
Presentation at the Renewable Energy Conference „Current Status and Future Possibilities for the World, Asia and the Philippines“

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Antipolo, March 12, 2012
• professor at the business school of the University of Applied Sciences in Saarbruecken since 1995
• at the same time scientific head of the Institute for Future Energy Systems (IZES), a university based research institute focusing on renewable energies, energy efficiency and decentralised power generation
• author and co-author of several books and articles liberalised electricity markets, feed-in law regulations and instruments for promoting renewable energies in the heat market.
• expert member of the Enquete commission “Sustainable energy supply” of the 14th German Bundestag
• alternate Board Member of the Agency for the Cooperation of Energy Regulators (ACER) of the European Union
about 40 staff members, 35 scientists

Shareholder: 70% state of Saarland, 4 regional utilities, University of the Saarland, University of Applied Sciences of the Saarland (HTW)
1. The Overall Energy Situation in Germany
2. Selected Developments
3. Framework
4. Lessons Learned
German primary energy supply 2009 (2008) by fuel

\[ \sum 2009: 13,500 \text{ PJ} \]

- Oil: 34,6 (34,3)
- Gas: 21,7 (21,6)
- Hard Coal: 11,1 (12,7)
- Lignite: 11,4 (10,9)
- Nuclear: 11,1 (11,4)
- Renewables: 9,1 (8,2)
- misc.: 1,0 (0,9)

Source: AGEB 2009

[Leprich, March 12, 2012, Antipolo, Philippines]
German final energy consumption 2009 by sectors

Final Energy Consumption 2009

- Traffic: 29%
- Private Households: 29%
- Industry: 16%
- Small Commercial, Trade, Services: 26%

Source: UBA 2009

[Leprich, March 12, 2012, Antipolo, Philippines]
German electricity generation 2009 by fuel

∑ 2009: 560 TWh

- Lignite: 24.6%
- Nuclear: 22.6%
- Renewables: 15.6%
- Misc.: 3.9%
- Gas: 12.9%
- Oil: 2.1%
- Hard coal: 18.3%

Source: BMWi 2010

[Leprich, March 12, 2012, Antipolo, Philippines]
Structure of electricity supply from renewable energy sources in Germany 2010

Total: 104.3 TWh

- Wind energy: 36.2%
- Biogenic share of waste: 4.6%
- Landfill gas: 0.6%
- Sewage gas: 1.1%
- Biogas: 13.9%
- Biogenic solid fuels: 10.7%
- Biogenic liquid fuels: 1.6%
- Photovoltaics: 11.2%

Share of biomass*: 32.5%

* Solid and liquid biomass, biogas, sewage and landfill gas, biogenic share of waste; electricity from geothermal energy not presented due to negligible quantities produced; deviations in the totals are due to rounding; 1 TWh = 1 Billion kWh; Source: BMU 2011 according to Working Group on Renewable Energy-Statistics (AGEE-Stat); as at: December 2011; all figures provisional.

Source: BMU 2011

[Leprich, March 12, 2012, Antipolo, Philippines]
### Contribution of renewable energy sources to energy supply in Germany in 2010

<table>
<thead>
<tr>
<th>Share of renewable energy sources</th>
<th>[%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>in total final energy consumption</td>
<td>11.3</td>
</tr>
<tr>
<td>in total gross electricity consumption</td>
<td>17.1</td>
</tr>
<tr>
<td>in total heat supply</td>
<td>10.2</td>
</tr>
<tr>
<td>in total fuel consumption&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>5.8</td>
</tr>
<tr>
<td>in total primary energy consumption&lt;sup&gt;2)&lt;/sup&gt;</td>
<td>9.4</td>
</tr>
</tbody>
</table>

Source: BMU 2011

[Leprich, March 12, 2012, Antipolo, Philippines]
Energy related CO2 emissions in Germany

Source: DIW 2009

[Leprich, March 12, 2012, Antipolo, Philippines]
Composition of Electricity Prices for Private Households

generation and retail costs

network charges

public fees and taxes

Quelle: BNetzA 2010

[Leprich, March 12, 2012, Antipolo, Philippines]
### Composition of Electricity Prices for Private Households

<table>
<thead>
<tr>
<th></th>
<th>Grundversorgung</th>
<th>Tarif außerhalb der Grundversorgung (Vertragswechsel)</th>
<th>Tarif außerhalb des Grundversorgungsnetzgebietes (Lieferantenwechsel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nettonetzentgelt</td>
<td>5,01</td>
<td>5,01</td>
<td>5,01</td>
</tr>
<tr>
<td>Entgelt für Abrechnung</td>
<td>0,34</td>
<td>0,34</td>
<td>0,34</td>
</tr>
<tr>
<td>Entgelte für Messung</td>
<td>0,10</td>
<td>0,10</td>
<td>0,10</td>
</tr>
<tr>
<td>Entgelte für Messstellenbetrieb</td>
<td>0,35</td>
<td>0,35</td>
<td>0,35</td>
</tr>
<tr>
<td>Konzessionsabgabe</td>
<td>1,52</td>
<td>1,52</td>
<td>1,52</td>
</tr>
<tr>
<td>Umlage nach EEG</td>
<td>2,06</td>
<td>2,06</td>
<td>2,06</td>
</tr>
<tr>
<td>Umlage nach KWKG</td>
<td>0,13</td>
<td>0,13</td>
<td>0,13</td>
</tr>
<tr>
<td>Steuem (Strom- und Umsatzsteuer)</td>
<td>5,85</td>
<td>5,74</td>
<td>5,71</td>
</tr>
<tr>
<td>Energiebeschaffung und Vertrieb</td>
<td>8,49</td>
<td>7,84</td>
<td>7,68</td>
</tr>
<tr>
<td><strong>Gesamtpreis</strong></td>
<td><strong>23,87</strong></td>
<td><strong>23,10</strong></td>
<td><strong>22,91</strong></td>
</tr>
</tbody>
</table>

_Tabelle 15: Durchschnittliches Einzelhandelspreisniveau (fixe und variable Preisbestandteile) mit Stand 1. April 2010 für Haushaltskunden innerhalb sowie außerhalb der Grundversorgungsnetzgebiete gemäß Abtage Großhändler und Lieferanten._

1 €ct/kWh ~ 1,3 $ct/kWh ~ 0,5 PhP/kWh
1. The Overall Energy Situation in Germany

2. Selected Developments

3. Framework

4. Lessons Learned
“Decoupling” GDP from Energy Consumption since the 70s

Gross Added Value
Primary Energy Consumption
Gross Electricity Consumption

Source: Thöne/Fahl/Blesel 2009
Contribution of renewable energy sources to electricity supply in Germany

Source: BMU 2011

[Leprich, March 12, 2012, Antipolo, Philippines]
Development of the number and installed capacity of wind energy plants in Germany

Source: BMU 2011

[Leprich, March 12, 2012, Antipolo, Philippines]
Economies of Scale

500-fold yield increase since 1980

Increase in capacity
In a mere 20 years, the yield of wind turbines has increased 100-fold. With the new 5 MW turbines, it will multiply another fivefold.

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated power</td>
<td>30 kW</td>
<td>80 kW</td>
<td>250 kW</td>
<td>600 kW</td>
<td>1,500 kW</td>
<td>3,000 kW</td>
<td>6,000 kW</td>
</tr>
<tr>
<td>Rotor diameter</td>
<td>15 m</td>
<td>20 m</td>
<td>30 m</td>
<td>46 m</td>
<td>70 m</td>
<td>90 m</td>
<td>126 m</td>
</tr>
<tr>
<td>Hub height</td>
<td>30 m</td>
<td>40 m</td>
<td>50 m</td>
<td>78 m</td>
<td>100 m</td>
<td>105 m</td>
<td>135 m</td>
</tr>
<tr>
<td>Annual energy yield</td>
<td>26,000 kWh</td>
<td>46,000 kWh</td>
<td>100,000 kWh</td>
<td>1,250,000 kWh</td>
<td>2,500,000 kWh</td>
<td>6,000,000 kWh</td>
<td>ca. 20,000,000 kWh</td>
</tr>
</tbody>
</table>

Source: BWE 2009

[Leprich, March 12, 2012, Antipolo, Philippines]
Average size of new installed wind turbines

Quelle: DEWI 2010

[Leprich, March 12, 2012, Antipolo, Philippines]
Development of biomass use for electricity supply in Germany

* Solid and liquid biomass, biogas, sewage and landfill gas; 1 GWh = 1 Mil. kWh;
Source: BMU-KI III 1 according to Working Group on Renewable Energy-Statistics (AGEE-Stat); Image: BMU / Brigitte Hiss, as at: December 2011; all figures provisional

Source: BMU 2011
Installed capacity and energy supply from photovoltaic installations in Germany

Source: BMU 2011

[Leprich, March 12, 2012, Antipolo, Philippines]
PV Cost reduction

Price reduction of PV systems in Germany

Reduction in average:
12.6% / yr

Price for PV system
<100 kWp:
3260 € / kWp

Source: Schlegel 2009

[Leprich, March 12, 2012, Antipolo, Philippines]
remuneration for PV in ct/kWh

Source: BSW 2011

[Leprich, March 12, 2012, Antipolo, Philippines]
Electricity prices at the power exchange / Futures Baseload

Phelix Futures | Prices and trading volumes | Phelix Baseload Year Futures (Cal:14) | 2012/03/08 | EEX Power

Source: EEX 2011

[Leprich, March 12, 2012, Antipolo, Philippines]
Contribution of renewable energy sources to heat supply in Germany

*Biomass*, *Solar thermal energy*, *Geothermal energy*

**Biomass share of RES - heat: 92.5 %**

Source: BMU-KI III 1 according to Working Group on Renewable Energy-Statistics (AGEE-Stat); Image: BMU / Brigitte Hiss; as at: December 2011; all figures provisional

* Solid and liquid biomass, biogas, sewage and landfill gas, biogenic share of waste; 1 GWh = 1 Mill. kWh; RES: Renewable energy sources.
Source: BMU 2011

[Leprich, March 12, 2012, Antipolo, Philippines]
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The European 20/20/20 targets

Political context

- Climate change considerations
- Higher relevance of security of energy supply

Policy implications

- **CO₂ abatement**: 20% reduction of CO₂ emissions by 2020
- **Energy efficiency**: 20% less energy consumed in 2020 than “business-as-usual”
- **Renewable energy**: 20% of consumed energy in 2020 from renewable sources
- **Biofuels**: 10% of all transportation fuels from bio-sources by 2020 (part of renewables)
### Targets of the German Energy Concept 2010

<table>
<thead>
<tr>
<th></th>
<th>Climate</th>
<th>Renewable Energies</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Greenhouse gases (vs. 1990)</td>
<td>Share of electr.</td>
<td>Overall share</td>
</tr>
<tr>
<td>2020</td>
<td>- 40%</td>
<td>35%</td>
<td>18%</td>
</tr>
<tr>
<td>2030</td>
<td>- 55%</td>
<td>50%</td>
<td>30%</td>
</tr>
<tr>
<td>2040</td>
<td>- 70%</td>
<td>65%</td>
<td>45%</td>
</tr>
<tr>
<td>2050</td>
<td>- 80-95%</td>
<td>80%</td>
<td>60%</td>
</tr>
</tbody>
</table>

Source: Schafhausen 2011
The toolbox

Instruments

- voluntary agreements
- financial support programmes
- innovation support programmes
- legal framework
- market-based: taxes, information, consulting, labels
a) Feed-in tariff
Europe favours Feed-in tariffs

[Leprich, March 12, 2012, Antipolo, Philippines]
The Feed-in tariff

• Main idea: a framework to ensure investments
• Market entry against the interests of the incumbents ➔ Priority access to the grid
• Enabling the financing of the investment through the banks ➔ stable remuneration for „moderate“ returns
• Technical progress ➔ output oriented remuneration with a built-in degression

Create a protected market to use market forces for technology development!
The German Renewable Energy Sources Act

Renewable Energy Sources Act, main features

- Term of the contracts: maximum 20 years
- Planning and investment reliability by guaranteed fixed prices for RE-power
- Returns of 7% taken as the basis for the calculations
- Annual decrease of the tariffs
- RE-priority for grid access, transmission and distribution
- Equalization of additional costs for electricity from RES between all grid operators and electricity suppliers; Costs paid by all consumers
- All different types of RES are considered
Explicit aims of the German Feed-in law

not just environment and climate protection, but

- internalisation of social costs of energy consumption
- avoidance of conflicts about fossil resources
- support and development of technologies
- building an energy system that is cheaper in the long run than the existing one
## Feed-in tariffs 2009

<table>
<thead>
<tr>
<th>Technology</th>
<th>Payment time [years]</th>
<th>Feed-in tariff [€cent/kWh]</th>
<th>Degression rate annually</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind power (onshore)</td>
<td>20</td>
<td>9.70 (...5.02)**</td>
<td>1%</td>
</tr>
<tr>
<td>Wind power (offshore)</td>
<td>20</td>
<td>15.0 (...3.5)**</td>
<td>5% as of 2015</td>
</tr>
<tr>
<td>Photovoltaics</td>
<td>20</td>
<td>31.94 –43.01</td>
<td>8% -10%</td>
</tr>
<tr>
<td>Hydro power &lt; 5 MW</td>
<td>20</td>
<td>7.65 -12.67</td>
<td>-</td>
</tr>
<tr>
<td>Large hydro &gt; 5 MW</td>
<td>15</td>
<td>3.50 -7.29</td>
<td>-</td>
</tr>
<tr>
<td>Biomass</td>
<td>20</td>
<td>7.79 -11.67</td>
<td>1%</td>
</tr>
<tr>
<td>Geothermal energy</td>
<td>20</td>
<td>10.5 –16.0</td>
<td>1%</td>
</tr>
</tbody>
</table>

* Additional bonus up to 13 €ct/kWh if renewable raw material is used
** The tariff is paid in the beginning and is reduced during the payment time to the lower level
b) Direct support scheme
German market incentive program ("MAP")

Subsidies in 2007 and 2008 for REN and EE in the heat market

Auszahlungen 2008: 221 Mio. €
The problem: discontinuity, dependent on the available budget

[Leprich, March 12, 2012, Antipolo, Philippines]
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Lessons learned (1)

• National targets help a lot to keep the process going on

• Instruments to support renewable energies should not be budget-dependent

• Do not rely on the incumbents (the utilities) – try to address a new industry!

• Try to address a broad range of technologies!

• It is decisive that the instruments are effective; secondly they should be efficient

[Leprich, March 12, 2012, Antipolo, Philippines]
Lessons learned (2)

• If you decide in favour of a feed-in tariff, keep the law simple
• If you decide in favour of a feed-in tariff, be sure to adapt the remunerations contemporary
• Be careful with the energy intensive industry – avoid disadvantages with respect to their global competitiveness
• Consider all advantages for the economy as a whole
So

Source: BMU 2011
Investments in the construction of renewable energy installations in Germany 2010

Total: approx. 27.9 Bill. EUR

- Hydropower: 500 Mill. EUR
- Geothermal energy*: 850 Mill. EUR
- Solar thermal energy: 950 Mill. EUR
- Biomass (heat): 1,150 Mill. EUR
- Biomass (electricity): 2,450 Mill. EUR
- Wind energy: 2,500 Mill. EUR
- Photovoltaics: 19,500 Mill. EUR

* 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-Württemberg (ZSW); as at: December 2011; all figures provisional.
• Intermittent resources like wind and solar power need flexible options for a consistent system → large nuclear and coal power plants are not compatible with them in an optimised system
Load simulation for 2020: residual load instead of base load

Source: IWES 2010

[Leprich, March 12, 2012, Antipolo, Philippines]
Lessons learned (3)

• Intermittent resources like wind and solar power need flexible options for a consistent system ➔ large nuclear and coal power plants are not compatible with them in an optimised system

• The best fossil option to complete the system are gas plants

• The best controllable renewable option to optimise the system depends on the individual situation of the country; biomass, geothermal plants, and CSP plants are serious options

• Before considering storage solutions upgrade the network and use Demand side management options on the customer side of the meter
Progress towards the increasing use of renewable energy technologies heavily relies on

- the overall spirit to go for a low carbon society
- national overall and sector targets to fill the spirit with life
- the implementation of effective instruments and measures to reach the targets
- a fair burden sharing of the costs during the intermediate period of higher costs
- networks from NGOs to the scientific community, the administration and the parliament
Thank you very much for your attention!

Institut für ZukunftEnergieSysteme (IZES)

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