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# Geothermal Energy Use in Germany

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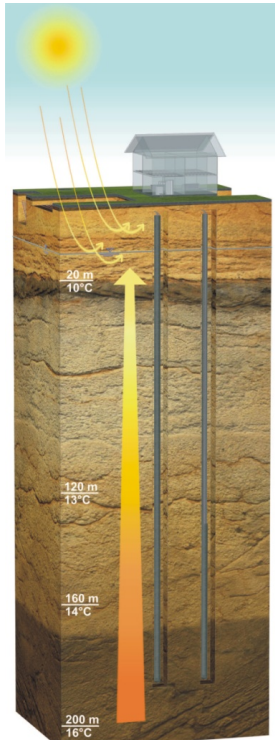
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# Geothermal Energy Use in Germany

|   |            |   |
|---|------------|---|
| NEAR-SURFACE GEOTHERMAL ENERGY (max. 400 m) | 10 - 20°C  | Heating (requires heat pump)<br>Cooling       |
| HYDROGEOTHERMAL ENERGY<br>Deep Aquifers     | 20 - 150°C | District Heating<br>Power Generation (>100°C) |

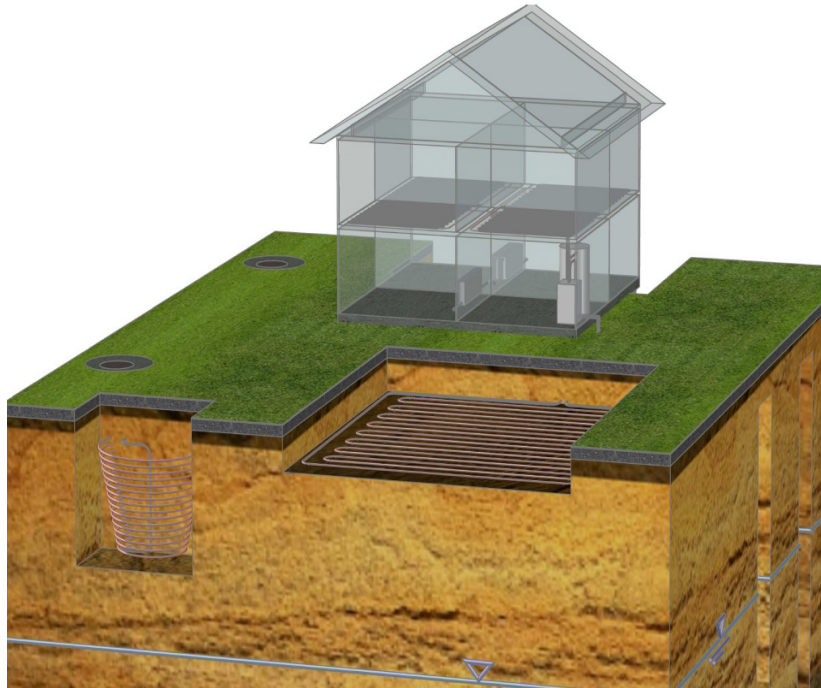
# Borehole heat exchangers



©LBEG

- ◆ Market share ca. 80 %
- ◆ Drilling depth ca. 40-150 m
- ◆ Source temperature ca. 10-13 °C
- ◆ Closed system for (almost) every subsurface
- ◆ High standards of material
- ◆ Different designs and working mediums

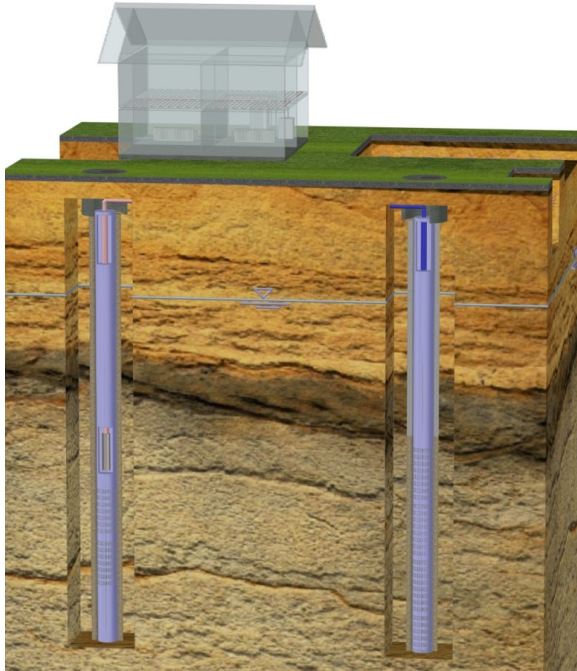
# Ground heat collectors



- ◆ Market share ca. 15 %
- ◆ Different designs (horizontal heat exchanger, baskets, spirals, etc.)
- ◆ Solar radiation required
- ◆ Heat withdrawal may delay plant growth

©LBEG

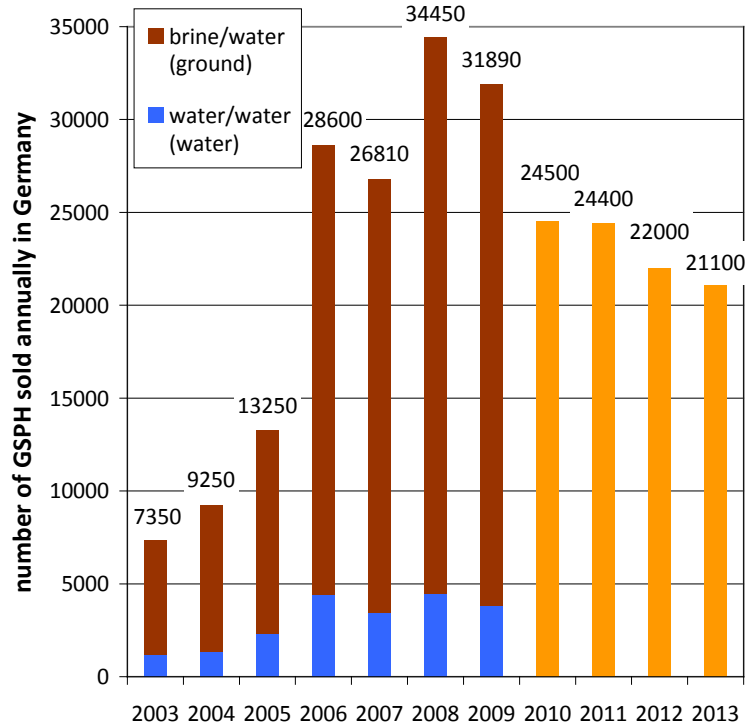
# Groundwater heat pumps



©LBEG

- ◆ Market share ca. 5 %
- ◆ Direct heat use from groundwater
- ◆ High heat capacity of water → much usable energy (e.g. single family home: well performance ca. 1.5 m<sup>3</sup>/h)
- ◆ Restriction 1: water quantity
- ◆ Restriction 2: water quality

# Ground source heat pumps



after data from BWP 2014

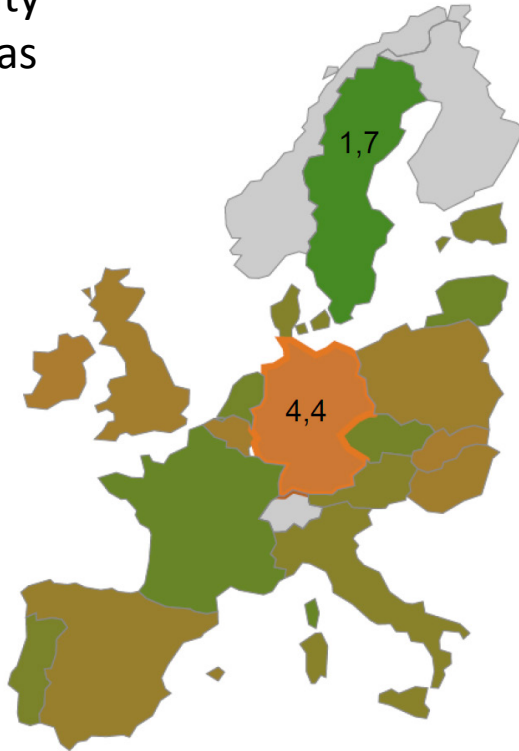
Number of heat pumps (2013):  
286,000

Total installed capacity: 3,450  
MWt

Pure geothermal contribution:  
2,590 MWt

Annual production: 4,500 GWh

Electricity  
price/Gas  
price



Quelle: EHPA

**bwp** Bundesverband  
Wärmepumpe e.V.

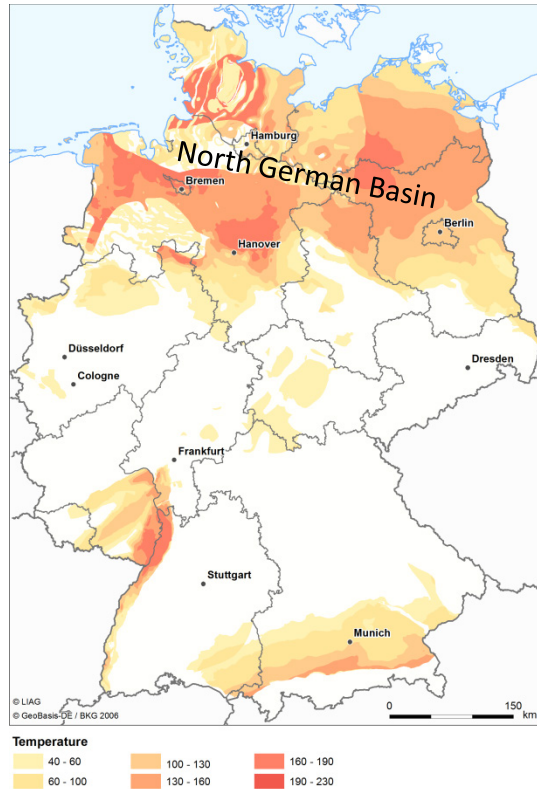
- High cost for drilling
- Lower cost for installation of air source units
- Complicated approval practices
- Price of electricity for heat pumps (HP) is 4.4 times higher than natural gas

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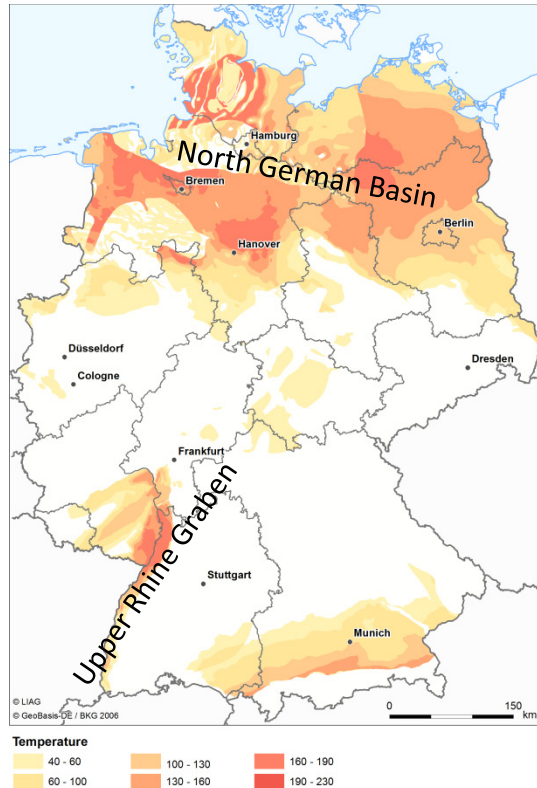


# Hydrothermal Energy



North German Basin:  
- Upper Rotliegend (Upper Permian)  
sandstone aquifer

# Hydrothermal Energy



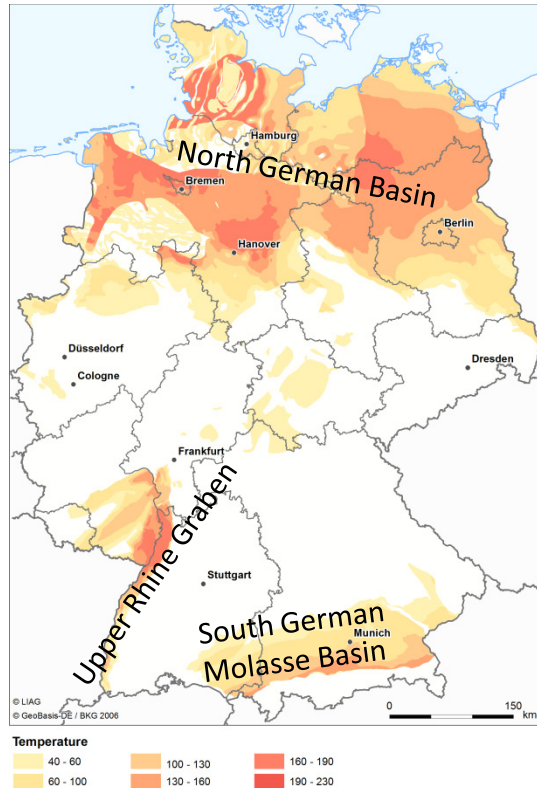
North German Basin:

- Upper Rotliegend (Upper Permian) sandstone aquifer

Upper Rhine Graben:

- Upper Muschelkalk and Buntsandstein (Middle and Early Triassic)

# Hydrothermal Energy



North German Basin:

- Upper Rotliegend (Upper Permian) sandstone aquifer

Upper Rhine Graben:

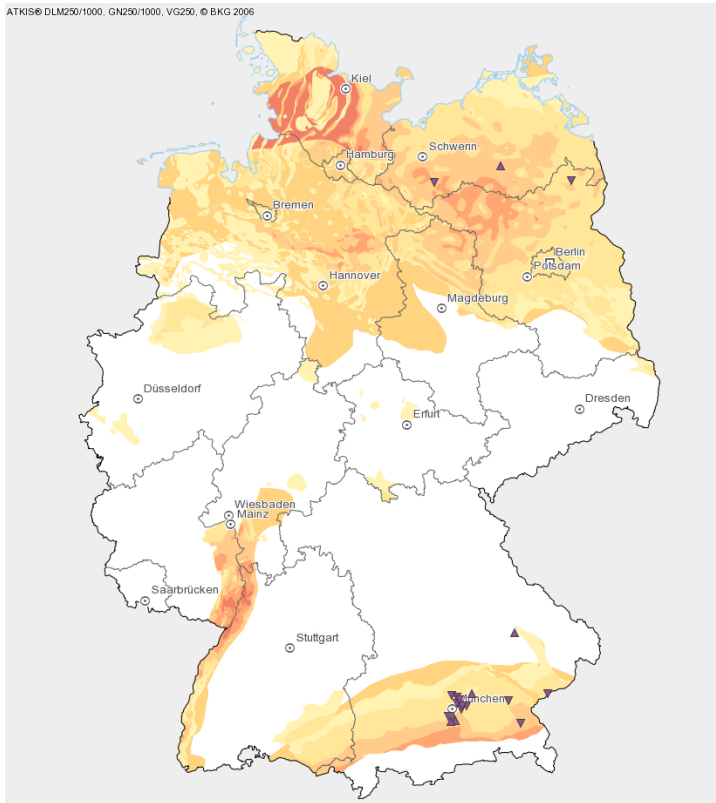
- Upper Muschelkalk and Buntsandstein (Middle and Early Triassic)

South German Molasse Basin:

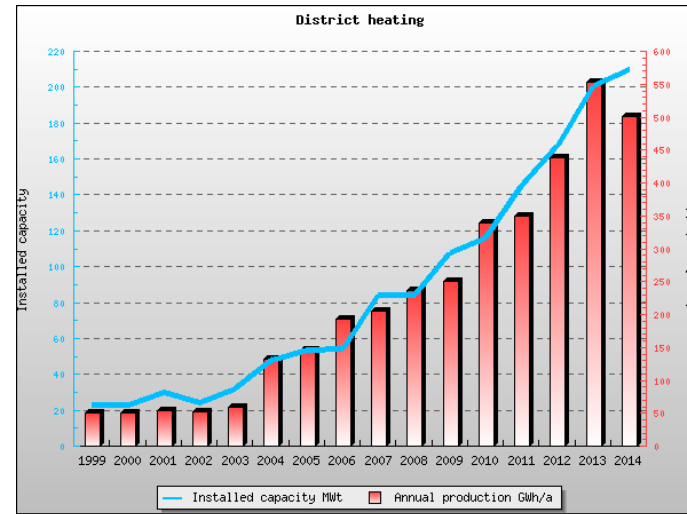
- Malmkarst (Upper Jurassic)

# Hydrothermal Energy – Geothermal Heat

ATKIS® DLM250/1000, GN250/1000, VG250, © BKG 2006

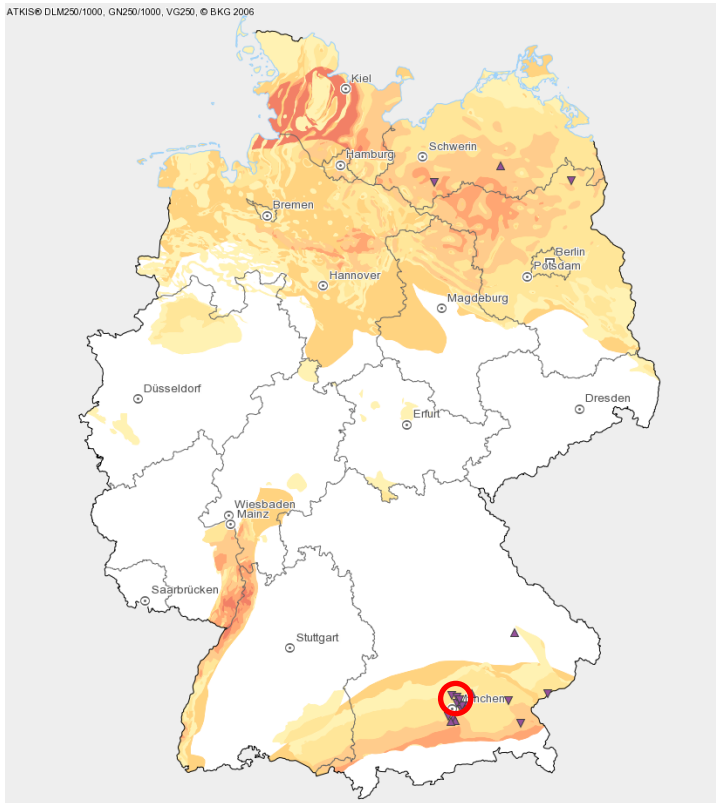


District heating status 2014:  
19 installations  
Installed capacity: 209.9 MWt  
Energy produced: 501.4 GWh/a



# Hydrothermal Energy – Geothermal Heat

ATKIS® DLM250/1000, GN250/1000, VG250, © BKG 2006



Unterföhring I:

Max. flow rate: 75 l/s

Temperature (wellhead): 86 °C

Installed capacity: 10 MWt

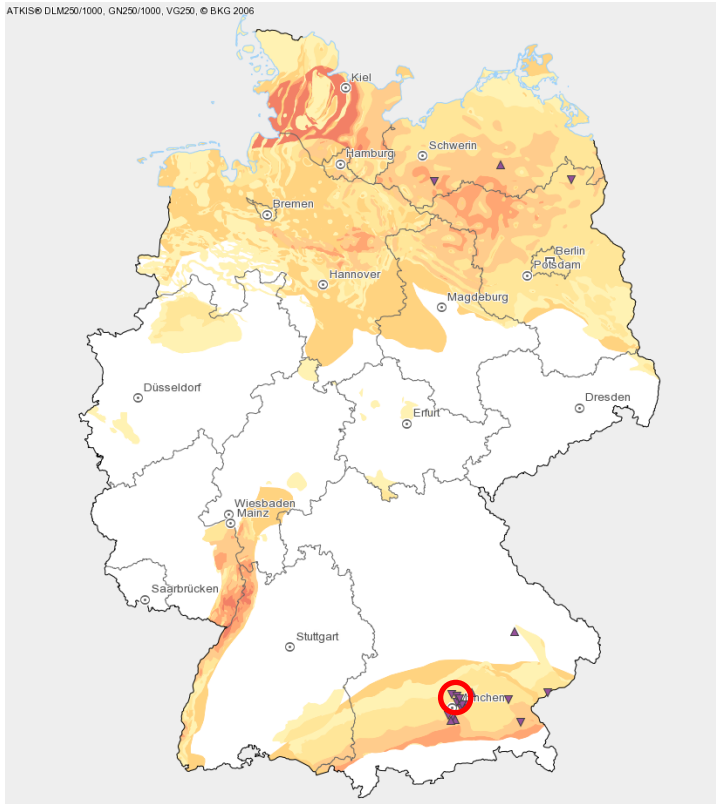
Annual production: 34 GWh

Depth: 1,986 m



# Hydrothermal Energy – Geothermal Heat

ATKIS® DLM250/1000, GN250/1000, VG250, © BKG 2006



Unterföhring I:

Max. flow rate: 75 l/s

Temperature (wellhead): 86 °C

Installed capacity: 10 MWt

Annual production: 34 GWh

Depth: 1,986 m

Unterföhring II (under construction):

Max. flow rate: approximately 90 l/s

Temperature (reservoir): 93 °C

Depth: 2,341 m

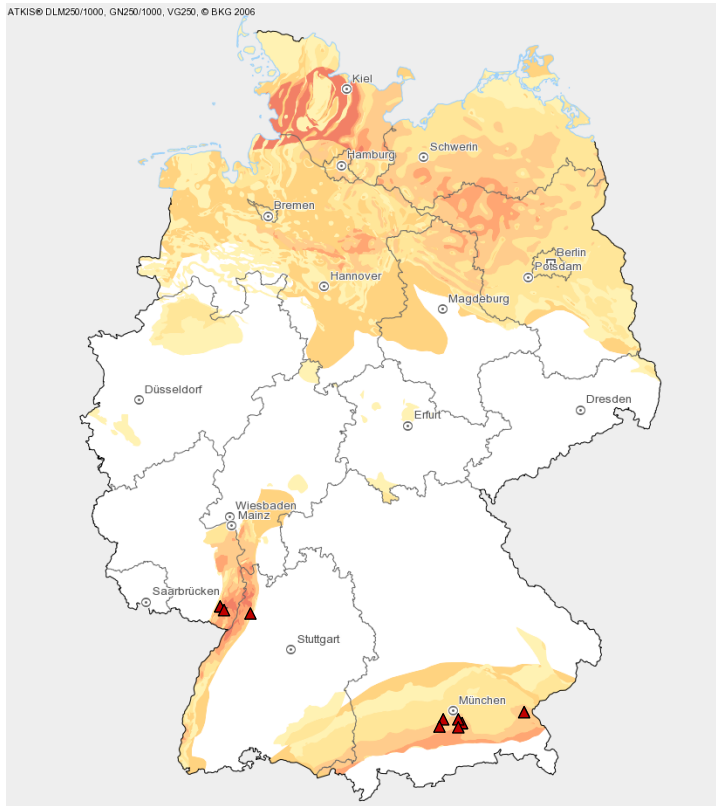
# Geothermal Heat – Summary (end of 2014)

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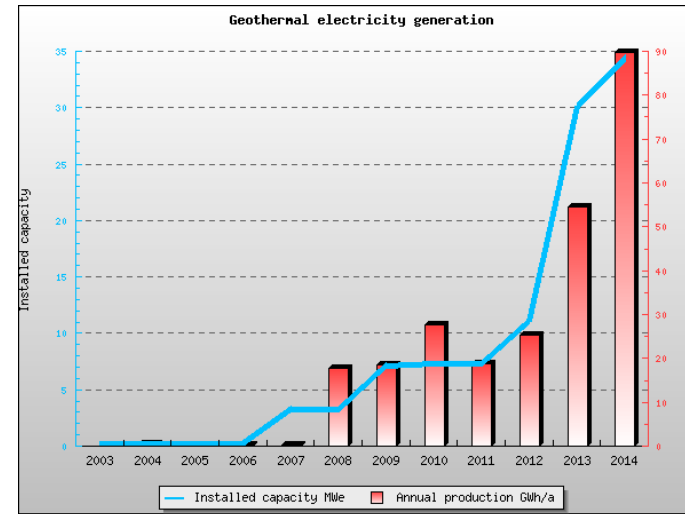
|                     |                     |  |
|---------------------|---------------------|--|
| • District heating: | 209.9 MWt,          | 501.4 GWh (9 %)                            |
| • Thermal Spas:     | 48.3 MWt,           | 400.0 GWh (7 %)                            |
| • Space heating:    | 3.4 MWt,            | 7.4 GWh (0.1 %)                            |
| • Heat pumps:       | 2,590/3,450 MWt,    | 4,500 GWh (83 %)                           |
| • <b>Total:</b>     | <b>2,851.6 MWt,</b> | <b>5,408.8 GWh</b><br><b>(19,471.7 TJ)</b> |

# Hydrothermal Energy – Geothermal Power

ATKIS® DLM250/1000, GN250/1000, VG250, © BKG 2006



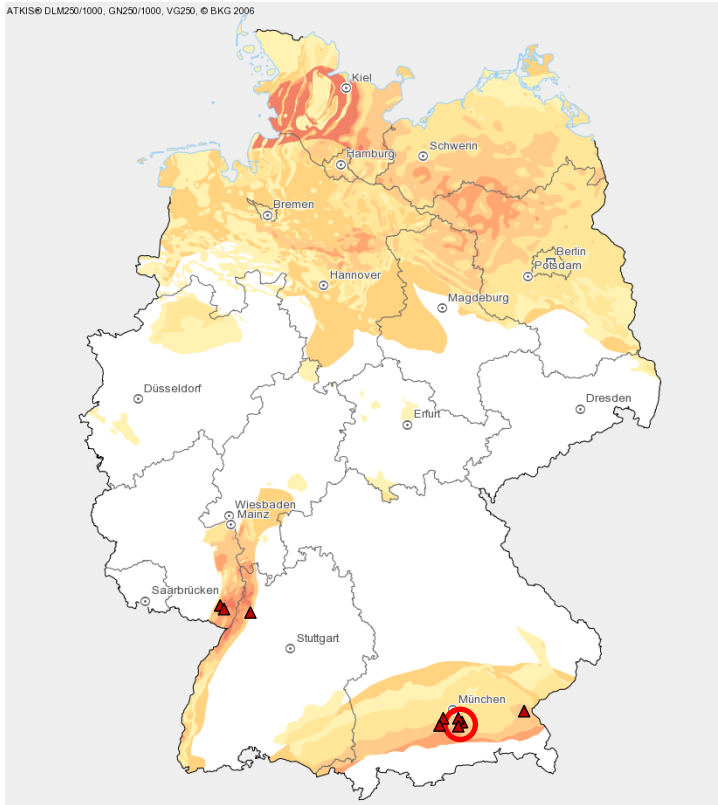
Power generation status 2014:  
8 installations (incl. 2 CHP)  
Installed capacity: 34.4 MWe  
Energy produced: 89.8 GWh/a





# Hydrothermal Energy – Geothermal Power

ATKIS® DLM250/1000, GN250/1000, VG250, © BKG 2006



Dürrnhaar:

Max. flow rate: 110 l/s

Temperature (wellhead): 135 °C

Installed capacity: 7 MWe

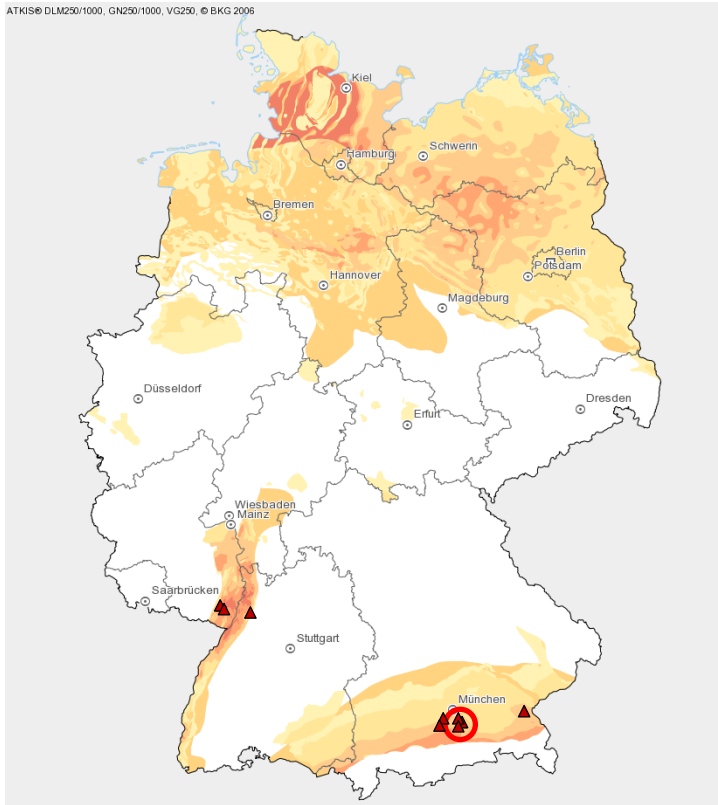
Annual production: 7 GWh

Depth: 3,926 m



# Hydrothermal Energy – Geothermal Power

ATKIS® DLM250/1000, GN250/1000, VG250, © BKG 2006



Dürrenhaar:

Max. flow rate: 110 l/s

Temperature (wellhead): 135 °C

Installed capacity: 7 MWe

Annual production: 7 GWh

Depth: 3,926 m

Kirchstockach:

Max. flow rate: 130 l/s

Temperature (wellhead): 134 °C

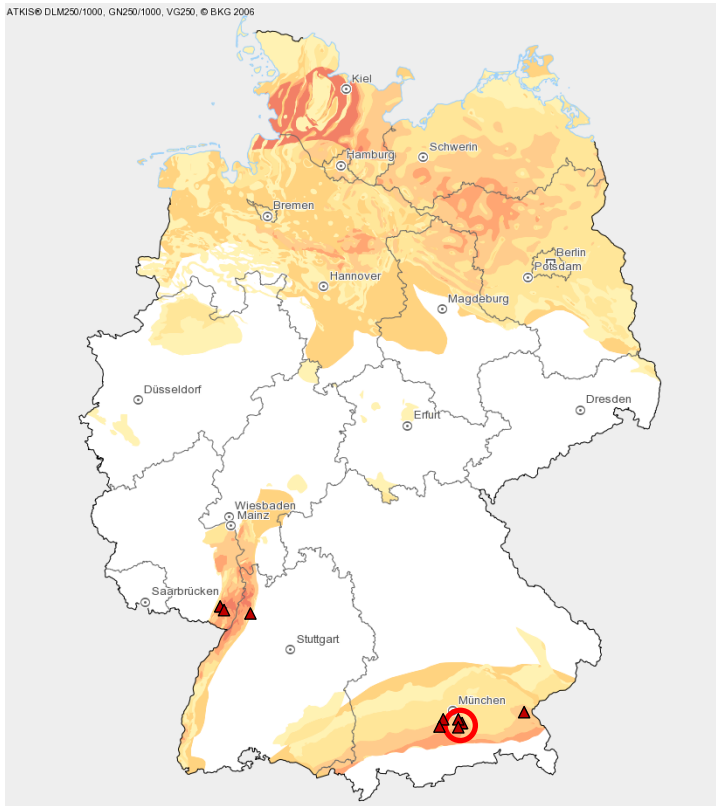
Installed capacity: 7 MWe

Annual production: 15 GWh

Depth: 3,882 m

# Hydrothermal Energy – Geothermal Power

ATKIS® DLM250/1000, GN250/1000, VG250, © BKG 2006



Sauerlach:

Flow rate: 110 l/s

Temperature (wellhead): 140 °C

Installed capacity: 5 MWe

Annual production: 27.6 GWh

Depth: 3,926 m



# Renewable Energy Sources Act

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A first revised edition of the Renewable Energy Sources Act came into force in **August 2004**. The payment rates for the feed-in allowance increased **from 8.9 to 15 €-Ct/kWh** for electricity produced from geothermal energy.

New provisions valid from **January 2009** (basic tariff and bonuses for a plant capacity < 10 MW):

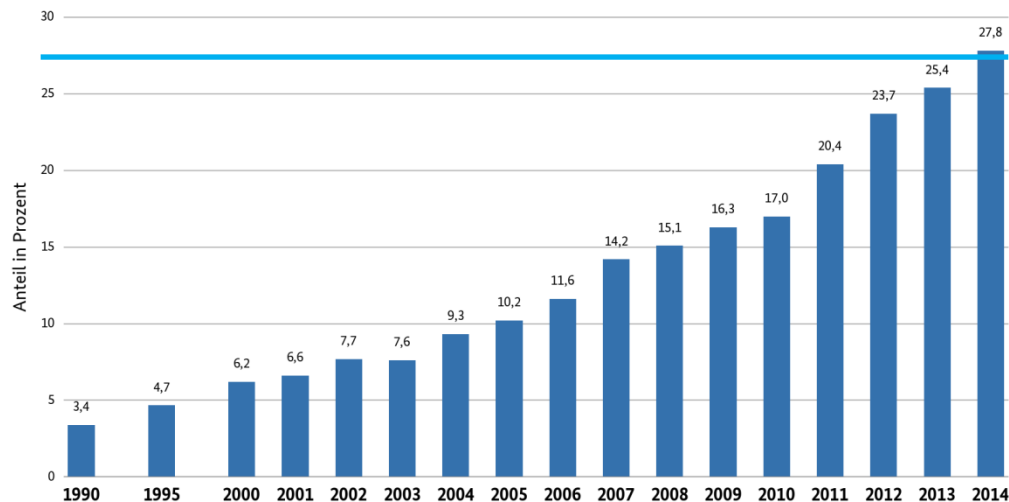
- Electrical power basic tariff: 16 €-cents/kWh
- Plants starting up until 2015: 4 €-cents/kWh
- Power heat coupling: 3 €-cents/kWh
- Petrothermal techniques (EGS): 4 €-cents/kWh
- maximum feed-in tariff: 27 €-cents/kWh

An amendment of the EEG with improved conditions for geothermal energy has come into effect on **1<sup>st</sup> January 2012**:

- The subsidy for geothermal electricity has been increased to 25€-cents/kWh with an additional 5 €-cents/kWh for the use of petrothermal techniques.

A revision of the EEG in the **summer of 2014** abolished the petrothermal bonus, and deteriorated the economic boundaries for selling electricity.

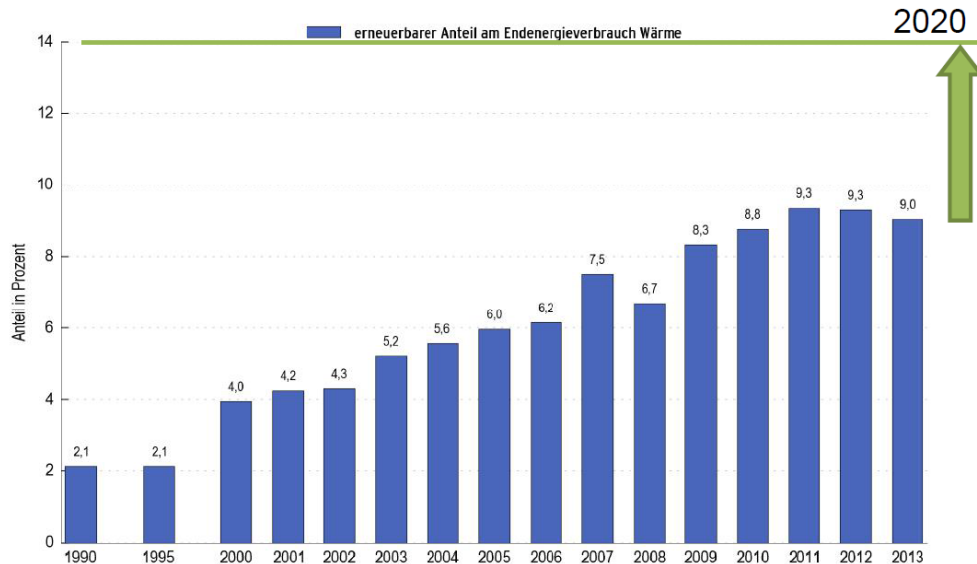
# Share of renewable energies in gross electricity consumption in Germany



Goal:  
Increase share of  
renewable energies  
in gross electricity  
consumption to 25  
to 30 % until 2020.

BMWi auf Basis Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat); Stand: Februar 2015; Angaben vorläufig

# Share of renewable energies in final energy consumption for heat in Germany



ZSW nach Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat); Stand: Februar 2014; Angaben vorläufig

Erneuerbare Energien in Deutschland 2013

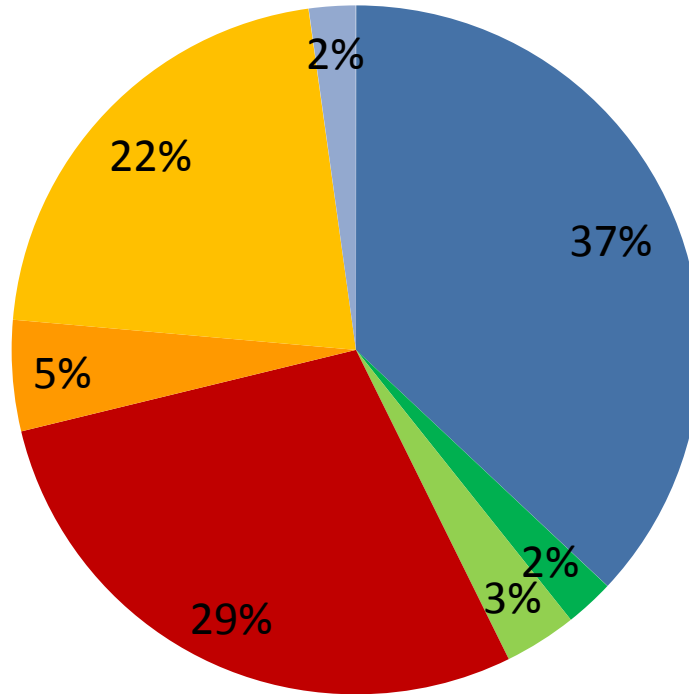
Goal:  
Increase share of  
renewable energies  
in final energy  
consumption for  
heat to 14 % until  
2020.

# Final energy consumption

Final energy consumption  
(2012):  
8,998 PJ

Heat consumption: 56 %

Power consumption: 44 %



- mechanical energy
- information and communications technology
- electric lighting
- district and space heating
- hot water
- process heat
- cooling

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***Thank you for your attention.***