INCREASING NUTRIENT RECYCLING AND BIOGAS PRODUCTION FROM SEWAGE SLUDGES THROUGH CENTRALIZED TREATMENT

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Project website: https://www.hamk.fi/jarkki/

Aim: Sewage sludge to products

1) Finding suitable size ranges and locations for centralized sewage sludge treatment plants.

2) Creating alternative centralized sludge treatment concepts that combine nutrient, energy and carbon recovery.

3) Inspiring, involving and engaging key stakeholders to reform Finland's sludge treatment.

Centralized sludge treatment concept

The economy of the scale enables efficient and viable sludge valorization processes, and we anticipate that the efficiency compensates for increased transportation. Using simulation modeling, we examine the performance of sludge transport in different scenarios of centralized treatment in Finland. The scenarios comprise biogas production of 40 GWh/a at the minimum, integrated with various carbon and nutrient valorization techniques. The optimal locations of the centralized plants are estimated based on minimized transportation. In addition, the use of biogas and nutrient products along with their required transportation are taken into account in the evaluation of effectiveness.

Municipal wastewater treatment plant

Produces either raw sludges or digested sludge from iron precipitation or RAVITA -process[1]. Outputs are transported to further processing.

Centralized sludge treatment plant

AD plant, hydrothermal carbonization (HTC) or pyrolysis or incineration and nitrogen recovery by evaporation or stripping.

Products

- Ammonium water
- Struvite
- HTC char, sludge char
- Carbon dioxide (CO_2)
- Sulphur (S)
- Clean water
- Liquefied biogas (LBG)

Nutrient products are transported for use

Biogas is used in the processes and LBG is used for sludge and product transport and delivered to refilling stations.

Results

Here, two scenarios are presented: one with the current outputs of wastewater treatment plants and the other with hypothesis that all plants would output only raw sludge. In both cases, we compare two and four centralized facilities. Maximum distance to transport from wastewater treatment plants was set to 300 km. Trucks have 45 ton load capacity in the analyses and if they run with LBG, their consumption ranges between 3,6 and 7,6 percent of the biogas energy production. Shown numbers are annual totals. Most southern plant is 1.5 to 2 times larger than the others in the given scenarios.

Current situation:
Both raw and digested sludge are produced and transported

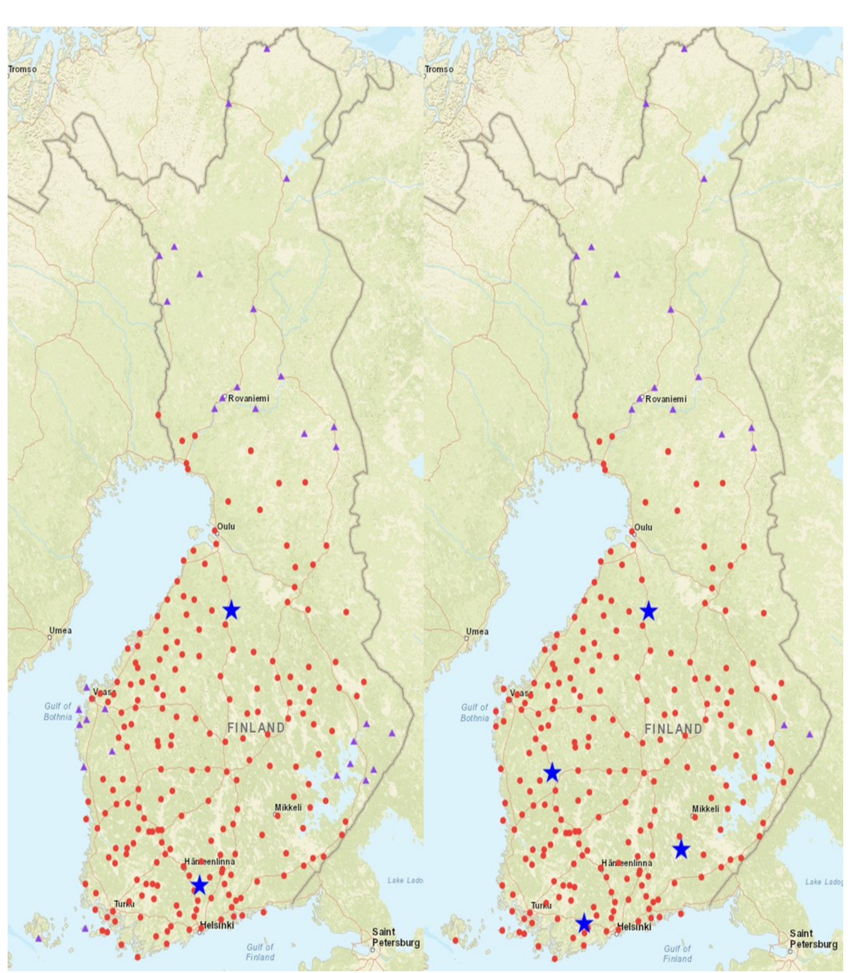
Energy potential in total ca. 175 GWh

Phosphorus ca. 3 100 t/a

Nitrogen ca. 5 200 t/a

Two facilities process 395 000 t/a raw and 165 000 t/a digested sludge with transport cost of 1,60 million km / 13,3 GWh of LBG.

Four facilities process 405 000 t/a raw and 170 000 t/a digested sludge with transport cost 1,28 million km / 10.7 GWh of LBG.



Scenario with maximum output potential:
Only raw sludge is produced and transported

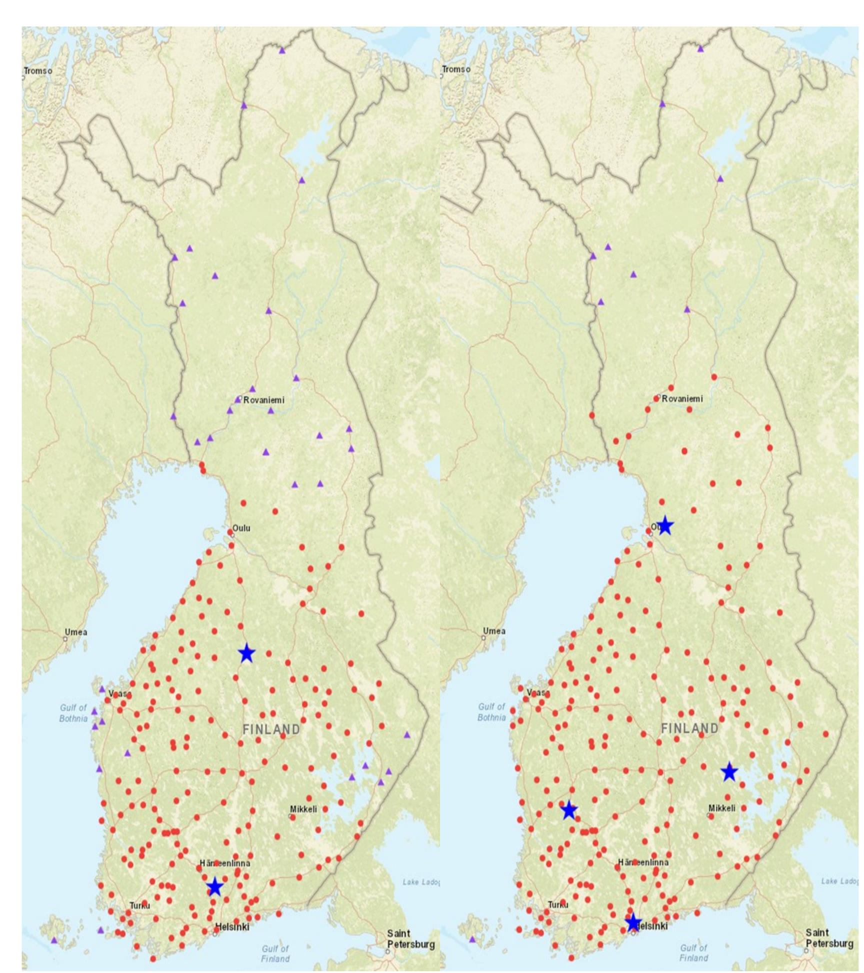
Energy potential in total ca. 320 GWh

Phosphorus ca. 3 100 t/a

Nitrogen ca. 6 700 t/a

Two facilities process 700 000 t/a of raw sludge with transport cost of 1,78 million km / 14,8 GWh of LBG.

Four facilities process 725 000 t/a of raw sludge with transport cost of 1,45 million km / 12.1 GWh of LBG.



Blue stars: optimal locations for centralized facilities. Red points: wastewater treatments plants. Purple triangles: wastewater treatment plants that are further than 300 km.

Reference: [1] Rossi L., Reuna S., Fred T. & Heinonen M. (2018). RAVITA technology–new innovation for combined phosphorus and nitrogen recovery. Water Science and Technology, 7(12), 2511-2517.

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