NIBIO
NORWEGIAN INSTITUTE OF
BIOECONOMY RESEARCH

Country Report Norway

Tormod Briseid

Berlin (Germany), October 2015

Status of biogas production in Norway (2014)

Substrate/Plant type	Number of plants	Production (GWh/year)*
Sewage sludge	26 (+1)	222 (+20)
Biowaste	13	95
Agriculture	5 (+1)	46 (+2)
Industrial	4 (+3)	> 39 (+112)
Landfills	85 (decline)	270 (decline)
Total	**48 + 85 (landfills)**	**402 + 270 (landfills)**

Numbers from ENOVA (2010 - 2014) ENOVA is a public enterprise that is owned by the Norwegian Ministry of Petroleum and Energy and from "Underlagsmateriale for tverrsektoriell biogass-strategi "(2013), Miljødirektoratet TA 3020
Numbers are produced gas, independent of the utilisation (some cases the production, in other cases the capacity)
Numbers in bracket - plants built during 2015, but not started up yet

Methane from landfills in Norway (1987 - 2010)

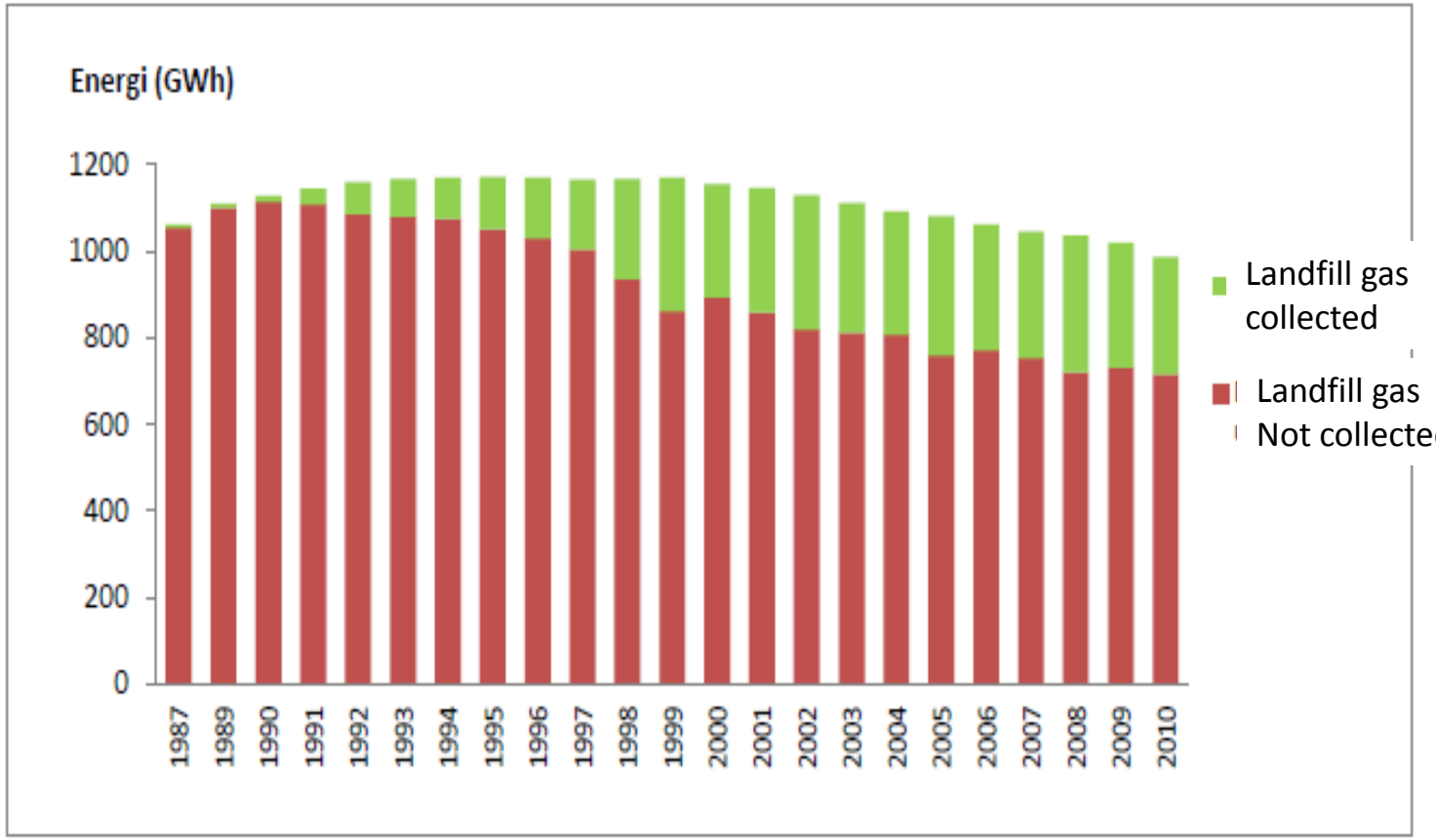


Figure from "Underlagsmateriale for tverrsektoriell biogass-strategi "(2013), Miljødirektoratet TA 3020
Green: assembled gas (used and flared off, mostly used as heat at the plant without upgrading)

Utilization of biogas in Norway

Utilization type	Number	GWh	%
Electricity	7	42	6
Heat	19	174	26
Vehicle fuel	7	196 (264 capasity)	29
Flare	-	-	-
Unknown	-	-	-
Total	**133**	**672**	**-**

Underlagsmateriale for tverrsektoriell biogass-strategi (2013), Miljødirektoratet TA 3020 (Data from 2011).
Numbers from ENOVA (2010 - 2014) ENOVA is a public enterprise that is owned by the Norwegian Ministry of Petroleum and Energy

Biogas upgrading

Name	GWh delivered	Technology	Year	Place	Substrate	Productionor Capasity Nm3/h
BEVAS (Oslo)	14	Scrubber	2010	Oslo	Sludge	750
Romrike Biogassanlegg	(45)	W. scrubber + zeolitt- LBG	2013	Oslo/Nes	Biowaste	1100
Frevar	20	Aminscrubber /CBG	2001 2008 2013	Fredrikstad	Sludge/Bio w.	600
HRA	(20)	Membranes /CBG	2014	Hønefoss	Biowaste	
Greve Biogass	(65 - 70)	W. scrubber / into grid	2015	Tønsberg	Manure/ biowaste	1200 / 1400
Mjøsanlegget	25	Scrubber/CBG	2015	Lille-hammer	Biowaste	
Lindum	17	Aminscrubber /CBG	2015	Drammen	Sludge and Biowaste	300 / 700
IVAR - Grødaland	58		2009	Stavanger	Sludge	600

Trends: A new Norwegian biogas strategy

8. October 2014 the Ministry of Climate and Environment presented a new Norwegian strategy for biogas.

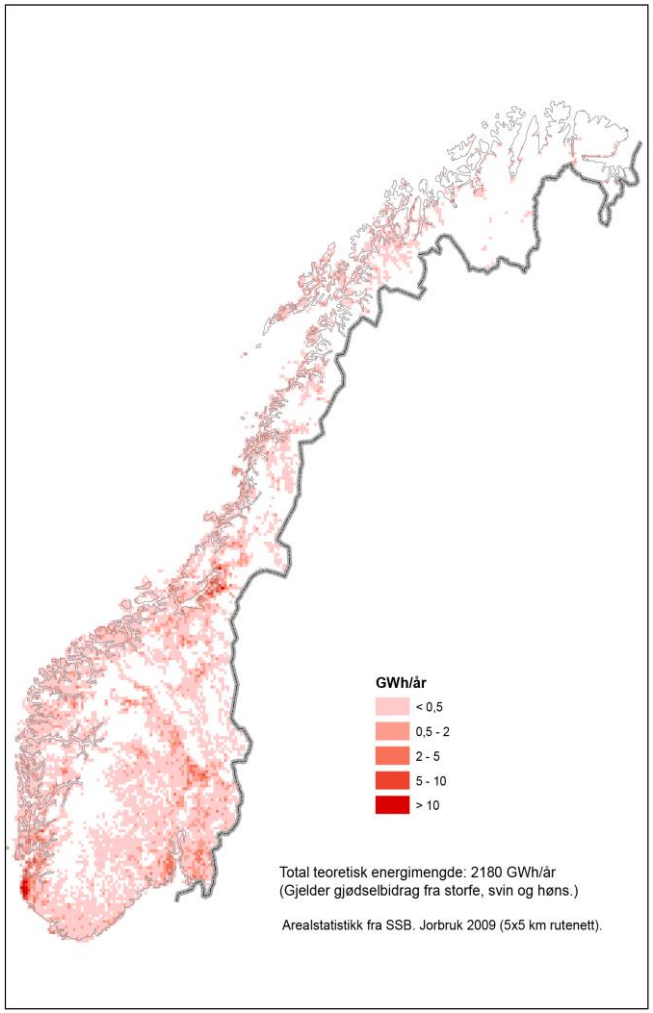
The objective is to stimulate the production of biogas from different substrates by:

- Research and development
- Ways to increase production and use of biogas
- Ways to increase the amounts of raw materials/substrates
- Ways to secure exchange of information

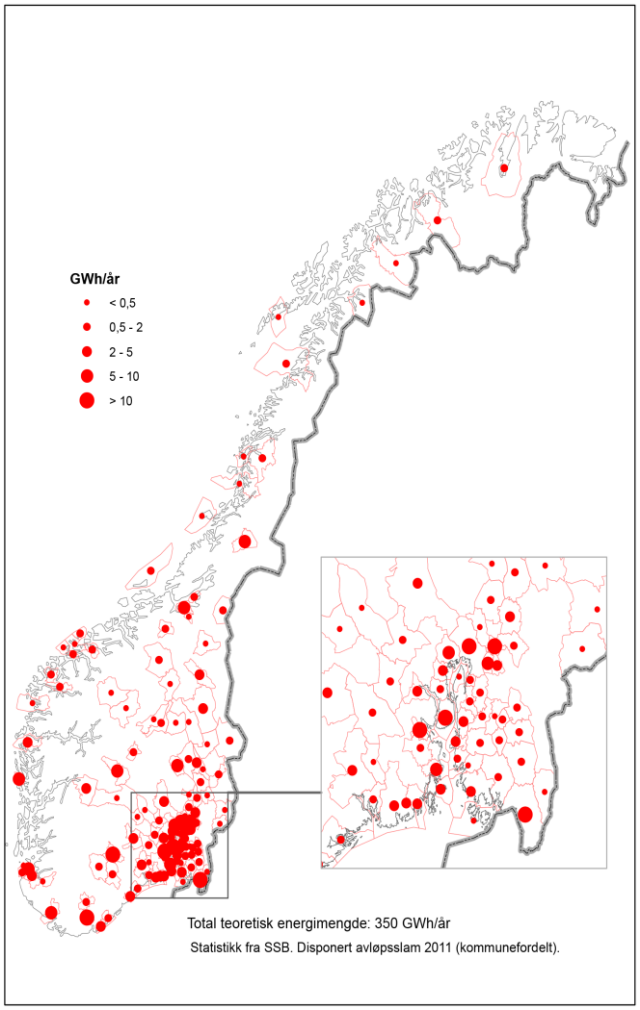
Trends – 6 different stages / different things:

- Landfill gas (1990 -2000)
- Biogas from sewage sludge (1990 – 2005)
- Biogas from biowaste – food waste (2000 – 2025?)
- Biogas from agriculture – manure, organic waste, straw, grass etc. 2010 – 2030?)
- Biogas from fish waste and fish sludge (2015 – 2030?)
- Industrial plants, e.g. pulp and paper industry (2000 – 2030)

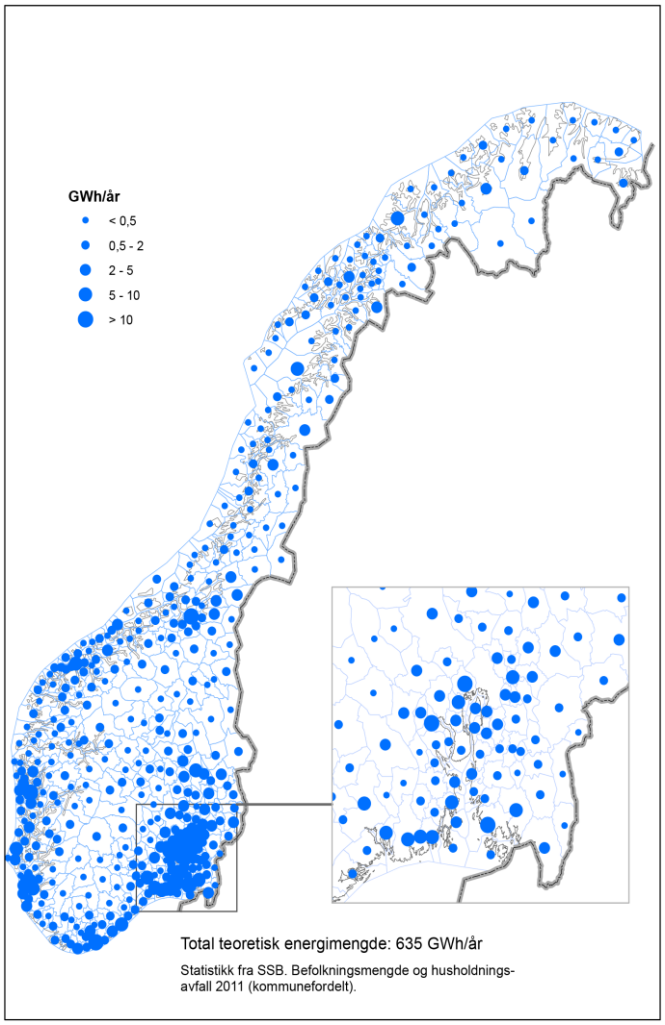
Not practical to handle this development by one graph
Biogas upgrading: Almost all larger plants upgrade their gas for vehicle fuel or for grid together with natural gas.
Difficult to use “number” of plants due to very large differences in capacity



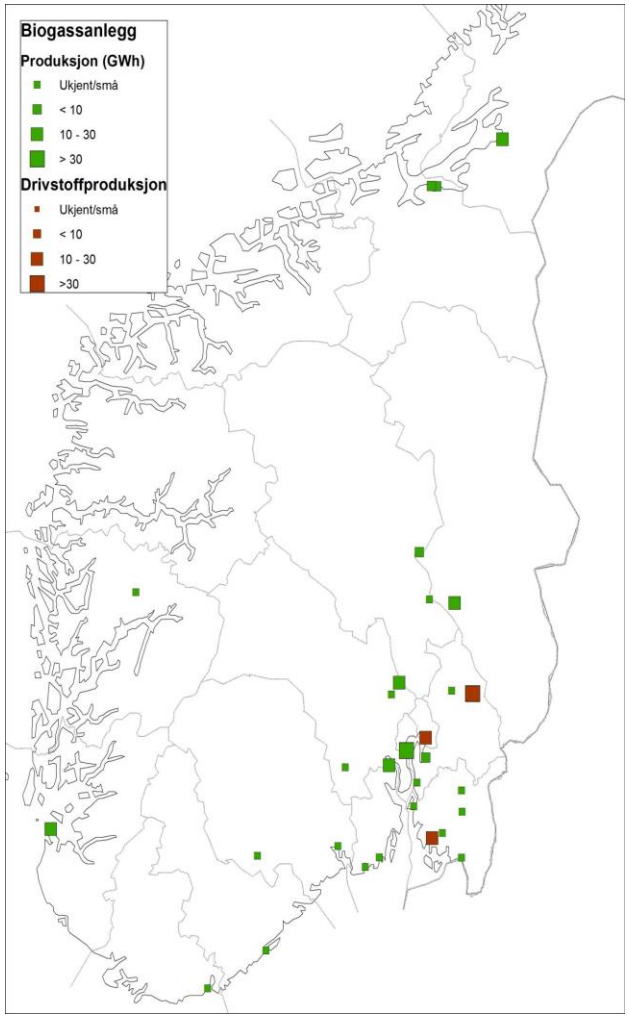
Manure potential: 2180 GWh/year



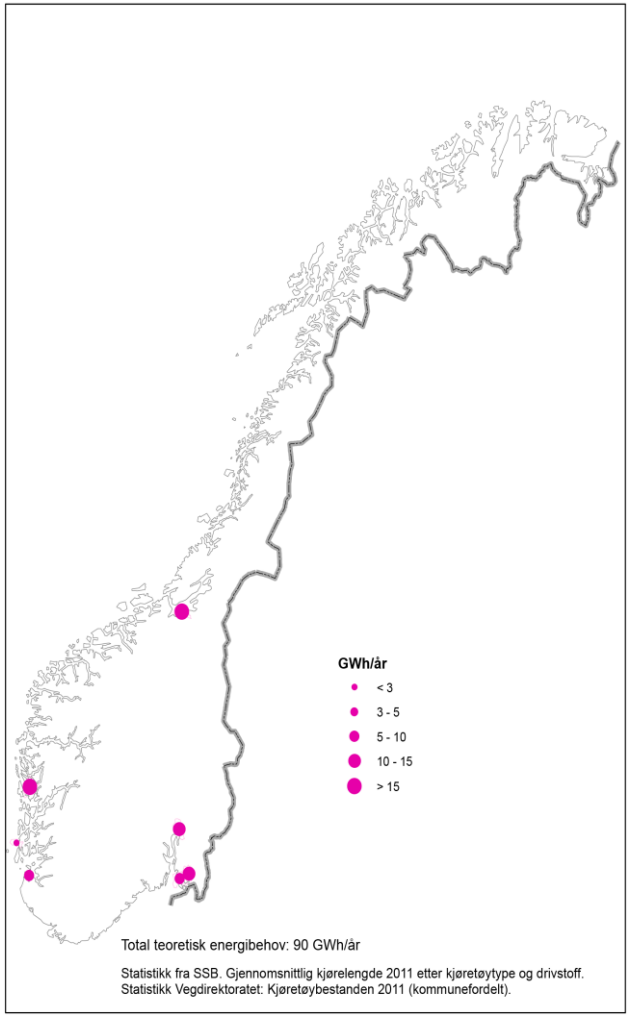
Sewage sludge: 350 GWh/year



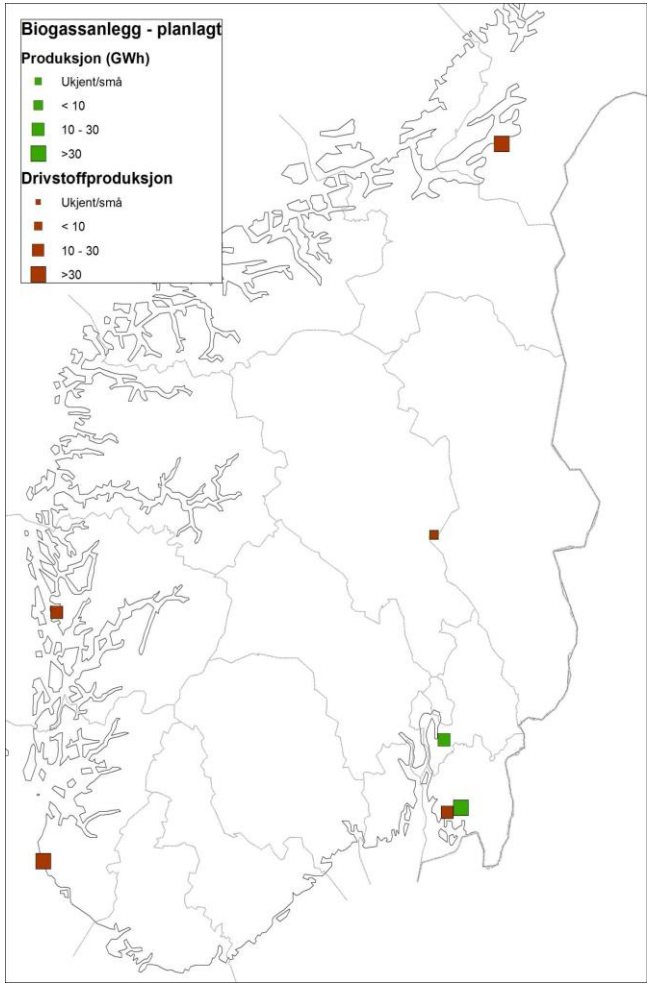
Food waste: 635 GWh/year
Biowaste from slaughterhouses, fish waste etc. in addition.



Biogas plants and biogas upgrading for fuel (2012). Fast development!



Busses using methane as fuel (natural gas or biogas)



New and planned biogas plants with upgrading for vehicle production (2012 – 2015)

Digestate handling:

- Most of the digestate produced is used in agriculture. Also digestate from WWT sludge, but with restricted use.
- The trend is to continue to use the digestate in agriculture.
- Due to long distances between biogas plants and agriculture in some cases, it is of interest to develop stabilized and concentrated digestate, e.g. as pellets.

Financial support:

- Biodegradable waste was banned landfilling from 2009.
- Investment grants, about 30% (as much as accepted by EEA – The European Economic Area Agreement), up to 50% in special pilot plant/research projects.
- Green certificates, but not important due to low el prices in Norway
- Tax-free in some ways when upgraded biogas is used for transport (more taxes for natural gas, earlier natural gas and biogas had the same taxes, gasoline has had higher taxes for a long time) This is a new decision made in 2015, to be implemented in 2016. Important for the establishment of new biogas plants which upgrade the biogas, almost all new plants.
- Manure treated in a biogas plant is paid NOK 60 per ton wet weight (about 6,50 Euro). A part of the Norwegian strategy. As much as possible (30% of the manure should be treated within 2020; Storting No 39 2008 – 2009).

Obstacles for the Biogas Development:

- AD plant permitting usually not a big problem, of course sometimes local interests do not want a biogas plant close by (possible odor problems and increase transport near by - NIMBY)
- Environmental licenses: It is necessary to make clear that plant is able to use/get rid of the produced digestate in a proper way, and that possible water effluents are treated well. Licenses are treated as every other plant.
- Grid connections: Not acceptable from an economic point of view to produce electricity for the electricity grid in Norway. No biogas plant is connected to heat grid, this is only possible for incineration plants (from an economic point of view). We have a few natural gas grids in Norway, a possibility for biogas plants.
- Digestate is used in agriculture, but up to now the farmers neither pay for the transport nor the use. Maybe this will change in the future.

Research activities:

- Microbial studies – use of molecular biology
- Improve substrate pretreatment technologies
- Make use of fish sludge from fish farming industry as substrate for biogas plants
- Make better use of the digestate (pellets or concentrated forms for storage, transport and practical use in agriculture)
- Combined systems – algae production and biogas plants

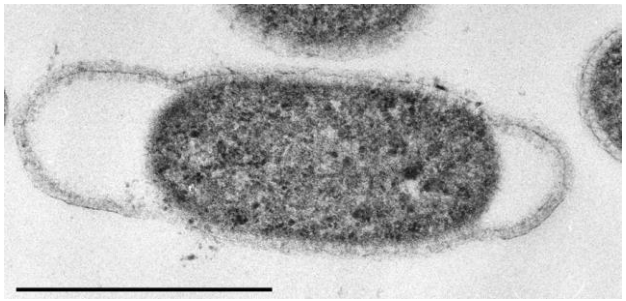
HYPERFERMENTAN

Use of hyperthermophiles for pretreatment

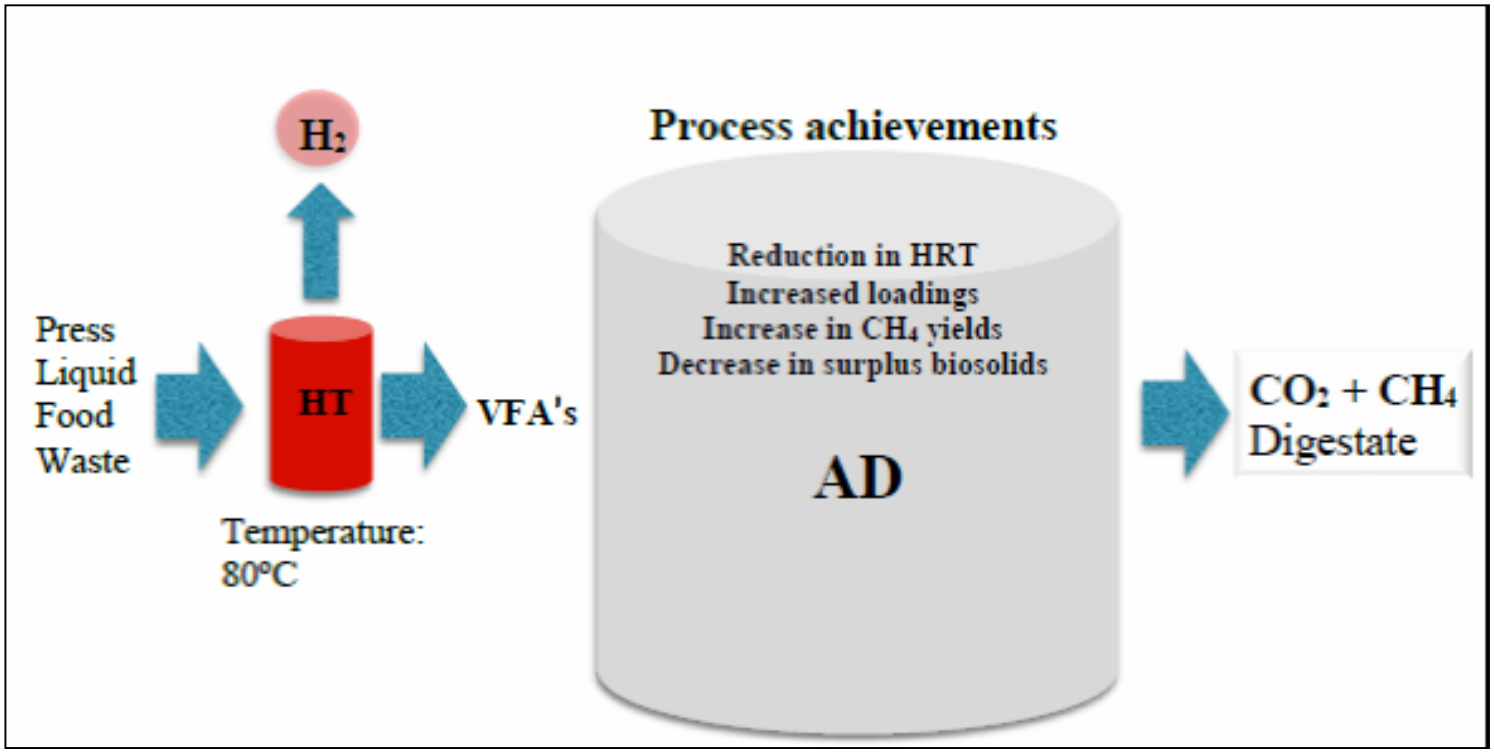
Norwegian companies (Hyperthermics energy, HØST), Hyperthermics Regensburg and The Research Council of Norway

Definition: A hyperthermophile is an organism that thrives in extremely hot environments. The optimal growth temperature of hyperthermophiles is above 80°C.

Objective: To establish the hyperthermophilic process as a stable pretreatment step to a biogas process, digesting press liquids from food waste and other waste qualities, with emphasis to hygienisation and increased biogas (methane) yield.



Hyperthermic process and the biogas process combined



Degradation of polysaccharides by *Thermotoga*:

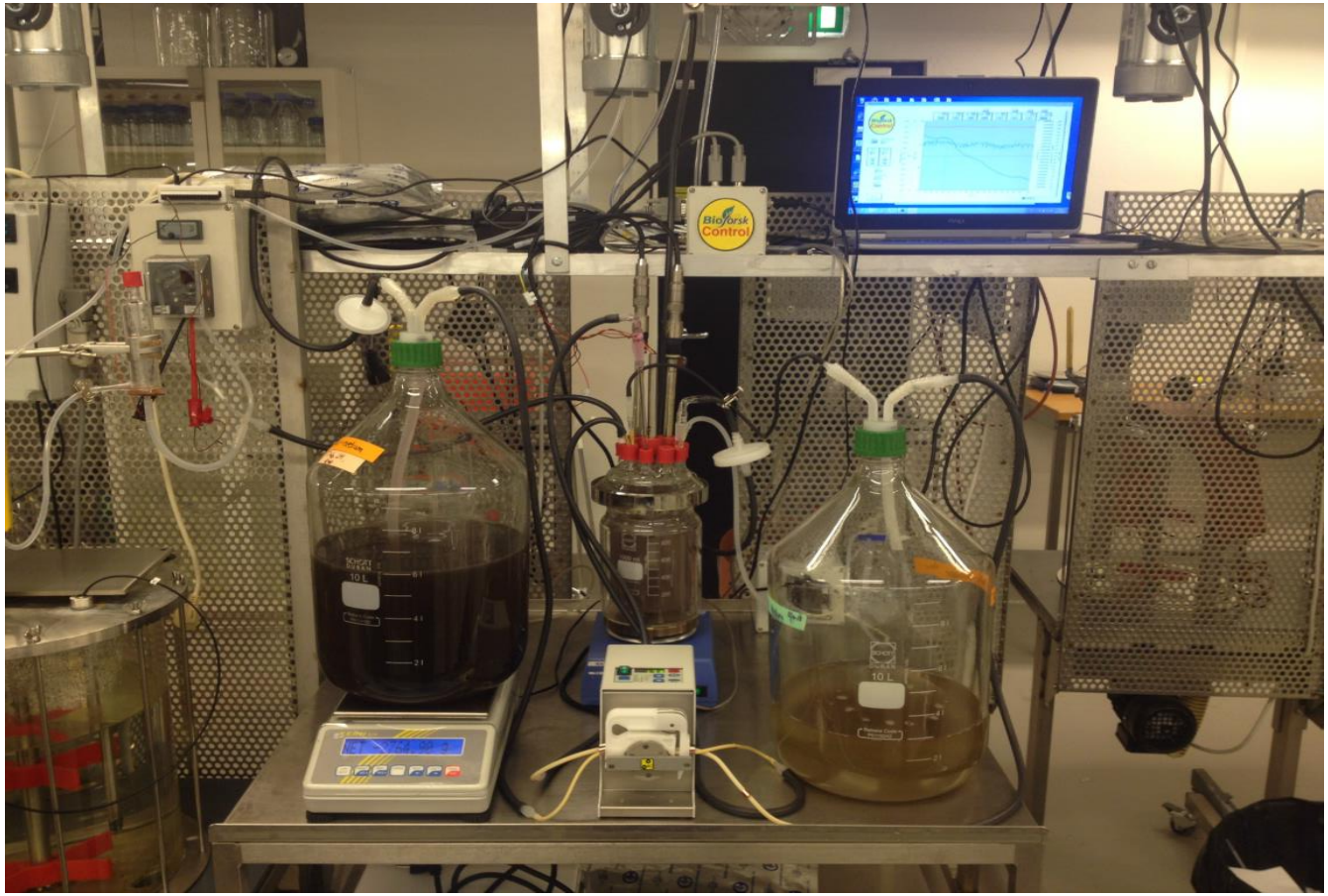
($C_6H_{12}O_6$) is converted to:

(1-2) acetate + 2 CO_2 + (0-1) lactate + (0-1) ethanol + (2-4) H_2 + energy (heat)

Monosaccharides	Disaccharides	Polysaccharides	Complex organic substances
glucose, galactose, fructose, ribose, xylose	lactose, maltose, sucrose	cellulose, glycogen, starch, xylan	peptone, yeast extract

Biomass from land based crops	By-products from industrial processes	Aqua (marine) biomass
corn silage, straw, poplar	sugar beet slices, molasses, potato pulp, whey, chicken manure	Macroalgae (*Saccharina latissima*), Microalgae (*Spirulina platensis*)

Experimental setup at the lab - *Thermotoga*



I think I will/have to go a little more into the numbers presented before I deliver the full annual report!

Thank you!