Biogas in the loop of recycling
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Biogas and digestate in agriculture

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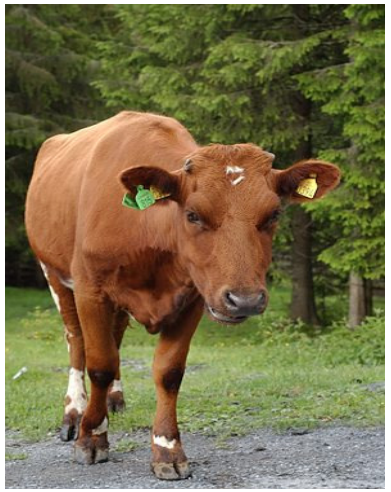
Biogas plants in Norway:

- Several biogas plants for sewage sludge treatment in the nineties - focus on treatment and stabilization.
- No biogas plants using manure or food waste before 2000, still very few plants.
- Focus on the climate effect – not energy production.
- Also a focus on nutrient reuse.
- Agriculture is important, both as a deliver of substrates and the user of nutrients/digestate.

Reduced greenhouse gases from agriculture



- Treatment of manure and food waste in biogas plants
  - Reduced methane emission
  - Reduced emission of N_2O
  - Reduced emission of ammonia
- Production of biogas as renewable energy – substitution of fossile fuels
- Other environmental effects of biogas in agriculture
- The cost of this action (NOK per tonn CO_2 ekv emission reduced)

Reduced greenhouse gases from agriculture - CO_2 ekv.(tons) - Biogas treatment of manure (Norway)

% manure treated:	20 %	30 %	40 %	50%	60 %
Methane	53 669	80 504	107 339	134 174	161 010
N_2O	37 315	55 973	74 630	93 288	11 194
Ammonia	5 717	8 576	11 434	14 293	17 151
Fossile energy sub.	124 524	186 786	249 048	311 310	373 573

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Biogas and agriculture:

- Farm biogas plants. Manure and other energy rich substrates. Digestate used at local farm.
- Central biogas plants for food waste treatment. Digestate used in agriculture.
- Central industrial biogas plants for treatment of manure, industrial orrganic waste and food waste. Digestate used in agriculture.

Ecopro in Skjørdalen/Ravlo i Verdal Kommune in Nord-Trøndelag.

What are the main challenges?

Farm biogas plants in Norway

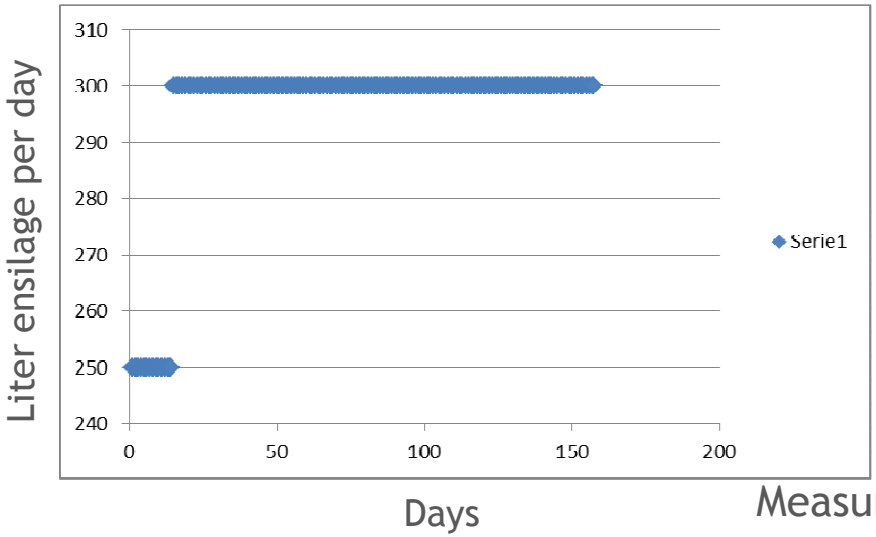
One plant (Åna) is studied in the project: Biogas as part of the agricultural reuse of energy and nutrients (2008 – 2011)

Biogas as part of the agricultural reuse of energy and nutrients (2008 - 2011)

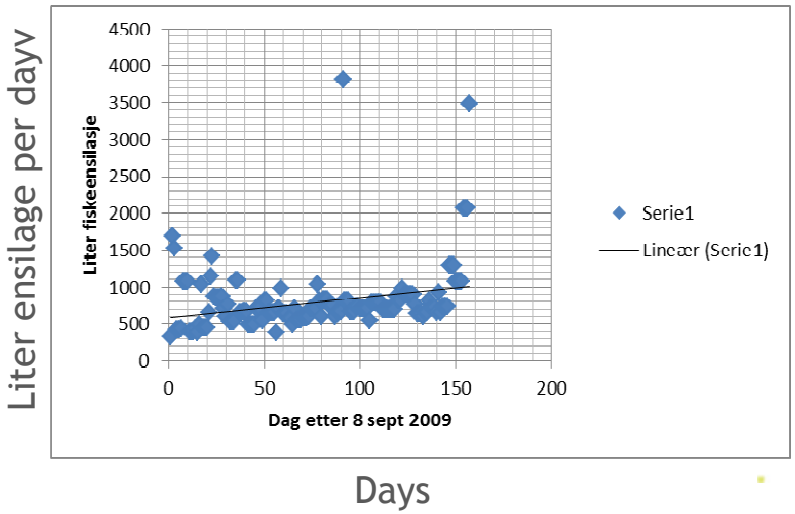
- 280 m^3 reactor volume, retention time 30 days
- Mesophilic process
- Substrates: Cattle manure (ca. 60m^3 per week, about 60% of VS) and fish ensilage (ca. 5 m^3, about 40% of VS).
- Methane production, about 1200 m^3 per week, only 500 m^3 when fish ensilage is not added.
- About 1/3 of the energy produced is used as heat and electricity at the plant. If fish ensilage is not used, no netto energy production is obtained during winter season.

Sensitive process to overloading

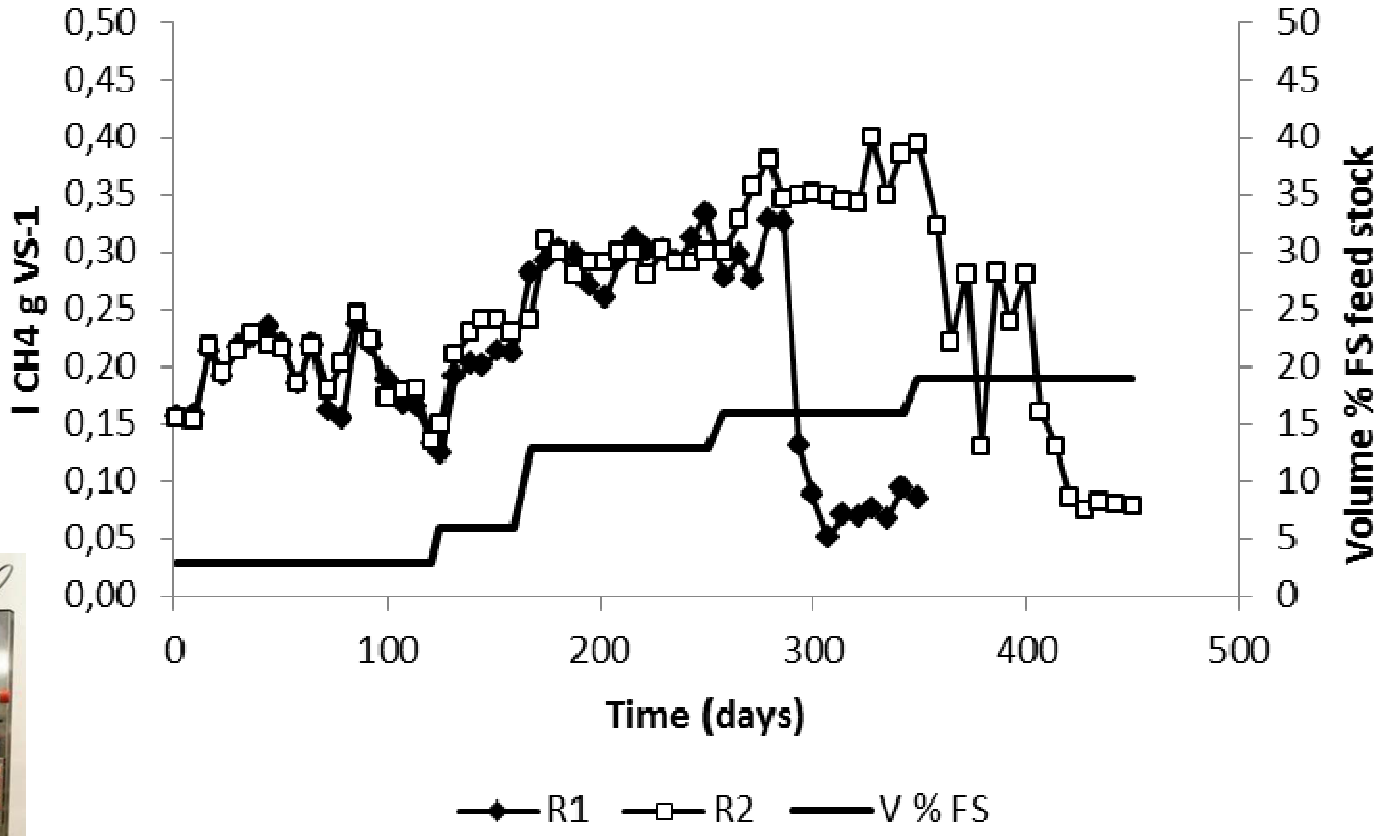
Planned amount of fish ensilage added



Measured amount of fish ensilage added



Specific methane production – Manure and fish ensilage as substrates – laboratory experiments



Barley crop – Åna farm biogas plant

Fertilizer type	Fertilizer Kg N/daa	Crop (15 % vann) kg/daa	Hektolitervekt kg	1000-kornvekt g	Protein %
No fertilizer	0	422 c	62,6	36,8	8,4
Mineral fert. 22-2-12	6	488 bc	64,2	35,5	8,4
Mineral fert.22-2-12	11	557 abc	66,1	39,6	10,0
Ammoniumnitrat + kaliumklorid	11	680 a	67,3	37,2	9,9
Manure Åna	12	551 abc	67,5	38,1	8,9
Digestate Åna	12	591 ab	68,9	40,1	9,6

Meadow crop – Åna farm biogas plant

Fertilizer type:	Fertilizer Kg N/daa	Fertilizer Kg P/daa	Fertilizer Kg K/daa	Crop, dry matter kg/daa
No fertilizer	0	0	0	384 b
Mineral 22-2-12	12	0,9	6,4	804 a
Mineral 22-2-12	24	1,9	12,8	990 a
Ammoniumnitrat + kaliumklorid	24	0	11,8	919 a
Manure - Åna	24	3,6	24	776 a
Digestate - Åna	24	3,0	20	823 a

Farm biogas plants in Norway

- Cold climate – high energy use.
- Dependent on energy rich co-substrate, f.ex. fish ensilage or food waste.
- Energy rich co-substrates may be marked sensitive to cost.
- The digestate give about equal yields as other fertilizers when equal amounts of mineral nitrogen is added.
- The digestate has lower viscosity and less odour than untreated manure.
- The main challenge for farm biogas plants in Norway is low energy prices and to high costs.

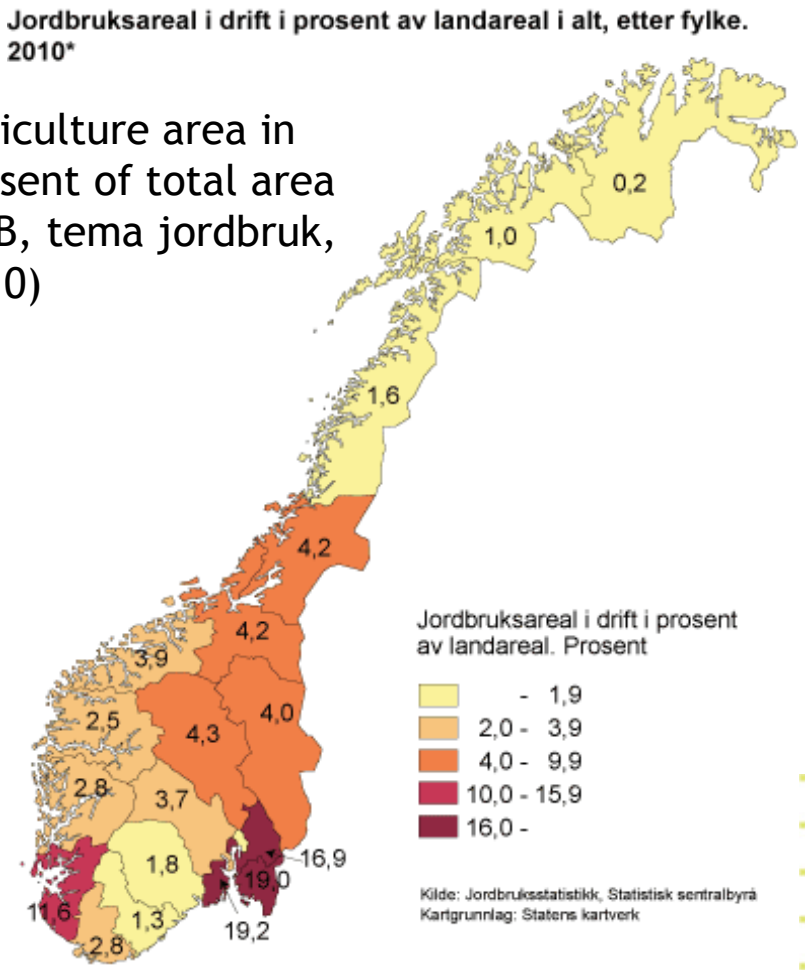
Central biogas plants – food waste or manure as main substrate

- In order to close the loop of recycling – the agriculture is the prefered receiver of the digestate.
- The agriculture needs accurate information about the nutrient content (N, P, K).
- The agriculture needs documentation about possible contaminants and the hygenic status to be sure that they run no risk using the digestate.
- The farmers must save money when they use the digestate instead of other fertilizers.
- Long transport distances and large volumes of digestate are important challenges for the economy. (Develop technologies to reduce liquid volume, combined by increased fertilizer concentration are important tasks for research)

Centralized biogas plants in agriculture

Agriculture area in prosent of total area (SSB, tema jordbruk, 2010)

Central biogas plants for agriculture are planned in some regions (Rogaland, Vestfold, Østfold and Trønderlag)



Summary – biogas and agriculture

<u>Driving forces:</u>

- Reduction of greenhouse gases from agriculture
- Recycling of nutrients – closing the loop
- Production of renewable energy
- The farmers are positive – more activities in agriculture

<u>Main challenges:</u>

- Farm biogas plants: The economy – low energy prices
- Centralized plants:
  - The economy – low energy prices
  - Transport and storage of digestate – large volumes
  - Cooperation between plants and farmers
  - Dokumentation of fertilizer effect and risk control

In future we expect increased need for climate actions, increased energy prices and scarcity of nutrients for food production, f.ex. phosphorus

so:

many biogas plants are expected to be established in orders to close the loop of recycling in future (also in Norway)

Thank you!