

Advanced sustainable energy technologies for cooling and heating applications

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SUMMARY

Multi-energy sources, for heating and cooling purposes, are considered to have a large potential in contributing to the penetration of renewable energy sources for domestic, building and industrial applications. But it requires that conventional heating and cooling systems have to be adapted or changed for incorporating renewable energy sources. Nowadays, the heating, ventilating and air-conditioning industries are the actors which have access to the market, and they provide services using mainly fossil fuels or electricity as energy sources. The objective is to have them using renewable energy, combining conventional and renewable sources and proposing environmental cost-effective products.

The technical goal of this project is to set-up technology resource centres in Europe, with the aim of building bridges between the technology providers (research centres, universities and industry) and the technology users (manufacturers, engineering companies...). The project outputs are:

- Creation of the clubs/grouping
- Collection of RTD results
- Development of design tools for evaluating and sizing the new technologies
- Best practice and training programme
- Creation of a knowledge resource centre relying on multi language search engines based on craft ontologies and terminologies
- International collaboration with China

For this 13 partners are collaborating to this project. The consortium is composed of centres of excellence in the area of renewable energies, energy agencies and professional associations representing industry.

INTRODUCTION

The growing demand for energy despite limited fossil fuel reserves and growing environmental concerns is probably the major challenge of the 21st century. To achieve a sustainable development, the origin and the usage of energy have to be addressed, and advanced renewable energy technologies and energy carriers have to be developed, requiring significant progress in research and technology.

The objective of this project is to support industrial manufacturers and engineering companies of heating and cooling systems (including energy storage) in their development, by introducing more renewable energy sources in their technology. For European countries, according to the IEA, thermal use of energy represents more than 25% of the gross energy

consumption. Multi-energy sources, for heating and cooling purposes, are considered to have a large potential in contributing to the penetration of renewable energy sources for domestic, building and industrial applications. But it requires that conventional heating and cooling systems have to be adapted or changed for incorporating renewable energy sources. Nowadays, the heating, ventilating and air-conditioning industries (HVAC) are the actors which have access to the market, and they provide services using mainly fossil fuels or electricity as energy sources. The objective is to have them using renewable energy, combining conventional and renewable sources and proposing environmental cost-effective products.

The technical goal of this project is to set-up technology resource centres in Europe, with the aim of building bridges (figure 1) between the technology providers (research centres, universities or industry) and the technology users (manufacturers, engineering companies, architects, local actors...). The technology user is a company or a professional organisation which is going to incorporate in its system/service renewable energy technologies.

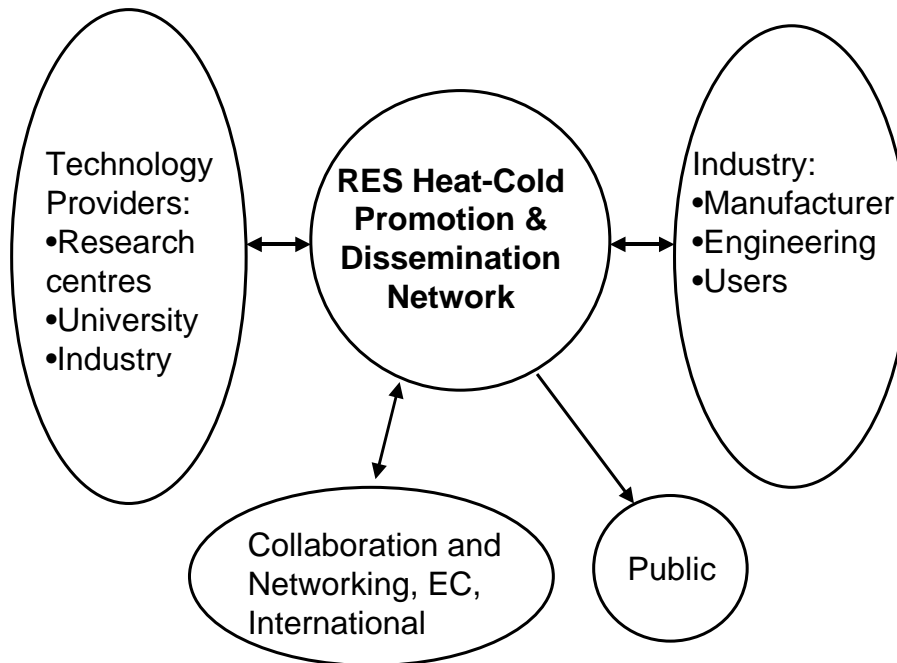


Figure 1 : Overview of the project methodology

A technology resource centre is where industry can find resources for developing and improving their technology. A resource centre might have its own research capacity or collaborates with technology providers such a research centre (private or public) or universities. A resource centre is the focus point of industrial actors in a same area, it associates manufacturers (components and systems), engineering companies, end-users, and energy providers.

Technology resource centres have five main goals:

- To bring new technologies from research to the market
- To promote trans-national collaboration
- To support companies in problem solving
- To be identified as a partner to manage industrial RTD projects
- To access and to share data and expert knowledge base

RENEWABLE ENERGY SOURCES FOR HEATING AND COOLING

To be effective and to take into account the specificity of the market, this project focuses on renewable heating and cooling technologies: **RES-HC**. It concerns **solar heating and cooling, biomass (heat), heat pumps, geothermal heat and energy storage**. The objective is to facilitate the introduction of RTD results into the market by establishing technology resource centres. These centres will operate on a common basis, sharing tools, data-base and exchanging information.

Within this project, 7 technology resource centres will be established and linked by the end of the project. The effective technology transfer will be insured by associating industrial partners to the project. The objective is to get at least 500 industrial partners connected to the network and benefiting from its output.

A virtual knowledge base resource centre relying on a dedicated multi-language search engine will be created. 6 centres of excellence in the area of RES-HC will contribute by linking their data and project results references. This platform will be open to other centre of excellence wishing to share informations.

This project is technology oriented, and aims in structuring the scientific and technical background for developing and optimising RES-HC systems. It contributes to the technology and industrial development phase of the product life cycle development, as the marketing phase is essentially controlled by non technical issues such as policy measures and financing options.

For RES-HC technologies, it is believed that the market penetration will be insured by associating the traditional actors of the sectors to manufacturers focusing on single RES-HC technology. The growing interest of manufacturers of gas-fired boilers for space heating and hot water to renewable energy sources confirms the strategy proposed in this project.

The traditional actors in the heating and ventilation industry are mainly composed of small and medium enterprises, which have low research and technology development activities. On the contrary, the companies involved in RES-HC are more innovative. Therefore, there is a clear need in supporting the traditional industry in incorporating renewable energy sources in their systems and to associate technology providers of RES-HC for developing and marketing new products.

Individual renewable energy sources have advantages but also drawbacks, such as intermittency of the source or difficulty of supply. To cope with these drawbacks, and to provide an efficient service to the final user, it is necessary to associate various energy sources and energy storage. Solutions have been proposed developed and tested within several research projects and need now to be appropriated by the actual industrial actors. For this they need to get the information, to identify the right partners and to set-up a collaborative agreement for optimising and marketing new products, and these are the role of technology resource centres.

THE POTENTIAL OF RES-HC TECHNOLOGIES

Market Potential

This project focus on renewable heating and cooling technologies for domestic, building and industrial applications. The renewable heating and cooling energy sources are biomass, solar thermal and geothermal (including heat pumps). In 2000, the energy consumption for thermal power generation (including district heating) is 410 Mtoe/year, which represents 25% of the gross EU-25 energy consumption [1]. At this value must be added 16 MWh/year of electricity consumption for building and residential air-conditioning (recent surveys have estimated an electricity consumption of 29 MWh/year in 2010[2]).

For RES-HC [3], the EU 1997 white paper on energy gives a target for 2010, of a market share of 80 Mtoe, 20% of the thermal power generation [1]. In 2001, the market share is 48.7 Mtoe, 12% of the thermal power generation [4]. This requests an average growing rate of 5 to 6% until 2010. Even if the situation has progressed since 1997 (see figure 2), the 20% average market share will probably not be reached in 2010, and an extra 2% must be achieved. In order to reach this objective both market pull and technology push measures have to be adopted. This project will concentrate on developing and promoting cost-effective technologies and systems. The Bielefeld Declaration (14 May 2004), has emphasised that specific measures have to be taken in favour of RES-HC if a 20% market share of the thermal power generation must be reached in 2020.

Even if the overall RTD expenditure on renewable energy sources is slowly increasing in Europe [5], the effort related to RES-HC is decreasing each year since 1980, representing nowadays less than 10% of the total effort on RES. This lower support is in contradiction with the high potential of RES-HC, and a more vigorous support policy must be implemented at the European level [6].

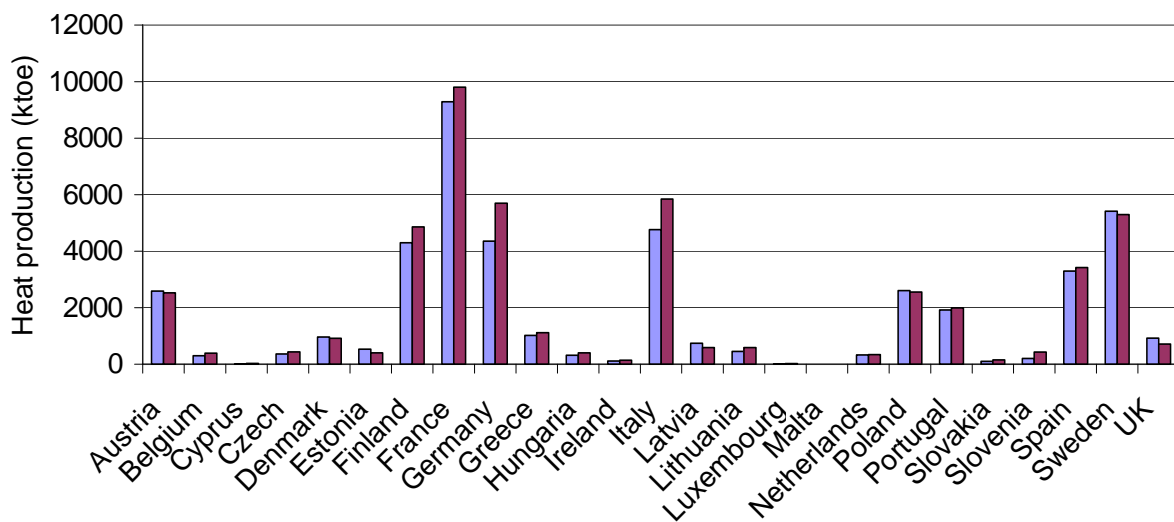


Figure 2: RES-Heat production for the EU-25 for 1997 and 2001

The potential of RES-Heat has been recently evaluated for the European Union [7] and is summarised in the table 1. As it can be seen, depending on the source and the country, there are very significant market penetrations of the renewable energy sources for heating and cooling (RES-HC). Biomass has from far the largest market penetration, having reached

almost 50% of its long term potential. For EU-25; biomass and geothermal energies are mature technologies that contribute about 3% to primary energy supply. Solar, heat pumps other new renewables have experienced rapid technology development, but as yet they represent only a small share.

The main figure is that biomass is nowadays the major provider of renewable thermal energy, but it will reach 75% of its potential in 2010. The contribution of the other sources (heat pumps, solar and geothermal) could potentially contribute to the same amount but is nowadays much less important. Heat pumps and solar renewable sources needs another source of energy to provide the total thermal needs, therefore it is only by associating various energy source that these technologies could reach their full potential. This project will concentrate on multi renewable energy sources technologies.

Table 1: Market penetration of RES-HC systems in EU-25 [7-8-9-10]

Source	Penetration (year 2002)			Energy (Mtoe)		
	Minimal	Maximal	Average	2001	2010 target	Potential
Biomass	10%	70%	47%	46.90	75.0	100.0
Solar thermal	0%	30%	<2%	0.57	4.0	36.0
Heat pumps	0%	30%	<2%	0.40	1.0	32.0
Geothermal (grid)	0%	40%	<2%			3.0
Geothermal (total)*				0.83		
Total				48.7	80.0	171.0

* The total geothermal heat production is complex to analyse due to various applications and the calculations methods varies from one country to another (contribution of hot springs).

It has been recognised [5] that hybriding fossil fuel and renewable energies will accelerate market penetration of RES. The technical and financial risks can be minimised, therefore being more attractive for investors. Hybrid and multi-sources systems are particularly applicable to renewable heating and cooling.

Social and environmental impacts

Renewable energies and in particular heating and cooling technologies are decentralised markets and create employment essentially at a local stage. The manufacturers involved in such activity are often small and medium enterprises ranging from few employees to several hundreds. Furthermore, the installation and maintenance of these equipments will require specialised workers [5].

The replacement of fossil fuel heating systems by renewables will induce a modification of the individual behaviour and will have impact on employment [11]. Fossil fuel heating systems implies generally relatively low investment and after 10 years of operation, the cost for the fuel is largely the first expense. On the contrary, renewables have high capital cost and low operating cost. Therefore, the financial amount which is spent for buying fossil fuels (mainly imported) is mainly replaced by an equivalent amount in hardware which are mainly produced in Europe. An energy consumption of 80 Mtoe of fossil fuels (gas and oil), correspond roughly to an expense of 40,000 M€(30 €/MW.h and average energy efficiency of 70%). If this expense is partly replaced by capital costs for investment in renewable technologies, it is expected to induce the employment of 400,000 persons.

This project will contribute in creating employment in small and medium enterprise of the heating, ventilation and air-conditioning industries, by introducing more renewable energy technologies in the systems they are developing and installing. The activity of manufacturers of RES-HC systems (solar panels, biomass heaters, heat-pumps...) will also be strengthened.

From an economic point of view as RES-HC technologies are capital intensive energies, the present period is particularly interesting for the development of RES technologies. This is due to a relatively low cost of money (yearly interest below 4%) and high cost of energy. If the different incitation measures in favour of RES are promoted and increased it will guarantee the development of RES-HC in Europe.

The adoption of the Kyoto protocol implies that Europe has to reduce its CO₂ by 5% in respect to its level in 1990, and heating and cooling are particularly concerned by CO₂ emissions. Renewable energy sources are by definition environmental clean energies and contribute to preserving natural resources and prevent global warming. The CO₂ emissions of such system are significantly reduced compared to fossil fuel system, and this even taking into account the energy required for manufacturing the system (life cycle impact assessment). The use of renewable energies for heating and cooling purpose has indirect environmental impacts. If 80 Mtoe of fossil fuels are replaced by renewable energy it will affect the distribution schemes of energy: (1) less transport of liquid fuels by sea, river, train and road which reduces the harmful effects (pollution risks, number of trucks on the roads...); (2) reduced peak effects for the electric demand in winter time for heating and summer time for cooling and induces a better management of the electric network.

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