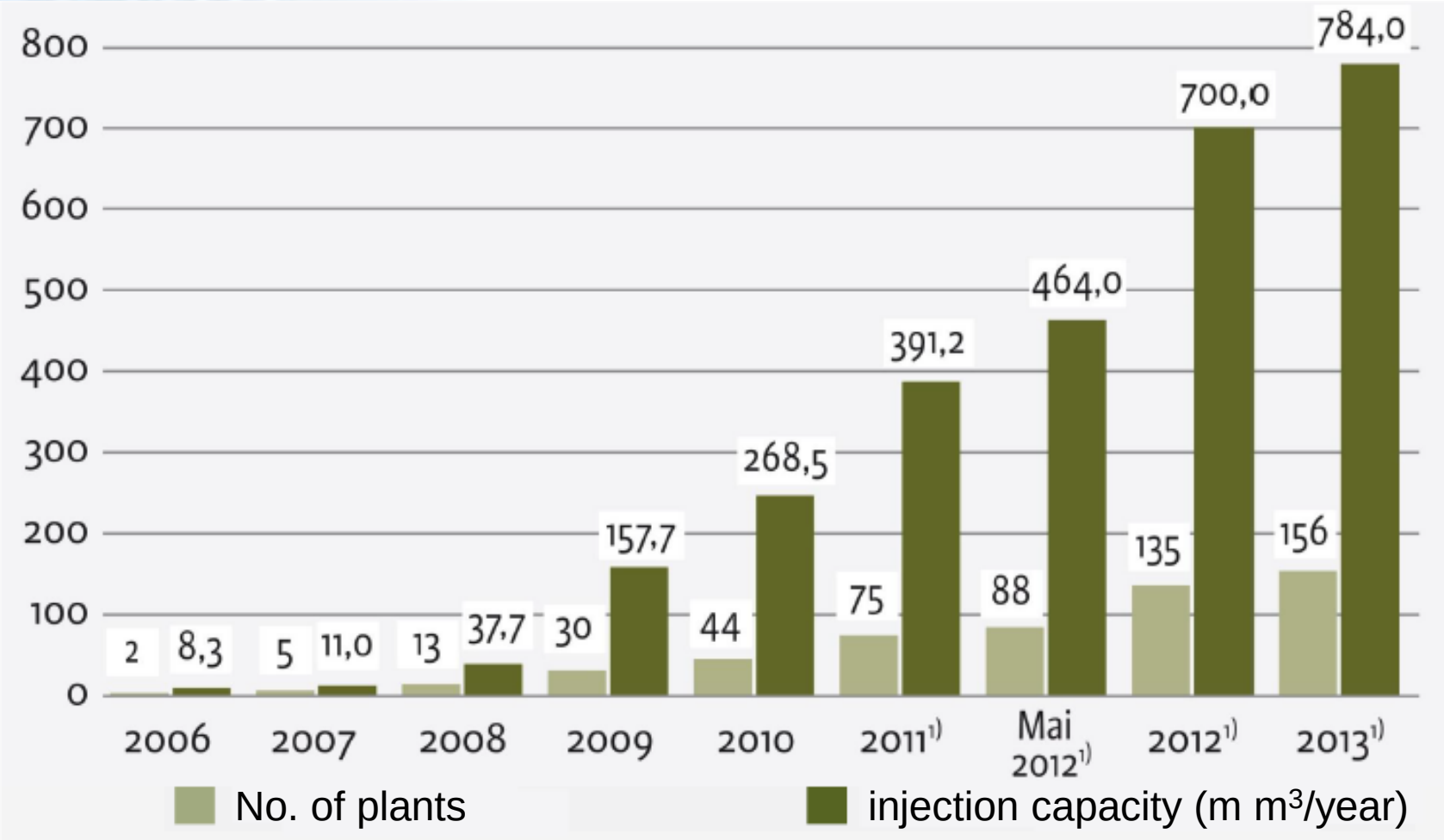
<u>The challenge:</u> Why not use excess wind or solar power by generating H_2 (or CH_4) and injecting it into the gas grid?

2. Renewable Energy sources in Germany

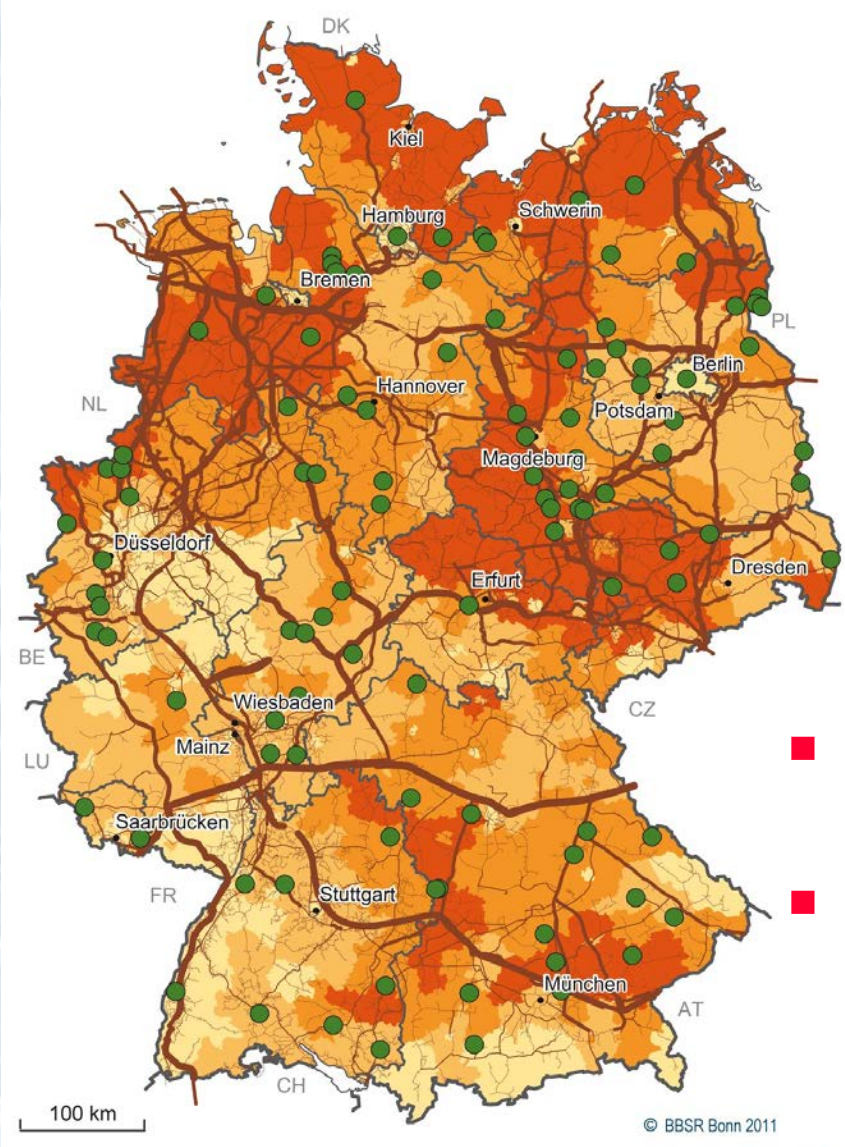


*projection

Injection of biogas into the natural gas grid



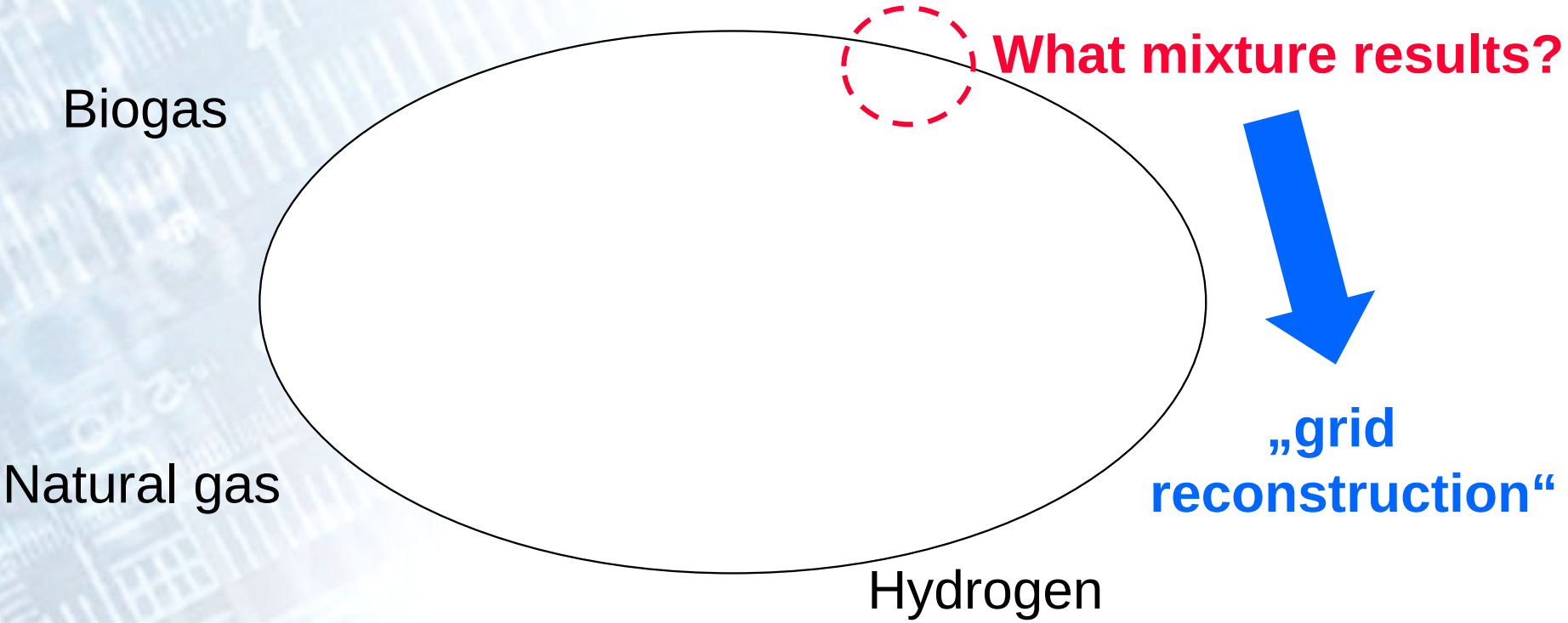
3. Instrumentation and metrology for biofuels



Decentralized biogas injection

- Biogas properties differ from natural gas‘ properties significantly!
- SMEs want to **know the energy delivered, but calorific value is not measured everywhere**

3. Instrumentation and metrology for biofuels



- Feeding/injection points ●: measurement of flow, cal. value, density, CO2 content
- Offtake points ●: flow (and pressure) measurement
- Each branch ●: minimum one pressure measurement

- **Numerical calculation of the grid (geometry, topology)**

3. Instrumentation and metrology for biofuels

Conformity assessment of volume meters for heating oil

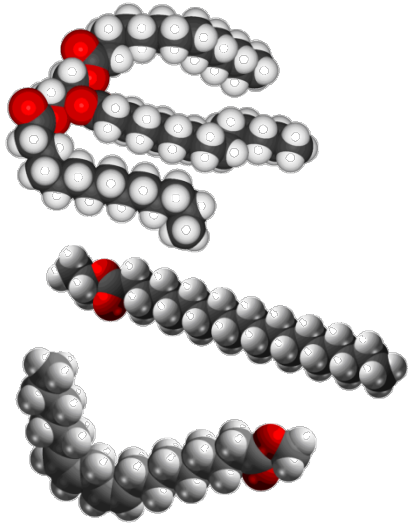
Measurements of **density** and **viscosity** of blends with up to 100 % biofuel (as f(*T*))

verification of a volume meter

3. Instrumentation and metrology for biofuels

Determining and predicting the calorific value:

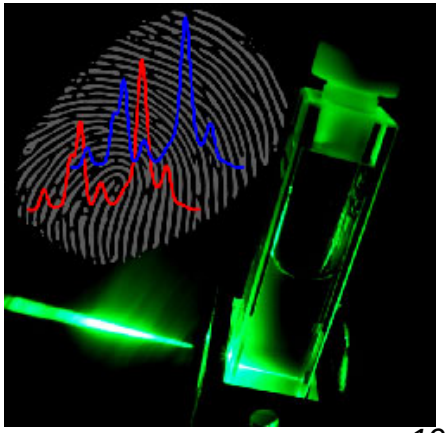
- **data base** with calorific values of biodiesels
  - raw material, processing conditions, storage conditions
- **standard enthalpies** of formation of the pure compounds
- **computational chemistry**
  - Calculation/prediction of thermodynamic properties
    - vapour pressure
    - standard enthalpy of formation
    - heat of combustion



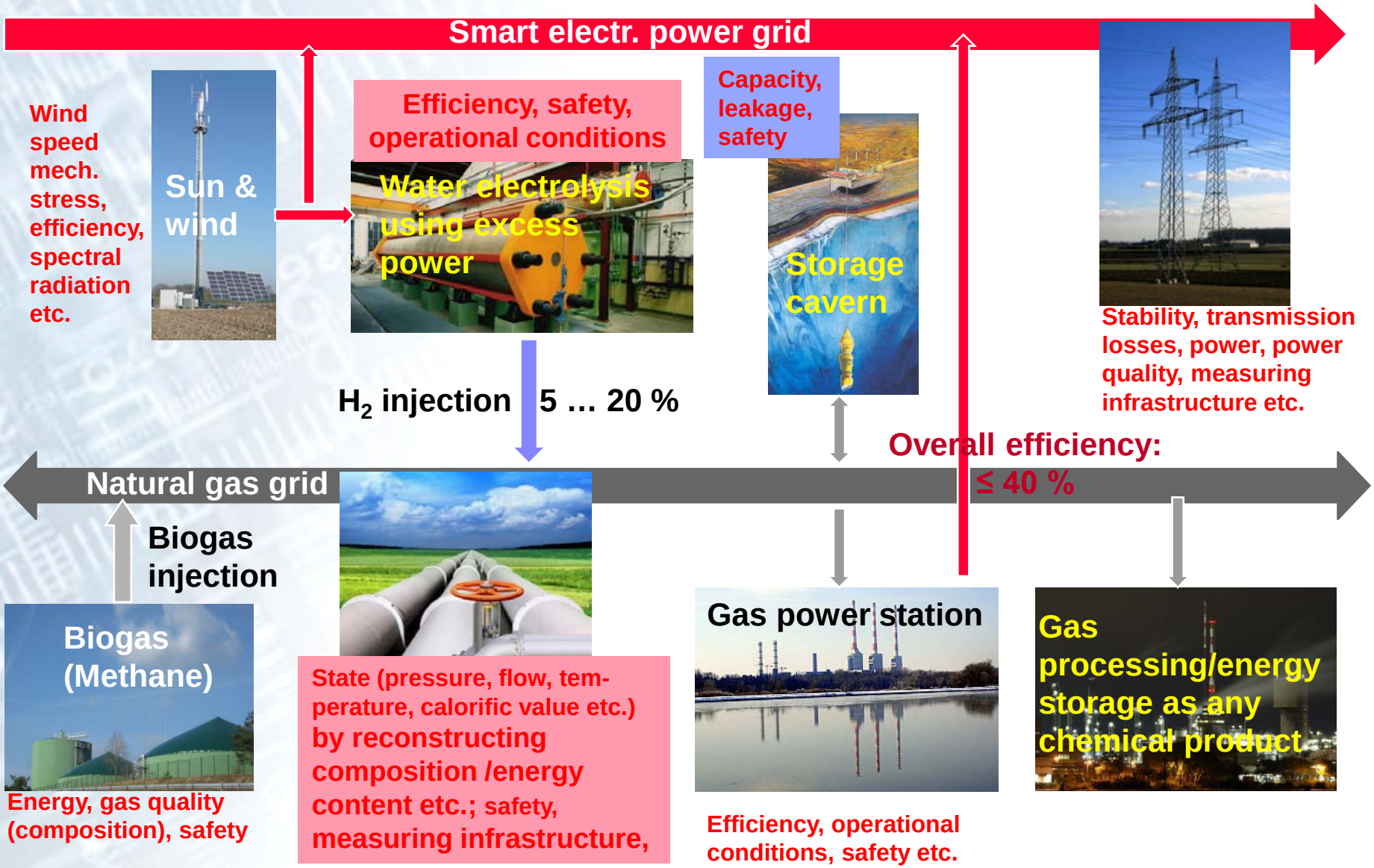
EMRP
European Metrology Research Programme
Programme of EURAMET

Determining the source of origin:

- **Reference materials** (e.g.soil samples from Brazil or fuel samples from European IRMM)
- **Isotopic analysis** using MS procedures
- Standardized sample preparation



4. Summary and conclusion



4. Summary and conclusion

PTB

Production (transformation of primarily available energy)

Transport / Distribution &

Consumption (transformation in effective and dissipative energy)

Storage & Mobility

Measurement & Standards for:

- Improved power plant technol.
- BioFuel properties and amounts
- Solar cells & solar-thermal conv.
- Wind energy conversion
- Next generation nuclear power plants
- Distributed energy harvesting

Measurement & Standards for:

- Energy efficiency of buildings
- Energy efficiency of plants and production processes
- Energy savings in devices and households
- Smart metering and billing

Measurement & Standards for:

- Smart electrical and gas grids
- Properties of energy gases and fuel
- Batteries and E-mobility

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This presentation is based on ideas and working results of many colleagues from PTB and other European NMIs; their contributions are appreciated very much!

Thank you

PTB is involved in or even coordinating
all of the activities mentioned.
You are invited to cooperate with us.

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EMRP projects: see
www.euramet.org/index.php?id=emrp

Long-term sustainable use potential of renewable energies for electricity, heat and fuel production in Germany

	Use 2010	Potential capacity Yield	Potential capacity Output	Remarks
Electricity generation	**[TWh]**	**[TWh/a]**	**[MW]**	
Hydropower [1]	20.6	25	5,200	Running water and natural inflow to reservoirs
Wind energy [2]	37.8			
on land	37.6	175	70,000	Power calculated on the basis of the average value of 2,500 h/a
at sea (offshore)	0.2	280	70,000	Power calculated on the basis of the average value of 4,000 h/a
Biomass [3]	33.3	60	10,000	Some generation as CHP generation
Photovoltaics	11.7	150	165,000 [4]	Only suitable rooftop, facade and municipal areas
Geothermal energy	0.03	90	15,000	Range of 66–290 TWh, depending on requirements pertaining to heat use (CHP generation)
Total	**103.5**	**780**		
Share with respect to gross electricity consumption in 2010	**17.0 %**	**128.3 %**		
Heat generation	**[TWh]**	**[TWh/a]**		
Biomass	125.3	170		Including useful heat from CHP generation
Geothermal energy	5.6	300		Only energy production from hydrothermal sources
Solar thermal energy	5.2	400		Only suitable rooftop and municipal areas
Total	**136.1**	**870**		
Share with respect to final energy consumption for heat in 2010 [5]	**9.5 %**	**61.1 %**		
Fuels	**[TWh]**	**[TWh/a]**		
Biomass	35.7	90		2.35 million ha cultivation area for energy crops (of a total of 4.2 million ha cultivation area)
Total	**35.7**	**90**		
Share with respect to fuel consumption in 2010	**5.8 %**	**14.5 %**		
Share with respect to total final energy consumption in 2010	**10.9 %**	**69.1 %**		The percentage share of renewable energy use potential increases due to improvements in energy efficiency and energy savings, making a 100 % supply of renewable energies possible in the long term.