BUSINESS CASES IN P2X CONCEPTS
RECENT M.SC. THESES

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Introduction

- PtX can be used for business in connection with NG grid (Orava)
  - Operated by entrepreneur
  - Operated by grid owner (electricity, NG)

- Adding hydrogen/oxygen to large CFB lower furnace (Mankonen)
  - Capability for improving flexible CFB operation may improve economics of the cases where boiler needs to run low loads
  - CFB offers change to use split hydrogen/oxygen

- The best P2X projects have something in common (Vartiainen)
  - Premise is high penetration of variable renewables
  - Study existing P2X projects
Ismo Orava

- To study investment, operation and maintenance costs of PtG plant.
- Four different operational schemes.
- The estimated cost was 2 497 k€/MWe.
Generally there is a trend for the electricity consumption to pick up in the morning.
First approximation of cost and efficiency

- **Sähkö**: 11,35 MW<sub>e</sub>
  - Elektrolyysi: 10,00 MW<sub>e</sub>
  - Apulaitteet: 1,20 MW<sub>e</sub>
  - Omakäyttö: 0,15 MW<sub>e</sub>

- **Hillidioksidi**: 1,177 kg, 800 Nm<sup>3</sup>

- **Elektrolyysi**
  - Sähköteho: 10,00 MW<sub>e</sub>
  - Hyöty suhde: 85,0 %
  - Reaktio: \( \text{H}_2\text{O}(l) \rightarrow \text{H}_2(g) + \frac{3}{2} \text{O}_2(g) \)
  - \( \Delta H = 286 \text{ kJ/mol} \)

- **Vety**: 216 kg, 2,398 Nm<sup>3</sup>
  - Yritys MP: 8,50 MW<sub>e</sub>
  - Käyttö MP: 7,19 MW<sub>e</sub>

- **Happi**: 1,712 kg, 1,199 Nm<sup>3</sup>

- **Jäähdystarve**: 1,50 MW<sub>e</sub>

- **Myytävä lämpö**: 1,35 MW<sub>e</sub>
  - Lämpötila: 70 °C
  - Hyöty suhde: 90 %

- **Metanoointi**
  - Hyöty suhde, lämpö: 81,0 %
  - Reaktio: \( \text{CO}_2(g) + 4 \text{H}_2(g) \rightarrow \text{CH}_4(g) + 2 \text{H}_2\text{O}(g) \)
  - \( \Delta H = -165 \text{ kJ/mol} \)

- **Metaani**: 429 kg, 500 Nm<sup>3</sup>
  - Yritys MP: 6,02 MW<sub>e</sub>
  - Käyttö MP: 5,97 MW<sub>e</sub>

- **Vesi**: 1199 Nm<sup>3</sup>, 964 kg

**NEC Carbon Energy**
Learnings

1. Investments costs are currently high for alkali water electrolysis.
2. Need to get the plant to run at least 6000 – 7000 hours.
3. Have to try to find a buyer for oxygen and heat.
4. If you produce e-SNG then you need a higher selling price than NG.
5. No paying power for CO2.
Aleksi Mankonen

- Create IPSEpro submodel of PtG plant.
- Improve submodel of large CHP plant lower furnace
- Use to study operation when low load.
Created IPSEPPro model for electrolysis-methanation
Created IPSEPro model for CFB lower furnace with H2/O2
Learnings

- Tools created can be used to study improved large CFB operation
- Tools finished but economic study uncomplete
Vesa Vartiainen

- The purpose of this work was the screening of existing power to gas projects worldwide and reviewing the technologies used and applications for the end products.
- Focus solely on technical solutions
- A total of 57 projects were reviewed
Learnings

• The driving force for projects was mainly the large penetration of intermittent sources such as solar and wind power.
• Additionally there were a number of local energy concepts where P2X was seen as a possibility to fulfil local energy demand using a renewable source.
Utsira wind-hydrogen system showing hydrogen storage

Not surprisingly the hydrogen was the more popular end product over methane.
Combining biogas plant with a PEM to increase the biomethane production needs to be studied.
References

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