POLITECNICO MILANO 1863

tecnalia

AES Solar Established 1979

THERMOWATT

Balkanika ENERGY

Solintel

Sunamp Heat Batteries™

WATT+VOLT ELECTRICITY | NATURAL GAS

HEAT4COOL

ehpa european heat pump association

IZNAB Sp. z o.o. "Innovation Oriented To Business"

Symelec ENERGIAS RENOVABLES

FAHRENHEIT Cooling Innovation.

HOCHSCHULE LUZERN

WP3 Integration of Heating and Cooling solution

Eliza Nowak, (Fahrenheit)

Heat4COOL project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 723925

Objectives

- Dimensioning and optimization of a plug&play solution based on an Adsorption Heat Pump assisted by Solar thermal system.
- Dimensioning, optimization and effective integration of a plug&play solution based on a PV array, AC/DC heat pump, and Heat/Cold Battery system.
- Evaluation of both solutions under real conditions at Kubik (pre-trials) and in multiple trial sites in different European Countries and climates
- Development of a new heat exchanger in order to install it in District 4 (Budapest) and optimize the heat recovery from sewage water. By matching optimised heat transferring surfaces with design elements to support resolution of the negative effects of sludge accumulation, the energy efficiency of the heat pump cycle as well as operation safety is significantly increased.

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Tasks, Deliverables and Milestones

Task leader	Task	Details
FAHRENHEIT	**T3.1.** Solar assisted thermal driven Adsorption Heat Pump	Duration: M4 – M53 **Achieved milestone:** M3 Optimized prototype of Solar assisted Thermal driven Adsorption Heat Pump. (see D3.3)
SUNAMP	**T3.2.** Effective design and integration of solar PV, AC/DC Heat Pump and PCM scalable heat storage system	Duration: M4 – M29 (M40) **Achieved milestone:** M4 Optimized prototype of the integration of Solar PV, AC/DC Heat Pump and PCM scalable heat storage system. (see D3.4)
TECNALIA	**T3.3.** Integration and evaluation of Heating and Cooling solutions at KUBIK testing building	Duration: M18 – M29 (M38)
THERMOWATT	**T3.4.** Design and optimization of an innovative heat exchanger utilizing sewage water	Duration: M4 – M18 (M24)
POLIMI	**T3.5.** Performance modelling and evaluation of the effective integration of Heating & Cooling solutions with the Heat Recovery system	Duration: M13 – M24 (M25)

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Tasks, Deliverables and Milestones

Reporting period	Deliverable	Details / Status
M1-M18	**D3.1.** First prototype of solar assisted thermal driven Adsorption Heat Pump (FAHR)	**Submitted & Approved**
	D3.2. First prototype of the integration of Solar PV, Heat Pump and PCM scalable heat storage system (Sunamp)	**Submitted & Approved**
	D3.7. Design and optimization of an innovative heat exchanger (Thermowatt)	**Submitted & Approved**
M19-M36	**D3.3.** Optimized prototype of Solar assisted Thermal driven Adsorption Heat Pump (FAHR)	**Submitted & Under Revision**
	D3.4. Optimized prototype of the integration of Solar PV, Heat Pump and PCM scalable heat storage system (Sunamp)	**Submitted & Under Revision**
	D3.5 Test report for the Solar assisted Thermal driven Adsorption Heat Pump (TECNALIA)	**Submitted & Under Revision**
	D3.6 Test report for the integration of Solar PV, Heat Pump and PCM scalable heat storage system (TECNALIA)	**Submitted & Under Revision**
	D3.8. Evaluation of the integration of Heating & Cooling solutions with the HEX system (POLIMI)	**Submitted & Approved**
M37-M54	**D3.9.** Additional test report for the solar assisted AHP installed in Toledo (FAHR)	**Submitted & Under Revision**

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Task 3.1. Solar assisted thermal driven Adsorption Heat Pump

Task completed in RP3 (M54)

Main goals:

- Development and optimization of the solar assisted thermally driven adsorption heat pump.
- Field testing of the optimized prototype in Toledo to enhance the exploitation potential of the developed technology.

Outcomes:

- First prototype built and tested at Fahrenheit's facility (D3.1)
- Optimized prototype for tests in Kubik
- Further optimization of the prototype (D3.3)
- Field testing of the prototype in progress (system ready for commissioning in week 20).

Activities in RP3:

- Production and lab testing of the optimized prototype for Toledo (D3.9)

Relation with other work packages:

- Simulation of the system performance (D4.7)
- Development of the engineering design with control and performance monitoring strategy (D6.9)

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Task 3.1. Solar assisted thermal driven Adsorption Heat Pump

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T3.2. Effective design and integration of solar PV, AC/DC Heat Pump and PCM scalable heat storage system

Task completed in RP3 (M40)

Main goals:

- Development and optimization of the prototype of the integration of Solar PV, AC/DC Heat Pump and PCM scalable heat storage system

Outcomes:

- Full range of calculations and simulations for different scenarios to help sizing the system ← not one system fits it all;
- Real tests with different solar array size, heat pump size, heat battery size and temperatures.
- Installation and commissioning of 2 full systems of different sizes in 2 different trial sites.
- Operation continues following the end of the project to keep delivering benefits to the final users and data for the hardware suppliers and trial site managers.

Activities in RP3:

- Submission of D3.6
- Delivery of systems to trial site and commissioning in person (beginning of 2020)
- Servicing of technical failures / issues related to the system

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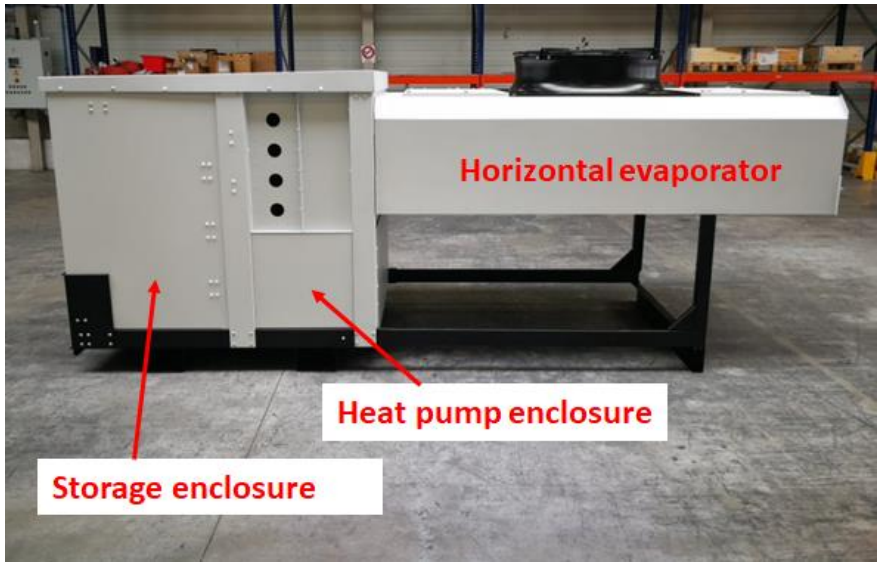
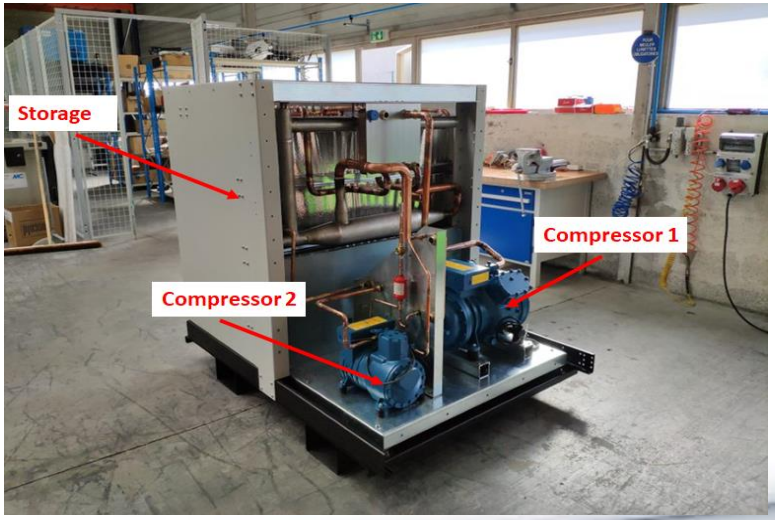
T3.2. Effective design and integration of solar PV, AC/DC Heat Pump and PCM scalable heat storage system





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T3.2. Effective design and integration of solar PV, AC/DC Heat Pump and PCM scalable heat storage system

Heat Batteries installation at Kubik

Heat Batteries installation at a trial site (Katowice)

Delivery of heat pump to at a trial site (Katowice)

Heat pump under construction (for Sofia trial site)

Commissioning phase of the heat pump+heat batteries sysem (Katowice)

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T3.3. Integration and evaluation of Heating and Cooling solutions at KUBIK testing building

Task completed in RP3 (M38)

Main goals:

- Proof of concept set up to assess the thermal performance of Heat4Cool system
- Installation and testing of the key components of the developed technologies in Kubik
- Validation of the energy savings associated with the Heat4Cool technologies

Outcomes:

- Test report for the adsorption heat pump (D3.5)
- Test report for the Solar PV, AC/DC heat pump and PCM storage (D3.4)
- The experience of designing, implementing and testing the two systems
- Data about the performance under realistic working conditions and identification of necessary further improvements.
- Provide valuable experiences and inputs based on the lessons learnt about the implications during installation, commissioning and adjustment of the systems and components.

Activities in RP3:

- Submission of D3.4

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T3.3. Integration and evaluation of Heating and Cooling solutions at KUBIK testing building

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T3.4. Design and optimization of an innovative heat exchanger utilizing sewage water

Task completed in RP2 (M24)

Main goals:

- Development of an innovative wastewater utilising heat exchanger to enhance performance, operational safety and economical operation of the wastewater heat recovery technology

Outcomes:

- Design and optimization of innovative HX, development of 5 different designs (D3.7)
- Manufacturing of the prototype heat exchangers – 2 designs, 2 pieces each (Nov 2018)
- HX Design aiding heat transfer simulation tool software (D3.7)
- Development of new design Fine Screen with built-in automated cleaning (D3.7)
- Manufacturing of the prototype fine screen (Dec 2018)
- Identification, experimentation and evaluation of different cleaning methods

Activities in RP3:

- None

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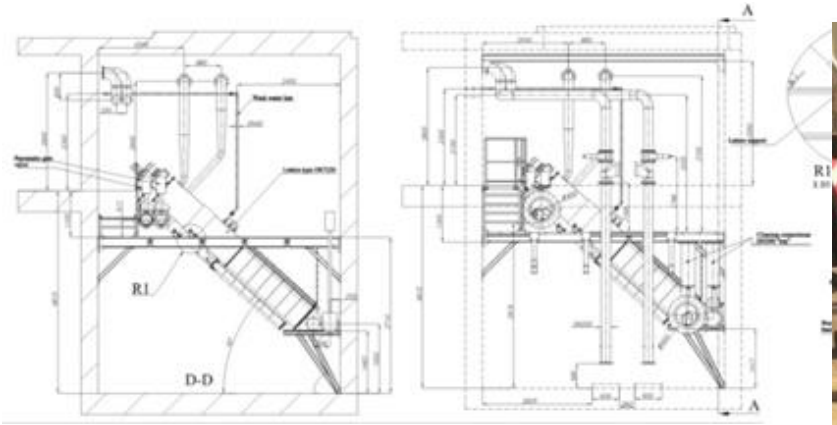
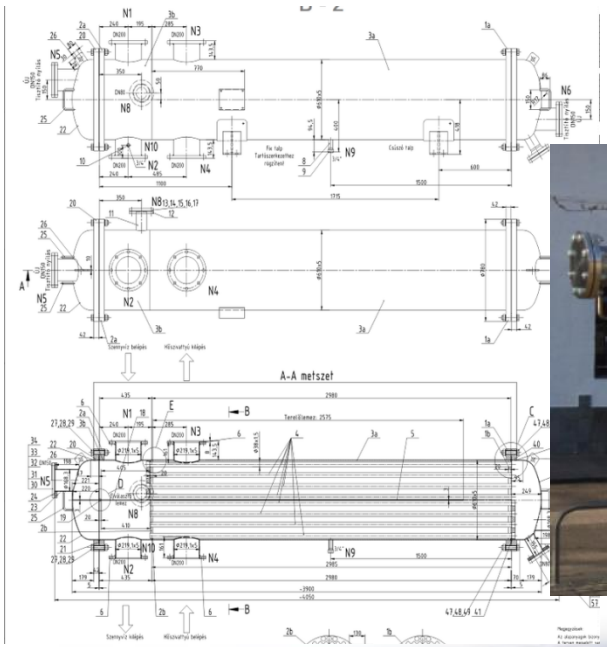
T3.4. Design and optimization of an innovative heat exchanger utilizing sewage water





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T3.5. Performance modelling and evaluation of the effective integration of Heating & Cooling solutions with the Heat Recovery system

Task completed in RP2 (M25)

Main goals:

- Simulate the energy performance of Heat4Cool technologies integrated with the wastewater heat recovery system, considering 1) representative buildings' heating and cooling loads in present and future district heating networks and 2) the wastewater flow characteristics (temperature, velocity, flow intermittence, seasonal variation)
- Carry out a project executive plan example with cost-benefit and environmental analysis.

Outcomes:

- Deliverable D3.8 completed (2/11/18)
- Paper presentation to 4DH conference (Aalborg, 13/11/18)
- Paper published on Energies (24/1/19)

From the abstract:

The energy and economic potential is explored for a commercial district in Italy. It is found that the overall seasonal COP and EER are 3.10 and 3.64, while the seasonal COP and EER of the heat pump alone achieve 3.74 and 4.03, respectively. The economic feasibility is investigated by means of the levelized cost of heating and cooling (LCOHC). With an overall LCOHC between 79.1 and 89.9 €/MWh, the proposed system can be an attractive solution with respect to individual heat pumps

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T3.5. Performance modelling and evaluation of the effective integration of Heating & Cooling solutions with the Heat Recovery system

Deliverable D3.8 Dissemination Level (CO) 723925-Heat4Cool

"This is part of the project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723925"

Project Title:

Smart building retrofitting complemented by solar assisted heat pumps integrated within a self-correcting intelligent building energy management system

HEAT4COOL

Heat4Cool

Grant Agreement No: 723925

Collaborative Project

Evaluation of the integration of heating & cooling solutions with the HEX system	
Deliverable No.	D3.8
Workpackage	WP3 – Integration of Heating and Cooling solutions
Task	Task 3.5. Performance modelling and evaluation of the effective integration of Heating & Cooling solutions with the Heat Recovery system.
Lead beneficiary	Polimi
Authors	Marcello Aprile, Rossano Scoccia (Polimi) Philipp Schütz, Damian Gwerder (HSLU) Peru Elguezabal, Alberto Armijo, Beñat Arregui (TEC) Dora Furesz, Marcell Dombrovszky (Thermowatt)
Delivery date	2/11/2018
Status	Release
File Name:	Heat4Cool_deliverable_3_8_Final.docx

Dissemination level		
PU	Public, fully open, e.g. web	
CO	Confidential, restricted under conditions set out in Model Grant Agreement	X
CI	Classified, information as referred to in Commission Decision 2001/844/EC.	

energies

MDPI

Article

District Power-To-Heat/Cool Complemented by Sewage Heat Recovery

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Abstract: District heating and cooling (DHC), when combined with waste or renewable energy sources, is an environmentally sound alternative to individual heating and cooling systems in buildings. In this work, the theoretical energy and economic performances of a DHC network complemented by compression heat pump and sewage heat exchanger are assessed through dynamic, year-round energy simulations. The proposed system comprises also a water storage and a PV plant. The study stems from the operational experience on a DHC network in Budapest, in which a new sewage heat recovery system is in place and provided the experimental base for assessing main operational parameters of the sewage heat exchanger, like effectiveness, parasitic energy consumption and impact of cleaning. The energy and economic potential is explored for a commercial district in Italy. It is found that the overall seasonal COP and EER are 3.10 and 3.64, while the seasonal COP and EER of the heat pump alone achieve 3.74 and 4.03, respectively. The economic feasibility is investigated by means of the levelized cost of heating and cooling (LCOHC). With an overall LCOHC between 79.1 and 89.9 €/MWh, the proposed system can be an attractive solution with respect to individual heat pumps.

Keywords: district heating; district cooling; heat pump; sewage; simulation

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Final results

- Innovative heat pump technologies developed, tested, and refined to be combined with solar energy (PV/Solar thermal).

- Further field testing of the adsorption heat pump in progress. The prototype has been manufactured and tested, engineering design has been completed and the simulation of the system performance has been performed. The system will be commissioned in week 20 and the monitoring of the cooling period will start.

- The experience of designing, implementing and testing the two systems in Kubik has provided relevant data about the performance under realistic working conditions. This has allowed better understanding of the system's response as well as to identify necessary further improvements.

- Heat exchangers for sewage water waste heat recovery with different designs, accompanying fine screen with automated washer system developed, tested and integrated in demo site – further testing of HX cleaning methods at demo site made possible.

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Issues encountered in M37-M54

- Massive delay in the completion of the installation in Toledo due to Covid 19 pandemic. The pandemic has influenced this activity through various reasons – difficulty in travelling, isolation of the residence, shortened production capacity, problems with suppliers and their lead times etc.

- When technical issues arose with the heat pump + heat battery systems, the whole issue assessment process and rectification process was more difficult then expected due to COVID-related travel bans. An issue that would have taken a few trips of Sunamp technicians to fix, turned out to take multiple weeks in order to: identify the issue from remote; find a local technician able and willing to fix the system, get the spare parts delivered, perform the service on the machine, recommission the machine.

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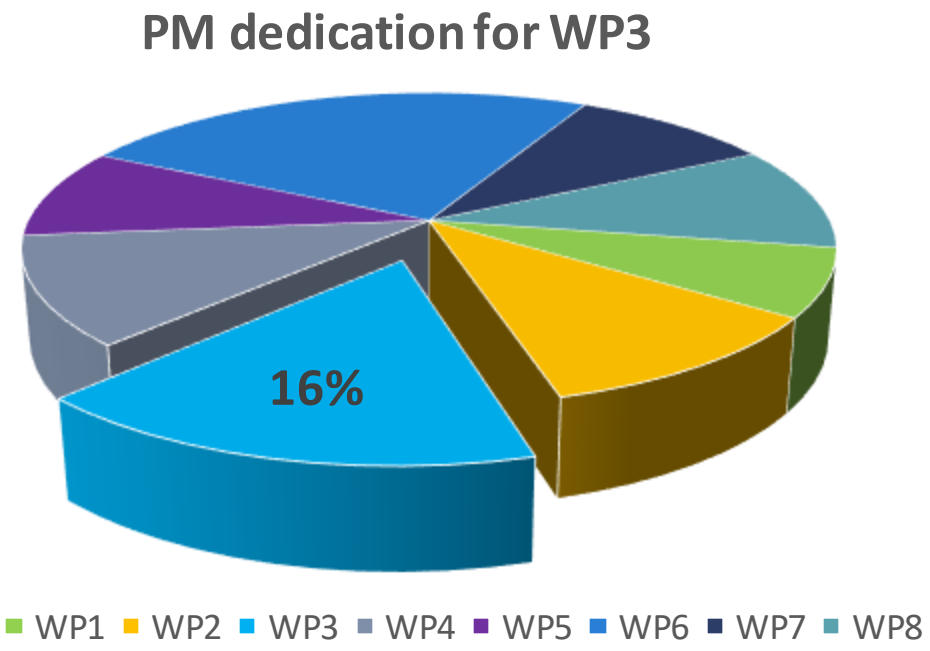
Planned use of PMs

WP1	53,5	7%
WP2	82	11%
WP3	126	16%
WP4	99	13%
WP5	70	9%
WP6	188	24%
WP7	73	9%
WP8	81	10%
TOT	**772,5**	**100%**



Associated Key Exploitable Result (KER):

Innovative HEX, cleaning methods, connecting screening

Solar PV assisted Heat Pump connected to advanced PCM heat energy storage

Solar assisted Thermal driven Adsorption heat pump

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Thank you

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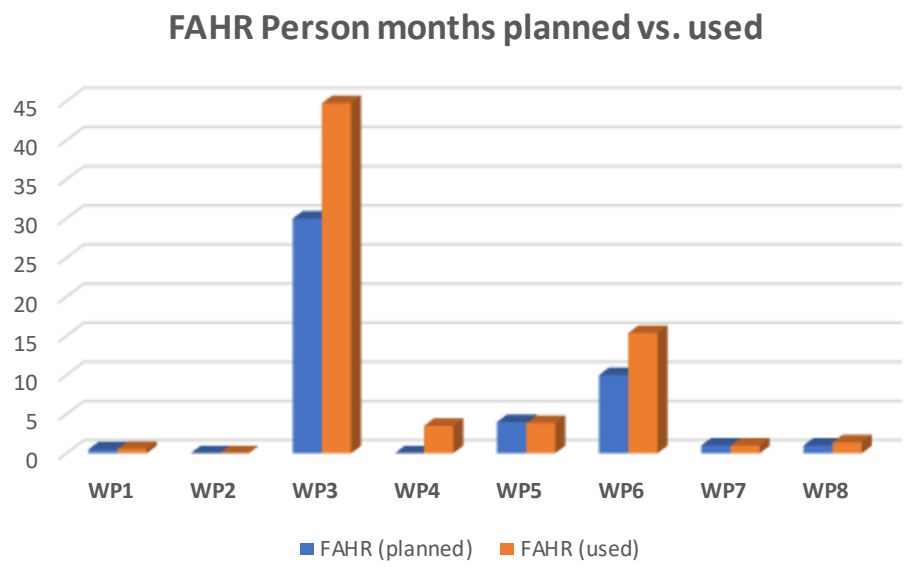
Use of PMs (FAHR)

WP1	0.5	0.55
WP2	0	0
WP3	30	44.74
WP4	0	3.50
WP5	4	3.88
WP6	10	15.38
WP7	1	1.00
WP8	1	1.39
TOT	**46.5**	**70.44**



Associated Key Exploitable Result (KER):

Solar assisted Thermal driven Adsorption heat pump

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Tasks, Deliverables and Milestones

Reporting period	Deliverable	Details / Status
M1-M18	**D3.1.** First prototype of solar assisted thermal driven Adsorption Heat Pump (FAHR)	Due in M15, submitted in M17
	D3.2. First prototype of the integration of Solar PV, Heat Pump and PCM scalable heat storage system (Sunamp)	Due in M15, submitted in M27
	D3.7. Design and optimization of an innovative heat exchanger (Thermowatt)	Due in M18, submitted in M24
M19-M36	**D3.3.** Optimized prototype of Solar assisted Thermal driven Adsorption Heat Pump (FAHR)	Due in M29, submitted in M37
	D3.4. Optimized prototype of the integration of Solar PV, Heat Pump and PCM scalable heat storage system (Sunamp)	Due in M29, submitted in M40
	D3.5 Test report for the Solar assisted Thermal driven Adsorption Heat Pump (TECNALIA)	Due in M29, submitted in M36
	D3.6 Test report for the integration of Solar PV, Heat Pump and PCM scalable heat storage system (TECNALIA)	Due in M29, submitted in M38
	D3.8. Evaluation of the integration of Heating & Cooling solutions with the HEX system (POLIMI)	Due in M24, submitted in M25
M37-M54	**D3.9.** Additional test report for the solar assisted AHP installed in Toledo (FAHR)	Due in M53, submitted in M53

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