

Lantti-talo: Designed for High Replicability for Detached, Terraced and Low-Rise Apartment Buildings

Lantti-talo (Lantti House) is Finland's first net zero energy single family house, which actually went over the limit of net zero demand, exporting more energy than importing. It demonstrates that it was possible to achieve the 2020 energy efficiency targets already ahead of time. The project contributed to the development of energy efficient building design and construction, recognising the future development needs in Finnish climatic conditions. The project produced information about the importance of city planning for the optimal positioning of building, PVpanels and solar collectors and for the achievement of high energy efficiency.

The goal was to use as many renewable and carbon dioxide -storing building materials as possible and simultaneously aim for energy savings. Design solutions were evaluated with sensitivity analysis. The energy consumption of the different building options was assessed with simulations in the design phase. As a result, Lantti is an overall eco-efficient house with an airtight and well-insulated structure. Eventually, the result was a plus energy house, as it produces considerably more electricity than it needs with photovoltaic panels and gets part of the heating from solar collectors. Authors: Krzysztof Klobut, VTT Technical Research Centre of Finland Ltd

Background image on case study title page: Kimmo Torkkeli / Aalto-yliopisto

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The Positive Energy Building in its Local Context

Lantti was inspired by the Luukku project, which was Finland's proposal for the Solar Decathlon Europe 2010 competition in Madrid. The competition, in which 17 universities participated, focused on new housing applications that simultaneously improve liveability and energy efficiency. The aim of the Luukku project was to develop a building that would have a net-zero energy performance in the Finnish and a net-plus energy performance in the Spanish climate. Against this background, Lantti was designed and executed for the 2012 housing trade fair in Tampere. The housing fair is an annual event that showcases current and future trends in the housing industry - architecture, building, materials, interior design, furnishing and landscaping.

It is the place where housing developers and builders as well as interior designers and furnishing manufacturers can introduce their work to a large audience of both professional and private visitors. The housing fair is set up in an area where actual houses are built and decorated and opened for the audience to visit. The houses are built for families that are going to move in and live there after the housing fair closes.

The Building's Special Features

The aim of Lantti was to implement zero-energy requirements to a "normal" detached house and thus examine possibilities to achieve objectives set by the EPBD directive. The demo-house had to provide the normal housing needs for a regular family. The building should be at least a net zero energy house on an annual basis i.e. E = 0 in the Energy Performance Certificate. Finally this target was even surpassed.

The favourable shape of the building is a result of optimising the positioning of the building on the plot using energy simulations of different options. Window orientation and size combined with the best available thermal performance (U-value 0.7 W/m²K) enabled the utilisation of natural light without causing overheating indoors. Good thermal insulation of the structure was achieved by using wood fibre insulation in walls (450 mm) as well as in the floor and ceiling (510 mm).

An important measure to mitigate energy losses was the avoidance of cold bridges and heat leaks. The careful specification and construction of the structure resulted in good air tightness of the envelope tightness indicator is $n50 = 0.3 \ 1/h$.



Image 1 _____ Photograph of the Lantti House under construction Source: Virve Rintasalo / Rakentaja.fi (<u>link</u>)



Image 2 Photograph of the PEBs living room. Source: Virve Rintasalo / Rakentaja.fi (<u>link</u>)

"... Lantti was designed and executed for the 2012 housing trade fair in Tampere [...] that showcases current and future trends in the housing industry."

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Lantti features a range of technical solutions to increase the building's energy efficiency. These include a ventilation unit that is coupled with a rotating heat recovery exchanger that has an annual efficiency of 80%. Supply air is preheated with thermal energy from the district heating network. The lighting system features energy efficient LED technology and all home devices and appliances have very high energy efficiency ratings. Lastly, a home / away switch automatically reduces energy consumption to a minimum when nobody is in the house.

Key Technologies Installed

- Solar collectors: Solar heating is used for domestic hot water production. The system is designed for a family of four. Three solar collectors with an area of 8 m². The annual yield of solar collectors is 2,660 kWh. The system has a 300 litre storage tank. Heat is distributed by hydronic (water-based) floor heating, equipped with room controls to ensure high comfort levels.
- District heating: Building heating and additional • hot water heating is supplied from the district heating network. A new solution was developed for the district heating connection of the building to function in harmony with solar heating.
- Mechanical ventilation (air exchange and indoor • environmental quality): The supply & exhaust mechanical ventilation system is highly energy efficient, with 80% of exhaust heat recovered.

Selected Performance Indicators

Building Envelope Performance:

U-Values of Walls: 0.085 W/m²K Low Floor: 0.08 W/m²K Roof: 0.08 W/m²K Air Tightness Value: 0.3 1/h (n50)

Degree of electrical energy self- supply based on renewables:	209%
Degree of thermal energy self- supply based on renewables:	30%
To what percentage is the PEB Energy Positive?	101%

Obtained Building Certificates / Ratings / Labels: Energy label E=-1 (energy certificate due to EPBD directive)



PV panels (Manufactured by Naps System Oy, model Naps Saana 250 P2 PBW): The PV-system produces more than double the amount of electricity the house consumes on an annual basis. The summertime surplus is fed into the national grid. The 40 panels have an area of 61 m², with estimated annual output 7,000 kWh.

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Non-Exhaustive List of Involved Stakeholders

Project Sponsor Sitra Fund https://www.sitra.fi/ **Developer** TA–yhtymä Oy konserni https://ta.fi/

Project Sponsor Housing Finance and Development Center ARA https://www.ara.fi/ **Construction Design** HP insinöörit Oy http://www.hpioy.fi **Design Team**

Aalto University International Wood Program https://www.woodsolutions.com.au/architectsand-designers/aalto-university-internationalwood-program

Construction Execution Lapponia House Oy https://www.lapponiahouse.com/

Catalysts, Challenges & Results

The goal of the Lantti House, designed by the Aalto University team, was to use as many renewable and carbon dioxide -storing building materials as possible. Based on previous experiences, the team ended up using wood. The house has a wooden frame, wooden insulation, wooden cladding and wooden surfaces. The interior surfaces also used more wood than usual, says Professor Pekka Heikkinen from Aalto University, who led the design of the house.

According to Heikkinen, the aim was to use wood in the Lantti House in very different ways: as far as possible processed and different materials from wood fiber wind protection boards to glued plywood parquets. Lantti is an overall eco-efficient house with an airtight and well-insulated structure. As a zero-energy house, it produces the electricity it needs with photovoltaic panels and is heated with solar collectors and district heating.

As a result of the project, a normal-sized, single-family house, with an E value of zero according to the primary energy requirements set in July 2012, was constructed for the Tampere Housing Fair 2012. The principal construction material used was wood. The project aimed at conserving energy in all sub-areas. Use of renewable energy and the careful execution of construction work were other important considerations. Forms of energy with weighting factors most advantageous to meeting primary energy requirements were selected for the project. The house is heated by district heating and a water-based floor heating system that can be adjusted separately for each room. Eight square meters of solar collectors satisfy 30% of annual consumption of warm water (DHW and heating), with municipal district heating warming the remainder. For electricity production, 61 m² of efficient solar electricity panels were installed on the roofs of the residential and storage buildings.

In this project, the goal of ARA was to create an example of an energy-efficient single-family home, whose solutions could be modified for use in semi-detached and detached houses and low-rise buildings, while meeting ARA's quality criteria. The floor plan and division of elements used in the property make it highly modifiable. Keeping construction costs under control proved to be a challenge. Sensors and monitoring systems were installed in the property, and the data collected by these will be used in research and development. The data will also be used to optimise the operation of the systems.

The project received development funds and an interest subsidy loan from ARA. Main partners were ARA, Aalto University and Finnish Innovation Fund Sitra.





Replication Potential

Among other actors, ARA and TA Companies were involved in Lantti-talo project. The Housing Finance and Development Centre of Finland (ARA) is a governmental agency, an expert partner, developer and moderniser of housing and promotes ecologically sustainable, high-quality and reasonably priced housing. TA Companies is a nationwide owner and developer of apartments that offers its residents safe housing for different stages of life. TA Companies currently owns more than 15,000 apartments, primarily comprising right-of-occupancy and rental apartments.

ARA believes that, in the future and in the right conditions, zero-energy single-family house projects can be implemented by ARA. Before zeroenergy construction solutions can be implemented by ARA on a large scale, particularly in the case of single-family houses, there is still room for development and much remains to be learned about the exploitation of such solutions.

On the basis of Lantti, a zero-energy small house area was further developed in the Koukkuranta district in Tampere. The area becomes Finland's first wooden zero-energy detached house area.

Conclusions & Lessons Learned

Lantti is Finland's first net zero energy single family house, and actually even complies with the PEB requirement by exporting more energy than it imports. It demonstrates that the 2020 energy efficiency targets achievement were possible ahead of time. With the project several good conclusions could be drawn about energy efficient building design and construction and the future development needs in Finnish climatic conditions. The project produced information about the importance of city planning for the optimal positioning of building, PVpanels and solar collectors and for the achievement of high energy efficiency.

In addition, project documented lessons learned about HVAC technology, costs and a zero-energy house design and construction guidance and the need for cooperation.



Cropped photograph of the PEB during the Tampere Housing Fair 2012. © Suomen Asuntomessut



"On the basis of Lantti, a zeroenergy small house area was further developed ..."

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Local Context Details

Address: Sartrenkuja 1, 33720 Tampere, Finland Geographic Coordinates [Google | EPSG:4326 – WGS 84]: 61°26'19.4"N 23°48'59.9"E

Local Government: City of Tampere

Population: 235,239 [2018]	Municipal Budget: approx. 1.7 billon € [2018]
Total Area Administered: 448.76 km ²	Total annual GHG emissions: 914,100 tCO2-eq. [2017]

Local Economy: Banking, Mechanical Engineering and Automation, Information and Communication Technologies, Health and Biotechnology, as well as Pulp and Paper Industry

Climatic Zone [Köppen]: Dfc - Subarctic climate | Cold (continental) | Without dry season | Cold summer

Local Climate Plans: Tampere's ambition is to become carbon neutral by 2030. Sustainable Tampere 2030 - towards a carbon-neutral city approved by the City Council - programme promotes low-emission and carbon neutral solutions in housing, transport, energy production and consumption.





Further Images & Plans of the PEB

Image 4



Energy efficient LED lighting installed throughout the PEB [Lantti brochure (link)]

Image 6



Energy efficient windows improve the thermal performance [Lantti brochure (link)]





PV-panels installed on the roof of the building [Lantti brochure (<u>link</u>)]





Cross-section of building showing the high levels of insulation [Lantti brochure (<u>link</u>)]

Image 9



Floorplan of the PEBs first floor [Lantti brochure (<u>link</u>)]

Image 8



Floorplan of the PEBs ground floor [Lantti brochure (<u>link</u>)]



