Smart Grids -
Business Opportunities in Germany

Germany Trade & Invest
Heiko Staubitz
The Agency

The foreign trade and inward investment promotion agency of the Federal Republic of Germany

**German Parliament**
Resolutions for Founding/Financing

**Federal Government**
Federal Ministry of Economics and Energy - Shareholder

**Company Tasks**
- Investment Attraction
- Export Promotion
- Location Promotion
### Main Objectives

#### Climate protection measures

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<tr>
<th></th>
<th>2020</th>
<th>2050</th>
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<tr>
<td>GHG cuts vs. 1990</td>
<td>-40%</td>
<td>-80%</td>
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#### Renewable share of...

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<tr>
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<th>2020 (2025)</th>
<th>2050</th>
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<tbody>
<tr>
<td>Total energy consumption</td>
<td>18%</td>
<td>60%</td>
</tr>
<tr>
<td>Electricity consumption</td>
<td>35% (40-45%)</td>
<td>80%</td>
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<tr>
<td>Heat generation</td>
<td>14%</td>
<td>60%</td>
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#### Energy efficiency measures

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<tr>
<td>Increase in energy productiveness</td>
<td>2.1% p.a.</td>
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<tr>
<td>Reduction of energy consumption</td>
<td>-50% (2050 vs. 2008)</td>
</tr>
<tr>
<td>Reduction of electricity consumption</td>
<td>-25% (2050 vs. 2008)</td>
</tr>
<tr>
<td>Renovation rate</td>
<td>2% p.a.</td>
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| Reduction of energy consumption for transportation | -10% (2020 vs. 2005)  
  -40% (2050 vs. 2005) |
The share of renewable energy in electricity generation has increased from 5% to 27.3% since 1998.

**Energy Source Share in Electricity Generation**

**1998**
- Nuclear Power: 29.1%
- Hard Coal: 27.5%
- Lignite: 25.0%
- Natural Gas: 9.1%
- Oil, Pumped Storage + Others: 4.6%
- Renewable Energies: 5%

Total: 557.2 TWh
Export: 0.6 TWh

**2014**
- Nuclear Power: 15.9%
- Lignite: 25.6%
- Hard Coal: 18.0%
- Natural Gas: 9.6%
- Oil and others: 5.1%
- Biomass & waste: 8.0%
- Wind Onshore: 8.4%
- Wind Offshore: 0.2%
- Hydro power: 3.4%
- Photovoltaic: 5.8%

Total: 610.4 TWh
Export: 34.1 TWh

Source: AG Energiebilanzen December 2014  
* Gross Electricity Generation
Plant utilization of conventional power plants remains the highest

### Energy Source Share of Installed Capacity 2013

- Nuclear Power: 6.6%
- Lignite: 11.6%
- Hard Coal: 14.4%
- Natural Gas: 14.5%
- Wind Power: 18.8%
- Hydropower: 3.1%
- Biomass and Waste: 3.5%
- Oil, Pump Hydro and Others: 8.6%
- Photovoltaic: 18.9%

**Total:** 183.6 GW

**Annual peak load:** app. 80 GW

**Wind power:** 34.5 GW

**PV power:** 34.7 GW (1.9 GW*)

Source: Bundesnetzagentur 2013, *BDEW 2014

### Average Hours of Yearly Full Load of German Power Plants (2013)

- Nuclear Power: 7.630
- Lignite: 7.030
- Biomass: 6.450
- Hard Coal: 4.380
- Hydropower: 3.560
- Natural Gas: 2.480
- Wind Power: 1.610
- Oil, Pump Storage: 1.150
- Photovoltaics: 1.000
- Others: 910

Year: 8,760 h

Source: Bundesnetzagentur 2013, *BDEW 2014
An enormous expansion of the high voltage grid system is required by 2024.

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<tr>
<th>Grid Expansion</th>
<th>Distance in Km.</th>
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<tr>
<td>DC-New Construction</td>
<td>2,200</td>
</tr>
<tr>
<td>AC-New Construction</td>
<td>1,300</td>
</tr>
<tr>
<td>DC/AC- Grid Reinforcement</td>
<td>5,200</td>
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**Expansion and Reinforcement**

*Transmission grid*

Grid expansion and Reinforcement of **8,700km** is required by 2024

→Baseline scenario with overhead lines requires:

- 22 bn €*

  - Additionally the connection of the offshore-grid is estimated to
  - 10-12 bn €

*Costs estimates per NEP-Draft 2014 49GW/12GW wind onshore/offshore
Source: TSO 2014
Grid Extension must be seen from a European perspective

Approx. 50,000 km of transmission lines needed to mitigate larger, volatile long distance power flows through EU by 2022

- On the European level, some 100 transmission projects from 100 MW to 4 GW need to address grid bottlenecks until 2022**:
  - 12,590 km HVDC and 37,520 km HVAC
  - **Worth EUR 104bn until 2022** (including EUR 23 bn for subsea cables)

### 100 main bottlenecks in Europe in 2020


<table>
<thead>
<tr>
<th>Need for new HVDC/HVAC cables until 2022 in km</th>
<th>2012-2014 (km)</th>
<th>HVDC</th>
<th>HVAC &gt;330 kV</th>
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</thead>
<tbody>
<tr>
<td>Subsea Cables</td>
<td>9,000</td>
<td></td>
<td>400</td>
</tr>
<tr>
<td>Underground Cables</td>
<td>1,490</td>
<td></td>
<td>420</td>
</tr>
<tr>
<td>New OHL</td>
<td>2,100</td>
<td>28,400</td>
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<tr>
<td>Upgrade OHL</td>
<td>0</td>
<td>8,300</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>12,500</strong></td>
<td><strong>37,520</strong></td>
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Massive needs to expand the distribution grid

Investment needs for the distribution grid extension and conversion until 2030

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<th>Scenario 1</th>
<th>Scenario 2</th>
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<td>(increased and faster expansion of renewables): €42.5bn</td>
<td>(conservative estimation): €27.5bn</td>
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### Results of the Distribution Grid Study (Dena, 2012):

- the German distribution grids require
  - expansions of 135,000 km up to 193,000 km
  - conversions of 21,000 to 25,000 km

- investment needs for the grid extension and conversion:
  - until 2020: €18.4bn – €26.7bn
  - until 2030: €27.5bn – €42.5bn

- investment needs can be reduced by various technical options, e.g.:
  - innovative operational resources,
  - down-regulation of power peaks of renewable generation,
  - storage systems

Source: German Energy Agency (Dena), 2012: Distribution Grid Study
AmpaCity Flagship Project in Essen

High voltage grid in Essen area

Situation 2010

Goal 2020

Source: RWE AG
AmpaCity Flagship Project in Essen

Testing phase 2014 - 2016

Source: RWE AG
The programme supports the establishment of SINTEG pilot regions/showcases:

- To develop and demonstrate large-scale solutions for a reliable and efficient energy supply and smart grids with a high degree of fluctuating energy (temporarily up to 100 % renewable energy).

- To improve the interplay between electricity generation, consumption, storage, and the grid.

**Example:** A pilot region might, for instance, use smart grids to improve demand-side flexibility, and to connect load centres where there is high population and industrial density, with regions in which there are temporary surpluses of renewable energy.

- Eligible are enterprises of the commercial economy, universities and non-university research organizations with registered office and core activities in Germany; supported are collaborative projects (Verbundprojekte)

- Amount of funding: total of up to Euro 80 million in funding for at least two large showcase regions

- Type of support: The support is provided in the form of a non-repayable cash grant. The rate depends on the type of organization.

- Deadline for submission of project draft: 31. Mai 2015. Funding is granted for a project duration of 4 years

Note: SINTEG = Förderprogramm "Schaufenster intelligente Energie - Digitale Agenda für die Energiewende"; Link to announcement (German only): http://www.bmwi.de/BMWi/Redaktion/PDF/B/bekanntmachung-foederung-schaufenster-intelligente-energie-digitale-agenda-fuer-die-energiewende,property=pdf,bereich=bmwi2012,sprache=de,rwb=true.pdf;  Source: Federal Ministry for Economic Affairs and Energy 2015
The German Energy Economy Law (§21c, §21b, §21d, §21e, §21f, §21i) already has requirements in place for a Smart Meter roll-out.

**Smart Meters are already required for:**

- Buildings newly connected to the energy supply grid or buildings undergoing large renovations.
- End users whose annual energy use exceeds 6,000 kWh.
- New (from 2011) power generating facilities with a capacity exceeding 7 kW.

- **Under current legislation, 23% of Germany’s 50 million meters would be smart by 2022.**

**EU requirement to prepare large roll-out by 2022**

Government-commissioned cost-benefit analysis recommends:

- Extending requirements to existing RE facilities and gradually replacing all meters with intelligent meters that can be upgraded to full Smart Metering Systems (SMS)
  - **50 million intelligent meters and SMS until 2029 for electricity (100%)**
  - **14 million intelligent meters for gas by 2029**
Low-price PV + Battery systems are reaching competitiveness now!

Battery system costs 2014 [EUR/kWh]

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<tr>
<th>Storage capacity [kWh]</th>
<th>Lead acid</th>
<th>Lithium</th>
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<tbody>
<tr>
<td>5000</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>4500</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>4000</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>3500</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>3000</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>2500</td>
<td>0.6</td>
<td>0.6</td>
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<tr>
<td>2000</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>1500</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>1000</td>
<td>0.9</td>
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</tr>
<tr>
<td>500</td>
<td>1.0</td>
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LCOS 2014 [EUR/kWh]

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LCOE of low price PV-system in Southern Germany: ~10 €ct./kWh
LCOS of low price PV-Battery system: ~20 €ct./kWh
→ Average household electricity costs: ~30 €ct./kWh

Source: PV-Magazine
German PV-battery installations increased >50% from 2013 to 2014. Approximately half of the customers use the KfW incentive program.

* Estimation (based on surveys among installers performed by EuPD and BSW). Source: KfW 2015
First commercial battery in Europe

Prequalified for the primary control power market (WEMAG/Younicos)

Key Data

- 5 MW/ 5MWh
- Lithium ion technology
- Bought and operated by medium sized German municipal utility WEMAG
- Fully automated, turnkey battery park
- Battery park will be ready for the primary control power market
- Performance guarantee of 20 years on the battery system

Source: Younicos
Interaction between three types of control power in case a generator goes down or there is another disruption to the supply.

Outage in a power plant in Saxony-Anhalt

Primary control power

Secondary control power

Tertiary control power
Primary Control Power Price Development

Control power (Operating reserve)

Weekly average 2011: 3,569 €/MW
Weekly average 2012: 2,757 €/MW
Weekly average 2013: 3,045 €/MW
Weekly average 2014: 3,583 €/MW (prognosis)

Tendering process change: weekly / minimum quantity 1MW

Source: regelleistung.net
Primary Control Power Market Overview

**Needed power per week [in MW]**

2011: 612  
2012: 567  
2013: 551  
2014: 568

(prognosis)

**Size of the market [in million €]**

2011: 111  
2012: 83  
2013: 87  
2014: 106

(prognosis)

**Calculation of break even CAPEX for new battery systems:**

- Mean specific capacity price payment per year:  
  \[\approx 165,000 \text{ €/MW}\]

- Interest rate: 5 %

- Operation costs: 2 %/a from CAPEX

- Amortization period: 10 a

- Energy/Power ratio: 1:1

\[\Rightarrow \text{max. CAPEX:} \approx 1,100 \text{ €/kWh}\]

Source: regelleistung.net; IEK-STE 2013
Large-scale batteries balancing the grid

Installed battery capacity in Germany for primary control provision

- Aachen, Eon Energy Research Centre at RWTH Aachen University (Li-ion, high-temperature, lead-acid)
- Dresden, Younicos & DREWAG (Li-ion)
- Pellworm, EON & Schleswig-Holstein Netz AG, Hybrid (Li-ion, Redox-flow)
- Braderup, Bosch, Hybrid (Li-ion, Redox-flow)
- Feldheim, Energiequelle GmbH, Li-Ion
- Schwerin, Younicos & Wemag, Li-Ion
- Berlin, Younicos & Vattenfall, LiFePo
- Berlin, Younicos & Vattenfall, Hybrid (Li-Ion, NAS)
- Völklingen-Fenne, Evonik, Li-Ion

Source: IEK-STE Database, Energiespeicher Jülich
Power to Gas pilot plant and H2 Filling Stations
Green Hydrogen and Power to Gas

H2 Mobility action plan until 2023

Air Liquide, Daimler, Linde, OMV, Shell and Total agree on an action plan for the Construction of a hydrogen refueling network in Germany.

**Targets:**

400 HRS until 2023 (100 HRS until 2017).

350 mio. € investment.

Max. 90 km distance between two HRS at the motorway.

10 HRS in each metropolitan area.

Source: NOW
Don’t hesitate to contact us!

Energy, Environment and Resources Division:

**Europe**

**Berlin - Headquarters**

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**Beijing Office**

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**Mumbai Office**

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