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Regulatory Situation in Germany

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Explanations

The documents from WP2 comprise:

- 11 national reports (English) on regulation framework and normative framework of geothermal resources used for GSHP
- Due for month 6 (October 2012)
- Previous projects were revised to avoid duplicities and produce added value documents

List of abbreviations

Technical:

ATES	Aquifer Thermal Energy Storage
BHE	Borehole Heat Exchangers
BTES	Borehole Thermal Energy Storage
COP	Coefficient of Performance
DHW	Domestic Hot Water
GIS	Geographical Information System
GSHP	Ground Source Heat Pump
GW	Groundwater
H&C	Heating and Cooling
HP	Heat Pump
HVAC	Heating, Ventilating, and Air Conditioning
RES	Renewable Energy Sources
SGE	Shallow Geothermal Energy
SPF	Seasonal Performance Factor
TRT	Thermal Response Test
UTES	Underground Thermal Energy Storage

Legal/administrative:

BAFA	Bundesamt für Wirtschaft und Ausfuhrkontrolle (Federal Office for Economy and Export Control, Germany)
BBergG	Bundesberggesetz (Federal Mining Act, Germany)
BW-EWärmeG	Gesetz zur Nutzung erneuerbarer Wärmeenergie in Baden-Württemberg (RES Heat Act of the State of Baden-Württemberg, Germany)
BWP	Bundesverband Wärmepumpen (Federal Association for Heat Pumps, Germany)
EEWärmeG	Erneuerbare Energien Wärme Gesetz (RES Heat Act, Germany)
LagerstG	Lagerstättengesetz (Mineral Resources Act)
MAP	Marktanreizprogramm (Market Incentive Program, Germany)
NREAP:	National Renewable Energy Action Plans (EU Member States)
RES-D:	Renewable Energy Directive (Directive 2009/28/EC, EU)
StatBA	Statistisches Bundesamt (Federal Office for Statistics, Germany)
VDI	Verein Deutscher Ingenieure (German Association of Engineers)
WHG	Wasserhaushaltsgesetz (Water Household Act, Germany)

As a preliminary

The definition of GEOTHERMAL ENERGY is given in the EU RES Directive :

> ***Article 2*** **(c)**
> **'geothermal energy' means energy stored in the form of heat beneath the surface of solid earth;**

COUNTRY: Germany

Definition of shallow geothermal Energy

Does a definition exist in your country?	x Yes	◯ No

Definition of Geothermal Energy (Ground Heat): Energy stored below the surface of the solid earth in the form of heat. (VDI 4640, see below)

SGE is usually considered as from surface to approximately 400 m depth

In case that yes, who is providing the definition (legal definition included in the regulations and codes, technical definition from official institutions, common accepted definition provided by associations

The definition was first put forward in VDI 4640 (since published draft 1998, last renewing with new VDI 4640 part 1 in 2010). VDI is the German Association of Engineers (Verein Deutscher Ingenieure), and VDI guidelines have a status close to standards. Several regulations and codes, mainly by some of the German states, make reference to VDI 4640 and thus back the definition officially.

VDI 4640 also stipulates the depth of approximately 400 m as the lower boundary of validity for the guideline, which hence is considered as the lower limit of shallow geothermal energy (SGE).

A similar definition is used in the renewable heat act EEWärmeG of 2009 (EEWärmeG § 2 (1)):

"Erneuerbare Energien im Sinne dieses Gesetzes sind

1. *die dem Erdboden entnommene Wärme (Geothermie),*
2. *…"*

(Renewable Energies in the context of this act are 1. the heat taken from the underground (geothermal), 2. …)

1. Introduction

1.1 Current situation in Germany

Designers are predominantly		x National	◯ Foreign
Installers are predominantly		x National	◯ Foreign
Technology providers are predominantly		x National	◯ Foreign
Designers are predominantly independent from installers		◯ Yes	◯ No
There is a difference concerning small and large systems. For small systems, the design is usually done by the installer. For larger systems, the design is typically done by an independent designer. There is a range of overlap.			
If no, specify:			
Designers' market			
for smaller projects is almost nonexistent.			
for larger projects is predominantly	◯ Local	◯ Regional	x National
Installers' market is predominantly	◯ Local	x Regional	◯ National

For Germany, the market development has to be seen in a bit longer timeframe, as the recent years since 2006 are different from what was before. Market data exist back to 1978, and they show a first increase in sales with the 2nd oil price crisis around 1980 (Figure 1). The market collapsed well before the oil price came down again, the reason for this being inadequate quality of heat pumps and insufficient knowledge of designers and installers. After a long depression, used for R&D to improve quality and knowledge, the sales increased again, partly driven by a national support program in the late 1990s. The main increase in 2004-2006, however, cannot be attributed to governmental support (as there was non in those years), but to the rising prices and, in particular, to fears the secure supply of natural gas from Russia might not be guaranteed.

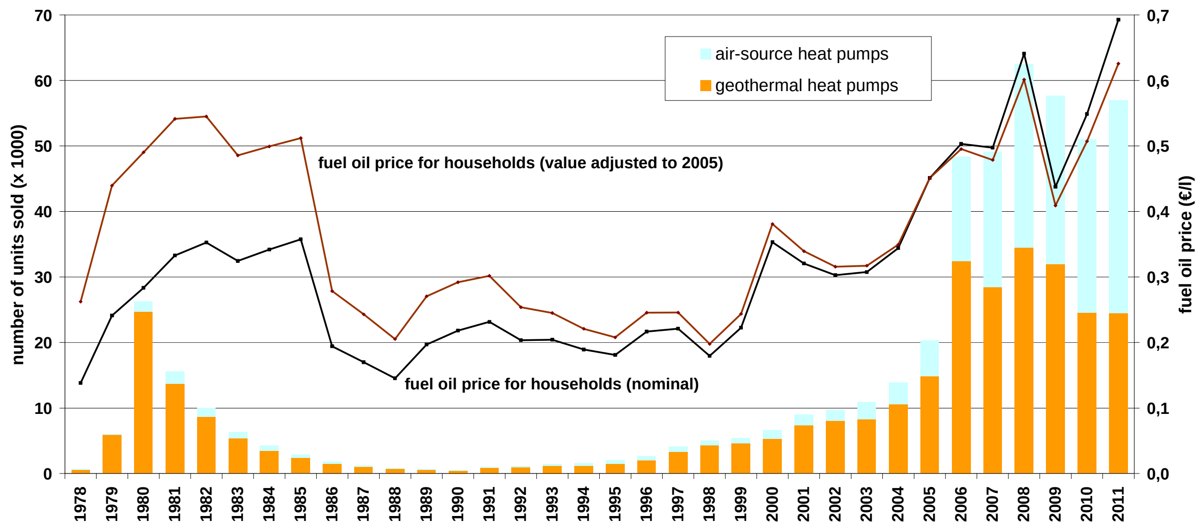

Figure 1: Development of heat pump sales in Germany 1978-2011 in comparison to the oil price (after data from BWP and StatBA; adjusted oil prices on basis of consumer prices 2005 = 100, pre-1991 only West Germany)

After a rather positive development of sales for geothermal heat pumps until about 2008, the sales numbers decreased substantially in the following years (Figure 2). While the decrease from 2006 to 2007 can be explained, at least partly, with the increase of VAT beginning 2007 (sales had been done in 2006, wherever possible, resulting in a higher demand in 2006 and reduced demand in early 2007), the decrease from 2008 on cannot be explained that way. On the contrary, an increase of sales could have been expected, with the legal support for GSHP available again, through the Renewable Energy Heat Act (EEWärmeG, in force since January 2009), and through the renewed opening of the Market Incentive Program (MAP) for heat pumps (see below and chapter 3.1). The share of GSHP in the total heat pump sales is decreasing since 2001 (Figure 3), mainly due to imported air-source heat pumps

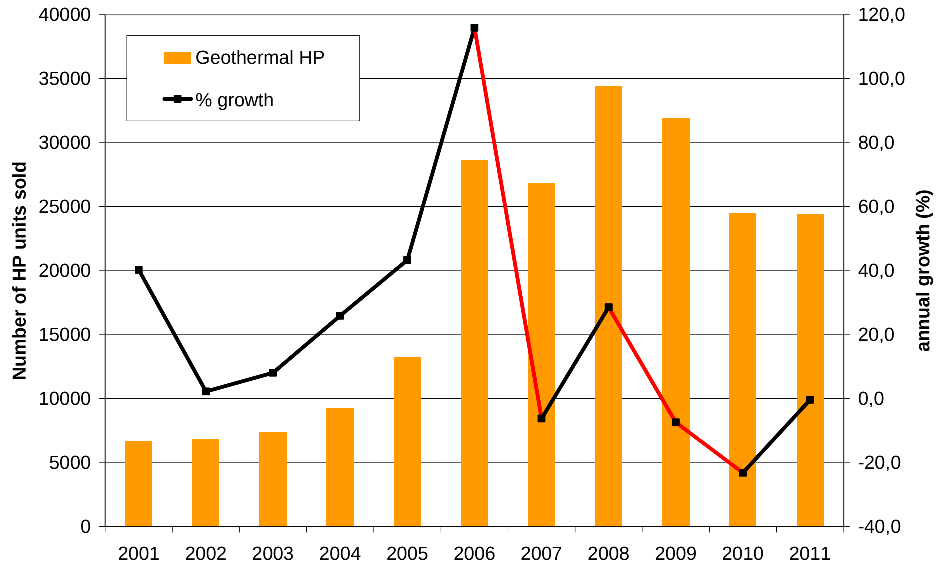

Figure 2: Development of sales of GSHP in Germany 2000-2011 and changes in % in respect to the previous year; in red years with a shrinking market (after data from BWP)

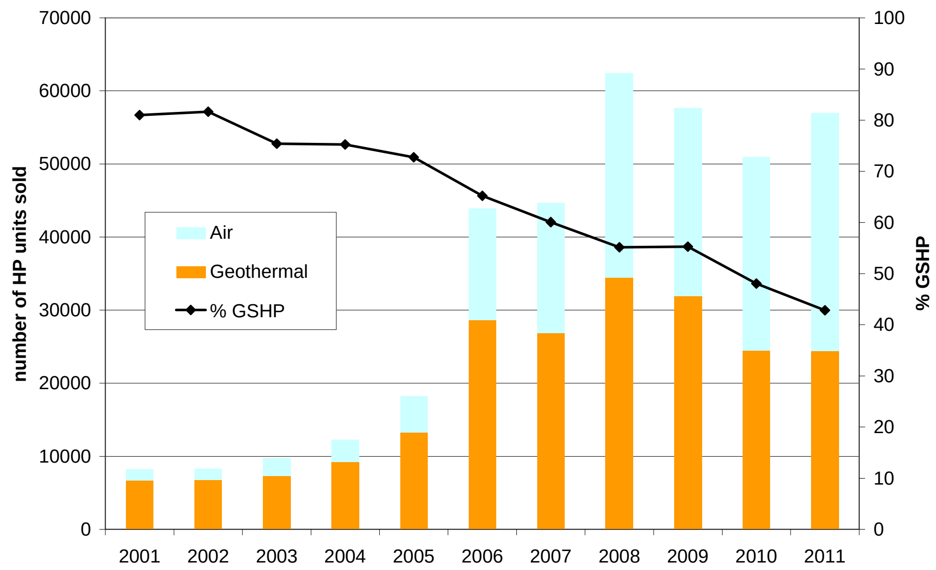

Figure 3: Development of heat pumps sales of all types in Germany 2001-2011 and share of GSHP in the total sales in % (after data from BWP)

The outlook on sales for GSHP in 2012 is also not encouraging. The temporary statistics of BWP show a reduction of about 10 % in comparison to the monthly values of the previous year (status September 2012, personal communication from BWP). A positive aspect is that GSHP were gaining a higher share in the (albeit overall shrinking) market for new buildings, both in the residential and the non-residential sector, reaching a total of 10.6 % in 2011 (see Figure A-1 in the appendix for details).

Design companies:
Most design companies are relatively small, some can trace their experience back to the early GSHP development in the 1980s. A few large engineering companies started, in response to the market increase, to establish their own GSHP design team, mainly by buying a small company. A general distinction can be made between building (HVAC) engineering companies with a ground-side design capability, and more geo-science-based companies with some understanding of the building side. A small number of the "geological" designers have equipment for site investigation (TRT, GW-tools) available. For BHE design, simple tools (tables from VDI 4640, software EED, EWS or other) are used mainly. A few specialised companies are able to use numerical simulation tools (e.g. FEFLOW) for more complex projects, environmental studies, etc. For design of GW-based systems, only designers with a hydrogeological background are suited, as both hydrogeological and hydrochemical issues have to be dealt with. The overall number of companies increased in accordance to the heat pump sales as in Figure 2, meanwhile it seems to be stagnant.

Drilling companies:
The number of drilling companies follows the development as can be seen in Figure 2, with a certain delay, of course. With the market explosion around 2006, many new, often small, drilling companies emerged, a number of which already left the market again after few years. In particular in these years, a lack of skilled personal was felt, and problems with installation quality and disrespect to environmental regulations became apparent. Meanwhile, a concentration process could be seen in the drilling market, with some larger companies integrating smaller ones, and other companies concentrating on specific regions and market segments. Some heat pump manufacturers have cooperation contracts with drilling companies, and at least 2 heat pump manufacturers are known to actually own a drilling company, albeit not under their name.

Heat Pump Manufacturers:
There are several heat pump manufacturers in Germany, most of them part of large companies in the heating market. While in the time of low sales numbers in the 1990s most heat pump manufacturers were smaller companies (with the notable exceptions of Stiebel-Eltron and KKW, the latter selling under the Siemens brand originally and now part of Dimplex/Bosch), the large players like Bosch/Buderus and Viessmann have reactivated their heat pump business they had abandoned in the early 1990s with the purchase of smaller companies. Most heat pump manufacturers are organised in the Federal Association for Heat Pumps (Bundesverband Wärmepumpe, BWP).

The financial support for heat pumps, and in particular for GSHP, is rather limited at this moment, and is dealt with in chapter 3 of this report. The main support mechanism for several years, the Market Incentive Program (MAP) [1] on the federal level, is no longer available for new buildings since 2009. Thereafter, only very innovative systems achieving high SPF could still be supported in new buildings, but that also ended in March 2012. The rules in the refurbishment sector are disadvantageous to GSHP (see chapter 3.1). As a result, the number of plants supported through the MAP dropped in the past years (Figure 4).

[1] The first edition of the MAP in the late 1990s brought the HP market back to growth from a downturn

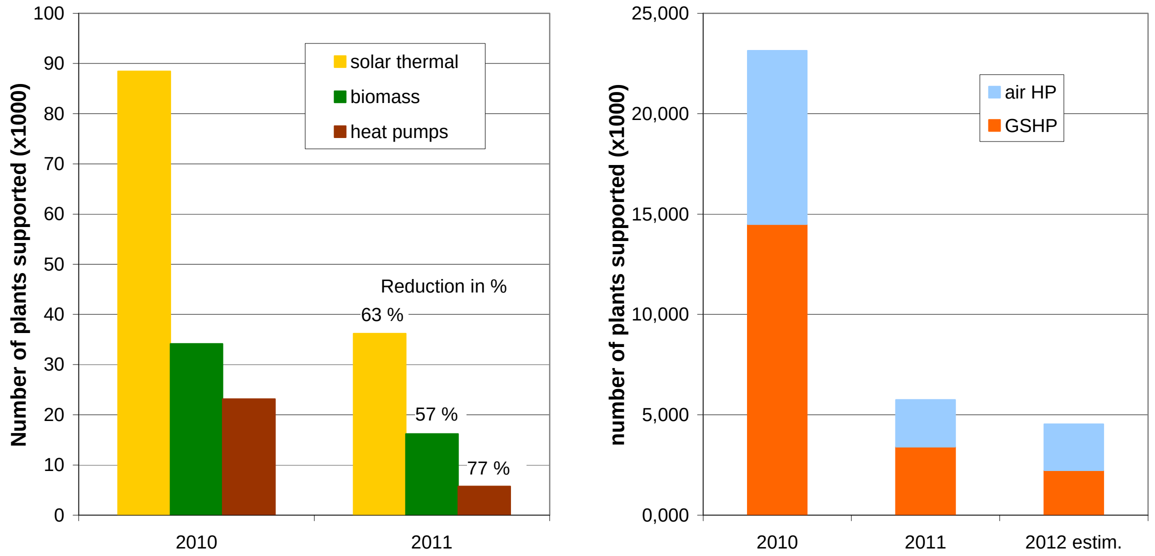

Figure 4: Number of RES heat plants supported within MAP (after data from BAFA; the values for 2012 are extrapolated from the status end of September to the whole year); reduction in three sectors (left) and details for heat pumps (right)

Please describe the typical procedures for drilling a borehole into the underground.

For any intrusion into the underground (drilling or digging), permission is required from a certain depth on. This depth limit can be given in meters within certain protected areas, e.g. 2 m or 5 m in some spa protection areas (*Heilquellenschutzgebiete*). A general rule is that permission is needed whenever the intrusion into the underground reaches the groundwater level. This is stated on the federal level in the Water Household Act (WHG, status 2009), e.g. in WHG § 49. There are some exceptions, listed in WHG § 46, like private garden wells, agricultural wells, etc. In any other case a license (*Erlaubnis* as to WHG § 8) from the relevant water authorities is required, and this is the case also for both open and closed loop geothermal systems. The license is applied for with the lower water authorities (on district or city level), the application typically being prepared by the driller and signed by the owner of the site.

For boreholes penetrating more than 100 m into the underground (100 m of drilling length, not necessarily vertical depth), the application has to go to the mining authorities as to BBergG § 127, and the mining authorities will carry out the licensing process including the water authorities into the procedures.

Another requirement is that all "drillings driven by mechanical power" have to be reported to the Geological Survey of the respective state. This is stipulated in the Lagerstättengesetz (LagerstG), which dates already from 1934, but has been updated in 1974. LagerstG § 4 states the reporting duty, § 3 requires geophysical measurements to be reported to the surveys.[2]

[2] It is currently disputed if a TRT is included within the scope of geophysical data concerned by LagerstG § 3.

1.2 Barriers

Several barriers against wider deployment of shallow geothermal energy can be identified for Germany. They can be classified mainly into the sectors of information, economy, and regulation. It has to be stated that regulatory problems (overregulation) eventually might result in becoming an economic barrier also.

Informational barriers:
Heat Pumps as such are known much more widely in the general public today than in the past. Also the negative image heat pumps had after the first market crash in the beginning of the 1980s (cf. Figure 1), mainly caused by poor design and installation quality as well as poor heat pump reliability, today is no longer a factor. Meanwhile the heat pump achieved the image of a clean, reliable heating and cooling technique. Some information deficits today can still be detected with some of the installers of classical heating system (plumbers), and with persons in regulatory authorities. However, the situation with the installers is rapidly becoming better, and also the available information sources both on the building and the ground side are becoming more and better.

Economic barriers:
The most evident barrier in this group is the development of the price for electricity for the private consumer in Germany that went up steadily (Figure 5). But it is not only the general increase, which in a similar way affects all heat sources, but also the case that special heat pump tariffs are disappearing. While until about the year 2000 in most regions favourable tariffs for base-load electricity[3] were available in the price range of 100-150 €/MWh, specific tariffs for GSHP are no longer available in many places. Instead of about 100 €/MWh, the owner of a newly installed GSHP might see up to 250 €/MWh in his electricity bill.

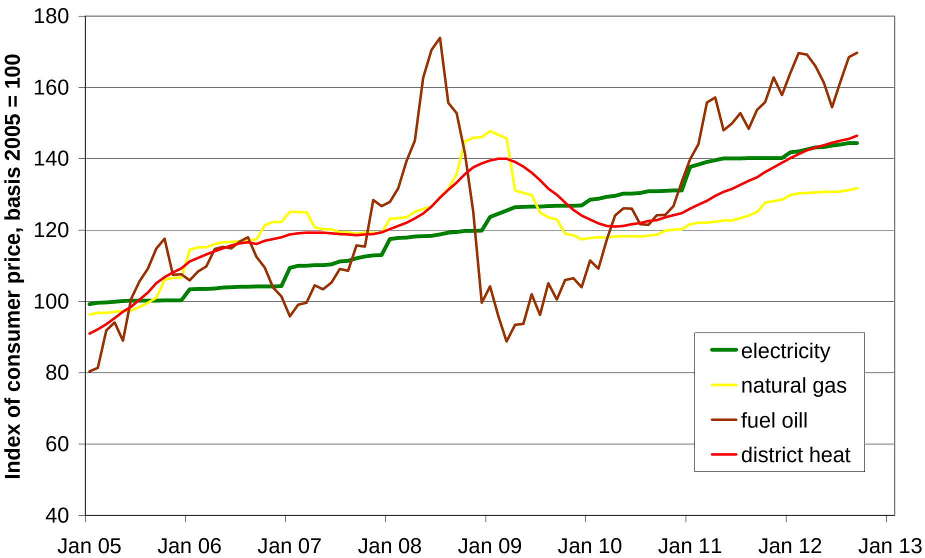

Figure 5: Development of energy prices for the (private) end consumer in Germany (after data from StatBa)

Another economic barrier is arising indirectly from the regulatory process. Limiting clauses (e.g. minimum permissible temperature, maximum drilling depth) and requirements for site investigations or monitoring are adding to the cost of the final system (cf chapter 0). Some of these clauses are

3 to be switched of remotely by the utility in peak hours, and heating secured by buffer storage

justified and understandable, while others might be reduced or even lifted. Also fees and additional administrative cost can rise to the level of an economic barrier in individual cases.

No specific further barriers have been reported in previous EU projects like K4RES-H, GTR-H or Groundreach. General items concern the inadequacy of financial support systems and some lengthy environmental licensing procedures with uncertain chances. Also the lack of skilled workforce became apparent when the highest market growth occurred in 2006/07 (Figure 2). Meanwhile training and education has been strengthened in Germany (cf. chapter 2.1).

Figure 6: Drilling sites for GSHP should be clean, even for larger projects (above, near Frankfurt in 2007, drilling company TerraTherm, supervision UBeG GbR); however, working with the ground can be dirty (below, photo of part of a very large BHE-field in China, Mands 2004)

2. Review of existing documents/tools to support SGE development

2.1. National level

Dedicated Web sites and GIS (general public)	x Yes	◯ No

On the national level, there is just one geothermal database, mainly for deep geothermal. This database with free access is provided by the research institute LIAG in Hannover under the name GEOTIS, and beside deep geothermal plants it contains also information on some larger shallow installations. The database is financed as a project by the Federal Ministry of Environment (BMU).

Geothermal operations inventories	◯ Yes	x No
No official inventory, but see the entry on the database GEOTIS above.		
Underground operations inventories	◯ Yes	x No
Geothermal resources evaluation	◯ Yes	x No
Geothermal resources management	◯ Yes	x No
Water resources management	◯ Yes	x No

As the water resources management is a state task, and also the practical operation of the (federal) mining regulation is handled on the state level, there is no overarching, official federal inventory for groundwater or geothermal issues.

Best practice (or technical) Guideline documentation	x Yes	◯ No
If yes, do they include information about energy performances?	X Yes	◯ No
If yes, do they include information about economic performances?	◯ Yes	X No

Guidelines of the German Association of Engineers (VDI):

These guidelines have to be purchased through Beuth-Verlag (http://www.beuth.de). Guidelines on both the underground system and on the system efficiency exist.

The guideline for the underground part, VDI 4640 "Thermal use of the underground", contains 4 documents, and a 5th (on TRT) is under preparation:

- VDI 4640, part 1, Fundamentals, approvals, environmental aspects, 2010/06 [4]
- VDI 4640, part 2, Ground source heat pump systems, 2001/09
- VDI 4640, part 3, Underground thermal energy storage, 2001/06
- VDI 4640, part 4, Direct uses, 2004/09

[4] a sheet with corrections to VDI 4640, part 1, has been issued in 2011/12 in order to adjust the guideline to the new Federal Water Household Act

The guideline for system efficiency, VDI 4650 “Calculation of heat pumps - Simplified method for the calculation of the seasonal performance factor of heat pumps” contains 2 documents:

- VDI 4650, part 1, Electric heat pumps for space heating and domestic hot water, 2009/03
- VDI 4650, part 2, Gas heat pumps for space heating and domestic hot water, 2010/11

Regulations and Guidelines on Energy Saving in Buildings:

This is done within the “*Energieeinsparverordnung*” (EnEV, Energy Savings Directive), a first version coming into force in 2002. Currently the 4th version, EnEV 2009, is in force. A new version was planned for 2012 (EnEV 2012), however, due to necessary adjustments concerning the recast of the EU Directive for Energy Performance in Buildings (2010/31/EU) the process is delayed and the new version not expected before 2013 (and may be called EnEV 2013).

EnEV 2009 stipulates the maximum specific primary energy consumption per year (kWh/m^2/a) for heating, cooling and DHW in a buildings, calculated in comparison to a reference building of specific parameters (given in annex 1 of EnEV 2009). Because GSHP can achieve primary energy savings over gas boilers etc., the result is an incentive for using heat pump technology.

The current version EnEV 2009 is for free download at:

There are also several norms/standards concerning heat pumps and GSHP in particular, among them:

- DIN EN 378, Refrigerating systems and heat pumps - Safety and environmental requirements, 4 parts, 2012/08
- DIN 8901, Refrigerating systems and heat pumps - Protection of soil, ground and surface water - Safety and environmental requirements and testing, 2002/12
- DIN EN 14511, Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling, 4 parts, 2012/01
- DIN EN 14825, Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling - Testing and rating at part load conditions and calculation of seasonal performance, 2012/06
- DIN EN 15450, Heating systems in buildings - Design of heat pump heating systems, 2007/12
- DIN EN 15879-1, Testing and rating of direct exchange ground coupled heat pumps with electrically driven compressors for space heating and/or cooling - Part 1: Direct exchange-to-water heat pumps, 2011/05

These standards have to be purchased through Beuth-Verlag (http://www.beuth.de).

Training activities dedicated to SGE	x Yes	◯ No

Several institutions and associations offer short courses (1-2 days) for GSHP design and also for drilling and installation of BHE. These events are independent and not coordinated; some allow earning credits within refresher programs of professional association or chambers (e.g. *Architektenkammer* / chamber of architects)

For drilling, a general 3-year vocational training exists within the German dual-education system for craftsmen, leading to the job title “Brunnenbauer” (well driller). Within this education also drilling for SGE (both wells and BHE) is covered. A further step for well drillers with certain experience is an exam as “Brunnenbaumeister” (master well driller), with the license to educate others.

In practice, however, many drillers in the SGE sector do not have this explicit vocational education, but some similar education in the construction field followed by certain practical instruction on the drilling rig. This is often done internally within the company.

The only education program specifically destined for SGE has been created jointly by two large geoscientific associations in Germany, DGGT (German Geotechnical Society) and DGG (German Society for Geosciences). The full title is *"Fachkraft für Bohrungen für geothermische Zwecke und Einbau von geschlossenen Wärmeüberträger-Systemen (Erdwärmesonden)"* (Specialist for drilling for geothermal purposes and for installation of closed heat exchange systems (BHE)), the relevant document is for free download at http://www.dggt.de/images/PDF-Dokumente/fachkraft2.pdf (in German, status June 2010).

The courses are operated by several independent training institutions, based on the DGGT/DGG-document, with the exam being taken in front of a DGGT/DGG committee. Prerequisite for the exam is either a vocational education in certain construction-related crafts, 5 years experience in drilling for SGE, or a special DGGT/DGG permit. The courses are divided into two parts:

1) **Basics of geotechnical investigation**, covering basics of geology and hydrogeology as well as geotechnical investigation methods and tools (total 20 h).
2) **Drilling for geothermal purposes and for installation of closed heat exchange systems (BHE)**, covering general conditions of operation, tools and equipment, quality control, taking of samples, declaration of soil and rock, and documentation (total 76 h)

Hence the total course duration is about 3 weeks.

DGGT and DGG are among the other players (BWP, GtV, BDG) to set up the German national training coordinator for the EU-wide GEOTRAINET program. This national activity currently is lead by the German Heat Pump Association (BWP)

Certification for professionals	◯ Yes	x No

There is no personal certification yet. The document provided by the DGGT/DGG program (see above) can be seen as a kind of certification, however, it is not mandatory.

There is one item where a personal certification is required, which is the welding of plastic pipes on site. The person doing this part of the work has to be certified according to DVS 2212 (guideline issued by DVS, the German association for welding). This certificate is rather common, as it is required for many jobs in the construction industry, and courses and exams are organised frequently by chambers of craftsmen and similar organisations.

Certification for organizations	x Yes	◯ No
If yes, is it mandatory?	◯ Yes	x No
There is no simple answer here, as the certificate explained below is not mandatory per se on a national level. However, it is often made mandatory in state regulations, or in individual drilling permits.		

Drilling companies in Germany can attain a certificate for the whole company. The rules for this certificate are issued by the German Association for Gas and Water (DVGW) under the number DVGW W 120. In the past, DVGW W 120 dealt with a certificate for drilling companies in general (mainly water wells), but since a few years it is divided in two groups, DVGW W 120-1 for water wells, and DVGW W 120-2 for geothermal drilling. The document for the geothermal part was published as a draft in 2010/12, and the final version is not expected before early 2013. However, certification under DVGW W 120 has already some history, and many drilling companies in Germany are certified. The certification as such is mainly done by accredited certification bodies like DVGW-Cert, Zert-Bau, etc.

While the rules for certification and the certificates as such are valid on a national level (in some cases also outside Germany), there is no actual requirement on the national level for this certification. The request for certificate is typically made in state regulations, or in individual drilling permits.

2.2 Local/Regional level

In Germany, most of the 16 states[5] (Bundesländer) have at least some websites/tools. Because of the high number of entries, the description below is done following the individual questions and giving some examples from the states. A full list of websites with guidelines, databases and GIS-systems is given in the appendix.

Dedicated Web sites and GIS (general public)	x Yes	◯ No

Please see the list in the annex.

Geothermal operations inventories	x Yes	◯ No

Most states have such database with the relevant geological survey. Also in most cases this database is not (yet?) public. A notable exception is Bavaria, where at least the positions and some metadata are publicly available (Figure 7). Some other states (e.g. Hessen) have compiled maps from this data and thus published the BHE distribution at a certain spot in time.

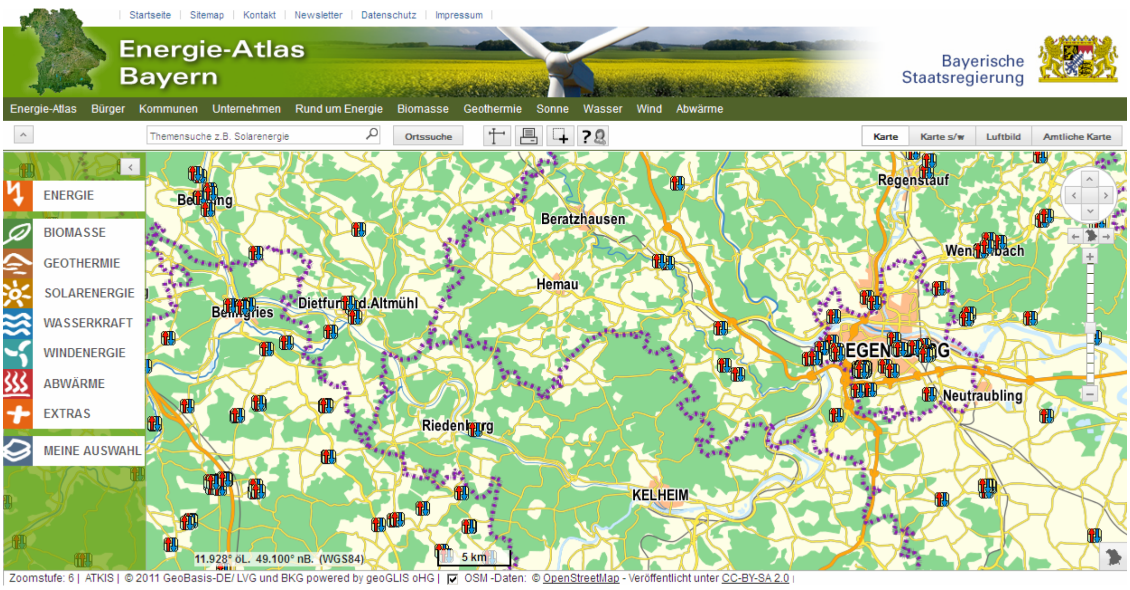

Figure 7: Location of BHE in the Regensburg area, from Bavarian database: http://geoportal.bayern.de/energieatlas-karten/

[5] for Germany, the regions are identical with the states

Underground operations inventories	x Yes	◯ No

Because of the obligation to report each drilling to the state geological surveys (LagerstG § 4), the inventory of boreholes is available and kept with the state geological surveys (an example is given in Figure 8). Other underground operations (mines, tunnels, cables) are registered with the respective authorities. A combined database of all underground operations does not exist as far as we know.

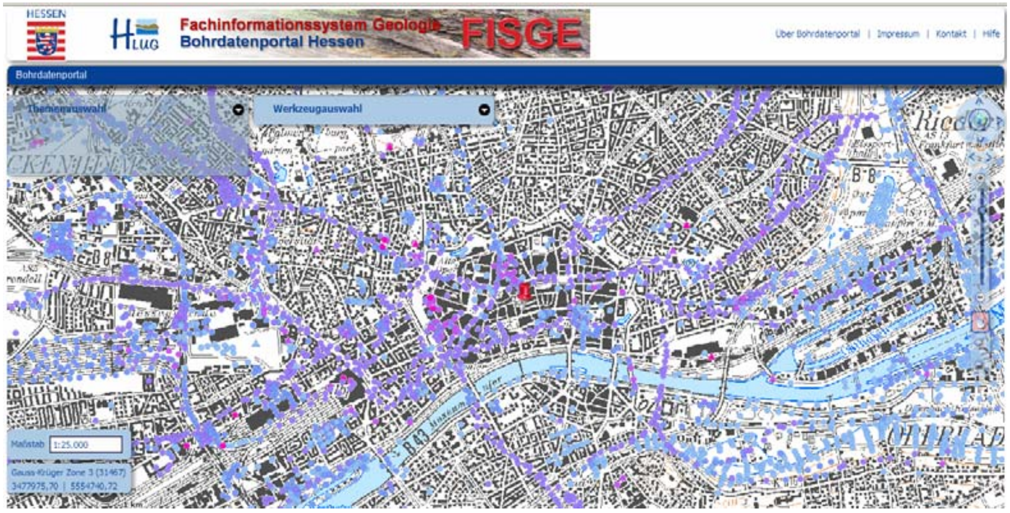

Figure 8: Location of boreholes in the Frankfurt area, Hessen; metadata for geological data etc. are linked in the map, http://geologie.hessen.de/

Geothermal resources evaluation	x Yes	◯ No

The evaluation and representation of the SGE resources started about 10 years ago in the state of Nordrhein-Westfalen, when a CD-ROM with relevant information was published. The ground to a depth of 100 m was evaluated and a “geothermal yield” based on specific data from VDI 4640 was calculated (Figure 9). Meanwhile, a few other states (including Baden-Württemberg, Bavaria and Saxonia) have compiled similar tools available as web-based GIS. An example from Bavaria is shown in Figure 10. In Baden-Württemberg, a fee is levied for access to the geothermal potential part of the database (more general parts are free); not all the state area is already covered (Figure 11).

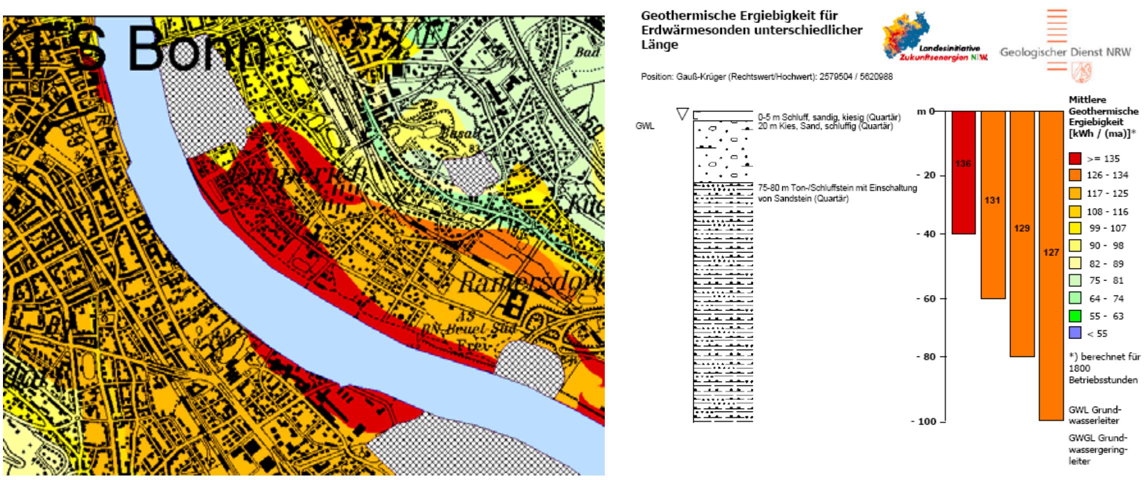

Figure 9: Example from the CD-ROM for SGE of the state of Nordrhein-Westfalen; SGE potential in the Bonn area (left), and geological cross-section and “geothermal yield” for different depth for one sector of the map (right)

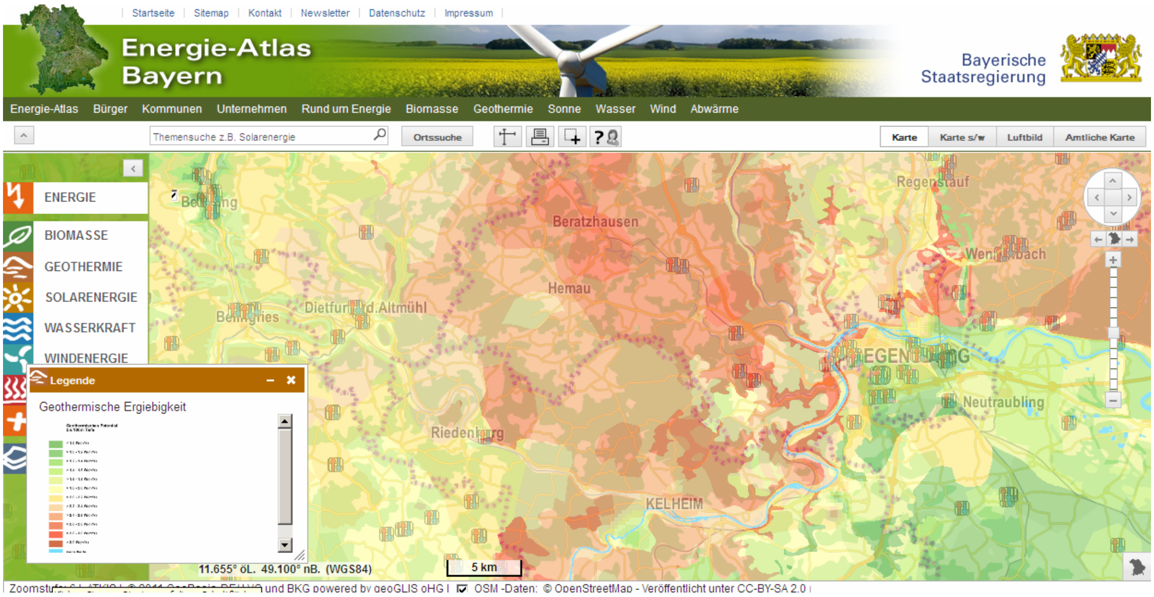

Figure 10: Example for "geothermal yield" in the Regensburg area, from Bavarian database: http://geoportal.bayern.de/energieatlas-karten/

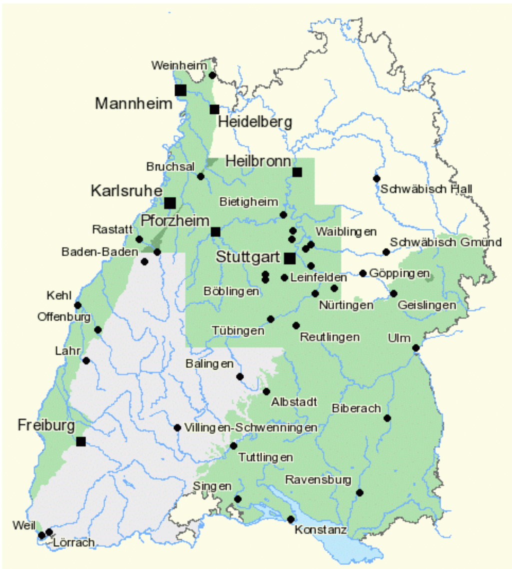

Figure 11: Status of finalization of geothermal database in Baden-Württemberg (green is online, grey in preparation, white not yet covered)

Geothermal resources management	◯ Yes	x No

Tools for actually managing SGE resources are not yet available in any German state.

Water resources management	x Yes	◯ No

Other web-based tools	x Yes	◯ No

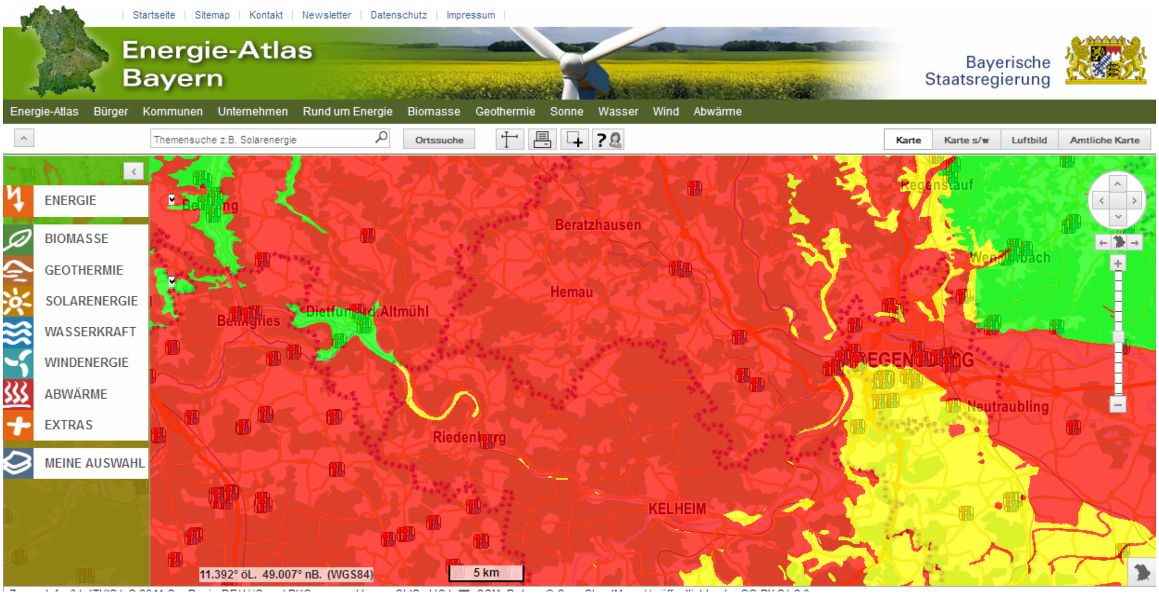

Figure 12: Example for possible licensing problems (red), detailed permit procedures (yellow) and unproblematic areas (green) in the Regensburg area, from Bavarian database: http://geoportal.bayern.de/energieatlas-karten/

Best practice (or technical) Guideline documentation	x Yes	◯ No
If yes, do they include information about energy performances?	◯ Yes	x No
If yes, do they include information about economic performances?	◯ Yes	x No

Guidelines for technical issues do not exist on state level, but guidelines for environmental issues and licensing are provided by almost all states. The full list including websites for download is given in the appendix.

Training activities dedicated to SGE	◯ Yes	x No
Certification for professionals	◯ Yes	x No
Certification for organisations	◯ Yes	x No
Codes/regulations	◯ Yes	x No

None of the above exists at state level. The state of Baden-Württemberg, however, has introduced some state-specific rules for environmental protection and grouting that the drilling companies need to adhere to. This includes a kind of extra certificate in cooperation with the German Heat Pump Association BWP, in addition to DVGW W120 (cf. 2.1).

3. Subsidies / Financial Incentives available

3.1. National level

Are there subsidies / financial Incentives available?	X Yes	○ No

The financial support for heat pumps, and in particular for GSHP, is rather limited at this moment. The main support mechanism for several years, the Market Incentive Program (MAP) on the federal level, is no longer available for new buildings since 2009. The reason is that according to the EEWärmeG (RES Heat Act) of 2008 each new building must comprise a certain percentage of renewable energy in its heat production. The obligation is fulfilled with reaching one of the following targets:

Solar Thermal Energy	15 %
Biogas	30 %
Biomass	50 %
Geothermal Energy and Heat Pumps	50 %

While this obligation in itself constitutes an incentive to use geothermal heat pumps, it lacks any financial support for installation. The legal reasoning is that there should be no financial incentive for fulfilment of an obligation that is stipulated by law. And because air source heat pumps and geothermal heat pumps both must achieve a minimum of 50 %, and the required minimum SPF for air source heat pumps is lower (Figure 13), the EEWärmeG resulted in a certain boom for air source heat pumps. The share of geothermal heat pumps in the sales of all heat pump types dropped from almost 60 % in 2007 to about 35 % in 2011 (cf. Figure 3).

After 2009, only very innovative systems achieving high SPF could still be supported in new buildings, but that also ended in March 2012. The rules in the refurbishment sector are disadvantageous to GSHP; the same high values for SPF (up to 4.0) are stipulated for financial support of systems in existing buildings than those required in EEWärmeG for new buildings! To achieve this high values, refurbishment at high extra cost in existing buildings is required, which cannot be offset by the support:

20 € per m^2 of floor area, capped at

- 3000 € per single family house or flat, or at
- 15 % of the system installation cost for buildings with more than 2 flats ore for non-residential buildings.

So it can be stated that neither the obligation after EEWärmeG nor the support after MAP have the potential to effectively foster the market growth for geothermal heat pumps.

Past support schemes included:

- MAP: The Marktanreizprogram (Market Incentive Programme) was established in 1995 and supported geothermal heat pumps with a given amount per kW installed heating capacity; a condition was that the efficiency of the system was calculated (from design values) and a minimum SPF of 3,5 was achieved, after three years increased to SPF ≥ 3.8. In 1999 the MAP was restricted to heat pumps not using electricity for operation (i.e. absorption heat pumps or engine driven heat pumps), and the number of systems supported dropped to near zero. In 2008, electric heat pumps were allowed again into the MAP.
- Electricity tariffs: Some electric utilities had offered preferential power tariffs for ground source heat pumps with the condition to switch them of during peak power demand. Most of this tariffs were either lost in the liberalisation process of the German end-consumer market for electricity, or became victim to

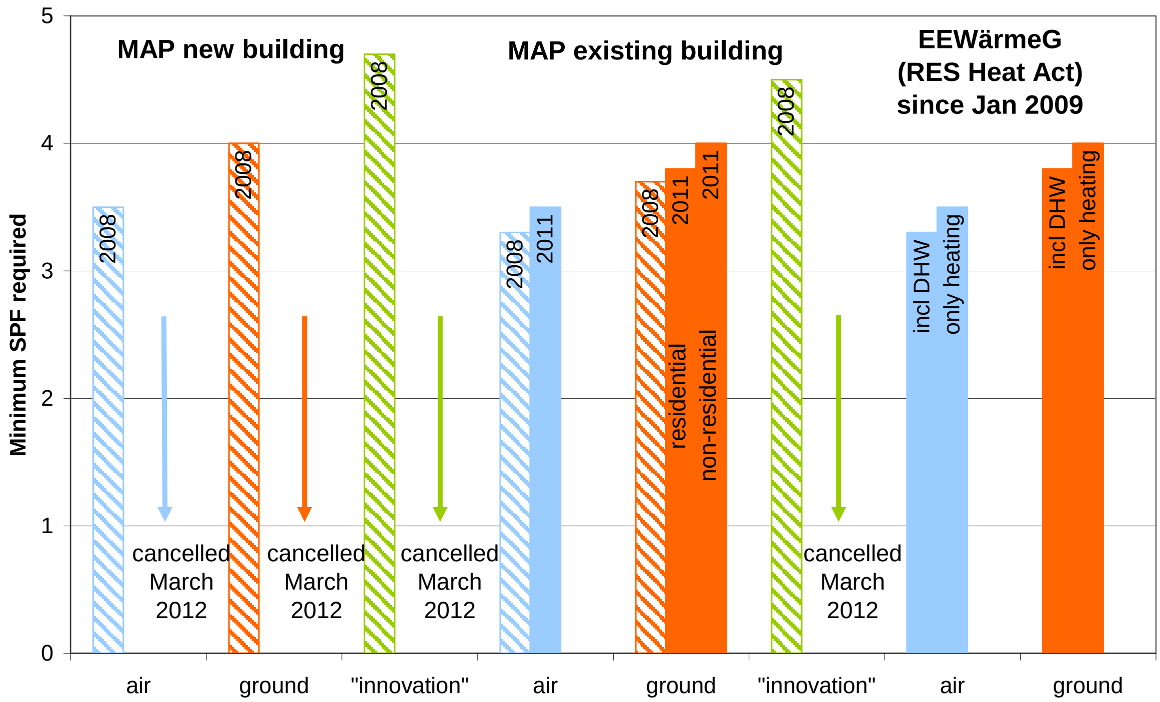

Figure 13: Minimum SPF required for support through MAP and to be accepted as fulfilment of the obligation after EEWärmeG

3.2 City or regional level

Are there subsidies / financial Incentives available?	○ Yes	X No

Currently no support schemes exist on the state level. One state, Baden-Württemberg, has a Renewable Heat Act similar to the EEWärmeG, the BW-EWärmeG from 2007. In this act, the fulfilment of the obligation (only for residential buildings) is possible e.g. by producing all heat through a heat pump with a minimum SPF of 3.5; the obligation exists both for new buildings and for the refurbishment of the heating system in a building. Generally federal law has higher validity than state law; so for Baden-Württemberg those regulations in the two laws apply that are the more strict in each case.

Past support schemes included:

- KES-Solar, a scheme run by the utility RWE mainly in the state of Nordrhein-Westfalen
- Some state schemes supporting heat pumps, e.g. in the Eastern German states in the 1990s

4. Insurance systems

Are there insurance systems available?	X Yes	◯ No

Insurance exists mainly for the environmental risks associated with a geothermal heat pump. This can be divided into:

- Risk during construction
- Risk during operation

For both types, the land owner eventually is baring the risk and will be made responsible.

For the risk during drilling and installation, the drilling company can have insurance; two schemes exist in cooperation with the German Heat Pump Association (BWP) and the German Geothermal Association (GtV), respectively. These insurances will cover any damage caused by the drilling and installation, in particular to groundwater quality, neighbouring houses etc., and will protect also the land owner for that part. In the state of Baden-Württemberg, where due to the geological setting some damage from subsidence and from swelling sediments can be reported, such insurance is mandatory; in other states it is voluntary.

For the risks during operation (e.g. leakage of antifreeze), classical insurance as exists for oil tanks can be obtained by the building owner.

There is no insurance concerning the energy performance. The costumer may have a contract with the installer where the installer guarantees a certain minimum performance, allowing for legal action against the installer if this is not achieved.

5. Existing action plans

5.1. Elements of the NREAP applying to SGE (heating & cooling)

The German NREAP includes geothermal heat pumps in the relevant tables; in the text only general measures like EEWärmeG and MAP are mentioned (cf. 3.1). The growth path of heat delivered by geothermal heat pump is shown in Figure 14; the final numbers in 2020 should be at least 521 ktoe (6.1 TWh). While this cumulative growth looks sound, a closer inspection shows some flaw in the numbers. When looking at the annual growth (Figure 15), it becomes evident that the annual targets for geothermal heat pumps decrease over time, i.e. the market would, after in initial increase, shrink until 2020 if the NREAP projections would come true.

From the expected annual heat production a calculation can be made of the number of sales per year, assuming an average heat pump size of 10 kW and 1500 full-load-hours per year. The curve in Figure 16 looks like the NREAP is going to extrapolate the market decrease over the last years towards 2020! The NREAP thus is intrinsically questionable for the expected numbers, and there are also no specific measures named how this (low) numbers might be achieved – the scenario thus is business as usual, with no ambition.

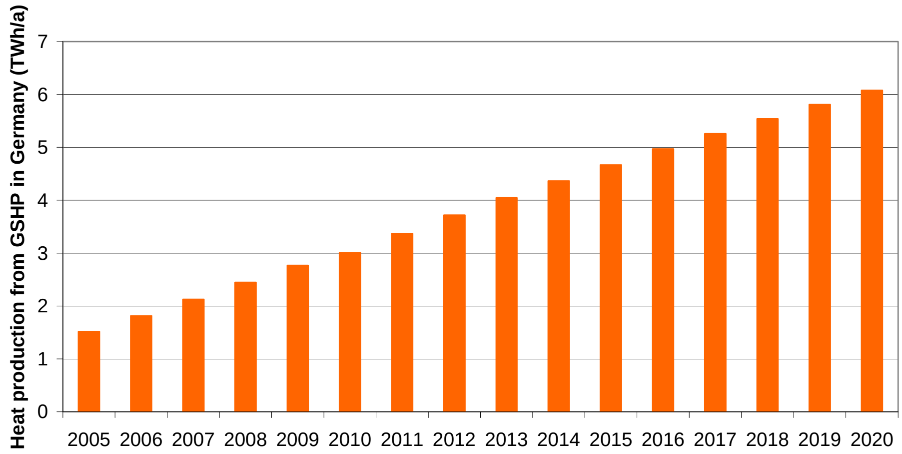

Figure 14: Growth path of heat produced by geothermal heat pumps in Germany, as to German NREAP

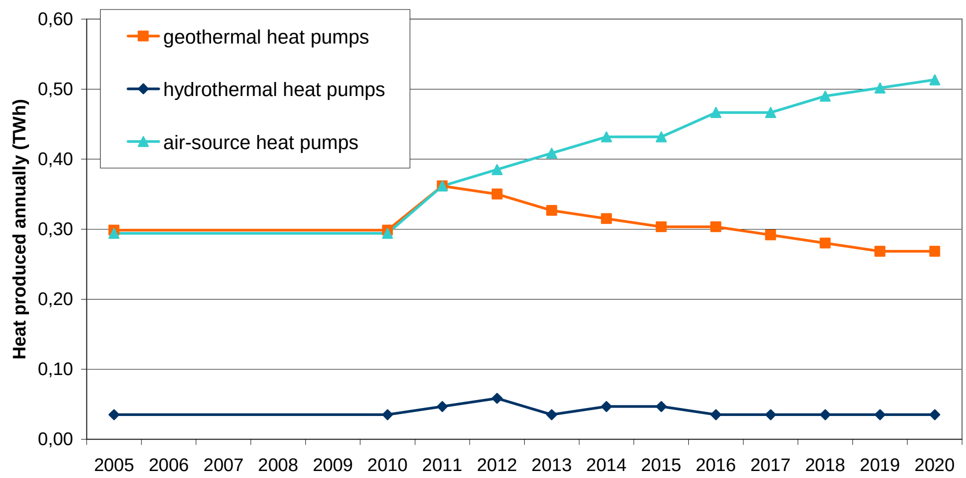

Figure 15: Growth of energy produced annually by the different types of heat pumps, projection of the German NREAP

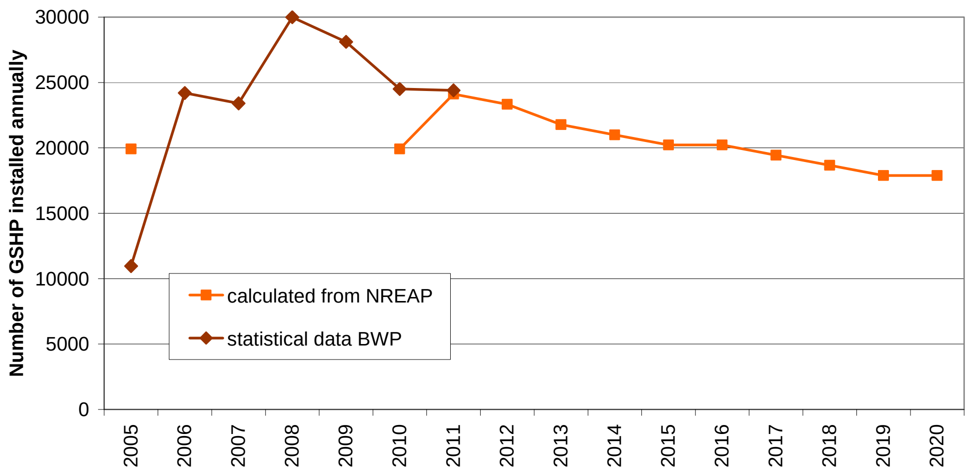

Figure 16: Number of new geothermal heat pump plants per year, calculated from the energy values in the NREAP, compared to the sales statistics of the German Heat Pump Association (BWP)

5.2 Sub-national energy scenarios

Are there energy scenarios by legal obligation?	○ Yes	X No
Are there voluntary energy scenarios?	X Yes	○ No

Some states have energy scenarios based upon a wider perspective (like the NREAP), however, these are not broken down to a local scale. Voluntary plans and scenarios exist in many communities, among them the cities being member of the Covenant of Mayors (cf. Table A-1 in appendix). The five target cities in Germany within the Regeocities project (Bonn, Frankfurt, Hamburg, Hannover, Köln) are all among the members. Their SEAPs comprise some SGE technology:

City	Year	What part of SGE is mentioned?	Measures
Bonn	2007	Ground Source Heat Pumps *(Deep Geothermal)*	Plans for use in some public buildings
Frankfurt	2009	Heat pumps	Support program in cooperation with utility Mainova
Hannover	2008	Ground Source Heat Pumps	General mentioning, also in context of public works
Hamburg	2009	Ground Source Heat Pumps *(Deep Geothermal)*	Support measures for high efficiency plants, relevant authorities (geology, water) are requested to cooperate and inform
Köln (Cologne)	2010	Ground Source Heat Pumps	General mentioning, no measures

Hamburg has by far the widest coverage of shallow geothermal (and deep geothermal) technologies.

6. Legal framework and Cities Planning

6.1. Current legislation and permit procedures in relation to SGE

A typical installation with one BHE of >100 m depth will allow for a heating capacity of about 6-8 kW, i.e. will be suitable for a small, well-insulated single family house. The design, licensing and installation procedure can be summarised as follows:

- Typically a local plumber or heating contractor will offer a GSHP-system to the house owner, based upon information from a heat pump manufacturer (most local installers have sales contracts with one or the other heat pump manufacturer).
- The local installer either has an agreement with a driller, or searches for offers for drilling the borehole and installing the BHE. A drilling contract is made between house owner and driller, sometimes the local installer takes the driller into his contract as a subcontractor.
- In some of the states, the authorities provide information on regions with limitations to drilling and BHE installation (e.g. groundwater protection zones). If installer and/or driller are wise, they check this information and suggest to the house owner to abandon the project in case the site is within a restricted zone.

- The design is provided by the driller in most cases. The procedure is simple, as VDI 4640, part 2, table 2 contains a list of specific heat extraction rates for different ground types, to be used for such small projects. Values range from 20 W/m to 100 W/m. However, in many cases just the "rule-of-thumb"-value of 50 W/m is used, resulting in a maximum heat extraction (equals heat pump evaporator capacity) of 5 kW from a 100-m-BHE, or in case of a heat pump with only 4 kW evaporator capacity, in a required BHE length of 80 m (4000 W divided by 50 W/m = 80 m).
- The driller prepares the application for a license for drilling, installation, and operation of the BHE. This application, signed by the house owner, goes to the water authorities at county level (or city level, in larger cities). The exact procedure is defined on the level of the individual states, and there is quite some variety in the documents to be provided, the complexity of the procedure, and the fee involved. These fees, for small projects, range from 0 € in Saarland to 350 € in Hessen. However, in some states mandatory requirements make for additional cost: In Bavaria, a site and risk assessment prepared by a licensed private expert has to be provided, costing from about 200 € upwards in addition to the state fee of 50 €; in Berlin, both a mandatory geological statement by the authorities (about 150 €) and a geophysical log of the borehole (in the order of 1000 €) have to be added to the state fee of 50 €.
- After obtaining the license for the BHE (which should take not longer than one month), the drilling and installation can start. The driller has to inform the water authorities and the Geological Surveys (on state level) of the date the drilling will start, and has to submit the geological data derived from the borehole to the Geological Survey (based upon a law dating back to 1938). The actual drilling and installation of one BHE up to 100 m deep takes a maximum of one day, in few cases two days.

The cost for licenses for geothermal heat pumps differ widely between the states (Figure 17). This cost not only comprise the actual fee, but also some mandatory private services and other cost. While the state of Hessen has the highest fee as such, the total cost is much higher in Bayern and Berlin. In Hessen, the fee is related to the heat pump capacity, from a minimum of 350 € to a cap at 3000 € (Figure 18).

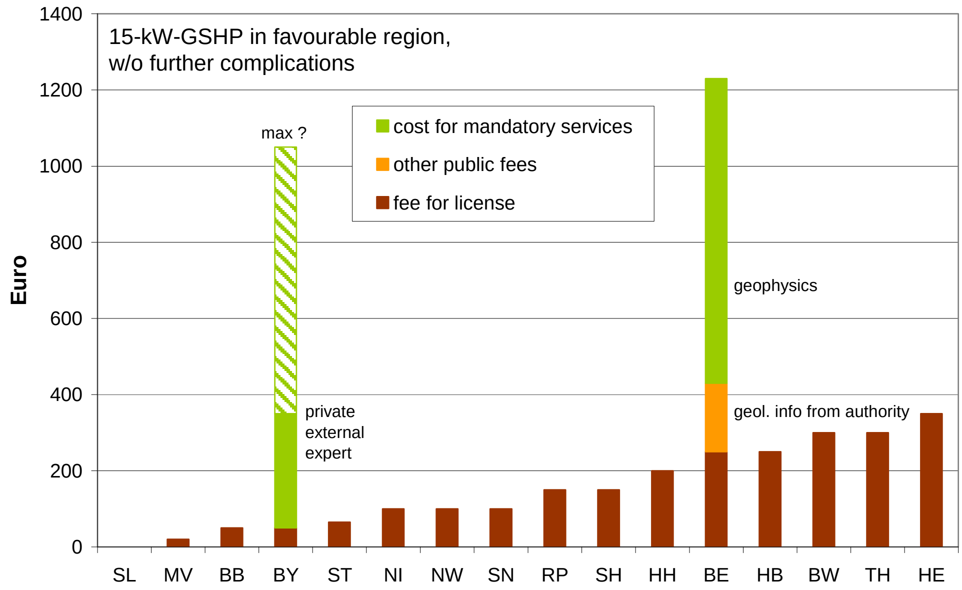

Figure 17: Cost for license for borehole heat exchangers for a typical single-family house

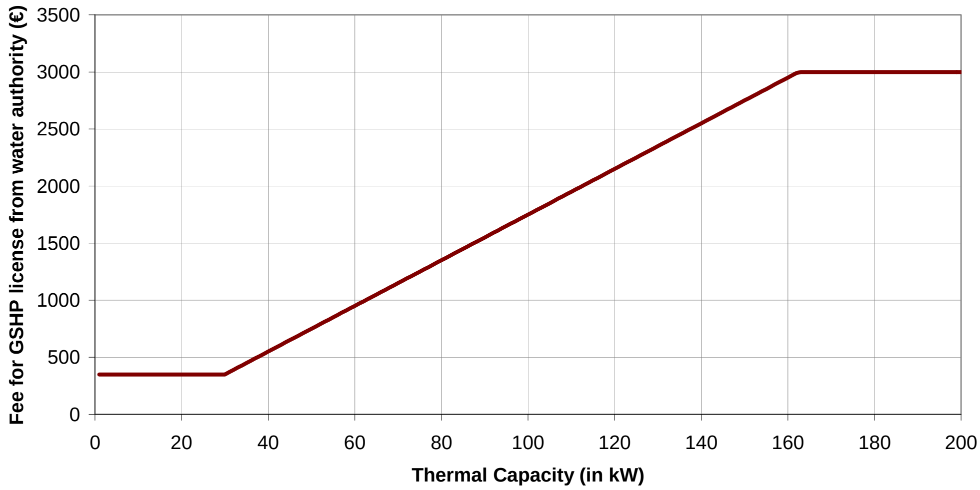

Figure 18: Cost for license for geothermal heat pump with borehole heat exchanger in the state of Hessen

6.2. (Underground) Space planning

There are no items in underground space planning other than supply lines, sewage, tunnels (metro) or similar. Underground for SGE use can only be accessed if there is no conflict with such uses. For groundwater (protection areas), minerals or other commodities, pro-active planning is not done, but licensing and planning is reactive to requests made be interested industry.

The German space planning law is rather complex. The main actors are again the states, following a federal space planning perspective (which In itself is compatible to the European Spatial Planning Charter). The states provide a "Landesentwicklungsplan" (State Development Plan), based upon which counties and cities develop their relevant development plans ("Stadtentwicklungsplan"), space use plans ("Flächennutzungsplan") and construction plans ("Bebauungsplan"). These plans deal mainly with different types of construction areas (residential, offices/shops, industrial), transport lines, recreational areas, etc., but not with the underground.

Is there a will in your country to link urban planning closer with renewable energy plans?	◯ Yes	x No

There may be some intentions in certain communities, however, it is not a trend yet. Renewable energies are covered in more regional plans, e.g. with areas for wind energy converters or for large PV arrays. In heating, the traditional items in such plans are district heating grids, but not necessarily based on renewable energy.

Are there specific considerations of renewable energy integration (i.e geothermal energy) into construction licenses?	x Yes	◯ No

This is already done through the energy saving directive (EnEV, several versions since 2002, cf. chapter 2.1), the fulfillment of which is an integral part of the construction license. Currently EnEV

2009 is in force, to be replaced by EnEV 2012[6]. Also the EEWärmeG stipulates the use of RES in new buildings, and construction licenses are subject to the fulfillment of this obligation.

Is there a regulation concerning interactions between thermal uses of the underground and other utilisations (such as constructions, use of water, …)?	○ Yes	x No

There is no specific regulation, but the local authorities try to integrate this item into the construction license.

Is there a national/regional/local database of wells?	X Yes	○ No

Basically, the responsibility for such data collection is with the states. A national database only exists for deep wells (hydrocarbon, deep geothermal); it is located in Hannover with the cluster around the German Geological Survey (BGR), comprising the Lower Saxony Geological Survey (LBEG) and the Leibniz Institute for Applied Geosciences (LIAG). Most states have own databases, some of them available publicly on the internet, like in Hessen (cf. Figure 8)

Are there public databases concerning all the uses of the underground	○ Yes	X No

6.3. Integration of H&C systems in buildings

Do you have specific targets for considering the integration of RES into H&C systems concerning renovation/refurbishment of buildings?	○ Yes	x No

There is no regulation on the national level, only the state of Baden-Württemberg established an obligation[7] that with refurbishment (defined as the replacement of the core components of a heating system) a minimum of 10 % of the annual heat demand has to be provided from RES. This is considered as being fulfilled if a heat pump with a minimum SPF of 3.5 is installed to cover the whole heating demand; with this SPF, typically a GSHP will be the only solution

Do you have a specific regulation on H&C systems concerning new constructions?	○ Yes	x No

[6] due to necessary adjustments concerning EU EPBD, the planned EnEV 2012 is delayed and might become EnEV 2013

[7] *„Gesetz zur Nutzung erneuerbarer Wärmeenergie in Baden-Württemberg (EWärmeG BW)"*, law of 20.11.2007

This is already done through the energy saving directive (EnEV, several versions since 2002, cf. chapter 2.1), the fulfillment of which is an integral part of the construction license. Currently EnEV 2009 is in force, to be replaced by EnEV 2012[8]. Also the EEWärmeG stipulates the use of RES in new buildings, and construction licenses are subject to the fulfillment of this obligation.

What are the intentions in the regulations and specific targets and how does it fit with geothermal energy development?

There is no specific addressing of SGE in the building energy regulations, however, the provisions e.g. in EnEV are favoruable for SGE.

Are existing plants subject to periodic monitoring/report?	◯ Yes	x No

Not when it comes to energy performance. Geothermal systems with borehole heat exchangers now become subject to a periodic check of the underground system, based upon regulations in the state ordinances on handling of materials hazardous to water (VAwS). While the VAwS legally only concern non-residential buildings, some states (lead by Hessen) tend to make the regular check mandatory also for residential buildings including single family houses. This check has to be done by a company or person certified after VAwS (like TÜV) in a regular interval of 5 years, and in shorter intervals under certain conditions as in water protection areas.

Are existing plants subject to mandatory maintenance?	◯ Yes	x No

No, but manufacturers recommend this and most installers offer appropriate service contracts. Mandatory maintenance is common for boilers (gas, oil, biomass), but not for SGE.

[8] due to necessary adjustments concerning EU EPBD, the planned EnEV 2012 is delayed and might become EnEV 2013

Appendices

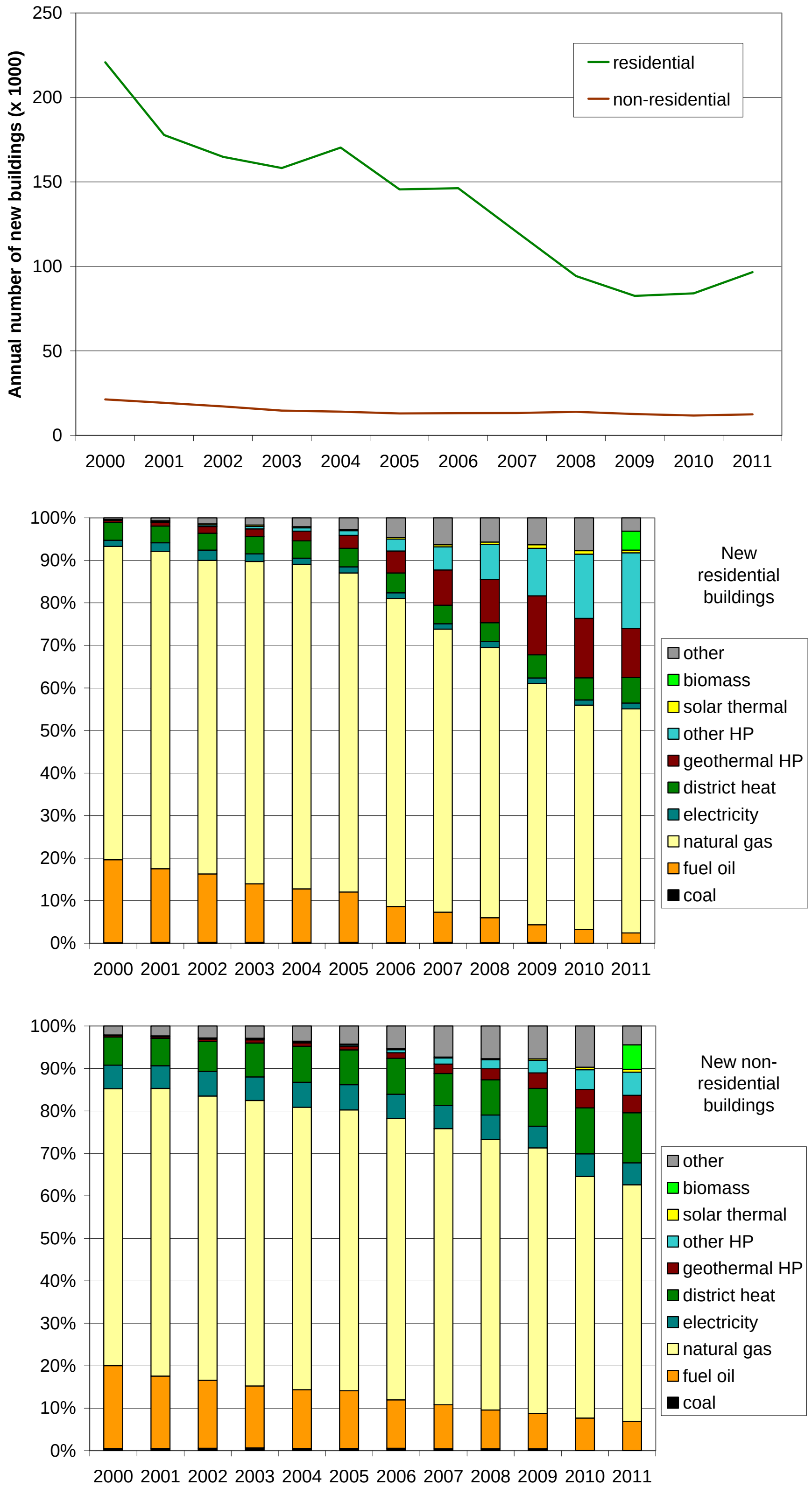

Figure A-1: Number of new construction in Germany, and distribution of sources for respective heating systems (after data from StatBA; distinction of HP types for 2010 and earlier as to percentage in data from BWP)

Table A-1: German members of the Covenant of Mayors and status of their SEAP

City	Target CO_2 reduction	SEAP
Aachen	40%	accepted by EU
Berlin	40%	accepted by EU
Bielefeld	40%	accepted by city
Böhl-Iggelheim	25%	accepted by city
Bonn	20%	accepted by city
Bottrop	35%	accepted by city
Bremen	40%	accepted by city
Dormagen	20%	accepted by city
Dortmund	40%	accepted by city
Duisburg	40%	accepted by city
Düsseldorf	46%	accepted by city
Eppelheim	20%	accepted by city
Essen	40%	accepted by city
Esslingen am Neckar	25%	accepted by city
Frankfurt am Main	31%	accepted by EU
Freiburg	29%	accepted by EU
Friedrichshafen	20%	accepted by city
Fürstenfeldbruck	35%	accepted by city
Geislingen	30%	accepted by city
Greifswald	14%	accepted by city
Hamburg	40%	accepted by EU
Hannover	40%	accepted by EU
Heidelberg	20%	accepted by city
Herten	27%	accepted by EU
Kaiserslautern	40%	accepted by city
Karlsruhe	27%	accepted by city
Koeln	20%	accepted by city
Landau in der Pfalz	25%	accepted by city
Lörrach	48%	accepted by city
Ludwigshafen am Rhein	22%	accepted by city
Mainz	50%	accepted by city
Mannheim	40%	accepted by EU
München	47%	accepted by EU
Münster	40%	accepted by EU
Neumarkt in der Oberpfalz	50%	accepted by EU
Nürnberg	40%	accepted by EU
Pforzheim	35%	accepted by city
Rheinberg	40%	accepted by city
Rheine	30%	accepted by city
Rimbach	20%	accepted by city
Rostock	24%	accepted by EU
Sankt Leon-Rot	20%	accepted by city
Stuttgart	20%	accepted by city
Teltow	20%	accepted by city
Vaterstetten	20%	accepted by EU
Willich	20%	accepted by EU
Wolfsburg	20%	accepted by city
Worms	20%	accepted by EU

Table A-2: Weblinks to public guidelines and databases on shallow geothermal energy in Germany

Guidelines and web-based information systems of the German states (Bundesländer) concerning design and licensing of GSHP (links valid and checked as of August 2012):

Joint Geothermal Portal of the State Geological Services
http://www.geothermieportal.de/geothermie_6.0/

Baden-Württemberg, guideline as pdf, 4th ed. 2005, LGRB Freiburg
http://www.lgrb.uni-freiburg.de/lgrb/home/leitfaden_erdwaerme
detailed maps at:
http://www.lgrb.uni-freiburg.de/lgrb/Fachbereiche/geothermie/is_geothermie

Bayern (Bavaria), guideline as pdf, 4th ed, 2012, StMUGV, Munich and LfU, Hof
http://www.bestellen.bayern.de/shoplink/stmug_klima_00006.htm
further information, database, etc. at:
http://geoportal.bayern.de/energieatlas-karten/

Berlin, status Feb. 2012, SenStadtUm (senatorial office for city development and environment)
http://www.stadtentwicklung.berlin.de/umwelt/wasser/wasserrecht/pdf/leitfaden-erdwaerme.pdf
detailed maps at:
http://www.stadtentwicklung.berlin.de/umwelt/umweltatlas/k218.htm

Brandenburg, in 2012 no valid guideline; a guideline was provided until 2011: 1st ed. 2009, ETI Potsdam
http://www.eti-brandenburg.de/energiethemen/geothermie/
detailed maps (currently only for hydrogeology) at:
http://www.geo.brandenburg.de/hyk50

Bremen, 2-papge paper of GDfB (Bremen Geological Survey), without date, Bremen:
http://www.gdfb.de/pdf/TuR_Hinweise_EWS.pdf

Hamburg, 3rd ed. 2011, office for city development and environment:
http://www.hamburg.de/wasser/151658/start-erdwaermenutzung.html

Hessen, 4th ed. 2011, HLUG, Wiesbaden
http://www.hlug.de/start/geologie/erdwaerme-geothermie/oberflaechennahe-geothermie/downloads.html
detailed maps at:
http://www.hlug.de/start/geologie/erdwaerme-geothermie/oberflaechennahe-geothermie/karten-standortbeurteilung.html

Mecklenburg-Vorpommern, 1st ed. 2006, LUNG Güstrow
http://www.lung.mv-regierung.de/insite/cms/umwelt/geologie/produkte/ews_leitfaden.htm
(only a summary and appendix avaliable online, full version can be ordered online)
detailed maps at:
http://www.umweltkarten.mv-regierung.de/atlas/script/index.php

Niedersachsen (Lower Saxony), 1st ed. Dec. 2006
http://www.umwelt.niedersachsen.de/themen/wasser/grundwasser/leitfaden_erdwaermenutzung/8927.html
detailed maps at:
http://memas01.lbeg.de/lucidamap/index.asp?THEMEGROUP=WASSER

Table A-2 (continued): Weblinks to public guidelines and databases on shallow geothermal energy in Germany

Nordrhein-Westfalen, various online sources incl. Simple site check, offline database on a CD-ROM:
http://www.gd.nrw.de/l_gt.htm
brochure with summary of the offered material:
http://www.gd.nrw.de/zip/gbrosgt.pdf
detailed maps (site-check) at:
http://www.geothermie.nrw.de/viewer.html

Rheinland-Pfalz, 5th ed. 2012, MULEWF, Mainz and LGB, Mainz
http://www.lgb-rlp.de/erdwaerme_d.html
detailed maps at:
http://mapserver.lgb-rlp.de/php_erdwaerme/index.phtml

Saarland, 1st ed. 2008, MfU, Saarbrücken
http://www.saarland.de/dokumente/ressort_umwelt/08-05_Leitf_Erdwaerme.pdf
no detailed maps

Sachsen, 4th ed. 2011, SMULG, Dresden/Freiberg
https://publikationen.sachsen.de/bdb/artikel/11868
detailed maps at:
www.umwelt.sachsen.de/umwelt/geologie/26631.htm

Sachsen-Anhalt, 1st ed. 2012, LGAB, Halle
http://www.sachsen-anhalt.de/fileadmin/Elementbibliothek/Bibliothek_Politik_und_Verwaltung/Bibliothek_LAGB/geothermie/portal/info_geothermie.pdf
detailed maps / site-check at:
http://www.geodaten.lagb.sachsen-anhalt.de/lagb/?pgid=18

Schleswig-Holstein, 2nd ed. 2011, LANU, Flintbek
http://www.umweltdaten.landsh.de/nuis/upool/gesamt/geologie/geothermie_2011.pdf
no detailed maps

Thüringen, preliminary guideline document, Feb. 2010, TLVWA, Weimar
http://www.tlug-jena.de/geothermie/dokumente/arbeitshilfe_erdwaerme.pdf
detailed maps at:
http://www.tlug-jena.de/geothermie/index.html