Key Issues for Renewable Heat in Europe (K4RES-H)

Contract EIE/04/204/S07.38607

Deliverable 3 : Proposal for a method to set verifiable targets for Geothermal energy at national and European level

This paper presents some ideas to set targets for geothermal energy, and proposes targets for geothermal heating & cooling in 2020.

From the collection of statistics presented in the deliverable 2, we can have a good panorama of the situation for geothermal heating and cooling in 2004.
Now, the proposal is to set targets in order to take all measures needed for this development, notably actions from policy makers are asked.

I) INTRODUCTION

Geothermal heating and cooling is divided into two categories :

- Shallow Geothermal Energy for heating and cooling, ground source heat pumps, 0-400 m deep
  The various shallow geothermal methods :
  - horizontal loops : 1.2 - 2.0 m depth
  - borehole heat exchangers : 10 - 250 m depth (vertical loops)
  - energy piles : 8 - 45 m depth
  - ground water wells : 4 - >100 m depth
  - water from mines and tunnels

- Deep Geothermal Energy for "direct use", heating, cooling, process heat
  400-3000 m deep

Geothermal energy is a promising component of the renewable energy mix in the European Union.

The European Commission's White Paper for a Community Strategy sets out a strategy to double the share of renewable energies in gross domestic energy consumption in the European Union by 2010 (from the present 6% to 12%) including a timetable of actions to achieve this objective in the form of an Action Plan.
The main feature of the Action Plan includes an objective for heat production = 5000 MW_{th}.
Our estimation and compilation of statistics for 2004 results in an installed heat production capacity of 8871 MW_{th} in operation : thus the objectives are yet reached !
In the geothermal sector, with the new member states in Eastern and Southeastern Europe, a substantial area of application and potential for geothermal energy became part of the Union. It is not clear, how this fact had been anticipated in the Action Plan targets; for EU 15, the heating capacity in 2004 summed up to 7529 MW_{th}.

As set by the Directive 2001/77/EC of the European Parliament and of the Council on the promotion of electricity produced from renewable energy sources in the internal electricity market, the overall EU target is to double the share of renewables to 12 % by year 2010 in the gross energy consumption and in particular to achieve a 22.1% indicative share of electricity produced from renewable energy sources. The directive and its amendment due to the Accession Treaty published reference values for each Member State.

Recent Community legislation, such as the Water Framework Directive, the Cogeneration Directive, the draft on heating and cooling, the Buildings Directive and the Thematic Strategy on Natural Resources will have a major impact on the exploitation of geothermal energy, which, however, cannot be quantified or extrapolated by now.

The above facts justify why there was a need for setting verifiable targets for heating and cooling at national and European level.

The methodology will be firstly to make recommendations on how to define targets for geothermal heating and cooling, and secondly to present figures on the market for 2020.
For geothermal energy, It appears more realistic to make recommendations as firstly statistics on heating and cooling need to be more detailed.

Moreover a unified definition of geothermal energy, at national and European level, has to be adopted soon and will be used in each regulations, communications, statistical methodology, prospective…

The EGEC proposal is :
Geothermal energy is the energy stored in the form of heat beneath the surface of the solid earth.

The definition needs to comprise all geothermal energy use, like :

- geothermal heat extracted from thermal water
- the geothermal fraction of ground source heat pumps
- other

If the first goal will be to present good statistics, to have a good view of the present situation for geothermal heating and cooling, the discussion of the perspectives have to be agreed by all the geothermal Community.

For that, a future creation of a Technology Platform will be more than useful.

Indeed, a European Geothermal Energy Technology Platforms could :

- Provide a framework for stakeholders to define research and development priorities, timeframes and action plans in the medium to long term.
- Play a key role in ensuring an adequate focus of research funding
- Address technological challenges that can potentially contribute to a number of key policy objectives.

And, it is clear that the actual market conditions for energy have to be taken into account in all these perspectives for geothermal energy.

II) AN OVERALL METHODOLOGY

1) the present conditions :

The settings of targets imply boundary conditions to be taken into consideration :

- the current status of the geothermal market in the EU-27 (in RES-H energy production per capita)
- the potential of geothermal energy based on a market study and an inventory of the resources in each EU country ; and the market structures (e.g. penetration of district heating)
- achievable growth rates

The methodology has to concern :

- the different applications: DHW, space heating, cooling, process heat, etc..
- the kinds of usage: small residential, large residential, hotels, office buildings, swimming pools, agricultural applications, process heat in different kinds of industries (laundries, food industry, heat intensive industrial sectors ...), desalination, ...

2) recommendations :

The target settings have to take into count different structural elements:
- develop training of architects, heating engineers, construction companies, installers
- rates of new construction in Europe
- distribution chains of geothermal products
- penetration of district heating
- assumptions on technological development able to make innovative applications largely available and/or price reductions
- management of social and economic impact
- technological / market developments

It is recommended to not make projection only based on growth-rate, because for example the GSHP market is yet juvenile in a lot of countries and all conditions are not yet present to make such prospective.
Targets could be defined for specific technology (geothermal heat pumps, district heating, cooling…) ; and for different intermediate period (2010, 2015)

3) the setting :

Concerning heating and cooling from geothermal resources : deep and shallow geothermal, the possibilities of accounting are double :

- the number of dwellings (objective 2010, 2015…)
- the total production in MW_{th}
- for deep geothermal systems, the number of dwellings in condensed regions (those suitable for district heating) and the geological potential (deep aquifers) are limiting factors

The difficulty for experts to determine the exact capacity of low and medium temperature geothermal applications makes the task of forecasting very hard with respect to the production of heat.
However, a low increase of 50 MW_{th} per year until 2010 would bring medium and low temperature capacity up to 4 540 MW_{th} , which seems a lower limit; 100 MWth per year is still a reasonable assumption on a EU-wide scale, which would result in 4 840 MW_{th}.

The situation of very low temperature geothermal energy (geothermal heat pump market) is much more favourable. If the sector is able to maintain an average annual growth rate of 15% of its capacity until 2010 (compared to ca. 14 % from 1995-2005), it could reach 10 700 MW_{th} capacity in 2010.

The combined number of 15 550 MW_{th} is very close to the EGEC target of 16 000 MW_{th} in 2010, and much higher than the White Paper target of 10 000 MW_{th} for 2010.

The new Commission guideline, the "Sustainable Energy Europe" programme, has determined new objectives to be reached between 2005 and 2008, i.e. 250 000 new heat pumps, 15 new electric power plants and 10 new low temperature power plants.

Taking current geothermal heat pump market growth into consideration (25% between 2003 and 2004),the new Commission objective appears to be completely feasible and attainable. Success of these objectives in terms of high and low temperature applications will mainly depend on the results of geothermal drillings that are currently underway and which will trigger investment decisions.

Shallow Geothermal Energy :

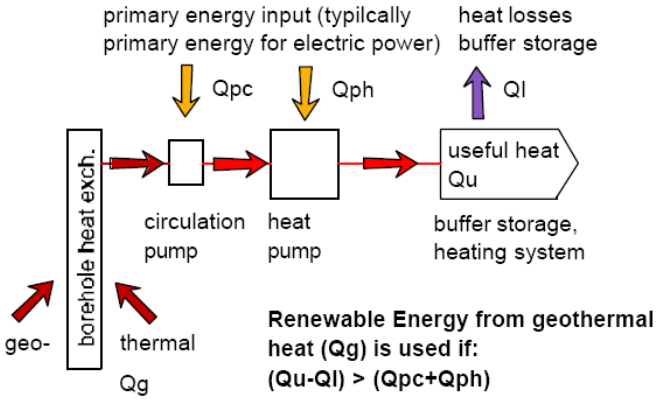
For the geothermal heat pump sector the methodology to set targets is based on an Industry based / supply chain method.

Each EU country has to realise a yearly survey on sales figures. It will permit to know the new installations.
An alternative exists : The licensing process for drilling as measurement of new installations is actually the methodology done in Switzerland with good success, and also in some regions (e.g. in some German states, like in Hessen)

For old installations, we have to compare data from all entities implied :

- national/local authority in charge of licensing – of financing
- the drillers
- the heat pumps companies
- the energy agencies

In a second step, in all ground source heat pump systems (GSHP), there is a basic difference between the heat output to the heating system, and the geothermal heat input into the system (Qg). The auxiliary energy (mainly Qph) is always higher than 5 %, and is typically in the order of 20-30 % of the final energy output. Thus it cannot be neglected.



Calculation of the energy delivery of geothermal systems : EGEC suggestion:

For the purposes of a geothermal energy statistic, however, only the heat from the ground should be considered, and the heat output corrected by the annual average COP. The formula then should be completed as follows:

$$P = Q_{mean} * h_a * ((COP-1)/COP)$$

With :

- P : the annual heat delivery [kWh/a]
- Q_{mean} : the heating capacity (heat output) of the heat pump [kW]
- h_a : the annual operation hours (full-load hours, depending on the climate) [h/a]
- COP : the seasonal mean COP

A specific problems for GSHP is given for the number of sales, in the fact that the different types of heat sources for the heat pump are often not distinguished, so a guess on the fraction of GSHP in the total heat pump sales has to be made. (In Germany, the figures for 2005 show that more than 70% of HP sales are GSHP)

As further steps, the countries need to agree on the methodology of sampling and calculation.
Reliable statistics of the sales numbers should be established in all countries, distinguishing at least the heat sources (groundwater, ground incl. direct expansion) and some capacity classes (e.g. <5 kW, 5-10 kW, 10-15 kW, 15-25 kW, 25-50 kW, 50-100 kW, 100-250 kW, and exact values for those above). For the full-load hours and COP, more monitoring campaigns are required to get sufficient data for extrapolation, and for calibration of methods to calculate the values from climatic data, etc.

The heat pump output and efficiency (COP, or SPF) should be given according to standards EN 255, EN 14511, EN 15450, or other applicable standards of the member states.

Deep geothermal Energy :

For deep geothermal applications, the methodology to set targets cannot be based on the industry supply chain.

For the district heating, industrial applications…we have to collect and compare data from :

- public communication
- public authorities, in particular municipality and region
- geothermal associations
- energy agencies

For agricultural and industrial applications, the drillers could be the good contact to collect statistics.

Because most of the deep geothermal systems are subject to licensing and supervision by authorities (typically on a regional level), these authorities are key information sources for statistics on deep geothermal applications

For the quantification of heat delivery from geothermal district heating plants, we agree with the proposals of the ThERRA-project (slightly adjusted):

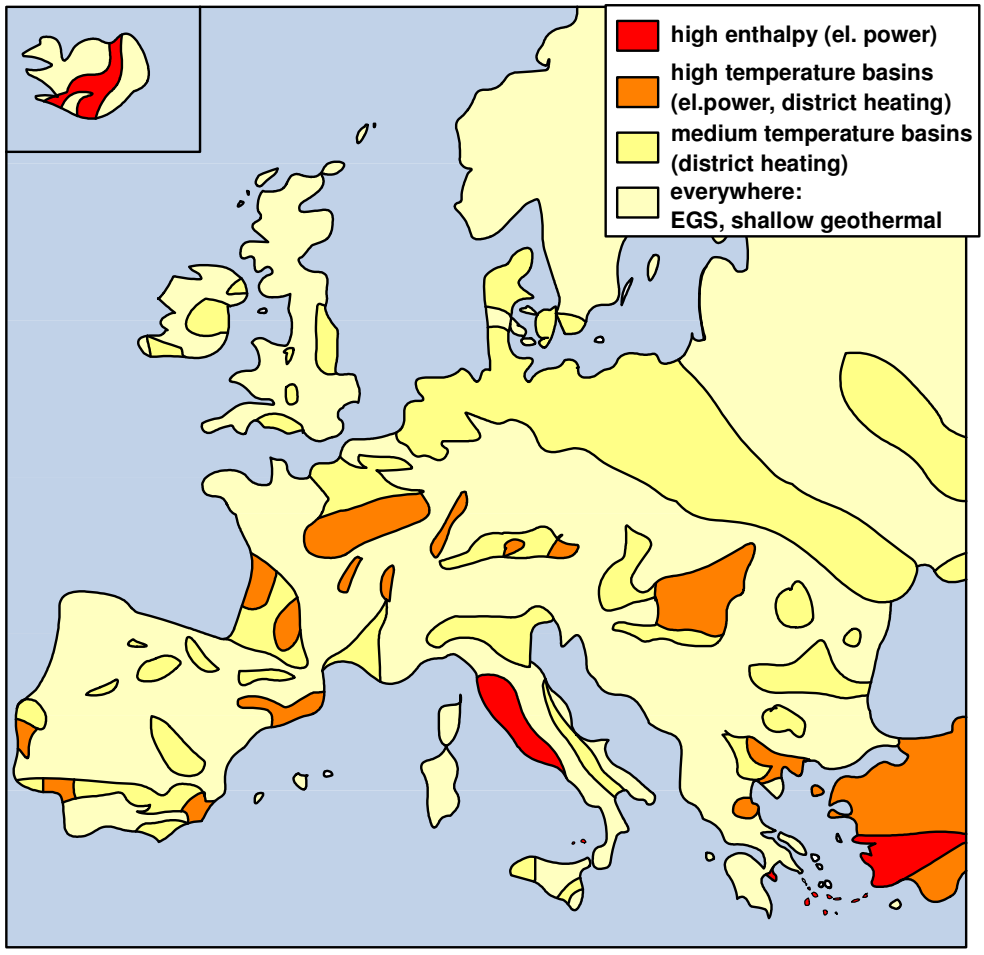
Proposal 1 - Monitoring: Data from monitoring (system temperatures and flow rates as well as efficiency). This is the most preferable method, and should be the standard in any district heating application.

Proposal 2 – plant side estimation: Calculation of the renewable heat output from the nominal, installed capacity (ground), the number of full load hours and the system efficiency. This method can replace proposal 1 for smaller plants (without monitoring), in agriculture etc.; in

general this is the default method for smaller geothermal heat pump plants (shallow geothermal energy).

Proposal 3 – load side estimation: Calculation of the renewable heat from geothermal plants from the demand side. Based on the definition of the number of equivalent households connected to the geothermal plant and considering an average heat demand of these households, the total heat delivered to the households can be calculated. This method only works for district heating networks, and it is the least desirable. In such installations typically a monitoring system should be installed. The accuracy of the estimation is low, in particular in a district heating net with diverse demand structure.

For the forecast and the setting of targets for deep geothermal systems, the geological potential has to be considered in addition to the demand. The demand can be determined by the number of dwellings in condensed regions (those suitable for district heating), and the geological potential by the existence of suitable deep aquifers with sufficient temperature and permeability (see figure below). Methods known as Enhanced Geothermal Systems (EGS), developed currently for geothermal power production (cf. the project in Soultz-sous-Forêts), may allow in the future to increase the geothermal potential to low-permeability areas, too.



Map showing suitable areas for deep geothermal systems in Europe

III) Targets for a geothermal energy development in 2020

Targets up to 2020 :

Geothermal	2000	2005	White paper targets 2010	Target 2020
electricity	3,43 Mtoe	4,786 Mtoe	5,2 Mtoe	8 Mtoe 24 Mtoe [x]
heating & cooling	0,66 Mtoe	1,838 Mtoe	2 Mtoe (3.2 Mtoe)*	5 Mtoe (7.8 Mtoe)*

[x] achievable with specific support mechanisms EU-wide
* after projection EGEC from January 2005; status 2003: 1.9 Mtoe for heating and cooling

MW installed and future potential

Geothermal		2005	2010	2020
Heating & Cooling	WP / Eurostat	8500 MW_{th}	10000 MW_{th}	
	projection EGEC	8850 MW_{th}	16000 MWth *	39000 MWth *

Annual growth rates up to now and expected until 2020

Geothermal	Real growth 1995-2001	AGR (Needed to meet WP targets) 2001-2010	AGR 2010-2020 (straight)	AGR 2010-2020 (accumulated)
Heating & Cooling	3,3 %	11,7 %	15,0 % (14,4 %)*	9,7 % (9,3 %)*

* after projection EGEC from January 2005

For comparison: Ferrara-declaration of EGEC 1999

	1998	**2010**	**2020**
Heat*	920.000 dwellings 5.200 MW_{th}	3.000.000 dwellings 15.000 MW_{th}	12.000.000 dwellings 48.000 MW_{th}
Electricity**	940 MW_{el} 4.300 GWh/y	2.000 MW_{el} 16.000 GWh/y	without support: 3.000 MW_{el} 24.000 GWh/y ecologically driven: 8.000 MW_{el} 64.000 GWh/y

* Deep and shallow resources
** incl. engineered geothermal systems