EGEC views on

"The European Investment Bank review of its Energy Sector Lending Policy"

Brussels, 20th December 2012

EGEC, the European Geothermal Energy Council, was founded in 1998 as an international non-profit association in Brussels, with the aim of promoting the use of geothermal energy. EGEC has more than 120 members from 22 European countries: private companies, national associations, consultants, research centres, geological surveys and other public authorities.

EGEC welcomes the call for public views launched by the European Investment Bank (hereinafter referred to as "the Bank") as part of the review of its Energy Sector Lending Policy. This document presents the geothermal sector's views on how the Bank should shape its next Energy sector lending policy, notably in relation to geothermal energy. We remain at disposal of the Bank for any further details.

Among other things, EGEC recommends that in the new energy sector lending policy of the Bank:

- *Each project applying for a loan will be examined whether it is compatible with the 80-95% reductions in GHG emissions as according to EU Energy Roadmap 2050;*
- *The Bank will update its energy specific eligibility criteria to include innovative geothermal technologies such as low temperature power plants under the categories "Emerging renewable energy technologies" or "Highly innovative renewable technologies";*
- *The Bank will go beyond the financing of single projects and will explore financial tools that can fit the needs of new renewable technologies and overcome the financial barriers to their development, e.g. the idea of a EU risk insurance scheme to overcome the geological risk for geothermal;*
- *The bank will assess the implications in terms of job creation and security of supply of each project applying for loans;*
- *The Bank will no longer support extraction of fossil fuels, their transportation, storage and refining in any region of the World.*

1. *Introduction to geothermal technologies and market development*

Geothermal electricity

Over the last 100 years, the production of geothermal energy has been concentrated in areas where rich hydrothermal resources were available. However, the development of advanced technologies has enabled the production of geothermal energy at low temperature in all European countries.

Today, three technologies exist to produce **electricity from geothermal energy** and one is under development:

1) Conventional high temperature, hydrothermal geothermal electricity production (dry steam and flash steam)

As demonstrated in numerous sites since already 1904, heat from the underground can be converted into electricity with dry steam power plants and flash steam plants (water dominated reservoirs and temperatures above 180°C).

2) Low temperature, hydrothermal geothermal electricity production (Binary: ORC and kalina Cycle)

Binary, known also as organic Rankine cycle (ORC) or Kalina Cycle, plants operate usually with waters in the 100 to 180°C temperature range. Adequate working fluid selection may allow extending the former design temperature range from 180°C to 75°C.

3) Enhanced Geothermal Systems – EGS , geothermal electricity production

An Enhanced Geothermal System is an underground reservoir that has been created or improved artificially. The concept of Enhanced Geothermal Systems is going to add a tremendous increase to the geothermal potential as it allows producing geothermal electricity nearly anywhere in Europe with medium and low temperature. This concept consists briefly of:

- Use the natural fracture systems in the basement rocks
- Enlarge its permeability through massive stimulation
- Install a multi-well system
- Through pumping and lifting, force the water to migrate through the fracture system of enhanced permeability ("reservoir") and use the heat for power production

A major effort to introduce EGS could create a substantial base-load electric power production, as geothermal energy is available independent from the time of day or year, of climate, weather, etc. A steady increase in geothermal power production could be expected in all EU countries.

4) Supercritical fluids

The long-term evolution for geothermal resource exploitation concerns the supercritical zones of geothermal fields with very high temperatures (up to 500°C) at relatively shallow (< 5 km) depths It is expected that supercritical fluid can provide 5-10 times more energy per volumetric flow compared to conventional geothermal power plants using condensing turbines. Thus it will have a dramatic effect on the production capacity of geothermal energy.

Geothermal heating and cooling

With geothermal energy for heating and cooling, two main resource types are distinguished:

1) The first one (very low temperature in the range of the annual mean air temperature on site, up to about 30 °C) is based on the relatively stable groundwater and ground temperatures at shallow depth (the limit is typically set at 400 m). Typically, heat pumps are used to extract energy from the ground and raise the temperature to the level required by the heating systems.

2) The second one (low and medium temperature, ranging from 30 °C to over 100 °C) extracts the heat from ground and groundwater at higher temperature, and typically at greater depth. If the geothermal heat is at a level of temperature compatible with the temperature required by the heating system, the energy from the ground or the ground water can be used directly (without any thermodynamic device). Direct applications are found in:

- district heating or combined heat and power installations
- agriculture (horticulture, aquaculture, drying)
- industrial processes
- balneology
- absorption heat pumps for cooling purposes

2. General energy and economic context

- Particularly in the current economic climate, is there a trade-off between promoting a competitive and secure energy supply and one which is environmentally sustainable?
- Where should the balance lie and what implications does this have for energy sector investments?
- How does investment in the energy sector contribute to growth and employment?
- Are investments in all energy sub-sectors equally valuable? And how does investment in the energy sector rank relative to other investments in the economy which support growth and employment?
- What impact do you consider the current economic crisis will have on the energy sector (demand, policies, supply)?

In January 2007, the European Commission put forward strategic objectives to guide "An Energy Policy for Europe"[1]:

- Increasing security of energy supply;
- Promoting environmental sustainability;

[1] COM(2007)1

- Ensuring the competitiveness of European economies and the affordability of energy supply;

This policy agenda was supported by heads of state and government that in March 2007 have committed to achieving the following goals by the year 2020:

- A reduction of at least 20% in greenhouse gas (GHG) emissions compared to 1990 levels;
- 20% of the final energy consumption to come from renewable sources;
- An improvement of energy efficiency by 20%.

Eventually, a legislative climate and energy package was adopted and the so-called 20-20-20 targets were fully integrated into the Europe 2020 strategy.

The European Council, in its conclusions of 4 February 2011, looked forward to the elaboration of a low-carbon 2050 strategy providing the framework for longer term action. As a follow-up, the European Commission presented its Communication on "a Roadmap for moving to a competitive low-carbon economy in 2050" followed by the elaboration of several 2050 Roadmaps among them the Energy Roadmap 2050, which sets out the need to reduce EU emissions by 80% in 2050.

Within this framework the Bank on its own tries to strike a balance between EU policy objectives. EGEC believes it is possible to reconcile these objectives by prioritising the right technologies. For instance, a higher share of geothermal energy in the EU energy mix can:

- facilitate the achievement of the EU climate and energy objectives (geothermal is a renewable and local energy source, using efficient technologies and having a huge potential in reducing GHG emissions[2]);

- contribute to the creation of new and stable occupation - 90% of the geothermal energy value chain is European. Due to the local character of the technology and the strong European technological leadership in this sector, the Bank should bear in mind that any geothermal project will create jobs that cannot be delocalised elsewhere and will bring added value to the whole European economy-;

- increase security of supply and can alleviate the need for additional grid infrastructures;

As far as security of supply is concerned it is worth highlighting that Geothermal can produce heat and power continuously as it is generally immune from weather effects and does not show seasonal variation. The base-load characteristic distinguishes geothermal electricity from several other renewable technologies that produce variable power.

Geothermal has by far the highest capacity factor[3] of all technologies, with new geothermal power plants capable of achieving rates above 90%. For instance, by using the data available in

[2] For more information see Goldstein, B., G. Hiriart, R. Bertani, etc., *Geothermal Energy*, in IPCC Special Report on Renewable Energy Resources and Climate Change Mitigation, 2011.
[3] The capacity factor is the ratio of the actual output of a power plant over a period of time and its potential output if it had operated at full nameplate capacity the entire time.

Annex I of the Impact Assessment related to the year 2010, it is possible to note that in terms of capacity factor geothermal (85%) clearly performs better than nuclear (79%). The results are depicted in Figure 1 overleaf.

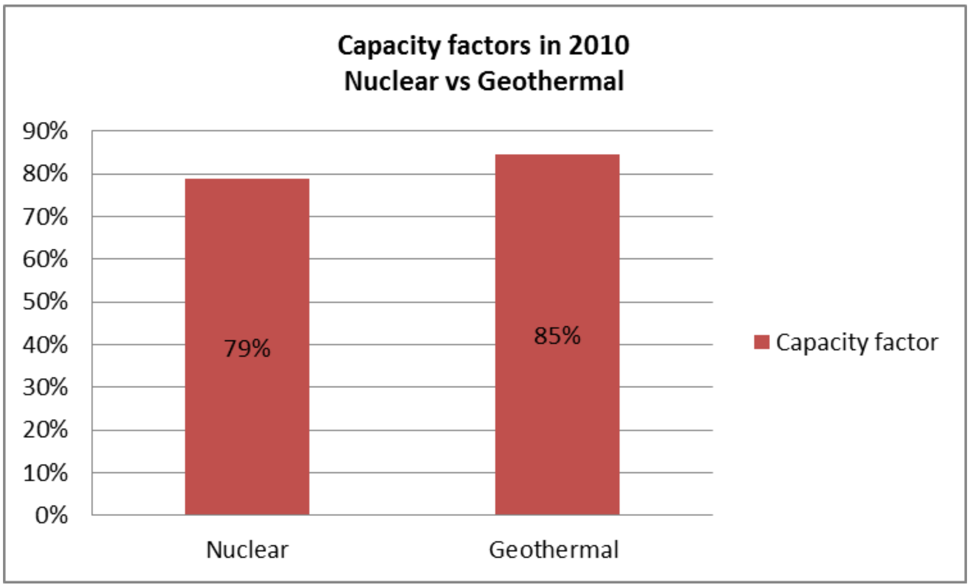

Figure 1: Capacity factors in 2010: Nuclear vs Geothermal

Further advantages of geothermal are its flexibility, as it can be ramped up or down in about six hours[4], and its scalability. Hence, it can easily be integrated in existing power systems providing balance to the grid to respond properly to the local or regional demand. Geothermal electricity is therefore well suited for the substitution of other non-RES base-load power sources such as coal and nuclear and for covering variability in the net load, therefore limiting the need for additional grid infrastructure and storage.

In its new energy sector lending policy, it is of the utmost importance that the Bank assessed and internalised all external costs in a transparent manner. Externalities include system costs (infrastructure and grid expansion), emission of greenhouse gases and other pollutants, and residual insurance responsibilities that fall to government.

Finally, with the current economic crisis and stressed capital markets, high capital costs can undermine the competitiveness of those projects with high upfront costs, which is the case for any geothermal project. In the short term, this can further favour investments in conventional technologies developed for decades under monopoly conditions and mow down the development of innovative renewable technologies.

To conclude, the Bank has a key role in leveraging private investments towards new energy technologies such as non-conventional geothermal and in exploring innovative financial tools to overcome specific barriers to their development. Furthermore, the Bank should assess whether

[4] The IEA recently pointed out that "the additional flexibility from base-load plants maybe particularly important" as some case-studies suggest that is the ramping capability of the system on the longest

each project proposed is compatible with the 80-95 percent reductions in GHG emissions as according to EU Energy Roadmap 2050 and its added value in terms of job creation and security of energy supply.

3. ***Renewable energy***

- The Bank's economic justification for supporting emerging renewable energy technologies, whose cost is significantly above that of conventional and mature renewable energy technologies, is that continued investments in these technologies will eventually lead to cost reductions and will ultimately be the least-cost approach to meeting the EU's renewable energy targets. Do you agree with this approach? Is there an alternative approach to the economic justification of these technologies which you consider more appropriate?

Considering the high potential in cost reduction for renewables in general and for innovative geothermal technologies in particular, the above justification for supporting renewables is valid. However, the rationale behind the Bank support is that renewable energy projects are crucial to achieve key objectives of the Union's policy (20-20-20 targets by 2020, decarbonisation EU economy by 2050 etc.)

Against this context EGEC believes that the Bank needs to update the energy sector specific eligibility criteria and to look beyond 2020. Currently, only conventional geothermal projects are eligible for loans from the Bank.

Innovative geothermal technologies (see above for more details) shall also be eligible under the categories *"Emerging renewable energy technologies"* or *"Highly innovative renewable technologies"*.
Indeed both low temperature hydrothermal and EGS power plants are emerging and have a potential for costs reduction in order to become competitive (around 96 €/MWh) by 2020. Costs reduction can be done by R&D in resource assessment, drilling, production technologies and surface systems.[5]

Moreover, as the Bank is the biggest public financial institution in the world we expect it is given the mandate to go beyond the financing of single projects and to explore financial tools that can fit the needs of new renewable technologies and overcome the financial barriers to their development.

For instance, one of the most important financial barriers to develop geothermal energy projects is the risk associated with the first drilling. In the absence of coverage against the mining risk, any failure of a drilling operation would require to charge back the taxpayers of the

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timescale assessed (36 hours) which is the greatest constraint on the system's ability to manage variable net load. IEA, *Harnessing Variable Renewables: A Guide to the Balancing Challenge*, 2011.

[5] See *Strategic Research Priorities for Geothermal Electricity*, TP Geoelec, April 2012

city or the tenants of subsidized housing concerned. Officials considered this as an unacceptable constraint.

The GEOELEC Project in the "Report on risk insurance"[6] concludes that support for geothermal projects should be channelled through a specialised financial institution to be called the **EUROPEAN GEOTHERMAL RISK INSURANCE FUND (EGRIF)**. **The EU should set up a EU-wide risk insurance scheme with financial and management participation by the European Investment bank and private sector financial intermediaries.** The mission of this programme should be to provide guarantees solely against resource-discovery risk. All other risks in supported geothermal projects should be borne by project operators (which could be public utilities or private enterprises) and their sponsoring financial institutions.

- What evidence is there that the cost of emerging renewable technology is falling?

Low temperature and EGS geothermal electricity are not mature technologies. Less than 10 low temperature power plants and only 3 EGS are operational in Europe. Costs reduction can be achieved by:

- Improving the efficiency of the turbines
- Decreasing the costs of the drilling
- Improving the production
- Increasing the size of the power plants

Low temperature power plants have decreased their capital costs from 7 Mio €/MWe (Neustadt-Glewe in 2003) to 5 Mio €/MWe (Bruchsal in 2011) - both in Germany. For EGS, the reduction of capital costs observed is from 12 Mio€/MWe (Soultz-sous-forêts in 2008) to 8 Mio€/MWe (Insheim inaugurated in 2012).

- What level of investment in RE do you expect in the short and medium term?

As a result of technology developments and despite the limited financial support received, geothermal energy is now being developed anywhere in Europe. The estimated development of the sector until 2019-2020 (and the estimated level of investments expected) is provided below.

Firstly, in the geothermal electricity sector there are 126 new power plants under construction or under investigation in EU member states. Figure 2 below highlights how geothermal is already, and will be further, contributing to the EU's security of electricity supply, with a total installed capacity amounting to 935 MWe in 2012 and with a minimum estimated capacity of approximately 1429 MWe expected already in 2019.

[6] Deliverable n° 3.2. *Report on risk insurance*, September 2012 – version 7. Geoelec project (www.geoelec.eu)

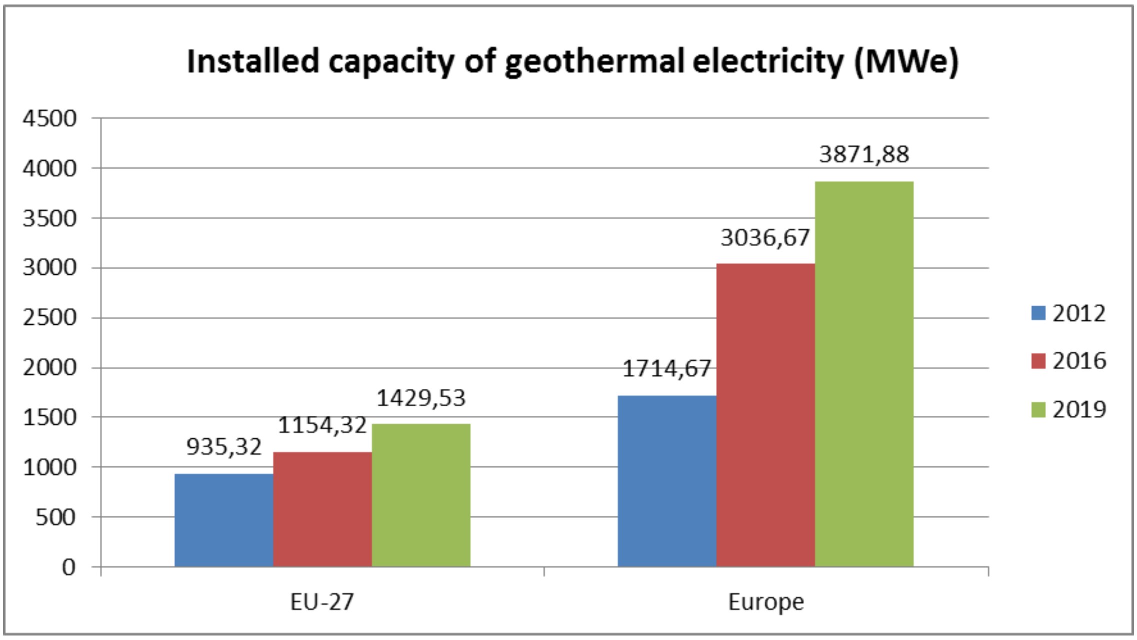

Figure 2: Actual installed capacity of geothermal electr.; MWe (2012-2019) Source: EGEC Geothermal Market Report 2012

Secondly, in many EU member states, notably in Central and Eastern Europe, there is an enormous potential for switching from fossil fuel-based to geothermal-based district heating systems. In fact, a revival of geothermal district heating is already happening as shown by the 146 projects under development in the EU-27 (Figure 3). In addition, much potential is still unknown and will be tapped following the deployment of EGS, if market distortions are removed and research and infrastructure funds are directed towards this local solution already available today.

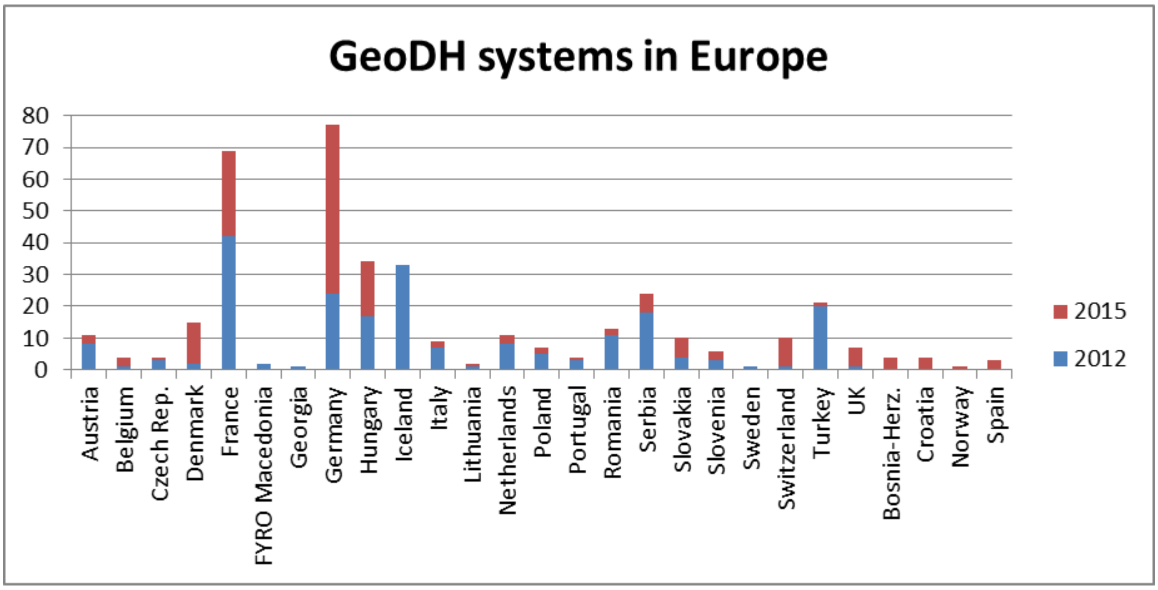

Figure 3: GeoDH systems in the EU (2012-2015) Source: EGEC Geothermal Market Report 2012

Finally, from the National Renewable Energy Action Plans it is possible to estimate the trend in Ground Source Heat Pumps in the EU up to 2020.

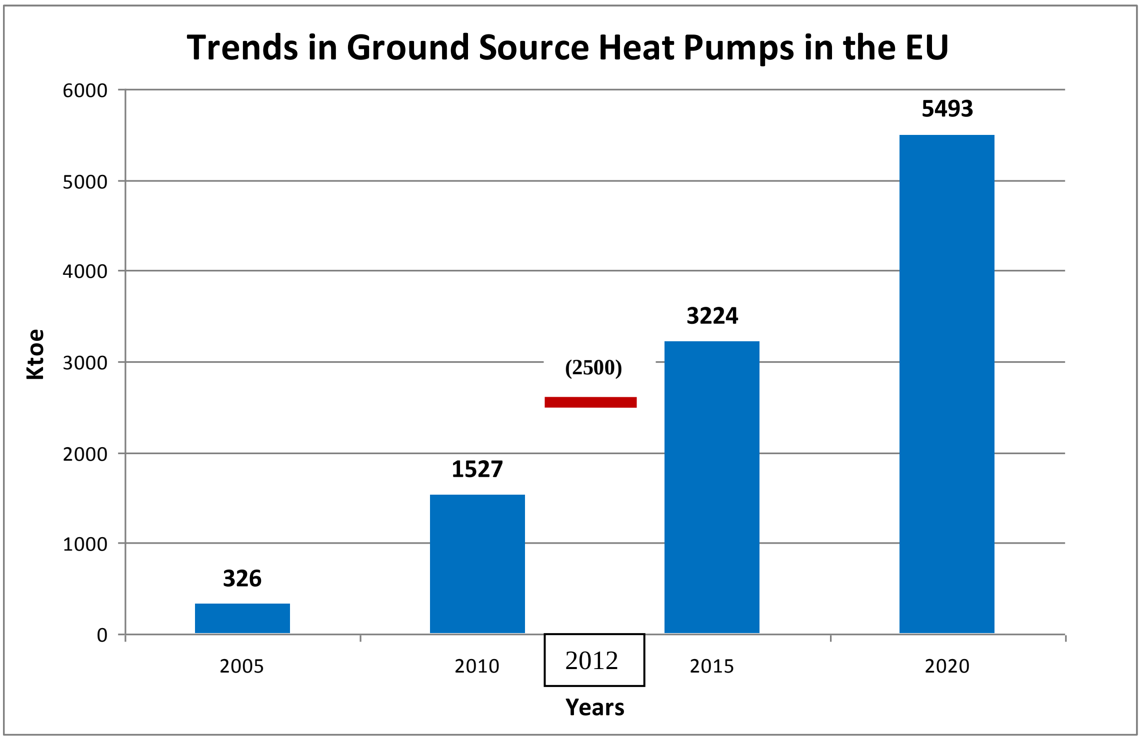

Figure 4: Summary of heat production from Ground source heat pumps in the EU as given in the NREAPs; the actual value achieved in 2011 was about 2'500 ktoe. Source: EGEC Geothermal Market Report 2012

- Do you agree that there is significant scope for investment in renewable heating and cooling?

EGEC agrees that there is significant scope for investments in renewable heating and cooling. Figures 3 and 4 above give an example of the on-going development in the geothermal heating and cooling sector.

In this regard, it is important to remind that the heating and cooling sector plays a crucial role within our primary energy supply. Heat accounted for 47% of the final energy consumption in Europe in 2010. However, the vast majority (81%) of this energy is today produced through the combustion of fossil fuels, while cooling is predominantly produced from electricity-driven processes and, therefore, also largely relies on coal and gas. This is why the current heating and cooling system is not only boosting costly imports of fossil fuels into Europe, but is also major contributor to the overall EU's greenhouse gas emissions.

A shift towards carbon-free and locally produced energy sources is crucial if the Union wishes to reduce its greenhouse gas emissions by 80-95% by 2050. To this end, we invite the Bank to properly address the sector in the review of its next lending policy and to take into account:

- the decentralised and in some cases smaller scale of many renewable heating and cooling projects;

- The interplay between renewable heating and cooling technology and energy efficiency.

➢ What are the barriers to investments in this sector and how might these be overcome?

A non-exhaustive list of barriers to investments in geothermal heating and cooling (valid also for geothermal electricity) is provided below:

- Risk associated to the first drilling and its coverage (see above);
- High upfront costs;
- High drilling costs and lack of drilling rigs for geothermal energy;
- Lack of new business models to make for instance geothermal district heating economically viable despite the decrease in heating demand;
- Fragmented and very limited support financial support; unfair competition with conventional sources;

The Bank could contribute to overcome or alleviate the above barriers by:

- Exploring innovative financial tools, for instance the possibility of a EU risk insurance scheme for geothermal (see above);
- No longer supporting extraction of fossil fuels (among which gas), their transportation, storage and refining in Europe or in any other region of the World;

Renewable heating and cooling technologies such as geothermal are competitive with a level playing field.

The comparison of cost for heating is very difficult, because numerous factors contribute with their specific impact. To mention a few: type of building, size of building, climatic zone, availability of fuel types, and many more. In the past, the usual method was to compare the price of different fuel types, taking into account their respective energy content (e.g. 10.1 kWh per litre of fuel oil). With modern heating technologies using condensing boilers, heat pumps, or solar thermal energy, this comparison does not make sense anymore. The only way is to calculate the full cost of heat, including the capital cost, energy cost, and operating and maintenance cost for a certain standard building.

For the situation in 2011, ASUE, an association funded by the German natural gas utilities, had commissioned a comprehensive study[7] for different modern heating types for a residential house with 150 m^2 floor area and the up-to-date insulation standards in force in Germany. While the absolute numbers from this study are valid for Germany only, the comparison among the basic systems might be valid for other countries too. The values in the study are given in €/year for the standard building, including all taxes, and take into account storage for hot water

[7] ASUE Ratgeber Wärmeversorgung, 40 p., Arbeitsgemeinschaft für sparsamen und umweltfreundlichen Energieverbrauch e.V. (ASUE), Berlin, 2011

and the heat distribution system; this explains the rather high values when compared with simpler assumptions. In the graph below specific values for such a small building based on the ASUE study are shown. The value for GeoDH was calculated by EGEC by using the ASUE assumptions and replacing only the district heating prices by those of geothermal district heating systems (mean value from 5 DH-suppliers in the Munich area). The variation in natural gas, LPG and fuel oil is due to different amounts of solar heat fed into the systems, in order to comply with the German law on renewable energy for heat (EEWärmeG).

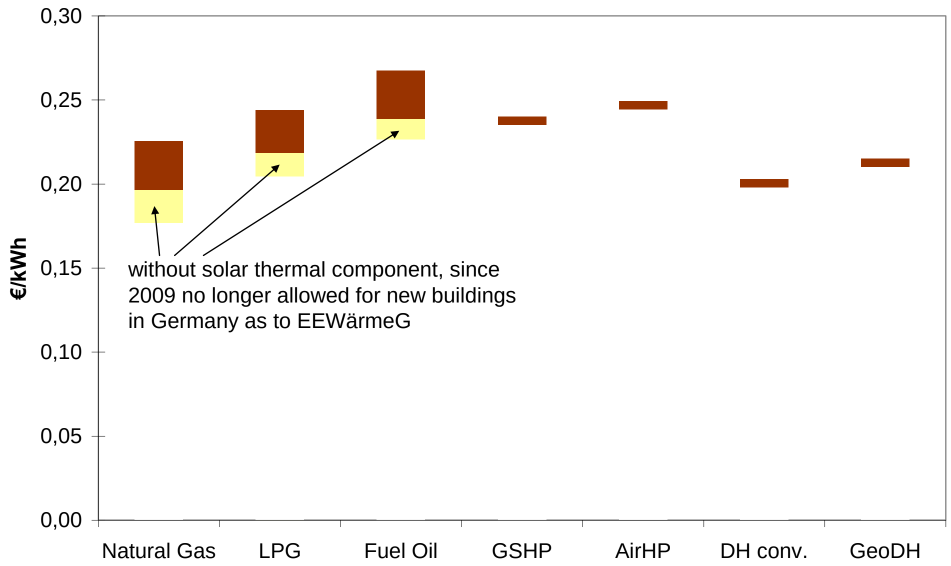

Figure 5: Heat full cost in a modern residential house with 150 m² floor area in Germany in 2011, including all taxes and comprising the heat distribution in the building, after values from ASUE

To better compare the different technologies in a European perspective, values without VAT and without heat distribution and hot water storage where calculated from the data sheets given in the ASUE study. This approach is closer to the simple calculations used for heat cost in many studies, including the cost given in graph 6 in the GSHP section of this market report. The result is given in the graph below. It should be noted that these data are for very small heat demand (about 10 MWh/year) and with German prices, so they might represent the maximum values for heat from the different sources, as larger installations will have a better cost efficiency.

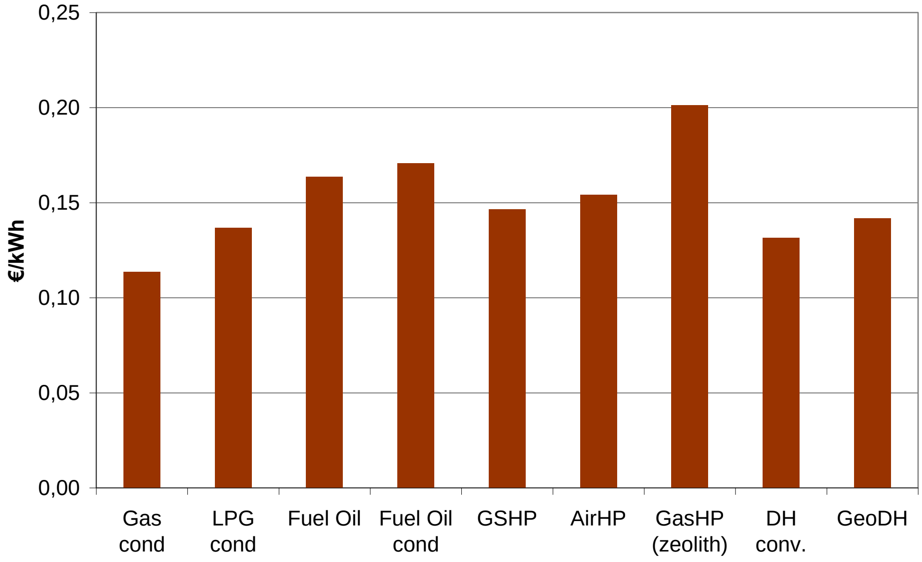

Figure 6: Heat full cost in a modern residential house with 150 m^2 floor area in Germany in 2011, excluding VAT, solar components and heat distribution in the building, own calculation based upon values from ASUE

The ASUE study also gives values for CO_2-emissions from the different heating systems. The graph below shows specific CO_2-emissions, converted from total values with the same assumptions as described before, and not comprising possible reduction by adding solar thermal components. The assumption for geothermal DH is just an estimated 50 % of that of conventional DH, as in GeoDH also peak boilers, production pumps, and circulation pumps are required. In any case, the two geothermal technologies (GSHP and GeoDH) achieve the lowest emissions.

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