Outline

Bioenergy in Germany

• The Agency for Renewable Resources (FNR)

• A Success Story – Status quo
  o Bioenergy as a renewable energy source for power and heating
  o Electricity
  o Heating
  o Biofuels
  o Biogas

• Cultivation Area and Economic Factor

• Policies and frameworks - Creating a renewables future

• Challenging Outlook
Bioenergy in Germany – 20 Years of Research and Competence

AGENCY FOR RENEWABLE RESOURCES (FNR)
<table>
<thead>
<tr>
<th>Facts and Tasks</th>
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<tbody>
<tr>
<td><strong>Founded:</strong></td>
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| **Tasks:**      | • Support of research, development and demonstration projects in the field of material and energetic use of renewable resources  
                  • Information and advice, public relations activities  
                  • International and EU activities |
| **Target Group:**| Commercial enterprises, small and medium-sized enterprises, private and public research institutions, universities, authorities, consumers |
FNR
Facts and Tasks

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<th>Founded:</th>
<th>1993</th>
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<td>Main office:</td>
<td>Gülzow (Mecklenburg–Western Pomerania)</td>
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<td>Federal Ministry of Food and Agriculture (BMEL)</td>
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<td>Employees:</td>
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               | • Information and advice, public relations activities
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| Target Group: | Commercial enterprises, small and medium-sized enterprises, private and public research institutions, universities, authorities, consumers |
Promotion policy objectives:

1. Contribution to sustainable resource and energy provision
2. Reduction of environmental impacts by resource protection and CO₂ reduction
3. Improving the competitiveness of domestic agriculture and forestry
Bioenergy in Germany – The Success Story

STATUS QUO
Final energy consumption Germany 2013

- Fossil: 87.7% fuels and nuclear energy
- Renewable energies (RE): 12.3%
  - Hydropower: 0.8%
  - Wind energy: 2.1%
  - Biomass: 7.6%
  - Solar energy: 1.4%
  - Other RE: 0.4%

Total: 2,590 TWh

Source: BMWi, AGEE-Stat (February 2014)
Energy supply from renewable energies 2013

- **Biofuels**: 10.3%
- **Hydropower**: 6.7%
- **Wind energy**: 16.8%
- **Solar thermal**: 2.1%
- **Geothermal**: 3.0%
- **Photovoltaic**: 9.4%
- **Biomass (electricity)**: 15.1%
- **Biomass (heat)**: 36.7%

Total: 318.0 TWh, approx. 62% from bioenergy

Source: BMWi, AGEE-Stat (February 2014)
Renewable energies in Germany
Development 2004 - 2013

1st Amendment of the EEG (Aug 2004)
2nd Amendment of the EEG (Jan 2009)
3rd Amendment of the EEG (Jan 2012)
4th Amendment of the EEG (Aug 2014)

Source: BMWi, AGEE-Stat (February 2014)
Electricity generation from renewable energies 2013

- Wind energy: 35.0%
- Photovoltaic: 19.7%
- Hydropower: 13.9%
- Bioenergy: 31.4%

Total: 152.6 TWh

Geothermal electricity generation is not shown due to the small quantities involved

Source: BMWi, AGEE-Stat (February 2014)
Electricity from renewable resources: development

- 1st Amendment of the EEG (Aug 2004)
- 2nd Amendment of the EEG (Jan 2009)
- 3rd Amendment of the EEG (Jan 2012)
- 4th Amendment of the EEG (Aug 2014)

Source: BMWi, AGEE-Stat (February 2014)
Heat from renewable energies 2013

86.5 % Bioenergy

Biogenic 14.4 %
solid fuels
(industry)

Biogenic 49.8 %
solid fuels
(households)

5.8 % Biogenic
solid fuels (CHP/HP)

0.4 % Biogenic
liquid fuels

8.9 % Biogenic
gaseous fuels

7.2 % Biogenic
fraction of waste

5.1 % Solar thermal

7.2 % Geothermal

1.3 % Sewage and
landfill gas

Total 132.9 TWh

Source: BMWi, AGEE-Stat (February 2014)

© FNR 2014
Heat from renewable energies: Development

Biomass share 87%
Fuel consumption in Germany 2013

- Diesel 60.7% (32,660,000 t)
- Biofuel 5.2%
  - Biomethane < 0.1%
  - Bioethanol 1.4%
  - Hydrogenated vegetable oil (HVO)* 0.8%
  - Biodiesel 2.9%
  - Vegetable oil < 0.1%
- Liquefied petroleum gas* (LPG) 1.0% (514,000 t)
- Natural gas* 0.5% (216,000 t)
- Petrol 32.6% (17,230,000 t)

* Estimations on the basis of 2012 figures
Percentages in relation to energy content

Source: BAFA, erdgasmobil, DVFG, BMF, AGEE-Stat, FNR (2014)
Biofuel consumption in Germany 2013

- Bioethanol: 27.1% (1,206,000 t)
- Vegetable oil: <0.1% (1,000 t)
- Hydrogenated vegetable oils (HVO): 15.6% (420,000 t)
- Biomethane: 1.4% (32,000 t)
- Biodiesel: 55.9% (1,792,000 t)

Total: 3.5 m t

*Estimations on the basis of 2012 figures. Percentages in relation to energy content.

Source: BAFA, BMF, AGEE-Stat, FNR (July 2014)
Biofuels in Germany: Development 2005 - 2013

Source: BAFA, BMF, FNR (2014)
Biogas plants in Germany: Development

Number of plants vs. Installed electrical capacity (GW)

- **1st Amendment of the EEG (Aug 2004)**
  - Number of plants: 2,050
  - Installed electrical capacity: 0.4

- **2nd Amendment of the EEG (Jan 2009)**
  - Number of plants: 2,680
  - Installed electrical capacity: 0.7

- **3rd Amendment of the EEG (Jan 2012)**
  - Number of plants: 3,711
  - Installed electrical capacity: 1.3

- **4th Amendment of the EEG (Aug 2014)**
  - Number of plants: 3,891
  - Installed electrical capacity: 1.4

- **Outlook for 2014**
  - Number of plants: 4,984
  - Installed electrical capacity: 1.9
  - Installed electrical capacity: 2.3
  - Installed electrical capacity: 5,905
  - Installed electrical capacity: 7,175
  - Installed electrical capacity: 7,515
  - Installed electrical capacity: 7,850
  - Installed electrical capacity: 7,960

Source: Fachverband Biogas e.V. (2014)

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Biogas plants for biomethane production in Germany

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of plants</th>
<th>Upgrading capacity Biomethane (Nm$^3$/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2007</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>2008</td>
<td>13</td>
<td>25,000</td>
</tr>
<tr>
<td>2009</td>
<td>28</td>
<td>50,200</td>
</tr>
<tr>
<td>2010</td>
<td>46</td>
<td>80,000</td>
</tr>
<tr>
<td>2011</td>
<td>50,285</td>
<td>116,000</td>
</tr>
<tr>
<td>2012</td>
<td>70,125</td>
<td>147,000</td>
</tr>
<tr>
<td>2013</td>
<td>86,395</td>
<td>177,000</td>
</tr>
<tr>
<td>2014/15*</td>
<td>106,795</td>
<td>135,000</td>
</tr>
</tbody>
</table>

*Outlook

Source: FNR based on Dena and Fachverband Biogas e. V. (2014)

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Bioenergy in Germany

CULTIVATION AREA

ECONOMIC FACTOR
Cultivation of renewable resources in Germany

Cultivation area in hectares

**2013** (in 1,000 hectares)

- Industrial use \( \sum 280.5 \)
  - Fibre plants \( 0.5 \)
  - Medical plants and vegetable dyes \( 13 \)
  - Sugar crops \( 9 \)
  - Starch crops \( 121.5 \)
  - Oil crops \( 136.5 \)

- Energy use \( \sum 2,114.5 \)
  - Crops for solid biofuels \( 11 \)
  - Sugar and starch for bioethanol \( 200 \)
  - Crops for biogas \( 1,157 \)
  - Rapeeseed for biodiesel/vegetable oil \( 746.5 \)

Source: FNR (2013)
Bioenergy as economic factor
Total turnover with renewable energy sources 2013

- Biomass 48.4% (electricity & heat) 7.4 bn €
- Biomass 24.3% (fuels) 3.7 bn €
- 5.9% Geothermal 0.9 bn €
- 9.3% Wind energy 1.4 bn €
- 1.7% Hydropower 0.3 bn €
- 8.7% Photovoltaics 1.3 bn €
- 1.7% Solar thermal 0.3 bn €

Total 15.2 bn €

Source: BMWi, AGEE-Stat (February 2014)
Bioenergy as economic factor

Jobs 2013

Jobs in the renewable energy sector (gross employment impact)

Total
371,400

Of which bioenergy
126,400

Source: FNR, after BMWi study, “Short and long-term impacts of the expansion of renewable energy on the German labour market”
Bioenergy in Germany – Creating a Renewable Energy Future

POLICIES AND FRAMEWORKS
Framework for Bioenergy Success

EEG – Renewable Energy Sources Act since 1990
- The feed-in tariff of the EEG was the main driver of bioenergy developments in Germany
- Guaranteed priority green access

The EEG - Amendment came into force on 1 August 2014
- Further development of renewable power generation technologies
- Increasing the share of renewable energies
- But: Capping the construction of new bioenergy plants by 100 MW/\text{el}/a and reduction of fees

Heat production
- The Renewable Energy Heat Act (EEWärmeG) (enacted since January 2009)
  - Defining of requirements for heat use from renewable energies in new and public buildings
Framework for Bioenergy Success

Biofuel production
- The Biofuel Quota Act (BioKraftQuG)
  - Tax exemption for biomethane till end of 2015
  - The use of residues counts double towards the biofuel quota
  - 2015 starts the conversion from biofuel quota to greenhouse gas quota

Biomethane production
- Gas Grid Access Ordinance (GasNZV) & Gas Grid Changes Ordinance (GasNEV) (enacted since April 2008)
  - Acts and guidelines for feeding upgraded biogas into the natural gas grid
EU’s Frameworks for Bioenergy Success

EU 20-20-20 Goals
- 20 % GHG emission reduction
- 20 % Energy efficiency
- 20 % Renewable energies

EU 2009 Renewable Energy Directive (RED)
- 20 % target for the overall share of energy from renewable sources by 2020
- 10 % target for renewable energy sources in the transport sector by 2020; greenhouse gas (GHG) reduction and sustainability requirements

EU 2009 Amendment of the EU Fuel Quality Directive (FQD)
- Establishment of GHG reduction targets for transport fuels of at least 6 % in 2020 compared to 2010 and sustainability requirements

Biofuel Sustainability Regulation (BioKraft-NachV) (2009)
- National regulations on sustainability certification and proof of evidence
Bioenergy in Germany – Challenging Futures

OUTLOOK
Energy scenario for Germany 2050

Primary energy consumption in PJ

- Other renewable energies
- Biomass
- Fossil energy sources

2011 vs. Scenario 2050
Potential for bioenergy: Germany 2050

100 %
6,950 PJ
Total German energy demand

23 %
1,640 PJ
Bioenergy potential

11 %
5 %
4 %
3 %

Energy crops 740 PJ
Woodfuel from forestry 360 PJ
Agricultural coproducts and residues 300 PJ
Other biogenic waste 240 PJ

Source: FNR

Rounded figures
Bioenergy Challenges & Need for action

Challenges

- Limitation of future development of bioenergy by the amended EEG 2014
  - An economical viable operation of biogas or woody heating plants will be difficult

- Economical and ecological sustainability
  - Increased competition for land (food, feed, energy)
  - LUC / ILUC / Water / Soil quality / Biodiversity
  - Higher costs of electricity production from bioenergy compared to other renewables (and fossil resources)

- Decreasing public acceptance
Bioenergy Challenges & Need for action

Need for action

- Implementation of favourable political and legal frameworks
- Combination of bioenergy with fluctuating renewables
- Increasing use of residual matter and waste materials
- Consideration of sustainable aspects
- Improvement of PR activities for more acceptance
- Raising prices for conventional energy carriers

- Raising efficiency in production and use of bioenergy
- Flexible and demand driven bioenergy production
- Development of alternative substrates and energy crops
- Process optimization (e.g. process control, substrate pre-treatment)
- New business models
Arguments for a prosperous Bioenergy future

Bioenergy
- is a strong support of rural development
- fosters decentral energy production
- can be used multifunctional (heat, electricity, fuel)
- reduces the dependency from fossil and nuclear energy
- delivers $\frac{2}{3}$ of renewable energy share (in Germany)

German energy transition cannot be managed without bioenergy!
Thank you for your attention

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Bioenergy in Germany

END
Bioenergy in Germany

BIOFUELS
Biodiesel feedstocks in Germany 2013

- Soya oil: 10%
- Palm oil: 13%
- Waste materials such as used cooking oils, fatty acids and animal fats: 13%
- Rapeseed oil: 64%

Source: FNR based on VDB-members survey (July 2014)
Biodiesel consumption in Germany 2007 - 2013

Source: BAFA, FNR (July 2014)
Biodiesel production and consumption in Germany 2005 - 2013

Source: Ufop, VDB, BAFA, BMF, FNR (April 2014)

© FNR 2014
Bioethanol production and consumption in Germany 2007 - 2013

Production capacity 2013: 1 m t

Source: BAFA, BDBe (2014)
Consumption of unblended biofuels in Germany 2007 - 2013

Source: BAFA, FNR (July 2014)
History of German biofuels legislation

- Pre 2004: Full detaxation of pure biofuels- focus on biodiesel in the market (B100)
- 1 Jan 2004 to 31 July 2006: Full detaxation of all biofuels (pure and blended).
- Biofuels quota law from 18 Dec 2006: Blending obligation of biofuels for gasoline and diesel from 1 Jan 2007.
Changes in biofuel support

<table>
<thead>
<tr>
<th>Year</th>
<th>Biodiesel (Cent/l)</th>
<th>Vegetable oil (Cent/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>9.0</td>
<td>0</td>
</tr>
<tr>
<td>2007</td>
<td>9.0</td>
<td>2.15</td>
</tr>
<tr>
<td>2008</td>
<td>14.88</td>
<td>9.85</td>
</tr>
<tr>
<td>2009</td>
<td>14.29</td>
<td>18.15</td>
</tr>
<tr>
<td>2010</td>
<td>18.60</td>
<td>18.46</td>
</tr>
<tr>
<td>2011</td>
<td>18.60</td>
<td>18.46</td>
</tr>
<tr>
<td>2012</td>
<td>18.60</td>
<td>18.46</td>
</tr>
<tr>
<td>From 2013</td>
<td>45.03</td>
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</table>

**Energy tax**

**Tax rate:**

Since January 2013 pure biofuels have the same tax rate as fossil diesel fuel (45.03 cents per liter).

**Tax reliefs still exist for pure biofuels used in agriculture, and**

- bioethanol (bioethanol 70 – 90 %, lignocellullosic ethanol)
- synthetic biofuels
- biomethane until 2015

The tax relief for natural and liquefied natural gas used for fuel exists until 2018.
Changes in biofuel support

Biofuel Quota Act (BioKraftQuG) -2006:

The government has set a reference value for the market quota for biofuels:

• 5.25 % by 2010
• 6.25 % until 2014

From 2015 the benchmark for biofuels quotas will be converted from the present energetic evaluation to the net greenhouse gas reduction.

The net quota will increase from a rate of 3.5 % in 2015, to 4 % in 2017 and to 6 % in 2020 (revision 9 Oct. 2014).

Biomethane mixed in natural gas can also be taken into account to fulfill the quota.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total quota (%)</th>
<th>Biodiesel (%)</th>
<th>Bioethanol (%)</th>
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<tbody>
<tr>
<td>2009</td>
<td>5.25</td>
<td>4.4</td>
<td>2.8</td>
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<tr>
<td>2010</td>
<td>6.25</td>
<td></td>
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<td>2011</td>
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<td>6.25</td>
<td>4.4</td>
<td>2.8</td>
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2015 3.5* % GHG reduction through biofuels
2017 4* % GHG reduction through biofuels
2020 6* % GHG reduction through biofuels

* Revised 2014 from 3/4.5/7 %
Biofuels- Legal framework- 12th Act to amend the federal immission control act (BiImSchG) 2014

- Change from energy quota to GHG quota
- Biofuel market value determined by GHG reduction
- Amended limits to GHG reduction targets 2015-2020- close to 2014 biofuels consumption
- No double counting
- Exclusion of animal fats, co-refined oils
- Reporting origin, point of purchase, GHG reduction per energy unit
- Provisions to include electricity use in road transport
- Under discussion:
  - Inclusion of power-to-gas, hydrogen, biomethane

- Decision of the German Parliament expected for Oct 2014
- Expected to be in force 1 Jan 2015
Biofuels- Legal framework

• Not accepted under the biofuel quota:
  – Biogenic oils processed/hydrogenated in an oil refinery together with mineral oils

• Double counting since 2011 (fuels from wastes, residues, lignocellulose, UCOME)

• Synthetic biofuels and lignocellulosic ethanol: detaxation and accountable under biofuels quota (until end of 2015)

• E85 (E70-E90): Ethanol tax free until end of 2015
Biofuels in Germany 2020 and beyond

• **Mobility and fuel strategy 2013 (until 2050):**
  - “Decisions on further increasing the proportion of biofuels, taking account of the technical framework conditions for renewable energy targets in transport, should only be made when new biofuel options and sufficiently sustainable biomass sources have been established / tapped and the additional costs associated with this for the transport sector can thus be foreseen.”

• **German government coalition treaty from 17 Dec 2013 on biofuels:**
  - Fundamental requirement: sustainability
  - Development of a biofuels strategy based on realistic potentials
  - R&D on new fuels; LNG for ships
  - Continuation of tax reduction for CNG and LPG
Biofuels in Germany 2020 and beyond

[Graph showing biofuels production from 2005 to 2025 with projected data up to 2025.]

Dieselkraftstoffe
Ottokraftstoffe

Quelle: BAFA, MWV, FNR

* Prognose
© FNR 2011
Biofuels in Germany 2020 and beyond

- Germany is confident to meet the 10% target of the RED in 2020
- GHG quota of 6% in BImSchG will continue after 2020
- But: Uncertainty about EU legislation
- Germany in favour of grandfathering clause for current consumption level of food based biofuels
- Key issue also the regulation of ILUC-issue by caps
- Electrification of transport
Bioenergy in Germany

BIOGAS
Framework requirements for biogas

Acts and ordinances

• Electricity production
  – The Renewable Energy Sources Act (EEG) *(Amendment came into force on 1 August 2014)*
    ▪ Further development of renewable power generation technologies
    ▪ Increasing the share of renewable energies
    ▪ But: Capping the construction of new biogas plants, reduction of fees

• Heat production
  – The Renewable Energy Heat Act (EEWärmeG) *(enacted since January 2009)*
    ▪ Defining of requirements for heat use from renewable energies in new and public buildings

• Biofuel production
  – The Biofuel Quota Act (BioKraftQuG)
    ▪ Tax exemption for biomethane till end of 2015
    ▪ The use of residues counts double towards the biofuel quota
    ▪ 2015 starts the conversion from biofuel quota to greenhouse gas quota

• Biomethane production
  – Gas Grid Access Ordinance (GasNZV) & Gas Grid Changes Ordinance (GasNEV) *(enacted since April 2008)*
    ▪ Acts and guidelines for feeding upgraded biogas into the natural gas grid
Framework requirements for biogas

Status quo in Germany

• State-of-the-art (End of 2013)
  – 7,850 biogas plants with 3,500 MW\textsubscript{el} performance
  – Approx. 26.4 billion kWh electricity from biogas equals 4.2 \% of total electricity generation
  – Cultivation area of crops for biogas approx. 1,157,000 ha
  – Approx. 40,000 jobs

• Use of biogas
  – Various uses of biogas (electricity, heat, fuel; currently mainly used in decentralized combined heat and power generation (CHP))
  – First filling station provided biomethane as fuel since 2006; currently about 350 filling stations offer biomethane in Germany
  – 147 plants inject biomethane into the German natural gas grid

• Potential
  – Biogas has a technical energetic potential of 440 PJ/a; this equals to about 7 \% of total electricity consumption in Germany
Framework requirements for biogas
National government aid and funding programmes

- Granting loans with low interest rates for RES projects (KfW)
- Promotion of investments in local heat and biogas pipelines (KfW)
- Promotion of investments by the Agro-Investment-Programme (AFP) or by supporting programmes of the Federal States
- Assistance for consultation and diversification for farmers
- Funding of R & D by the research programme “Renewable Resources”, managed by FNR on behalf of BMEL
- Other R & D programmes (BMUB, BMBF)
Framework requirements for biogas  
National government aid and funding programmes

- International Climate Protection Initiative – IKI (BMUB)
- Renewable Energy Export Initiative (BMWi)
- Cooperation international - Government’s strategy for globalising research and development (BMBF IB)
- Bilateral Cooperative Programme (BMEL)
- Different programmes and projects of the German Society for International Cooperation (GIZ)
- KfW Bankengruppe and its subsidiary DEG both promote and support projects in the area of climate and environmental protection in developing and transition countries
Framework requirements for biogas

Problems and need for action

• Problems
  – Limitation of future development of biogas by the amended EEG 2014
  – Increased competition for substrates and land, caused by extended energy crop/maize production
  – Higher costs of electricity production from biogas compared to other Renewables
  – Decreasing public acceptance

• Need for action
  – Increasing use of residual matter and waste materials
  – Further development of alternative substrates and energy crops
  – Raising efficiency in production and use of energy from biogas
  – Process optimization (e.g. process control, substrate pre-treatment)
  – Flexible and demand driven biogas production
  – Combination of biogas with fluctuating renewables
  – Consideration of sustainable aspects (e.g. reduction of emissions)
  – Improvement of PR activities for more acceptance
Targets of the Federal Government until 2020

- Share of electricity produced from renewable energy: 30 % (23 % in 2012)
- Share of heat produced from renewable energy: 14 % (10 % in 2012)
- Replacing 6 % imports of natural gas by feed-in of biogas (currently 1 %)
- Doubling share of CHP electricity to 25%
- Fuels: 7 % reduction of the emission of greenhouse gasses by the use of biofuels / equal to 10-12% biofuels share (6 % in 2012)

The share of renewable energies has to increase significant until 2020!