



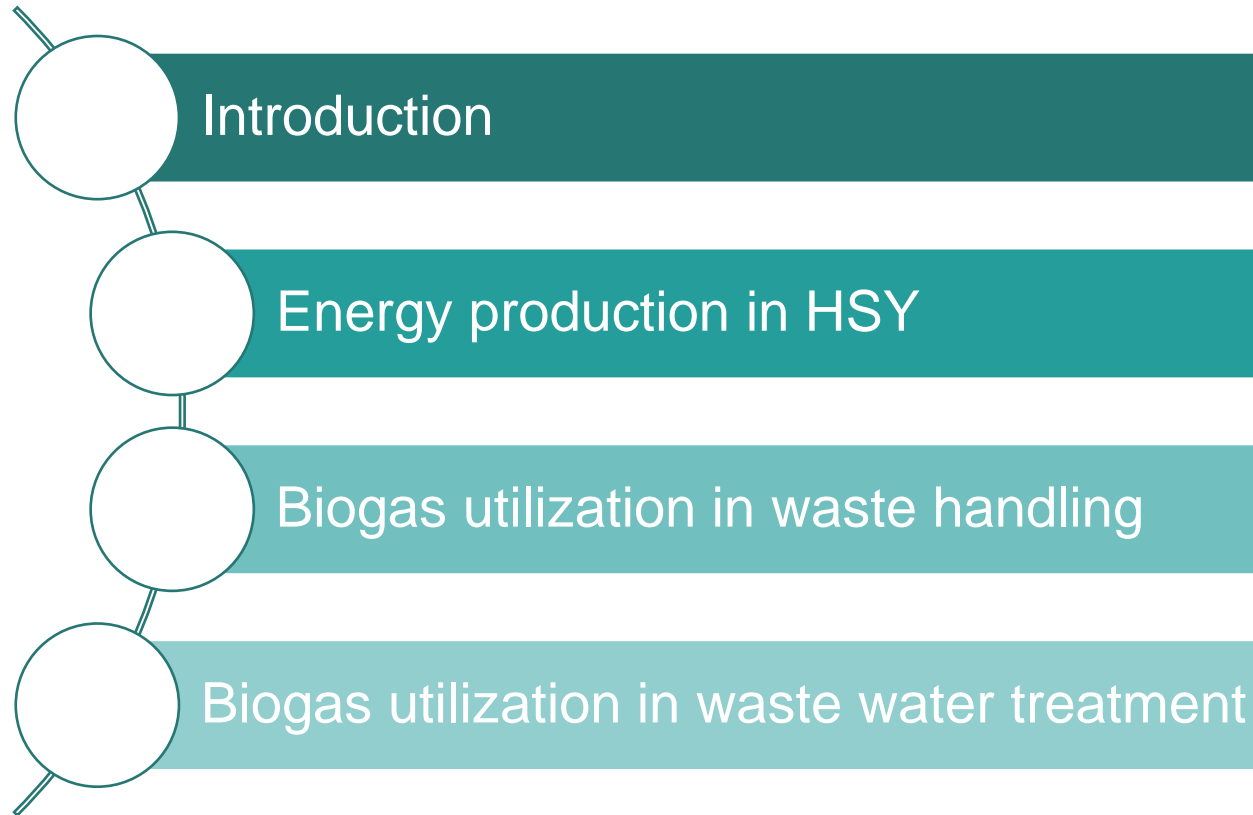
Biogas and energy efficiency in Helsinki Region Environmental Services

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Juha Viholainen, Energy efficiency manager

Contents

Biogas and energy efficiency in Helsinki Region Environmental Services



Juha Viholainen, Energy efficiency manager

- Energy and GHG-reports, energy efficiency development, action planning, project support etc.

Working experience

- Climate Specialist, HSY
- Energy Consultant, Granlund
- Researcher, LUT

Education

- M.Sc. (Tech.) in Environmental technology, LUT
- Ph.D. (Tech) in Energy technology, LUT

Helsinki region



Helsinki metropolitan area

HSY (Helsingin seudun ympäristöpalvelut)



Water services



Waste services



Regional- and Environmental Information services

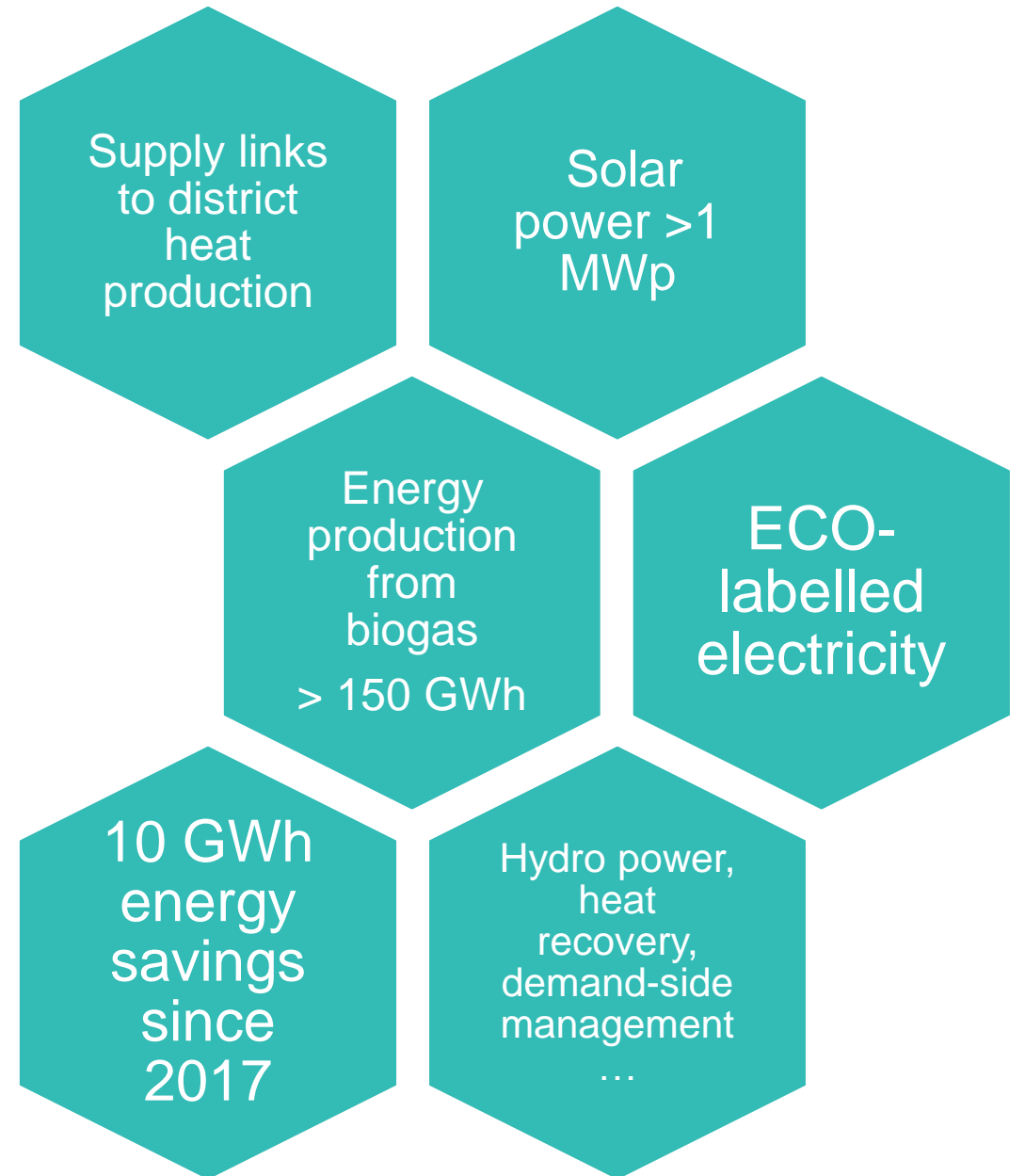


Communications, customer services, support services etc.

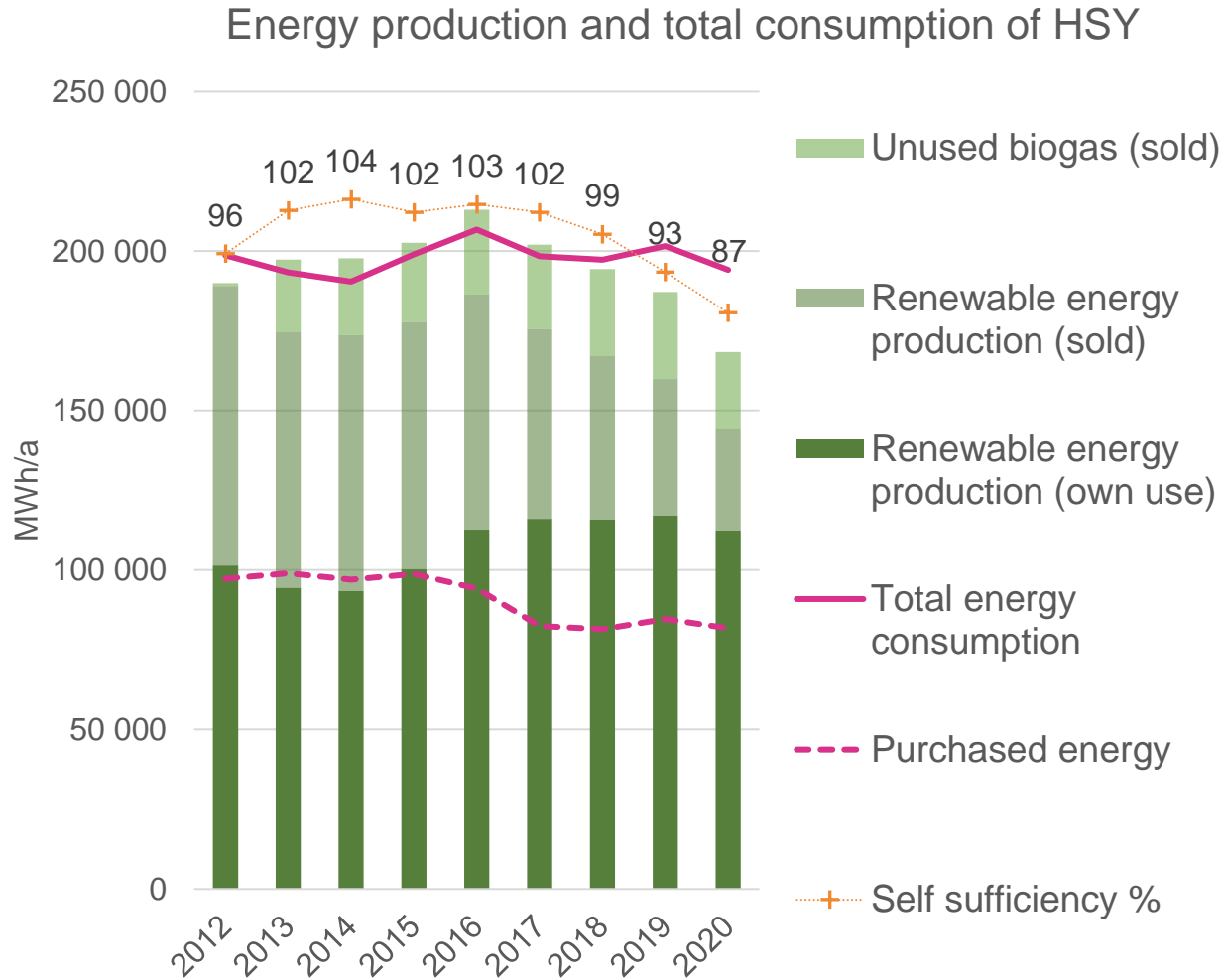
nearly 800 people and a turnover of more than EUR 350 million

Energy efficiency in Helsinki Region Environmental Services

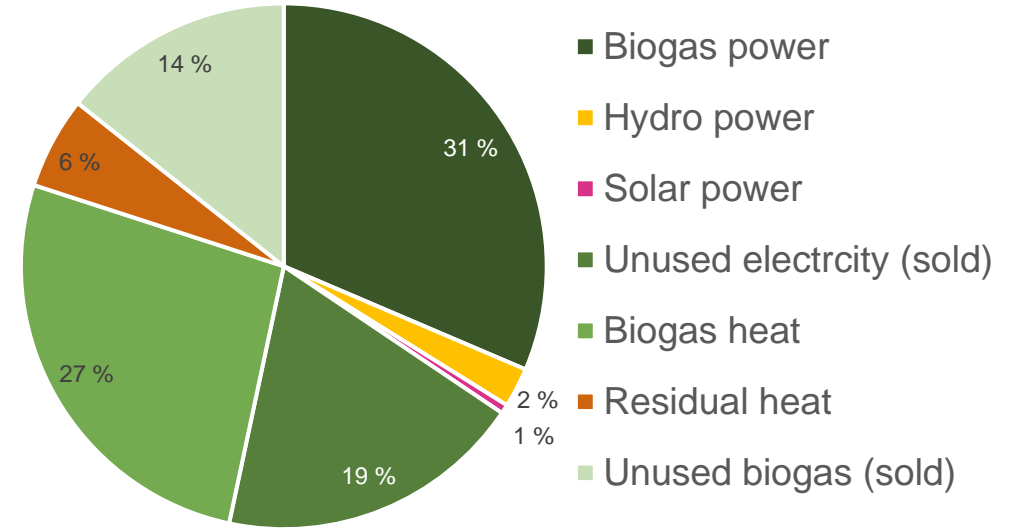
- Strategic goal: Forerunner in environmental responsibility and resource efficiency
- Carbon neutral by 2030
 - Note: most of our energy is already from renewables, main part of our GHG-emissions comes from processes
- Energy efficiency goals
 - Reduce energy consumption: targetting 7,5 % energy savings by 2025 (base year 2015)
 - Uphold energy self sufficiency



Energy production and energy consumption in HSY

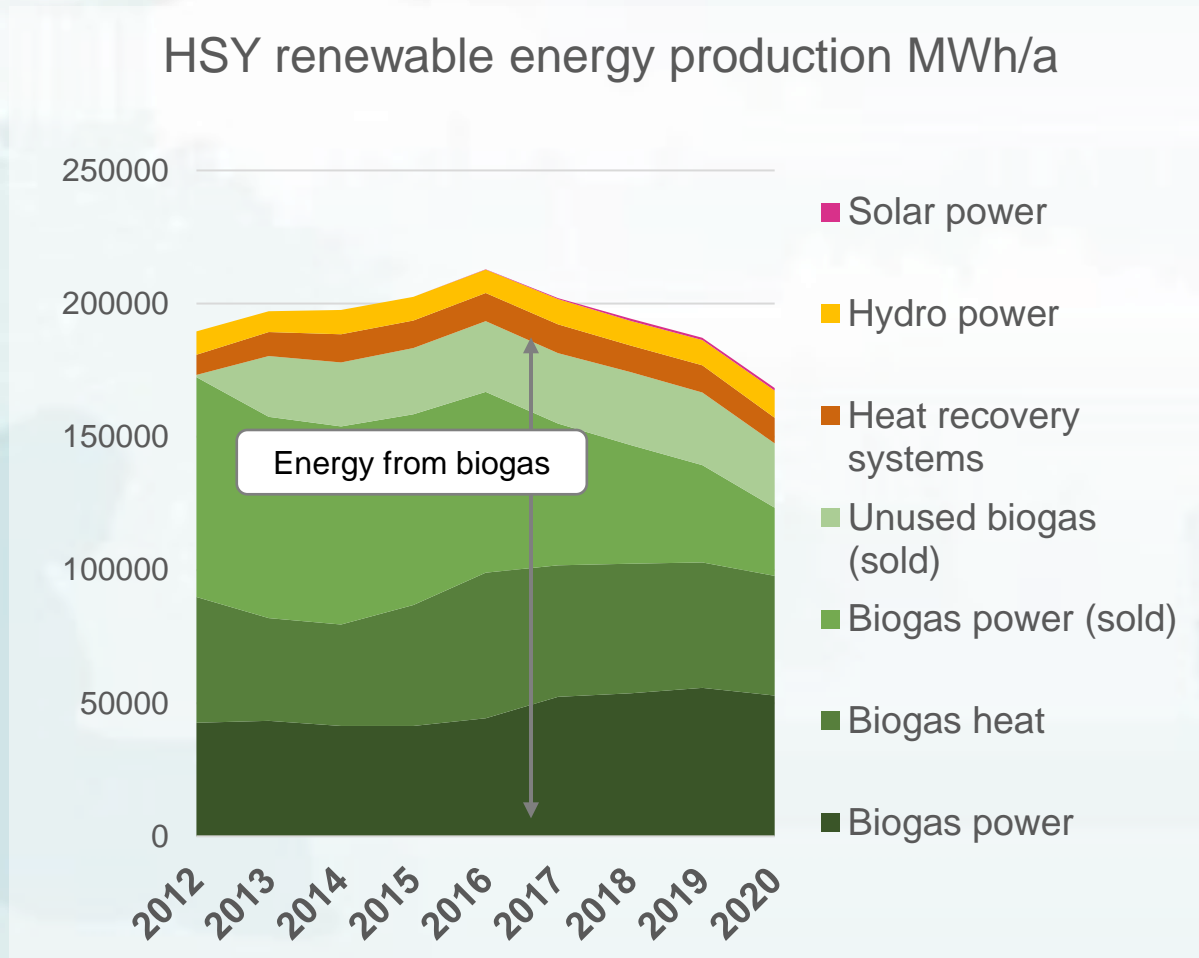


Renewable energy production of HSY (2020)



- Our energy use is based on renewables
- Main share of our consumed energy is from our own renewable energy plants: biogas motors, heat recovery systems, hydro and solar power...
- We are operating very close to net-self sufficiency

Biogas is the main source of our renewable energy production



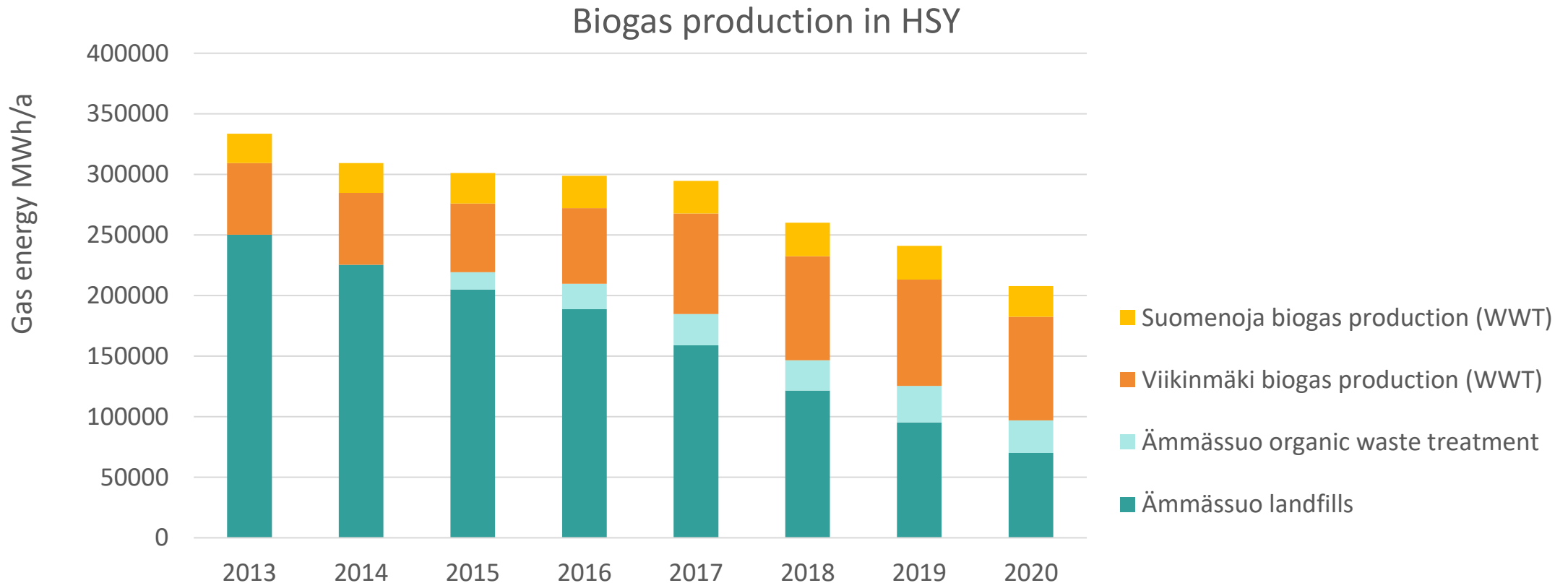
Our biogas comes from

- **Waste water treatment:** digestion of sludge in WWTplants at Viikinmäki and Suomenoja
- **Biorecycling of organic waste:** digestion of organic waste in Ämmässuo eco-industrial center
- **Landfills:** capturing landfill gas in Ämmässuo (and Seutula)

Biogas is utilized to

- **Combined heat and power generation** using gas motors
- **Heating** using gas boilers
- **Transport fuel/fuel** (refined and distributed by Gasum)

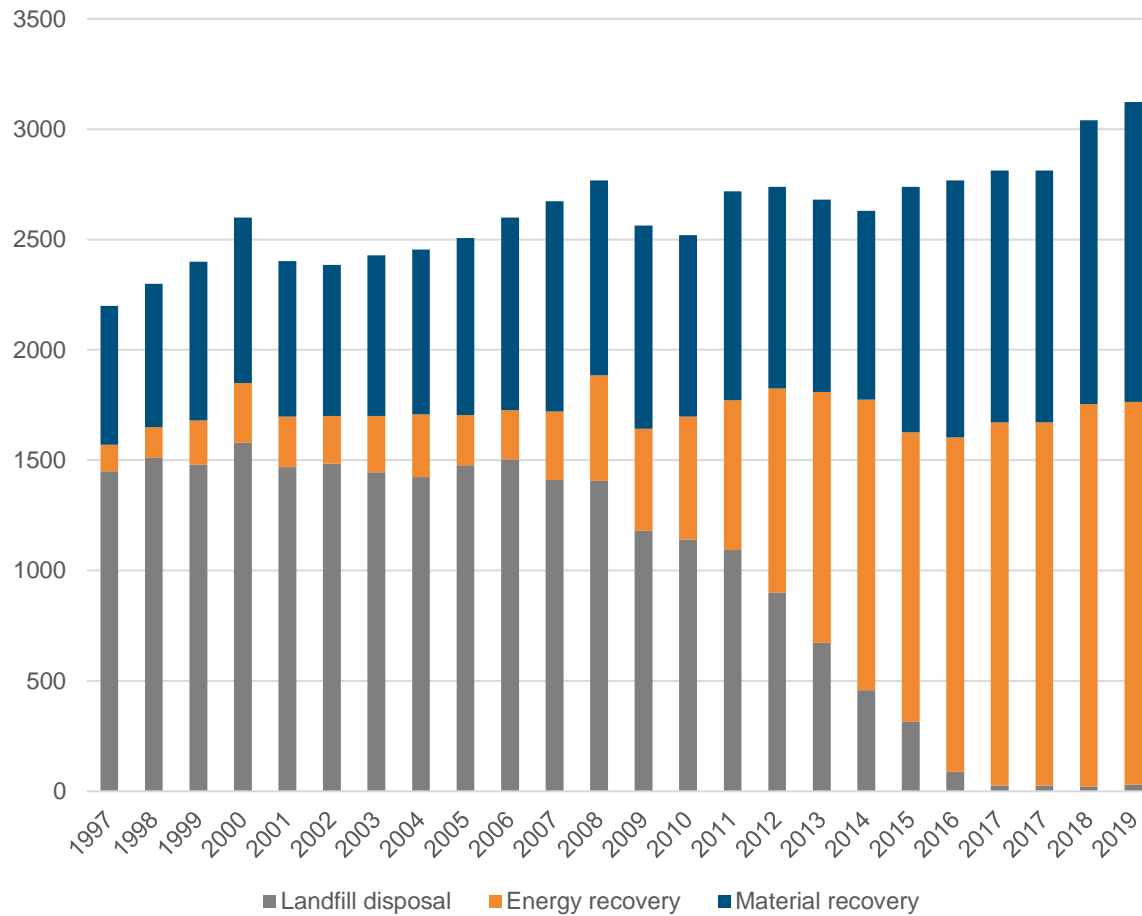
Biogas production at WWT-plants and in Ämmässuo eco-industrial center



- In Finland, total amount of biogas produced in 2018 was approx 1 TWh – over 25% from HSY
- Landfills have been the main source for biogas, but the amount of gas recovered from landfills has decreased considerably in past five years
- At present, most of our biogas comes from waste water treatment plants

Energy and material recovery have replaced landfill disposal of waste

Municipal waste in Finland, arranged by treatment methods, 1000 t

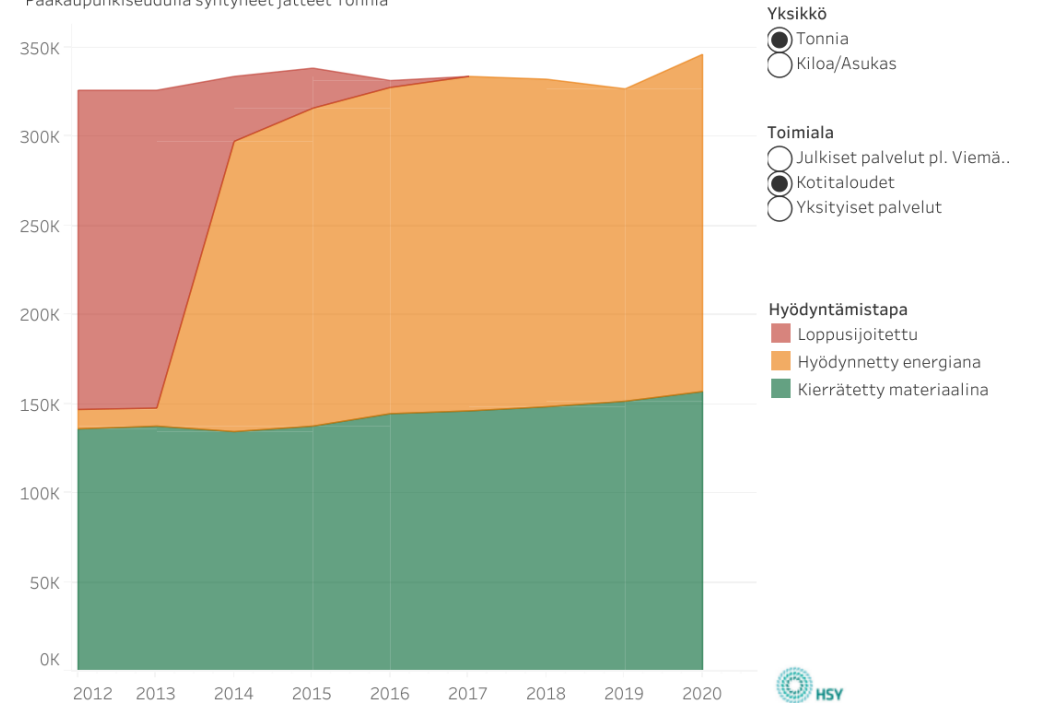


Pääkaupunkiseudun jätteiden hyödyntäminen

Kierrätysaste 2020	Kierrätysasteen kehitys	Hyödyntämisaste 2020	Hyödyntämisasteen kehitys	Vuosivalinta 2020
45,38%	-1.01	100,00%		

Yhdyskuntajätteet

Pääkaupunkiseudulla syntyneet jätteet Tonnia



Source: Statistics Finland, HSY

The largest waste treatment center in the Nordic countries



Ämmässuo eco-industrial center

- | | | | |
|----------------------------|---------------------|--|------------------------|
| 1. Office buildings | 7. PIMA hall | 11. Sedimentation basin for aggregate-containing sludge material | 15. Ash compartment |
| 2. Ämmässuo Sortti Station | 8. PIMA field | 12. Baling field | 16. Old landfill |
| 3. Scale station | 9. Water station | 13. Landfill | 17. Slag field |
| 4. Composting facility | 10. Gas power plant | 14. Reception field | 18. Sorting station |
| 5. Old composting facility | | | 19. Biogas facility |
| 6. Biowasher | | | 20. Biogas power plant |

Energy flows and energy use in Ämmässuo eco-industrial center

Primary energy


Energy production

Distribution

End use


Biogas from
landfills




Gas engines + ORC (~17
MW), combined heat and
power production (**CHP 1**)

Biogas from
digestion facility




Gas engines + ORC (1,5
MW), combined heat power
production (**CHP 2**)

Fuel oil
(purchased)




Heat boilers in
various facilities

Electricity
(purchased)



25 MWh

~30 000–50 000 MWh

Power plant network
(self-powered
operation of the
plants)

~8 000
MWh

~9 000
MWh

**Industrial
electricity network**
(other end users of
Ämmässuo area)

18 000
– 20 000 MWh

85-100 MWh


**Regional heating
network**

To end users via
national energy
grid




Power plants


Composting facility


Treatment halls, real
estates, other end use


Office building

Biogas plant (CHP 2)

Biogas from organic waste digestion

Energy production approx. 9 000 MWh of renewable electricity and 9 200 MWh of heat

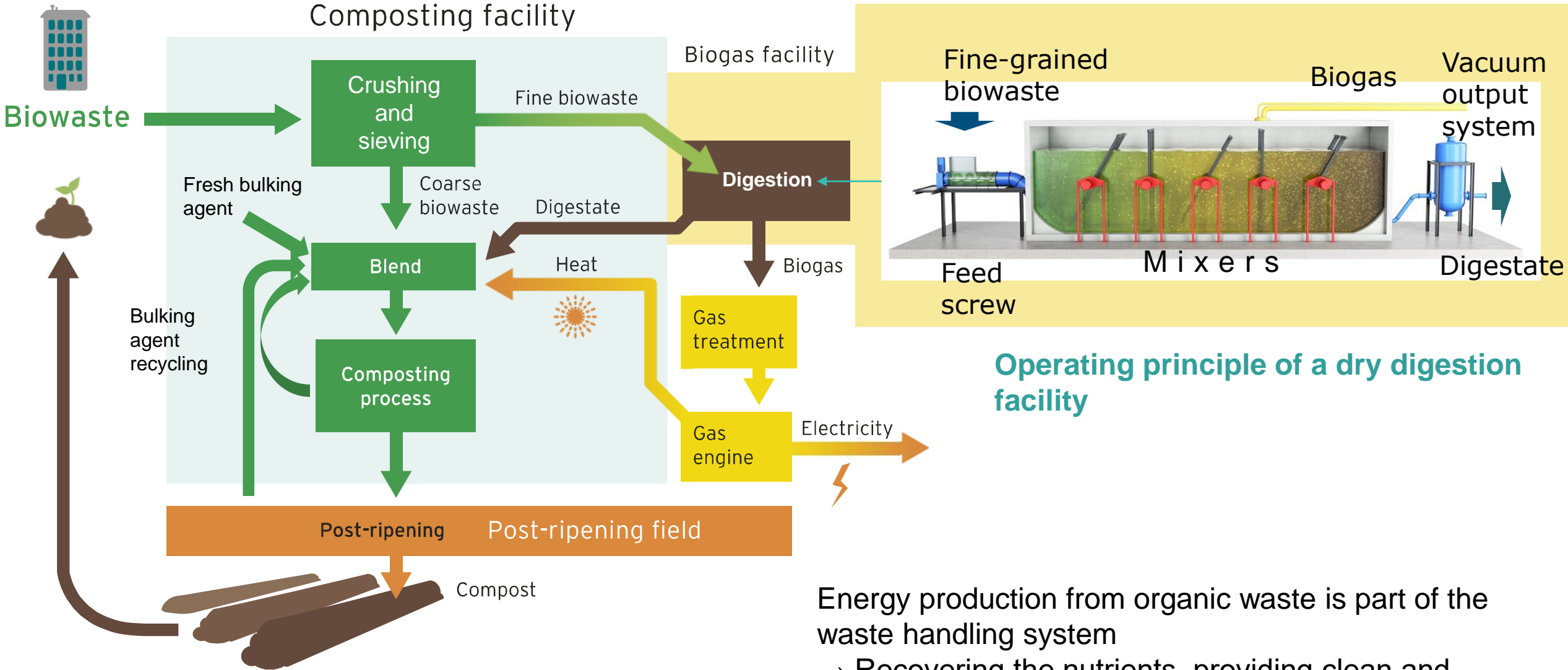


Biogas plant CHP 2 characteristics

- Two gas engines
 - Elect. power 2 x 1 560 kW
 - Heat power 2 x 1 600 kW
- Operating Efficiency:
 - CHP: 83,8 % (elec. 41,4 %, heat: 42,4 %)
- + ORC for energy production from exhaust gas
 - Heat power: 880 kW
 - Elect. power: 130 kW
- Started in 2017
- The role of the "smaller biogas-plant" is to provide necessary heat power to Ämmässuo area
 - Electricity is sold to national grid (cost-efficient because of "overall efficiency tariff")



Collection and treatment of biowaste



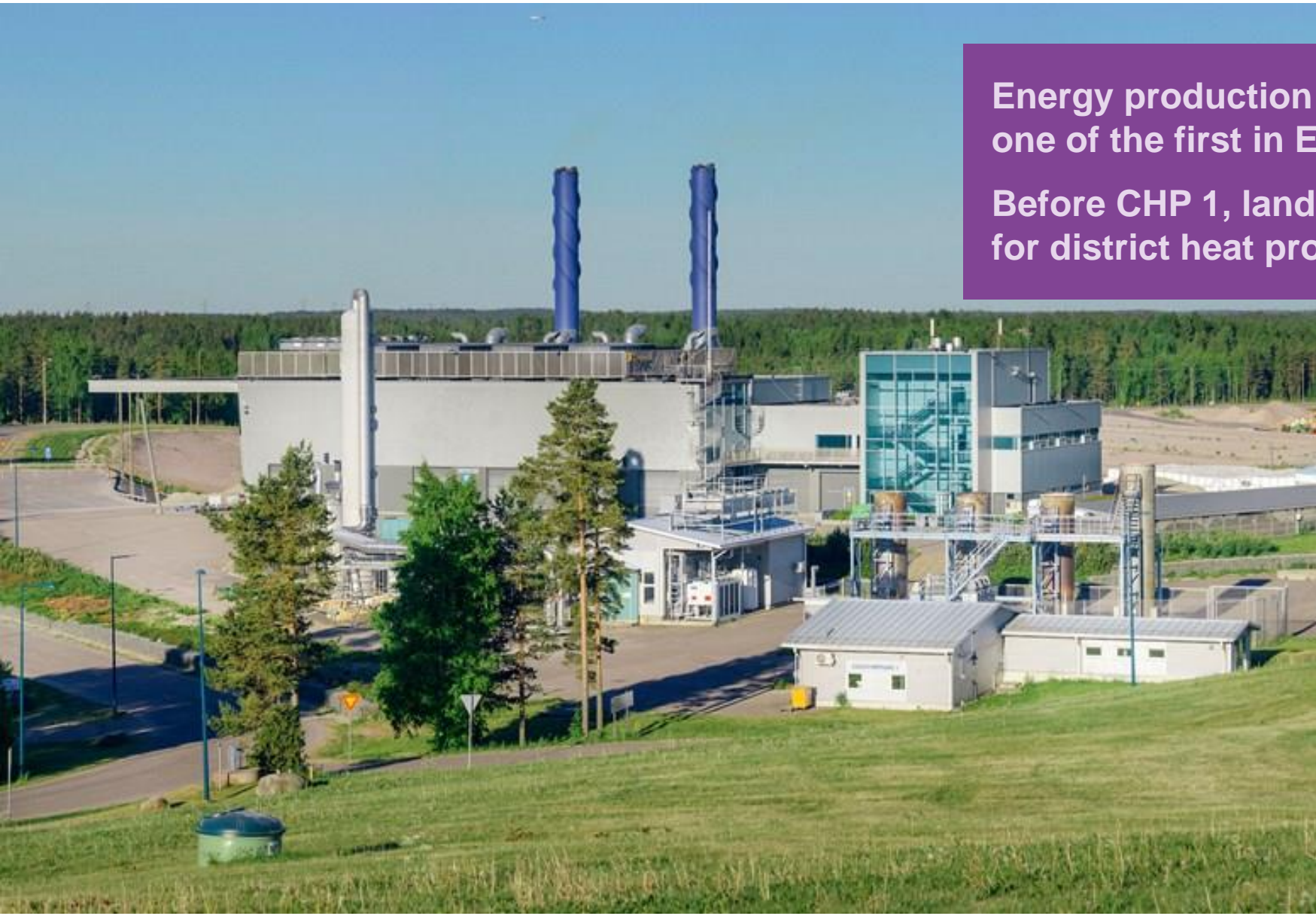
Operating principle of a dry digestion facility

Energy production from organic waste is part of the waste handling system
 → Recovering the nutrients, providing clean and healthy environment etc. – parts of the same puzzle

Landfill gas power plant (CHP 1)

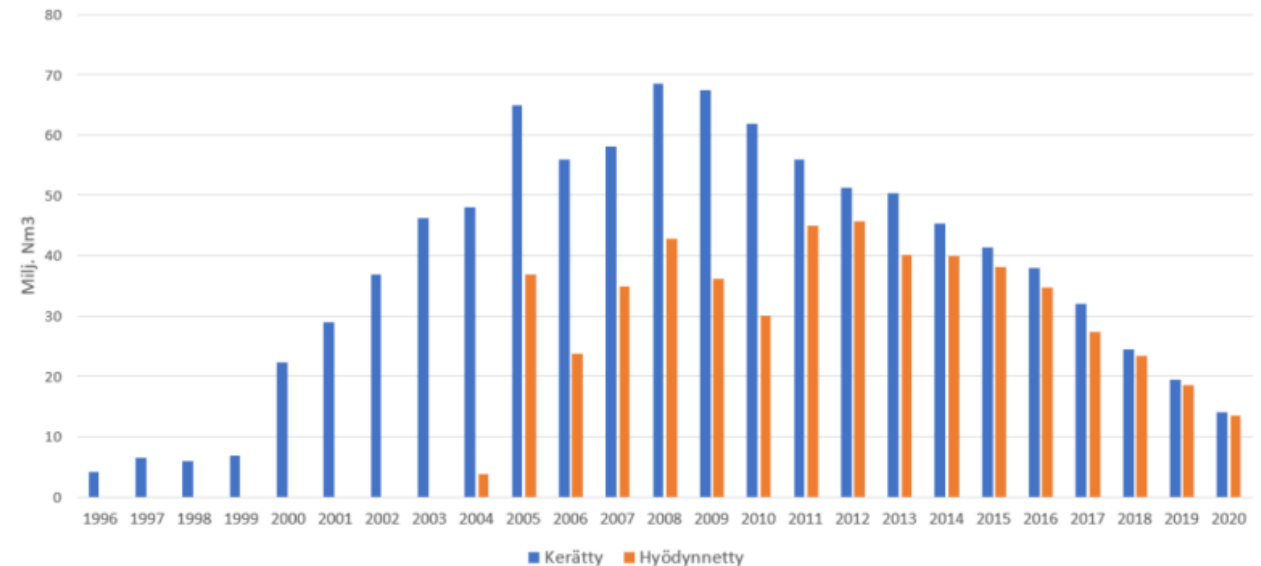
Energy production from recovered landfill gas - one of the first in Europe (started in 2009)

Before CHP 1, landfill gas was delivered to Espoo for district heat production

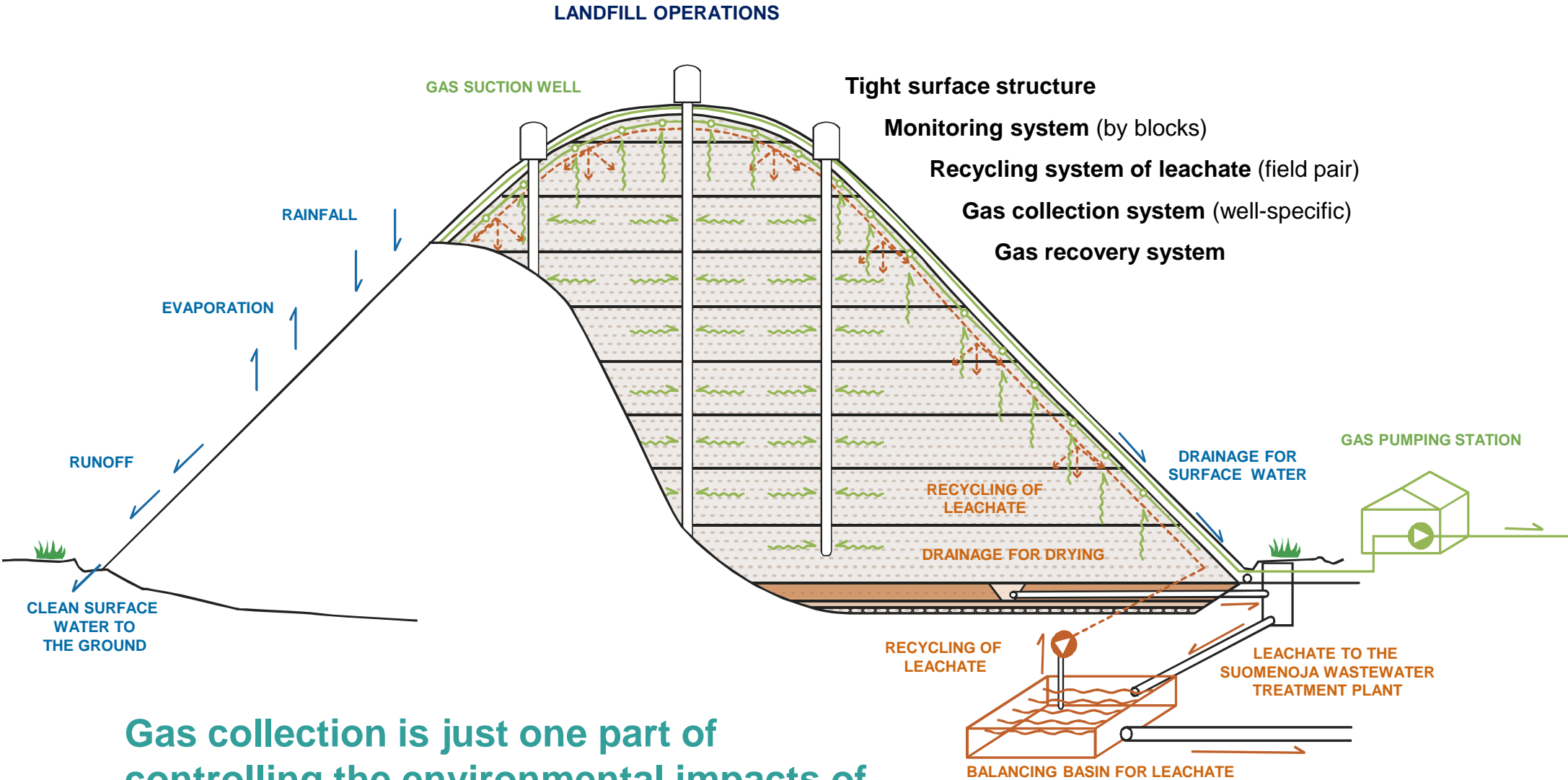


CHP 1 characteristics

- Four gas engines + ORC
 - Elect. power 17 MW
 - Heat power 18 MW
- Capacity to produce over 120 GWh electricity
- At present, the energy production is 25–35 GWh of electricity and 6–10 GWh of heat is recovered to local heating network
- Approx. 50 % of generated electricity is delivered to national grid
- "Larger biogas-plant" has been the main energy production unit in Ämmässuo since 2009, but the role has diminished due to decreasing gas volumes



Conceptual image of the closed-down landfill



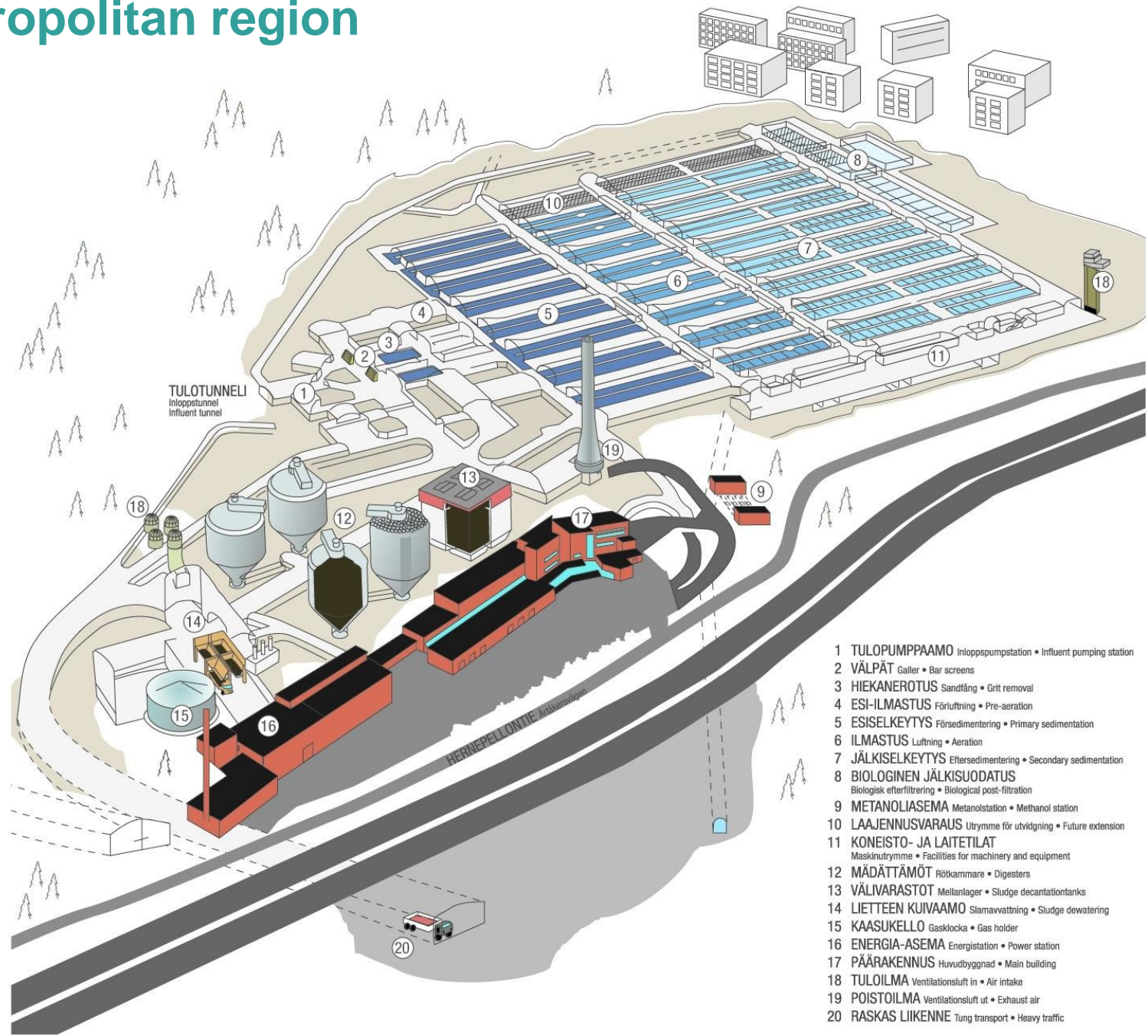
Gas collection is just one part of controlling the environmental impacts of landfills...



HSY

Waste water treatment in Metropolitan region

- Viikinmäki plant in Helsinki is the biggest WWTP in Nordic countries
 - Start-up year 1994
 - Is located mostly in underground rock caverns
 - Average influent flow 280 000 m³/d, 100 million m³/a
 - Energy solutions include biogas from digestion, gas engines, heat recovery, solar panels...
- In 2022–2023 new treatment plant in Blominmäki, Espoo will replace Suomenoja plant



- 1 TULOPUMPPAAMO Inloppspumpstation • Influent pumping station
- 2 VÄLPÄT Galler • Bar screens
- 3 HIEKANERÖTUS Sandfång • Grit removal
- 4 ESI-ILMASTUS Föriluftning • Pre-aeration
- 5 ESISELKEYTYS Försedimentering • Primary sedimentation
- 6 ILMASTUS Luftning • Aeration
- 7 JÄLKISELKEYTYS Eftersedimentering • Secondary sedimentation
- 8 BIOLOGINEN JÄLKISUODATUS Biologisk efterfiltrering • Biological post-filtration
- 9 METANOLIASEMA Metanolstation • Methanol station
- 10 LAAJENNUSVARAUS Utrymme för utvidgning • Future extension
- 11 KONEISTO- JA LAITETILAT Maskinutrymme • Facilities for machinery and equipment
- 12 MÄDÄTTÄMÖT Röttkammare • Digesters
- 13 VÄLIVARASTOT Mellanlager • Sludge decantation tanks
- 14 LIETTEEN KUIVAAMO Slamavvattning • Sludge dewatering
- 15 KAASUKELLO Gasklocka • Gas holder
- 16 ENERGIA-ASEMA Energistation • Power station
- 17 PÄÄRAKENNUS Huvudbyggnad • Main building
- 18 TULOILMA Ventilationsluft in • Air intake
- 19 POISTOILMA Ventilationsluft ut • Exhaust air
- 20 RASKAS LIIKENNE Tung transport • Heavy traffic

Energy production capacity in Viikinmäki WWTP

- Viikinmäki electricity production
 - Biogas engines 1050 kW + 3 x 1560 kW
 - ORC 112 kW + 175 kW
 - Solar power 257 kW
- Viikinmäki heat production
 - Exhaust gas boilers 2100 kW
 - ORC 600 kW
 - Boilers 7000 kW
 - Heat recovery 2000 kW



Wastewater treatment requires a lot of energy – aeration, sludge dewatering, pumping processes...

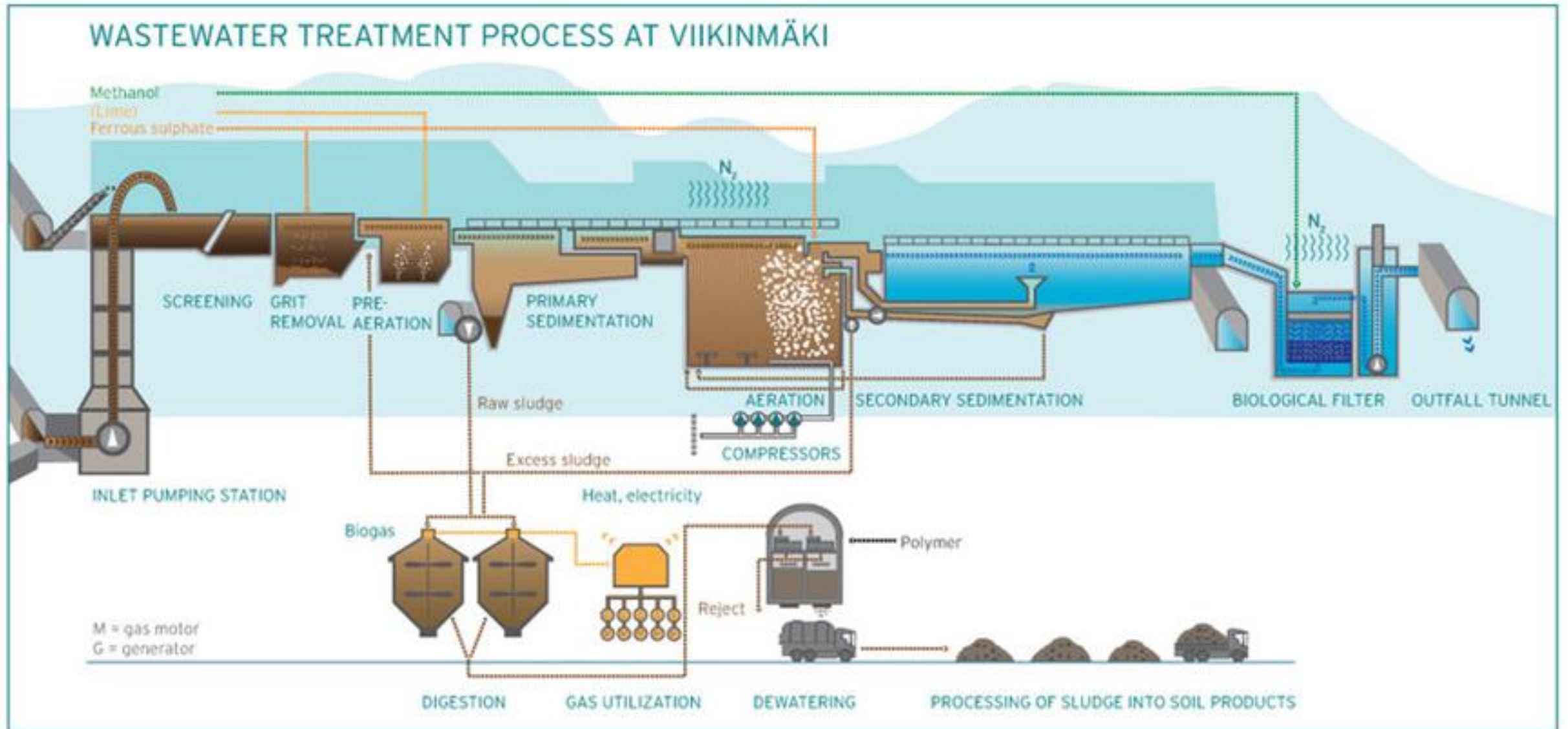
Energy solutions in Viikinmäki enable operating the plant with renewables and (net)self-sufficiency

Energy production in HSY wastewater treatment plants in 2020

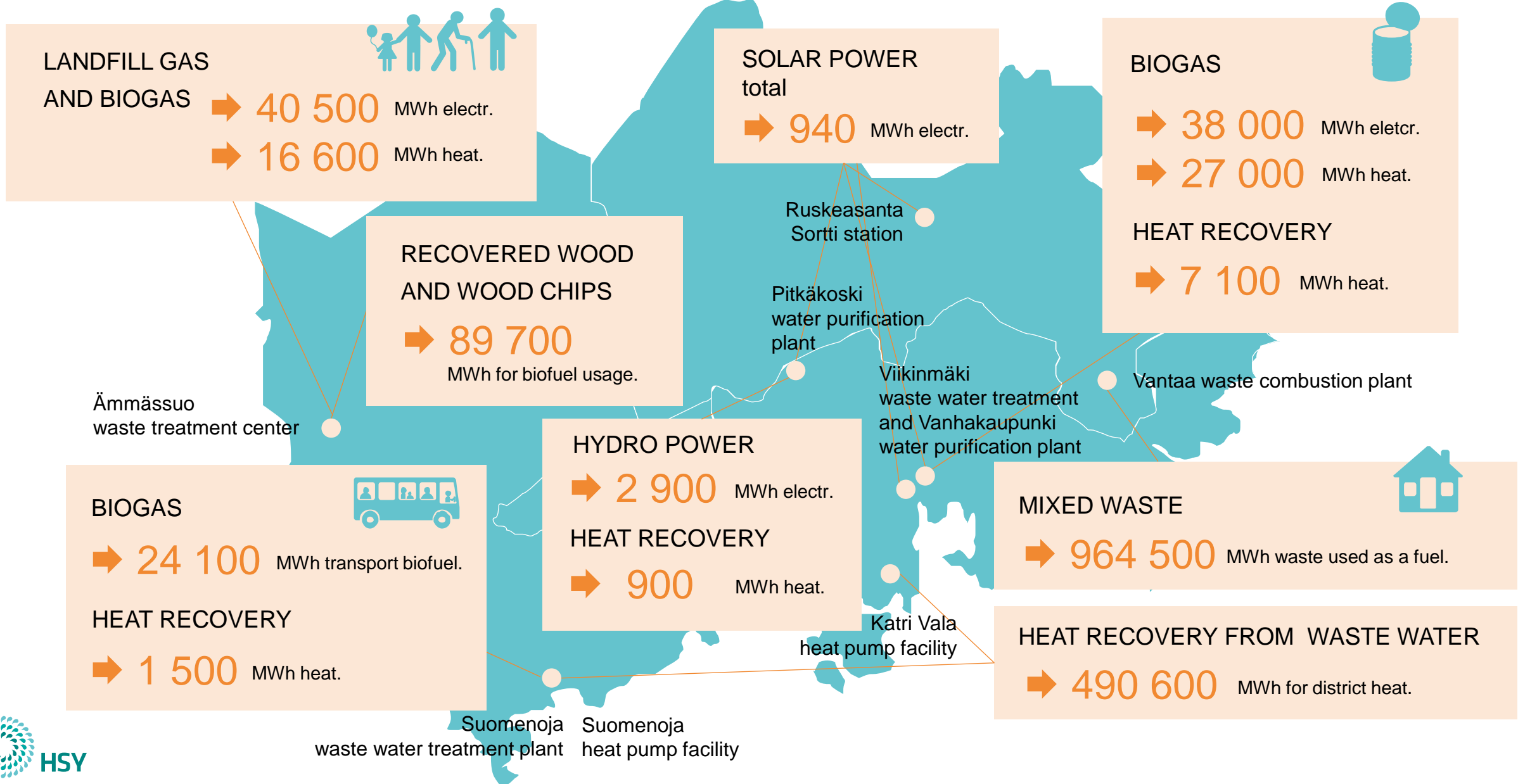
Viikinmäki		Suomenoja	
<u>Gas production</u>	<u>mill. m³</u>	<u>Gas production</u>	<u>mill. m³</u>
Produced biogas	14,9	Produced biogas	4,7
		Sold biogas (to Gasum)	3,9
<u>Heat production</u>	<u>GWh</u>	<u>Heat production</u>	<u>GWh</u>
Gas engines (biogas)	26,3	Boilers (natural gas)	7,48
Boilers (biogas)	0,98	Boilers (biogas)	1,17
Boilers (fuel oil)	0,14	Boilers (fuel oil)	0,01
Heat recovery units	7,1	Heat recovery units	1,51
<u>Electricity productions</u>	<u>GWh</u>		
Gas engines (biogas)	36,7		
ORC	1,27		
Solar power	0,22		



Biogas production and energy utilization are parts of the wastewater treatment process



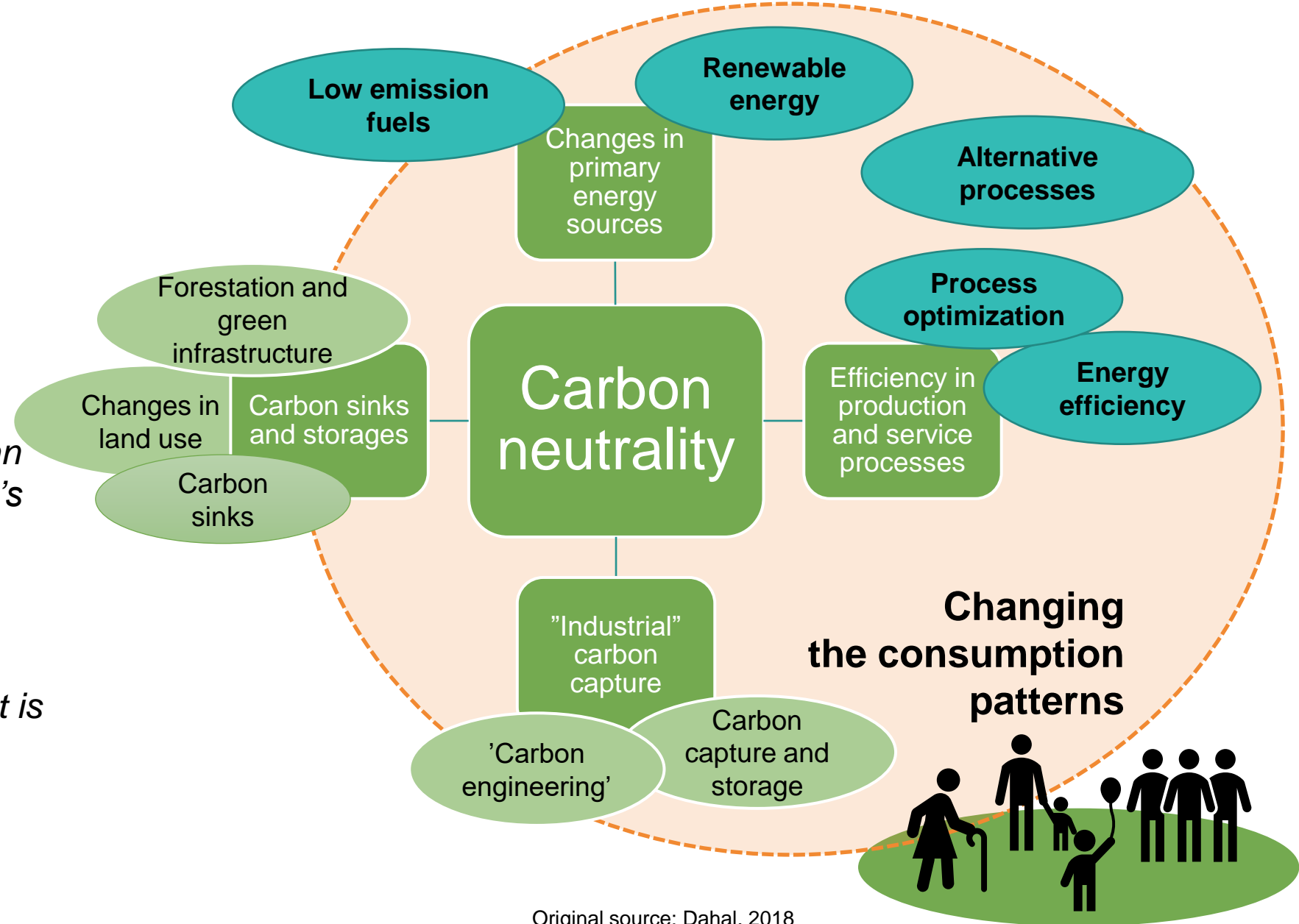
Renewable energy production by HSY in 2020



What does carbon neutrality mean in our case? What we should change?

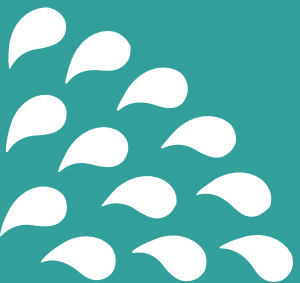
Main tasks for HSY:

- Controlling the GHG-emissions from waste handling processes
- Renewable energy supply
- Energy efficiency is still a significant factor – *if you can use renewable energy, that's nice but don't waste it!*
- Carbon sinks and compensating the ghg-emissions – *the main target is the emission mitigation, however*



Puhtaasti parempaa arkea | En rent bättre vardag | Purely better, every day

Thank you!



Helsingin seudun ympäristöpalvelut -kuntayhtymä
Samkommunen Helsingforsregionens miljötjänster
Helsinki Region Environmental Services Authority