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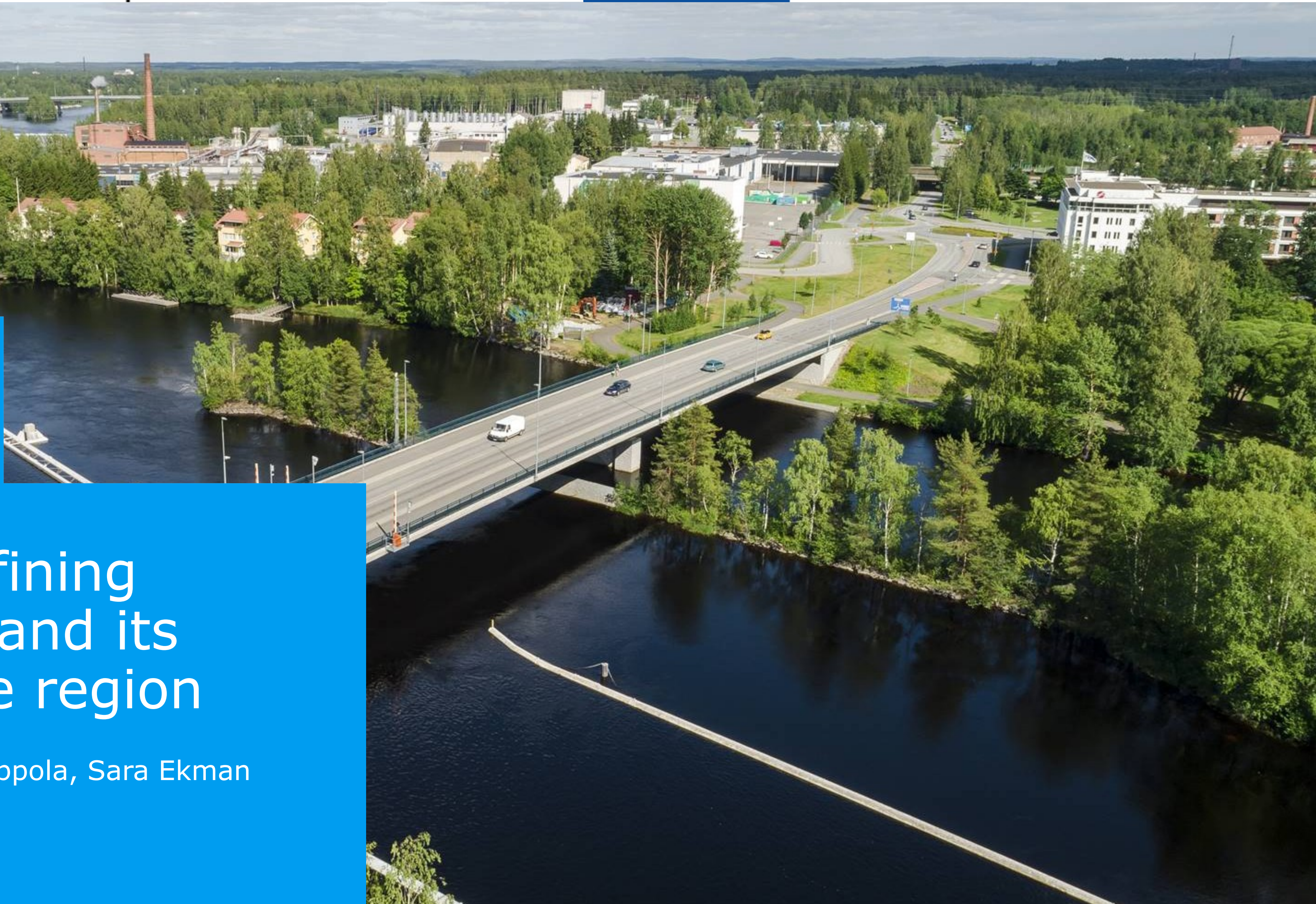

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Executive summary

Increasing the refining rate of hydrogen and its possibilities to the region

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Business Joensuu

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Contents

The goals of the study

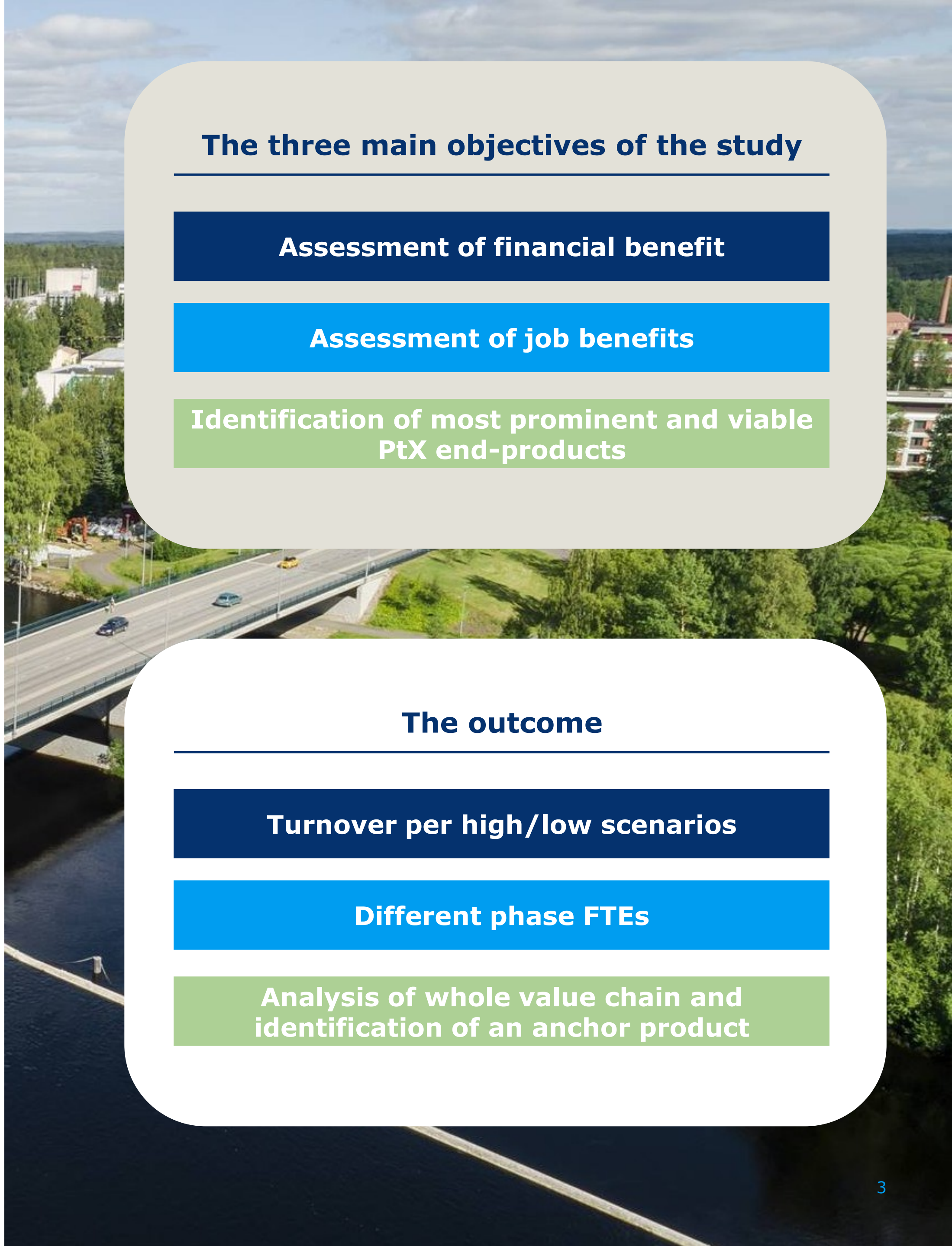
The report examines the development of the hydrogen and Power-to-X (PtX) economy in the Joensuu region as part of the regional transition towards a low-carbon and sustainable energy system.

The purpose of the work is to provide *data-driven information to support the decision-making* of the nine municipalities in the Joensuu region regarding increasing the refinement level of hydrogen and developing the hydrogen economy.

The objectives

- assess the financial benefits for the region from PtX end-product processes
- estimate job benefits for the region from the potential establishment of PtX end-product facilities
- identify the most prominent and viable PtX end-products for the region.

The focus is not only on increasing hydrogen production but also on elevating its refinement level and building sustainable and economically viable PtX value chains across the region.



The three main objectives of the study

Assessment of financial benefit

Assessment of job benefits

Identification of most prominent and viable PtX end-products

The outcome

Turnover per high/low scenarios

Different phase FTEs

Analysis of whole value chain and identification of an anchor product

Methodology used in the study

The methodology is based on scenario analysis and uses local data on renewable electricity and biogenic CO_2 availability.

The study evaluates the technical and economic feasibility of producing **e-methanol**, **e-methane**, **e-ammonia**, and electro-based sustainable aviation fuel (**e-SAF**) in the region. For each product, the analysis considers production volumes, taking into account bottlenecks such as electricity network capacity and biogenic CO_2 availability.

The cost assessment includes capital expenditures and operational expenditures, with assumptions on plant size, electricity price, and other economic factors.

The study also reviews market demand, logistics, and price outlooks for each PtX product using European and Finnish market data.

The economic impact assessment is based on industry benchmarks and previous analyses, estimating direct and indirect employment effects during construction and operation phases.

The methodology provides high-level estimates of the magnitude of potential impacts.

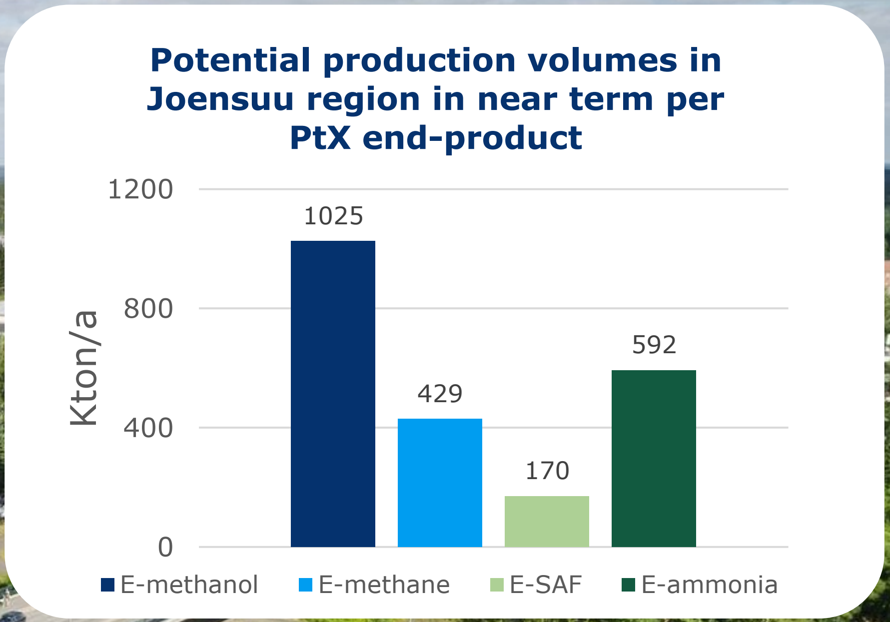
Production volumes and production costs

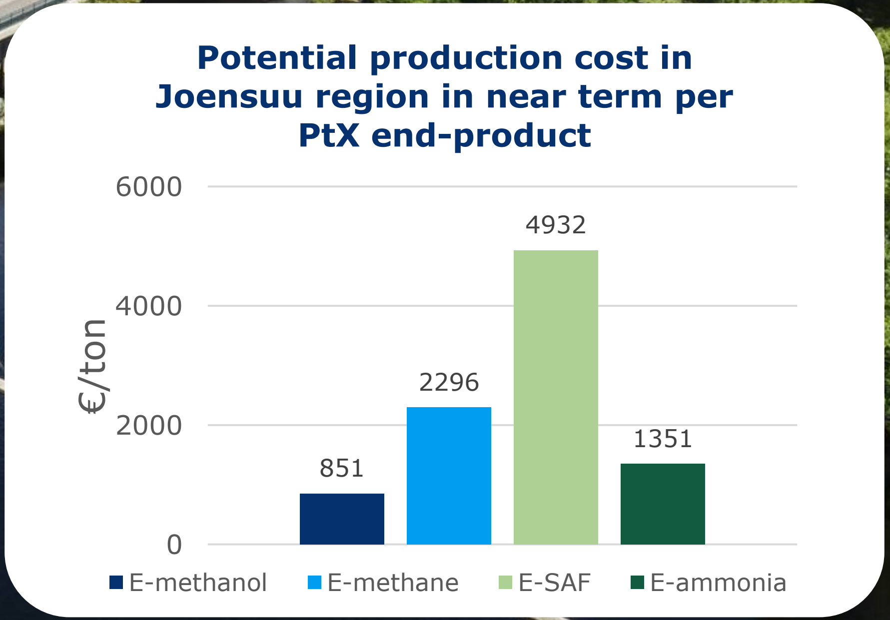
The results show that the Joensuu region has potential for developing a local hydrogen and PtX economy.

E-methanol is identified as the anchor product, with the highest turnover potential and the ability to meet domestic demand. E-methane and e-ammonia are also considered promising, but e-methane would not fulfill all domestic demand, and the economic viability of e-ammonia is sensitive to cost and policy developments. E-SAF is the most expensive to produce and is seen as a future opportunity as costs decrease and policy drivers strengthen.

The main driver of production costs in general are the costs associated with the production of hydrogen and more specifically, the variable operational expenditures.

> Securing long-term PPAs and documenting RFNBO compliance from the start is important. Utilizing biogenic CO_2 (and contractually confirming availability) while de-risking DAC for future is supported. Anchoring off takers with buyers exposed to mandates. Grants/CfDs and other financial support improves potential and project bankability.
>
> Note! It might be beneficial to produce more than one PtX end-product to e.g., de-risk projects, but also to consider other PtX projects planned in the region.





Value chain analysis per PtX end-product

Positive impact
Neutral
Negative impact

Factors	E-methanol	E-methane	E-SAF	E-Ammonia
Indicative cost today	Lowest	Similar to e-methanol	Highest	High
Main cost driver	Hydrogen (~70 %), CO_2 (~17%), Synthesis (~13%)	Hydrogen (~67 %), CO_2 (~12%), Synthesis (~21%)	Hydrogen (~50 %), Synthesis (~40%)	Hydrogen (~84 %)
Production viability in today's costs	High	Moderate	Moderate/low	Low
Domestic demand fit	Good, could fulfill domestic demand	Moderate, cannot fulfill all domestic demand	Moderate, cannot fulfill all domestic demand	Good, could fulfill domestic demand
Export pathway readiness	Good	Good	Good	Good
Turnover potential	Very large as marine fuel	Moderate, could be higher with certain assumptions	Depends on mandates	With current costs and without grants, not positive
Construction-phase FTE impact	Largest	Second largest	Lower near-term	Lower near-term
Operations-phase FTE impact	High	High	Moderate	Moderate
Key enables	Low electricity price, biogenic CO_2, demand signals, policy	Low electricity price, biogenic CO_2, policy, drop-in for LNG	Hard mandates, public money and de-risking	Policy pull in shipping
Key risks	Power & H_2 cost/availability, project bankability	Power & H_2 cost/availability, project bankability, methane slip and leakage	Cost and scale, certification/LCA, project bankability	Cost and scale, safety and emissions, engine maturity, project bankability

Note! This table is a simplification of different factors, which typically are multi-faceted. For more background on certain factors, please refer to the full report. The analysis is based on the assumptions and information available during the research about topics that evolve over time; the results and thus this table may be subject to change.

Main results

Most prominent and viable PtX products for the region

Based on today's evidence, the most credible near-term pathway is to anchor on **e-methanol**, leveraging regional renewables and biogenic CO_2, and using rail-to Port of HaminaKotka for export where needed. This configuration delivers tangible financial benefits through local value-add and accessible markets, while creating significant construction-phase employment and steady operations jobs. E-methane could be a complimentary product for the region. E-SAF and e-ammonia should remain on the roadmap for post-2030 scale-up as costs fall and policy drivers strengthen.

The region's renewable potential and biogenic CO_2 sources provide key inputs for hydrogen refining and PtX value chains.

Financial benefits for the region

Local value creation from on-site conversion: producing PtX locally converts regional resources into higher-value, transportable fuels and chemicals, improving the economics of the green transition in the region.

Every PtX end-product is seen to have demand on the domestic market. Some products can meet the national demand in the future. There is also access to the EU market with a credible logistical railway route to port of HaminaKotka.

E-methanol as the anchor product has the potential to reach 600 – 1 500 M€ turnover in the high scenario, while the low ranges between -40 to -340 M€.

Job benefits for the region

Construction phase: analysis indicates a large national-level impact ranging from roughly 6 500 to 15 000 FTE over the construction phase.

Operation phase: ranging from 20 to 65 direct FTE and from 200 to 400 FTE via multiplier effects during operations.

Construction phase has the largest FTE impact on the region. Further refining hydrogen into PtX end-products increases the FTE impact.

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