Rethinking the energy system: The potential of distributed energy

The Case of Germany

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Overview

1. **the trends** | Germany’s energy transition
2. **the enablers** | Vision, policies, governance
3. **the impacts** | Busted myths, changed paradigms
4. **the lessons** | Key take-aways
1. *the trends*
Germany’s Energy Transition
Energy efficiency

Tons of Oil Equivalent per USD 1,000 GDP

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Source: World Bank
Renewables share in electricity mix

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Source 1990-2011: EIA
2011-2012: EC Pocketbook
Renewables share in electricity mix

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Source 1990-2011: EIA
2011-2012: EC Pocketbook, ClimateScope, EIA
Generation trends in Germany

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Source: World Bank
Annual RE additions, Germany

Million KW

Source: EnergyMap
Total Solar PV Capacity
Global Leaders, 2013

Source: REN21
Annual average solar resource data are for a solar collector oriented toward the south at a tilt = local latitude. The data for Hawaii and the 48 contiguous states are derived from a model developed at SUNY/Albany using geostationary weather satellite data for the period 1998-2008. The data for Alaska are derived from a 40 km satellite and surface cloud cover database for the period 1988-1991 (NREL, 2003). The data for Germany were acquired from the Joint Research Centre of the European Commission and is the yearly sum of global irradiation on an optimally inclined surface for the period 1981-1990.

Map credit: NREL
2. *the enablers*

Vision & Goals
Policies & Measures
Effective Governance & Administration
German energy transition: high certainty with long-term targets
Long-term, comprehensive energy and climate targets set by the German government in 2010

Source: BMU

- **Power consumption** (compared to 2008)
  - 2020: 100%
  - 2030: 90%
  - 2040: 35%
  - 2050: 50%

- **Gross energy consumption** (compared to 2008)
  - 2020: 100%
  - 2030: 80%
  - 2040: 18%
  - 2050: 30%

- **Heat demand, buildings** (compared to 2008)
  - 2020: 100%
  - 2030: 80%
  - 2040: 14%
  - 2050: 20%

- **Final energy consumption, transport** (compared to 2005)
  - 2020: 100%
  - 2030: 90%
  - 2040: 10%
  - 2050: 60%

- **Greenhouse gases** (compared to 1990)
  - 2020: 100%
  - 2030: 45%
  - 2040: 50%
  - 2050: 75%

- **Trend**
  - In terms of primary energy

German Energy Transition
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Germany is gradually shutting down all nuclear power plants

Declining nuclear energy installed capacity in Germany, 2000-2022

Source: Institute of Applied Ecology, BMJ, own calculations

- Nov 2003: Stade
- May 2005: Obrigheim
- Aug 2011: Biblis A+B, Brunsbüttel, Isar 1, Krümmel, Neckarwestheim 1, Philippsburg 1, Unterweser
- May 2015: Grafenrheinfeld
- Dec 2017: Gundremmingen B
- Dec 2019: Philippsburg 2
- Dec 2021: Grohnde, Brokdorf, Gundremmingen C
- Dec 2022: Isar 2, Neckarwestheim 2, Emsland

Phase-out over 20 years

Remaining nuclear capacity in megawatts:
- 2000: 22,100
- 2022: 

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Policies & Instruments: Emissions Trading

Figure 1. ICE CER Futures - Emissions CER Index

Source: IntercontinentalExchange, Inc.
Feed-in tariffs grow renewables
Renewable electricity generation in Germany, 1990–2012

Source: BMU

Electricity generation in terawatt-hours

160

120

80

40

0


Original feed-in tariffs

EEG 2000

EEG 2004

EEG 2009

Photovoltaics
Wind power
Biomass
Hydropower

Renewables

23% renewables by 2012

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Germany's plan: drive down energy demand

Primary energy demand in Germany, 2000-2020

Source: AGEB, BMWi

20,000

Primary energy demand in petajoules


Target 2020

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3. the impacts
Busted Myths | Changed Paradigms
Centralized vs. Distributed Power
1990 - 2014

Source: EnergyMap

KW

PV
Wind
Hydro
Biomass
Gas
Geothermal
Electricity Tariff Trends

Development of the Electricity Tariff
In Germany from 2007-2013

- **Private Household**
  - 2007: 13.10 Ct/kWh
  - 2013: 29.19 Ct/kWh

- **Industry**
  - 2007: 25.50 Ct/kWh
  - 2013: 18.79 Ct/kWh

- **Incl. Tax**
  - 2007: 25.50 Ct/kWh
  - 2013: 29.19 Ct/kWh

Quelle: Eurostat
Germany to other EU Countries

International Electricity Tariffs Comparison of private Households 2013 of an annual Usage of 1000 to 2500kWh

- UK
- Slovenia
- Italy
- Malta
- Finland
- Sweden
- Portugal
- Czech Republic
- Austria
- Belgium
- Spain
- Cyprus
- Norway
- Ireland
- Germany
- Denmark

Quelle: Eurostat

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Air & Water quality

Emissions of certain atmospheric pollutants

Quelle: Umweltbundesamt, Nationale Trendtabellen für die deutsche Berichterstattung atmosphärischer Emissionen seit 1990, Emissionsentwicklung 1990 bis 2012 (Stand 15.04.2014)
Germany: growing economy, declining emissions
Change of Gross Domestic Product (GDP) and Greenhouse Gas (GHG) emissions in Germany, 1991-2012

Source: BMU, BMWi, Destatis

- GDP per capita (1991 = 100)
- GHG emissions in CO₂-equivalent (1991 = 100)
GDP per Capita

Source: Worldbank
Renewables help make economy healthy
Gross Domestic Product and share of renewables in power generation from 1991–2012, Germany

Source: BMWI, AG Energiebilanzen, Destatis
Development of External Trade

Import, Export and Export surplus, 1991-2012
Renewables create more jobs than conventional energy does

Employment in Germany in renewable and conventional energy sectors, 2005–2011

Source: BMU, BMWI
Numbers of patent application in renewable Energy sector in Germany 2005-2013

- Total of RE
- PV
- Wind energy
- Geothermal, Biogas, other sources
- Hybrid

Quelle: DPMA; Stand: 06/2014

www.unendlich-viel-energie.de
Impacts Yet to Come

• Likely “real” electricity price development
• Job prognoses
Revenue of Siemens AG of 2008/2009 till 2012/2013 in Million Euro

- 2008/2009: 68,726 million Euro
- 2009/2010: 67,862 million Euro
- 2010/2011: 72,526 million Euro
- 2011/2012: 77,395 million Euro
- 2012/2013: 75,882 million Euro
Employees

Die Energie ist da

juwi

[Graph showing the increase in employees from 2003 to 2011]
Founded 1988

Revenue:
- 2011: 122 Mio Euro
- 2012: 200 Mio Euro
- 2013: 234 Mio. Euro
Privat Sector

Source: BWK Bd. 64

Diagram showing the proportion of autonomous consumption (% Eigenverbrauchsanteil) versus PV power (PV-Leistung in kWp) for different systems:
- PV-System
- PV-Batterie-System
- PV-Wärmespeicher-System
- PV-Batterie-Wärmespeicher-System

Source: BWK Bd. 64
## Case study

<table>
<thead>
<tr>
<th>Photovoltaikanlage in Berlin-Zehlendorf</th>
<th>by 0%</th>
<th>by 20%</th>
<th>by 40% own consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifetime Income of FiT</td>
<td>14.710€</td>
<td>11.776€</td>
<td>8.822€</td>
</tr>
<tr>
<td>Lifetime Savings through own consumption</td>
<td>0€</td>
<td>8.973€</td>
<td>17.920€</td>
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<td>Overall Lifetime income (a year)</td>
<td>14.710€ (712€)</td>
<td>20.749€ (1.004€)</td>
<td>26.743€ (1.294€)</td>
</tr>
<tr>
<td>Lifetime cost</td>
<td></td>
<td>12.562€</td>
<td></td>
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<tr>
<td>Lifetime Surplus (a year)</td>
<td>2.148€ (104€)</td>
<td>8.186€ (396€)</td>
<td>14.180€ (686€)</td>
</tr>
<tr>
<td>Rate of Return</td>
<td>2.26% p.a.</td>
<td>6.77% p.a.</td>
<td>10.29% p.a.</td>
</tr>
</tbody>
</table>

Source: PVSolarstrom
Forecast of electricity landscape

Source: ET
4. *the lessons*

Key Take-Aways
• Energy transition globally a necessity
• Energiewende produced enormous environmental, economic & social benefits
• Paradigm change is underway
• Winners and losers; policy-makers need to set market framework; corporations decide how to play
• Corporations are increasingly seeing opps, but need supporting policies
• Political and private sector decision-making should go hand in hand: stakeholder dialogues
• Integrated assessments/roadmaps: Technical, socio-economic, financial, political analysis necessary
thank you!

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the future

New Challenges | New Ideas
Technology/Market Challenges

• The future grid
  *How does it look like and what are the necessary investments?*
  *Who runs the grid/back-up in a distributed system?*

• The need for storage
  *What is are the right support systems for technical options?*

• More research needed on DSM

• New Business model needed
  *How to create the right market incentives and support sustainable energy business models?*
Ideas

Portfolio of policies which provides ambitious and continuously updated goals and keep being reliable.

These includes financial bonuses or rebates and reformation about legislation.

For example: bill the building instead of the builder
# Impact of insolvent Solarbranche

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Wind onshore</td>
<td>100.800</td>
<td>18.200</td>
<td></td>
<td>119.000</td>
<td>104.000</td>
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<tr>
<td>Wind offshore</td>
<td>17.500</td>
<td>1.300</td>
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<td>18.800</td>
<td>17.800</td>
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<tr>
<td>Photovoltaik</td>
<td>45.100</td>
<td>10.900</td>
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<td>56.000</td>
<td>100.300</td>
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<tr>
<td>Solarthermie</td>
<td>10.100</td>
<td>1.300</td>
<td></td>
<td>11.400</td>
<td>12.200</td>
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<td>Solarthermal Power</td>
<td>1.100</td>
<td></td>
<td></td>
<td>1.100</td>
<td>1.400</td>
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<tr>
<td>Hybrid</td>
<td>8.300</td>
<td>4.800</td>
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<td>13.100</td>
<td>12.900</td>
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<td>Geothermie</td>
<td>14.600</td>
<td>2.700</td>
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<td>17.300</td>
<td>16.400</td>
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<td>Biogas</td>
<td>17.200</td>
<td>11.800</td>
<td>20.200</td>
<td>49.200</td>
<td>50.400</td>
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<tr>
<td>Biomass</td>
<td>16.100</td>
<td>12.500</td>
<td>23.000</td>
<td>51.600</td>
<td>51.700</td>
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<td>Biofuel</td>
<td>6.000</td>
<td>8.600</td>
<td>8.400</td>
<td>25.600</td>
<td>25.400</td>
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<tr>
<td>Sum</td>
<td>230.800</td>
<td>63.500</td>
<td>68.800</td>
<td>363.100</td>
<td>392.500</td>
</tr>
<tr>
<td>public funded Research/Administration</td>
<td></td>
<td></td>
<td></td>
<td>8.300</td>
<td>7.300</td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td></td>
<td></td>
<td>371.400</td>
<td>399.800</td>
</tr>
</tbody>
</table>

Source: Ec Pocketbook