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SUMMARY

ENERGINET WORKSHOP ON HYDROGEN QUALITY AND GRID CONNECTION – KEY NOTES AND TOPICS

Date:
January 26, 2024

Author:
CWB/JTD

Time:

January 18, 2024, from 10:00 to 14:45

Place:

Pederstrupvej 76, Ballerup (Energinet offices)

The hydrogen quality and grid connection workshop on January 18, 2024, hosted presentations from Energinet's perspective on following matters:

- Subject 1: Grid connection
  - Rules and Regulations
  - System development
  - Grid connection terms and conditions
  - Group Session
- Subject 2: Hydrogen quality and specifications
  - Hydrogen quality
  - Measurement
  - Energy determination/billing

1. Subject 1: Grid connection

1.1 Rules and Regulations

- Energinet gave a brief introduction to the expected underlying legislation framework.

1.2 System development

- Energinet presented the current approach and assumptions for the Danish high pressure hydrogen grid.
  - Expected capacity, linepack flexibility, pressure fluctuation, possible system connection and possible pressure increase over time.

- **Energinet comment:** The initial system – the lower "T" towards Germany would consist of re-purposed pipelines and would be operating at 50-90 bar. Energinet also comments that there will be no benefit or opportunity to deliver pressures outside of the given pressure range although, the range is not set in stone yet. There are still a lot of uncertainties like who will operate the low-pressure grid and who handles the pressure difference. Analysis will continue and knowledge will be shared with stakeholders in the future.

1.3 Grid Connections and Conditions

- The rules and regulations for system users to be connected to the hydrogen grid are currently being developed by the Danish Energy Agency in dialogue with Energinet and Evida.
- The rules and regulations are the legal framework for the terms and conditions.
- Purpose of the workshop in that matter was to get feed-back on those thoughts from the market.
  - **Energinet comment:** Energinet mentions that everyone will have access to the same level of data exchange and that pre-defined terms and conditions will be developed. The system will have pre-defined connections points, these will be decided based on information gained through the commitment process. Based on the commitment process the connection points will be placed where actors are most likely to be present. A commercial balancing model is being developed, it may include a way for consumers/producers to provide system assistance if needed, e.g. through pressure and flow. Energinet also remarks that definitions for large and small consumers/producers are still under works. However, large consumers/producers will need to establish their own compression or pressure reduction facilities. Whereas smaller consumers/producers will most likely be connected to a cluster or a low-pressure grid. This is related to who should bear the cost of compression.

Discussion points on that topic: Connection point (property limit); Construction, Operation and Ownership; Cost allocation

2. Subject 2: Hydrogen Quality

2.1 Hydrogen Quality

- Energinet introduced hydrogen quality, how hydrogen is currently used, purity from electrolysis, the preliminary specification CEN/TS 17977 and possible future corrections to this specification. Following the specifications, a water content "deep dive" was done discussing possible water contents in future specifications.
  - **Energinet comment:** Energinet acknowledges that other hydrogen standards have been developed. However, most national standards in Europe will most likely follow this standard and Energinet wants to aid in the homogenization of standards across European borders. CEN has also started work to increase the hydrogen purity in the standard. Energinet also emphasizes that the transmission system is not expected to be able to deliver fuel cell grade hydrogen over long distances.

2.2 Measurement

- A short presentation of why measuring is important, also mentioning that it is unknown how and what will be measured as it will depend on risk assessments, but it is essential for running the system.

2.3 Energy determination/Billing

- A short presentation on how natural gas quality differs from hydrogen quality. Furthermore, a short discussion on how hydrogen should be billed, i.e. for the full energy content of the gas or only the energy content of the hydrogen.

Key notes from group work sessions

GROUP SESSION 1: GRID CONNECTION

ASSUMPTIONS FOR DISCUSSION

Assumption 1: Energinet should construct, operate and own the part of the connection facility that could be develop into a collective hydrogen system with 3rd party access

Assumption 2: The location of hydrogen system connection points should be decided from the collective hydrogen perspective and not the specific System User

Assumption 3: The connection point for a System User should be decided by a common agreement between the Network Owners

Assumption 4: All costs related to specific connection should be paid by the System User (including cost share of possible expansion of the collective system for future development)

Assumption 5: Operational coordination between electrolysis and connection/feed-in compressor unit are more sensitive than system balancing due to low local storage

Assumption 6: Long-term cost-efficient analysis of the system development could result in parts of the connection facility being developed into the collective system

Assumption 7: Large pressure range in the system with high linepack flexibility is more essential for a business case than cost saving for a compressor unit with less pressure range

Online group

- Assumption 1:
  - A private owner does not have rights to expropriate and can therefore have difficulties with building pipelines.

Group 1

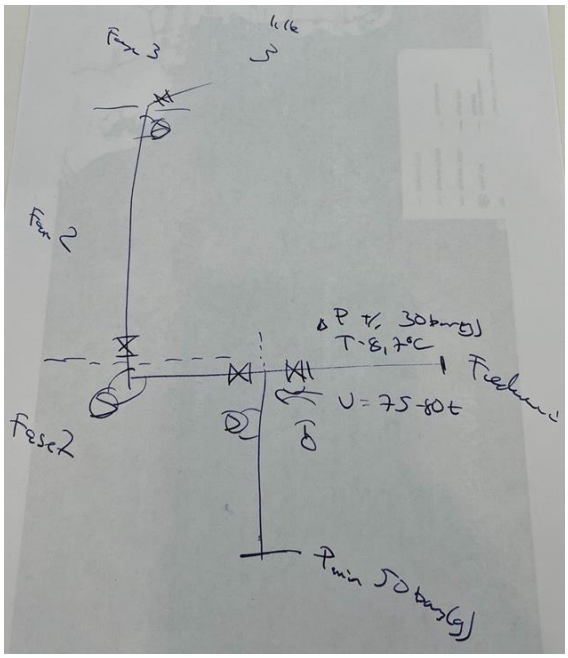
- Assumption 1:
  - The group expressed uncertainty regarding development perspective in clusters. The questions concerned what if multiple companies show interest in the same area? When does it become a cluster?

- Q: How is the development of clusters facilitated?
- A: In blocks of capacity. No clarification regarding how the costs would be shared between actors in the clusters.
- A process following user-commitments is needed to establish a proper solution for the clusters.
- What if there are multiple large actors in the same spot?
  - Energinet states that no process regarding multiple big actors has been established.
  - One actor may want something shared while another actor may want to build on their own.
- The group expressed concerns relating to the difficulty when building pipelines using 90 bars across open fields in Denmark.
- Commercial actors do not have the right to expropriate.
- The process regarding establishment of clusters following user-commitment needs to be clearer.
- A cluster solution would most likely be ideal.

- Assumption 2:
  - Since the pre-defined connection points are defined by the user commitments it cannot be different.
- Assumption 3:
  - The process is easy to understand.

Group 2

- Made a very detailed proposal regarding use of pressure in the system.



    - Comments to the drawing - General idea: Section of the gas grid with control valves effectively using part of the system as storage and let other parts run at a higher pressure. This way a producer could deliver high pressure and "rent" a part of the upper pressure area.
    - A suggestion also shown on the drawing was to run Egtved-Fredericia connection at high pressure, Esbjerg-Border low pressure when only the lower backbone is established. This way a low-pressure system is possible without storage as the high-pressure Egtved-Fredericia would be used to balance the system.
- Proposal from group: operate the system at varying pressures.
- Pressure agreement: different actors will pay based on what pressure they deliver up to 90 bar.

Group 3

- Assumption 2:
    - The group expressed concerns about high CAPEX for building pipelines for long distances to connections points.
    - Pre-defined connection points may limit development of the Hydrogen industry in Denmark.
- Assumption 4:
    - in favor of a DSO solution for connection to backbone and paying the investment through tariffs.
- Assumption 5:
    - This solution is technically complicated.
    - A producer should have no obligation to deliver a minimum feed-in compressor.
- Assumption 7:
    - A large pressure range for the linepack takes priority over cost saving regarding compressor units.

Group 4

- Assumption 1:
    - Yes, Energinet should build simple connections directly connected to producers/users.
- Assumption 2:
    - Yes, it seems that Energinet has already found the right connection points based on user commitments.

- Assumption 4:
    - Difficult assumption. In both gas and electricity systems some of these costs are socialized.
- Assumption 5:
    - Agree with group 3.

Group 5

- Assumption 1:
    - The group agrees with the assumption.
- Assumption 2:
    - How fixed would the pre-defined connection points be after user-commitment? Can you move the production of consumption afterwards?
    -

GROUP SESSION 2: HYDROGEN QUALITY

Water content

WHAT SHOULD THE WATER CONTENT LIMIT BE IN THE HYDROGEN SYSTEM?

Discuss the pros and cons of different water content limits

Water content	Compliant with	Pros	Cons
≤ 20 ppm	ASME B31.12		
≤ 60 ppm	CEN TS 17977		

Reflections from participants

- Generally, the lower water content was preferred.
- Lacking SOEC.
- One group commented that some compressors have no problem handling 60 ppm so it may not make a difference.
- Producers will need to dry the gas for local storage no matter the water content.

- Some groups expressed that drying the gas to 20 ppm is not difficult. However, others mentioned that may lead to higher costs due to purification.
- Methanol processes are not sensitive to the water content.
- General expectation from the groups that the lower water content will be the final water content.
- A question came up wrt. how will the TSO ensure dryness of the gas?

Hydrogen purity

WHAT SHOULD BE THE MINIMUM HYDROGEN PURITY IN THE HYDROGEN SYSTEM?

Discuss the pros and cons of different minimum hydrogen purity requirements

Hydrogen purity	Pros	Cons
≥ 98 mol%		
≥ 99.5 mol%		

Reflections from participants

- Traditionally the hydrogen purity would be agreed upon bilaterally.
- 98%: Easier for producers and storage facilities. Fewer consumers would be able to use it. May not be good enough for export to Germany.
- 99,5%: Possible with electrolysis. Storage facilities will need to purify the gas before export.
- Most participants were in favor of the higher purity, 99,5%.
- It does not make sense to have a higher purity than Germany.
- It is expensive to be first movers.
- 99,5% would be the best purity to have in Denmark.
- Producers using ammonia cracking may have a difficult time producing purity at 99,5%
- Look at what they do in Germany. Quality needs should be balanced with socioeconomic value.

Questions

QUESTIONS

Were you surprised by the presence/lack of any impurities in the presented specifications? Which components in the H_2 quality is most important to you and why?

Answer:

Hydrogen gas can be billed, either in the form of the energy content from hydrogen or the overall energy content of the gas. Which type of billing do you prefer? Would the final purity affect your preference?

Answer:

Repurposing previous natural gas systems will likely lead to more impurities in the hydrogen gas. What is your opinion on the possibility of different exit and entry specifications?

Answer:

Online group

- Prefer the payment for the energy content of hydrogen. It is fairer for the consumer using the hydrogen.
- Support for re-purposing the pipelines. They also mention a study showing only very few contaminants were found in re-purposed pipelines. They do not specify which study.

Group 3

- Most important contaminants are oxygen (O2), water, nitrogen (N2), carbon monoxide (CO), carbon dioxide (CO2), Sulphur and ammonia (NH3).
- Billing by mass of hydrogen is preferred.
- Cleaning due to impurities can be expensive.
- Plants may be told to shut down if they do not meet the quality specifications. Who could be responsible for this?

Group 4

- Group suggests to look toward Germany.
- Ask what large German consumers need.
- Expressed curiosity regarding how long contaminants will be a problem.
- Prefer hydrogen billing in tons.

Additional reflections from participants

- Oxygen content is limited.
- Solid oxide fuel cells (SOFC) do not produce oxygen.
- Billing; Consensus on the energy content of hydrogen and not the energy content of all components in the gas. Most important is to have Germany billing in the same way.

- Billing should be for hydrogen volume not energy.
- How big is the billing problem?
- Producers would like the exit and entry specifications to be the same.
- Impurities from hydrogen storage?
- Loss of hydrogen in the transport system?
- Re-purposing existing pipelines can accelerate the establishment of hydrogen infrastructure.
- To what extent will compressor stations add impurities to the hydrogen?
- Pressure swing adsorption would lead to 10% hydrogen loss.