

The International District Energy Climate Awards

The wastewater utilization in Kakola heat pump plant

I.1 Name and location of the system

Kakola heat pump plant
Ecologic district heating and district cooling from treated wastewater
Located in the city of Turku Finland

I.2 Name on the owner and type of ownership

Turku Energy which is 100 % owned by the city of Turku

I.3 Contact persons:

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2.1 Our system is a

- a) municipal scheme with more than 10 000 users

2.2 Which award category describes best your programme

- a) new district energy scheme
- d) district cooling

2.3 Why and how the programme was implemented? What has been achieved?

Kakola wastewater treatment plant, Heat pump plant and biogas plant was reclaimed in the beginning of the year 2009. Excavation (total 50 000 m³) was started year 2007. By building the new wastewater treatment plant it was able to substitute for five old ones. The heat pump uses wastewater instead of pumping the water to the sea and produces both district heating and cooling for public buildings and homes in Turku.

European Union countries have agreed on UN and Kyoto climate treaties. In Finland the renewable energy target level is 38 %, Turku Energia will implement the goals in Turku. Turku Energia Environment Management Programme's objective is to exceed 50 % renewable milestone by the year 2020, this project was one step to that. Annual volume of the heat pump plant will cover approximately 80 % of district cooling volumes in Turku and nearly 10 % of district heating volumes in Turku. This Kakola heat pump plant increases the total share of renewable energy sources in heat acquisition from 22 % to 30 %. Heat pump substitutes mainly coal-based energy production, annual CO₂-reduction is 45 000-50 000 tonnes.

3. Summary and logos

The summary is included this application's attachments. There is also summary of Turku Energia's annual report 2009.

Turku Energia

4. Written description

4.1.1 System history, configuration of production units, distribution network, number of square footage of building/customer facilities served, average age of production and distribution system facilities

Kakola wastewater treatment plant, heat pump plant and biogas plant was reclaimed in the beginning of the year 2009. Excavation (total 50 000 m³) was started year 2007. The new wastewater treatment plant substituted for five old ones. The heat pump uses wastewater instead of pumping the water to the sea. The Kakola heat pump plant utilize waste heat from treated wastewater and produces both district heating and cooling for public buildings and homes in Turku.

Treatment plant deals over 100 000 m³ wastewater in 24 hours. The average temperature and hence also the energy content of the water varies according to the time of the year. The heat recovery is carried out after the wastewater treatment process prior to discharging the water through the drain pipe to the sea. In the heat pump the wastewater is still used for producing district cooling. The chilled wastewater is used for cooling the water in the district cooling network after the water is discharged through the drain pipe to the sea. The wastewater is nowhere in direct contact with the water in the district heating or district cooling networks.

The heat pump does not produce any local emissions to the air. The plant is located in a cavern deep inside the Kakola rock; no noise is emitted outside the cavern. The water used by the heat pump doesn't release any odours to the environment.

The heat produced by the heat pump is equivalent to a heat demand of 12 000 inhabitants. Due to the high quality technology the heat pump can produce district heating water at almost 90° C with high efficiency. Adjacent to the heat pump there is also 17 000 m³ chilled wastewater accumulator, which is used to balance the daily fluctuations of the district cooling network. The plant is remotely monitored and controlled from the Turku Energia's Linnankatu control room.

4.2 Data supporting the systems overall energy efficiency in terms of useful energy delivered to end use customers divided by fossil primary energy input to production/distribution process, specification of fuel/energy input mix

The heat pump plant's heat output is 19,5 MW and cooling output is 13,0 MW. Its share of year heat production year 2010 was 170 GWh and district cool output 70 GWh/year. Process electricity input is about 5,6 MW (45 GWh/year). Due to the high quality technology the heat pump can produce district heating water at almost 90° C with high efficiency. The process is more precisely described in the attachment named as "Process".

4.3 How has the programme reduced greenhouse gas emissions and/or other emissions in your community? Environmental benefits which the system provides over other available energy options (trends in CO₂, NO_x, SO₂, particle emissions). Please describe fuel and water conservation achieved.

In the center of city, the wastewater management plant is treating the wastewaters of the city of Turku and its nine environmental municipalities (altogether 280 000 inhabitants). More efficient wastewater cleaning decreases Turku region's wastewater loading 30-50 %.

Turku city's and Turku Energia's Environment Management Programme's objective is to exceed 50 % renewable milestone by the year 2020, this project was one step to that. Annual volume of the heat pump plant will cover approximately 80 % of district cooling volumes in Turku and nearly 10 % of district heating volumes in Turku. This Kakola heat pump plant increases the total share of renewable energy sources in heat acquisition from 22 % to 30 %. Heat pump substitutes mainly coal-based energy production, annual CO₂-reduction is 45 000-50 000 tonnes.

The heat pump does not produce any local emissions to the air. The heat produced with the heat pump reply to 12 000 Turku citizens' demand of heat. In the sewer water which is proceeding through the cleaning process, temperature declines to 4 °C, which means that also water's heat impact to water systems stays very slight.

The silt which is arised in the cleaning process is used in bioreactor in Topinoja, it produces methane which is produced to district heat and electricity. Biogas is environment friendly, domestic and renewable energy source. Treated silt is used as a soil improvement material. Then the nutrients and humus which were deleted by the foodstuff chain retrieves back to fields and substitute for artificial fertilizers and heal the soil's own microbe action.

The process is more precisely described in the attachment named as "Process".

4.4 What makes your programme outstanding and innovative?

The project as a whole is innovative, new building and technical project which is based to many operators' cooperation. The totality is important for water protection, for prevention of climate change and it is very important also economically and for society.

4.5 How has the programme improved the quality of life of your community?

The annual local emissions has declined 50 000 CO2-tons. Because Turku Energia has also plan ready for another heat pump, the annual local emission will be in the next five years 500 000 CO2- tons.

4.6 What were the challenges you faced and how were they overcome?

The most difficult challenge was the fast timetable with lot of different operators. The project was realized with tight cooperation with Turku region`s municipality, plant`s neighbours and many different fields` authorities. The matters involved with this project has been handled in many environmental facet and the impacts has been positive.

4.7 How was the programme financed?

Turku Energia and Turun Seudun Puhdistamo and Biowakka Suomi paid it. It also got some energy support from the Ministry of Labour and business.

A close-up photograph of water splashing, with numerous clear droplets and bubbles against a blue background. The image is partially obscured by a white curved shape in the top right and an orange curved shape at the bottom.

Kakola Heat Pump Plant

**Ecologic district heating
and district cooling from
treated wastewater**

Turku Energia



Ecologic district heating and district cooling from treated wastewater

The Kakola heat pump plant, which utilizes waste heat from treated wastewater, produces both district heating and cooling for public buildings and homes in Turku. The plant was completed in spring 2009 and is located adjacent to the Kakola wastewater treatment plant.

The heat pump plant for its part slows down the climate change because the heat produced by it replaces district heating made by fossil fuels. The part of renewable heat production in Turku district heating production has risen almost up to 30 % along with the Kakola heat pump plant. The emissions of the Turku district heating production are correspondingly reduced.

The cooling power produced by the heat pump replaces own local cooling production at public buildings and homes.

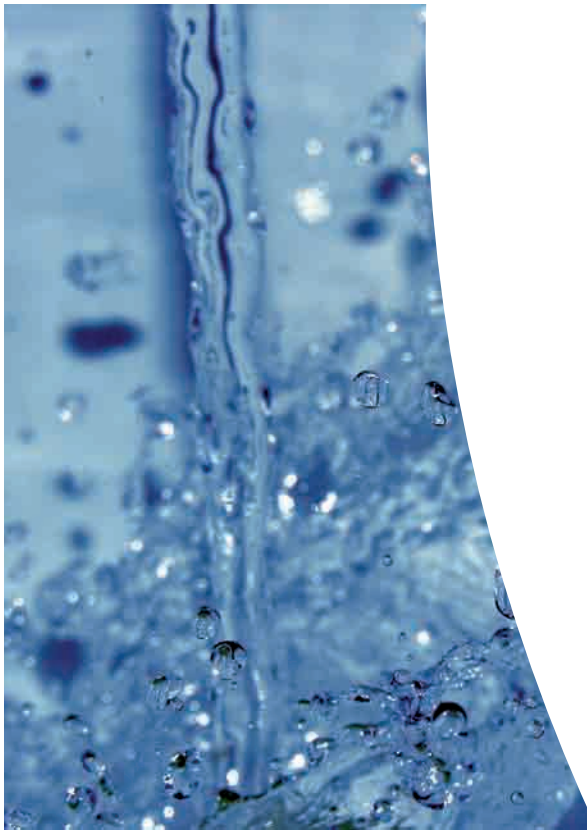
Wastewater is a significant source of energy

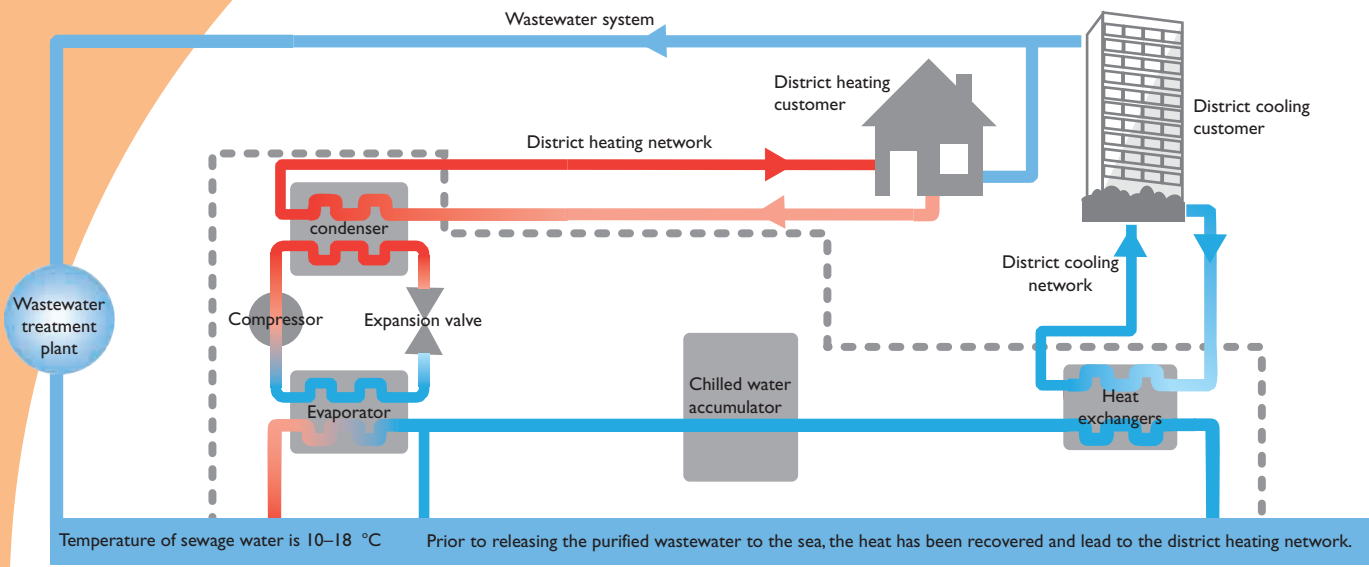
The heat source for the heat pump is treated wastewater from Turku and its nearby communities. A major part of the household water is warm water, which has been heated by electricity or district heating. With a heat pump the remaining heat energy can be captured instead of being wasted to the sea. The wastewater treatment plant treats over 100.000 m³ water per day. The average temperature and hence also the energy content of the water varies according to the

time of the year. The heat recovery is carried out after the wastewater treatment process prior to discharging the water through the drain pipe to the sea. In the heat pump the wastewater cools down as it releases the thermal energy to the water circulating in the district heating network, after that the chilled wastewater is still used for producing district cooling. The chilled wastewater is used for cooling the water in the district cooling network after which the water is discharged through the drain pipe to the sea. The wastewater is nowhere in direct contact with the water in the district heating or district cooling networks.

Environmental facts have been taken into account

The heat pump does not produce any local emissions to the air, in addition the electricity for the heat pump is to a major part produced carbon dioxide free. The plant is located in a cavern deep inside the Kakola rock; hence no noise is emitted outside the cavern. As the water used by the heat pump is treated wastewater does not release any odours to the environment.





The heat produced by the heat pump is equivalent to a heat demand of 12.000 inhabitants and it replaces approximately 21.000 tons of coal burning per annum. Corresponding reduction in green house gas emissions is approximately 50.000 tons carbon dioxide a year.

The volume of refrigerant used in the heat pump is monitored regularly and the plant is equipped with refrigerant leak sensors. The intention is to produce district heating and district cooling for the citizens of Turku reliably and environmentally friendly close to the consumers.

Best available technologies

The heat pump is supplied by the Swiss company Friotherm AG, which represents the most advanced heat pump technology. Due to the high quality technology the heat pump can produce district heating water at almost 90 °C with high efficiency. With one unit of electric energy three units district heating and two units district cooling can be produced.

Adjacent to the heat pump there is also a 17.000 m³ chilled wastewater accumulator, which is used to balance the daily fluctuations of the district cooling network. The accumulator makes it possible to momentarily almost triple the cooling power. The heat pump plant operates unmanned except during maintenance and inspection visits. The plant is remotely monitored and controlled from the Turku Energia's Linnankatu control room.

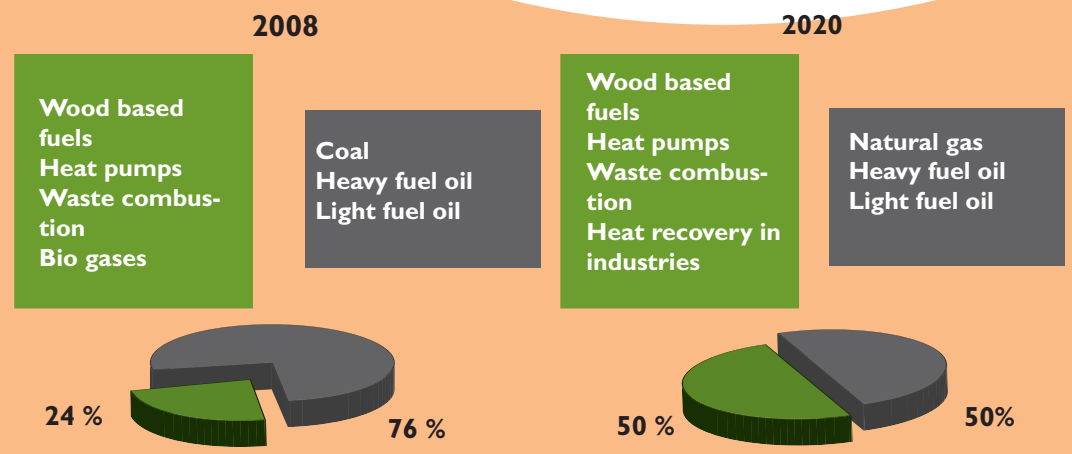
Turku Energia increases furthermore its environmental friendly energy production

Carbon dioxide formed in burning fossil fuels is a significant greenhouse gas, which has proved to speed up the world wide climate change. Energy production is a considerable source of greenhouse gases and therefore production methods used by energy companies are in key position in controlling climate change.

The long term goal for Turku Energia is to move as much as possible towards carbon dioxide free heat and electricity production. The intention by Turku Energia is to produce over half of the district heating demand of Turku carbon dioxide free by year 2020.

The biggest carbon dioxide free heat production plants of Turku Energia are the Oriketo bioheating plant, which uses different types of wood based fuels and the Kakola heat pump plant which uses waste heat of purified wastewater. A reservation has been made already in the construction phase to double the capacity of both plants by reserving space for additional production units.

In addition to wood based fuels and heat pump technology carbon dioxide free district heating production is among others increased by developing heat recovery in industries and by utilizing biogas formed in landfills.



The goal of Turku Energia is to exceed national climate targets by increasing the portion of renewable energy sources in district heating to 50 %.

Kakola Heat Pump Plant

- Heat pump plant utilizing treated wastewater
- Commissioned 2009
- Heating power 21 MW
- Cooling power 14.5 MW
- COP 3.3
- Input power (electricity) 6.5 MW
- Annual district heating production 160 GWh (appr. 8 % of Turku demand)
- District cooling production 90 % of demand

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