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TALLINNA TEHNIKAÜLIKOOL

TALLINN UNIVERSITY OF TECHNOLOGY

Prospects of biogas (bio-methane) production in Estonia

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Topics

- Biogas Sector in Estonia - Current Status and Developments
 - Estonian biogas resource
 - Biogas potential in Estonia
 - Potential number of BGS
- Combustion of biogas for energy production
- Total actual biogas production in Estonia
- Bio-methane
- CNG stations in Estonia

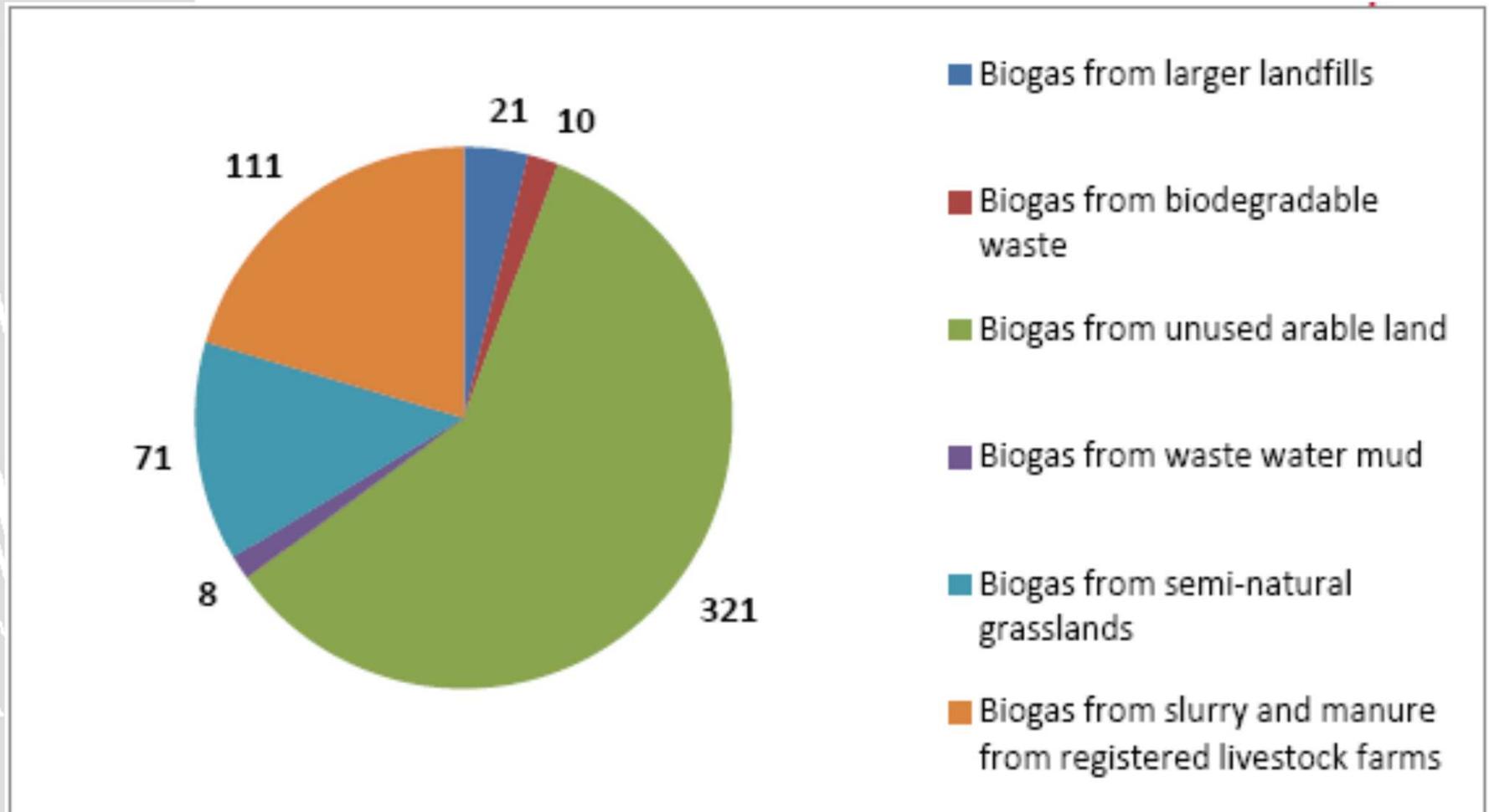
Biogas Sector in Estonia - Current Status and Developments

- The biogas sector in Estonia is in an early stage of development, both in the sense of acquiring know-how and implementing practical solutions.
- In Estonia, the resources of biogas would theoretically enable to produce approximately 10% of primary energy based on biogas; the percentage of resources that could be taken into actual use is around 37%.
- In reality, the amount of Estonian biogas production is only around 13 million Nm³ (2010) of gas originating from landfills, sewage sludge and slurry (liquid manure).

Estonian biogas resource

- The total theoretical annual biogas quantity 545 million Nm³:
 - could supply 264 000 households or
 - 871 000 people, 1.25 MWh/person with produced electricity 2 kWh_{eI}/Nm³
 - and 153 270 households
 - 505 791 people, 3.23 MWh/person) with heat energy.
- The same amount of energy expressed in gasoline equivalent (60% methane concentration) would be 327 million litre, what is approximately one-half of the total quantity of transport fuel used in Estonia annually.

The theoretical potential of biogas by sources, Nm³



Annual quantity of economically usable biogas in Estonia and corresponding producible electricity

	Theoretical			Usable		
Substrate	Biogas potential (60% CH ₄)	Actually usable biogas, % of the theoretical*	Economically usable biogas quantity	-20% loss during the biogas production process	Electricity per year (2.4 kWh _{el} /m ³)	MW _{el} service capacity
	Nm ³ /a x 10 ⁶	%	Nm ³ /a x 10 ⁶	Nm ³ /a x 10 ⁶	GWh _{el} /a	8200 h/a
Hay from ecological reserves	72	20	14	12	28	3.41
Silage from unused fields	321	20	64	51	123	15.00
Silage from energy crops	4 480 ^{**}	5	224	179	430	52.44
Landfill gas	21	80	17	13	32	3.90
Sewage sludge	9	50	4	4	8	0.98
Manure and slurry	111	30	33	27	64	7.80
Bio waste	10	10	1	1	2	0.24
Total	544^{***}		358	286	688	83.90
	768^{****}					

Remarks:

* Prognosis. Finding a more precise percentage and setting presumptions is a separate and time consuming research.

** Theoretical construction. This would be the quantity of biogas if energy crops would be grown on all land parcels (830 000 ha), which cannot be done, since growing food crops takes priority.

*** Without the biogas originating from the silage from energy cultures.

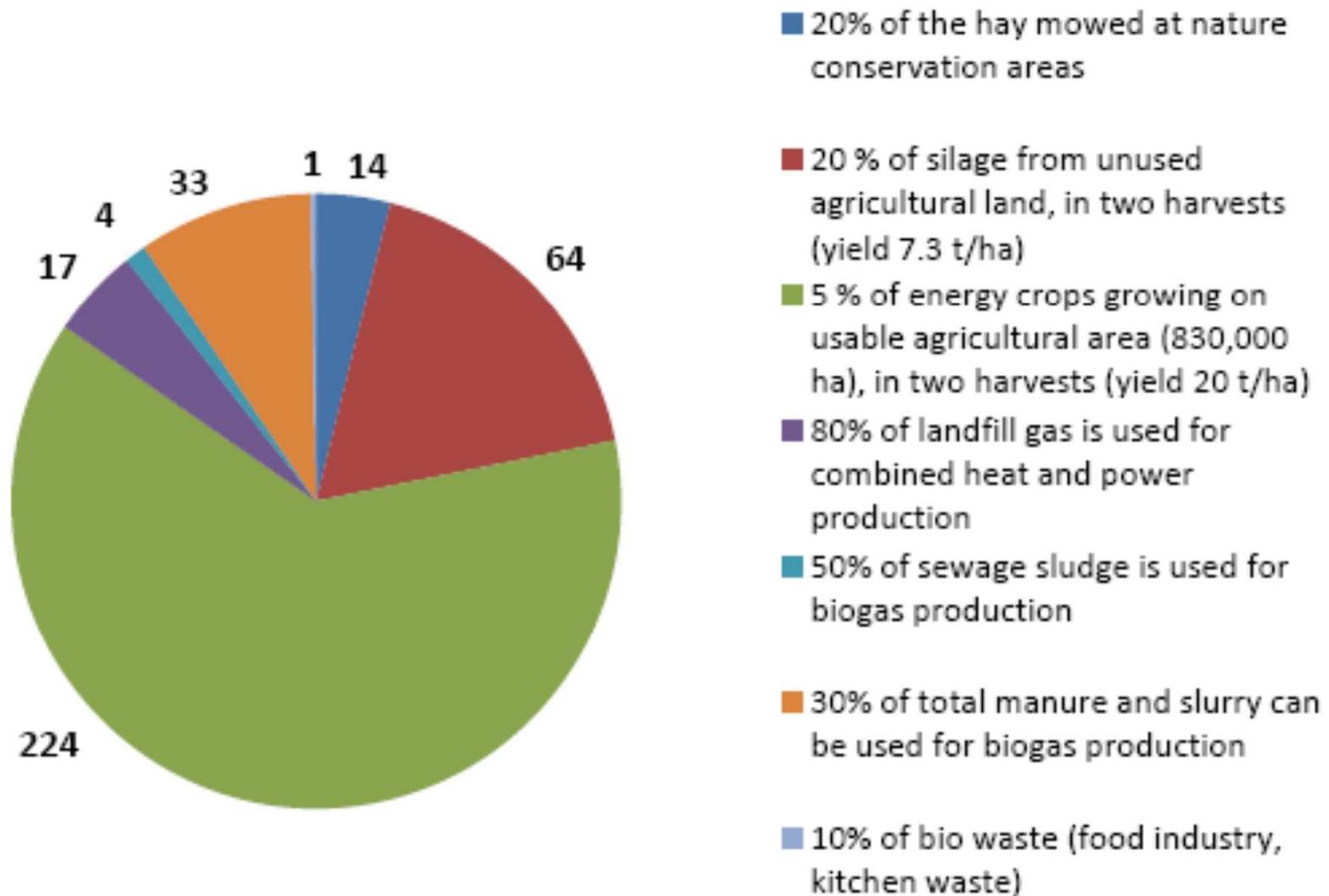
**** With the theoretical biogas quantity that comes from the silage from energy crops grown on 5% of agricultural land.

The economically usable biogas potential of Estonia

It is estimated to be the following percentage of the named substrates:

- 20% of the hay made at nature conservation areas,
 - 20 % of silage from unused agricultural land, in two harvests (yield 7.3 t/ha),
 - 5 % of energy crops growing on usable agricultural land (830,000 ha), in two harvests (yield 20 t/ha),
 - 80% of landfill gas is used for combined heat and power production,
 - 50% of sewage sludge is used for biogas production,
 - 30% of total manure and slurry can be used for biogas production,
 - 10% of bio waste (food industry, kitchen waste),
- By this estimation, the yearly usable biogas resource would be 358 million Nm³/a.
 - Then the actual usable quantity is 286 million Nm³/a (30% for own use). This amount of gas could be used to produce 688 GWh_{el} annually, with electrical nominal power of 78 MW.

The amount of biogas produced from biomass from different sources that is actually usable on the given presumptions, Nm³



Potential number of biogas stations

- Depending on the electric capacity of a gas motor (0.5-1.0 MW_{el}) there could be 100-200 biogas stations in Estonia,
- Therefore, the realistic number of biogas stations has been considered to be 50-75.
- If the sector gets developed, it would be possible to produce approximately 20% of the heat energy and 15% of electricity used in Estonia from the theoretical biogas quantity.

Combustion of biogas for energy production

- 4 CHP-s on landfills
(Pääsküla, 2 (~1,7 MW_{el}); **Tallinna** landfill (1, 1,9 MW_{el}); Rääma landfill, 1, 0,85 MW_{el})
- 2 CHP-s in sewage sludge treatment plant
(**Tallinn** (biogas engine runs compressor) and Kuressaare)
- 1 CHP farm scale CHP
(**Jööri**, Saaremaa, swine manure, 350 kW_{el})



Biogas stations with CHP under construction

Farm scale Biogas stations

- ▣ Aravete (1,7 MW),
- ▣ Ilmatsalu (1,4 MW),
- ▣ Vinni (1,4 MW),
- ▣ Oisu (0,7-1,2 MW)
- ▣ Torma

Sewage sludge based biogas stations

- ▣ Tartu
- ▣ Narva

Total actual biogas production in Estonia, Mm³

	2007*	2008	2009	2010	Muutus ‘10/’09 +/-%
KOKKU BIOGAASI TOOTMINE	12,54	11,85	13,59	13,13	-3,5
sh biogaas reovee settest	2,64	2,84	2,69	2,96	10,1
biogaas sealägest	0,57	0,39	0,59	0,85	43,6
prügilagaas	9,34	8,62	10,32	9,32	-9,7
Reovee settest biogaasi osakaal kogu biogaasist, %	21,0	23,9	19,8	22,5	2,8 %-punkti
Sealägest biogaasi osakaal kogu biogaasist, %	4,5	3,3	4,3	6,5	2,1 %-punkti
Prügilagaasi osakaal kogu biogaasist, %	74,5	72,8	75,9	71,0	-4,9 %-punkti

Source: EKI (Estonian Institute of Economic research)

- Sewage sludge and share from total, %
- Swine slurry and share from total, %
- Landfill gas and share from total, %

Biogas production and consumption in Estonia, Mm³

	2007*	2008	2009	2010	Muutus '10/'09 +/-%
Biogaasi toodang	12,54	11,85	13,59	13,13	-3,5
Import	-	-	-	-	-
KOKKU BIOGAASI RESSURSID	12,54	11,85	13,59	13,13	-3,5
Eksport	-	-	-	-	-
Siseturul tarbimine kokku	12,54	11,85	13,59	13,13	-3,5
sh elektrienergia tootmiseks	3,67	3,18	2,04	2,75	34,7
soojusenergia tootmiseks	4,47	4,12	3,16	3,16	-
põletatud	3,78	3,80	7,87	6,16	-21,7
tehnoloogilistes protsessides	0,62	0,75	0,52	1,05	102,7
KOKKU BIOGAASI RESSURSSIDE KASUTAMINE	12,54	11,85	13,59	13,13	-3,5

- Consumption in home market Source: EKI (Estonian Institute of Economic research)
 - For electricity
 - For heat
 - Burned in flare
 - For technological use

Heat and electricity produced on biogas, TJ

	Biogaasist saadud soojusenergia					Biogaasist saadud elektrienergia				
	2007*	2008	2009	2010	Muutus ‘10/’09 +/-%	2007*	2008	2009	2010	Muutus ‘10/’09 +/-%
KOKKU BIOGAAS	68,4	63,0	48,4	71,8	48,3	56,1	48,7	31,2	42,1	34,7
sh prügilagaas	40,6	39,5	21,7	44,7	106,0	56,1	46,3	27,6	36,9	33,5
reovee settest biogaas	19,1	20,0	21,3	19,3	-9,3	-	-	-	-	-
sealägaast biogaas	8,7	3,6	5,4	7,8	43,6	-	2,4	3,6	5,2	43,6

Heat

Electricity

- Landfill gas
- Biogas from sewage sludge
- Biogas from swine slurry

Yearly average coefficient of efficiency of CHP was taken 85%

Source: EKI (Estonian Institute of Economic research)

Bio-methane

- Currently (spring 2012) biogas is not upgraded (cleaned) into bio-methane (i.e., to gas with at least 95% of methane content in Estonia. Therefore, the relevant optimal cleaning technologies are also not yet adopted.
- Since biogas is not cleaned up to natural gas quality, it cannot be sold to natural gas companies, used as motor fuel, or transported to end users by natural gas pipelines.
- Also, there are currently no legislative grounds or quality requirements for selling cleaned biogas or bio-methane into a natural gas network.
- There are two compressed natural gas (CNG) filling stations in Tallinn and Tartu are nowadays and some more are under design and construction).

CNG station in Tallinn



In nearest future AS Eesti Gaasi will establish three more CNG filling stations to Tallinn (Mustamäe), Narva and Pärnu.

CNG buses in Tartu



From spring 2011 five CNG buses started to operate public lines in Tartu.

Future CNG stations in Estonia



CNG – filling stations planned to build nearby existing gasoline stations

Bio-methane as a transport fuel challenge for W-Fuel target area - Harju County, Hinnu farm

- Considering that by annual gross production of bio-methane 1 307 253 m³ the energetic net output could reach about 12 GWh/year about 1 200 cars or 135 heavy vehicles (trucks) can be supplied annually. Bio-methane could supply waste disposal trucks, vehicles of local transportation companies or private cars.
- Three possibilities of supplying these potentials to consumers:
 - 1) Building the filling station at the biogas production/upgrading plant in Hinnu farm
 - 2) Building the filling station (CNG station) near by Tallinn-Narva road – using the existing petrol-station.
 - 3) Feeding the up-graded to bio-methane quality gas to the existing natural gas grid



Bio-methane as a transport fuel, challenge for W-Fuel target area - Lääne-Viru County

In Lääne-Viru County and in Rakvere 34 876 motor vehicles were registered (except motorbikes and trailers), about 75% of them in private use.

By 2020 the amount of cars will probably increase by 3% reaching 35 922.

By optimistic scenario 1.5% or 536 of those vehicles could use bio-methane as a fuel in 2020, for instance:

- 30 buses (5.6%),
- 20 trucks (3.7%),
- 20 garbage trucks (3.7%),
- 466 cars (87%).

Biogas upgrading and filling station:

- A. Wastewater Treatment Plant
- B. Meat Processing Factory



Thank You for Your Attention!



Bioenergy is in a good run!