HyNet North West

VERTEXHYDROGEN

HyNet Hydrogen Production Plant 1 – Technical Note

EPR Response 9h – BAT for energy efficiency CHP

Summary

Q9h i - Provide further explanation of the potential engineering systems complexities referred to in table 3-41 of the Application Supporting Document in support of your justification for not including a Combined Heat and Power (CHP) scheme as part of your proposal.

Q9h ii - Explain whether there are any opportunities for efficient energy integration of the hydrogen production plant with the overall power generation system and steam supply of the Stanlow manufacturing complex. This should cover, if applicable, any future plans for the development of CHP schemes, such as the plan described in section 7.3.17 of the Permit Application Supporting Document.

Q9h iii - Discuss the benefits, technical and operational limitations and constraints and proposals for the implementation of the opportunities identified in response to item ii. above.

Notes: *We note reference to a future hydrogen-fired CHP plant in section 7.3.17 of the Permit Application Supporting Document, being developed as part of a separate project, not in the scope of this variation application. In responding to this request for additional information you should assess whether there are opportunities for supplying steam to the HPP from the new CHP plant in a more efficient energy configuration, or whether such option would result in other inefficiencies such as an excess of PSA tail gas to be flared; or whether, for example, the excess PSA tail gas may be supplied to the new CHP plant as opposed to being fed to the auxiliary boiler in the scope of the current proposal.*

Details

9h i:

Notes: *Table 3-41: Energy Efficiency – Guidance and Status states: "The HPP represents of a first-of-a-kind plant in terms of its overall processing objectives and combination of systems. For this reason the design focus has, from the outset, been on the avoidance, wherever possible, of engineering system complexity and ensuring the reliability of the HPP. The adoption of CHP has not therefore been considered at this stage of the plant's development."*

To support the UK's ambition to decarbonise industry at pace, HPP is designed to be deployable as soon as government support frameworks are agreed. Therefore, it is a critical design constraint that any technologies selected to become a constituent part of the overall project design are technically ready and commercially demonstrated at an appropriate scale.

The adoption of a CHP was considered and excluded from HPP1 design in early development. The JM **LCH** heat and material balance is optimised in such a way that zero fuel or heat import is required for either process heating or steam generation; the PSA tail gas, produced during the purification of product hydrogen, contains precisely the fuel required by the Steam Boiler and Feed Fired Heater.

An onsite CHP (to produce the required power, as well as heat) would require more duty than is available in the PSA tail gas. This would, therefore, either need to be a hydrogen fired gas-turbine or a gas turbine with carbon capture. Currently gas turbines able to fire 100% H_2 whilst reliably meeting NO_x limits are not commercially proven and a post-combustion carbon capture plant on a ~20MW_e gas-fired power plant (with varying power demand as HPP throughput changes) would be cost prohibitive.

In addition, DCO permitting for development of the CHP was flagged up as a significant project risk, due to the impact on electrical infrastructure both on and off site. This led to a potential 2-3 year delay. Therefore, it was decided to proceed with HPP1 on a standalone basis whilst progressing CHP in parallel.

Once 100% hydrogen fuelled gas engines and gas turbines of a suitable size, with robust emissions controls are commercially available, hydrogen-fired power generation plant is planned to be built to provide power to industrial power consumers in the region including HPP1. This approach will unlock generation efficiencies, by including HPP1's load in a larger base-load generation plant, versus a standalone power generation solely for HPP1. Options which may be considered will be combining this duty with the repowering of the existing Stanlow Refinery fired CHP to hydrogen fuel and/or a standalone hydrogen fuelled power generator in the HyNet region.

9h ii:

Notes: Table 3-41: "As noted in the comments above, the HPP does not have a significant source of low grade heat because of the extent of heat integration incorporated within its design (noting this is key requirement of the BAT Guidance for Hydrogen Production)."

Stanlow Refinery's heat and power plant is currently sized and operated to meet the demands of Stanlow Refinery operations. Therefore, as no spare capacity is available (indeed the existing asset is unable to provide all the required power, and is periodically short of steam), the sharing of this asset for HPP was not considered.

However, Stanlow Refinery's balance of steam and power requirements is evolving, as more projects are considered, such as the post-combustion carbon capture plant on the Fluidised Catalyst Cracker Unit.

Essar Oil (UK) Limited are exploring options for the repowering of the existing refinery CHP to hydrogen fuelled, as studied under the BEIS Industrial Fuel Switching programme. Those plans have not yet been finalised. HPP will be considered, alongside other potential projects on Stanlow Manufacturing Complex, when sizing the new hydrogen fired CHP plant. This will allow the opportunity to consider HPP's heat and power demands, alongside the moving requirements of Stanlow Manufacturing Complex as a whole, to find the most energy efficient holistic solution.

As the JM LCH package is fully reliant for process heat and steam generation, HPP1 design currently imports power only. The design, currently taking power from the grid, does not block the option to provide this power from the Stanlow Manufacturing Complex CHP (or, in fact, any other local low-carbon power generator in the area) in the future.

Furthermore, once high-hydrogen fired gas turbines are technically ready, the option to send HPP PSA tail gas to the new Stanlow Manufacturing Complex CHP for combined steam and power generation is currently being investigated, as follows:

1. HPP1 Steam pressure is higher than the Essar Refinery site distribution system. However, options to add a new high pressure steam main are being considered as this would allow some fired heat to be decarbonised using high efficiency H_2 fired CHP steam
2. Exchange of HPP1 PSA tailgas to the new CHP (either gas turbine or HRSG) and steam to HPP1 would potentially provide a small improvement in overall efficiency, and support the CHP with a larger steam sink. This opportunity can be implemented readily in a retrofit situation by installing flange connections for steam and fuel, which could be provided from a new CHP later.

HPP1 is a technically ready, deployable plant; optimisation of heat and power generation with Stanlow Refinery is feasible, but not on a timeline which facilitates the delivery of the plant (and associated decarbonisation for the UK). However, HPP is designed so that any optimisations and integrations are retrofittable in the future, at a time when hydrogen fired gas turbines are commercially available and Essar is preparing to upgrade its site CHP.

9h iii:

Benefits – potential to maximise holistic efficiency of heat and power generation within the Stanlow Manufacturing Complex, minimising the hydrogen (or natural gas) consumption by the combined site. This will reduce operating costs of the site and maximise the volume of HPP hydrogen that can be sent to "external" customers to decarbonise the region.

Technical Limitations – Essar is not able to invest in the proposed hydrogen fired CHP at Stanlow Manufacturing Complex until OEMs are able to demonstrate and guarantee the performance of hydrogen-fired gas turbines, particularly with regards to NOx emissions.

Operational Limitations – There would be additional complexities related to heat and power availability. For example, if HPP is required to shut down due to steam or power generation shortage and conflicting priorities on Stanlow Refinery.

Commercial Limitations – Linked to Operational Limitations, there may be some complex arrangements related to liquidated damages to consider, if lack of hydrogen has caused Stanlow Refinery to revert to natural gas fired power generation, or a CHP issue has caused HPP to lose steam and power for operations.

Consenting for large scale power generation is potentially a significant risk, should HPP steam supply be tied to a new CHP.

Constraints – Given the above operational and commercial limitations, HPP would as a minimum look to retain the option to self-generate or import from the grid both steam and power, respectively. This would be regardless of any optimisation with Stanlow Manufacturing Complex, to ensure robust operations of the site, even if Stanlow CHP has reliability issues etc.

In conclusion, there is likely a reasonably attractive option to integrate HPP and the refinery, but the need to ensure timely and reliable independent operation means the plant will start-up with its own dedicated boiler. Only minor modifications are required to switch to CHP firing of PSA tailgas and generation of steam, which are being actively pursued, but will rely on surety of emissions performance from any Gas Turbine power generation which is installed.