Renovation of heating systems in multifamily buildings in Finland

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Connecting to district heating is normally regarded as a good opportunity because of the high density of energy demand in inner-city areas with large 'one-point' demand in the substation of a multifamily building. However, due to relatively high costs for district heating, this may not be the case. In Finland, as in other Scandinavian countries, getting off of the district heating grid is a trend. Three examples are described. In the first, only the largest system losses were addressed by installing a domestic hot water heat pump. The two other examples show complete make-overs, where also space heating is generated by a collective heat pump.

Introduction

The total length of the district heating network in Finland at the end of 2015 was about 14,600 km. In cities and in other major population centres, the network covers virtually the entire area that can be connected economically to the district heating system. Especially the large and dense energy demand in inner cities with a great number of dwellings in apartment buildings is an interesting revenue model for energy companies.

However, there is also a growing trend in Scandinavian multifamily buildings to disconnect from the district heating network by installing individual air source heat pump water heaters or installing collective heat pumps in multifamily buildings. Significant reduction in the distribution losses and cost savings can thus be achieved. This is in line with the policy indicated by the City of Vienna in Austria, where it is advised, especially for domestic hot water, to generate the hot water at the location where it is needed to avoid distribution losses [1]. In the present article, three examples from Finland are shown, where heat pumps were installed in renovation projects by housing corporations.

The Jyväskylä project

A heat pump recovering exhausted air system was installed in January 2013 in one large apartment building in the city of Jyväskylä. This six-floor building was built in 1971, and district heating energy consumption was 750 MWh annually. The heat pumps (NIBE F145-40) are connected to the radiator heating circuit as well as to the domestic hot water (DHW) circuit via a buffer tank. Automation takes care of when heating of radiators is needed and when there is a need for DHW.

Although recovery of exhausted air with heat pumps is not a new, it has not been much used in large apartment buildings. Interest for this application has been raised

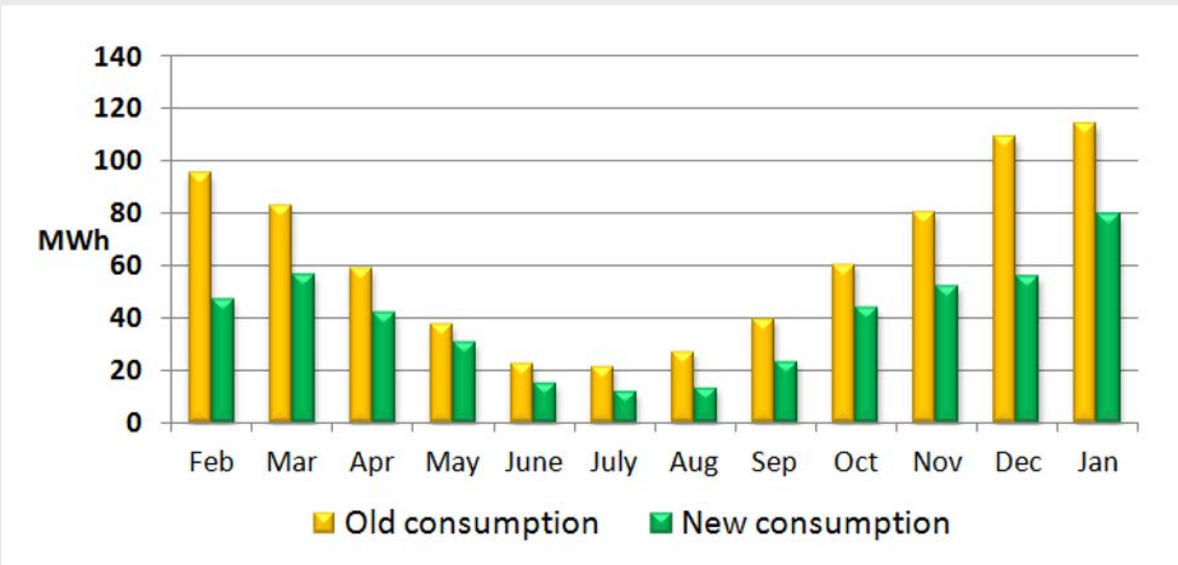

Fig. 1: Change in monthly energy consumption [2].

only during the last couple of years as energy prices for district heating have risen and awareness regarding potential savings of this application has been growing. Also, the reported savings in pilot installations, with high return of investment, has been positively received by the market.

After one year, the annual district heating energy has decreased by 45% (from 750 to 412 MWh) resulting in an annual reduction of 73 tonnes of CO_2 emissions, while the heat pumps used 61 MWh electricity corresponding to an annual increase of 13 tonnes of CO_2 emissions. Overall net energy consumption has decreased by 37% from 750 to 473 MWh; annual CO_2 emissions have decreased by 60 tonnes of CO_2. See Figure 1.

Energy costs have decreased from € 53 700 to € 34 800. The Return on Investment is 16% per year. The heat pump SCOP (Seasonal COP) is 3.8.

Thus, significant cost savings can be achieved by recovering the energy of the exhausted air and transferring it back to the building's heating system. With this method, the district energy consumption is nearly halved, and, when adding the energy needed by the heat pump, the net energy saving is typically around 40%. Depending on the energy prices the heating cost saving is typically between 30-40%. Additionally, the basic fee of district heating is also reduced by 50% as it is linked to the volume of energy used.

The Raisio project [3]

Completed in 1972, the real estate developer Sorolaisenmäki has a total of 90 apartments in Raisio connected to the local district heating network. The board of directors from the real estate developer wanted to keep housing costs under control, so that low-income retired people could live in their own homes. Thus, in 2015 Sorolaisenmäki decided in a renovation project to upgrade the building, abandoning district heating. Otherwise, housing costs would have increased every year simply because of district heating price increases. This was open-minded and unprecedented in Raisio. They were the first real estate developer to decide to abandon district heating. They were considered as a threat, and their calculations were suspected to be incorrect.

Ground source heat pumps were installed with nine geothermal wells, each 230 meters deep. The heat pumps centrally provide space heating and DHW. In connection with the renovation of the heat generation, the vertical pipes of the circulation system were renewed, and water meters for each apartment were installed. Heat recovery from the ventilation exhaust air was introduced. The ground source heat pump and heat recovery was covered by a treatment facility loan used by a few housing companies. It reduces the loan using savings on care fees for heating costs and, as a result, the purchase had no significant effect on residents. According to calculations the payback time of the geothermal system is about 9 years.

Project in Suvela, Espoo [4]

The Espoo housing company Jalmarin-Salva changed from district heat to geothermal heat three years ago, see figures 2 and 3. The continuous rise in the price of district heating caused the Espoo housing company to switch to geothermal heating. The project originated from an initiative of the shareholders. They wanted to get away from the rise in the price of district heating. The change did not happen in an instant. It took a couple of years to prepare and make decisions. The issue was discussed for a long time and voted on at two general meetings. There were many sceptics.

Fig. 2: In connection with the geothermal renovation, a heat recovery system was added to the mechanical exhaust ventilation of the Espoo apartment building company. The pipes in the system run on the roof of the house. Photo: K. Rautaheimo, Helsingin Sanomat.

Fig. 3: Geothermal heat is local heat, originating from the rock on which the houses are built. With these devices, heat is pumped from the earth's crust. Photo: K. Rautaheimo, Helsingin Sanomat.

The condominium consists of two buildings, each with seven floors and a total of nearly one hundred apartments. The renovation of the main buildings began in October 2016. Disturbances in the daily life of housing were surprisingly minor. District heating operated until *the ground source heat pumps with 12 deep ground sources were started. There was a break in the hot water supply for only a few hours.

The project has now been using geothermal energy for three years. The system has worked flawlessly since the initial challenges. During the first year, there were small problems especially in regulating the water temperature.

As the shareholders were not ready to borrow, the housing association implemented the project together with the Energy Service Company (EsCo) Lähienergia that owns the system and is responsible for its maintenance and sells heat to the housing association. The heat pump system with the ground sources requires maintenance and replacement of parts. It is estimated that the equipment will last 30 years, the compressors about 15 years and the boreholes and pipes more than 50 years. The functioning of a geothermal system requires not only expert planning but also monitoring and maintenance. In this case the system maintenance is outsourced in a monitoring and maintenance contract between the housing association and the EsCo. The contract is valid for eight years, after which the system is transferred to the housing association. In practice, the housing association gradually pays for the system with savings due to reduced heating costs. When a housing association moves from district heating to geothermal energy, the need for energy purchased for heating is significantly reduced or even altogether eliminated. The decrease in district heating cost was € 70,000–80,000 per year. It is estimated that after the investment is amortized, the savings will be nearly € 50,000 per year. Other energy-saving measures have included renovations of windows, balcony doors and facades. In addition, mechanical exhaust ventilation has been equipped with heat recovery.

Outlook: economic aspects

In other countries there is a growing tendency towards collective systems for new buildings and district heating for existing buildings, often in densely populated areas with social housing. This approach passes on costs on to third parties, with a lot of subsidies, and is not in the interest of those inhabiting the houses, often from the less fortunate social classes. Social housing has a long history associated with low-income households, traditionally housing vulnerable people and those that are disadvantaged within society.

Energy bills and energy costs per household reflects how the end user interacts with the provision of energy. Focusing on these costs therefore relates the energy need to the implications of meeting that energy need. Describing how households are affected by energy costs (a part function of housing quality), can be summed up in one term – fuel poverty. In energy terms, fuel poverty creates a base point upon which we can begin to target low cost heating deployment.

Conclusion

In Finland the process of multi-family houses choosing other heating than district heating continues, with about 500 new corresponding cases annually. The reasons for this are largely economic. In other countries, district heating for new buildings is common. This may have negative implications for those living in social housing buildings.

References

[1] Farghadan, M. et al., Technologieleitfaden Warmwasser. Magistrat der Stadt Wien, 2016. In German. https://www.wien.gv.at/stadtentwicklung/energie/pdf/leitfaden-warmwasser.pdf

[2] Heinonen, J., Heat Pump Application recovering Exhaust Air Energy in Large Apartment Buildings. Enermix Ltd. 11th IEA Heat Pump Conference, Montréal, 2014. https://heatpumpingtechnologies.org/publications/heat-pump-application-recovering-exhausted-air-energy-in-large-apartment-buildings/

[3] Aatsalo, J., Energiaremontti pisti kulut kuriin – taloyhtiö säästää kymmeniä tuhansia euroja vuodessa. [Energy repairs kept costs under control - the housing association saves tens of thousands of euros a year]. Helsingin Sanomat. In Finnish. https://www.rakennuslehti.fi/2020/03/energiaremontti-pisti-kulut-kuriin-taloyhtio-saastaa-kymmenia-tuhansia-euroja-vuodessa/

[4] Takala, S., Espoolainen taloyhtiö vaihtoi kaukolämmön maalämpöön kolme vuotta sitten – kannattiko vaihto? [A housing company in Espoo switched from district heating to geothermal energy three years ago - was the exchange worthwhile?]. Helsingin Sanomat. In Finnish. https://www.hs.fi/koti/art-2000006453253.html?fbclid=IwAR2lHkQRFYCnc_CwFw44dElEC02oSwyXRw-UGDX0b8oy23AEXxNh3icwu2Iv

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