CULTIVATION RESOURCES PRODUCTS

With support from

Federal Ministry of Food and Agriculture

by decision of the German Bundestag
CULTIVATION OF RENEWABLE RESOURCES

Land use in Germany

| Settlement area, traffic area, water area, wasteland | 7.6 M ha |
| Agriculture area | 16.7 M ha |
| Forest area | 11.4 M ha |
| TOTAL | 35.7 M ha |

Source: FNR based on Statistisches Bundesamt, BMEL (2016) © FNR 2017

Cultivation of renewable resources in Germany 2014–2016 (in hectares)

<table>
<thead>
<tr>
<th>Plants</th>
<th>Feedstock</th>
<th>2014</th>
<th>2015*</th>
<th>2016**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial starch</td>
<td>106,000</td>
<td>108,500</td>
<td>108,000</td>
<td></td>
</tr>
<tr>
<td>Industrial sugar</td>
<td>12,500</td>
<td>15,000</td>
<td>16,000</td>
<td></td>
</tr>
<tr>
<td>Technical rapeseed oil</td>
<td>115,500</td>
<td>129,000</td>
<td>122,500</td>
<td></td>
</tr>
<tr>
<td>Technical sunflower oil</td>
<td>6,000</td>
<td>6,500</td>
<td>6,000</td>
<td></td>
</tr>
<tr>
<td>Technical linseed oil</td>
<td>3,500</td>
<td>3,500</td>
<td>3,500</td>
<td></td>
</tr>
<tr>
<td>Plant fibres</td>
<td>1,000</td>
<td>1,500</td>
<td>1,500</td>
<td></td>
</tr>
<tr>
<td>Plant-based drugs and dyes</td>
<td>12,000</td>
<td>12,000</td>
<td>12,000</td>
<td></td>
</tr>
<tr>
<td><strong>Industrial crops total</strong></td>
<td>256,500</td>
<td>276,000</td>
<td>269,500</td>
<td></td>
</tr>
<tr>
<td>Rapeseed oil for biodiesel/vegetable oil</td>
<td>798,500</td>
<td>800,000</td>
<td>760,000</td>
<td></td>
</tr>
<tr>
<td>Crops for bioethanol</td>
<td>188,000</td>
<td>200,000</td>
<td>184,000</td>
<td></td>
</tr>
<tr>
<td>Crops for biogas</td>
<td>1,353,500</td>
<td>1,400,000</td>
<td>1,450,000</td>
<td></td>
</tr>
<tr>
<td>Crops for solid fuels (e.g. farmed wood, miscanthus)</td>
<td>10,500</td>
<td>11,000</td>
<td>11,000</td>
<td></td>
</tr>
<tr>
<td><strong>Energy crops total</strong></td>
<td>2,350,500</td>
<td>2,411,000</td>
<td>2,421,000</td>
<td></td>
</tr>
<tr>
<td><strong>Total acreage of renewable resources</strong></td>
<td>2,607,000</td>
<td>2,687,000</td>
<td>2,690,500</td>
<td></td>
</tr>
</tbody>
</table>

Source: FNR (2017)

*preliminary values; **estimated values

© FNR 2017
WOOD

German forest in figures

Total area Germany

Forest area 31.9% 11.4 M ha

Most common tree species in German forests

- Oak: 10.3%
- Beech: 15.4%
- Pine: 22.3%
- Spruce: 25.4%

Source: BMEL (2014) © FNR 2015

Growth of the timber stock in German forests

Stock balance in M m³

- 2002: Stock 2002 3,436
- 2012: Stock 2012 3,663
- Growth 1,252
- Outflow 1,091

Source: BWI (2014) © FNR 2014

Wood raw material balance 2015

Trunk wood, 59% other merchantable wood, residual forest wood 76.8 M m³

- Stock: Total 131.4 M m³
- Stock balance: 4% Bark 4.5 M m³
- 11% Sawmill by-products 14.9 M m³
- 4% Industrial residual wood, black liquor 5.7 M m³
- 11% Waste wood 15.0 M m³
- 11% Other wood raw materials 14.5 M m³

Source: Mantau/Holzrohstoffbilanz Deutschland (2017) © FNR 2017

Use of wood in Germany 2015

Sawing industry 27% 35.9 M m³

- Stock: Total 131.4 M m³
- 12% Wood materials 15.4 M m³
- 8% Cellulose and wood pulp 10.0 M m³
- 1% Others 1.7 M m³
- Bioenergy 52% 68.4 M m³

Source: Mantau/Holzrohstoffbilanz Deutschland (2017) © FNR 2017
RESOURCES TOTAL

Material use of renewable resources in Germany 2015

<table>
<thead>
<tr>
<th>Resource</th>
<th>Share</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch</td>
<td>26%</td>
<td>870,000 t</td>
</tr>
<tr>
<td>Fats and oils</td>
<td>34%</td>
<td>1,145,000 t</td>
</tr>
<tr>
<td>Chemical pulp</td>
<td>11%</td>
<td>386,000 t</td>
</tr>
<tr>
<td>Natural fibres</td>
<td>4%</td>
<td>136,000 t</td>
</tr>
<tr>
<td>Proteins</td>
<td>3%</td>
<td>114,000 t</td>
</tr>
<tr>
<td>Others</td>
<td>18%</td>
<td>596,000 t</td>
</tr>
</tbody>
</table>

Total: 3.4 M t

Material use of carbohydrates in Germany 2015

<table>
<thead>
<tr>
<th>Resource</th>
<th>Share</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper starch</td>
<td>43%</td>
<td>656,200 t</td>
</tr>
<tr>
<td>Chemical pulp</td>
<td>25%</td>
<td>386,000 t</td>
</tr>
<tr>
<td>Chemical starch</td>
<td>23%</td>
<td>358,000 t</td>
</tr>
<tr>
<td>Natural fibres</td>
<td>9%</td>
<td>136,000 t</td>
</tr>
</tbody>
</table>

Total: 1.536 M t

Development of the material use of renewable resources in Germany

Without timber use

Material use of other biogenic resources in Germany 2015

<table>
<thead>
<tr>
<th>Resource</th>
<th>Share</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other biogenic resources</td>
<td>12%</td>
<td>72,000 t</td>
</tr>
<tr>
<td>Cork</td>
<td>5%</td>
<td>32,500 t</td>
</tr>
<tr>
<td>Natural rubber</td>
<td>37%</td>
<td>218,000 t</td>
</tr>
<tr>
<td>Glycerol</td>
<td>31%</td>
<td>181,900 t</td>
</tr>
<tr>
<td>Waxes, resins, tannins</td>
<td>15%</td>
<td>91,600 t</td>
</tr>
</tbody>
</table>

Total: 596,000 t

Source: FNR, BMEL (2016) © FNR 2017

* provisional estimate
CHEMICAL INDUSTRY

Material use of organic resources in the chemical industry in Germany 2015

<table>
<thead>
<tr>
<th>Resources</th>
<th>Amount</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fossil resources</td>
<td>17.5 M t</td>
<td>87 %</td>
</tr>
<tr>
<td>Biogenic resources</td>
<td>2.5 M t</td>
<td>13 %</td>
</tr>
</tbody>
</table>

Total: 20.0 M t

Material use of renewable resources in the chemical industry in Germany 2015

<table>
<thead>
<tr>
<th>Resources</th>
<th>Amount</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fats and oils</td>
<td>1.145 M t</td>
<td>45 %</td>
</tr>
<tr>
<td>Starch</td>
<td>214,000 t</td>
<td>8 %</td>
</tr>
<tr>
<td>Sugar</td>
<td>144,000 t</td>
<td>6 %</td>
</tr>
<tr>
<td>Chemical pulp</td>
<td>386,000 t</td>
<td>15 %</td>
</tr>
<tr>
<td>Proteins</td>
<td>114,000 t</td>
<td>5 %</td>
</tr>
<tr>
<td>Others</td>
<td>532,000 t</td>
<td>21 %</td>
</tr>
</tbody>
</table>

Total: 2.54 M t

Source: FNR, VCI (2016) © FNR 2017

BIOCOMPOSITES

BIOPLASTICS

World market for polymers, quantities and biobased shares 2013

- **Polymers**
  - Total: ca. 393 M t
  - Biobased: 32.6 M t (= 8.3 % of total)

- **Elastomers**
  - Total: 26.5 (2012) M t
  - Biobased: 11.3 (2012) M t (= 43 % of total)

- **Thermoplastics and thermosets**
  - Total: 314 M t
  - Biobased: 15.3 M t (= 4.9 % of total)

- **Synthetic fibres**
  - Total: 55 M t
  - Biobased: 6 M t (= 11 % of total)

- **Functional polymers**
  - Total: 58 M t
  - Biobased: 10 M t (= 17 % of total)

- **Structural polymers**
  - Total: 256 M t
  - Biobased: 5.3 M t (= 2 % of total)

- **Paper starch**
  - 8 M t

- **Biobased functional polymers**
  - (additives for paints, adhesives, others)
  - 2 M t

- **Biobased structural polymers**
  - 5.2 M t

- **Linoleum**
  - 0.1 M t

Source: nova-Institut (2017) © FNR 2017
Global production capacities for bioplastics 2017

- PLA: 10.3% (biodegradable)
- Bio-PE: 9.7% (biodegradable)
- Bio-PET: 26.3% (biodegradable)
- Others: 1.5% (biodegradable)
- Biodegradable starch blends: 18.8%
- PHA: 2.4%
- PBAT: 5.0%
- PBS: 4.9%
- Other (biobased/non-biodegradable): 9.2%
- Bio-PA: 11.9%

Total: 2.05 Mt

Global production capacities 2017–2022

<table>
<thead>
<tr>
<th>Year</th>
<th>Biobased/non-biodegradable</th>
<th>Biodegradable</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>2,054</td>
<td>1,174</td>
</tr>
<tr>
<td>2018</td>
<td>2,093</td>
<td>1,182</td>
</tr>
<tr>
<td>2019</td>
<td>2,138</td>
<td>1,192</td>
</tr>
<tr>
<td>2020</td>
<td>2,189</td>
<td>1,202</td>
</tr>
<tr>
<td>2021</td>
<td>2,248</td>
<td>1,215</td>
</tr>
<tr>
<td>2022</td>
<td>2,440</td>
<td>1,354</td>
</tr>
</tbody>
</table>

Source: European Bioplastics, nova-Institut (2017)

BIOCOMPOSITES

Production of biocomposites in Europe 2017

- Decking boards: 49% (biodegradable)
- Technical uses, furniture, consumer products, others: 14%
- Automotive sector: 37%

Total: 410,000 t

Use of wood and natural fibres for composites in the European automotive industry 2012

- Cotton: 25%
- Flax: 19%
- Kenaf: 8%
- Others: 7%
- Wood: 38%
- Hemp: 5%

Total: 80,000 t

**OLEOCHMISTRY**

**Areas of industrial applications for vegetable oils in Germany 2011**

Polymers and additives 22 %
Technical surfactants and textile additives 5 %
Detergents and toiletries 21 %
6 % Coating agents
4 % Inks
1 % Adhesives and putties
2 % Lubricants
39 % Others

Total 1.2 M t

Source: MEO (2014) © FNR 2014

**BIOLUBRICANTS**

**Total market of biolubricants in Germany 2011**

| Source: MEO (2014) © FNR 2014 |

**Total amount of vegetable oils and fats in the lubricant market in Germany 2016**

| Source: T+I Consulting (2017) © FNR 2017 |

**Sources of raw materials for biolubricants in Germany 2016**

- **Rapeseed oil** 25 %
- **Castor oil** 5 %
- **Palm kernel oil** 20 %
- **Palm oil** 15 %
- **Sunflower oil** 2 %
- **Animal fats** 25 %
- **Others** 8 %

**Total** 48,800 t

**Total market of biolubricants in Germany 2011**

| Source: T+I Consulting (2017) © FNR 2017 |

- **Greases**
- **Mould oils**
- **Saw-chain oils, saw-frames oils**
- **Metalworking oils**
- **Engine oils, compressor oils, turbine oils**
- **Base oils**
- **Process oils**
- **Metalworking oils**
- **Greases**
- **Engine oils, compressor oils, turbine oils**
- **Others**

**Total** 29,810 t

| Source: T+I Consulting (2017) © FNR 2017 |

**Greases**
**Mould oils**
**Saw-chain oils, saw-frames oils**
**Metalworking oils**
**Engine oils, compressor oils, turbine oils**
**Base oils**
**Process oils**
**Metalworking oils**
**Greases**
**Engine oils, compressor oils, turbine oils**
**Others**

**Total** 48,800 t

Source: T+I Consulting (2017) © FNR 2017
SURFACTANTS

Ingredients in detergents and cosmetic care products in private households in Germany 2015

- Sodium sulfate: 14% (76,088 t)
- Sodium carbonate: 15% (80,355 t)
- Surfactants: 35% (184,419 t)

Total: 530,470 t

Share of the different surfactant groups in detergents and cosmetic care products in Germany 2015

- Mixed tensides: 43%
- Purely petrochemical tensides: 50%
- 7% Purely biobased tensides

Total: 184,400 t

Utilisation of surfactants in Western Europe 2014

- Cosmetics and pharmacy: 15%
- Textiles and fibres: 10%
- Industrial cleaners: 5%
- Building and metalworking industry: 3%
- Chemical industry: 3%
- Others: 10%

Total: 2.5 M t

Paper and cardboard

Production of paper, carton and cardboard in Germany 2016

- Paper, carton, cardboard for packaging: 50% (11.39 M t)
- Toilet paper: 7% (1.5 M t)
- Paper, carton, cardboard for technical and special uses: 6% (1.38 M t)
- Graphic papers: 37% (8.36 M t)

Total: 22.6 M t

Consumption of cellulose and fibres for paper production in Germany 2016

- Mechanical pulp: 1.05M t (5%)
- Chemical pulp: 4.58M t (20%)
- Total: 22.49M t (75% Paper of recycling)

Source: Verband Deutscher Papierfabriken e.V. (2017) © FNR 2017

Consumption of cellulose in Germany 2016

- Other applications: 363,000 t (6.8%)
- Mechanical pulp: 4,571,000 t (86.0%)
- Fibres, films: 211,000 t (4.0%)
- Chemical derivates: 169,000 t (3.2%)
- Total: 5.31M t

Source: T+i Consulting (2017) © FNR 2017

WOOD PRODUCTS AND BUILDING MATERIALS

Production of saw wood in Germany

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Softwood timber</td>
<td>19.7</td>
<td>23.1</td>
<td>23.7</td>
<td>22.0</td>
<td>20.4</td>
<td>20.8</td>
<td>20.4</td>
<td>21.1</td>
</tr>
<tr>
<td>Hardwood timber</td>
<td>1.1</td>
<td>1.1</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Total</td>
<td>20.8</td>
<td>24.2</td>
<td>24.7</td>
<td>23.0</td>
<td>21.4</td>
<td>21.8</td>
<td>21.5</td>
<td>22.2</td>
</tr>
</tbody>
</table>

Source: Statistisches Bundesamt, BMEL (2017) Data in million cubic meters

Production of wood materials in Germany

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chipboards</td>
<td>9.3</td>
<td>9.4</td>
<td>8.5</td>
<td>8.2</td>
<td>8.2</td>
<td>8.1</td>
<td>8.0</td>
<td>8.3</td>
</tr>
<tr>
<td>Fibreboards</td>
<td>3.8</td>
<td>2.9</td>
<td>3.0</td>
<td>3.5</td>
<td>3.6</td>
<td>3.6</td>
<td>3.7</td>
<td>3.8</td>
</tr>
<tr>
<td>Plywood</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.4</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Total</td>
<td>13.3</td>
<td>12.4</td>
<td>11.6</td>
<td>11.8</td>
<td>11.9</td>
<td>12.1</td>
<td>12.2</td>
<td>12.6</td>
</tr>
</tbody>
</table>

Source: Statistisches Bundesamt, BMEL (2017) Data in million cubic meters
Share of wooden structures on the overall approved residential buildings

<table>
<thead>
<tr>
<th>Year</th>
<th>Total residential buildings</th>
<th>Share of wooden structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>94,008</td>
<td>13.2%</td>
</tr>
<tr>
<td>2008</td>
<td>87,674</td>
<td>16.4%</td>
</tr>
<tr>
<td>2009</td>
<td>89,509</td>
<td>16.6%</td>
</tr>
<tr>
<td>2010</td>
<td>94,602</td>
<td>15.5%</td>
</tr>
<tr>
<td>2011</td>
<td>112,698</td>
<td>15.2%</td>
</tr>
<tr>
<td>2012</td>
<td>109,128</td>
<td>15.2%</td>
</tr>
<tr>
<td>2013</td>
<td>113,391</td>
<td>15.0%</td>
</tr>
<tr>
<td>2014</td>
<td>111,610</td>
<td>15.1%</td>
</tr>
<tr>
<td>2015</td>
<td>120,771</td>
<td>16.0%</td>
</tr>
<tr>
<td>2016</td>
<td>125,213</td>
<td>16.2%</td>
</tr>
</tbody>
</table>

Source: Statistisches Bundesamt (2017) © FNR 2017

Share of wooden structures on the overall approved non-residential buildings

<table>
<thead>
<tr>
<th>Year</th>
<th>Total non-residential buildings</th>
<th>Share of wooden structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>29,376</td>
<td>16.9%</td>
</tr>
<tr>
<td>2008</td>
<td>31,418</td>
<td>18.7%</td>
</tr>
<tr>
<td>2009</td>
<td>31,069</td>
<td>19.9%</td>
</tr>
<tr>
<td>2010</td>
<td>31,069</td>
<td>19.6%</td>
</tr>
<tr>
<td>2011</td>
<td>32,099</td>
<td>18.1%</td>
</tr>
<tr>
<td>2012</td>
<td>30,364</td>
<td>18.6%</td>
</tr>
<tr>
<td>2013</td>
<td>28,611</td>
<td>17.6%</td>
</tr>
<tr>
<td>2014</td>
<td>26,765</td>
<td>17.6%</td>
</tr>
<tr>
<td>2015</td>
<td>26,533</td>
<td>16.8%</td>
</tr>
<tr>
<td>2016</td>
<td>29,095</td>
<td>19.3%</td>
</tr>
</tbody>
</table>

Source: Statistisches Bundesamt (2017) © FNR 2017

Total market for insulating materials in Germany 2011

- **Mineral resources**: 13.5 Mm³ (48%)
- **Fossil resources**: 12.9 Mm³ (45%)
- **Renewable resources**: 2.0 Mm³ (7%)

Source: FNR (2014) © FNR 2014

Furniture market in Germany 2016

- **Other materials**: 2.0bn € (11%)
- **Metal furniture**: 3.1bn € (18%)
- **Plastic furniture**: 0.6bn € (4%)
- **Wooden furniture**: 11.8bn € (67%)

Source: Möbelindustrie/Verbände der Deutschen Holz-, Möbel- und Fertigbauindustrie © FNR 2017
PLANT-BASED DRUGS

Cultivation of medical plants, spice plants and aromatic plants in Germany 2011

- Chives 5% 
- Camomile 9%
- Parsley 15%
- Linseed 21%
- 5% Dill
- 5% Seabuckthorn
- 40% Others (fennel, marjoram, mustard, mint, caraway, thyme, coriander, milk thistle, balm, St. John’s wort, chervil)

Total 12,239 ha

Source: MEO (2014) © FNR 2014

Demand for plant-based drugs in Germany 2011

- Milk thistle 5% 1,550 t
- Balm 5% 1,500 t
- Anise 5% 1,500 t
- Nettle 4% 1,250 t
- Mint 20% 6,000 t
- 13% Fennel 4,000 t
- 15% Camomile 4,500 t
- 33% Others 10,440 t

Total 30,760 t

Source: MEO (2014) © FNR 2014

Distribution of demand of plant-based drugs in Germany 2011

- Health Food 20%
- Cosmetics 5%
- Veterinary products 5%
- 70% Phytopharmaceuticals Human applications
- 20% Veterinary products

Total 30,760 t

Source: MEO (2014) © FNR 2014

Turnover of human medicines in pharmacies 2011

- Herbal 3% pharmaceuticals
- Synthetic pharmaceuticals 97%
- 3% Others

Total 39.1bn €

Turnover of phytopharmaceuticals in pharmacies: 1.1bn €

Source: MEO (2014) © FNR 2014
### BIOECONOMY

#### Turnover in the biobased economy in Germany 2014

- **Forest-based industry** 20 %
  - 48.3 bn €
- **Textiles** 6 %
  - 11.0 bn €
- **Biofuels** 4 %
  - 8.5 bn €
- **Forestry** 5 %
  - 8.8 bn €
- **Agriculture** 28 %
  - 55.0 bn €
- **Paper industry** 20 %
  - 39.8 bn €
- **Chemical and pharmaceutical industry** 17 %
  - 33.5 bn €

Total turnover: 196.9 bn €


called 20/12/2017

#### Employees in the biobased economy in Germany 2014

- **Chemical and pharmaceutical industry** 9 %
  - 101,012
- **Paper industry** 13 %
  - 145,232
- **Forest-based industry** 21 %
  - 236,625
- **Textiles** 6 %
  - 60,382
- **Biofuels** 1 %
  - 15,706
- **Forestry** 3 %
  - 33,000

Total employees: 1,120,457

called 20/12/2017

### Further information

- [www.fnr.de](http://www.fnr.de)
- [mediathek.fnr.de](http://mediathek.fnr.de)
- **Market Analysis of Renewable Resources:**
  - Abstract: [www.fnr.de/marktanalyse](http://www.fnr.de/marktanalyse)
  - Long version: [www.fnr.de/marktanalyse/marktanalyse.pdf](http://www.fnr.de/marktanalyse/marktanalyse.pdf)
- **National Policy Strategy on Bioeconomy:**
  - [mediathek.fnr.de/nationale-politikstrategie-biookonomie.html](http://mediathek.fnr.de/nationale-politikstrategie-biookonomie.html)
- **Facts and figures on bioenergy:**
  - [factsandfigures.fnr.de](http://factsandfigures.fnr.de)
  - [www.bio-based.eu](http://www.bio-based.eu)

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