Techno-economic assessment of offshore PtX

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Motivation

- Possible improved domestic energy production for higher independence at locations far offshore
- PtX as possible solution has to be assessed comparably
- TEA should assess best processes and find optimization potentials

Funded by the German research ministry (BMFTR) with 105 M€, the flag ship project H_2Mare analyzes the large-scale offshore production of hydrogen and its derivatives. PtX-Wind has been funded with 38 M€ to analyze possible solutions, technical feasibilities, costs and environmental impacts of methanol, ammonia, Fischer-Tropsch-product and synthetic LNG.

Within the project the TEA-group of the DLR does stringent stationary process simulation, adaption of the methodology to offshore environment and techno-economic analysis for methanol, ammonia, Fischer-Tropsch-product.

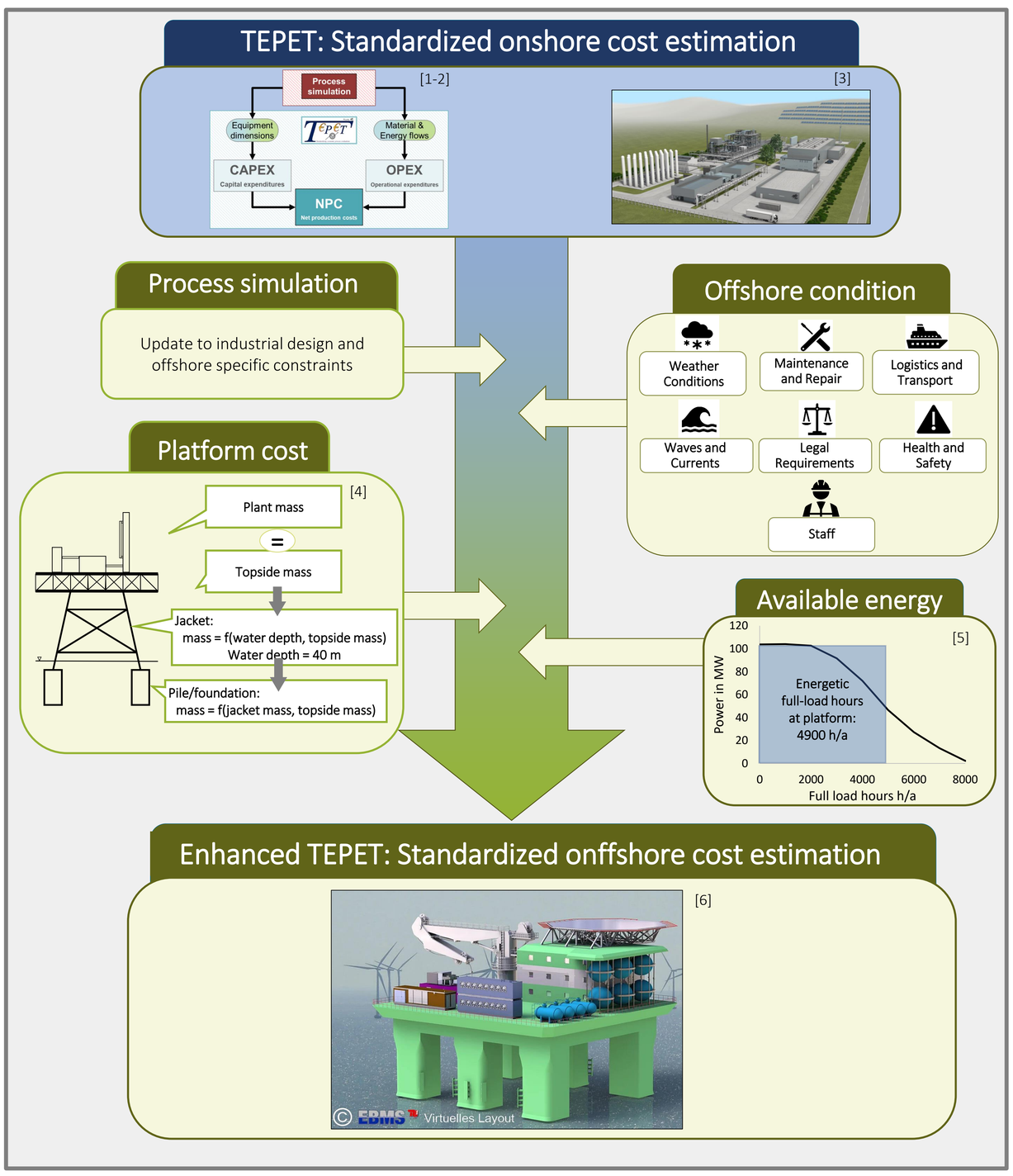

Figure 1. Adaption of PtX from onshore to offshore.

For offshore cost assessment, the methodology was adapted. This included costs for water desalination and waste-water treatment, platform cost calculations, definition of storage sizes depending on transport options and cost of workforce.

Thanks to the cooperation with Thyssenkrupp Uhde, methanol and ammonia could be simulated close to industrial production processes. The one-stage Fischer-Tropsch production[7], is adapted for production of pumpable hydrocarbon-mixture, which are easier to handle offshore and could be further upgraded onshore.

With adaption to the process and cost calculation as depicted in Figure 1, the techno-economic assessment (TEA) is carried out using DLR in-house tool TEPET[1,2] (Techno-Economic Process Evaluation Tool), where capital (CAPEX) and operational expenditures (OPEX) can be calculated based on the process simulation results. In the end, net production costs (NPC) of the synthetic fuels can be derived. Additionally, the weight of the production plant has to be estimated. With a semi-automated extension to TEPET this can be done easily. Based on the weight, the platform cost has been estimated comparably for all processes[4].

References

[1] Maier et al. (2021): https://doi.org/10.1016/j.enconman.2021.114651
[2] Albrecht et al. (2016): https://doi.org/10.1016/j.fuel.2016.12.003
[3] DLR e.V. DLR (CC BY-NC-ND 3.0)
[4] DNV-Report: COST AND PERFORMANCE DATA FOR OFFSHORE HYDROGEN PRODUCTION; 2023
[5] Based on calculation for SEN I
[6] EBMS TU Berlin
[7] Adelung, Dietrich 2022, https://doi.org/10.1016/j.fuel.2022.123440

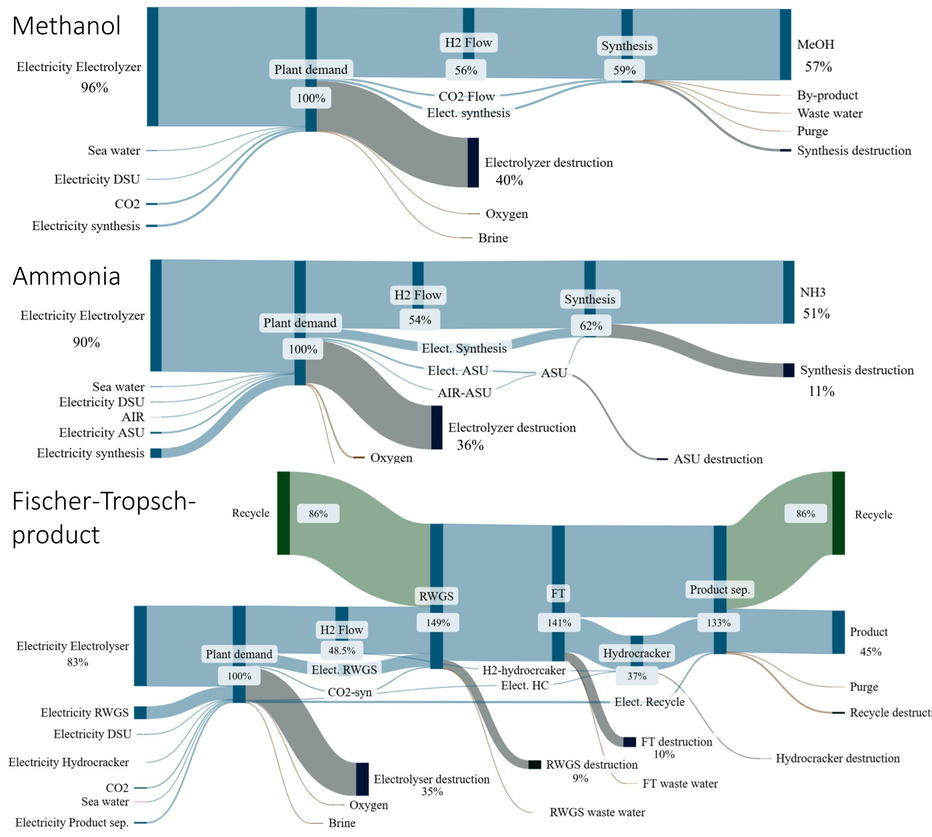

Figure 2. Exergy flows of syn-fuel productions for evaluated processes.

Methanol and ammonia production have a comparably high exergetic efficiency followed by Fischer-Tropsch. The large recycle in the Fischer-Tropsch process is necessary to maximize pumpable hydrocarbon product yield. The hydrocracker is included to cut the non-pumpable waxes into smaller chain length molecules.

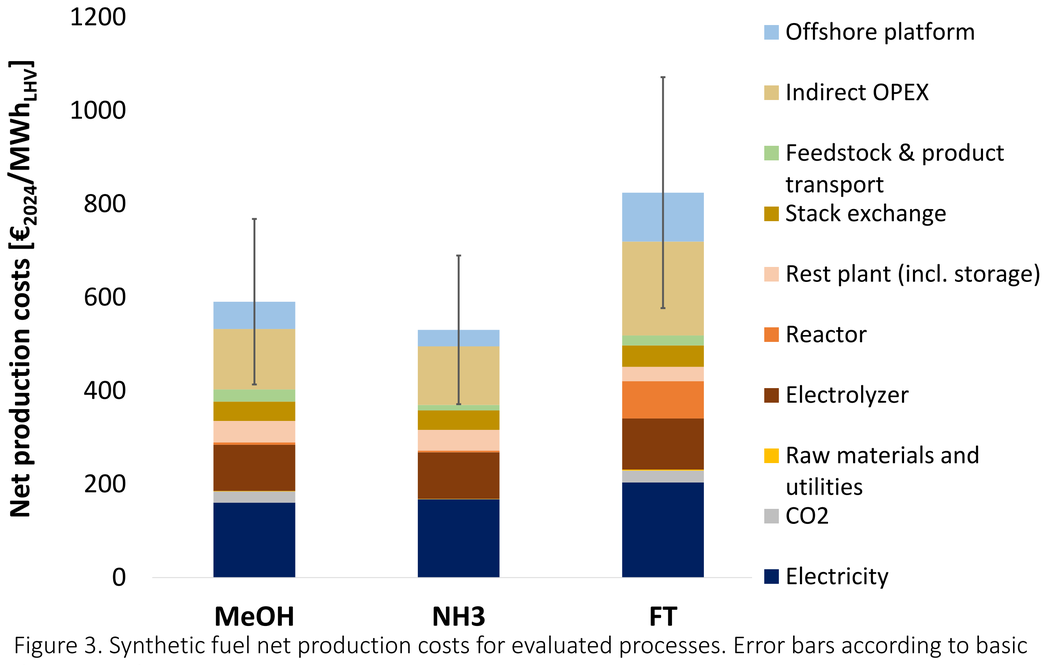

Figure 3. Synthetic fuel net production costs for evaluated processes. Error bars according to basic design simulation

NPC suggest, that ammonia is the most competitive for its high efficiency with no need for CO_2. Methanol is comparable with moderate CO_2-costs, which has to be confirmed in future. Fischer-Tropsch product shows the highest NPC for its lower efficiency, large recycle and therefore, large hydrocracker.

Towards standardized offshore PtX production

- Process designs and simulations according to industrial specification
- New TEPET functionality implemented: platform cost (semi-automated weight calculation), water management, storages, transportation
- Ammonia identified as promising PtX offshore product

Outlook

- Proof of fluctuating offshore production (research platform: 5 MW_{el})
- Adaptation of cost calculation according to results of research platform
- Stepwise upscale towards industrialization

Funded by:
Flagship Project H_2Mare
Federal Ministry of Research, Technology and Space
Funded by the European Union NextGenerationEU
DLR
Funding number: 03HY300A-R