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ANNEX 51 "ACOUSTIC SIGNATURES OF HEAT PUMPS"
IN THE FRAMEWORK OF THE INTERNATIONAL,
ENERGY AGENCY TECHNOLOGY COLLABORATION
PROGRAMME ON HEAT PUMPING TECHNOLOGIES
(IEA HPT)



Acoustics of Heat Pumps

Workshop, 29.08.2019



Acoustic Signatures
of Heat Pumps

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IEA HPT Annex 51



POLITECNICO
DI MILANO



MOTIVATION

"Especially Air-to-Water Heat Pumps play an important role to reach the **climate goals**."

"**Acoustic Emissions** have the potential to **slow down** the necessary market growth."

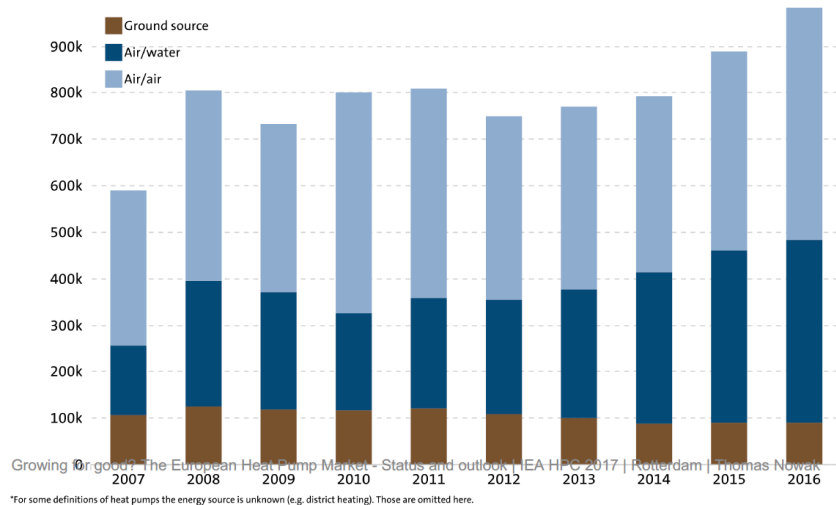


MOTIVATION MARKET INCREASE IN HEAT PUMP SALES

- Europe

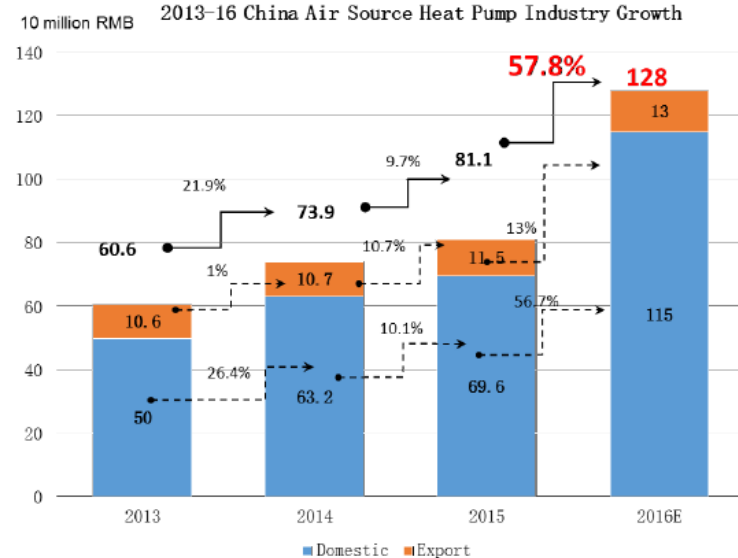
Heat pump sales 2007 - 2016

By energy source



- China

In 2016, 12.8 billion RMB turnover
(Factory price)



IEA TECHNOLOGY COLLABORATION PROGRAMMES



ANNEX
51

START DATE:
1 April 2017
END DATE:
31 March 2020



Cross-Cutting

End-Use: Buildings

End-Use: Electricity

End-Use: Industry

End-Use: Transport

Fossil Fuels

Fusion Power

Renewable Energy

End-Use: Buildings

- » Buildings and Communities (EBC TCP)
- » District Heating and Cooling (DHC TCP)
- » Energy Efficient End-Use Equipment (4E TCP)
- » Energy Storage (ECES TCP)
- » Heat Pumping Technologies (HPT TCP)



IEA TECHNOLOGY COLLABORATION PROGRAMME ON HEAT PUMPING TECHNOLOGIES

- **What is the HPT TCP?**

- A Technology Collaboration Programme (TCP) within **the IEA** since **1978**
- An international framework of **cooperation** and **networking** for different HP actors
- A forum to exchange **knowledge** and **experience**
- A contributor to **technology improvements** by RDD&D projects (Annexes)
- 17 member countries



- **Main areas of work**

- Affordable and competitive heating and cooling technologies
- Flexible, sustainable and clean system solutions using heat pumps with other technologies
- Opportunities offered by developments in digitalisation and the Internet of Things
- New or special markets and applications for heat pumping technologies
- New, alternative or natural refrigerants with low global warming potential



- **13th IEA HEAT PUMP CONFERENCE 2020,**

- “Heat Pumps - Mission for the Green World”
- May 11 – 14, 2020 / Ramada Plaza Hotel Jeju, Korea

Reduction of acoustic emissions and the transient behaviour of acoustic signatures during different operating conditions (e.g. icing, de-frosting, capacity control, cooling mode) is important to further **increase the acceptance of heat pumps** as air-to-water, water-to-air and air-to-air units (referred to as “units” in the following text. Depending on the source used, noise is an indoor-only issue for the end user and/or an outdoor issue, for the neighbour as well. Furthermore, both **new and retrofit markets** are important to be considered, and a silent and effective way to exploit the potential energy savings.

**Increase the acceptance
of heat pumps!**

Acoustic emissions have to be assessed in a hierarchical approach considering the **component level** (e.g. low noise components: fans and compressors), the **unit level** (combining the components, unit control, transient acoustic features), and the **application level** (building/neighbourhood, including smart grid, **psychoacoustic effects** & acoustic propagation). Furthermore, **Education & training** are very important aspects in heat pump acoustics (placement, noise reduction measures, modes of control & operation) so that bad installations will not go against good acoustic design and construction of the units. As the current legislation is globally very diverse (also serving the needs of the different locations & countries), the Annex is structured to contribute to **guidance and future standards** in this field.

PARTICIPATING COUNTRIES AND TASKS



Task 1: *Legislation and standards*



Task 2: *Definition of heat pump units to be covered by the study / testing*



Task 3: *Identification of noise at component and unit levels and noise control techniques*



Task 4: *Analysis of the effect of operating conditions of heat pumps on acoustic behaviour*



Task 5: *Heat pump installation and effects on surrounding environment*



Task 6: *Improved measuring and description of the acoustic performance*

Task 7: *Diffusion & dissemination of information; Guidelines, Education material, Recommendations for different user groups*



ANNEX 51 INFORMATION

ANNEX 51

Acoustic Signatures of Heat Pumps

Reduction of acoustic emissions is important to further increase the acceptance of heat pumps as air-to-water, water-to-air, air-to-air and brine-to-water (ground source) units. To increase this acceptance and minimize noise annoyance more focus has to be put on the acoustics emissions at steady state and transient behaviour of acoustic signatures during different operating conditions (e.g. icing, de-frosting, capacity control, cooling mode).

The primary aim with Annex 51 is to further increase the acceptance of heat pumps (as air-to-water, water-to-air, air-to-air and brine-to-water units) for comfort purpose with respect to the noise and vibration emissions.

A second focus is placed on increasing knowledge at different levels (manufacturers, acoustic consultants, installers, legislators). To reach this goal, first different reasons to reduce sound emissions depending on countries (legislation), locations and applications have to be gathered and understood. The main influencing factors to the acoustic signature of these units will be identified. Collecting and combining research results in these fields on the different implementation levels (component, unit and application) will finally lead to directions for improved components, units and control strategies including guidelines, as well as training and inputs to future standards. The aim is to gather the knowledge and expertise of the participants on the different levels in order to forward this knowledge and establish recommendations and advices.

<https://heatpumpingtechnologies.org/annex51/>

SUMMARY AND OUTLOOK

- **IEA HPT Annex 51** "Acoustic Signatures of Heat Pumps" with 12 participating institutions from 6 countries
- **Legislative situation** complex
- Innovative **measurement techniques** allow for sound source localisation and time-, space- and frequency resolved analysis of emissions on **component-** and **systemlevel** and assessment of **vibrations**
- **Simulation techniques** (frosting / defrosting, sound field simulations, 1D system simulations, VR/AR)
- Psychoacoustics
- Measurements and data analysis in several European institutes



ACKNOWLEDGEMENTS



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 Federal Ministry
Republic of Austria
Transport, Innovation
and Technology



FFG



IEA RESEARCH
COOPERATION



THANK YOU!

Thomas Fleckl

29.08.2019

