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OIL & GAS

How do H_2 and CO feed-in levels effect Green Gas costs?

Case study for large-scale gasification of biomass in the Netherlands

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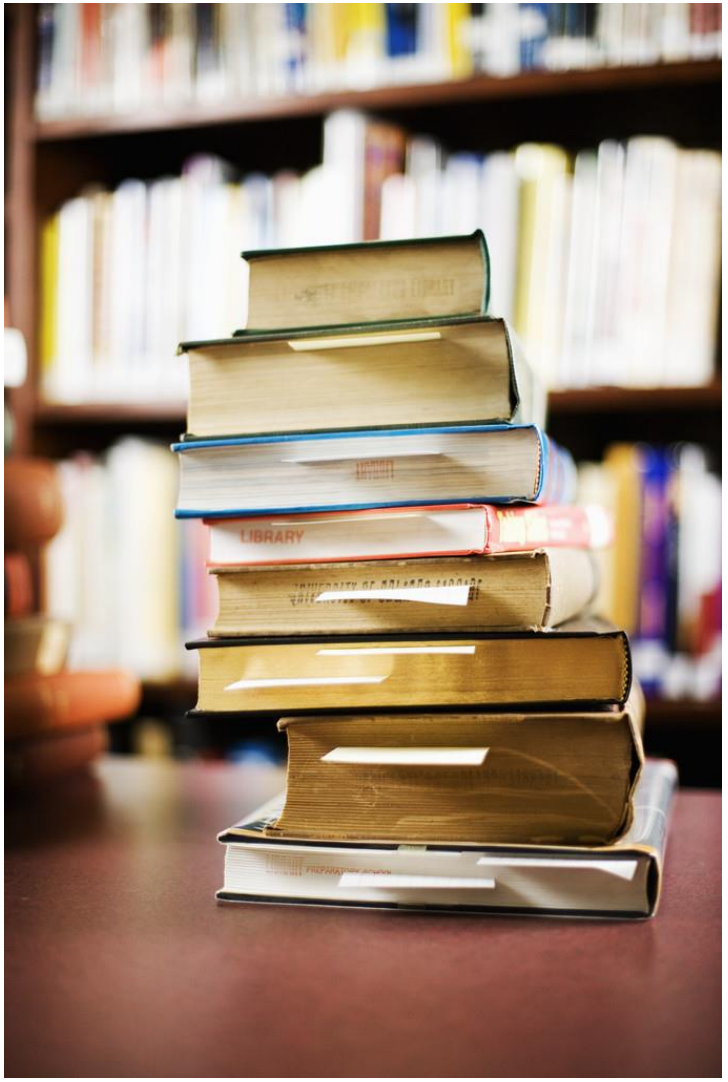
Content

1. Introduction
2. Natural gas pipeline specifications
3. Production process
4. Approach Methanation
5. Cases
6. Results cost price
7. Conclusion



Introduction

- Green gas can play a significant role in achieving the climate targets of the Netherlands
- Gasification is one of the crucial technologies to convert dry-biomass into green gas (green SNG)
- Green gas is normally injected into the Groningen quality gas system
- By definition green gas is of pipeline gas quality, however the produced green SNG may contain hydrogen and carbon monoxide. The composition of the green SNG to be injected in the natural gas system is a key quality parameter for its acceptance.

Natural gas pipeline specifications

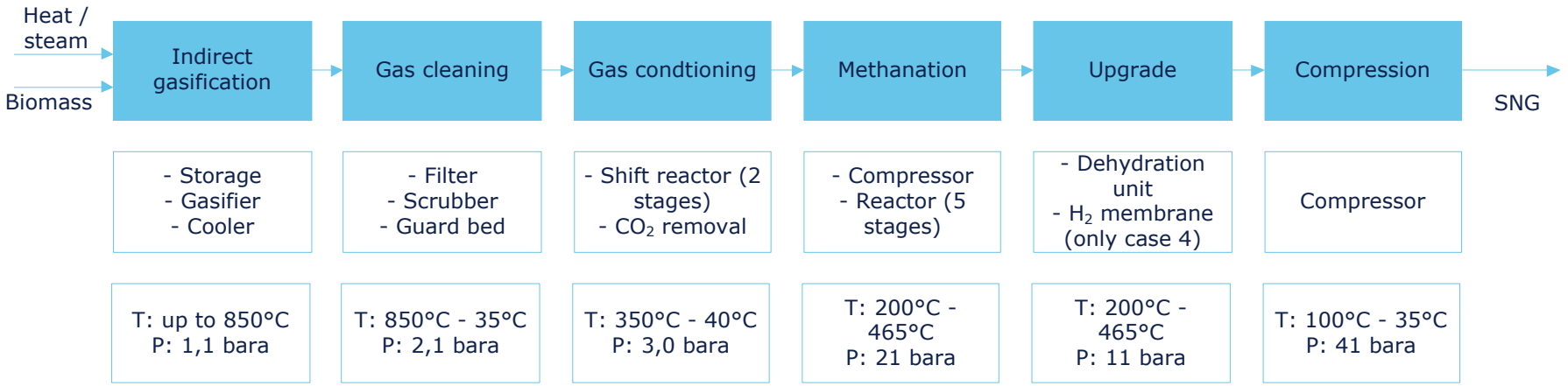
- Low H_2 and CO levels are required to ensure health, safety and network integrity

Current Groningen pipeline specification and anticipated development for hydrogen and carbon monoxide (Ministry of Economic Affairs, 2014)

Component	Current specification	Anticipated development
Hydrogen	**≤ 0,02 mol% (high pressure network) ≤ 0,1 mol% (distribution network)**	**Increase to < 0,5 mol%**
Carbon monoxide	**2.900 mg/m3 (n)**	**No changes**



Production process



- Modelling based on mass and heat balance.
- Gas compositions and efficiencies from the literature.
- Cost based on unit size (hardware, installation and maintenance) and capacity (energy, personnel and commodities)

Approach methanation

Input
P, T, X

Reaction Kinetics

$$3H_2 + CO \leftrightarrow CH_4 + H_2O$$
$$CO + H_2O \leftrightarrow CO_2 + H_2$$
$$4H_2 + CO_2 \leftrightarrow CH_4 + 2H_2O$$

Energy balance

$$r_1 \quad \Delta H_R^O = -206\ kJ/mol$$
$$r_2 \quad \Delta H_R^O = -247\ kJ/mol$$
$$r_3 \quad \Delta H_R^O = -165\ kJ/mol$$

Material balance

$$F_{H_2} = F_{H_{2,0}} \cdot \left(1 - x - \frac{r_2}{r_1} \cdot x - \frac{r_3}{r_1} \cdot x\right)$$

Output
Amount of catalyst

$$r_{H_2} = r_1 - r_2 + r_3$$

Four steps

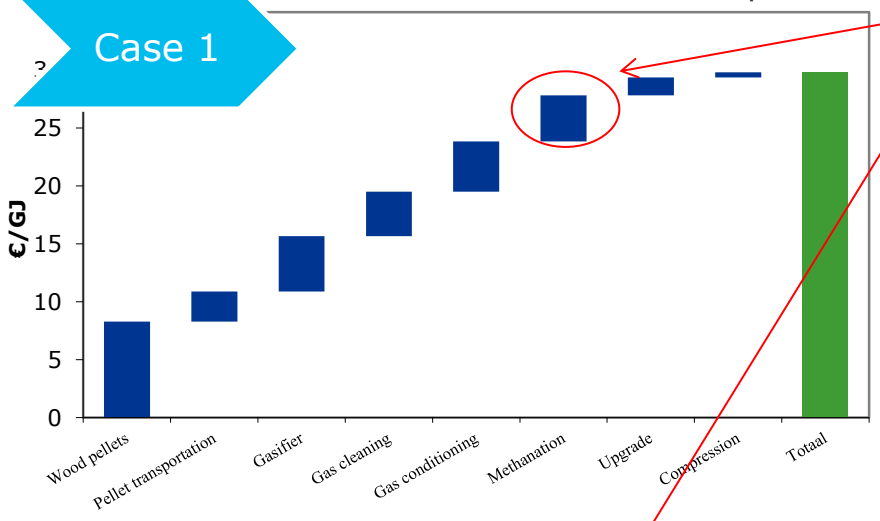
The assessment makes clear that the current available technologies are capable to reach the required gas quality specifications

Case (step)	H_2 [mol%]	CO [ppm]	CH_4 [mol%]	CO_2 [mol%]	Inerts [mol%]	Wobbe index [MJ/m³]
1	**2**	**4000**	**88,4**	**5,4**	**3,8**	**45,66**
2	**1**	**1000**	**88,9**	**6,2**	**3,7**	**45,25**
3	**0,6**	**200**	**89,3**	**7,1**	**3,0**	**44,42**
4	**0,07**	**200**	**89,8**	**7,1**	**3,0**	**44,67**

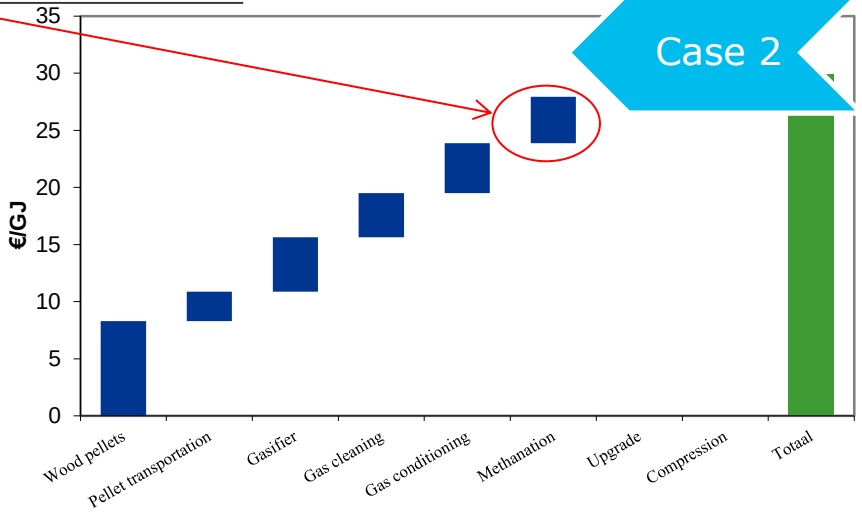
Results

Cost price of methanation increases

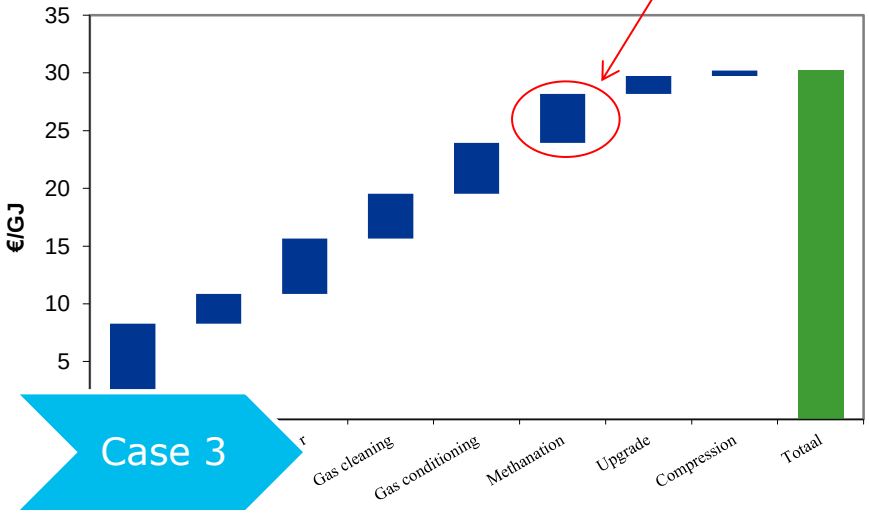
Case 1



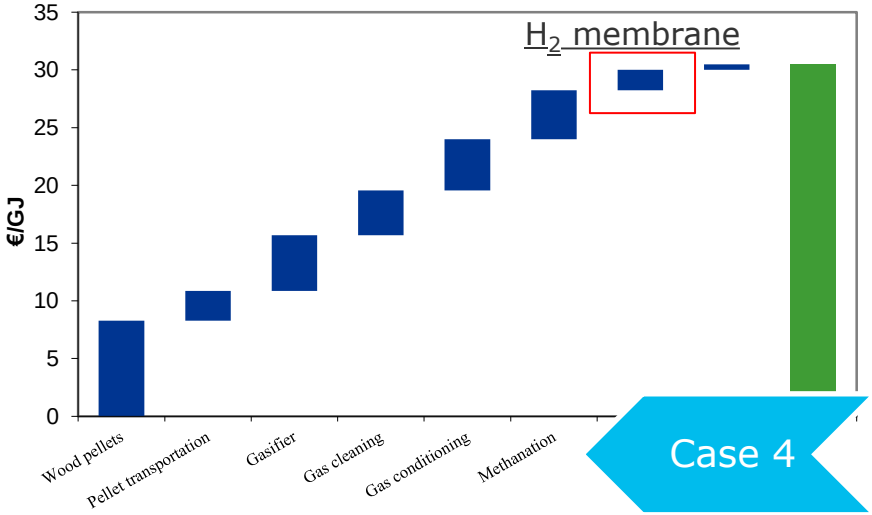
Case 2



Case 3

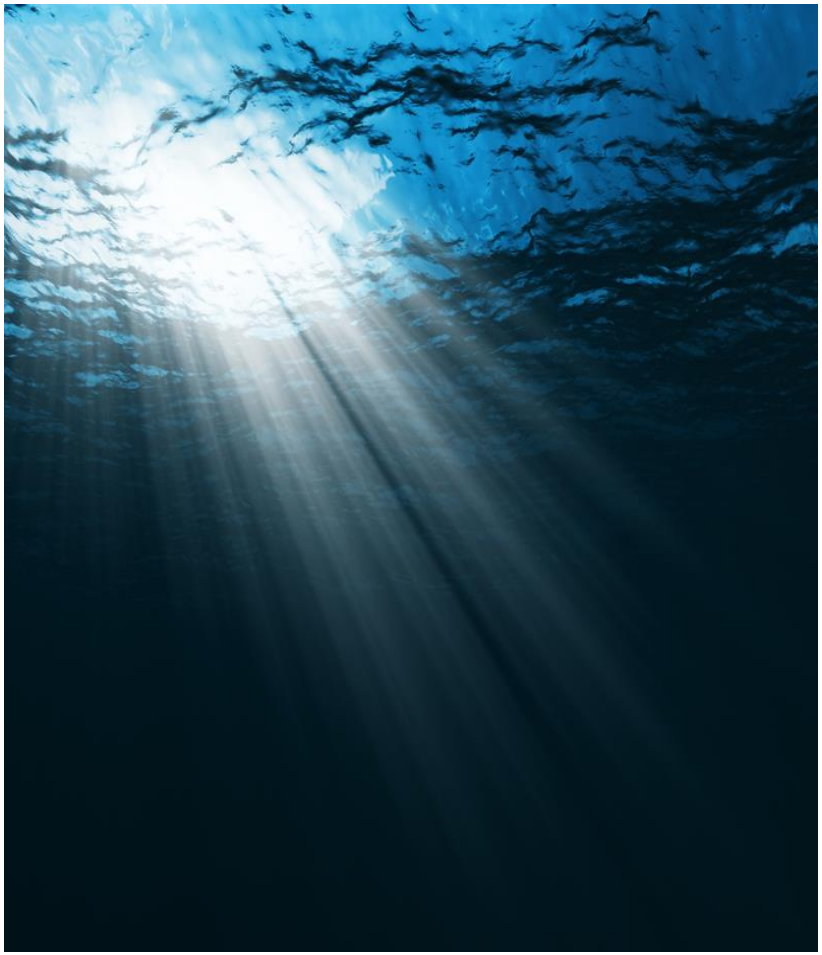


Case 4



Conclusion

1. The cost price (excluding the cost for biomass) for green gas production increases with **2,5%** if the level of hydrogen decreases from 2 mole % to 0,07 mole % and the level of carbon monoxide decreases simultaneously from 4000 ppm to 200 ppm
2. Cost prices (excluding the cost for biomass) for green gasses ranges in this study from **0,67 – 0,69 €/m³**
3. The price sensitivity towards the different gas product qualities can be judged as **moderate** and
4. required gas specification **can be met** by green SNG producers



Questions?

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