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Title: Heat pumps in energy and cost efficient nearly zero energy buildings in Finland

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Presentation abstract:

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

When comparing the primary energy consumption with Finnish national 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 bring added value in example by cooling the building when no extra investment for cooling is needed.

In HP4NZEB project the following building types and concepts were studied:

1. **New detached house (180 m2):** Concept 1: Ground Source Heat Pump GSHP, Concept 2: Air-to-water Heat Pump AWHP, Concept 3: Exhaust Air Heat Pump EAHP, Concept 4: Air-to-air Heat Pump AAHP
2. **A new apartment building (Järvenpään Mestaritorppa):** Concept 1: GSHP, Concept 2: AWHP, Concept 3: District Heating DH
3. **An existing 1960s apartment building:** Concept 1: DH, Concept 2: EAHP, Concept 3: GSHP, Concept 4: AWHP

All studied concepts were given some common energy efficiency values, in example passive level in insulation, water based heating system and LED-lighting. In addition it was calculated how adding solar heating and PV affects the E-number and life cycle costs.

According to the Finnish building code, energy performance of buildings is calculated by means of E-value, which is total delivered energy consumption of the building weighted by the energy carrier factors (D3, 2012). The official Finnish definition of E-value is:

$$E_{D3(2012)} = \frac{\sum_i \left(E_{DE,i} \cdot f_{DE,i}\right)}{A_{net}} \qquad \textbf{(1)}$$

where

$E_{DE,i}$ *= delivered energy i (district heating, electricity, fuels used for energy production of the building and district cooling), kWh/a*

$f_{DE,i}$ *= weighing factors of delivered energy form i (0,7 for district heating, 1,7 for electricity, 1,0 for fossil fuels, 0,5 for renewable fuels, 0,4 for district cooling), -*

A_{net} *= heated net floor area of the building,* m^2.

Finnish cost efficient ”nearly zero” level for new buildings was 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.

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.

All calculation material and the detailed results of the project can be found in a report “Heat Pumps in Nearly Zero Energy Buildings in Finland” at http://www.vtt.fi/inf/pdf/technology/2015/T235.pdf.