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Energy

Biogas Infrastructure from Farm-Scale to Regional Level, Line-pack Storage in a Biogas grid.

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Biogas Infrastructure from Farm-Scale to Regional Level, **Line-pack Storage in a Biogas Grid.**

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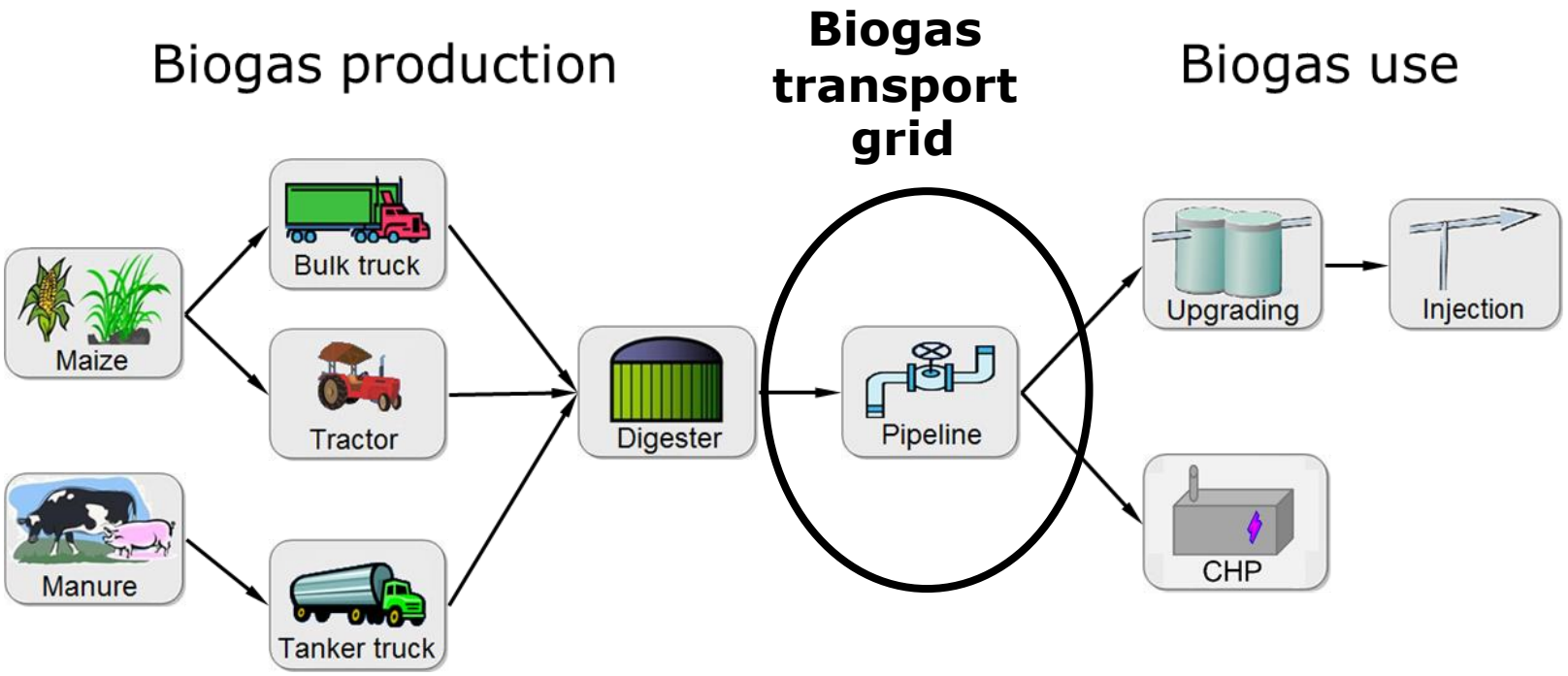
Flexigas project:

Overview

This presentation:

* Introduction
* Biogas transport grid
* Model of line-pack storage
* Results
* Conclusions

A chain model of biogas production and use to estimate costs and energy use.



Recent work:

Biogas infrastructures from farm to regional scale, prospects of biogas transport grids.
(E.J. Hengeveld *c.s.*, Biomass & Bioenergy, 2016).

- Model of a dedicated biogas grid
- Collection of biogas to a hub, using pipelines
- Costs and energy use of biogas transport to a hub
- Two different lay-outs of the grid;
  a star lay-out and a fishbone layout
- Different digester scales and region sizes

Line-pack storage in a biogas transport grid:

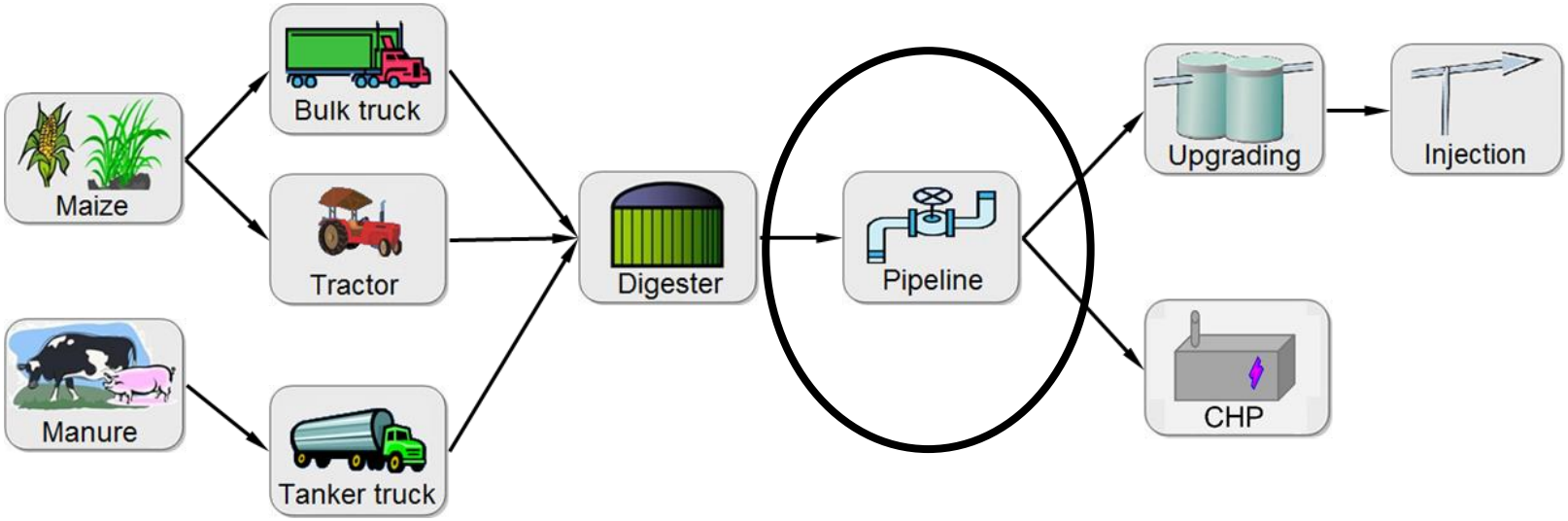
The main function of the grid is biogas transport.

Additionally pipelines may serve as a storage facility by means of line-pack storage, *i.e.* a surplus of biogas can be stored in the grid by controlling the pressures

Research question:

For a grid with lowest transport costs in the transport model.

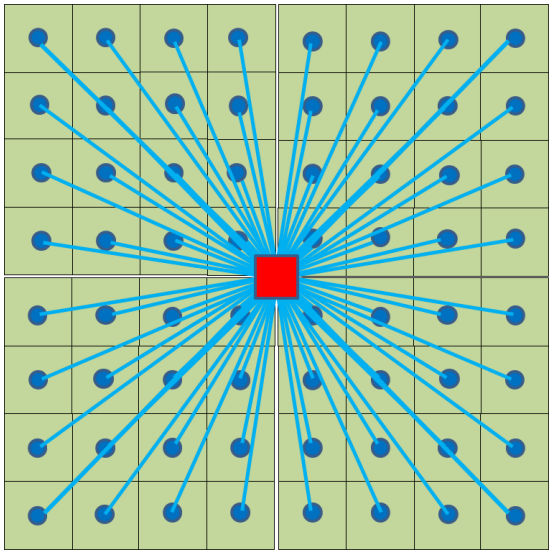
- What volume of line-pack storage is available in the biogas grid?
- How do costs of line-pack storage depend on grid lay-out and region and digester scale?
- How do line-pack storage costs compare with costs of other types of biogas storage?



Model of biogas transport grid

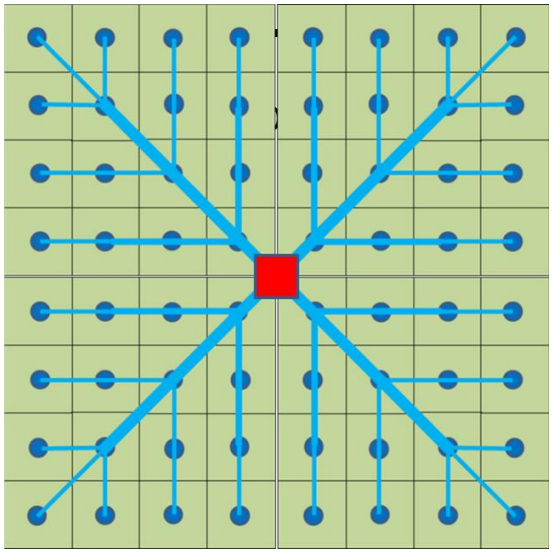
Star lay-out

Individual pipelines to connect each digester to the hub.



Fishbone lay-out

Biogas collected in a main pipeline that leads to the hub.



Biomass source area for one digester

Compressor at the digester sites.

Hub at the centre of the region

Minimize biogas transport costs (€ct m^{-3}) by choosing the diameter of the pipeline-segments.

Determine the grid with lowest transport costs

Pressure in the transport grid: < 0.9 MPa

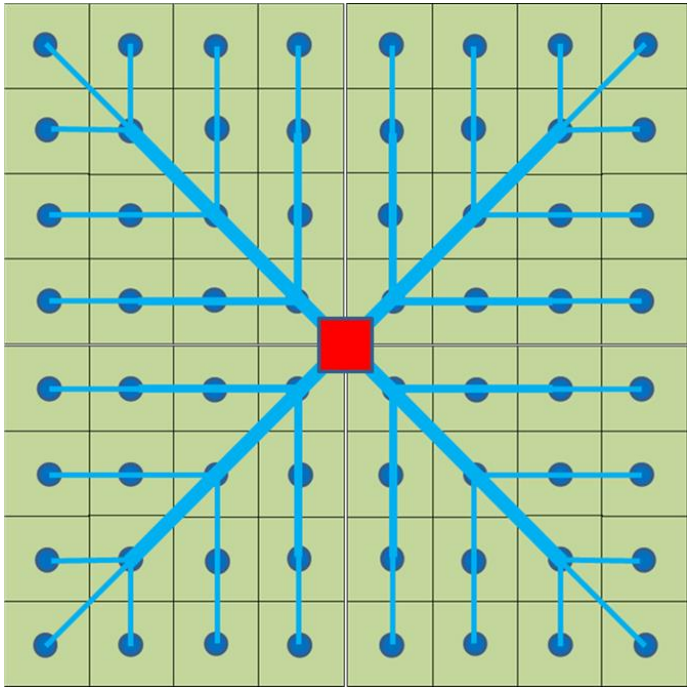
Increase pressure in the grid up to the maximum: = 0.9 MPa

Line-pack storage is <u>additional</u> biogas volume in the grid.

<u>Extra</u> energy costs for compression determine line-pack storage costs.

Line-pack storage model

Example dimensions:
Digester scale 300 m^3h^{-1}



6.8 km

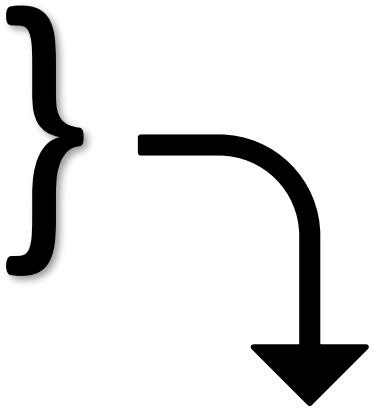
Region side = 54.3 km

Total: $19.2 \cdot 10^3$ m^3h^{-1} biogas

Line-pack storage model

Pressure in the transport grid: < 0.9 MPa

Increase pressure in the grid up to the maximum: = 0.9 MPa



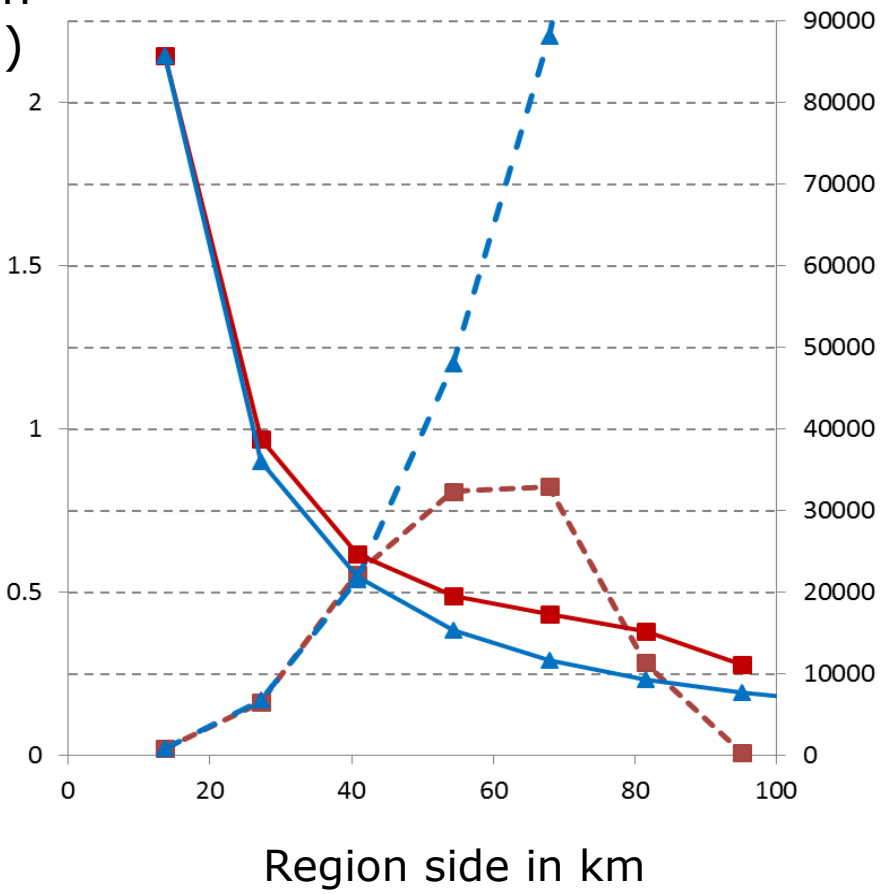
Line-pack storage volume depends on the *pressure increase ΔP*.

Line-pack storage volume depends on the *volume in the pipelines.*

Results, Line-pack storage costs and volume

Costs in €ct $m^{-3}h^{-1}$ (solid)

Maximum storage volume in m^3 (dashed)



Digester scale is 300 m^3h^{-1}

Star lay-out (blue)

Fishbone lay-out (red)

Results, Line-pack storage costs

Cost structure for types of biogas storage

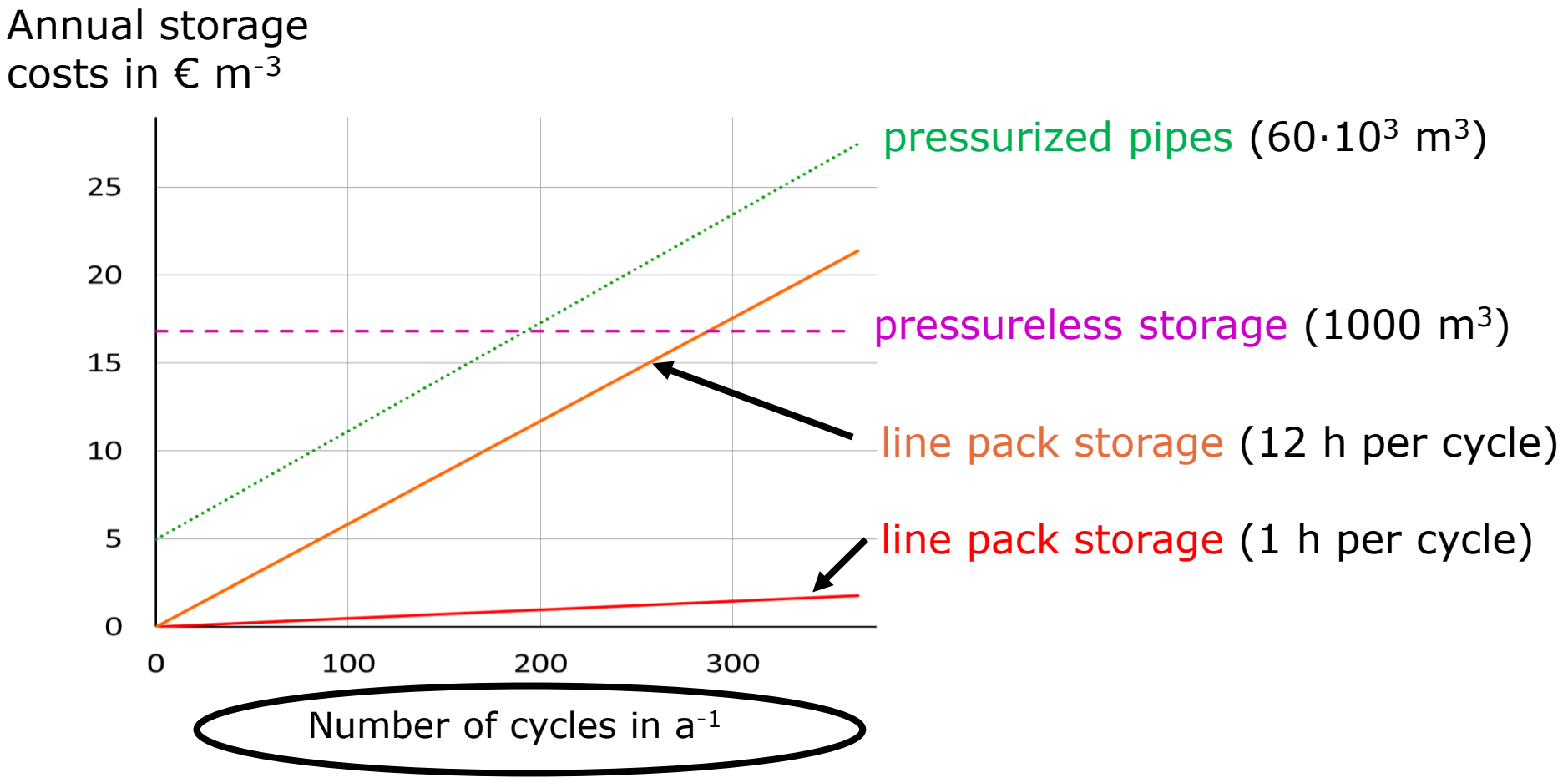
Biogas storage type	Variable costs	Investment costs
Pressureless storage	low to negligible	yes
Pressurized pipes	yes	yes
Line-pack storage	yes	no

Comparison of types of biogas storage

- Pressureless storage (1000 m^3)
- Pressurized pipes ($60 \cdot 10^3$ m^3)
- Line-pack storage ($32.4 \cdot 10^3$ m^3)
  as in a fishbone grid with digester scale 300 m^3h^{-1}
  and total biogas production $19.2 \cdot 10^3$ m^3h^{-1}

Results, Line-pack storage costs

Comparison with other biogas storage methods



Conclusions

- Biogas line-pack storage costs are roughly between 0.3 €ct m^{-3} h^{-1} and 1.5 €ct m^{-3} h^{-1} (costs of the transport grid not included)
- Line-pack storage costs depend on the duration of the storage; so not specifically on the number of charge/discharge cycles

  Not suitable for seasonal storage
- Line-pack storage can compete with pressureless storage for short term storage

Further research …

- Dynamic aspects of charge/discharge of line-pack storage
- Simulation of use of line-pack storage in order to supply flexibility in electricity production.

Thank you for your attention.

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