AN ESTIMATION OF THE IMPROVEMENTS OF ENERGY EFFICIENCY AND REDUCTION OF GREEN HOUSE GAS EMISSIONS MADE BY A WIDE INTRODUCTION OF GROUND SOURCE HEAT PUMPS IN EUROPE

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"Reaching the Kyoto targets by means of a wide introduction of ground coupled heat pumps (GCHP) in the built environment"

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1 Introduction

Although it has become evident that the use of fossil fuels will have to be reduced not only drastically but quickly, the world is still continuing to increase the use of oil and gas. The alarm clock went off a long time ago, but the developed countries have repeatedly pressed the “snooze button” and continued business as usual. Instead of reducing the use of fossil fuels, the industrialised world has focused on improving and increasing the extraction rate of already scarce resources. Our current use of energy is far from sustainable and will have to be pushed in another direction. International agreements and legislation will have to force nations onto a different path increasing the use of abundant continuously replenished renewable energy and enforce substantial energy conservation measures. The European Union have realised the immediate need for action and have launched several directives putting the member states under pressure to change their use of energy. The energy performance of buildings directive, energy service directive, energy using product directive and the recently launched proposal for a directive on the promotion of renewable energy sources are all examples of legislation pushing the development in a new direction. The future costs of doing nothing will be tremendously higher than the costs of acting now. Those countries that adapt renewable and energy efficient technologies quickly will be able to preserve a high standard of living whereas those countries that don’t will put a lot at risk.

International exchange of knowledge and experience is crucial for speeding up the necessary changes. The Ground-Reach project being part of the Intelligent Energy Europe Programme is one example of broad international collaboration in the field of a very promising renewable energy technology. The results given in this report reveal that a wide introduction of heat pumps reduce the use of primary energy and lead to substantial green house gas emissions reduction while increasing the use of renewable energy. Heat pumps will play a vital role in many member states for fulfilling their national targets regarding the use of renewable energy and the reduction of green house gas emissions.

This report presents estimations of the mitigation of green house gas emissions, primary energy savings and increased use of renewable energy savings that will be the result of a wide introduction of heat pumps. The estimations are the results of calculations based on a methodology that has been developed in within the Ground-Reach project and presented in a previously presented project report (Forsén, Roots, 2007). Whereas the previous report was aiming at presenting the methodology itself, this report is applying the methodology on available statistics in the European Union. Three different scenarios is used for estimating the benefits of a wider use of heat pumps in five countries and EU-25. While determination of the consequences of retrofitting a small number of installations with heat pumps is a fairly easy task it becomes a challenge when the calculations are aiming at describing the consequences for a whole nation.

As in any broad scale energy assessment the results of calculations will be highly dependent on the accuracy of available statistics. Even though heat pumps have been in use for decades and reached a recognisable market share in several countries they are very seldom included in national energy statistics. The need for improvements in energy statistics is highlighted as the lack of reliable and consistent energy statistics will hamper the evaluation of all energy measures that are taken. The results in this report can only be seen as indications of what can be reached when different scenarios are applied to changes in the use of energy.

2 Heat pumps and related data in statistics

Data on the number of heat pumps sold is currently collected by the different national heat pump associations. While the European Heat Pump Association aggregates these data to a EU sales statistic, its coverage and methodological rigor is still limited. Different from the US, where the provision of sales data on (ground surce) heat pumps is mandatory, such data is rarely collected and available in the energy statistics of all EU member states. In addition the approach to collect this data is not unified throughout Europe, data quality can be considered poor.

2.1 Heat pumps in European and international statistics

The joint statistics manual from the International Energy Agency (IEA), the Organisation for Economic Co-operation and development (OECD) and the European statistics office (EUROSTAT) describes heat from air, water and ground as primary energy that is made useful by heat pump technology. Heat provided by heat pumps is secondary energy which is "…produced by transforming electricity to heat in electric boilers or heat pumps" (OECD/IEA 2005, p39) This wording ignores that the predominant share of energy provided by heat pumps constitutes of renewable energy from air, shallow ground and water. In contradiction to recent market developments the authors of the statistics manual still seem to consider heat pumps rarely used, with a contribution to energy supply too small to account for.

However a general approach towards the inclusion of heat from heat pumps exist (Figure 1): New heat will be included in the section on heat production. The electricity portion is counted towards a transformation process. The total output of the heat pump is counted as heat production.

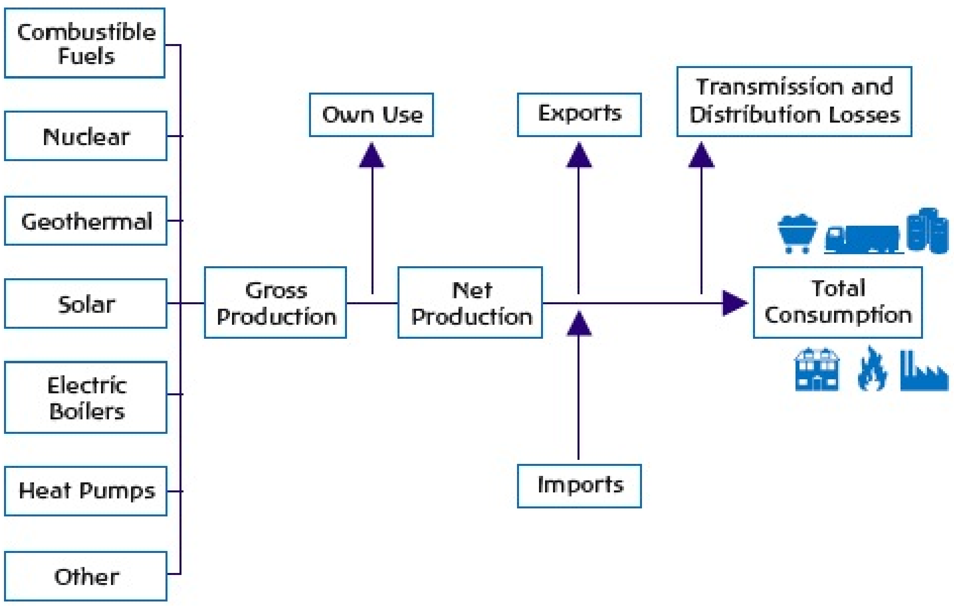

Figure 1: Simplified flow chart for heat (OECD/IEA 2005)

Without further explanation, such heat from heat pumps is currently only taken into account for when the thermal energy output is sold to third parties, e.g. in case of use within a district heating grid. As a consequence the ever increasing share of thermal energy provided by heat pumps is hardly ever taken into account for.

However due to the proposed EU-targets regarding increased use of renewable energy it is being recognised that an agreement on how renewable energy provided by heat pumps shall be taken into account for needs to be established. In addition to this a common agreement on which requirements heat pumps have to meet in order to be taken into account for will have to be defined and agreed upon.

2.2 Building and energy demand data in the European energy statistics

Similar to the lack of data for the number of heat pumps, there is a lack of precise data on the building stock, its energy demand and the energy source used for heating. The most comprehensive document available is the "Housing statistics in the European Union 2004" (Boverket, 2005). Although a version for 2005/2006 exists, this volume, for most data sets, does not provide updated data. The document is a compilation of the national building statistics. However its use for the purpose of this paper is limited: While a table on "Dwellings completed by types of building" exists, it only allows for a distinction into one/two family houses and multi family buildings. A rough overview on the dominant heating source for the EU-25 countries is available (Pye, Thistlethwaite, Adams 2004), but precise and complementary data on energy sources used in the building stock and in new buildings is lacking.

Such information could be gathered as part of the national implementation of the Energy Performance of Buildings Directive (EPBD), where an energy certificate is required for all newly established buildings and renovated buildings that are sold or rented. Such a certificate should describe the actual energy performance of the building. As the EPBD will have to be implemented in all countries, more detailed information on the energy demand will gradually become available.

2.3 The PRIMES data set

The PRIMES model (Capros 2005) is widely used for energy related studies. It was developed and is maintained by the National Technical University of Athens. The model is the result of work accomplished under different EU research programs. It attempts to create a realistic picture of the development of the European energy demand including technology development trends as well as market related and policy influence. As it is a general purpose model, it is designed and has been used for a multitude of analysis on the EU and national levels.

With regard to the residential sector it distinguishes five categories of dwellings, further split-up into four energy use types and allows for the integration of auxiliary heating systems. Among the fuel sources it includes low enthalpy geothermal energy to be used by heat pumps, however there is no transparency on the details of these categories, particularly on the assumptions made for energy demand and heating systems employed. Still we chose this set, as it includes all European countries and distinguishes energy demand for heating and cooling by type of fuel used (Table 1).

TWh	2005	share	2020	share
Final energy demand	3.413,44		3.827,72	
heating and cooling	258.410,51		280.687,52	
heating (incl cooking)	256.080,75		276.402,80	
Final energy demand for heating (excl. cooking)	2.860,76	100,00%	3.083,85	100,00%
solid fuels	67,67	2,37%	13,95	0,45%
liquid fuels	577,13	20,17%	527,25	17,10%
gas fuels	1.415,47	49,48%	1.721,91	55,84%
biomass	310,24	10,84%	275,49	8,93%
waste	0,00	0,00%	0,00	0,00%
solar thermal and other renewables	12,37	0,43%	32,71	1,06%
steam	217,35	7,60%	236,45	7,67%
electricity	260,53	9,11%	276,09	8,95%
electricity (HP)	0,00	0,00%	0,00	0,00%

Table 1: Final energy demand from households, EU-25. Adjustments made for cooking and electricity used for heat pumps (Source: PRIMES baseline)

It must be noted however, that this approach most likely lays ground to a certain margin of error due to:

- Lack of transparency on the underlying model,
- It is unclear which share of the annual change in energy demand that relates to new construction versus refurbishment,
- It does not take into consideration that households in multi-family buildings require less energy than those in one and two family houses.

Even though the results will not provide the initially appreciated precision, they will produce a valid general tendency and will allow for the comparison of the impact of heat pump use in different countries.

2.4 The methodology revisited

In the project report describing the methodology (Forsén, Roots, 2007) the system boundaries were drawn to illustrate the flow of energy to the final user and to illustrate the impact of heating systems on the environment. In order to apply the formulas for Greenhouse gas emissions (GHG), Final and primary energy use, and Renewable energy production to aggregated data, information on the respective energy demand for buildings, on the environmental impact of different energy sources, on conversion efficiency and on energy input required to provide final energy should be available at a sufficient level of detail. Ideally, statistics would provide the following type of data:

1. A split of **building stock** according to
   a. energy demand ($E_{building}$)
   b. energy source used for heating (index s)
   c. auxiliary energy source used (share of total energy demand; index a)
   d. number of buildings per class (index x)
2. the **average efficiency** of different heating systems (η)
3. **environmental impact** (GHG emission per unit of final energy demand, eimp)

2.4.1 Data on building stock and energy use

Each class to (1) could then have indicators with the following values:

a. demand classes (index q). For the calculation of the **energy demand of each building class**, an average would have to be taken.
b. energy sources for heating (oil, gas, district heating, direct electricity, electricity for heat pumps, biomass): index s
c. auxiliary energy source (solar thermal for hot water, solar thermal for hot water and heating support, electricity for hot water, electricity for hot water and heating support): index a

A fourth indicator (index c) would indicate the energy demand per country. The total energy demand for all houses in a geographic area would then be calculated as:

$$E_c^{building} = \sum_{q=1}^{5}\sum_{s=1}^{6}\sum_{a=1}^{4}((E_{q,s} \cdot x_{q,s}) - (E_{q,s,a} \cdot x_{q,s,a})) \qquad \text{(TWh)} \qquad (1)$$

q= energy demand
s= energy source
a= auxiliary source
x= number of buildings per category, energy source and with auxiliary source

This demand will be aggregated on the EU level to

$$E_{EU-25}^{building} = \sum_{c=1}^{25} E_c^{building} \qquad \text{(TWh)} \qquad (2)$$

c=country

The **final energy** demand is derived from this value as

$$E^{final} = \sum_{s=1}^{6}(\frac{E_s^{building}}{\eta_s}) \qquad \text{(TWh)} \qquad (3)$$

aggregated to the EU-25 area:

$$E_{EU-25}^{final} = \sum_{c=1}^{25}(E_c^{final}) \qquad \text{(TWh)} \qquad (4)$$

Lastly, the **primary energy demand** is calculated based on upstream efficiency values as

$$E^{primary} = \sum_{s=1}^{6}(\frac{E_s^{final}}{\eta_s^{up}}) \qquad \text{(TWh)} \qquad (5)$$

aggregated to the EU-25 area:

$$E_{EU-25}^{primary} = \sum_{c=1}^{25}(E_c^{primary}) \qquad \text{(TWh)} \qquad (6)$$

While this would be the most precise way to approach data collection, this level of detail is not available in current statistics in general and particularly not for all EU-25 countries. Some countries provide more detail on the number of houses according to classes, but very little information is available on the buildings energy demand, the type of energy source used for heating, or the existence of an auxiliary heater, particularly not when searching for this data for all EU countries.

Thus the methodology developed in part I of this paper is applied to the previously mentioned data set from the PRIMES model, as it at least distinguishes energy demand for all households by type of fuel. It also allows the comparison of the impact of the application of heat pumps across countries.

2.4.2 Data on conversion efficiency of heating technology

In order to calculate the final energy necessary to cover a buildings energy demand, efficiency values are required. The values for gross calorific value (thermal efficiency) are taken from the global emission model for integrated systems (GEMIS v4.4.2) (Öko-Institut 2008). This model uses a total life-cycle approach to estimate the energy and material use products and processes as well as their impact on the environment. Values have been corrected by 10 percentage points for gas and six percentage points for oil, as suggested in the ecoboiler study (VHK 2007) leading to the values presented in table 2.

Table 2: Conversion efficiency of heating technology (source: Gemis, datasets as in Table 3).

		conversion efficiency η	**Upstream efficiency, η^{up}**
solid fuels		65%	90,91%
liquid fuels	Oil condensing boiler	85%	90,91%
gas fuels	Gas condensing boiler	92%	90,91%
biomass	Pellet boiler, wood	85%	84,62%
solar thermal and other renewables		100%	95,22%
waste		95%	90,09%
electricity	Direct electricity	100%	44,10%
electricity (use for heat pumps)	Heat pumps (SPF)	300%	44,10%

2.4.3 Data on environmental impact of energy sources

Data on the environmental impact of different energies is widely available. For consistency, the values presented in table 3 are taken from the GEMIS model.

Table 3: Emission values for different energy sources (Source Gemis)

environmental impact	GHG emissions 2020 kg/kWh	dataset used
solid fuels	0,4460	Braunkohle-Brikett-Heizung-DE-Lausitz-2000 (Endenergie)
liquid fuels	0,3065	Öl-Heizung-DE-2005 (Endenergie)
gas fuels	0,2425	Gas-Heizung-DE-2005 (Endenergie)
biomass	0,0267	Pellets: Holz-Pellet-Holzwirtsch.-Heizung-10 kW-2005 (Endenergie)
solar thermal and other renewables	0,0348	SolarKollektor-Flach-2000
steam	0,0064	Fernwärme-Heizung-DE-2000 (Gas-GuD-HKW/el-mix)
electricity	0,4280	Specific for each country and EU-25
electricity (use for heat pumps)	0,4280	Specific for each country and EU-25

These values include all energy and material input required to produce one kilowatt-hour of the respective energy; all upstream losses are included. The used datasets represent the situation in Germany, but the environmental impact of solid and liquid fuels should be similar throughout Europe. Emissions values for electricity are different for each country – the above-mentioned values apply to the EU-25 average electricity mix while for all calculations of national emissions, the values for the national electricity mix are used.

3. Scenarios

Three scenarios have been created to get a better understanding of different market shares for heat pumps as well as for a gradually improving average efficiency of the appliances (Table 4).

Table 4: Scenarios for the employment of heat pumps

		Reach out	Jackpot	Full impact
	2005	2020	2020	2020
Share of HP	0,0	0,2	0,3	1
SPF	3	4	4,2	4,2

For the different countries compared an increase in the share of RES in the electricity mix as well as in the cumulated energy content per kWh produced can be observed. Emission values are shown in Table 5.

Table 5: Development of GHG-emission (eimp) for different countries (Source: Gemis)

GHG emissions (kg CO2 equ/kWh)	2005	2020
EU-25	0,38	0,36
Austria (AU)	0,21	0,21
Switzerland (CH)	0,07	0,10
Germany (DE)	0,56	0,57
France (FR)	0,09	0,13
Sweden (SE)	0,07	0,16

The scenarios use the year 2005 for comparison. For each country, values for

- the total energy demand from buildings ,
- the primary energy demand,
- the final energy demand, and
- the environmental impact

were calculated. A simple business as usual-scenario (BAU) is developed assuming that no heat pumps are introduced. This scenario is based on the PRIMES data for 2020 and is based on the same values as used for the year 2005. As PRIMES presents the final energy consumption, the following formulas can be used to calculate the buildings energy demand and the final energy demand per heat source and region:

Building energy demand: $E_{building} = E_{final} * \eta_s$ (TWh) (7) ⇔ (3)

Primary energy demand: $E^{primary} = \sum_{s=1}^{6} (\frac{E_s^{final}}{\eta_s^{up}})$ (TWh) equal to (5)

The final energy demand from PRIMES for gas and electricity is adjusted for energy used from cooking by an assumed demand of 600kWh per household and year.

$$E^{final} = E_{PRIMES}^{final} - \sum_{s=1}^{2} E_s^{building} \cdot n_s \cdot 600 \quad \text{(TWh)} \quad (8)$$

s= gas, electricity

n_s = number of households heating with source s

The calculation of the environmental impact per energy source is performed based on final energy use. As values for $eimp_s$ are based on final energy used, the upstream efficiency losses (η_s^{up}) can be neglected in the formula.

Environmental impact: $eimp = \sum_{s=1}^{6} E_s^{final} \cdot ef_s$ (Mt) (9)

s=1 – oil, 2 – gas, 3 - district heating, 4 - direct electricity, 5 - electricity for heat pumps, 6 - biomass

Savings are calculated as a subtraction of the values from the BAU-scenario to the respective scenario with heat pumps.

For **final energy** savings:

$$\Delta E^{final} = E_{PRIMES}^{final} - E_{scen}^{final} \quad \text{(TWh)} \quad (10)$$

scen= reachout, jackpot or fullimpact

For **primary energy** savings:

$$\Delta E^{primary} = E_{PRIMES}^{primary} - E_{scen}^{primary} \quad \text{(TWh)} \quad (11)$$

For **reduced environmental impact** from the use of heat pumps in the scenarios:

$$\Delta eimp = eimp_{PRIMES} - eimp_{scen} \quad \text{(Mt)} \quad (12)$$

For RES production the formula as suggested by the Therra document is used. RES produced is the difference between electricity needed and total energy output:

$$E^{RES} = E^{building} - E^{final} \quad \text{(TWh)} \quad (13)$$

$$\Leftrightarrow E^{RES} = E^{building} \cdot (\frac{SPF - 1}{SPF}) \quad \text{(TWh)} \quad (14)$$

3.1 Business as usual

The business as usual scenario is the reference. It does not take the use of heat pumps into consideration at all. The application of formulas leads results as shown in table 6.

Table 6: Business as usual scenario (2020)

Results table	EU25	AU	CH	DE	FR	SE
Building energy demand ($E^{building}$)	2.944,99	62,16	50,73	597,67	389,23	64,22
Final energy demand (E^{final})	3.083,85	68,18	53,39	638,48	413,47	66,13
Primary energy demand ($E^{primary}$)	3.613,86	77,97	67,41	597,67	389,23	64,22
Environmental impact (eimp)	700,03	12,69	14,59	597,67	389,23	64,22

3.2 Scenario Reach Out

This scenario foresees that in 2020 20% of the building stock is heated by heat pumps and that heat pumps operate on average with a SPF of 4. Changes of emission factors are taken into account on a national basis as estimated in the PRIMES model. Results are displayed in the table below.

Table 7 Comparison of results for the reach out scenario (2020)

		Primary energy demand [TWh]	Final energy demand [TWh]	GHG emissions [M ton CO_2]	Renewable energy [TWh]
EU25	**BAU**	3443	3084	696	308
	Reach-OUT	3043	2608	607	668
	Change	-400	-476	-88	360
	Relative change	**-12%**	**-15%**	**-13%**	**117%**
DEU	**BAU**	703	638	151	70
	Reach-OUT	632	540	137	142
	Change	-70	-99	-14	72
	Relative change	**-10%**	**-15%**	**-9%**	**104%**
Austria	**BAU**	71	68	11,5	20,7
	Reach-OUT	60	58	9,8	25,7
	Change	-11	-11	-1,7	5,0
	Relative change	**-15%**	**-16%**	**-14%**	**24%**
CH	**BAU**	65	53	11,4	1,4
	Reach-OUT	58	45	9,4	8,5
	Change	-8	-8	-2,0	7,1
	Relative change	**-12%**	**-15%**	**-18%**	**492%**
France	**BAU**	583	413	81	76
	Reach-OUT	523	350	67	117
	Change	-61	-64	-14	41
	Relative change	**-10%**	**-15%**	**-17%**	**54%**
Sweden	**BAU**	76	69	7,4	6,44
	Reach-OUT	68	58	6,4	14,90
	Change	-8	-10	-0,9	8,46
	Relative change	**-11%**	**-15%**	**-13%**	**131%**

At 20% market share in the heating sector would result in green house gas emission savings in the range of 9%-18% for the studied regions. The final energy saving are around 15% with the primary energy savings a little less. The results must however be used with caution as the national energy statistics given by PRIMES, like other sources for energy statistics, is not accurate enough to give precise results. One of the problems is that heat pumps are not registered in the statistics at all. This will lead to misleading results for those countries that where heat pumps already have a recognisable heat market share. The used datasets in this study will in the continuing work be exchanged as soon as they are made available.

3.3 Scenario Jackpot

This scenario foresees that in 2020 30% of the building stock is heated by heat pumps and that heat pumps operate on average with an SPF of 4,2. Improvements in the electricity production have lead to reductions in emissions and in the total energy input required to produce one kilowatt-hour of electricity. Results are shown in table 8:

Table 8: Comparison of results for the Jackpot scenario (2020)

		Primary energy demand [TWh]	Final energy demand [TWh]	GHG emissions [M ton CO_2]	Renewable energy [TWh]
EU25	**BAU**	3443	3084	696	308
	Reach-OUT	2823	2359	560	858
	Change	-620	-725	-136	550
	Relative change	**-18%**	**-23%**	**-20%**	**178%**
DEU	**BAU**	703	638	151	70
	Reach-OUT	592	488	129	180
	Change	-111	-150	-22	111
	Relative change	**-16%**	**-24%**	**-14%**	**159%**
Austria	**BAU**	71	68	12	20,7
	Reach-OUT	55	52	9	28,5
	Change	-16	-16	-3	7,8
	Relative change	**-23%**	**-24%**	**-22%**	**38%**
CH	**BAU**	65	53	11	1,4
	Reach-OUT	54	41	8	12,2
	Change	-12	-13	-3	10,8
	Relative change	**-18%**	**-23%**	**-27%**	**750%**
France	**BAU**	583	413	81	76
	Reach-OUT	488	316	60	139
	Change	-95	-97	-21	63
	Relative change	**-16%**	**-24%**	**-26%**	**83%**
Sweden	**BAU**	76	69	7	6,4
	Reach-OUT	63	53	6	19,4
	Change	-13	-16	-1	12,9
	Relative change	**-17%**	**-23%**	**-20%**	**201%**

3.4 Scenario Full Impact

This scenario foresees that in 2020 100% of the building stock is heated by heat pumps and that heat pumps operate on average with an SPF of 4,2. Improvements in the electricity production have lead to reductions in emissions and in the total energy input required to produce one kilowatt-hour of electricity. This scenario shows **what would be possible** in terms of energy savings and emission reduction if all existing heating was completely covered by heat pumps. Results are given in table 9:

Table 9: Comparison of results from the full impact scenario (2020)

		Primary energy demand [TWh]	Final energy demand [TWh]	GHG emissions [M ton CO_2]	Renewable energy [TWh]
EU25	**BAU**	3443	3084	696	308
	Reach-OUT	1375	669	243	2140
	Change	-2068	-2415	-453	1832
	Relative change	**-60%**	**-78%**	**-65%**	**594%**
DEU	**BAU**	703	638	151	70
	Reach-OUT	334	137	79	439
	Change	-369	-501	-72	369
	Relative change	**-53%**	**-79%**	**-48%**	**531%**
Austria	**BAU**	71	68	12	20,7
	Reach-OUT	17	15	3	46,6
	Change	-54	-54	-8	25,9
	Relative change	**-76%**	**-79%**	**-73%**	**125%**
CH	**BAU**	65	53	11	1,4
	Reach-OUT	26	12	1	37,3
	Change	-40	-42	-10	35,9
	Relative change	**-61%**	**-78%**	**-90%**	**2501%**
France	**BAU**	583	413	81	76
	Reach-OUT	267	89	11	286
	Change	-316	-324	-70	210
	Relative change	**-54%**	**-78%**	**-86%**	**276%**
Sweden	**BAU**	76	69	7	6,4
	Reach-OUT	33	15	3	49,5
	Change	-44	-53	-5	43,1
	Relative change	**-57%**	**-77%**	**-66%**	**669%**

4. Primary energy savings

Several documents mention the fact that heat pumps or other technologies using renewable energy would save primary energy. This statement must be taken with caution. The following definition from the IEA/OECD energy statistics manual shows that renewable energy sources are also counted as primary energy sources:

“Primary energy commodities may also be divided into fuels of fossil origin and renewable energy commodities. Fossil fuels are taken from natural resources which were formed from biomass in the geological past. By extension, the term fossil is also applied to any secondary fuel manufactured from a fossil fuel. Renewable energy commodities, apart from geothermal energy, are drawn directly or indirectly from current or recent flows of the constantly available solar and gravitational energy.” (IEA/OECD 2005, p. 19)

Consequently the use of renewable energy does not automatically lead to a decrease in primary energy usage. What is commonly understood as the “saving of primary energy” from the use of heat pumps or other technologies using renewables should precisely be named “saving of non-renewable primary energy”.

The above calculation examples show that given sufficient efficiency of energy production and high efficiency of the heating systems, even with this extended understanding primary energy is saved. To be clear: the employment of heat pumps does always save non-renewable primary energy sources and deserves support for this contribution to energy savings and emission reduction.

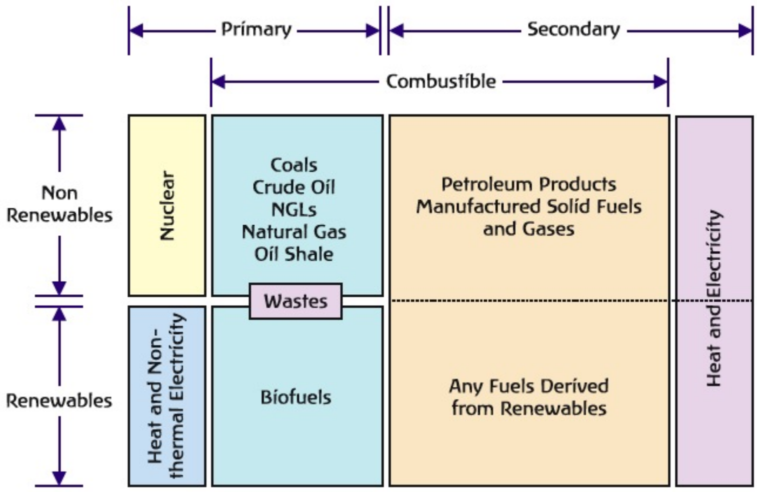

Figure 2: Overview of terminology (Source: IEA/OECD 2005, p 18)

5. Concluding remarks

The scenarios show that **a widespread implementation of heat pumps does lead to considerable savings in the demand of non-renewable primary energy** and subsequent improvements of environmental pollution from the production, transportation and use of these resources. Even in a scenario with rather moderate expectations (Reach out), which might be achieved from a continuous development of the current market, heat pumps could contribute 8% towards the reduction goal of 1 073 Mtonnes of GHG emissions (See table 10). The presented calculations confirm the assumption that in countries with low carbon intensive electricity the environmental impact of heat pumps is very small.

Table 10: GHG emission in the EU-25 vs. contribution of heat pumps to emission reduction

Million Tonnes	**1990**	**2004**	**2020**
GHG Emission EU-25 (excl. LULCF)	5.369 (100%)	4.986,40 (92,88%)	4.294,80 (80%)
Reduction Goal			1.073,70 (20%)
Contribution from		**Reach out**	88
		Jackpot	136
		Full impact	453

The more ambitious scenarios Jackpot and Full-Impact would result in a share of 13% and 42 % respectively.

These results are only a guideline. Nevertheless they stress the importance of better statistics for heat pumps. Given their contribution potential towards the targets as set in the EU energy and climate package, the contribution towards the “production” of renewable energy sources, towards final energy savings and towards GHG emission savings must be counted and included into statistics.

The market for heat pumps in Europe has reached a state where the technology can no longer be labeled as unimportant, unavailable or negligible. Heat pump technology requires adequate recognition and support. But again this requires the introduction of the contribution into statistics. Only then can support programs as foreseen by the proposed RES Directive be created, executed and monitored efficiently on a national and on a European level.

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Project Description

The GROUND-REACH project is expected to effectively assist EU policy towards both short and long term market penetration of ground coupled heat pumps, through analysing the market for ground coupled heat pumps and providing best practices, guidelines for local/regional authorities and key professional groups, conferences, meetings, website, brochure and other promotional tools. It will facilitate: A better understanding of ground coupled heat pumps merits and benefits and their importance towards Community policy objectives in relation to Kyoto targets and the buildings performance directive. An increased awareness and improved knowledge and perception of the ground coupled heat pumps technology among key European professional groups for short term market penetration.

The work is grouped in the following work packages:

WP#1 – Project management

WP#2 - Estimating the potential of ground coupled heat pumps for reducing CO_2 emissions and primary energy demand for heating and cooling purposes in the built environment: evaluation of available statistical information, definition of competing heating/cooling technologies, analysis of existing calculation tools, CO_2 emissions calculation.

WP#3 - Compiling and evaluating existing ground coupled heat pumps best practice information in Europe: identifying and updating information from all European member states, including case studies, and technical guidelines.

WP#4 - Analysing the contribution of ground coupled heat pump technologies to reach the objectives of the Buildings Performance Directive: Analysis of the technical, environmental and economic feasibility of ground coupled heat pump technologies; Guideline for supporting planners and architects in detailed technical aspects and in general questions; Standards review, evaluation and proposals.

WP#5 - Defining measures to overcome barriers for broader market penetration and setting up a long term dissemination plan: identification of market barriers including legal/ regulatory, economical and technical, proposals for long term EU level interventions to overcome them, including a new directive on RES-Heat.

WP#6 - Launching a large scale promotional campaign at European level: brochure, poster, promotional text, presentations, interactive Internet site, setting-up the European Geothermal Heat Pump Committee, publications, international conference and exhibition, a series of regional meetings targeting key professional groups.

WP#7 - Common dissemination activities

Project partners

Project Coordinator: Centre for Renewable Energy Sources (CRES)

SVEP Information & Service AB (SVEP)

Ecofys Netherlands b.v. (ECOFYS)

Cestec SpA

European Geothermal Energy Council (EGEC)

University of Oradea (UOR)

The Energy Efficiency Agency (EEA)

Agence de l'environnement et de la Maîtrise de l'energie (ADEME)

European Heat Pump Association (EHPA)

BESEL S.A. (BESEL)

Escola Superior De Tecnologia De Setubal (ESTSetubal)

Narodowa Agencja Poszanowania Energii S.A. (NAPE)

COWI A/S (COWI)

Österreichisches Forschungs- und Prüfzentrum Arsenal Ges.m.b.H (ARSENAL)

Ellehauge & Kildemoes (E & K)

Fachinformationszent rum Karlsruhe G mbH

EnPro Engineers Bureau Ltd (ENPRO)

Bureau de Recherches Géologiques et Minières (BRGM)

Flemish Institute for Technological Research (VITO)

Geoteam Technisches Büro für Hydrogeologie, Geothermie und Umwelt Ges.m.b.H (GEOTEAM)

TERA Energy S.r.l. (TERA)