



Project

Promotion of efficient heat pumps for heating  
( ProHeatPump)

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**Deliverable N° 9**

**Report on analysis of marketing instruments**



Work Package 3  
Marketing of RES-Heat

**Intelligent Energy**  **Europe**

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## D9: Report on the analysis of marketing instruments

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## **1. Introduction**

This report contains a preliminary examination of the market structures of space heating business with a special focus on heat pumps in the member states represented in the *ProHeatPump* consortium – namely Germany, France, Sweden, the UK and Bulgaria.

This examination is the first step towards the major goal of WP3 Marketing of RES-Heat of understanding and evaluating existing marketing instruments. The structure of a market has a major impact of the marketing instruments which are established. The findings will be combined with insights from interviews with experts and other investigations in WP3, particularly to examine how effective such marketing instruments have been in increasing their uptake.

## **2. Sweden**

### **2.1 Market context and overview**

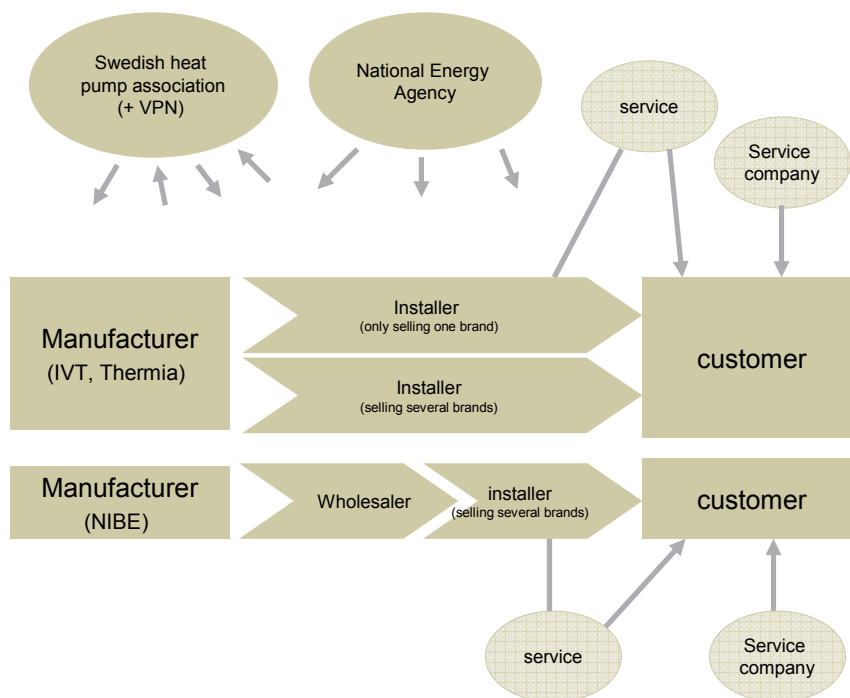
Space heating and water heating in Sweden are dominated oil, electricity and biofuels. Also large district heating networks in Sweden has been established and these are mainly supplied by biofuels, but also from waste, waste heat from industry and larger heat pumps.

### **2.2 The Swedish market structure of space heating**

The main actors on the heat pump market in Sweden are:

- Manufacturers
- Installers
- Drilling companies
- National energy agency
- SVEP (Swedish heat pump association)

The market chain is shown below.



## 2.3 Description of market players in HP-market

### 2.3.1 Manufactures

Several manufacturers produce HPs in Sweden. Larger manufacturer are: IVT, Thermia, NIBE, CTC/ Enertech AB.

Other manufacturers include AB Kyl & Värmepumpar, AQS-Produkter AB, Autoterm Försäljnings AB, Clima AB, ECONomic THERMology AB, Euronom AB, Evi Heat, Mecmaster Energi AB, Miljö & Värmeteknik i Göteborg AB, Qvantum Energi AB, Save It Naturvärme AB, Svensk Värmepumps Industri AB and , Thorén Energiprodukter AB.

Manufacturers generally supply direct to installers rather than through wholesale equipment suppliers, but it differs between manufacturers. IVT and Thermia supply for example directly to the installers and NIBE through wholesalers.

### 2.3.2 Installers

There are HP installers that are specialist HP firms, which cover both housing and commercial/public building systems and carry out the necessary design or customisation of the installation. IVT and Thermia has for example installers only selling their products. But there are as well firms installing all kind of heating systems (plumbers) that also install heat pumps.

Installers usually get education from the manufacturers on heat pumps that they sell. By educating the installers the manufacturers decrease the risk for having “bad” installations and dissatisfied customers.

If the customer is having problem or need service for the heat pump, it's natural to first contact the installer. But if the first installer doesn't manage to make it right some manufacturers also have special trained installers to make service on heat pumps. Other manufacturers/installers cooperate with independent refrigeration technology companies.

### **2.3.3 Drilling companies**

The installer is cooperating with some drilling companies. The customer normally just has contact with the installer.

### **2.3.4 National energy agency**

The national energy agency is working in several areas that can influence the market for heat pumps and is a market actor in that way.

The energy agency is working to create conditions for an efficient and sustainable use of energy. Some parts of this is to push the energy efficiency work in Sweden by for example supporting municipal energy advisors, pushing energy efficiency in buildings and making tests to influence manufacturers and users.

The national energy agency is also supporting research and technology development, which is an important factor to influence the Swedish energy system. Prioritized questions are to make results useful and commercialized.

The agency is also working with development and handling of instruments that contribute to the change of the energy system.

### **2.3.5 SVEP (Swedish heat pump association)**

SVEP, Swedish heat pump association is an independent trade association and the official information channel for heat pumps to the public, authorities, organisations and decision makers in Sweden.

They have most of the manufacturers, importers, retailers as members and also companies and organisations with interests in the heat pump market. SVEP cooperates with authorities and institutes, supplies and disseminates neutral information, organise education and certification of installers etc.

To be a member of SVEP the installer or manufacturer has to fulfil the organisations regulations. For the customer it is good to know if the installer is connected to SVEP since it reduce the risk of using a less reliable installer.

### **2.3.6 VPN(The heat pump association board for consumer complaints)**

VPN replaced ARN in the end of 80-ies in order to only handle complaints regarding heat pumps or heat pump systems. VPN is a board for consumer complaints that handle all issues regarding heat pumps, no matter what brand, producer or installer. The cost is today, April 2007, 1500 SEK to get a case examined in VPN. Time for handling a case is today about one year. VPN handled about 50 cases during 2006 and about 2/3 of them was in favour for the consumer and the rest was rejected. SVEP, The Swedish heat pump association, works as secretariat for VPN but has no right to vote.

## **3. France**

### **3.1 The French market structure**

#### General data on energy

The total energy consumption of the building sector in France in 2005 is 807 TWh of which 68% in the residential area and 32% in non-residential or tertiary buildings. The energy mix is composed of 53% for fossil fuels, 34% for electricity and 13% renewables.

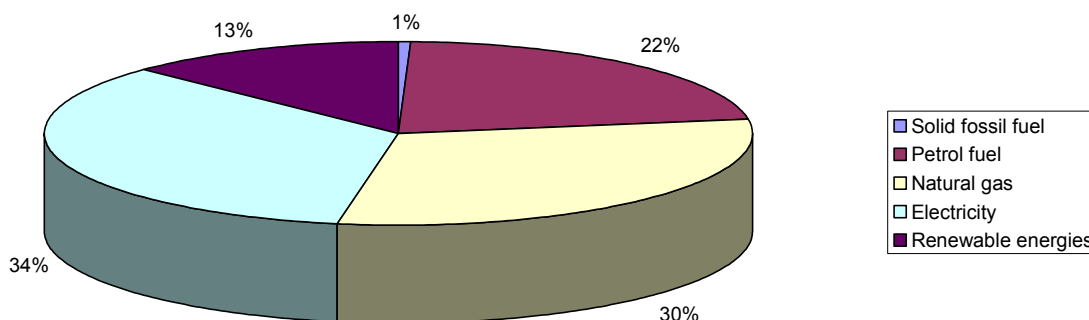


Figure : Share of energy sources in the energy consumption of buildings

The need for heat represents 88% for residential (486 TWh) and 67% non-residential buildings (172 TWh), the rest is consumed as electricity for internal usage.

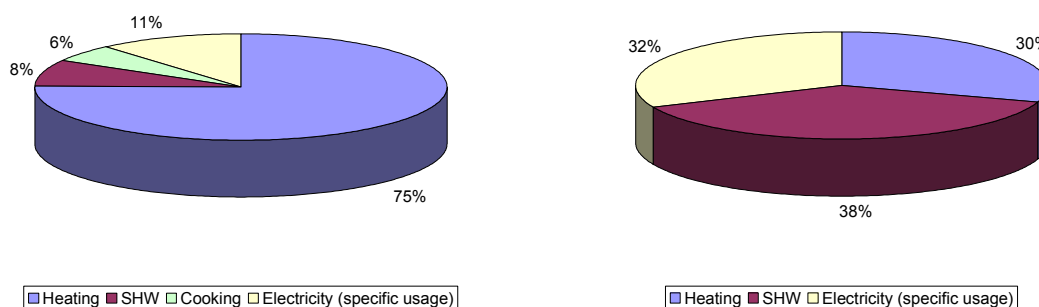


Figure : Energy usage in (a) residential and (b) non-residential buildings

In 2005, the 130000 heat pumps installed have produced 4.2 TWh, which covers only 0.6% of the needs. In comparison the heat supply is 103 TWh for wood energy and 0.44 TWh for solar thermal.

According to the EU survey on the share of renewable energy for electricity and heat in Europe realised in 2004, the French potential for heat pumps was estimated at almost 50 GWh, which correspond to 10% of the heating needs for buildings.

### 3.2 The French structure of heat pump business

#### Company profile

Almost 30 industrial companies are manufacturing or distributing heat pumps in France. A large number are SME's and large industrial groups such as Viessmann or Buderus are also present in France.

#### Professional association

The French heat pump association AFPAC (<http://www.afpac.org/>) has been created in 2002, it groups manufacturers, installers, public and private organisms and research centres related to heat pumps. The aim of AFPAC is :

- To promote the usage of heat pumps;
- To coordinate scientific and technical activities;
- To be in relations with national and international organisations;

- To setup norms, certification and training procedures.

#### Quality label and training schemes

Since 2007, the heat pumps manufacturer can apply for quality label (NF-PAC). This quality label is delivered to industrial companies which manufacture or distribute heat pumps in France, it covers all type of heat pumps up to 50 kW. This label defines minimum COP for several operating conditions, the heat duty and the noise level. The label is provided by an official organism.

Heat pump installers can apply to a quality chart 'Qualipac'. This chart has been established with the support of EDF and Ademe, at the initiative of AFPAC. The AFPAC delivers the label Qualipac to installers with three main requirements:

- The personnel is trained according to the EU-CERT (European Certification for Installers)
- Accept that some installations will be inspected by an independent organism
- To respect 10 commitments related to
  - First contact with the customers
  - The evaluation of the heating needs
  - The installation and commissioning of the installation
  - Offer a 2 year guarantee

#### Training

Within the frame of the EU-CERT project (<http://eucert.fiz-karlsruhe.de/>) a training schemes for installers has been prepared and is delivered by 5 organisms in France. The course is separated in three main modules:

- Introduction to heat pumps (2 days)
- Conception and commissioning of installations
- Maintenance.

This training is mandatory for applying to the Qualipac label.

### **3.3 The French heat pump market.**

The French market has strongly evolved during the last ten year.

The action of EDF via its Vivrelec has actively contributed in growing the market from some 1500 units per year in 1997 to 17300 units in 2004 (without air to air systems). The market growth has accelerated since due to the tax credit mechanism (40% in 2005 and 50% in 2006) and has reached 53500 units in 2006. France is now in the top three markets for heat pumps in Europe.

Year	2002	2003	2004	2005	2006
<b>Ground / Floor and Ground / Water</b>	7 700	5 400	6 800	7 800	9 600
<b>Water / Water</b>		3 600	4 900	5 400	8 850
<b>Air / Water</b>	4 400	4 700	5 600	12 000	35 050
<b>Air / Air</b>	No data				
<b>Total</b>	12 100	13 700	17 300	25 200	53 500

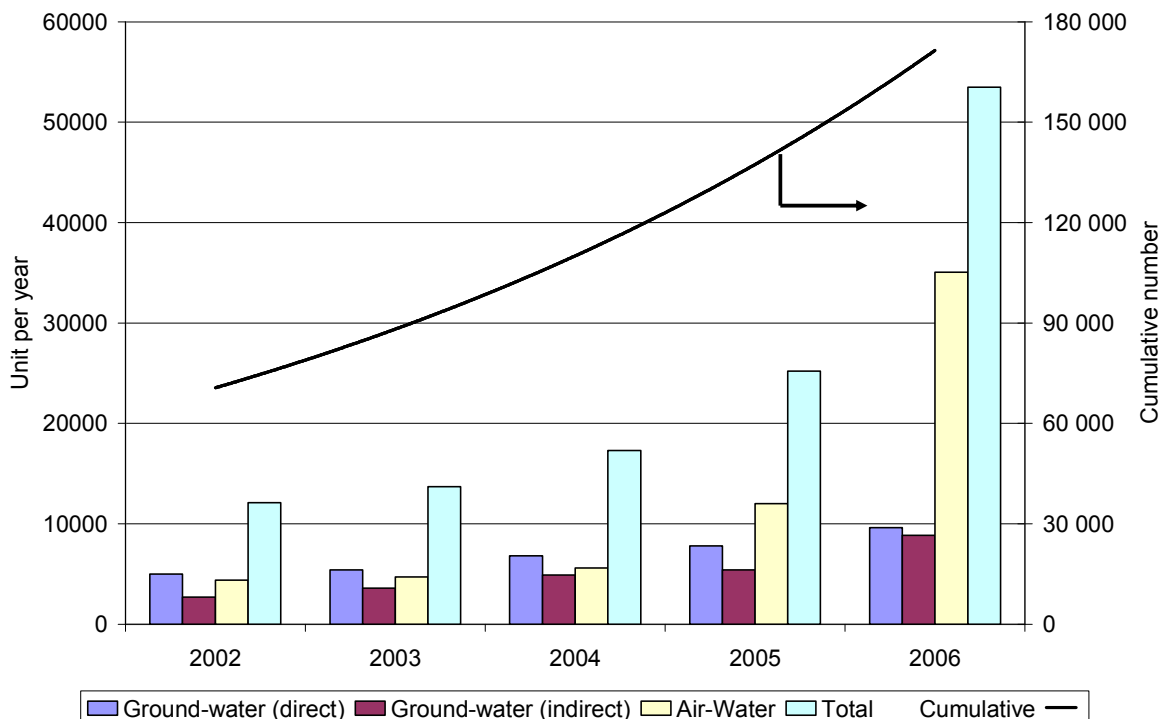


Figure : The French heat pump market

**Reference**

DGEMP : [http://www.industrie.gouv.fr/energie/statisti/f1e\\_stats.htm](http://www.industrie.gouv.fr/energie/statisti/f1e_stats.htm)

DGEMP : [http://www.industrie.gouv.fr/cgi-bin/industrie/frame23e.pl?bandeau=/energie/developp/econo/be\\_eco.htm&gauche=/energie/developp/econo/me\\_eco.htm&droite=/energie/developp/econo/cee-sommaire.htm](http://www.industrie.gouv.fr/cgi-bin/industrie/frame23e.pl?bandeau=/energie/developp/econo/be_eco.htm&gauche=/energie/developp/econo/me_eco.htm&droite=/energie/developp/econo/cee-sommaire.htm)

DGEMP, "Les energies renouvelables en France 1970-2005", June 2006

DGEMP, « Bilan énergétique de l'année 2006 de la France », April 2007

AFPAC : <http://www.afpac.org/marche-pac.php>

AFPAC : <http://www.afpac.org/> (Qualité)

Vivrelec : <http://particuliers.edf.fr/141396i/EDF-Particuliers/je-fais-construire/je-realise-mon-projet/le-Pret-Vivrelec-Habitat-Neuf.html>

**4. Germany**

**4.1 Market context and overview**

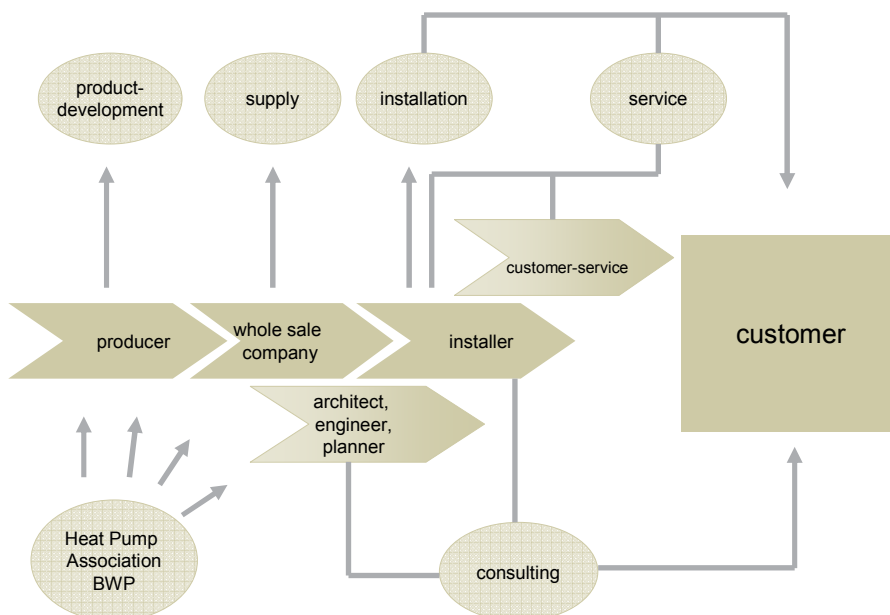
Space heating and water heating in Germany are dominated by gas and oil. All other energy sources have been much smaller shares such as district heating, coal, electricity storage heating systems, heat pumps and renewables.

**4.2 The German market structure of heat pump business**

The main actors in the heat pump market in Germany are:

- Manufacturer

- Whole sale companies
- Installer
- Planer/Architects
- Drilling companies
- Heat pump association (BWP)



## 4.3 Description of market players in HP-market

### 4.3.1 Manufactures

Several manufacturers produce HPs in Germany. Larger manufacturer are Viessmann, Buderus, Vaillant, Stiebel Eltron, Watterkotte, Alpha innotec, etc.

In Germany exists a classic 3-way sales channel. Manufacturers generally supply direct to whole sale companies, where installer buy the heat pumps to install them by the customer. Only a few of the manufactures sell there products directly to installers, in classic 2-way sales channel.

Some international heat pump companies have been established in Germany, esp. from Austria and Sweden. Japanese companies tried to enter the German market, but have not been successful jet. These companies are successful in the air conditioning business.

### 4.3.2 Whole sale companies

Whole sale companies for space heating are local or sometimes regional distribution facilities. They keep all kind of installation material in stock for installers. Therefore they also keep heat pumps from different manufactures in stock, where local installers buy them after the finalised a contract with a customer.

### 4.3.2 Installers

Installers in Germany become a dual education. They learn the theory in school and the practice in the installer firm they work for. After 3 years they become an assistant after they pass an exam. To become a foreman an additional education for another 2 years is necessary.

Installers work normally with 1 to 3 manufactures together. Manufactures offer special training course for their products, so installers are familiar with the products of their manufactures.

The installation of heat pumps follow the same way as normal heating systems. If the installer has the capability they customise the installation. Otherwise the installer collect the needed data and send it to the manufacture, who design the heating system for him. When the installer have the design and dimension of the heating system he calculate an offer for the customer.

Due to the recent boom of heat pumps in Germany more and more installers offer heat pumps. Some installer firms offer the whole variety of heating systems, others are specialised in heat pumps.

#### **4.3.3 Drilling companies**

The installer is cooperating with some drilling companies in his region. The customer normally just has contact with the installer.

#### **4.3.4 Planers/Architects**

Planers and architects offer know how and design capabilities to customers. The customer just indicate a wish, how the heating system should look like or he get advised by the planer/architect. The planer/architect organise the whole process, he design and calculate the heating system, ask different installers for offers, choose the best offer and supervise the installation.

#### **4.3.5 BWP (Bundesverband Wärmepumpe)**

BWP, the German heat pump association is an independent trade association and the official information channel for heat pumps to the public, authorities, organisations and decision makers in Germany.

In BWP are most of the manufacturers, importers, retailers, utilities and installers organised. BWP cooperates with authorities and institutes, supplies and disseminates neutral information, organise education and certification of installers etc.

#### **4.4 Marketing instruments**

In Germany different marketing instruments have been established by the different market actors. Beside the normal marketing heat pump manufacture have created various marketing events which all have in common to promote their heat pump products. Example are a heat pump train, which stands for several days in a railway station, so people can visit the exhibition. The same approach is done by another company with a truck. Another company offer a 300€ discount per heat pump. Beside the manufacture some of the utilities are very active to promote the heat pump technology. They offer also a discount on the investment, they have special electricity tariffs for heat pumps, they offer an extended guarantee or they offer training courses for installers.

### **5. Bulgaria**

A process of harmonizing of Bulgarian standards with European norms is under way, including in the field of energy, the mastering of Renewable Energy Sources, and environmental protection. Favorable opportunities for the utilization of Renewable Energy Sources are being created, including for Heat Pumps. The climate in Bulgaria requires

heating of apartments during the winter season, and cooling during the summer months, and the operation of the heat pumps is reversible.

### **5.1 Market context/overview**

The country is poor in fossil fuels, and 60% of those come from import. Their import comprises over 20 % of the total import of the country. Within the structure of consumed energy resources in every life electric power occupies a 20%-share. Firewood, briquettes, liquefied propane and butane petroleum gas are used in everyday life, and natural gas has been recently increasingly introduced. In the bigger cities there are gas supply networks, and the industrial plants, including small and medium industries, use primarily natural gas heating.

### **5.2 Manufacturers and installers**

There are few installed heat pumps, low experience and information in this matter. There is expansion and advertising of household gas supply network.

Installed ground/water heat pumps – in Varna – 5, in Sofia, etc.

In Bulgaria no heat pumps or parts for them are produced. 29 firms in the country offer heat pumps under the REECL program grant scheme for crediting. Most companies are located in Sofia – 18, the rest are in Plovdiv, Varna, Burgas, Ruse, Shumen.

There are other firms as well which offer heat pumps outside the RCEEL program (New Energy Technology – BG Ltd., Proximus – Varna, Tornado Deal – Varna, EKO-SOLAR, Barisol – Varna, ERATO – Haskovo, etc).

The current structure of the installation industry can be expected to change as the market expands. Companies may expand, merge or be taken over by more general HVAC and other types of company, or become subsidiaries of equipment manufacturers and suppliers.

### **5.3 Customers**

The kind of the prevalent number of residential buildings in the big cities, the way of building-up of the cities and the condition of the buildings make the use of the abovementioned heat pumps rather difficult. There are no yards for the apartment buildings.

There have been increasing preferences to buy or build a house near big cities instead of apartments within the cities. The ownership of suburban houses is no longer the priority of a restricted number of especially rich citizens. The number of the projects for closed-type villa settlements is increasing and the interest towards them is increasing as well because of the additional services and the infrastructure constructed nearby. For such settlements, heat pumps are especially feasible.

### **5.4 Intermediaries**

There is a wide range of intermediaries in the market chain and other organisations influencing it.

The energy policy in Bulgaria is conducted by the Ministry of the Economy and Energy. There is an operational national Agency for Energy Efficiency of the Ministry of the Economy and Energy.

In all district governments (numbering 28) Energy Efficiency Councils have been formed as part of the District Governor's Administrations. There are also Energy Efficiency Units in the

bigger municipalities. District and regional programs for short-term (till 2007) and long-term (till 2014) programs for Energy Efficiency and mastering of Renewable Energy Sources have been drawn up on the initiative of the municipal governments.

From the non-governmental organizations the Municipal Network for Energy Efficiency “Ecoenergy”, the Union of Bulgarian Black Sea Local Authorities, energy agencies, etc, work actively in this sphere.

## **5.5 Effects of policy and regulation**

The state policy for the introduction of heat pumps is reflected in the content of the operating laws – the Energy Act and the Energy Efficiency Act, and in the subdelegated legislation adopted with respect to them, also in the content of the prepared bills and subdelegated legislation documents, as well as in the acts and subdelegated legislation documents for protection of the environment. The following also need to be mentioned: the National Energy Strategy – in its first and second version (its third version is being prepared), in the attitude of the state and society towards non-governmental companies and organizations, conducting initiatives for energy saving, mastering of Renewable Energy Sources and environmental protection.

The educational institutions on all levels have supported in the introduction of concentrations, specializations, and scientific fields in the field of “Energy” – for energy saving, mastering of Renewable Energy Sources and environmental protection.

There are currently various forms and channels available for the financing of scientific research project in the abovementioned fields, including the utilization of the heat pump principle of energy transformation.

The state is the organizer and the main sponsor of the annually conducted Energy Forum – an international scientific and technical conference.

There are innovative projects which are subsidized (energy has been pointed out as a priority field).

The government conducts a policy of reducing the energy consumption in households and of adoption of RES. There are procedures under way for the mandatory inspection, certification and documentation of the buildings – of the existing ones and of the new buildings.

There are grant schemes in the country for crediting the population for small projects leading to energy savings and adoption of RES. The maximum grant for the time being is set at 400 EUR under REECL program ( [www.reecl.org](http://www.reecl.org) ) .

Another opportunity for financing of Municipalities, Small and Medium Industries, physical persons, etc is the Energy Efficiency Fund, and the credit may amount from 30 000 to 3 000 000 BGN with a maximum return period of 5 years. ( [www.bgeef.com](http://www.bgeef.com) ) .

## **6. United Kingdom**

### **6.1 Introduction**

The GSHP heating industry<sup>1</sup> is very small in the UK, with sales, installation and commissioning conducted by a small number of firms specialising in GSHP or in a range of micro-renewables. However, a broader inspection of the players involved in shaping the adoption of GSHP shows that the organisation of the range of functions in the GSHP heating sector is already complex, despite the overall poor development of the market so far. Different types of supplier and intermediary organisation are involved, some specialist and

some with diverse interests, they relate and intersect in different ways, and their roles overlap significantly. It is important to clarify the structure and monitor changes in it in order to judge the most appropriate and effective ways of intervening to strengthen the market.

## 6.2 Market context

Space heating and water heating in the UK are dominated by wet systems based on gas boilers. There is an extensive gas network reaching all but remote rural areas in the country, and almost all dwellings with access to the gas grid are connected routinely. There is extensive competition keeping down the capital costs of installation and the cost of gas. Oil, electric (direct radiant or storage), wood/peat/coal/'smokeless' solid fuel, and bottle gas heating serve small markets, though it is not clear the extent to which electric radiant heating is used to supplement other heating. In the UK overall, over 90% of the population has mains gas supply, though in Scotland some 25% of homes do not.

## 6.3 Manufacturers and installers

Several manufacturers produce HPs in the UK or assemble units from components sourced in the UK and overseas, and HP units from major overseas manufacturers are imported.<sup>ii</sup> Piping, controls and ancillary equipment are likewise sourced from UK and overseas suppliers.

Manufacturers generally supply direct to installers rather than through wholesale equipment suppliers.

HP installers are currently mostly specialist HP firms which cover both housing and commercial/public building systems and carry out the necessary design or customisation of the installation. Some also install related systems such as underfloor heating separately from HP units. These firms are struggling to keep up with current demand, pushed by government subsidies and recent changes in planning regulations. They currently cover wide geographical areas, entailing high costs in transporting equipment to and from central stores and in travelling to installations. Some are opening premises in extra locations to cope with demand and cut transport costs. Currently some installers subcontract specific tasks, especially borehole drilling or ground loop laying and installation of house heating internals, building their business on sales, design and commissioning. Reliability and quality are often cited as problems with subcontracting. Few general heating, ventilating and air-conditioning (HVAC) system installers include GSHPs. Some GSHPs are installed by companies covering a range of microgeneration systems. The energy services business model is not developed in the UK.

Some energy utilities also have interests in GSHP installers or more usually subcontract to specialist firms.

The current structure of the installation industry can be expected to change as the market expands. Companies may expand, merge or be taken over by more general HVAC and other types of company, or become subsidiaries of equipment manufacturers and suppliers.

## 6.4 Users

Clients and users of GSHPs are currently mostly home self-builders of larger remote properties; social housing agencies; government agencies at different levels – especially local authorities – with a range of medium or large premises and facilities, such as municipal buildings, schools and leisure facilities; owners of medium or large commercial premises. Supermarkets and other large property owners or developers are starting to adopt the technology, as a result of renewable obligations and corporate low- or zero-carbon policies.

## 6.5 Intermediaries

There is a wide range of intermediaries in the market network and of other organisations influencing it.

Industry and trade associations in a range of areas have actual or potential influence on their constituents' stance on HPs and, through their lobbying and other actions on their behalf, on policies and support schemes. The UKHPA and the GSHPA cover the main actors centrally involved in HPs. The key HVAC trade body is the Heating and Ventilation Contractors Association (HVCA), and there are several professional, occupational and trade associations covering architects (Royal Institute of British Architects), builders and plumber or sub-groups of these. Examples in Scotland include the Scottish Building Federation and the Scottish and Northern Ireland Plumbing Employers' Federation (SNIPEF). These bodies have a number of roles, such as lobbying, setting standards, research into issues affecting the whole industry (such as zero-carbon building requirements), training, and accreditation of member organisations.

Regional energy agencies, advice centres, consultancies, energy auditors and others may help raise awareness of HPs and provide information and advice on them, direct potential users towards or away from HPs, and in some cases be involved in practical projects. HPs are generally one energy saving or heating option. The organisation may be constrained to some extent to give technology-neutral advice, and in practice their stance towards HPs appears to vary. Their constitution (as private, public or charitable agencies), basis of operation, roles and target audiences vary, and their roles and audiences overlap. Their own associations, and some other public or private organisations with national scope<sup>iii</sup> in turn provide advice and information to more local or specific agencies and may influence their stance. Other energy campaigning groups arguably have an indirect role by encouraging awareness of general energy issues or the merits of specific technologies.

## 6.6 Effects of policy and regulation

The broad policy context, and the likely influence of general government statements on energy and environment – particularly emission reduction targets – on energy efficiency goals and activity, are described and commented on elsewhere. Here we focus on the channels by which specific and more tangible pressures and influences operate on HP activity and the effect on specific actors. While they accept the need to support the market, many actors consider the current policy and regulatory context confusing: grant schemes, tax relief, social marketing, obligations on energy companies and local authorities, and various accreditation and certification schemes can make everyday business and longer term planning difficult.

National energy agencies administer support schemes and crucially decide criteria for eligibility. The Energy Savings Trust (EST) is the primary agency through which many aspects of carbon emission reduction policies are implemented, focussing on demand-side improvements via the promotion of sustainable and efficient use of energy. As well as running networks of Energy Efficiency Advice Centres (EEACs), providing online information to consumers on technologies, supporting other energy advice and campaigning agencies, and providing policy advice, the EST operates and regulates (in cooperation with BRE) the major subsidy schemes for energy efficiency and renewables technologies: in England and Wales the *Low Carbon Building Programme Phase 1*, formerly the DTI *Clear Skies* programme, and in Scotland the SCHRI providing funding for householders and communities. The principal focus of the schemes for the next five years is building insulation, as the most cost-effective way of reducing carbon emissions. In the longer term they will also be concerned to develop the market infrastructure for large scale installation of microgeneration, including GSHPs.

We have described elsewhere the Energy Efficiency Commitment (EEC) and Carbon Emissions Reduction Target (CERT) schemes, overseen by the energy regulator Ofgem, which put obligations on utilities to promote improvements in domestic energy efficiency. While the current emphasis is on insulation as the most cost-effective means of reducing use, CERT is expected to stimulate utilities' interest and involvement in other measures such as microgeneration, as the insulation programmes become more difficult and expensive, and it become more cost-effective to invest in microgeneration. Some utilities are already pursuing at least tentative involvement in GSHP activity (e.g. Scottish and Southern, and npower).

In the building sector, most direct incentive for energy efficiency in housing comes from building regulations, the new Code for Sustainable Homes, and the recently announced long-term target of zero-carbon new homes. For public buildings, the pressure comes from policies to increase energy efficiency in hospitals, in local government and in particular in schools. Besides being potential HP users, as housing authorities and operator of public facilities, and hence clients for energy advice and design and installation services, local authorities also have an influence as planning authorities, indirectly over siting of buildings and directly in permitting drilling or other major siteworks.

The organisation of the range of functions in the HP industry is already complex despite the poor development of the market so far. Different types of supplier and intermediary organisation are involved, some specialist and some with diverse interests, they relate and intersect in different ways, and their roles overlap significantly. It is important to clarify the structure and monitor changes in it in order to judge the most appropriate and effective ways of intervening to strengthen the market.

- 
- i GSHP-based cooling is almost unknown.
  - ii The BRE list of approved GSHPs now has a range of models from 34 UK and overseas manufacturers.
  - iii e.g. BRE, now a private research and consultancy company but formerly a public agency as the Building Research Establishment.