

LECo - Feasibility study

– The current state and future possibilities of Lohtaja district heating

LOHTAJAN ENERGIAOSUUSKUNTA

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Centria TKI

1. Introduction

This feasibility study reviews the current state of Lohtaja's district heating and analyzes the potential for expansion. The study also presents an alternative heat production method for the current oil based heat plant in order to achieve a more environmentally friendly heat production in Lohtaja.

2. About the LECO-project

The LECO project supports small communities in becoming self-sufficient regarding energy. The project aims at raising awareness about energy efficiency and the possibilities to use locally available renewable energy, such as wind, solar and hydropower, as well as side streams from industry, households and agricultural origin.

The project gathers test groups from Finland, Sweden, Norway and Ireland. The goal is that the test group will become self-sufficient regarding energy making the most of locally available energy source and new technologies.

3. Lohtaja

Lohtaja is a village of Finland and is part of the Central Ostrobothnia region in western Finland. Lohtaja was merged with the city of Kokkola on January of 2009. The former municipality had a population of 2,900 and covered an area of 289.26 km² of which 3.33 km² was water. The population density was 10.0 inhabitants per km².



4. Lohtaja Heat Cooperative

Lohtaja Heat Cooperative was founded in 2001 and its aim was to collect mostly stem wood from the forests of its 40 members, chip it, run a member owned heat plant and supply energy for few buildings near the plant. Lohtaja Heat Cooperative operates in the village of Lohtaja, which is located in the city of Kokkola on the west coast of Finland.

The co-operative owns one heating plant in Maininki, which uses wood chips as a fuel, about 1400 loose m³ of wood chips annually. All the woodchips are bought from the members of the co-operative. The co-operative's aim for the future is to expand its activities. The co-operative explores the possibilities to expand its activities to Lohtaja centrum and to act as a sole heat producer in Lohtaja district heating network.

The cooperation currently operates one 300 kW woodchip heating plant in the area of Lepola located near Lohtaja. The heat plant provides 750-800 MWh annually to three different properties. The biomass used for heat is collected from a maximum distance of 20km. The total amount of wood chips required annually is around 500m³. This plant replaces the use of 100 000 liters of oil annually.



300kW heating plant

4.1 Woodchips and logistics

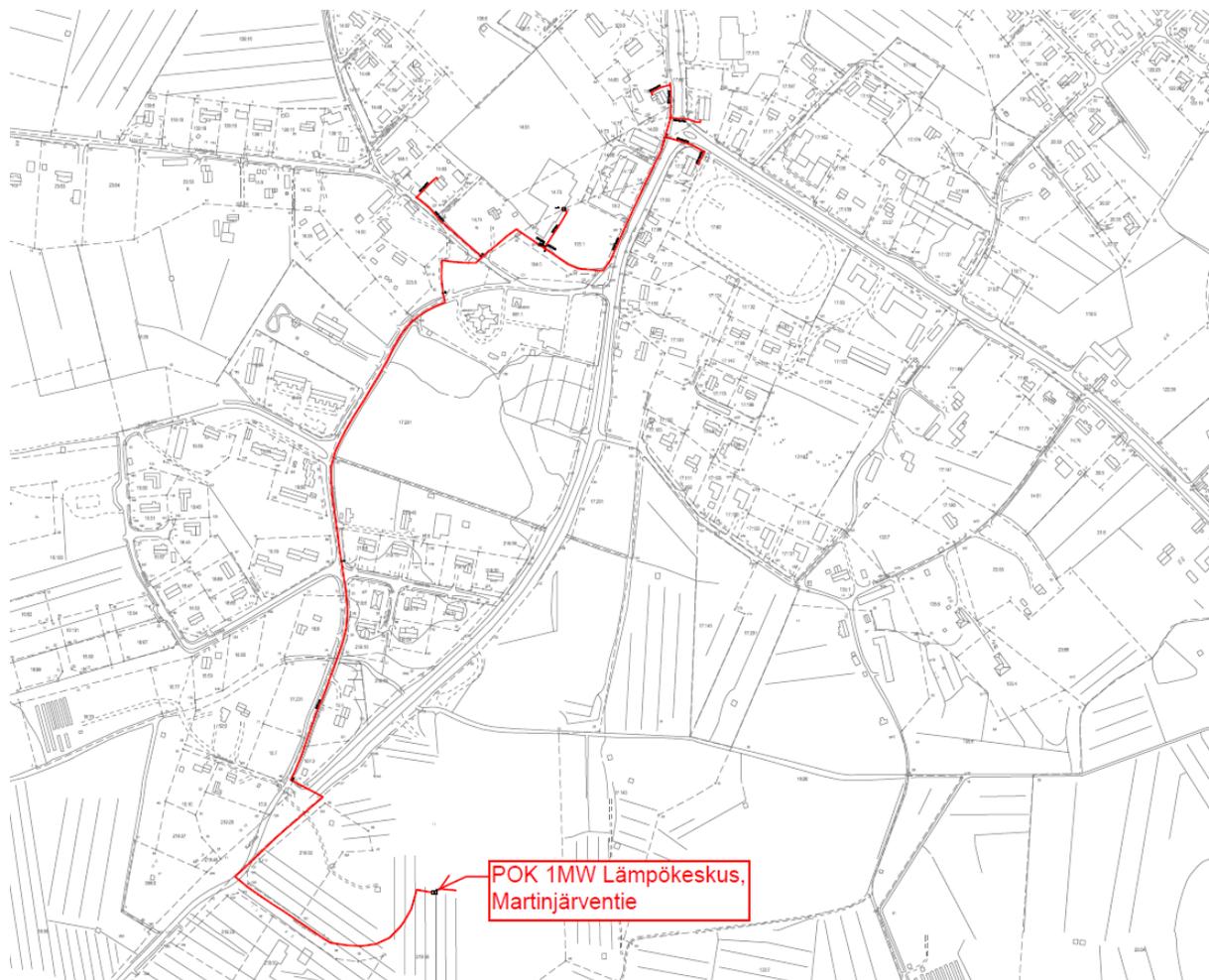
All the woodchips utilized by Lohtaja Heat Cooperative is collected from the members own forests. The woodchips have two price quality and price classes. The a-class consists of pruned trees with a moister percentage under 35 %. The b-class consists of non-pruned trees with a moister percentage over 35 %. The price of the b-class is $\frac{3}{4}$ the price of the a-class. The moisture content of wood chips is measured regularly.

The chipping process, handling and transportation are outsourced and the costs are paid centrally with the cooperative's funds. Wood chip deliveries are well documented, and compensated to the specific member. One wood chip delivery can consist of 40-50 m³ (loose cubic meters).

5. District heating network in Lohtaja

Lohtaja district heating consists of a 1MW-heating plant and an 1812 meters long heating network. The heating network was constructed in 2011 and the 1MW oil-fired boiler has been in use ever since. The heating plant and network is owned by the partially city hold energy facility Kokkolan Energia.

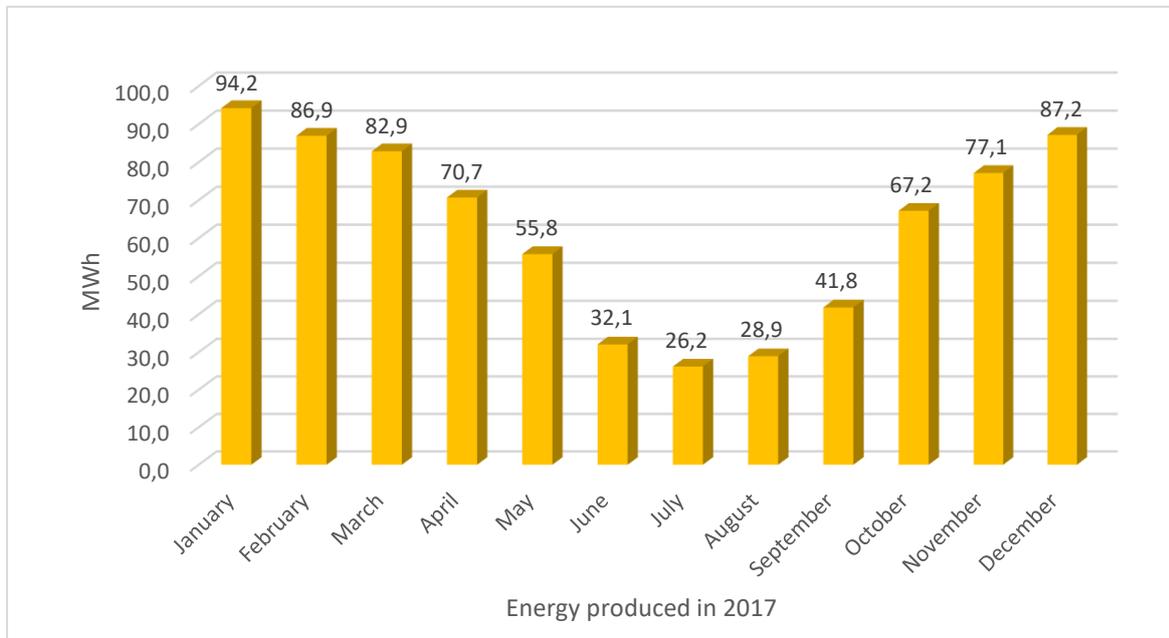
Lohtaja district heating network:



5.1 Energy production and sales

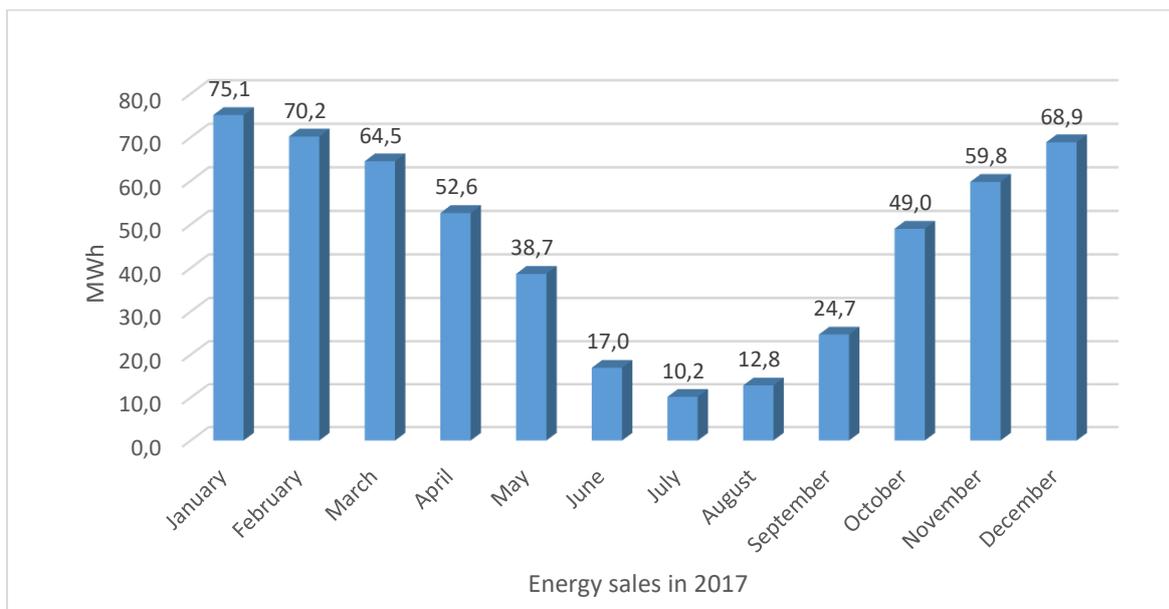
By the end of 2017, there was five heating-customers connected to the network and the total energy sale was 544 MWh. The total energy produced in 2017 was 751 MWh.

Energy produced in 2017:



Source: Kokkolan Energia

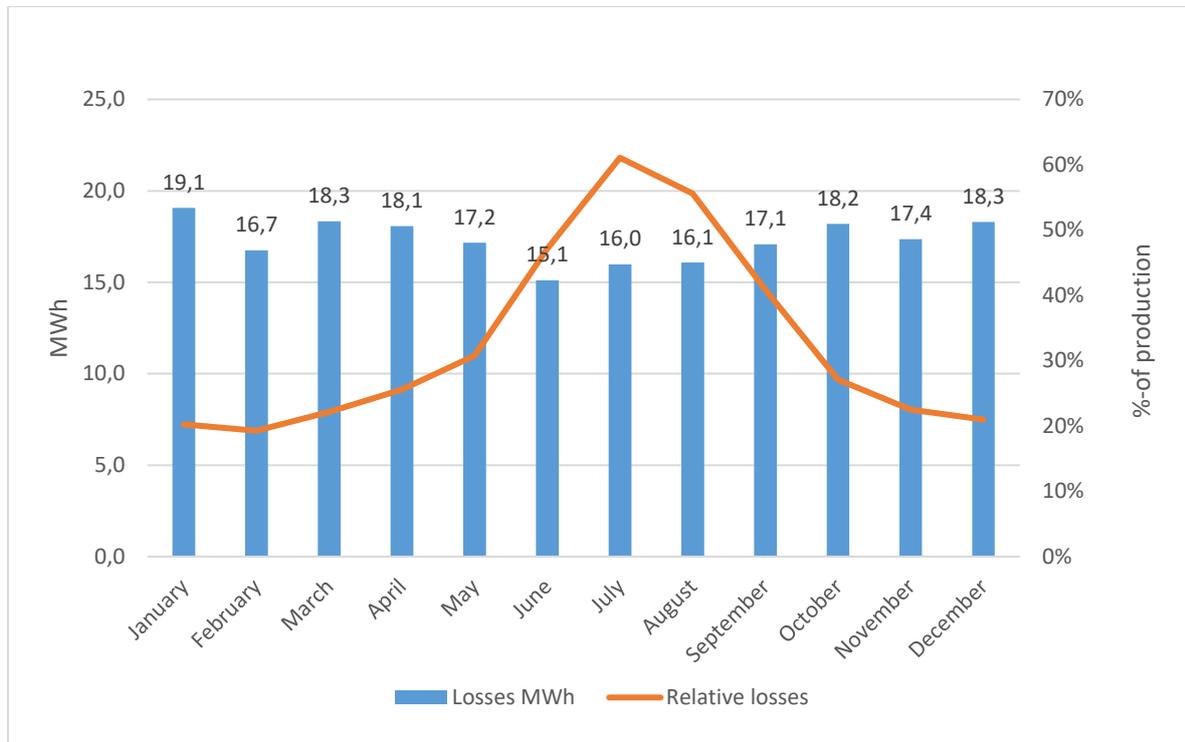
Energy sales in 2017:



Source: Kokkolan Energia

5.2 System losses and efficiency

The absolute and relative losses of Lohtaja district heating:



Source: *Kokkolan Energia*

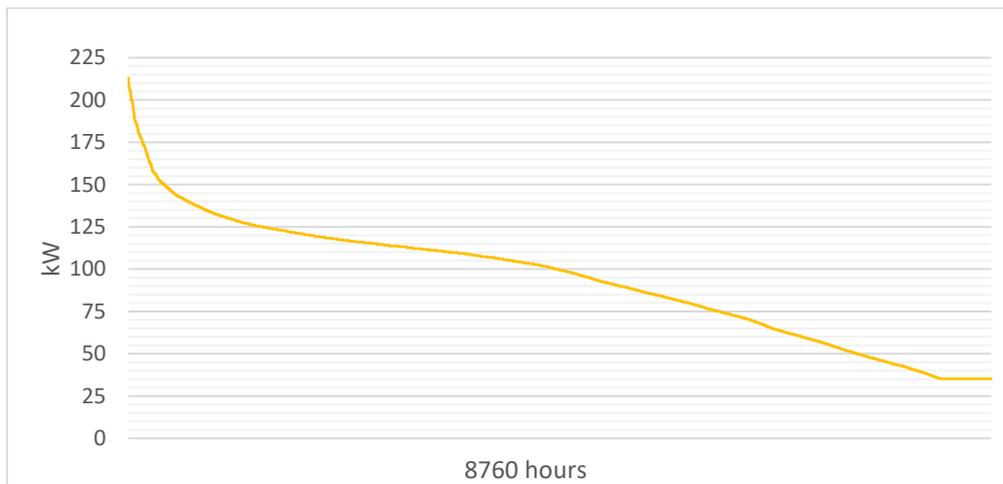
In a well-built large heating-network, the losses are about 4 - 10%, in smaller networks, losses are generally between 10 and 20%.

The total energy produced in 2017 was 751 MWh and sales were 544 MWh. The system-losses in Lohtaja district heating network are significant and constituted to 28 % of the total energy production.

The high losses – compared to average statistics – can partially be explain by the location of the heating plant. The plant is located relatively far from the end-customers and due to losses in the transportation, more power is required to distribute the same amount of energy as if the plant was in the near vicinity.

Losses can also accumulate due to low plant utilization. The heating plants peak usage hours in 2017 amounted only to 751 hours when the conventional amount for a small network is 2500 hours per year. A heating-plants efficiency usually decreases when it is operated below its nominal rated power. The loss increases as boiler output is reduced; hence, operating the boiler at full load lowers the percentage of loss.

Normalized production duration curve from 2017:



5.3 Fuel used and CO₂ emissions

Heat is produced into the district heating network by the burning of light fuel oil. The total energy produced in 2017 was 751 MWh. Calculated with a 90% burner efficiency; the primary energy consumed was 835 MWh. Light fuel oil has the energy content of 10 kWh per liter, there for the total oil consumption in 2017 amounts up to 83,5 m³.

The emission factor of carbon dioxide (CO₂) is 261 kgCO₂ per MWh. The carbon footprint of Lohtaja's district heating networks fuel consumption was approximately 218 tons in 2017.

According to the Finnish Transport and Communications Agency, persons living in Kokkola drives on an average 16 900 km per year. In 2018, the average CO₂ emissions of newly registered passenger cars in Finland were 116.8 g per km. Consequently, the CO₂ emissions of Lohtaja district heating amounts up to 110 citizen's average driving year.

5.4 Economic evaluation of the current state

In 2017, the average price of light fuel oil was 0.67 € per dm³. The fuel inquiring costs in 2017 amounts to 55 945 € when calculated with average prices.

According to information provided by Kokkolan Energia, the monetary value of the heat sales in 2017 was 40 181.87 € therefore the average sales price of was 73.92 € per MWh. This means that the losses – when only considering the purchase of fuel – are approximately 15 800 € annually.

When also taking into account investment, running, maintenance and personal costs, the overall losses increases further. According to a study commissioned by Kokkolan Energia in 2015, the production costs are over 120 €/MWh.

6. Potential for expansion

Lohtaja heat cooperatives is interested to acquire the heat network from Kokkolan Energia and launch their own woodchips based heat production. Kokkolan Energia has shown some interest in selling the heat network but no formal discussions has yet taken place. The current heat production is

6.1 Potential new customers in the area

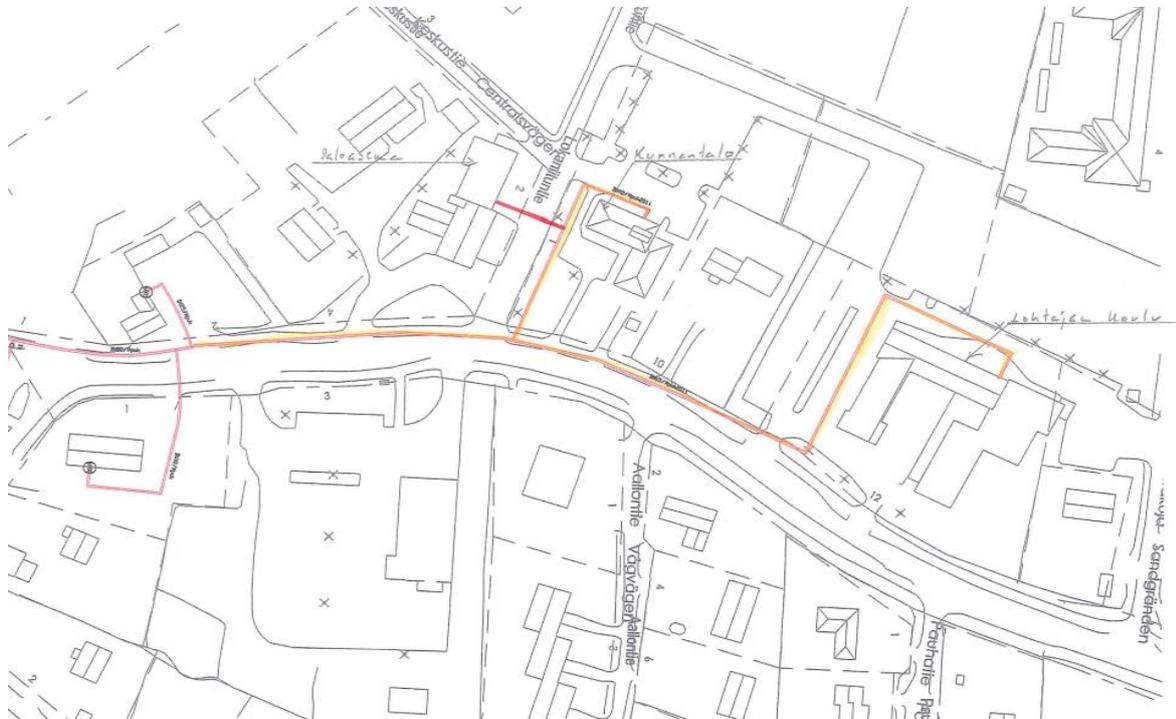
Lohtaja village is a part of the city of Kokkola and there are some city owned properties located along the heat network. The properties that has the most potential are Lohtaja municipality building, Lohtaja fire station and Lohtaja School. These are all oil-heated; city owned properties and thus have good starting points for heating method change. It is noteworthy that the price of light fuel oil has risen in Finland and was 97.7 € / MWh in the end of 2018.

Energy requirements for the Kokkola City owned properties:

| Property | Oil consumption m ³ /a | Actual oil purchase costs/a | MWh/a (primary energy) | Annual efficiency | MWh/a (heating) | €/MWh (real energy) | tCO ₂ /a |
|-------------------------------|-----------------------------------|-----------------------------|------------------------|-------------------|-----------------|---------------------|---------------------|
| Lohtaja municipality building | 14,1 | 9 148 € | 140,7 | 0,80 | 112,6 | 81,2 | 36 |
| Lohtaja fire station | 17,8 | 8 995 € | 178,2 | 0,80 | 142,6 | 63,1 | 47 |
| Lohtaja school | 79,7 | 52 391 € | 796,5 | 0,80 | 637,2 | 82,2 | 207 |
| | | 70 534 € | | | 892,3 | | 290 |

Source: Kokkola City technical office

Although the current heating network runs near these potential properties, approximately 350m additional heating network needs to be built. According to actual average network construction € VAT 0 % (Energiateollisuus, 2018). is estimated at 70 000 - 90 000 € VAT 0 % (Energiateollisuus, 2018).



Switching from oil heating to district heating also requires investment from the property owners. Although existing properties already have a water-based heating system, the heat distribution equipment must be renewed.

| Property: | Network costs: | Heating system costs: (approximately) |
|-------------------------------|----------------|--|
| Lohtaja municipality building | 8 300 € | 12 000 € |
| Lohtaja fire station | 6 700 € | 17 000 € |
| Lohtaja school | 21 000 € | 37 500 € |

The network costs are based on an estimate given by Kokkolan Energia to Kokkola City for the district heating connections. The price for a heating connection between a heating company and a new customer are heavily subsidized, thus the actual construction costs are higher.

7. Conclusions and next steps

When combining the current customers and the Kokkola City owned oil-heated properties the total energy delivered would amount up to approximately 1 400 MWh annually. This would makes heat sales more profitable as unit costs fall. The current oil-boiler could be used as a backup energy source and for peak power.

The current plant is positioned far from the final consumers and the network losses are significant. The new facility should be placed closer to the heat consumers to lower losses.

Following steps includes calculating the size of the heating plant and the levelized production costs.