



STORMOSSEN

Sustainable Waste Management – Fuel for Public Transportation

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22th March 2018

Vaasa City Hall

Finland

CONTENT

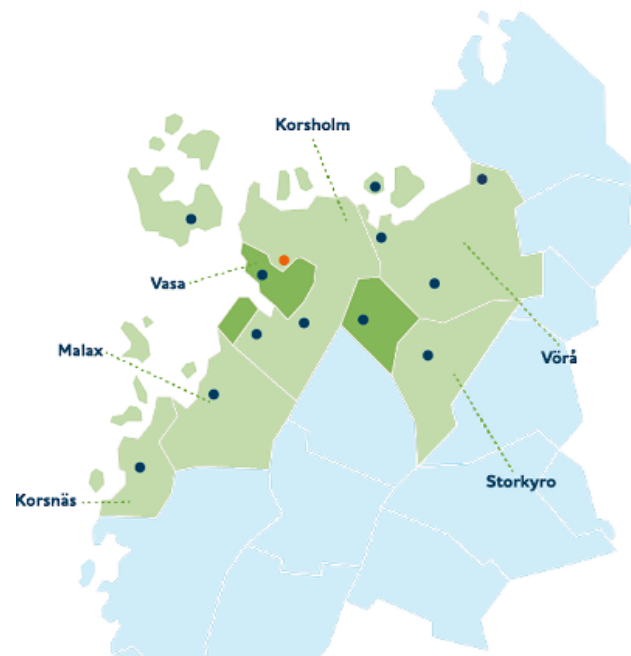
- Background
- Biogas production
- Biogas as vehicle fuel
- Benefits of biogas
- Summary



STORMOSSEN



- Founded 1985
- Employs 40 persons
- Owned by 6 municipalities
- 100 000 residents in the area
- Waste recycle rate 98,5 % (2017)
- Turnover 13,6 M.€ (2017)
- Products:
 - Biogas for fuel, electricity and heat
 - Compost soil
 - District heating and electricity
 - Raw materials



STORMOSSEN

- 1985 Founded
- 1990 Biogas production started
- 1994 Second Digester + gas-engine (330 kWe)
- 1995 Heating Botniahalli with biogas
- 2007 Landfill gas collection
- 2009 New gas-engine (730 kWe)
- 2012 Westenergy
- 2014 Agreement with the city of Vaasa to use bio-methane in public transport
- 2017 Upgrading and filling station



WESTENERGY

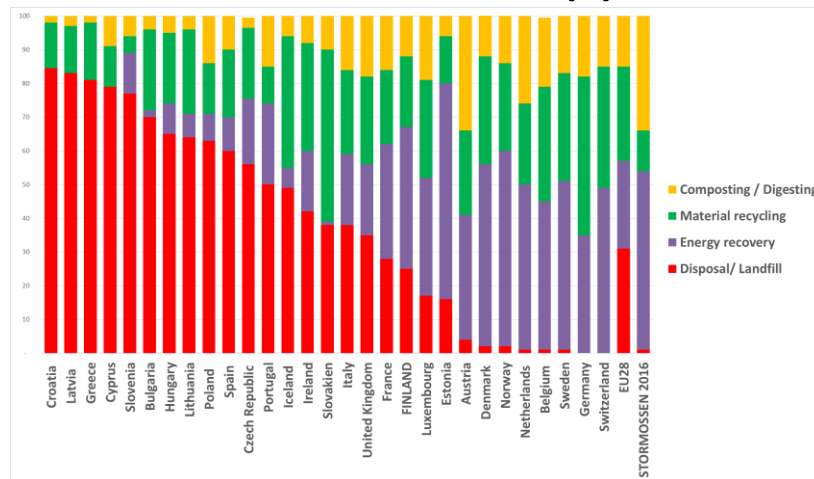
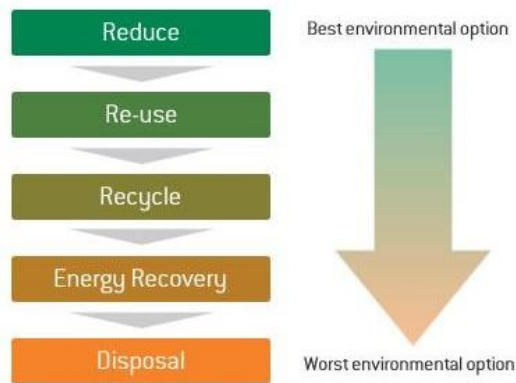
- Energy recovery
- 50 municipalities
- 400 000 residents in the area
- 150 000 ton/year = 20 ton/hour
- District heat 280 GWh = 1/3 of district heating in Vaasa
- Electricity 80 GWh = approx. 7000 homes



WASTE TREATMENT



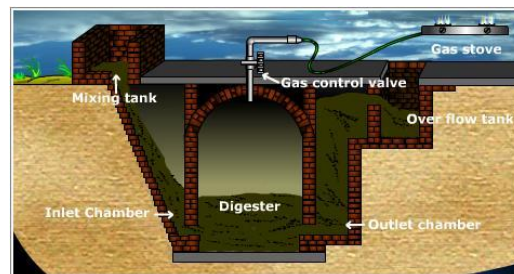
- National waste plan objectives
 - 50 % recycled as material
 - 30 % recycled as energy
 - 20 % maximum to landfill
- Stormossen 2017 (2016)
 - 49 % recycled as material (46)
 - 50 % recycled as energy (53)
 - 1 % maximum to landfill (1)



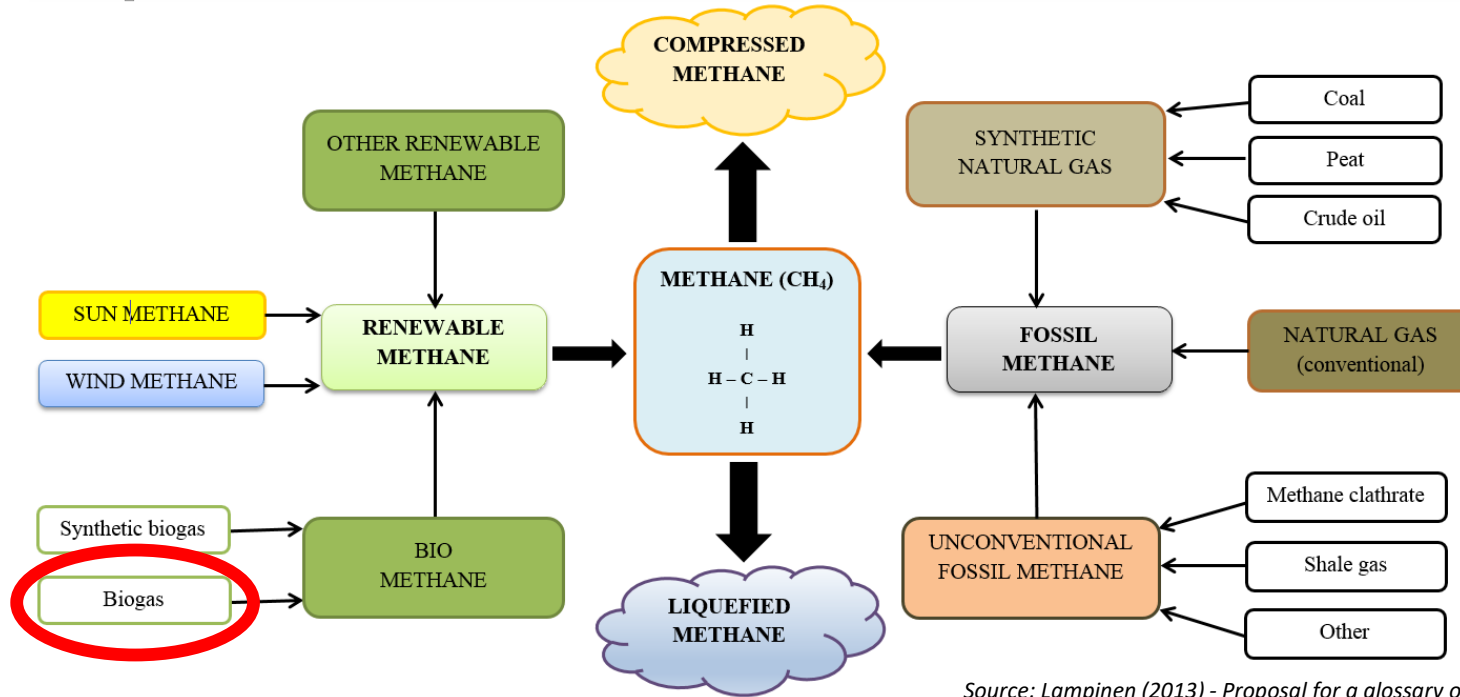
BIOGAS HISTORY



- 1859 First plant in India
- 1895 UK and Germany developed the process, for reducing sludge volumes and the gas was occasionally used as energy
- 19th and beginning of 20th century Town gas for lighting
- 1930s in India developed the process for farmers
- 1930s understanding the anaerobic bacteria producing methane gas
- 1940s Biogas plant and refueling in Helsinki and a biogas plant in Stockholm
- 1960s China and India as cooking fuel
- 1970s oil crisis slight increase in interest
- 1990s for treating organic waste streams



METHANE SOURCES



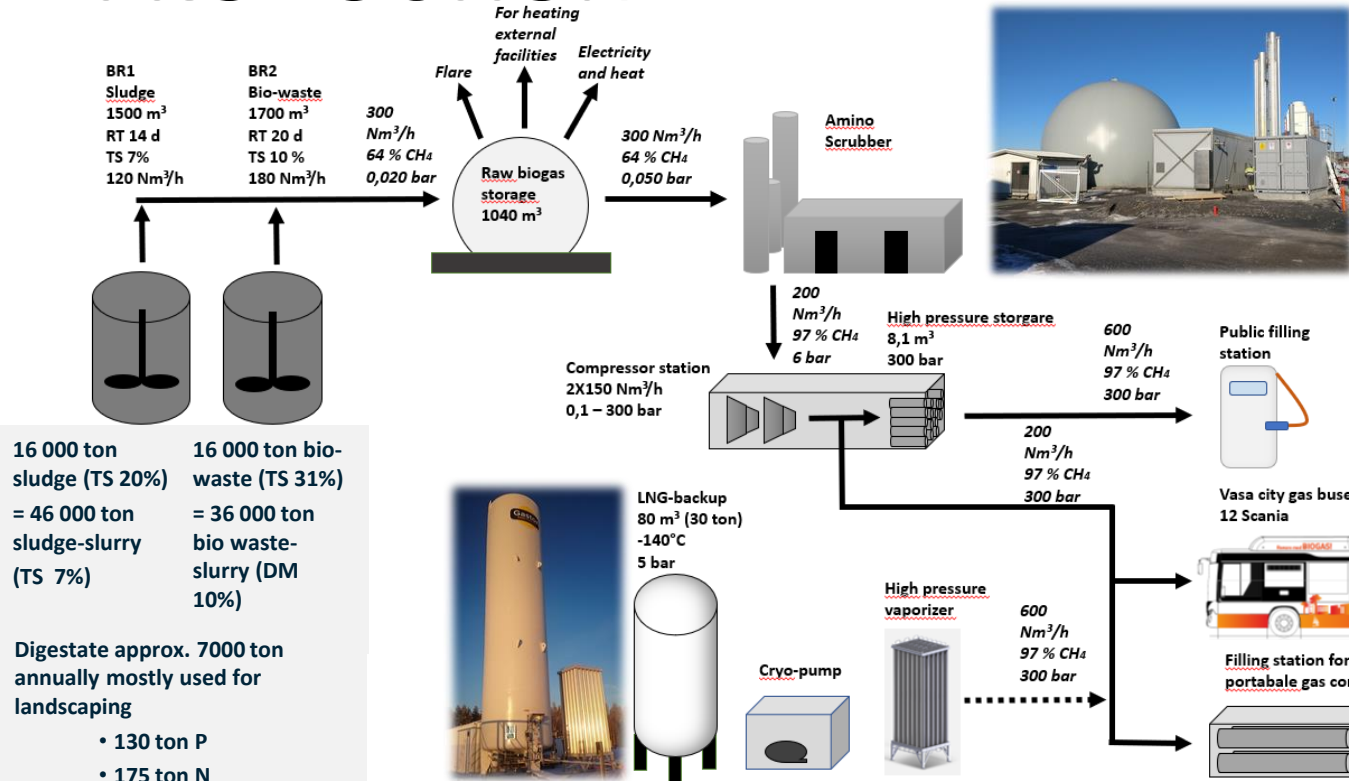
Source: Lampinen (2013) - Proposal for a glossary of methane fuels in transport.
Edited: Johan Saarela (2014)



PRODUCTION

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Raw biogas 63 % methane 2,4 million Nm³ =
Upgraded biogas 1,6 million Nm³ (97 %
methane) = 16 GWh = 1,6 million liter diesel
= Enough for 12 buses + 1000 vehicles or 24
buses

1,45 €/kg
= 0,97 €/liter
gasoline
= 1,10 €/liter
diesel

16 000 ton
sludge (TS 20%)
= 46 000 ton
sludge-slurry
(TS 7%)

16 000 ton bio-
waste (TS 31%)
= 36 000 ton
bio waste-
slurry (DM
10%)

Digestate approx. 7000 ton
annually mostly used for
landscaping

- 130 ton P
- 175 ton N

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22 March 2018



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PRODUCTION



	Gaskomponent	Densitet kg/Nm³	Undre värmevärde MJ/Nm³	Övre värmevärde MJ/Nm³	Medel värmevärde MJ/Nm³	Rysk naturgas	Rysk naturgas energiinnehåll MJ/nm³	Vikt, kg/nm³	Uppgraderad biogas, minimi	Uppgraderad biogas, minimi energiinnehåll MJ/nm³	Vikt, kg/nm³	Uppgraderad biogas, Aminscrubber Stormossen	Uppgraderad aminscrubber energiinnehåll MJ/nm³	Vikt, kg/nm³
Volym-%	Metan CH ₄	0,717	35,880	39,820	37,850	98,40 %	35,3059	0,7055	96,00 %	34,4448	0,6883	97,50 %	34,9830	0,6991
Volym-%	Etan C ₂ H ₆	1,355	64,350	70,310	67,330	0,60 %	0,3861	0,0081	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000
Volym-%	Propan C ₃ H ₈	2,011	93,210	101,230	97,220	0,20 %	0,1864	0,0040	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000
Volym-%	Butan C ₄ H ₁₀	2,701	123,470	133,690	128,580	0,05 %	0,0617	0,0014	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000
Volym-%	Pentan C ₅ H ₁₂	3,454	156,629	169,269	162,949	0,01 %	0,0157	0,0003	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000
Volym-%	Hexan C ₆ H ₁₄	4,204	189,601	204,630	197,116	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000
Volym-%	Kvävgas N ₂	1,2504	0	0	0,000	0,30 %	0,0000	0,0038	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000
Volym-%	Syrgas O ₂	1,429	0	0	0,000	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000
Volym-%	Koldioxid CO ₂	1,9783	0	0	0,000	0,30 %	0,0000	0,0059	4,00 %	0,0000	0,0791	2,50 %	0,0000	0,0495
Volym-%	Kolmonoxid CO	1,250	12,634	12,634	12,634	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000
Volym-%	Vätgas H ₂	0,090	10,780	12,740	11,760	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000
Volym-%	Vatten H ₂ O	0,833	0	0	0,000	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000	0,00 %	0,0000	0,0000
Volym-%	Svavelväte H ₂ S	1,536	23,377	25,361	24,369	0,00 %	0,0000	0,0000	0,00 %	0,0001	0,0000	0,00 %	0,0001	0,0000
Volym-%	SUMMA					100 %	35,9558	0,7291	100 %	34,4449	0,7675	100 %	34,9831	0,7485
							10,0 kWh/Nm³ 13,7 kWh/kg			9,6 kWh/Nm³ 12,5 kWh/kg		Average Up to	9,7 kWh/Nm³ 13,0 kWh/kg 13,5 kWh/kg	



FILLING STATION

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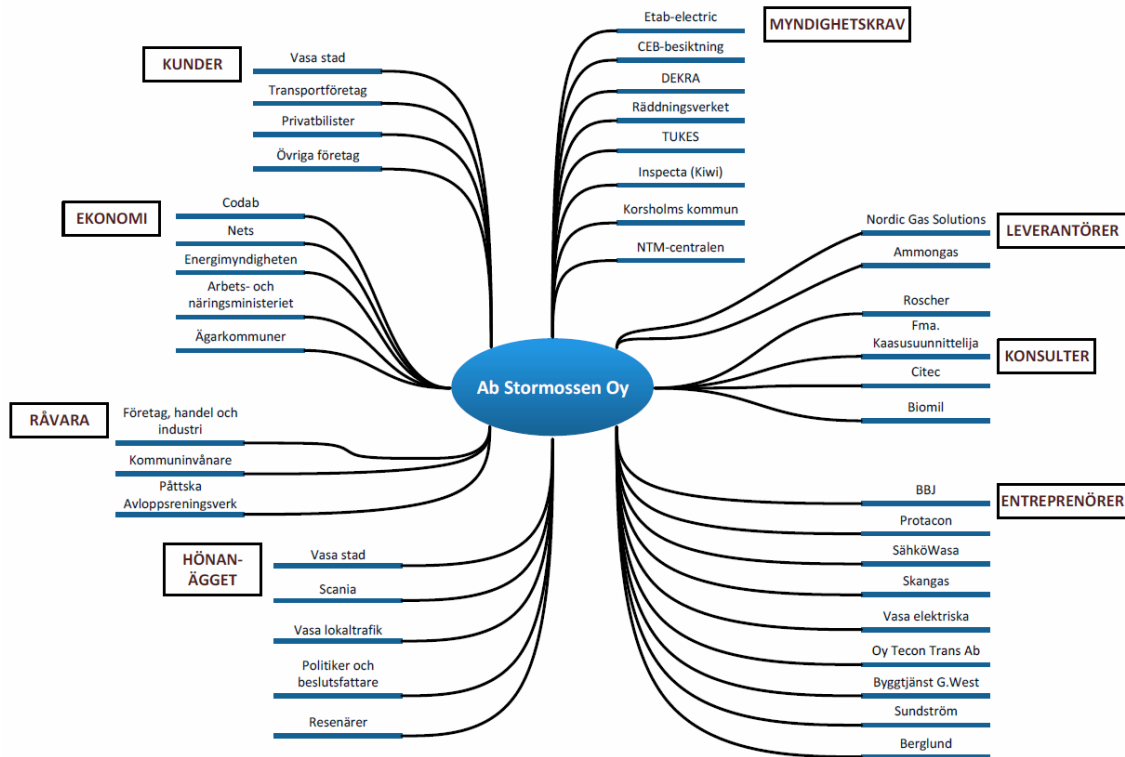


Vaasa Gas Exchange
22 March 2018

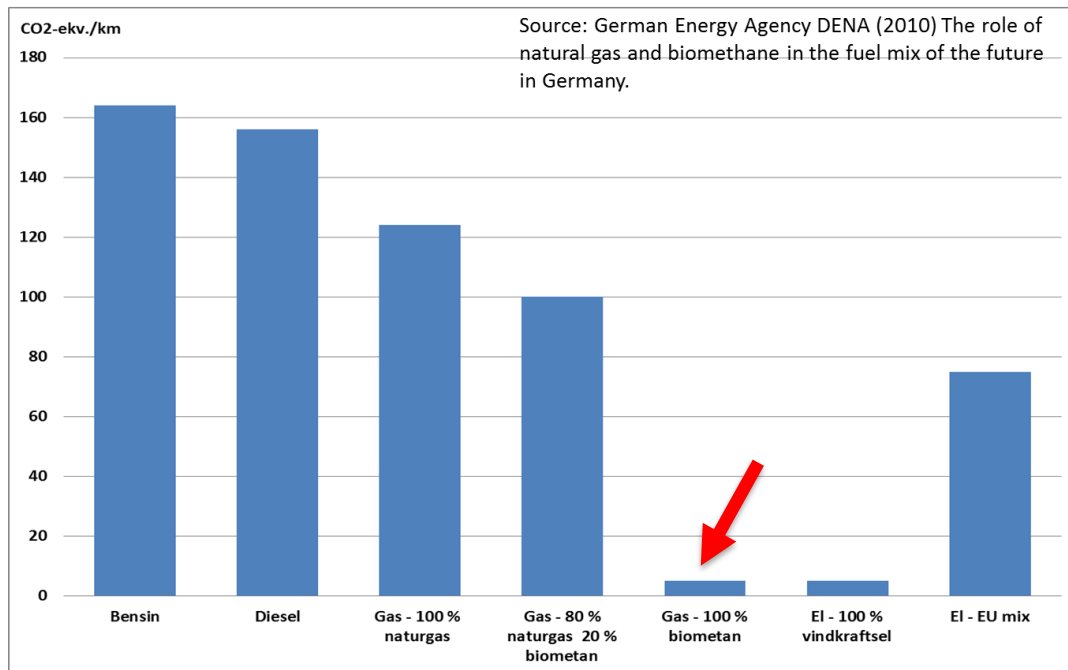


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MAP OF ACTORS



BIOGAS AS FUEL



BIOGAS AS FUEL



Oslo kommune
Vann- og avloppsetaten

Exhaust emission and noise

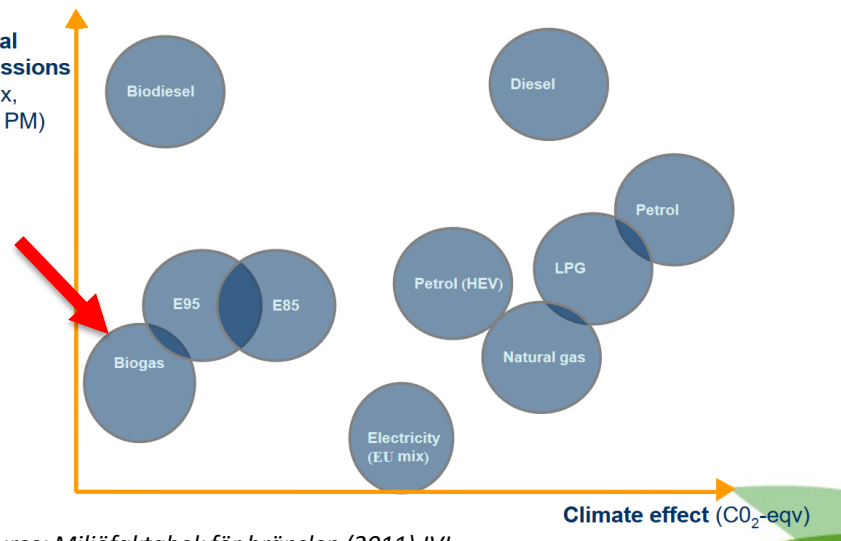


S/N	Units	Diesel	Bio-methane	Reduction%
NO _x	g/km	8.1	1.9	78
Particulate matter	g/km	0.3	0.005	98
CO ₂	kg/km	2.6	0	100
Noise	dBA	111	100	92



Source: Rashid Abdi Elmi (2013) Oslo kommune Vann- og avloppsvatten

Local Emissions
(NO_x, HC, PM)



Source: Miljöfaktabok för bränslen (2011) IVL Svenska miljöinstitutet. Edited figure: Sylwia Klatka



BIOGAS AS FUEL

Vehicle								
Range	Urban	Short	Medium	Long	Short	Medium	Long	Short sea and ferries
Electricity								
Hydrogen								
Biofuels								
Biogas							LNG/LBG	LNG/LBG

Source: Biogas 2020 (2016) project

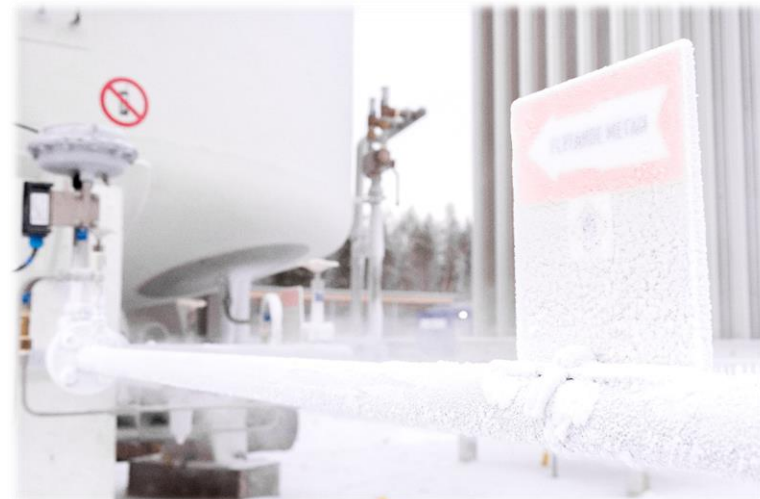


Photo: Stormossen (2016)



Source: EBA (2015) Statistics

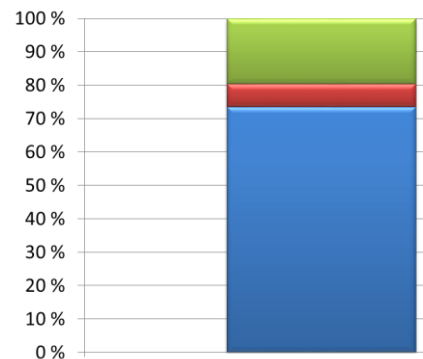
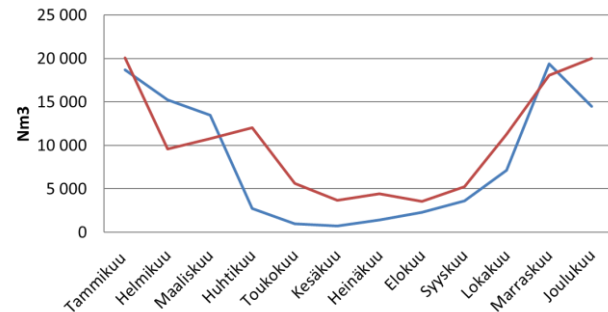


VALUE CHAIN

- Biogas upgrading
 - Biomethane for transport sector
- Less flaring
 - Flaring is done by the gas engine
- Reconstruction of pre-treatment and heating
 - District heating from Westenergy
 - Less electricity consumption



	Flare	Heat	Gas engine (CHP)	Vehicle fuel
Heat, €/MWh	0	42	42	0
El, €/MWh	0	0	80	0
Vehicle fuel, €/MWh	0	0	0	90
Output, % (heat)	0	95	43	-
Output, % (power)	0	-	38	-
Value, €	<u>0</u>	<u>40</u>	<u>49</u>	<u>90</u>



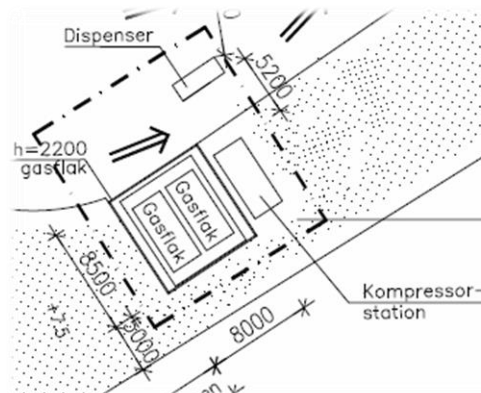
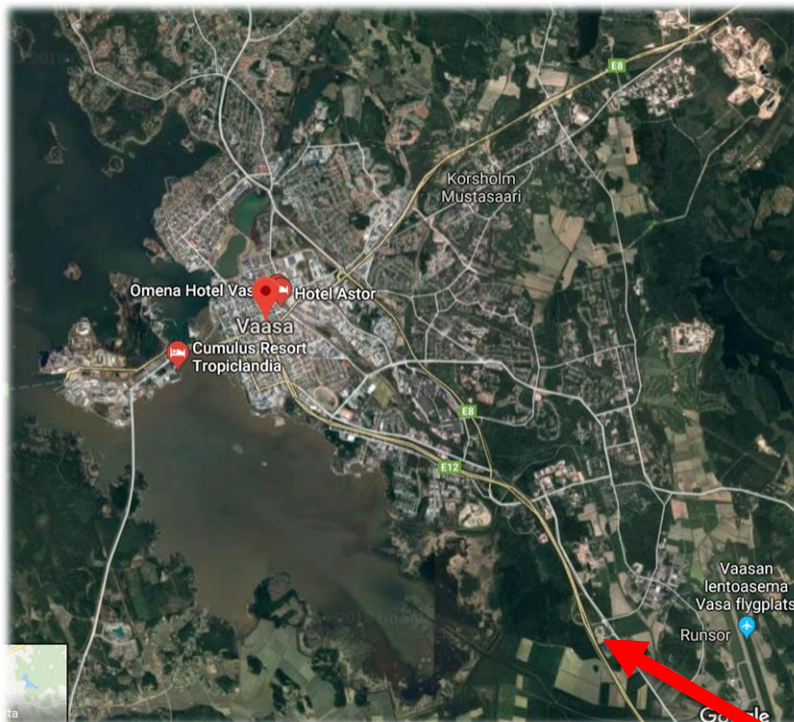
STRATEGY



- **First filling station for CNG-vehicles in the Vaasa region**
 - Upgrade biogas to bio-methane
- **District heating for process heat**
 - Optimize biogas production
- **Second filling station in the Vaasa region**
 - Increase substrate and biogas production
- **Third filling station in the Vaasa region**

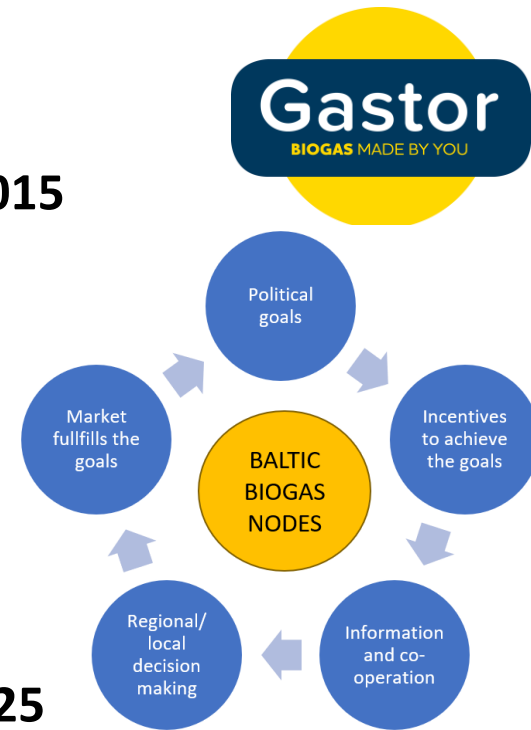


SECOND FILLING STATION



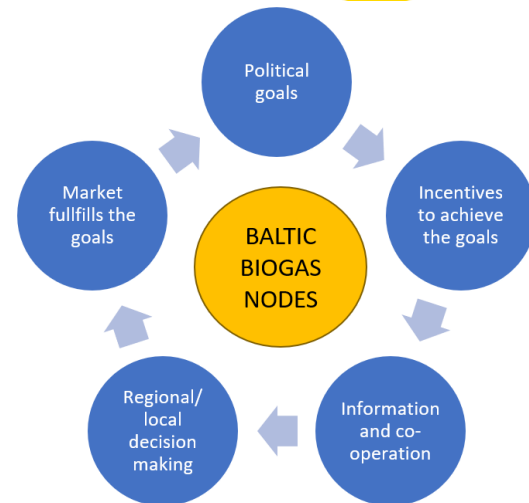
TARGETS

- The Paris climate agreement adopted in December 2015
 - Limit global warming to well below 2° Celsius
- EU 2020 strategy, directive for renewable energy
 - 10 % biofuel in transport
- EU 2030
 - 40 % cut of greenhouse emissions
 - 27 % share of renewable energy
- EU 2050
 - 80-95 % reduction & 60 % reduction in transport
- DAFI - Directive on alternative fuels infrastructure 2025
 - CNG/CBG fueling stations 150 km and LNG/LBG fueling station 400 km
- Finland 50 000 CNG-vehicles by 2030
- City of Vaasa to be CO₂-neutral by 2035

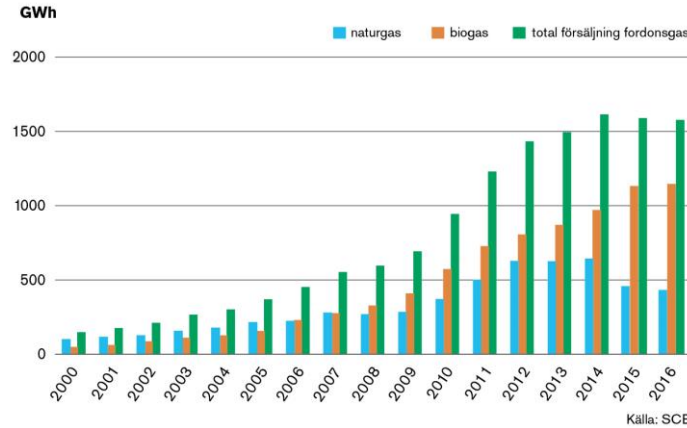
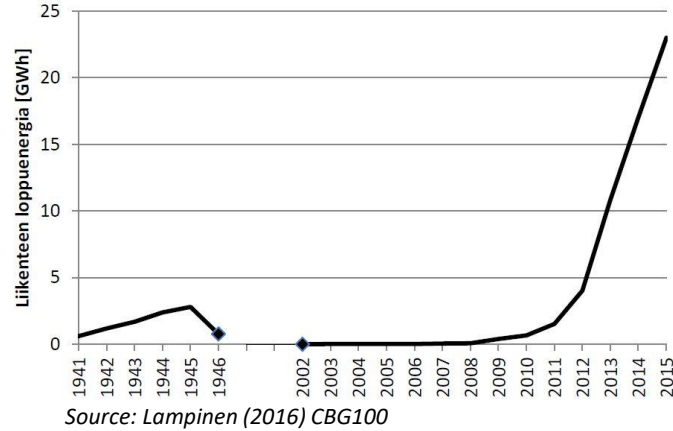


TARGETS

	FINLAND		VASA	KORSHOLM	MALAX	KORSNÄS	VÖYRI	ISOKYRÖ	LAIHIA	VAASA-REGION	
Henkilöä utot	2 652 765		33 705	11 626	3 202	1 273	3 843	3 293	4 776		
Pakettiau tot	316 095		2 705	1 449	560	283	701	599	612		
Kuorma- autot	95 626		697	350	145	50	245	196	149		
Linja- autot	12 516		104	76	27	2	6	26	16		
Erikoisau tot	2 749		35	7	3	1	7	7	7		
TOTAL	3 079 751		37 246	13 508	3 937	1 609	4 802	4 121	5 560	70 783	2,3 %
Goal 2030	50 000									<u>1 149</u>	

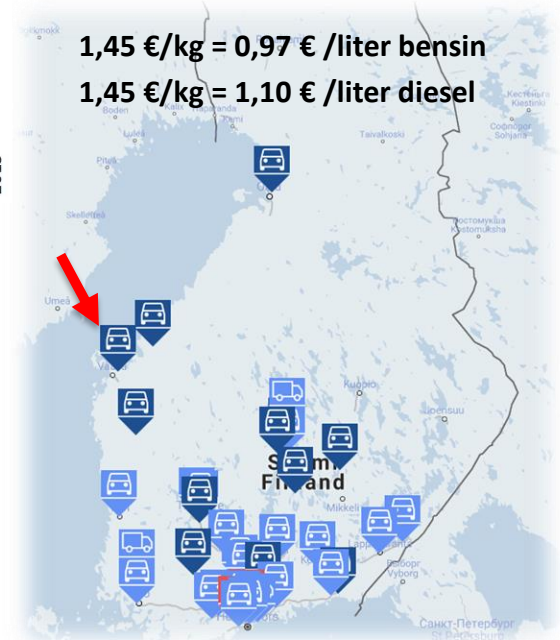


MARKET



1,45 €/kg = 0,97 € /liter bensin

1,45 €/kg = 1,10 € /liter diesel



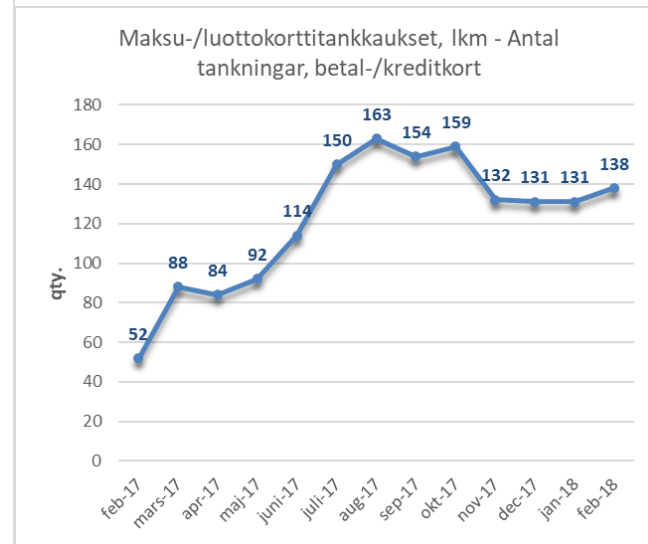
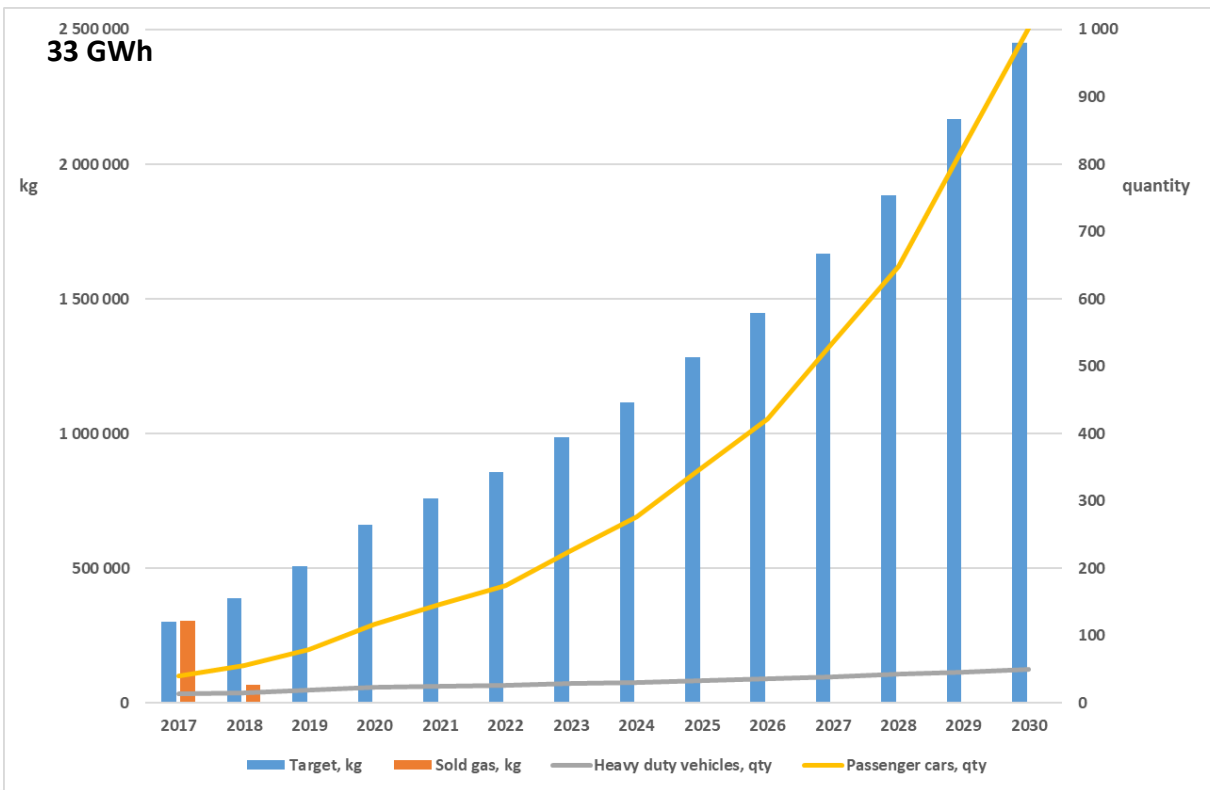
Source: Gasum (2017)



MARKET

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MARKET

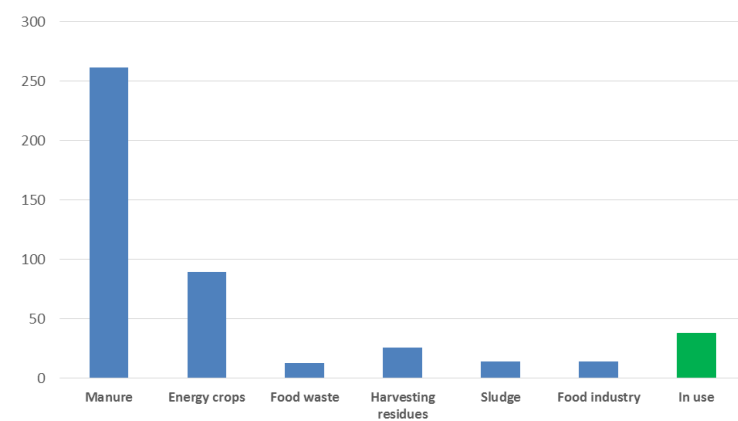


In use 9% of 420 GWh

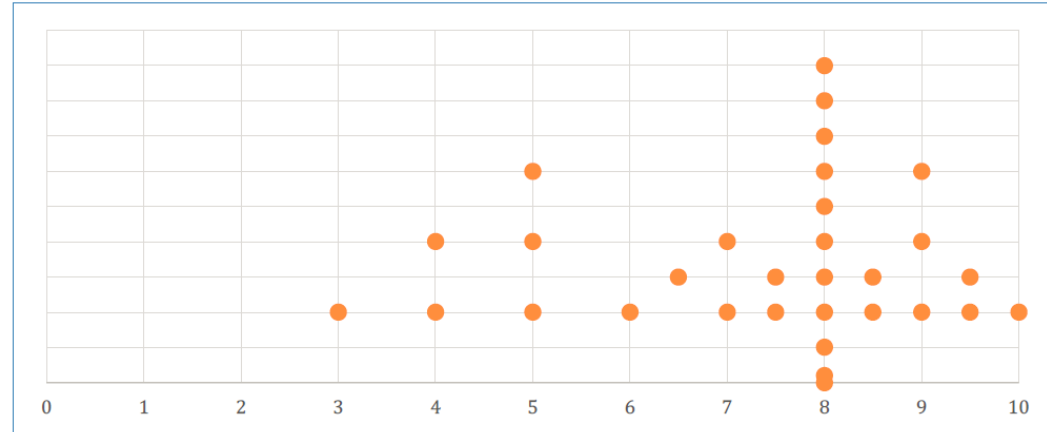
Fuel demand in Ostrobothnia:

1465 GWh → 420 GWh = 29 %

Biogas potential in Ostrobothnia



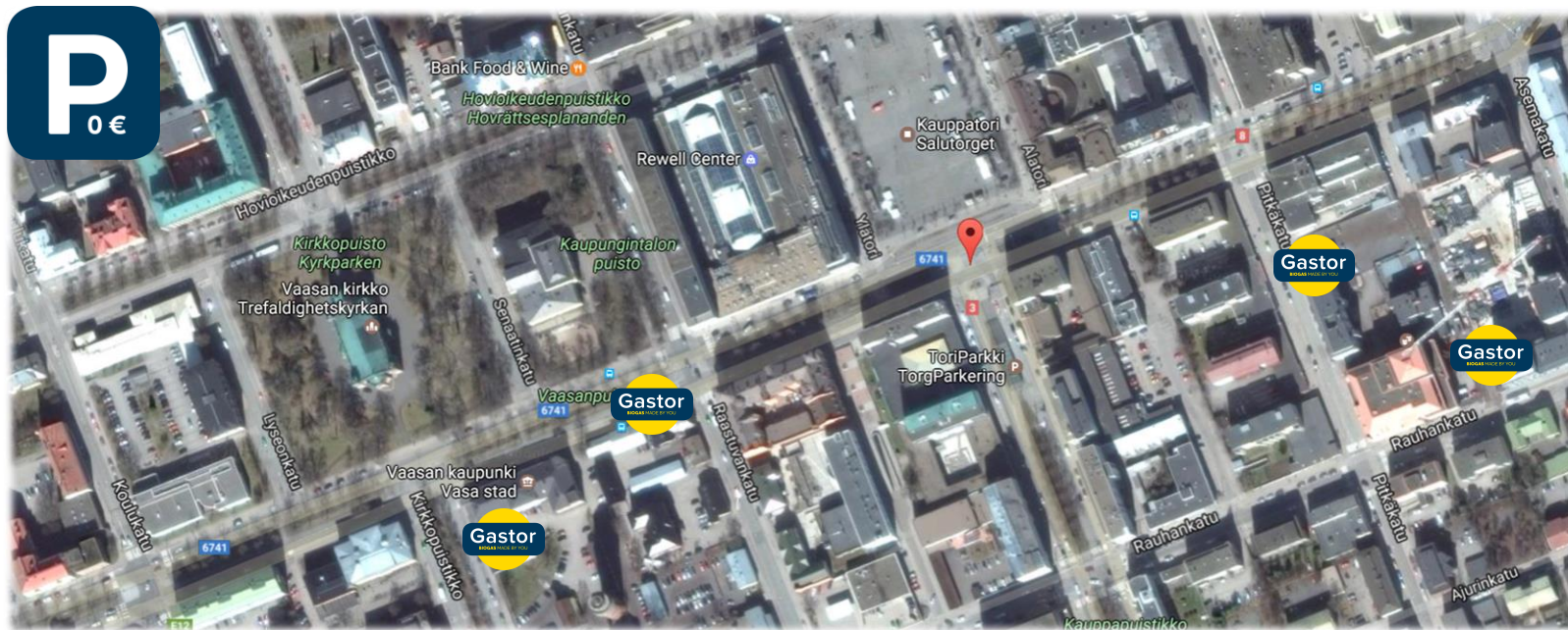
Attitude towards CBG-use in the Vasa region



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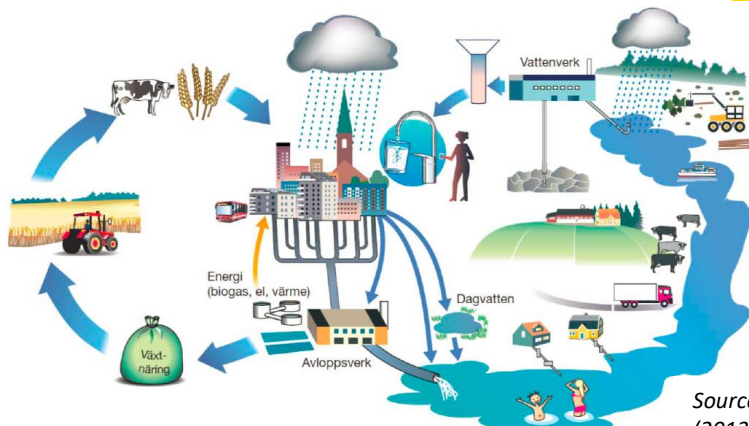
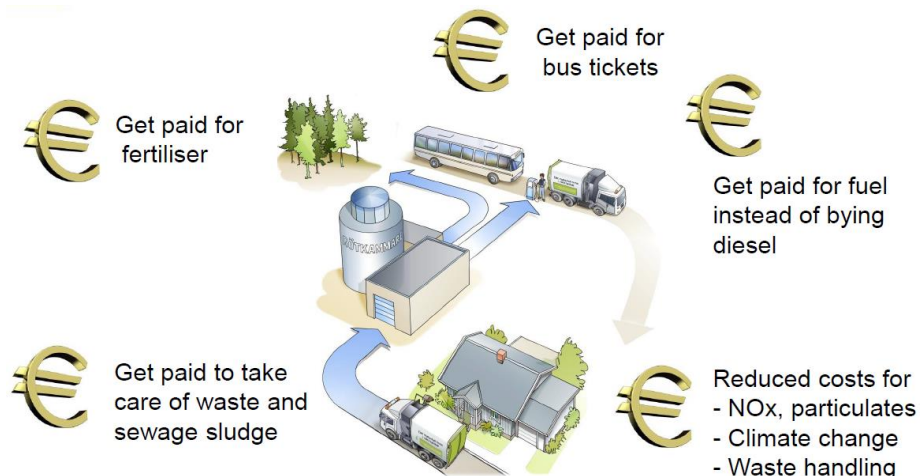


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CIRCULAR ECONOMY

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Source: Svenskt vatten (2013) Vattenvisionen

Source: BioGaC (2015) Skellefteå kommun and Biofuel region

Source: Biogas Botnia (2013) Samhällsekonomiska effekter av en utökad produktion och användning av biogas i Västerbottens län, Västernorrlands län och Österbottens län.

	Västerbotten	Västernorrland	Österbotten
GRP (BRP)-effect, million €	17	15	27
Earned income, million €	5	4	8
Disposable income, million €	3	2	5
Effect on tax revenue, million. €	2	2	3
Environmental effects, million €	3	2	3
Employment, persons	110	90	180

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SUSTAINABLE DEVELOPMENT GOALS

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SUMMARY



- High quality fuel from waste, versatile, local and renewable
- Lots of unused potential and better than burning the organic waste
- Working technology with very low emissions
- Biomethane benefits from the development of LNG
- To achieve environmental goals biogas has to be strongly considered when planning use of natural gas
- Biogas can't be compared one to one in terms of energy production
- A possibility to replace artificial fertilizers
- System integration to create circular economies



The logo consists of a white circle with a dark blue rounded rectangle overlaid on its right side. Inside the rectangle, the word "Gastor" is written in white.

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A central white circle is surrounded by four dark blue circles of varying sizes, creating a cluster-like effect.

Thank you!

Find out more at:
www.stormossen.fi/gastor



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