Gasgrid Finland and Fingrid joint hydrogen economy project's draft scenarios

Q&A

FINGRID

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Kysymykset ja vastaukset

1. Q: When will the hydrogen pipeline (depicted in the scenarios) be built?
   A: The scenarios assume that extensive hydrogen infrastructure is formed in Finland by year 2030.

2. Q: Is clean hydrogen for power generation considered in domestic and export hydrogen demand? In other words, hydrogen could be used as a fuel during windless periods.
   A: The scenarios assume that most of the produced hydrogen would be consumed as an industrial power source, raw material, or export. Only a small portion would be used for power in Finland. This share is estimated to be higher in Central Europe due to the larger role of fossil fuels in the power system.

3. Q: Is the goal to utilize also the heat produced in electrolysis, in district heat or otherwise (yearly in the order of hundreds terawatt-hours)? District heat companies would certainly be interested in emission-free waste heat.
   A: Waste heat utilization is considered in the scenario calculations mainly in Southern Finland. Utilization of the waste heat requires "priming" with a heat pump to increase the temperature level, but this has not been considered in the calculations. Selling waste heat to f.ex. district heat companies will improve the competitiveness of especially the first projects, but the market could eventually be saturated. Income from waste heat may also lead to electrolysers being located near cities, which would increase the power transmission requirements of the area.

4. Q: For Central European end users appliances, such as stoves and boilers, are fueled by natural gas. How have you researched this, i.e., how far/close to the end user could hydrogen be produced and how would it impact the end user on the technical side?
   A: This was not yet considered in the joint project. In the scenarios, the market potential in the Baltic Sea region is based on external analyses and reviews.

5. Q: Northern Sweden is likely to have very similar plans to be hydrogen producers or consumers?
   A: In the scenarios, we assume hydrogen production and consumption to increase significantly also in Northern Sweden, nearly the same as in Finland, and this has been considered in the modelling. If Nordic Hydrogen Route is built, Finland can export hydrogen also towards Swedish demand.

6. Q: Is there a threat that hydrogen production is more competitive in Sweden?
   A: This has not been discussed as a threat in the scenarios. With Nordic Hydrogen Route, hydrogen can be bidirectionally transferred between Finland and Sweden according to the situation. Thus, both sides benefit from a regionally developing hydrogen economy.

7. Q: Tallinn and Gdynia have recently initiated collaboration regarding hydrogen economy. Has hydrogen export outside Europe via ship been considered?
   A: The scenarios consider hydrogen export only through pipelines in Finland and in the Baltic Sea region. However, in a study to be started in the autumn, costs and value chain impacts of alternative hydrogen transport methods will be analyzed.

8. Q: What will be done if significant bottlenecks appear in the networks?
   A: The starting point of the scenarios is an energy transmission system that is cost-optimal for the Finnish society. The goal is to avoid the formation of structural bottlenecks through network investments. In the case

of the power transmission system, Fingrid analyses in its power system vision not only the investment needs, but also ways to avoid bottlenecks and to control them in case network investments can not be realized as quickly and as many as needed. Accordingly, Gasgrid supports the formation of a Finnish hydrogen economy through developing the Finnish hydrogen transmission network and the infrastructure needed to create a regional hydrogen market.

9. Q: How large is the storage potential of rock lined caverns? Does it for example offer flexibility for a period when wind and solar power produces low or no energy, or also longer-term seasonal storage?
   A: In the scenarios, rock lined caverns are estimated to offer flexibility for some days, but not for seasonal storage. In this sense, these caverns differ from salt caverns in Central Europe, which also offer seasonal storage.

10. Q: Utilization of hydrogen, for example in fuel cells, is not currently seen as efficient enough. What use/uses is hydrogen in your view the most energy efficient to consume in?
    A: The scenarios assume that hydrogen is being consumed in settings where the electrification of all energy use is difficult or unviable, such as in steel industry or heavy transportation. Additionally, replacing hydrogen currently produced from natural gas requires clean hydrogen in for example the fertilizer industry..

11. Q: Have you made available your assumptions on investment costs?
    A: For example for wind power, the scenario assumptions are based on the cost estimates used by the ENTSO-e in the TYNDP-process. In the scenario report, sources for investment costs are marked in the footer (mainly in Section 2.2). We are working with LUT university to study more thoroughly the expected cost developments during this and the next decade, according to different sources. Additionally, we will publish the investment costs used in the scenarios within the final report of the joint project.

12. Q: It would be interesting to see the estimates of the distribution of consumption and production if Finland would be divided into two price areas. In addition to the price ranges for electricity, then two price ranges would probably be needed for hydrogen as well. Or is it necessary?
    A: In this scenario report, questions related to the market model have not yet been deeply considered.

13. Q: It will be interesting to see how the market develops. The scenarios lack an assessment of the situation where the hydrogen does not even take off. This is an important benchmark for evaluating the reasonableness of infrastructure costs.
    A: In the later stages of the joint project, different situations will be compared in terms of value chains, energy transmission networks and market formation, based on different scenarios. In this comparison, a position will also be taken on the situation where an extensive hydrogen network is not built.

14. Q: How do you see the system level balance? The renewable hydrogen producer must currently consume and produce renewable electricity per hour in favor of the EU regulation proposed by the resolution, and balancing the process is largely the responsibility of the producer. Which "temporal correlation" do you see as optimal from the point of view of the system and why?
    A: So far, the modeling has not considered the detailed requirements of the regulation published in the spring regarding balancing. The calculation is assuming that hydrogen consumption in Finland is flat, and hydrogen production is optimized based on the price and availability of electricity, available electrolysis capacity and hydrogen storage capacity. We are investigating the effects of the new regulation on modeling and are

prepared to take them into account when preparing updated scenarios. Feedback on the subject, for example how this should be considered in the modeling (whether hydrogen is produced only with renewables, or also when "grid electricity is cheap"), are very welcome.

15. **Q: The market price of electricity and hydrogen should also be extracted from the market models. Is the price at such a level in all scenarios that the investments in electricity production and electrolysis are profitable?**
A: The scenarios have been modeled in such a way that investments in production of electricity and hydrogen and storing of hydrogen would be profitable for the price formation of the wholesale market, when the final demand for hydrogen is at the level that is assumed in the scenarios. The connection between the price of hydrogen and the final demand has not been examined separately at the European level, but it has been assumed that the final demand will be realized, for example by means of emission pricing, various subsidies or quotas/obligations, if competitiveness against fossil fuels is otherwise not sufficient.

16. **Q: The electricity market and electricity price trends in the coming years will affect the competitiveness of green hydrogen. Has this been evaluated in the scenarios?**
A: The rapid growth in Finnish hydrogen production, outlined in the scenarios, is based on the excellent availability of clean and affordable electricity in Finland. Especially, when compared to Central Europe, Finnish power generation projects are competitive and there are an exceptionally large number of them compared to the current demand for electricity in European comparison. The competitiveness of green hydrogen against fossil hydrogen has not been specifically evaluated in the scenarios, but it has been assumed that the hydrogen demand level modeled in the scenarios will be realized. However, green hydrogen can be not only cleaner than fossil hydrogen, but also more competitive.

17. **Q: Is there any use for the oxygen produced in the electrolysis process?**
A: There may be potential uses for oxygen in industry. In the joint project's preliminary scenario modeling, the value/market effect of by-product oxygen has not been considered. The value chain effects will be assessed in more detail in the survey to be carried out with LUT University in the coming autumn.

18. **Q: If hydrogen is more expensive in Central Europe than in Finland, doesn't hydrogen flow at full capacity to the more expensive price range?**
A: Yes, in the model hydrogen export/import behaves exactly as described in the question.

19. **Q: Has there been considered any other transmission forms than Hydrogen pipeline? For example, methanation could make use of current transmission infrastructure (LNG, natural gas network) and related solutions.**
A: In these preliminary scenario models, we have considered only the pipeline transfer of hydrogen. In the joint project, we will carry out a survey of hydrogen value chains during the fall of 2022. The study will select the most relevant hydrogen further processing routes in Finland and evaluate their impact on the formation of energy transmission networks.

20. **Q: What obstacles do you see for the development of wind power? Can NIMBY issues matter? Either for the turbines or for the power grid itself.**
A: The acceptability of renewable electricity production projects and the expansion of the electricity grid is a key condition for Finland's huge clean electricity potential to be utilized. Finland is the least populated country in Europe, the fifth largest country in Europe in terms of surface area, and competitive in terms of wind conditions, so the starting points for implementing acceptable projects are excellent in a European

comparison. Feedback also related to the pace of wind power development seen in the scenarios is very welcome.

21. Q: What kind of tariff structures have you thought about within Finland versus an export pipeline to Germany?
    A: In the scenarios, the price of hydrogen does not consider transfer fees. A certain investment cost has been assumed for pipeline investments, which must be covered to build a pipeline between, for example, hydrogen consumption and production areas.

22. Q: The price of hydrogen in Finland will increase if the transmission connection to a more expensive area has significant pipeline size. In that case, can't it happen that, at least from time to time, the demand for hydrogen in Finland decreases?
    A: The demand for hydrogen is assumed to be stable/even in the modelling. If the hydrogen transmission connection is built, it will encourage the construction of more electrolyser capacity and renewable electricity production, which can be used to produce the hydrogen that is exported through the pipeline.