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D4.3.Final design of the refrigerant circuit and strategy of operation between the two different heat sources - Executive Summary

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1. PUBLISHABLE EXECUTIVE SUMMARY

The present document is the deliverable D4.3 "**Final design of the refrigerant circuit and strategy of operation between the two different heat sources**" which describes the first results of the experimental campaign (task 4.1.3) carried out with prototype 1 with the objective of studying the switching system, the adequacy of the different components, problems identification and solution, and starting to experimentally characterise the differences in performance in between the two heat sources.

As a reminder, the tested dual source heat pump is basically an 8kW air to water heat pump, incorporating two extra BPHEs and all the necessary valves to be able to change among the different possible operation modes. The employed refrigerant is R32. The compressor is a new Scroll compressor from Copeland designed for R32. All the details of the design of the unit can be found in D4.1 – *Dual source heat pump design*. A full analysis of the dual heat pump performance and operation has been carried out. The following are the most important aspects of the unit design and operation which have been studied in detail. The main conclusion affecting each factor is indicated.

- Refrigerant charge. A refrigerant charge of 3 kg is enough for all operation modes.
- Compressor oil return. Compressor oil return is effective until a minimum compressor speed of 35Hz.
- Change of operation mode: valve switching strategy. An efficient valve switching strategy has been implemented and tuned up. The results are good and provide a reliable and smooth transition in between operation modes.
- Expansion valve control. The expansion valve control is able to keep superheat approximately constant in normal operation. Some miss functioning for the control of the maximum discharge temperature and during frost formation have been found which should be addressed by fine tuning of the valve control parameters.
- Performance characterization of the individual components: All components of the unit have been individually characterized.
- Determination of the air conditions which lead to frost formation at the air-evaporator surface. Two specific tests have been performed to start estimating the conditions at the outdoor coil will start to form frost. These tests have allowed a preliminary determination of the limits of the air and operating conditions leading to frost formation.
- First results of HP performance. A total of 29 steady state test points have already been measured.

All along the performed tests, the HP design has proved to be reliable and efficient. Apart from an initial completely unexpected failure of the compressor electronics, all components have performed as expected, and no other main problem has appeared. From the obtained performance and the detailed analysis carried out all along the experimental campaign, it seems that the design of the refrigerant circuit is perfectly adequate and is able to provide a reliable and efficient operation at all considered operation modes. Anyhow, a series of recommendations have been proposed for potential further improvement of the unit. The valves design and the switching strategy has turned to be very effective. No failure or malfunctioning has occurred. The tuning up of the valve switching has proven to provide a smooth change in between all the different operation modes. The unit seems therefore ready for field testing. All the experimental results now available allow to readjust the heat pump

mathematical model in order to take into account the complete range of possible variation of operating conditions, including: ambient and ground temperature and the variation of the compressor speed, the fan speed and the speed of the Ground, User and DHW circulation pumps. This information will provide the tool in order to optimize the operating parameters and the use of Air or Ground as the heat source for each demosite. This information will be then available to be implemented in the system control in order to minimize the year round energy consumption.