BUSINESS JOENSUU

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Executive summary

Business opportunities based on biogenic CO2 sources

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30.9.2025

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The goals of the study

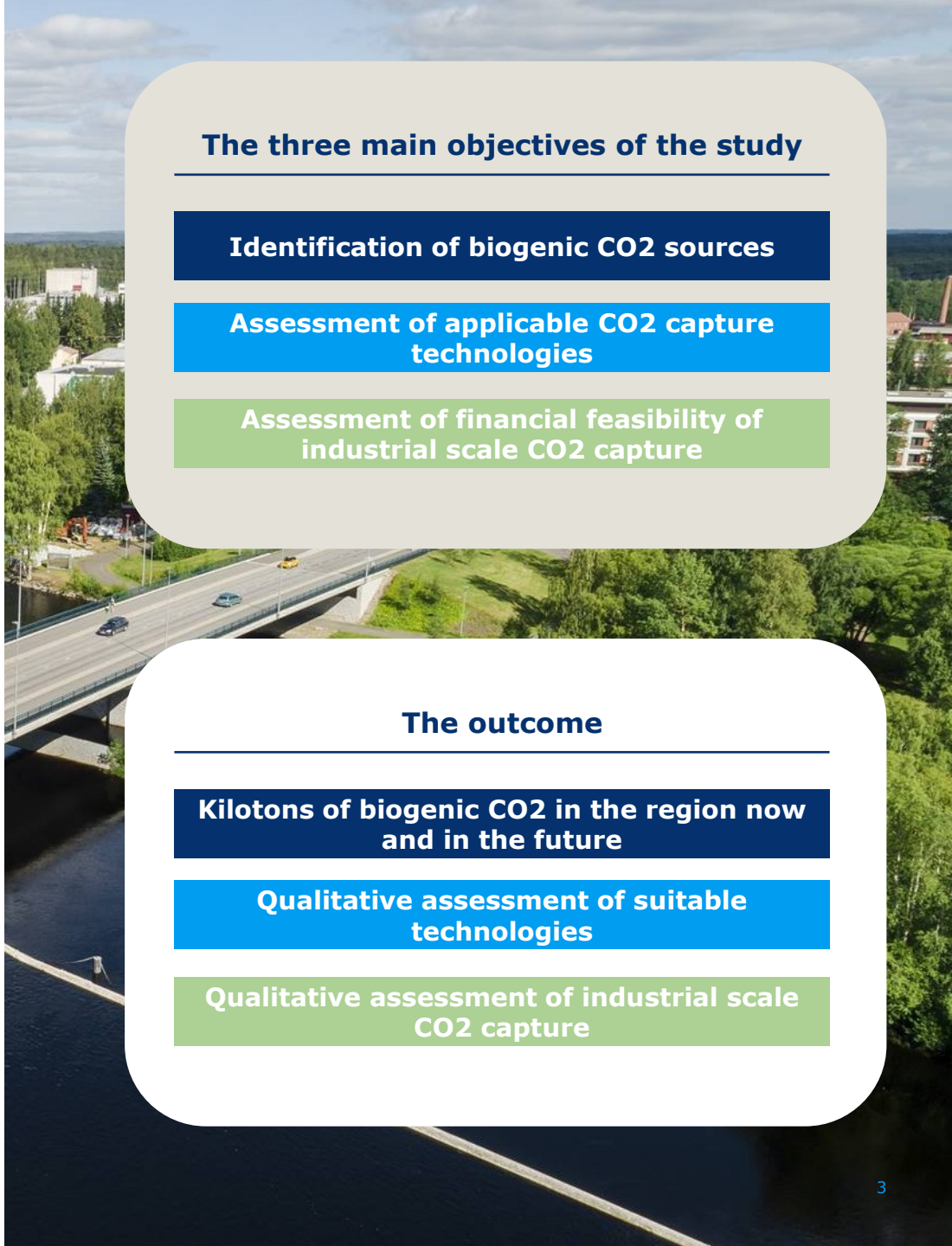
The study investigates business opportunities arising from biogenic CO_2 capture and utilization in the Joensuu and North Karelia region.

The objectives

- Identify and assess feasible sources of biogenic CO_2, including smaller CHP plants and industrial flue gases.
- Evaluate applicable CO_2 capture technologies for regional deployment.
- Analyze the financial feasibility and business potential of establishing industrial-scale CO_2 capture facilities.

The overarching goal is to support the region's transition to a low-carbon economy by leveraging local CO_2 resources for new industrial activities.

This study is part of the broader project titled "Identification of Business Opportunities in the Hydrogen Economy." by Business Joensuu.



The three main objectives of the study

- **Identification of biogenic CO2 sources**
- **Assessment of applicable CO2 capture technologies**
- **Assessment of financial feasibility of industrial scale CO2 capture**

The outcome

- **Kilotons of biogenic CO2 in the region now and in the future**
- **Qualitative assessment of suitable technologies**
- **Qualitative assessment of industrial scale CO2 capture**

Methodology used in the study

The methodology is based on scenario analysis that uses local data on renewable electricity and biogenic CO_2 availability to test the technical and economic feasibility of e-methanol, e-methane, e-ammonia, and electro-based sustainable aviation fuel (e-SAF).

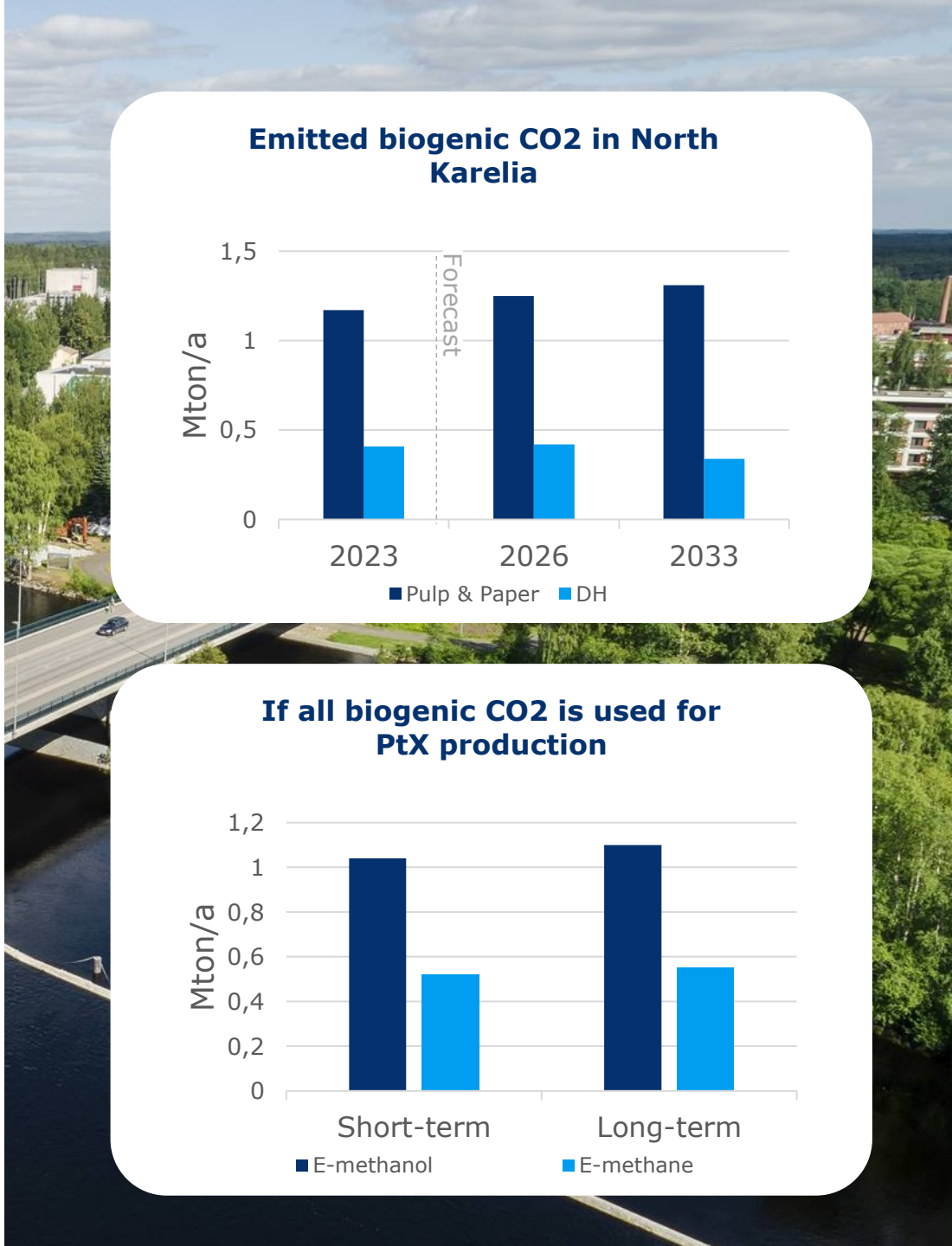
Time horizons are treated consistently across the analysis: short term (~1–5 years), medium term (~5–10 years), and long term (+10 years). For supply accounting, the study distinguishes between emitted, available (assuming a 95% capture rate), reserved (already committed volumes), and accessible CO_2 (available after known reservations).

Biogenic CO2 availability and demand outlook

The baseline indicates approximately **1.4 Mt/a of biogenic CO_2** in North Karelia (E-PRTR), with large pulp and board facilities dominating total volumes; availability increases to **13,2 Mt/a** when adjacent regions are considered.

Source segmentation shows large point sources as the primary near-term opportunity, while some small district-heating sources are not feasible at present. In addition, part of the utility-sector CO_2 is already reserved (e.g., for biocoal), which reduces the accessible volume for PtX. The supply accounting throughout the report applies the 95% capture assumption and deducts reserved volumes to reflect what can credibly be contracted for new investments.

Announced and emerging projects in Joensuu and neighbouring counties indicate a probable CO_2 demand ~100 kt/a by the end of this decade, rising to ~500–1,000 kt/a during the 2030s if projects materialize. When tested against the regional grid assumption, using all biogenic CO_2 for e-methanol enables on the order of ~1.0–1.1 Mt/a of product; in this case, electricity capacity is not the bottleneck and additional ~341–394 kt/a of CO_2 could be imported to fully utilize network capacity. For e-methane, the bottleneck flips: ~0.5 Mt/a is indicated by CO_2 supply, but network capacity becomes limiting, leaving ~110–162 kt/a of CO_2 unused or requiring export absent further upgrades.



Qualitative assessment of suitable capture technologies

The characteristics of the desired CO2 source narrow the available technologies to theoretically applicable ones. However, there are multiple different factors affecting the applicable technology selection, e.g., industrial context and integration options, TRL and performance of the technology, economic factors, regional and infrastructure considerations, environmental and social factors, but also the strategic fit and future flexibility.

Based on the characteristics of the CO2 source some "typically applicable" capture technologies can be short-listed, but the **selection of the capture technology is done case-by-case.**

When the CO2 content in the source is low, most typically amines are selected. However, there are technologies capable of performing in low concentrations. Some of the suitable technologies identified in the study (case dependent if applicable to certain source) are amines, HPC, physical absorption, membranes and PSA.

Transport feasibility insights

Legend

- 105 €/tCO_2 max.
- 150 €/tCO_2 max.
- 184 €/tCO_2 max.

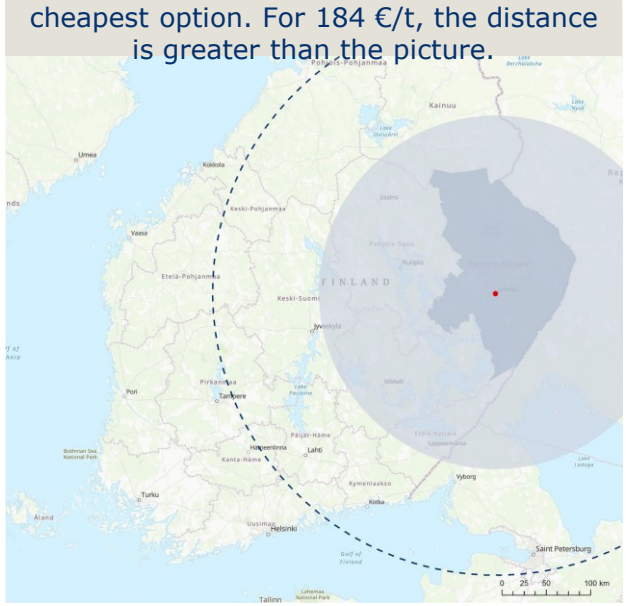
When considering how to transport captured CO_2 for Power-to-X (PtX) projects, the key factor is how much buyers are willing to pay per ton of CO_2. If the price is at the current fossil CO_2 benchmark of 105 €/t, it's generally not economically viable to transport CO_2 from medium-sized or smaller sources—transport costs are simply too high. If the price rises to 150 €/t, then transporting CO_2 via pipeline over short distances becomes possible for medium-sized sources. If the price reaches 184 €/t, it becomes feasible to transport CO_2 over longer distances using road, rail, or pipeline, though rail is typically only practical for distances greater than 200 km.

Road

Transportation not feasible for the 105 €/t price.

Rail

Rail transport not typically done for less than 200 km distances. Not feasible for cheapest option. For 184 €/t, the distance is greater than the picture.



Pipeline

For 184 €/t, the distance is greater than the picture.

Conclusions 1/2

North Karelia and the surrounding region has large quantities of biogenic CO_2 available.	Sources include large-scale units in the pulp and paper industry and biomass-based district heating plants. Pulp and paper represent 83% of biogenic CO_2. Companies have not yet published plans on how they will utilize this resource.
Future availability of biogenic CO_2 is expected to remain stable.	The pulp and paper industry is the largest source for biogenic CO_2 and it is expected to remain stable. The electrification of district heating has small decreasing effect on the amount of available biogenic CO2 in the future. There are also discussions on the utilization of forest-based biomass as forest carbon sink volumes have decreased drastically.
Depending on the P2X product, the bottleneck for production capacity is in either available CO_2 amount or electricity network capacity.	A new 400 kV electricity line opens possibilities for new P2X-production in the region. Available biogenic CO_2, used with hydrogen, opens possibilities to produce for example methanol or methane. Depending on the product, biogenic CO_2 can be exported from the area or imports are needed to fully utilize the available electrical capacity in the electricity network.
Choosing the most applicable capture technology for CO_2 capture is case-dependent.	Selection depends on various factors, including industrial context, integration options, technology readiness level (TRL), performance, economic factors, regional and infrastructure considerations, environmental and social factors, strategic fit, and future flexibility.

Conclusions 2/2

The cost of carbon capture can decrease by 40% until 2050.	Key factors in capture costs include: flue gas composition, plant size, heat availability and load profile. Drivers for cost reduction include the decline of energy costs and decline capital costs due to economies of scale and technological advancements.
The financial feasibility of synthetic fuel production depends on the end-product price development.	At the moment, fossil-based fuels are clearly lower than synthetic fuels. However, in the future it is expected that E-methanol will be competitive as the world moves towards low carbon economies.
Transport from small and medium emitters require higher prices.	If the price of CO_2 remains at the current level, transportation of CO_2 for P2X purposes is not feasible from medium sized CO_2 emitters or smaller. The smallest emitters require the highest CO_2 price to be feasible.
Local transport is the way to go for small emitters.	Local transport is favorable for small emitters if the prices increase. However, even if the price increases to 184 €/t, local transport is the only feasible option for smaller emitters.
Importing CO_2 outside of North Karelia is not feasible at current prices – unless the volumes are very large.	Importing CO_2 outside North Karelia can be feasible at current prices, if the volumes are large enough. However, large point sources outside North Karelia might favor using CO_2 closer at the emitter.

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