



Annex 51

Acoustic Signatures of Heat Pumps

Final Report – Part 6

2.1 Selection of Heat Pumps
for Round Robin Tests
Market figures

Editors:
François Bessac (CETIAT)
Michèle Mondot (CETIAT)

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Heat Pump Centre
c/o RISE – Research Institutes of Sweden
Box 857, SE-501 15 Borås
Sweden
Phone +46 10 16 53 42

Website

<https://heatpumpingtechnologies.org>

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Preface

This project was carried out within the Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP), which is a Technology Collaboration Programme within the International Energy Agency, IEA.

The IEA

The IEA was established in 1974 within the framework of the Organization for Economic Cooperation and Development (OECD) to implement an International Energy Programme. A basic aim of the IEA is to foster cooperation among the IEA participating countries to increase energy security through energy conservation, development of alternative energy sources, new energy technology and research and development (R&D). This is achieved, in part, through a programme of energy technology and R&D collaboration, currently within the framework of nearly 40 Technology Collaboration Programmes.

The Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP)

The Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP) forms the legal basis for the implementing agreement for a programme of research, development, demonstration, and promotion of heat pumping technologies. Signatories of the TCP are either governments or organizations designated by their respective governments to conduct programmes in the field of energy conservation.

Under the TCP, collaborative tasks, or "Annexes", in the field of heat pumps are undertaken. These tasks are conducted on a cost-sharing and/or task-sharing basis by the participating countries. An Annex is in general coordinated by one country which acts as the Operating Agent (manager). Annexes have specific topics and work plans and operate for a specified period, usually several years. The objectives vary from information exchange to the development and implementation of technology. This report presents the results of one Annex.

The Programme is governed by an Executive Committee, which monitors existing projects and identifies new areas where collaborative effort may be beneficial.

Disclaimer

The HPT TCP is part of a network of autonomous collaborative partnerships focused on a wide range of energy technologies known as Technology Collaboration Programmes or TCPs. The TCPs are organized under the auspices of the International Energy Agency (IEA), but the TCPs are functionally and legally autonomous. Views, findings and publications of the HPT TCP do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.

The Heat Pump Centre

A central role within the HPT TCP is played by the Heat Pump Centre (HPC).

Consistent with the overall objective of the HPT TCP, the HPC seeks to accelerate the implementation of heat pump technologies and thereby optimize the use of energy resources for the benefit of the environment. This is achieved by offering a worldwide information service to support all those who can play a part in the implementation of heat pumping technology including researchers, engineers, manufacturers, installers, equipment users, and energy policy makers in utilities, government offices and other organizations. Activities of the HPC include the production of a Magazine with an additional newsletter 3 times per year, the HPT TCP webpage, the organization of workshops, an inquiry service and a promotion programme. The HPC also publishes selected results from other Annexes, and this publication is one result of this activity.

For further information about the Technology Collaboration Programme on Heat Pumping Technologies (HPT TCP) and for inquiries on heat pump issues in general contact the Heat Pump Centre at the following address:

Heat Pump Centre

c/o RISE - Research Institutes of Sweden

Box 857, SE-501 15 BORÅS, Sweden

Phone: +46 10 516 53 42

Website: <https://heatpumpingtechnologies.org>



Acoustic Signatures of Heat Pumps

IEA HPT

Annex **51**

2.1: Selection of Heat Pumps for Round Robin Tests

Market figures



François BESSAC (CETIAT)

Michèle MONDOT (CETIAT)

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1 INTRODUCTION

This part of Annex 51 pursues several objectives:

First, performing a Round Robin Test between the participating laboratories to check that the measurements give close results and to get a feedback on the standards implementation.

This part §2.1 gives the approach used to select the type of heat pumps to be tested.

2 HP MARKET AND SELECTION OF HEAT PUMPS FOR RRTs

2.1 *Some figures of the HP market*

For this round robin test, units had to be selected.

It was decided to identify the European market shares for the different typologies and capacity ranges of heat pumps and to select the most representative ones.

Let's consider some figures of the EHPA Outlook 2017 (Table 1) which show that the most common heat pumps in the EU are air-to-air units with 500k unit, followed by air-to-water units (277k) and finally heat pump water heaters (125k).

This table also presents the amount of sold units in 2017 for the participating countries of Annex51, with highly contrasted values, e.g. no air-to-air units in Germany, no heat pump water heaters (HPWH) in Sweden.

Number of units	UE	AT	DE	DK	FR	IT	SE	Total
Air-to-water (Outdoor + exhaust)	277 712	12 076	45 800	3 773	74 595	26 960	23 413	186 617
water(brine)-to-water	86 076	4 479	18 350	2 248	2 199	762	22 843	50 881
Air-to-air (Outdoor + exhaust)	500 824	82	0	21 396	61 503	145 605	55 000	283 586
Heat pump water heaters (outdoor + exhaust)	124 844	5 556	12 450	40	80 753	2 944	0	101 743
Sub-total	989 456	22 193	76 600	27 457	219 050	176 271	101 256	622 827
Others	5 635							
Total	995 091							
Population (millions)	508	9	81	6	66	61	10	232

Table 1: the European HP market in 2017



Nb units per 1000 inhabitants

Number units / Million inhab.	UE	AT	DE	DK	FR	IT	SE
Air-to-water (Outdoor + exhaust)	546	14.1	5.6	6.8	11.2	4.4	24.0
water(brine)-to-water	169	5.2	2.3	4.0	0.3	0.1	23.4
Air-to-air (Outdoor + exhaust)	985	0.1	0.0	38.5	9.3	23.9	56.4
Heat pump water heaters (outdoor + exhaust)	246	6.5	1.5	0.1	12.2	0.5	0.0
Total	1947	26	9	49	33	29	104

Table 2: number of units sold per 1000 of inhabitants

Table 2 shows that Sweden and Denmark are the largest markets in terms of heat pump penetration, represented by the number of units installed per inhabitants.

Considering the figures for each country, it shows that air-to-water is widely used in Germany and Austria, and also in France. The HPWH is also common in these same countries. The air-to-air is widely used in Denmark, Italy and Sweden.

Market share	UE	AT	DE	DK	FR	IT	SE	Total	Annex 51/UE share
Air-to-water (Outdoor + exhaust)	28.1%	54%	60%	14%	34%	15%	23%	30%	67%
water(brine)-to-water	8.7%	20%	24%	8%	1%	0%	23%	8%	59%
Air-to-air (Outdoor + exhaust)	50.6%	0%	0%	78%	28%	83%	54%	46%	57%
Heat pump water heaters (outdoor + exhaust)	12.6%	25%	16%	0%	37%	2%	0%	16%	81%
Sub-total	100.0%	100%	100%	100%	100%	100%	100%	100%	63%
Population		4%	35%	2%	29%	26%	4%	100%	46%

Table 3: the European HP market in 2017 in % for the countries of Annex 51 participants

Table 3 shows the figures for the market share in EU and Annex 51 participating countries, highlighting the following points:

- Air-to-water units are widely used in the EU.
- HPWH are common in France, Austria and Germany
- Air-to-air units are widely used in Sweden and Denmark, but also in Italy maybe with reverse units for cooling
- Water-to-brine units are representing about 25% of the market share in Northern countries but less than 8% in the EU.

2.2 Selection of units

Following this market analysis and considering that as all typologies of heat pumps could be tested, the water-to-brine has been ignored.

For the project of standard prEN 12102-2 (finally published in 2019), which implements a new kind of approach due to non-steady behavior, a round-robin test on HPWH was a perfect opportunity.



According to these considerations, for the round robin tests (RRT) the following types of heat pumps have been selected:

- Air-to-water unit (RRT1)
- Air-to-air unit (RRT3)
- Heat pump water heater (RRT4)

The results of RRT1 and RRT4 are presented in the report 2.2.

3 CONSIDERATIONS FOR ESTABLISHING A TEST PROGRAM

3.1 Air-to-water heat pump

For this kind of heat pump, only outdoor unit noise is considered, as the indoor side has only a water pump.

The main idea is to determine the sound power levels for several operating conditions, of course the classical EN 14511 A7(6) W30/35 and EN 12102-1 conditions, but also the series of points A to F of EN 14825, with partial load operation of the heat pump.

The objective is to have a wide view of sound power levels in various conditions, which are rarely encountered and measured by laboratories, e.g. for the certification programs.

Moreover, in the colder conditions, frosting/defrosting cycle will occur, allowing describing the time evolution of the sound power level during the defrosting phase, but also the influence of icing on noise.

3.2 Heat Pump Water Heater

The heat pump water heaters are quite new types of units, and the standard to determine their sound power level was still in progress during the start of the Round Robin Test, with prEN 12102-2.

Their specificity is to be stand-alone units, without connection to continuous water circulation, as it is the case for air-to-water heat pump for example. This means that the operating condition is not steady during the heating up of the water tank, then during the acoustic measurement time, being quite different of all measurement of usual EN 12102-1.

This non-steady behavior requires performing measurement in a short time window (15 minutes max.) to avoid big temperature change on the condenser.

The selected HPWH is an "exhaust air with integrated fan", one of the most challenging type to implement with double duct, 3 different noise levels to measure, airflow and available pressure to manage, and finally, calculations to take into account the duct end correction and the elbow correction.



Heat Pump Centre

c/o RISE - Research Institutes of Sweden

PO Box 857

SE-501 15 BORÅS

Sweden

Tel: +46 10 516 5512

E-mail: hpc@heatpumpcentre.org

www.heatpumpingtechnologies.org

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