



The best available statistical data on RES-H for each EU-25 country

(Deliverable 4)

WIP Renewable Energies

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Abstract

The setting of binding and indicative targets is an important step in policy making. The rapid market development and technological advancement of the renewable energy sector in recent years ensured progress on the White Paper targets in the area of electricity and biofuels, where Directives have set concrete targets. Analogous targets for the heating and cooling sector will guide national and local policy makers in their decisions and send important signals to investors and the public.

Nevertheless, setting verifiable absolute targets for RES heating and cooling implies the solution of some statistical and methodological issues. One objective of the K4RES-H project is to tackle these issues and identify the improvements of the EU statistics and to develop recommendations for a methodology to set RES-H targets.

To fulfil these objectives all three technology sectors Solar Thermal, Biomass and Geothermal have elaborated own reports on the available statistics which have been compiled in K 4 RES HEAT Deliverable 2. This report brings the technology related results together and to compile one comprehensive data table for RES Heat generation in Europe which is based on the best available statistics. Furthermore, this report defines remaining weaknesses in the current situation of data compilation and processing and formulates recommendation on how to improve the statistical situation for RES Heat in Europe. In this way Deliverable 4 is an important prerequisite for Deliverable 5 which outlines a concrete methodology on how to set verifiable targets for RES Heat in Europe.

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CHAPTER ONE INTRODUCTION

1 Objectives

Targets represent an important step in policy making. The rapid market development and technological advancement of the renewable energy sector in recent years ensured progress on the White Paper targets in the area of electricity and biofuels, where Directives have set concrete targets. Analogous targets for the heating and cooling sector will guide national and local policy makers in their decisions and send important signals to investors and the public.

Nevertheless, setting verifiable absolute targets for RES heating and cooling implies the solution of some statistical and methodological issues. One objective of the K4RES-H project is to tackle these issues and identify the improvements of the EU statistics and to develop recommendations for a methodology to set RES-H targets.

The outcome of the K4RES-H project enables policy makers to discuss RES-H targets with stronger statistical knowledge and clear methodological proposals on how to set verifiable RES-H targets.

This report is elaborated by WIP, based on the reports provided by ESTIF, EGEC and AEBIOM.

2 Structure of the Report

This report tackles the statistical issues, identifies improvements for RES-H statistics and provides the best available RES-H statistics.

Chapter II of this report introduces common definitions for RES-H sources and RES-H production. Chapter III – V tackles issues and identifies improvements for solar thermal, biomass and geothermal statistics. Chapter VI presents the best available RES-H statistics.

Chapter VII summarizes conclusions and defines recommendations to improve statistics in the RES Heat Sectors.

Recommendations for a methodology to set RES-H targets are given in Deliverable 5 of the K4RES-H project.

CHAPTER TWO

DEFINITIONS OF RES – HEAT

For the purpose of the K4RES-H project common definitions for the sources for RES-H and RES-H production were elaborated by the project partners. The definitions follow as closely as possible the EUROSTAT / IEA definitions and search conformity with the EC legislation (e.g. RES-E Directive). Only where these definitions are not in line with the project objectives own definitions have been taken.

1 Definition for RES – H Sources

Renewable Heat is thermal energy generated from renewable non-fossil energy sources:

- **Solar Energy:** Solar Energy is the active conversion of solar radiation into thermal energy. Passive solar systems are excluded in the K4RES-H project.
- **Biomass** means the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste. (Details of the biomass definition are given in Annex 1)
- **Geothermal Energy** is energy in form of heat beneath the surface of the solid earth. This definition includes direct uses and geothermal - ground source heat pumps (GSHP). Ambient air heat pumps are excluded in the K4RES-H project. (Details of the geothermal definition are given in Annex 2)

2 Definition for RES – H Production

In the K4RES-H project the RES-H production means the **total amount of produced renewable and useful heat**¹. This definition comprises the following specifications:

- The heat is measured directly after the conversion which means that all storage and transfer issues are neglected. Biomass is measured after the combustion, solar thermal after the collector and geothermal after the heat exchanger (direct system) or after the heat pump.
- Auxiliary energy supply within the conversion process is only considered when being a considerable amount (suggestion for more than 5 %). It is expected that only Heat Pumps will find consideration as auxiliary systems.
- The energy used to produce and transport biomass shall not be considered.
- For Solar Thermal the technically produced energy will find a corrective by a general assessment of the energy consumption in the specific application (e.g. one – family house).
- Heat produced for sale as well as for the own production is recognized (the IEA differentiation between “public producer” and “autoproducer” is neglected).
- In cogeneration only the total amount of useful heat demand is considered as it is defined in the EC Cogeneration Directive

¹ Note: There is a clear difference between RES-H as defined above and the Eurostat final energy statistics that takes into account the fuels for heat without taking into account the conversion efficiency. Therefore the figures for RES-H will not be comparable with existing Eurostat statistics. That is also a reason why both biomass for heat and bioheat are important.

CHAPTER THREE

SOLAR THERMAL - BEST AVAILABLE STATISTICS

1 Analysis and Evaluation of Available Statistics

1.1 Existing Statistics

The solar thermal statistics in Europe stem from very different sources, use different definitions of solar thermal and are generally of varying quality in terms of (assumed) accuracy. Even the data available at European level (e.g. Eurostat, Eur'Observer, ESTIF, IEA-SHC) show considerable variations, often due to different definitions and methodologies used.

1.2 Raw Data collected

Until today, the raw data collected does not refer to the total amount of energy produced by solar thermal technologies, but typically to absolute size of the solar thermal collector area.

Differences in the raw data most often stem from the use of different sources i.e. from different persons or organisations collecting and aggregating the data and their different methodologies.

The most typical reasons for differences are:

- Inclusion or exclusion of unglazed collector
- Survey based data collection versus expert based data.

A Variations in the used definitions

Most obviously, solar thermal statistics depend very much on the definitions used.

While some solar thermal statistics include all active solar thermal technologies (glazed and unglazed collectors) others only show data for glazed collectors. Unfortunately, some statistics do not explicitly state what the data refers to. And although glazed collectors make up the largest part of the market in Europe, there is a considerable market for unglazed collectors, which are typically used to heat the water of swimming pools.

There is a particularity, which leads to the IEA's massive under- assessment of solar thermal energy in their publication 'Energy Statistics of OECD Countries. 2002-2003': In these statistics, the IEA only consider solar thermal energy, which was used in the "Transformation Sector". This means that only that part of the solar thermal energy was counted that was fed into a (district) heating grid. This excludes 99.8% of the solar thermal energy production, which is consumed domestically – without feeding into a grid. As it is the only place where solar thermal energy is shown in that publication, it gives the impression, that this energy source is absolutely negligible. Other IEA publications, namely the annual Renewables Information show a more complete picture of the market.

B Variations in the data collection strategy

In several countries, the “official” data (i.e. those published by national statistics offices, energy agencies, ministries etc.) are based on surveys of solar thermal companies active in that country (manufacturers or importers). These surveys are carried out by solar thermal associations or governmental agencies. The accuracy of this data depends on the knowledge and coverage of the market – e.g. have all relevant companies been identified? How many of those have answered to the survey? Not to forget the truthfulness with which the survey was answered. For different reasons, companies may have a reason to under- or overstate their own sales figures, especially where the raw data is expected to become public.

Other statistics are based on the estimations of one or several market experts. The accuracy of those statistics depends on the good knowledge and honest estimation of the expert.

1.3 Different assumptions in respect to the installed systems

A typical source for deviations between different statistics for the same country is due to a different concept of counting cumulative installed capacity versus capacity in operation.

A Cumulative installed capacity

Those statistics typically add all solar thermal capacity (either expressed in square metres of collector area or in kW_{th} of installed capacity) installed in the past. The market data for the latest year (newly installed capacities) is added to the total cumulative capacity. This, however, does not take into account that any heating system is replaced at some point in time. Thus the concept of cumulated capacities overstates the really existing capacities.

B Capacity in operation

The second concept, based on capacities in operation, provides a more realistic picture. It is based on an assumed life expectancy of the solar thermal systems or on (regular) surveys of heating systems in buildings. So far, only the assumed life expectancy has been used in solar thermal statistics: In the 2003 study ‘Sun in Action II – A Solar Thermal Strategy for Europe’, ESTIF introduced this concept by assuming a life expectancy of 20 years for solar thermal systems installed since 1990 and of 15 years for older systems. While typical solar thermal systems today could work for much longer than 20 years, it is safe to assume that even a share of the working systems are replaced or decommissioned at some point, e.g. because the building they were built into was torn down, because the use of the building changed, making the solar thermal system superfluous, or because the roof was refurbished without putting the existing solar thermal collectors back in place.

Based on the ESTIF assumptions, systems installed before 1990 are not “in operation” anymore. As in most European countries, as most of the installations took place after 1990, this assumption does not make a big difference in the final data today. However, in a few countries such as Greece or Cyprus, many solar thermal systems were already installed in the 1980s. In ESTIF’s statistics these installations are not included anymore, while others still count them in. For example: For Cyprus, the data of IEASHC are based

on the cumulative capacity, showing 514 MW_{th} of installed capacity. ESTIF on the other hand shows a capacity in operation of 315 MW_{th}.

1.4 Aggregation and conversion of raw data to energy output

The existing statistics show a different level of detail. While some of them explicitly highlight installed capacities of flat plate collectors, vacuum tubes or unglazed collectors, others show only aggregated and/or converted data. E.g. Eurostat does not directly publish solar thermal energy production. Instead the publication 'Energy: Yearly Statistics' gives the primary solar energy production. The solar thermal energy production must then be inferred by subtracting the given electricity production of photovoltaic modules.

Aggregations and conversions of data sometimes make it difficult to understand the reasons for differences between different statistics.

A Conversion from m² to kW_{th}

The conversion factor from square metres of collector area into kW_{th} of solar thermal capacity has been generally accepted to be 0,7 kW_{th}/m² (for details see the information at www.iea-shc.org or www.estif.org). This number gives the installed nominal capacity (similar to the peak capacity of photovoltaic modules). In many statistics, the nominal capacity more and more replaces the old collector area. Even the IEA has announced that kW_{th} should be used from 2007 onward as the unit for solar thermal statistics.

B Conversion from m² to kWh

Several energy statistics report the energy production from solar or solar thermal. However, since a generally accepted conversion methodology does not exist yet, each statistic and country often uses a different methodology.

Differences stem from different definitions as well as from different assumptions. The definitions for solar thermal energy range from the solar thermal irradiation meeting the collector surface (primary energy used) to the (conventional) energy saved by solar thermal. Eurostat and IEA use the concept of collector output, i.e. the energy that is available after the conversion of the sunlight in the collector. But even that assumption can be interpreted differently: Some statistics use the output as calculated based on the collector performance in the European norm EN 12975. Others calculate the energy production of the collector as if it was built into an existing system (with parameters different from the test procedures).

A calculation of the Eurostat data shows that the annual energy production of one square metre of collector area was assumed to be 451 kWh/(m²*a) in Germany but only 357 kWh/(m²*a) in Austria, although both countries use very similar technologies and applications. In Belgium this factor would be as high as 1600 kWh/(m²*a), which is physically impossible.

1.5 Conclusions of the problem

The biggest differences between statistics are due to two reasons:

- Different raw data (due to different collection methods or varying methodology and definitions)
- Different aggregation and conversion methodologies

The existing statistics approach solar thermal in different ways, sometimes with very heterogeneous results. In many cases it is not a question of high or bad quality of the data, but rather a question of definitions and methodologies used. Differences between statistics for the same country thus do not mean that one is right and one is wrong. Rather they show different views of solar thermal energy production.

This poses a problem when comparing different statistics/countries: 100 GWh of solar thermal energy may have different meanings in statistic X and statistic Y.

2 Compilation of best available statistics for EU 25

The following table summarises the best available statistics for Solar Thermal heating in Europe. The energy production is based on a weighted average for Europe, based on data of the International Energy Agency's Solar Heating and Cooling Programme (IEA-SHC) but adjusted for the K4RES-H methodology.

	Glazed Collectors			
	m ² newly installed in 2005	kW _{th} newly installed in 2005	kW _{th} in operation	toe energy production in 2005
AT	233.470	163.429	1.623.271	99.715
BE	20.234	14.164	47.938	2.945
CY	50.000	35.000	350.140	21.509
CZ	15.550	10.885	46.130	2.834
DE	950.000	665.000	4.587.800	281.822
DK	21.250	14.875	235.886	14.490
EE	250	175	574	35
ES	106.800	74.760	369.016	22.668
FI	2.000	1.400	9.786	601
FR	121.500	85.050	276.920	17.011
GR	220.500	154.350	2.133.040	131.030
HU	1.000	700	3.675	226
IE	3.500	2.450	7.553	464
IT	72.000	50.400	361.400	22.200
LT	500	350	1.505	92
LU	1.900	1.330	9.380	576
LV	1.000	700	1.855	114
MT	4.000	2.800	13.552	832
NL	20.248	14.174	212.629	13.062
PL	35.000	24.500	96.264	5.913
PT	16.000	11.200	112.665	6.921
SE	22.621	15.835	145.873	8.961
SI	4.800	3.360	71.680	4.403
SK	7.500	5.250	44.975	2.763
UK	28.000	19.600	137.844	8.468
Total EU-25	1.959.623	1.371.736	10.901.350	669.654

Table 1 Best available statistics for Solar Thermal in Europe

The “in operation” capacity is calculated based on an assumed lifetime of 20 years (15 years for systems installed before 1990). Most current systems will last longer than 20 years, but individual systems can have a shorter lifetime for reasons such as demolition or change of use of the buildings.

3 Recommendations to improve quality of statistics

It is desirable that (solar thermal) energy statistics are harmonised at least in their definitions and methodologies. This would make the specific statistics comparable and transparent and would help in setting European solar thermal targets broken down by country.

There are several ways in which solar thermal statistics should be improved.

A Improvement of the data quality

- Improvement of data collection

In all countries in which no national register of solar thermal systems exists (“what is where installed and in operation?”), data collection should be based on:

- Surveys of solar thermal manufacturers/importers, which are done in co-operation with the relevant national trade association and which keep the individual data confidential
- Data obtained from financial support schemes at national level, if they are generally believed to cover most of the solar thermal market (i.e. only few installations are done, which do not receive these financial incentives)
- Ideally, the two methods are used together in order to cross-check the data and to fill potential information gaps.

- Non-inclusion of old systems, which can be assumed not to be in operation anymore

Statistics which do not foresee that old systems are decommissioned at some point in time will show less and less realistic figures. ESTIF strongly recommends using a uniform assumption on the usage time of solar thermal systems: Due to various reasons, solar thermal systems are decommissioned after 20 years (15 years for systems that were installed before 1990). This means that systems installed before 1990 are not included in today’s data of solar thermal systems in operation.

B Improvement of comparability of statistics

Furthermore, it would be highly desirable to come to a more harmonised approach when aggregating and converting the raw data. This is not so much a recommendation for improvement of the individual statistics but for making different statistics more comparable.

- Inclusion of all active solar thermal systems

For many reasons, ESTIF and others have only included in their statistics those systems which are water-based and use glazed collectors. Although these systems represent the large majority of the market and systems in operation, it is desirable to include all active

solar thermal systems. This would include systems which use unglazed collectors (typically for swimming pool heating) or air collectors.

- Unified definition of solar thermal energy production

Energy statistics are gaining importance at national and international level. In order to facilitate the comparability of different (country's) statistics, it is important that the growing use of solar thermal technologies is represented based on comparable definitions.

ESTIF recommends that for statistical purposes solar thermal energy should be defined as the energy output of the collector under conditions of a real (reference) system.

- Unified conversion methodology (from m^2 or kW_{th} into kWh)

The approach mentioned above allows for a formula, which is both reasonable (science-based) and simple. The European countries and regions could use individual factors to accommodate for different climatic conditions and reference systems. ESTIF is currently in the final phase of agreement with IEA-SHC and other experts on such a unified methodology.

CHAPTER FOUR BIOMASS - BEST AVAILABLE STATISTICS

1 Analysis and Evaluation of Available Statistics

A first important remark on terminology is essential to differentiate bioheat and biomass for heat.

- Biomass for heat/cogeneration: biomass as primary energy used to feed a conversion process aiming at producing heat or cogeneration
- BioHeat: final heat produced by a conversion technology

This distinction is important because the efficiencies of installations might range from a few percents (open fire) up to more than 90% (automatic systems).

1.1 Existing Statistics

The following major statistics for Biomass exist at European level :

- Eurostat
- European Commission
- IEA
- EurObservEr (wood & biogas)

Other sources are available especially from specific IEE projects (EUBIONET, Pellets for Europe, Boosting Bio, etc.).

National statistical offices are also appropriate sources of information as well as targeted associations (district heating, pellets, biogas).

A EUROSTAT

These official data are originating from national statistical bodies and do include several types of products like biomass and wastes, wood and wood waste and biogas (also municipal solid waste that includes part of biomass, but not specified). The main problems are the following:

- It is not clear if the data for biomass based district heating include cogeneration or refers to “heat only” applications.
- The indicator input to conventional and public power stations do not mention any cogeneration and can hardly be used.

B European Commission

European Commission statistics are given for EU25 countries defined as biomass for heat. However no detailed data is given regarding the source of the information, the way it is gathered and the types of biomass covered, etc. Eurostat is the main source of information

and we can assume that biomass for heat is obtained by taking the biomass primary production and by deducing the biomass for electricity and liquid biofuels.

Biomass for cogeneration is not included as it is part of the biomass for electricity figures. This generates confusion as bioheat will be included in the framework of biomass for electricity statistics.

C International Energy Agency

IEA statistics are given for some member states, as gross heat production, for heat only or CHP applications and for each of these with three categories: municipal solid waste renewable, solid biomass, biogas.

In the principles used for statistical collection IEA admits that the division into renewable and non renewable municipal waste is often based on estimates and national data are of bad quality in this respect. To the same extend data sources for non commercial biomass are not complete.

For many countries it was found that IEA statistics for heat are far below the statistics provided by Eurostat. Maybe this is due to the terminology that is not similar as for Eurostat. Gross heat is mentioned but without a clear definition (at least for AEBIOM). Does gross heat mean biomass (or fuels) for heat purposes?

D EurObservEr – Wood energy

These statistics are given for EU15 and Poland. They consider wood energy as primary energy source. The distinction between electricity and heat is only globally mentioned (83,4% for heat and the rest for electricity). This is a main constraint as the various wood routes have a strong impact on the final energy, and particularly heat. Therefore the global figure of wood consumption cannot be used at all to evaluate biomass for heat.

In addition, sources of information remain hard to find.

E EurObservEr – Biogas

Theses figures are given for crude biogas and final heat production (bioheat).

Bioheat figures can be used in the framework of this project, taking into account that this figure cannot be assimilated with the biomass for heat figures.

F Other sources

For some countries national detailed statistics are available (Germany, Austria, Sweden for example). Associations dealing with specific bioenergy areas (biogas, pellets, boilers, district heating, cogeneration, etc.) do also have statistics for a part of the bioheat market. (for details please refer to the detailed report from AEBIOM in deliverable D2).

The statistics at EU level are giving a broad image of the biomass for heat picture. However aggregated data are extremely difficult to compare and to comment. Therefore

national sources of statistics are needed that are focussed on specific bioenergy areas (biogas, pellets, boilers, district heating, cogeneration, etc.).

1.2 Conclusions

AEBIOM faced a lot of difficulties to treat and compare the various sources of statistics. Establishing reliable statistics for the biomass sector is definitely not an easy task. Figures from different sources are often hardly comparable because of different categories of biomass and classification systems. For some countries however (Austria, Germany, Finland and Sweden) statistics from several agencies or associations are sufficient to reach a reliable estimation.

The main deficits are:

- The data are generally not complete for all sectors and sub-sectors. The global figures for all biomass for heat are vague, probably reached through broad assumptions, and cannot be considered as reliable. The figures for biomass for heat, electricity and/or cogeneration sometimes are not documented with the required differentiations.
- The data do not refer to the same type of biomass (waste included or not)
- The data are not classified the same way. Sometimes the primary criteria is the type of biofuel - forest wood chips, industrial wood waste, etc. Sometimes it is the type of use - households, collective, industries, etc.
- The terms are not defined clearly (what gross heat production means in IEA statistics?)
- MSW incineration has a large potential and is an increasing source. Main difficulty is the determination of the renewable fraction of the energy content of MSW.
- A major source of renewable heat is combustion of wood in private households. But the statistics for this source are poor and a lot of wood is combusted with a low efficiency.

2 Compilation of best available statistics for EU 25

As explained above the collection of data on biomass for heat is not easy. An attempt of summary is given below for the year 2004. Here AEBIOM takes the best available figures out of the tables for each country. The table is a result of some Eurostat and various other sources. For some countries medium and large scale is underestimated because of the lack of data (only district heating is available with Eurostat).

ktoe	Small scale individual heating systems for households			Medium and Large scale boiler			CHP					Total		
	biomass for heat	Efficiency	bioheat	biomass for heat	Efficiency	bioheat	biomass for CHP	Efficiency for heat	Efficiency for electricity	bioheat	Bio-electricity	biomass for heat and CHP	overall efficiency	bioheat
Austria	1420	69%	980	655	80%	524	835	55%	25%	459	209	2.910	67%	1.963
Belgium	188	50%	94	191	80%	153						379		247
Cyprus	0		0			0						0		0
Czech Republic	466	50%	233	13	80%	10	125	40%	25%	50	31	604	49%	293
Denmark	485	50%	243	478	80%	382	844	40%	25%	338	211	2.030	47%	963
Estonia	337	50%	169	88	80%	70	26	40%	25%	10	7	573	0%	
Finland	1.120	70%	784	450	85%	383	5190	60%	30%	3.114	1.557	6.760	63%	4.281
France	7325	40%	2.930	1422	80%	1.138	1276	40%	25%	510	319	10.023	46%	4.578
Germany	4.130	63%	2.602	740	78%	577	2140	22%	27%	471	578	7.010	52%	3.650
Greece	702	50%	351		80%	0	8	40%	25%	3	2	710	50%	354
Hungary	496	50%	248	3	80%	2	22	40%	25%	9	6	521	50%	259
Ireland	43	50%	22		80%	0		40%	25%			43		22
Italy	3.235	40%	1.294	1.536	85%	1.306	297	78%	20%	232	59	5.068	56%	2.832
Latvia	696	50%	348	278	80%	222	3	40%	25%	1	1	977	59%	572
Lithuania	432	70%	302	95	85%	81	9	50%	30%	5	3	536	72%	388
Luxembourg	15	50%	8		80%	0		40%	25%			15		8
Malta		50%	0		80%	0		40%	25%			0		0
Netherlands	223	50%	112		80%	0	177	40%	25%	71	44	400	46%	182
Poland	2469	50%	1.235	25	80%	20		40%	25%			2.494		1.255
Portugal	1158	50%	579		80%	0	922	40%	25%	369	231	2.080	46%	948
Slovakia	31	50%	16	7	80%	6	186	40%	25%	74	47	224	43%	96
Slovenia	324	50%	162	9	80%	7	84	40%	25%	34	21	417	49%	203
Spain	2019	50%	1.010		80%	0	780	40%	25%	312	195	2.799	47%	1.322
Sweden	1.101	65%	716	6.552	85%	5.569	360	50%	30%	180	108	8.013	81%	6.465
United Kingdom	226	50%	113	59	80%	47	176	40%	25%	70	44	461	50%	231
EU25	28.641	51%	14.547	12.601	83%	10.498	13.460	47%	27%	6.313	3.671	55.047	57%	31.108
Biomass for heat only	41.242													

Table 2 Best available statistics for Biomass (for 2004, in ktoe, thousands of ton oil equivalent)

It should be noted that when using Eurostat we can define biomass for heat figures by taking the biomass as primary energy and by deducing the input to conventional thermal power stations and liquid biofuels. This is shown in the table below. We obviously have different figures in comparison with the table above but the reliability of the data is questionable.

Biomass for heat based only on Eurostat (for 2004, in ktoe)

ktoe	Biomass and wastes - Primary production	Input to conventional thermal power stations	Liquid biofuels	Biomass for heat
EU 25	71.898	21419	1.982	48.497
BE	913	601	-	312
CZ	1.324	315	54	955
DK	2.154	1207	62	885
DE	9.367	3607	936	4.824
EE	685	4	-	681
EL	953	32	-	921
ES	4.853	1149	135	3.569
FR	12.007	1878	375	9.754
IE	214	22	-	192
IT	3.145	1998	286	861
CY	5	0	-	5
LV	1.866	39	-	1.827
LT	706	9	4	693

LU	59	43	-	16
HU	860	234	-	626
MT	-	0	-	-
NL	2.175	1794	-	381
AT	3.452	656	51	2.745
PL	4.126	208	23	3.895
PT	2.877	397	-	2.480
SI	470	29	-	441
SK	385	31	13	341
FI	7.556	1976	-	5.580
SE	8.883	2838	34	6.011
UK	2.863	2352	8	503

Table 3 Biomass for heat statistics from Eurostat

3 Recommendations to improve quality of statistics

For future statistics AEBIOM suggests to define as much as possible the source of the information and how it has been collected, the type of biomass considered and sub-sectors.

A Cogeneration

A special notice has to be made for cogeneration. This sector is classified by the Commission within biomass for electricity (in the Biomass Action Plan for example), what should be avoided in future. In addition it makes no sense to add biomass for heat and biomass for cogeneration, so it has to be treated separately (see below). This was not the case for example for the EurObservEr data that, as a consequence, cannot be used for reliable statistics in terms of biomass for heat.

B Biomass for Heat versus Final Heat

This brings the reflection to the final heat. The most important objective for bioenergy is to replace as much fossil fuels as possible to increase our energy independence. The goal is not to use as much biomass as possible for heat, cogeneration and electricity.

The final energy production has to be considered. Therefore it is recommended to use a clear terminology:

Input	Output
Biomass for heat	bioheat
Biomass for cogeneration	bioheat and bioelectricity
Biomass for electricity	bioelectricity

Table 4 Suggestion for a clear terminology for bioheat

The same terminology should be used in all member states, especially within the national action plan.

C Better Classification of the Sectors and Sub-sectors

A better classification of the sectors and sub-sectors is of primary importance to calculate bioheat. AEBIOM suggests to include for each item a classification that is detailed enough especially regarding the type of biomass and type of conversion process (because efficiency differences are involved). Such classification will avoid general aggregated figures that cannot be considered as reliable without detailed explanations.

For small scale and domestic systems collective figures should be avoided because of the large variety of biomass use (e.g. log wood stoves have nothing to do with pellet boilers in terms of quantity of biomass and efficiency). The classification used by the Institute for Energy and Environment in Germany is quite detailed for small scale with the following categories:

1. Wood logs
 - 1.1. stove heating (as main heating system)
 - 1.2. wood/coal burning stove
 - 1.3. tiled stove
 - 1.4. open fire
 - 1.5. additional stove
2. Wood central heating system
3. Chips boiler
4. Pellets stoves/boilers

D Special Attention to Private Households and Specific Statistics for Pellets

A major sector of renewable heat is combustion of wood in private households. But the statistics for this sector are poor, mainly because a large part of the biomass is not traded. Furthermore, the bioheat in this sector is difficult to be analysed because a lot of wood is combusted with low efficiency.

For this reason special attention should be put on the private household sector. In this respect it is also important to differentiate between the different biomass sources and to give especially a strong focus on the pellets sector.

The questionnaire of Eurostat should be adapted according to the above principles.

CHAPTER FIVE

GEOTHERMAL - BEST AVAILABLE STATISTICS

1 Analysis and Evaluation of Available Statistics

1.1 Existing Statistics

There are three major statistics for Geothermal Energy:

- Eurostat
- EHPA (European Heat Pump Association)
- WGC (World Geothermal Congress, organized by International Geothermal Association)

Euroserv'ER compiled different sources of information, and notably data from the World Geothermal Congress. It does not add new or more reliable data.

A Eurostat

In June 2006, Eurostat published the 'Energy: Yearly Statistics' with data from 1999-2004 for geothermal energy as total primary energy (heat), as (heat) input into heat and power production, and as final energy use in form of heat (non-electrical use). The differentiation between the two latter categories is not very clear and seems not to be consistent.

EGEC assumes that the inconsistencies are a consequence of different national statistics forming the basis of Eurostat data. For geothermal, the direct use mainly is considered only, because this technology is typically used in larger district heating networks, where measurement and reporting is mandatory.

Ground source heat pumps (GSHP), in the contrary, are not considered in all countries but Germany (where the data seem to be derived from sales numbers and estimation). For Italy, Portugal and Spain the exclusion of GSHP is obvious, but could not be verified.

As a conclusion, Eurostat provides good data for heat production from geothermal direct use for 13 out of the EU 25 countries: Austria, Belgium, Denmark, France, Germany, Greece, Hungary, Italy, Poland, Portugal, Slovak Republic, Spain and UK. In addition data were provided for the total geothermal heat use for Germany (however, apparently with a definition not consistent with the K4RES-H definition above).

B EHPA (European Heat Pump Association)

EHPA collects each year (sales) statistics from their national associations, which collect data from the manufacturers. If there is no national association or no response, EHPA has to estimate the data. FIZ Karlsruhe and the EHPA are in charge of this survey.

All heat pumps in the fields water / water, brine / water, and direct expansion / water can be GSHP and thus use geothermal heat.

As a conclusion, the EHPA statistics is good for new installations in 15 out of the EU 25 countries, 7 of which provide very reliable data (Austria, Estonia, Finland, France, Germany, Netherlands and Sweden). A problem exist in the exact distinction between GSHP and other heat pumps using surface water, sewage water, waste heat, etc. Also, with only the new sales considered, the EHPA statistics cannot directly serve as a basis for calculating the annual geothermal heat production from GSHP.

C WGC 2005 (World Geothermal Congress)

The International Geothermal Association (IGA) organises every 5 years a World Congress. The latest event was held in Turkey in April 2005. For this event every country is expected to report about the national market developments. Unfortunately, not all countries responded to this request in a similar manner. In some cases, with the help of the extensive IGA knowledge and international experiences, reasonable estimates could be made of the various uses, especially for geothermal heat pumps, and bathing and swimming pool heating. In the country update paper reference often had to be made to other publications. Sometimes, the reports from WGC 2000 were just utilized and updated partially.

In the WGC 2005 collection, data refers to the installed capacity (MWt), to the annual energy use (TJ/yr and GWh/yr) and to the capacity factor. The data mainly are valid for 2003/2004. Through this work, the European level of direct use of geothermal energy can be reviewed, updating the previous surveys carried out in 1995 and 2000. An effort was made to include and quantify GSHP data.

As a conclusion, the WGC 2005 data have the widest coverage of technologies and countries (20 out of the EU 25 countries). A drawback is the fact that this survey is made only every 5 years, and not for a given year exactly (ca. 2003-2004). Also the quality of the data and the basis of the sample are varying. However, in most cases sufficient explanation is given in the related country papers which are part of the survey.

1.2 Raw Data collected

Typically, the raw data collected for geothermal heat pumps do not refer to the energy produced by geothermal application, but to the number of installations.

A Different definitions and methodologies

Unfortunately there is no standard international terminology in use throughout the geothermal community as this would facilitate mutual comprehension:

- some statistics (e.g. EGEN) distinguish the geothermal heating and cooling production with heat pumps from the other direct heat use applications (e.g. EHPA).
- in some statistics geothermal energy is limited to the deep applications only (e.g. Eurostat) excluding (all) heat pumps.

So it is always necessary to look at different sources and to check the basic definition for the specific statistics.

B Different collection of data

The differences between the raw data could mainly be explained by the use of different sources and methodologies associated: estimation from experts or data collection based on a survey. The expert estimations depend on the good knowledge of the situation. The market survey on the other side is representative only if it covers a large part of the market.

Traditionally, direct use of geothermal energy has been on small scale level and was implemented by individuals. More recent developments involve large-scale projects, such as district heating, greenhouse complexes or major industrial use. The problem is to take into account all applications in a country. An important difficulty concerns the spas and bathing-swimming applications.

Many national statistics and the data from International Institutions only refer to geothermal electricity. Until now, they mostly do not consider it relevant to calculate geothermal production for heating and cooling.

In Germany, the working group of energy statistics for BMU started compiling data for all geothermal uses in 2004. The procedure is apparently still under development and fine-tuning.

The geothermal sector is not yet fully structured. National geothermal organisations don't have all data available. So only few Member States, like France and Germany, have national associations which are strong enough to publish data each year.

1.3 Different Assumptions on the base of installed systems

For the district heating plants, a difference between the figures comes from varying concepts of installed capacity versus capacity in operation (see the same discussion in the Solar Thermal sector in Chapter 3)

1.4 Aggregation and conversion of raw data to energy output

As the raw data collected for heat pumps typically do not refer to the energy produced by geothermal application, but to the number of installations. The conversion mainly concerns this sub-sector.

The estimation of the number of heat pumps installations (capacity installed) permits to calculate the energy production:

- with an average capacity (e.g. 5-20 kWth),
- with assuming a seasonal COP (e.g. 3-4)
- and with a number of equivalent full-load hours per year (e.g. 1,800-2,200 h/a)

Information about operating data for GSHP cannot be gathered covering whole countries, but is limited to exemplary monitoring, and to information to be found in papers describing operating experiences for projects with known operating data.

Sometimes, international institutions consider geothermal energy in reporting only geothermal energy that is for direct use. Production (TJ) is then the difference between the enthalpy of the fluid produced in the production borehole and that of the fluid eventually disposed of (re-injection borehole).

According to EGEC the use of heat pumps to extract heat from the air or lakes etc. should not be included in the geothermal statistics.

1.5 Conclusions

Data was collected for 21 countries of the EU 25 (Malta seems not to have any geothermal application, in Cyprus and Latvia the existence of some GSHP cannot be excluded, and in Luxembourg a few GSHP are expected). The quality of statistical data provided from the 21 countries differs considerably.

There is no single source providing all data in good quality for all countries.

- WGC 2005 comes closest to this goal. WGC 2005 covers 20 countries and does not provide data only for 5 countries (Cyprus, Estonia, Latvia, Luxembourg and Malta).
- Eurostat has data only for 13 countries, and mainly for direct use excluding GSHP.
- EHPA gives data on GSHP for 15 countries. Only seven countries can provide reliable statistics (Austria, Estonia, Finland, France, Germany, Netherlands and Sweden).

In general there is a lack of attention to geothermal heating. As in the case of other state-owned territorial commodities, low-resolution, static inventories of geothermal resources and installations are available or being prepared by institutes or geological services, that are not capable of meeting the requirements of neither the investing enterprises nor the licensing environment protection and water management authorities. In some countries not even the data access for the competent agency hosting the geo information and/or the inventory is enforced by the law.

In general, not all direct use applications are reported, and the number of GSHP in heat pump sales figures are not always easy to separate (in some cases only by estimation).

A major problem for Southern Europe countries is to draw a distinction between reversible heat pumps primarily used for heating purposes and air-conditioners with heat pump function. Some million air-conditioners with heat pump function predominantly used for cooling purposes in Southern Europe are disregarded in this statistics.

2 Compilation of best available statistics for EU 25

EU aggregated for Geothermal (Table geo) : 2004

	Medium and low enthalpy				Very low enthalpy (HP)				Total	
	— newly Installed in 2004	— In operation	kW _n in operation (MW _t)	toe energy production In 2004	number of HP newly Installed in 2005	number of HP in operation	kW _n in operation (MW _t)	toe energy production In 2004	kW _n in operation (MW _t)	toe energy production In 2004 (KTOE)
Austria			52	6 000	6 100	30 577	611,5	75 000	663,5	81
Belgium			3,9			5 000	60		63,9	10
Denmark			21,2		4 000		80,4		101,6	10
Finland					5 307	40 000	260		260,0	47
France			291,9	122 000	13 200	49 950	549,5	85 000	841,4	207
Germany			104,6	31 500	25 486	48 662	632,6	108 800	737,2	140
Greece			70,8			319	4		74,8	14
Ireland			0,4		2 300		19,6		20,0	2
Italy			486,6	194 000	13 000		120	19 000	606,6	213
Netherlands					1 891		254		253,5	16
Portugal			30,4		150		0,2		30,6	9
Spain			22,3						22,3	8
Sweden			2 140		61 350	185 531	1 700		3 840,0	860
UK			3	800	750		10	1 600	13,2	2
Czech Republic			4,5		4 000		200		204,5	29
Hungary			690,2			400	4		694,2	190
Lithuania			21,3			200			21,3	11
Poland			67,3		1 465	8 000	109,6		170,9	20
Slovak Republic			186,3				1,4		187,7	72
Slovenia			44,7		50	204	3,9		48,6	17
Estonia					1 085		15,6	3 000	15,6	3
Latvia										
Malta										
Cyprus										
Luxembourg										
Total EU-25			4 241,4		140 144	368 843	4 630		8 871	1 962

Table 5 Best available statistics for Geothermal sources

3 Recommendations to improve quality of statistics

Joint efforts to improve reliability and completeness of data are required. Main emphasis is to be placed on Southern European countries and information concerning the stock of installed systems. In southern Europe, the best solution is to firstly establish organizations to collect each year GSHP sales statistics.

There are several ways in which geothermal statistics should be improved.

More attention to geothermal heating

Institutions like Eurostat and the IEA or the national statistical offices have to pay more attention to geothermal heating and cooling in considering all applications.

Unified and generally accepted definition of geothermal energy

A well designed and generally valid definition of geothermal energy is needed in a relevant piece of Community legislation, e.g. the heating-cooling legislation in preparation.

The definition of geothermal energy is lacking in the *acquis communautaire* and the national practice is diverse - some authorities consider it as a type of energy carried by

thermal waters exclusively - which hampers the distribution of most up-to-date technologies using shallow depth reserves via heatpumps or deeper closed-circuit heat-exchanger fluids.

EGEC recommends that geothermal energy should be defined as the energy in form of heat beneath the surface of the solid earth, in all data collection.

Unified conversion methodology

An important topic concerns the adoption of a unified conversion methodology for geothermal installations and notably heat pumps (GSHP). For GSHP, also a unified approach to count only the heat from the ground and to exclude the auxiliary power from the supply values should be found.

To conclude, we need an EU-wide harmonised methodology to convert data into energy units, and to increase resources for RES-H statistics at national level and Eurostat/IEA.

Development of Inventories

The development of national dynamic inventories of geothermal energy as to being capable of registering annual changes and allowing country-scale modelling is highly recommended. To make such inventories comparable on a pan-European level a common basic methodology shall be elaborated, preferably via the assistance of Community level professional associations, e.g. EGEC, EuroGeoSurveys.

For the **heat pump** sector, EGEC suggests that each country realises a survey on sales figures. This survey will permit to know the new installations. Moreover for old installations, we have to compare data from all entities implied:

- national authority in charge of licensing or financing
- the drillers
- the heat pumps companies
- the energy agencies

The licensing process for drilling as measurement of new installations is actually the methodology done in Switzerland with good success.

For the **district heating, agricultural and industrial applications** EGEC recommends to collect and compare data from:

- drillers
- public communication
- public authorities
- geothermal associations
- energy agencies

CHAPTER SIX

BEST AVAILABLE STATISTICS FOR RES-H IN EUROPE

Country	Solar Thermal 2005 ktoe	Bioheat* 2004 ktoe	Geothermal 2004 ktoe	Total ktoe
AT Austria	100	1.963	81	2.114
BE Belgium	3	247	10	259
CY Cyprus	22	0		15
CZ Czech Republic	3	293	29	324
DE Germany	282	3.650	140	3.987
DK Denmark	14	963	10	983
EE Estonia	0		3	3
ES Spain	23	1.322	8	1.346
FI Finland	1	4.281	47	4.328
FR France	17	4.578	207	4.797
GR Greece	131	354	14	460
HU Hungary	0	259	190	449
IE Ireland	0	22	2	24
IT Italy	22	2.832	213	3.061
LT Latvia	0	572		572
LU Luxembourg	1	8		8
LV Lithuania	0	388	11	399
MT Malta	1	0		1
NL Netherlands	13	182	16	207
PL Poland	6	1.255	20	1.279
PT Portugal	7	948	9	962
SE Sweden	9	6.465	860	7.331
SI Slovenia	4	203	17	223
SK Slovakia	3	96	72	170
UK United Kingdom	8	231	2	239
Total	670	31.108	1.961	33.538

Table 6 Best available statistics for RES HEAT in Europe

* according to definition in chapter 2.

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

1 Main Conclusion on RES-H Statistics

Most EU countries collect/publish data on renewable energy sources in heating/cooling. Eurostat and the IEA have helped the development of RES-H statistics by proposing common definitions. The available statistics are in most cases sufficient to use them as reference for target setting and monitoring. It lies in the nature of a project like K4 RES HEAT to point out remaining weaknesses of RES-H statistics and to propose how they can be improved in the future. Both of this will be done in the next paragraphs.

A General

There are weaknesses which are shared by all technology sectors, namely:

- Lack of attention
In general there is a lack of attention to RES-H in the statistics. Most countries and international statistics don't report RES-H data separately. The focus of statistics is mostly on renewable electricity
- Different definitions
Most obviously, statistics depend very much on the definitions used. Vast variances in the statistical data are often due to different definitions used.
- Different concepts to collect data
In several countries, statistics are based on surveys of companies active in that country (manufacturers or importers). In other countries statistics are based on the estimations of one or several market experts. The accuracy of those statistics depends on the good knowledge and honest estimation of the expert.
- Different concepts of cumulative installed capacity vs. capacity in operation
A typical source for deviations between different statistics for the same country result from a different concept of cumulative installed capacity vs. capacity in operation.
- Different methodology for the conversion of numbers of installations and installed capacity to RES-H
RES-H in smaller applications is not measured but calculated from statistics of the installed capacity. Different methodologies are used in different statistics and countries.

B Solar Thermal

The biggest differences between solar thermal statistics are due to the following reasons:

- Different definitions
- Different collection of data
- Different aggregation and conversion of raw data
- Conversion from m^2 to kWth
- Conversion from m^2 to kWh

C Biomass

The main deficits for biomass statistics are:

- The data are generally not complete for all sectors and sub-sectors. The global figures for all biomass for heat are vague, probably reached through broad assumptions, and cannot be considered as reliable.
- The data do not refer to the same type of biomass (e.g. waste included or not)
- MSW incineration has a large potential and is an increasing source. Main difficulty is the determination of the renewable fraction of the energy content of MSW. At least MS should apply the same methodology.
- The data are not classified the same way. Sometimes the primary criteria is the type of biofuel - forest wood chips, industrial wood waste, etc. Sometimes it is the type of use - households, collective, industries, etc.
- The terms are not defined clearly (e.g. what does gross heat production mean in IEA statistics?)
- A major source of renewable heat is combustion of wood in private households. But the statistics for this source are poor and a lot of wood is combusted with a low efficiency.

D Geothermal

The main deficits for geothermal statistics are:

- Different definitions
 - some statistics distinguish the geothermal heating and cooling production with heat pumps from the other direct heat use application.
 - in some statistics geothermal energy is limited to the deep applications only excluding (all) heat pumps.
- Different collection of data, e.g. registers, surveys and estimations by experts
- Different aggregation and conversion of raw data

2 Recommendations to Improve Quality of Renewable Heat Statistics

K4RES-H gives the following recommendations to improve the quality of data and the comparability of statistics.

A General

- Special attention to RES-H
In general RES-H requires more attention in the statistics and should be reported separately (especially separately from renewable electricity figures).
- Unified definitions for RES-H sources and RES-H production
Unified definitions will make statistics more comparable and reliable.
- Unified concepts to collect data and development of inventories
The development of national dynamic inventories being capable of registering annual changes and allowing country-scale modelling is highly recommended. To make such inventories comparable on a European level a common basic methodology shall be elaborated with the assistance of professional associations.
- Unified concept for calculation of capacity in operation
K4RES-H strongly recommends using a uniform assumption on the usage time of heating systems. Due to various reasons, heating systems are decommissioned after certain period of time and shall not be considered in the statistics.
- Unified methodology for the conversion of installations to RES-H.
- Transparency in all statistics about the collection methodology for the raw data and the conversion and calculation methods.

B Solar Thermal

For the solar thermal sector K4RES-H especially recommends:

- Development of national registers for solar thermal systems
In the meanwhile surveys of manufacturers/importers should be cross-checked with data from national financial support systems to fill potential information gaps.
- Non-inclusion of old systems, which can be assumed not to be in operation anymore
ESTIF strongly recommends using a standard assumption on the usage time of solar thermal systems, e.g. 20 years for newly installed systems and 15 years for systems that were installed before 1990.
- Inclusion of all active solar thermal systems
ESTIF recommends to include into the RES Heat statistics also systems which use unglazed collectors (typically for swimming pool heating) or air collectors.

- Unified definition of solar thermal energy production
ESTIF recommends that solar thermal energy should be defined as the energy output of the collector under conditions of a real (reference) system.
- Unified conversion methodology (from m² or kW_{th} into kWh)
Development of a formula, which is both reasonable (science-based) and simple. Different countries/regions could use different factors to accommodate for different climatic conditions and reference systems. ESTIF is currently in the final phase of agreement with IEA-SHC and other experts on such a unified methodology.

C Biomass

For the biomass sector K4RES-H especially recommends:

- Usage of a clear terminology and separation of biomass for heat, biomass for cogeneration and biomass for electricity.
- Statistics for Biomass and for Bioheat
The most important objective for bioenergy is to replace as much fossil fuels as possible to increase our energy independence. The goal is not to use as much biomass as possible for heat, cogeneration and electricity. AEBIOM suggests to report statistics for the input and output side, using the following terminology:

Input	Output
Biomass for heat	Bioheat
Biomass for cogeneration	bioheat and bioelectricity
Biomass for electricity	Bioelectricity

- Better Classification of the Sectors and Sub-sectors
AEBIOM suggests to include for each item a classification that is detailed enough especially regarding the type of biomass and type of conversion devices (because of efficiency differences are involved).
- Special Attention to Private Households and Specific Statistics for Pellets
AEBIOM suggests to include into the RES HEAT statistic specific statistics for pellets and biofuels (e.g. vegetable oil, biodiesel, especially for cogeneration) for the future heat market.

D Geothermal

For the geothermal sector K4RES-H especially recommends:

- Unified and generally accepted definitions of geothermal energy
EGEC recommends that geothermal energy should be defined as the energy in form of heat beneath the surface of the solid earth in all data collection. This includes direct use applications and ground source heat pumps.
- Unified conversion methodology
EGEC recommends the development of a unified and generally accepted conversion methodology for geothermal installations and notably heat pumps (GSHP).

- Development of inventories
The development of dynamic inventories of geothermal applications showing annual changes and allowing country-scale modelling is highly recommended. The licensing process for drilling as measurement of new installations is actually the methodology done in Switzerland with good success.

ANNEX 1

Definition for Biomass

The biomass sector comprises the following additional definitions for the biomass subsectors:

- **Solid Biomass:** Covers organic, non-fossil material of biological origin which may be used as fuel for heat production or electricity generation. It should be reported on a net calorific value and comprises:
 - o **Charcoal:** covers the solid residue of the destructive distillation and pyrolysis of wood and other vegetal material.
 - o **Wood, wood wastes, other solid wastes:** Covers purpose-grown energy crops (poplar, willow etc.), a multitude of woody materials generated by an industrial process (wood/paper industry in particular) or provided directly by forestry and agriculture (firewood, wood chips, bark, sawdust, shavings, chips, black liquor etc.) as well as wastes such as straw, rice husks, nut shells, poultry litter, crushed grape dregs etc.
- **Biogas:** A gas composed principally of methane and carbon dioxide produced by anaerobic digestion of biomass, comprising:
 - o Landfill gas, formed by the digestion of landfilled wastes
 - o Sewage sludge gas, produced from the anaerobic fermentation of sewage sludge
 - o Other biogas, such as biogas produced from the anaerobic fermentation of animal slurries and of wastes in abattoirs, breweries and other agro-food industries.
- **Liquid biofuels:** cover the fuels listed below (not exhaustive list) :
 - o Bioethanol: ethanol produced from sugar/starch based biomass;
 - o Biodiesel: a diesel quality liquid fuel produced from vegetable oil plants or used fried oils;
 - o Biomethanol: methanol produced from biomass and/or the biodegradable fraction of waste;
 - o Biodimethylether: a diesel quality fuel produced from biomass and/or the biodegradable fraction of waste;
 - o Biooil: a pyrolysis oil fuel produced from biomass.

Wastes considered as biomass for RES- HEAT production:

- o **Industrial Wastes:** Report under this category wastes of industrial **renewable** origin (solids or liquids) combusted directly for the production of electricity and/or heat. The quantity of fuel used should be reported on a **net** calorific value basis. Renewable industrial waste should be reported in the Solid biomass, Biogas and/or Liquid biofuels categories.
- o **Municipal solid waste (renewables):** Waste produced by households, industry, hospitals and the tertiary sector which contains **biodegradable** materials which are incinerated at specific installations. The quantity of fuel used should be reported on a **net** calorific value basis.

ANNEX 2

Definition for Geothermal

- Direct Use – Geothermal heat is produced at higher temperature levels (above ca. 25 °C), suitable for direct heating. This typically means deeper drillings (>200 m, sometimes several km) and large installations. In some cases heat pumps are installed also in this kind of applications, in order to bring the delivery temperature to desired values.
- Geothermal Heat Pumps (Ground Source Heat Pumps, GSHP) – Geothermal heat is produced at low temperature levels, so generally a heat pump is required to increase the temperature to useful levels. Depth is typically less than ca. 200 m, the size of plants can range from small residential houses to large offices, etc.; cooling often is combined into these types of applications.