

All heat pump types more cost-efficient than district heating in Finnish nearly zero energy buildings

Finnish nearly zero energy level for buildings can be achieved more cost-efficiently with concepts utilizing heat pumps than district heating. This was one of the main result of development project "HP4NZEB - Heat Pump Concepts for Nearly Zero Energy Buildings", where the main objective was to outline the role of heat pumps in energy- and cost-efficient nearly zero energy building solutions.

When comparing the E-number and life cycle costs of concepts utilizing heat pumps with district heating, the heat pump concepts were more cost efficient in both larger apartment buildings and in smaller detached houses. In addition to lower life cycle costs heat pumps can also cool the building and no extra investment for cooling is needed.

HP4NZEB project - coordinated by Green Net Finland and with project partners Aalto University, Technical Research Centre of Finland VTT and Finnish Heat Pump Association SULPU - was the Finnish national project participating IEA Heat Pump Programme's Annex 40. HP4NZEB project calculated the E-number and life cycle costs of concepts utilizing different type of heat pumps and compared them with the E-number and life cycle costs of district heating.

All studied heat pump types achieved "nearly zero" level

In HP4NZEB project three different building types were studied: typical Finnish new detached house, new apartment building and the renovation of a 1960s apartment building.

"We studied concepts utilizing ground source heat pump, air-to-water heat pump, exhaust air heat pump, and in detached house also air-to-air heat pump. In addition we also calculated how adding solar heating and PV affects the E-number and life cycle costs. All studied concepts were given some common energy efficiency values, in example passive level in insulation, water based heating system and LED-lighting", explains Managing director **Suvi Håkämies** from Green Net Finland who coordinated the project.

Finnish cost efficient "nearly zero" level for new buildings has been defined in a project called FInZEB during Spring 2015. The level recommended by FInZEB project was achieved by all heat pumps types studied in HP4NZEB project. When studying the renovation concept of 1960s apartment building, all heat pump concepts achieved lower E-number level than district heating which was used as a reference level. The optimal cost- and energy efficient level for apartment building renovation settled in the minimum requirement level for a new apartment building defined in the Finnish building code.

Nearly zero energy building needs cooling

The simulation of all studied building types showed that there is a demand for cooling in Finnish nearly zero energy building in order to ensure the comfortable indoor environment conditions throughout the year. The cooling feature of a heat pump brings added value to the investment since no additional investment for cooling is needed when utilizing heat pump. Heat pump is able to cool the building in an energy efficient way.

Air-to-water heat pump turned out to be more cost-efficient than expected

Even though ground source heat pump was the most cost- and energy efficient in all the studied building types, air-to-water heat pump turned out to be more efficient than the project team initially expected. Until now the researchers thought that the outside temperature in Finland is too low in order to reach good operating efficiency for air-to-water heat pump. The results of HP4NZEB project show that the long-term investment technical development work has paid off and air-to-water heat pump was almost as cost- and energy efficient as ground source heat pump.

In the case of new apartment building both ground source heat pump and air-to-water heat pump achieved an E-number value less than 100 without any added solar energy – ground source heat pump's $E=95.7 \text{ kWh/m}^2/\text{a}$ and air-to-water heat pump's $E=98.4 \text{ kWh/m}^2/\text{a}$. The calculated reference level for district heating was $E=107.6 \text{ kWh/m}^2/\text{a}$. When looking at life cycle costs over 25 years, the ground source heat pump's cost were 173 €/m^2 and air-to-water heat pump's 183 €/m^2 . For district heating the costs were 225 €/m^2 .

Finnish companies actively involved in the project

HP4NZEB project was implemented in 2013-2015. The main financier was Finnish Funding Agency for Innovation Tekes. In addition to Tekes, ten Finnish companies participated the project actively giving detailed information about their solutions' performance and capacity, as well as market price information.

“HP4NZEB project has promoted the know-how of the Finnish businesses. With this project a lot of valuable know-how from the companies has been transferred to the researchers and vice versa. All the results of the project were by far excellent when it comes to heat pump business, and they give valuable information for property owners, designers, construction companies and others considering what is the best way to heat your house. The project has also given a solid prove that when the EU requirement for all new buildings to be nearly zero energy buildings comes into effect, heat pumps will be a very likely one of the top heating solutions”, says the chairman of the project's steering committee, Executive director of Finnish Heat Pump Association SULPU **Jussi Hirvonen**.

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