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Utilisation of the data center excess heat

EU-funded JTF-project

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Konesalien hukkalämmöt hyödyksi –projekti | Utilisation of the data center excess heat -project

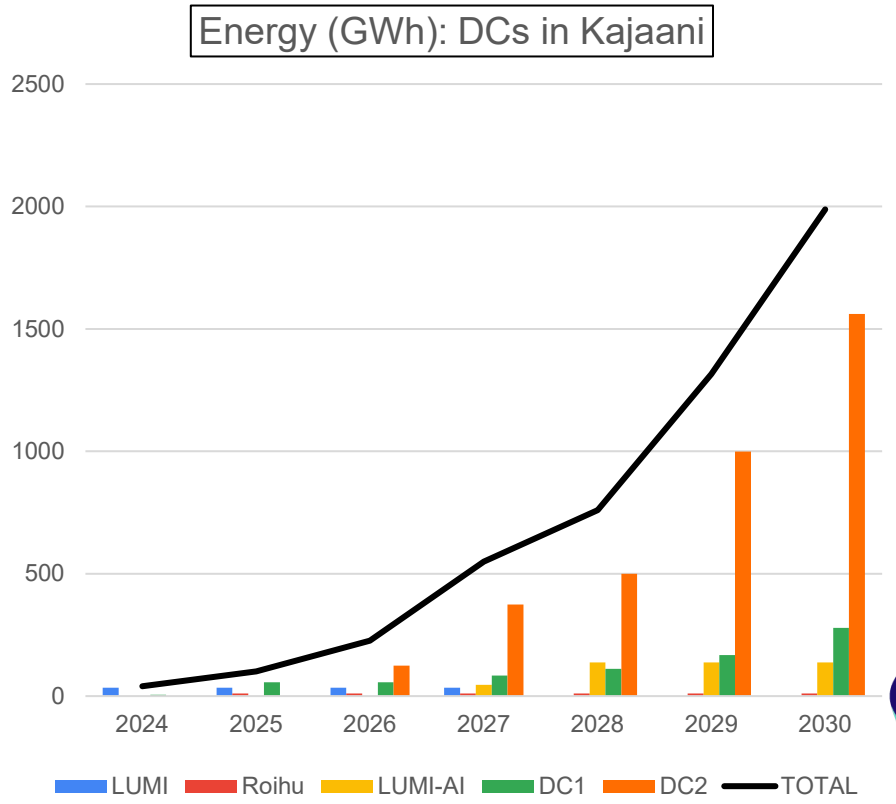
Why should a data center utilize excess heat?

- Profitability: Electricity tariff class
  - Electricity tax category I: 2.253 cents / kWh -> 22.5 e / MWh
  - Electricity tax category II: 0.063 cents / kWh -> 0.63 e / MWh
- Obligation: EU Energy Efficiency Directive
  - Member States must ensure that data centers with a nominal total energy input of more than 1 MW utilize excess heat or apply other excess heat recovery solutions, unless they can demonstrate that it is not technically or economically feasible.
- Incentive: Clean transition investment permit
  - New Construction Act (751/2023) includes an opportunity for a clean transition investment permit
  - This includes also data centers

Excess heat amounts

Estimating the potential amounts of the excess heat in Kajaani, Renforsin Ranta area.

- Estimate indicates that by 2027, the amount of raw excess heat from data centers will be approximately 500 GWh
- Total amount of excess heat power will be almost 2 TWh in year 2030
- For comparison (not scalable one to one): Heat demand for Kajaani district heating is 300 GWh per year.



Utilisation of the Data Center Excess Heat - project

Objectives

- Getting data center investments in Kajaani
- Development of new business operations around excess heat from data centers
- Promoting a circular low-carbon economy

Demography

- Funding: JTF (EU's Just Transition Fund for phasing out peat)
- Duration: 1.1.2024 – 31.12.2025
- Budget: 385 500€
- Implementers: Kajaani University of Applied Science (KAMK)
  CSC – IT Center for Science
  Natural Resources Institute Finland (LUKE)
- Financing: JTF 80%, other: KAMK, CSC, LUKE, City of Kajaani, Redeve and Loiste Heat

Excess heat utilisation possibilities

- District heating
- Biomass drying (timber, sawdust, biogas digestion residue, etc.)
- Food production: greenhouse, mushrooms, algae, fish
- Heat to electricity
- Cooling
- Wastewater treatment optimization
- Other possibilities: various chemical industry processes, hydrogen production integration, snow melting…

Latest updates

- Literature review published. Available in Finnish already, translation into English to be published soon.
- This seminar ☺
- Articles published soon in Biokierto & Biokaasu magazine, Puutarha & Kauppa magazine, and the City of Kajaani's newsletter
- Webinar series planned for next autumn
- A project related to DC and excess heat research has been applied for

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DC excess heat possibilities in bioeconomy

Heating and drying processes

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Excess heat potential in bioeconomy

Identified application areas

1. Sawmill products and sidestreams drying
2. Biogas reactor heating and recycled fertilizer production
3. Wastewater treatment enhancement
4. Greenhouses and mushroom cultivation
5. Aquaculture: fish and crustacean (*e.g.* shrimp)
6. Insect farming

Drying of lumber and sawmill by-products

- Sawn timber production in Finland more than 11 million m^3
  → export value almost 2.6 billion EUR
  - In Kainuu: approx. 430,000 m^3 → 130 million EUR
- In addition to sawn timber, significant amount of sidestreams produced
  - Product yield is <50%
  - Sidestreams: sawdust (14%), bark (9%), and sawmill chips (32%)
- The timber products need to be thermally dried
  - Original moisture 50-60% → max. 20%
  - Needed hot air temperature 50-130 °C (depend on the technique)
  - Currently, sidestreams combusted for heat production
- **Excess heat: potential to commercialize sidestreams & decrease CO_2 emissions**

Biogas production and digestate drying

- Biomethane (CH_4) is produced in anaerobic bioreactors
  - Raw materials: agricultural and industrial biodegradable sidestreams (livestock manure, food waste, wastewater, sewage sludge etc.)
  - Biomethane used as (transport) fuel, replacing natural gas
  - Production in Finland 1 TWh (2019), probably increased in the future
- Bioreactor temperature normally 30-42 °C
  - Higher temperatures (up to 55 °C) enhance methane production but make the process challenging to control

  → Heating required!
- Residual sludge a.k.a. digestate: dry matter content 5-7 w.%, contains valuable nutrients
- **Excess heat: potential to enhance methane production and drying of digestate to recycled fertilizer production**

Wastewater treatment

- Wastewater treatment largely based on microbiological processes
  - Efficiency depends on temperature
- Legislation becoming more stringent
  - Nitrogen-containing effluents may cause eutrophication of lakes & rivers

  → Nutrient removal from wastewater needs to be more efficient
- In Finland, wastewater treatment temperatures naturally low (6-14 °C)
  - Optimum temperature for nitrogen removal 20-32 °C
- **Excess heat: potential to enhance wastewater treatment, e.g. removal of nitrogen**

Greenhouses and mushroom cultivation

- In Finland, total area of greenhouses 350 ha (2023)
  - Most important production greenhouse vegetables, also ornamental plants
  - Most important area Ostrobothnia – only 1.7 ha in Kainuu
  - Currently self-sufficiency in Finland: cucumber 94%, tomatoes 59%
- Greenhouses require heating → enhances growth
  - Energy used for heating: 619 GWh electricity, 311 GWh heat (most important fuel: forest chips)
  - Very few greenhouses use excess energy from industrial processes
  - Some experiments made with data centre excess heat (e.g. Sweden, Japan)
- Also mushroom cultivation can be enhanced with heat (optimum 20-30 °C)
- **Excess heat: can increase sustainability and self-sufficiency in the greenhouse vegetables and mushroom production**

Aquaculture: fish and shrimps

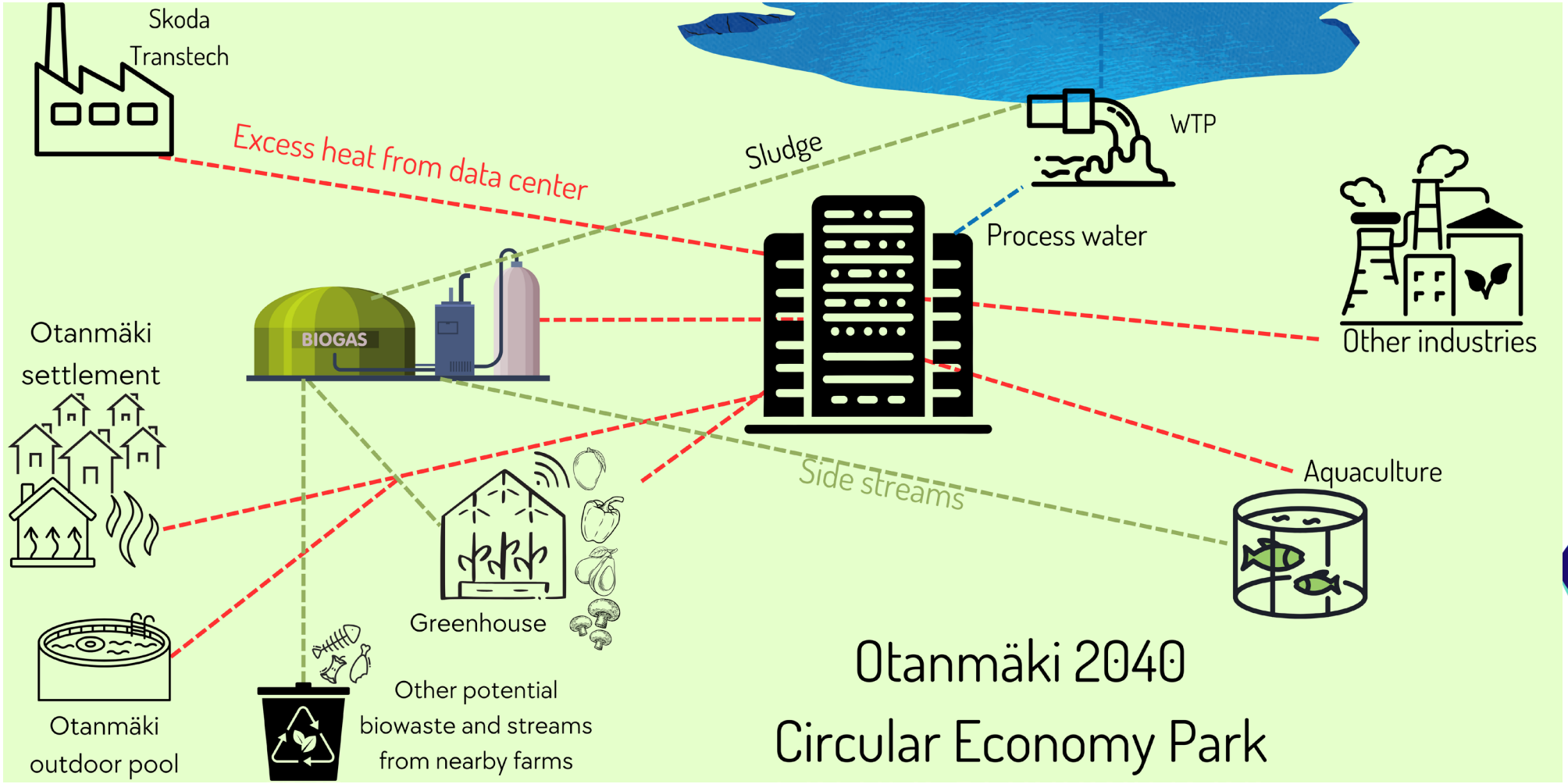
- Finnish production of farmed fish: 15.2 million kg (2023)
  - Rainbow trout (95%), also arctic char, whitefish, trout, sturgeon
  - Most production in the marine areas, inland fish farming 3.2 million kg (especially in Kainuu & Lapland)
  - Aim: increasing the production
- Heating the incoming water in recirculating aquaculture system (RAS)
  - water circulated continuously between fish tanks and water treatment units → optimizing water consumption, minimizing effluents
- Optimum for rainbow trout 15-17 °C, pikeperch 16–20 °C, whiteleg shrimp 26–32 °C
- **Excess heat: possible to make fish and crustacean farming more efficient, introduction of new species**

Insect farming

- Insects can be grown
  - for food: house cricket (*Acheta domesticus*)
  - for feed: mealworm (*Tenebrio molitor*)
  - for waste management: black soldier fly (*Hermetia illucens*)
- Insect farming is a developing business: two recently founded Finnish companies developing industrial-scale black soldier fly facilities
  - Converting food waste to protein, fat, and nutrient-rich residue (frass)

  → Producing feed, fat, biofuel, fertilizers
- Optimal temperature for rearing mealworms and black soldier fly 25–30 °C
- **Excess heat: making production of insect-based food and feed more sustainable**

Industrial ecosystem based on DC excess heat



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Thanks from your side

Next:
Chairman of the Board, Risto Oikari, from local energy company, Loiste
is presenting their plans for district heating renewal

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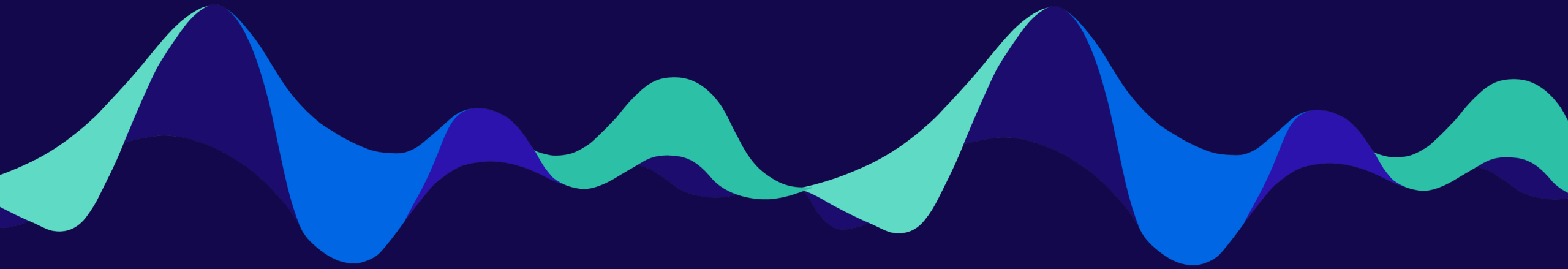
Loisteen slidet tähän väliin



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Introductions of the partners

Seminar partners

RITTAL

M-Solutions

MiNTLY
Cyber
Security
First

Tässä slide per yhteistyökumppani

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Next: Lunch break

We continue here at