Luke
NATURAL RESOURCES
INSTITUTE FINLAND

Biogas and nutrient recycling research in Luke

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Luke in brief

22
locations

1337
employees

133 M€
turnover

Profitable and Responsible Primary Production

- Technologies and operational models in primary production
- Profitable agriculture and food system
- Productive forests

Circular Bioeconomy

- Optimised material cycles
- Added value and new products
- Transition to circular bioeconomy

Climate Smart Carbon Cycle

- Productive soil
- Smart land use
- Carbon neutral society

Adaptive and Resilient Bioeconomy

- Diversity and coexistence
- Ecosystem services
- Damage agent management
- Resilient society

Genetics and breeding

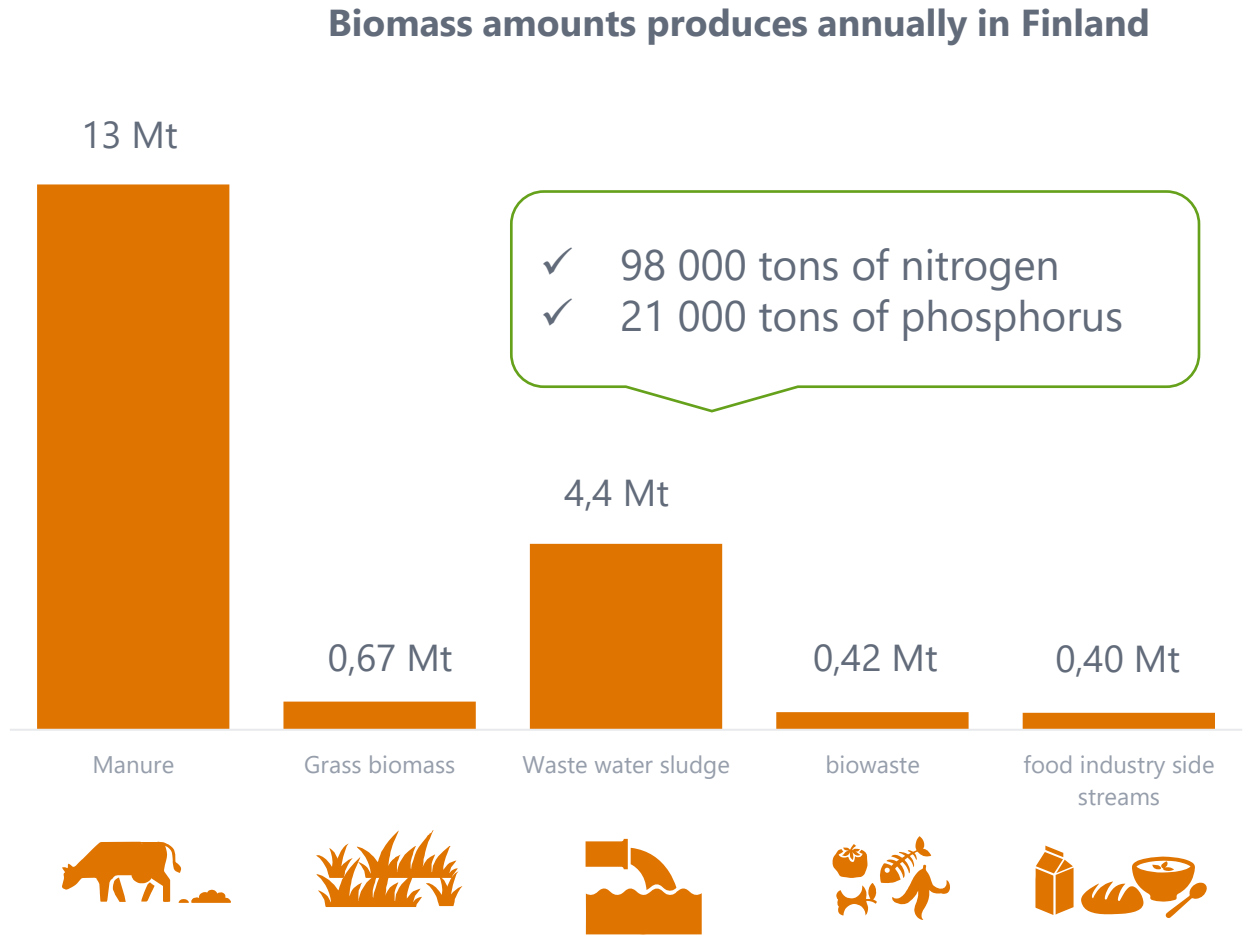
Policy and governance

Solutions from research

Biogas production in Finland

Nutrient recycling and utilization of biomasses

- Reduces the need for mineral fertilizers
  - Phosphorus reserves are running low
  - Biomasses suitable for biogas production in Finland contain 21 000 t of phosphorus, which covers 90 % of the yearly need
- Reduces nutrient leakages
  - optimized nutrient recovery reduces emissions to air and water
  - Returning organic matter and carbon to soil improves soil structure, and retention capacity of water and nutrients
- Improves security of supply in food production
  - Energy and nutrients
  - Self sufficiency
- Fosters transition from fossil economy to circular economy
  - replacing mineral fertilizers, valuable chemicals and energy, produced with fossil fuels with renewable ones

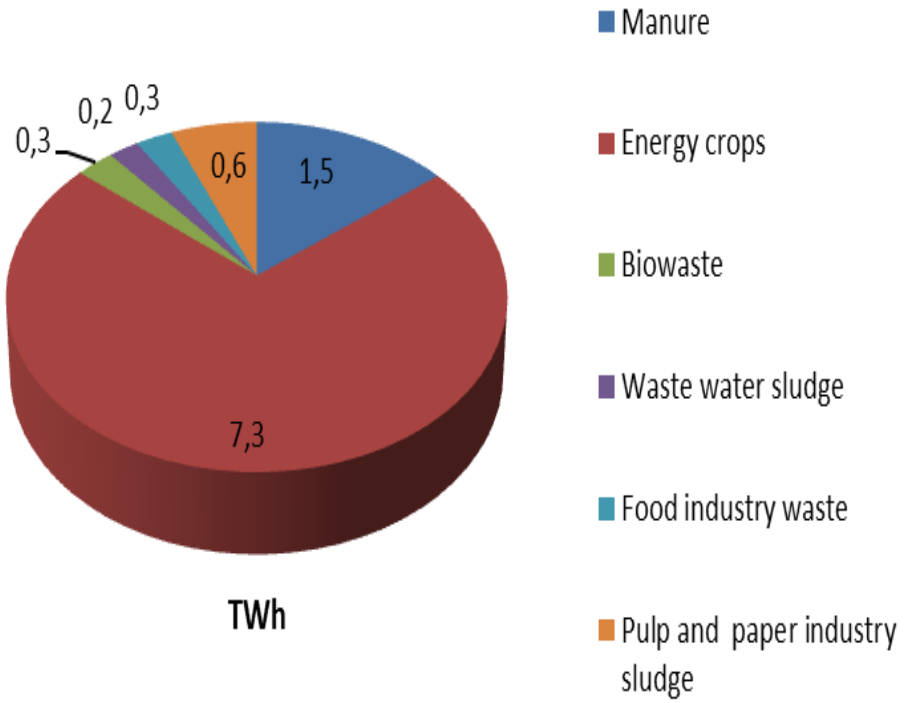


Ravinnelaskuri-työkalu. Alueellisen ravinnekierron suunnittelutyökalu (Luonnonvarakeskus Luke & Suomen ympäristökeskus SYKE)

Biogas potential in Finland

- Techno-economic potential is around 10 TWh
- Theoretical biogas potential is 18-24 TWh
- Nearly 90 % of the potential originates from the agriculture
  - Manure
  - Grass silage (evaluation of the potential varies, 4-7 TWh/a)
  - Straw

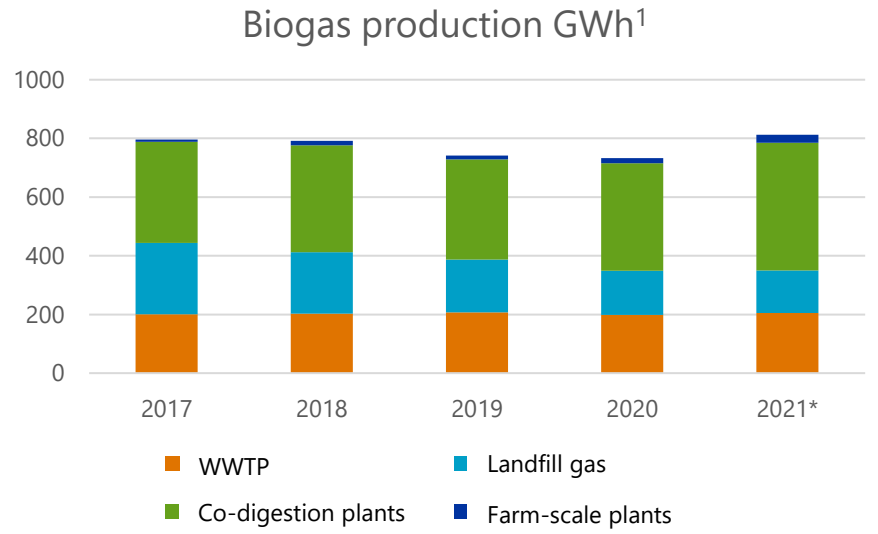
Techno-economic potential ~10 TWh

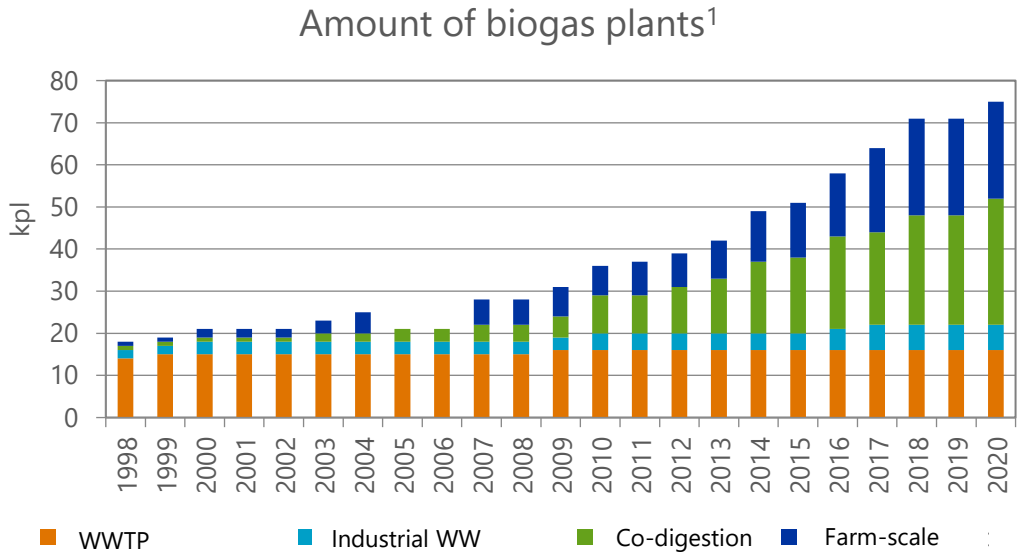


Marttinen ym. 2015. Rural biogas: feasibility and role in Finnish energy system. https://jukuri.luke.fi/handle/10024/543444

Biogas production in Finland

- Over 70 biogas plants with biogas production about 800 GWh[1]
  - Amount of farm-scale biogas plants has increased
- About 1 TWh production is achieved by the end of 2022
- In 2023-2025 about 740 GWh production is under planning[3]
- About 15% of production goes to vehicle fuel[2]
- More biomethane is needed in traffic, and production and upgrading of biomethane is expected to increase notably





[1]Suomen virallinen tilasto (SVT): Energian hankinta ja kulutus. http://www.stat.fi/til/ehk/index.html
[2]Suomen Biokierto ja Biokaasu ry 2022. Tilastot. https://biokierto.fi/tilastot/
[3]Suomen Biokierto ja Biokaasu ry 2022. Tiedote 28.9.2022. https://biokierto.fi/tiedote-biometaanin-ja-biokaasun-tuotanto-kovassa-kasvussa/

Future trends for biogas in Finland

- The amount of manure will decrease
  - Due the structural changes in agriculture, It is expected, that manure biogas potential will decrease from 3,7 to 3,2 TWh by 2050[1]
- Share of landfill gas will decrease
- Utilization of plant biomass, namely grass, is expected to increase
- Increase in amounts of source separated biowaste and use of municipal waste in biogas production
- Potential of P2G (power to gas)
  - Investments possible in 2024 or 2025[2]
  - Electricity price is in a key role

[1]Miettinen ym. 2022. Hiilineutraali Suomi 2035. Maatalouden lisätoimenpiteiden ja ruokavaliomuutoksen päästövähennysvaikutukset. http://urn.fi/URN:ISBN:978-952-380-500-2

[2]Suomen Biokierto ja Biokaasu ry 2022. Tiedote 28.9.2022. https://biokierto.fi/tiedote-biometaanin-ja-biokaasun-tuotanto-kovassa-kasvussa/

Biopaja – solutions for the circular bioeconomy

Biopaja – solutions for the circular bioeconomy

- Biogas production research
- Manufacturing and utilization experiments for bio-based fertilizers
- Pyrolysis experiments and research of pyrolysis products
- Regional and local biomass potential assessments
- Laboratory analytics
- Techno-economic assessments

Website:

https://www.luke.fi/en/services/biopaja-solutions-for-the-circular-bioeconomy#biogas-production-research

Youtube:

https://youtu.be/kFmxfy5_jLA

Biopaja – Research facilities 1/3

Biochemical conversion - Anaerobic digestion in different scales:

- Biomethane potential (BMP) test system for up to 40 samples
- Continuous stirred tank reactors that can be fed using solid or liquid feedstocks
- Plug-flow reactor for examining the progress of process during different stages with three measurement points
- Laboratory and pilot scale leach-bed reactor for dry feedstocks, including grass, straw and dry manure (or a mixture)

Biopaja – Research facilities 2/3

Pre and post treatment: concentration and recovery of nutrients and carbon:

- Solid-liquid separation of sludge and slurry
- Membrane filtration system for liquids materials

Biomass dryer, Combination of IR drying and vacuum suction

Pelletizing and granulation equipment for treatment (refining) of solid fractions

Biopaja – Research facilities 3/3

Farm scale biogas plants

- Maaninka, Northern Savonia (120 dairy cows)
- Minkiö, Tavastia Proper (about 200 cows), start-up in summer 2023

- Pilot scale leach-bed reactor for dry feedstocks in Biopaja, Jokioinen

Nutrient rich slurries

Biogas process

Lab-scale
- BMP devices
- CSTRs
- Leach-bed reactor
- Plug-flow reactor

Pilot
- Leach-bed reactor

Separation

- Screw-press
- Decanting centrifuge
- Vibrating screen

Membrane treatment

- Small-scale for screening
- Larger scale device

Liquid fertilizer products

Pelletizing and granulation

- Pelletizer
- Disc granulator

Drying

- IR+vacuum belt-dryer

Grinding

- Hammer mill
- Knife mill

Pyrolysis

- Lab-scale slow pyrolysis

Dry soil amendments

Granular fertilizer products

Topical research themes

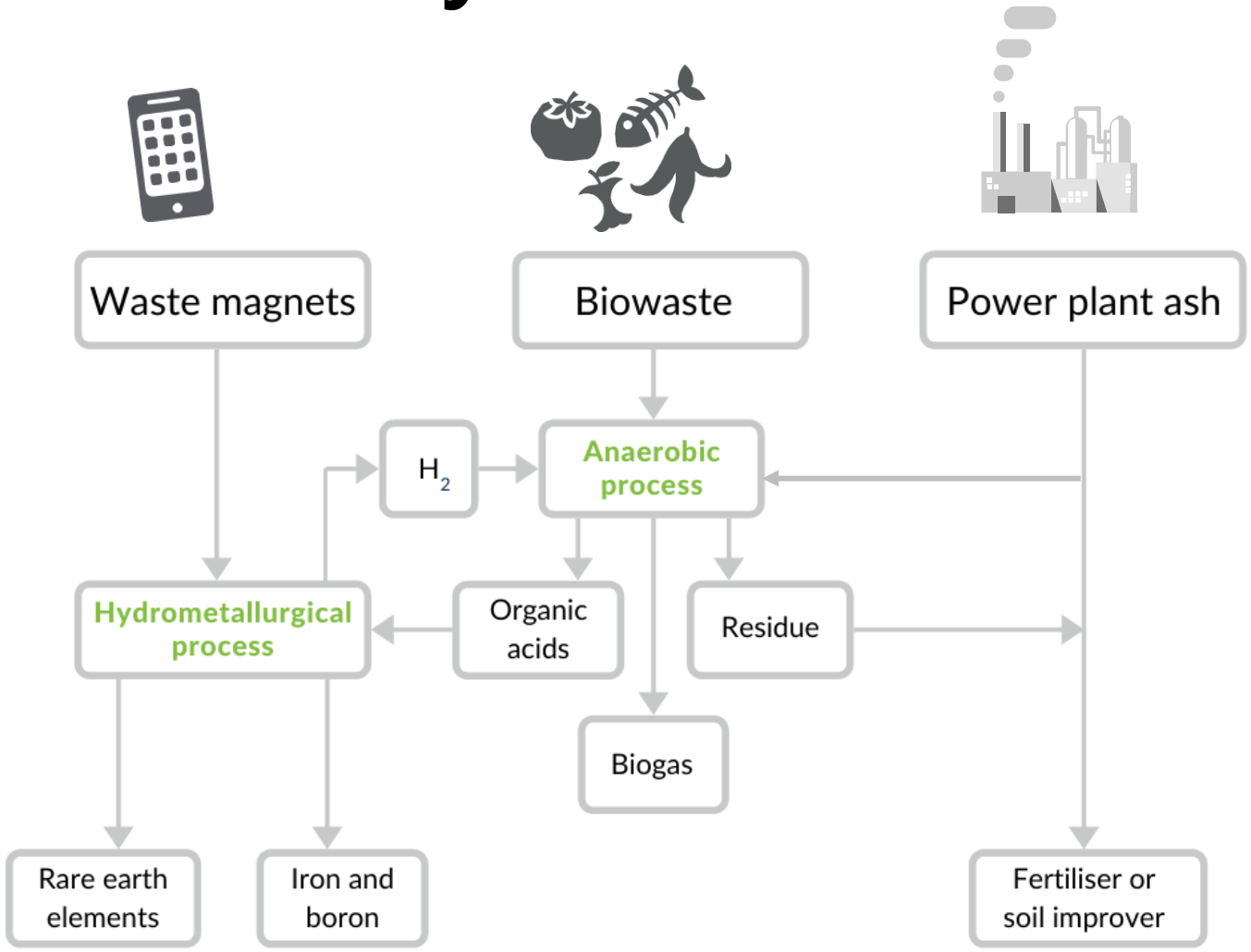
Process stability under drastic feedstock changes and utilization of seasonal co-feedstocks

- Challenges in utilization of locally and seasonally produced organic side streams and wastes.
- Seasonal production of certain biomasses, e.g.,
  - Reindeer and sheep slaughtering wastes
  - Organic wastes from tourism
  - Fish biomass
- Remote locations with long transportation distances

➢ Small scale decentralized processing solutions are needed

  - Anaerobic digestion with changing (co)feedstocks

Biogas process as a part of whole waste management to increase circularity



JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

European Union
European Regional Development Fund

Leverage from the EU 2014–2020

KESKI-SUOMEN LIITTO
REGIONAL COUNCIL OF CENTRAL FINLAND

https://www.jyu.fi/science/fi/kemia/tutkimus/kemian-kiertotalous/kiertotalouden-ekosysteemi

External organic matters for climate mitigation and soil health EOM4SOIL

Objectives:

- Increase C sequestration potential of anaerobic digestates through selection of co-feedstocks in anaerobic digestion
- Increase the circular utilization of the materials
- Create additional value for the EOMs
- Nutrient value of the digestate and stability of the AD process are not being compromised

Task 2.1 Anaerobic digestion

- Optimization of anaerobic digestion for improved C sequestration potential of EOM's
- Processing (AD, composting, pyrolysis) decreases solubility/degradability of carbon, but can we increase non-soluble carbon fraction?
- BMP and pilot tests in Luke

https://ejpsoil.eu/soil-research/eom4soil

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Thank you!

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