



A circular perspective on carbon dioxide in biofuel production

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Outline

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2. The challenge
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St1 at a glance

An aerial photograph of a power plant facility. Several tall smokestacks are visible, emitting a large, billowing plume of white smoke that rises into the sky. The plant itself is situated in a rural area with green fields and some buildings. A large, semi-transparent white '#1' is overlaid on the image, centered over the smokestacks and the rising smoke.

#1

St1 solving global energy challenges

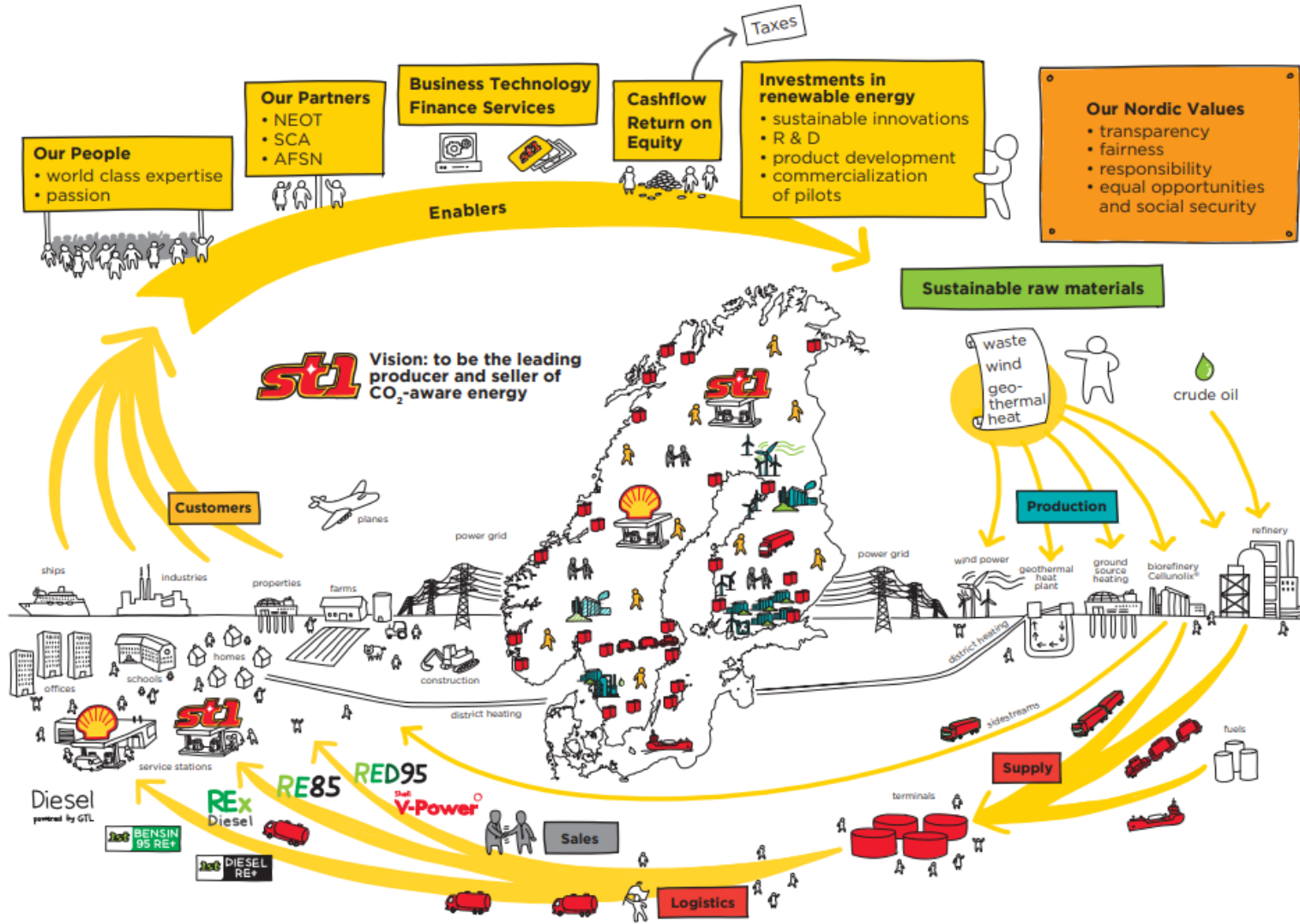
St1 Vision is to be the leading producer and seller of CO₂-aware energy

In the spirit of our vision, we research, develop, produce and invest to be able to provide our customers with CO₂-aware energy while creating positive societal impact

Our operations are strengthened by strategic long-term partnerships in various areas

GROUP STRATEGY:

STI VALUE CHAIN



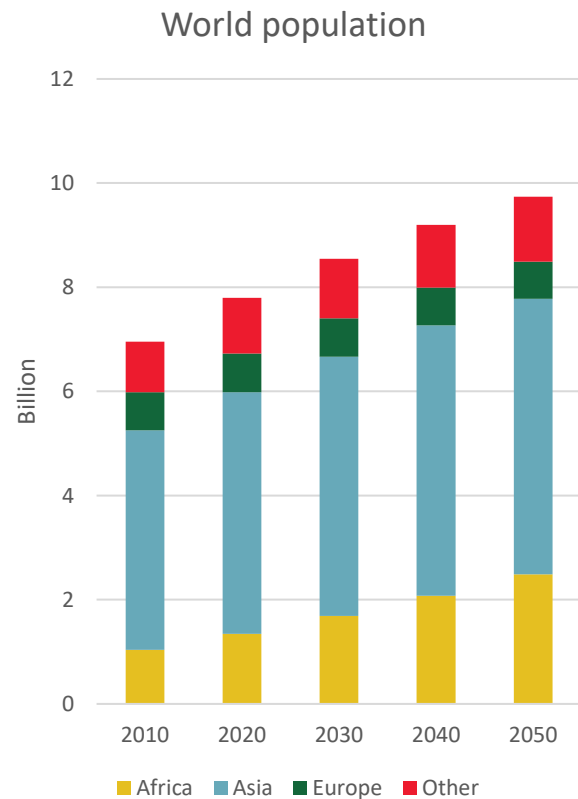
[Watch the video](#)

The challenge

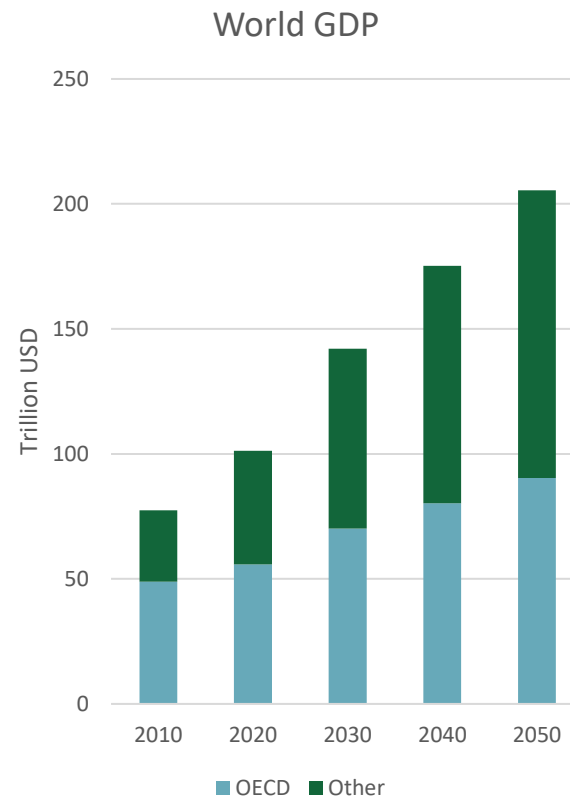
An aerial photograph of a power plant facility with several smokestacks emitting a large, billowing plume of white smoke. The surrounding landscape is a patchwork of green fields and some buildings. A large, semi-transparent white '#2' is overlaid on the image, with the smoke plume appearing to pass through the number.

#2

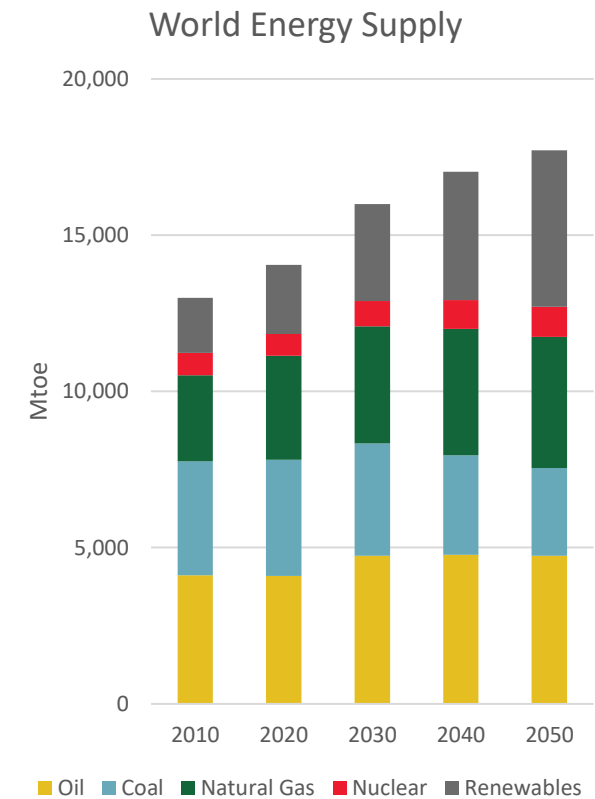
The Global Energy Challenge



United Nations, World Population Prospects 2019, Medium variant



OECD (2022) Real GDP long-term forecast

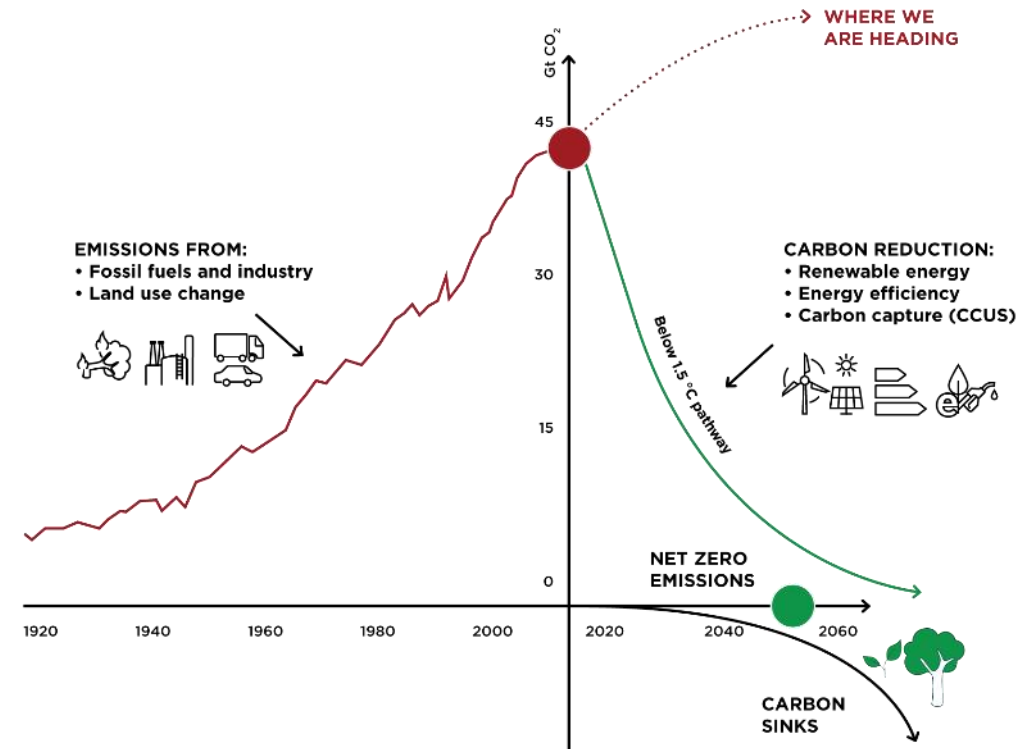


IEA (2021), World Energy Outlook 2021, IEA, Paris, Stated policies scenario (STEPS)

Where we are
going vs.
where we should
go

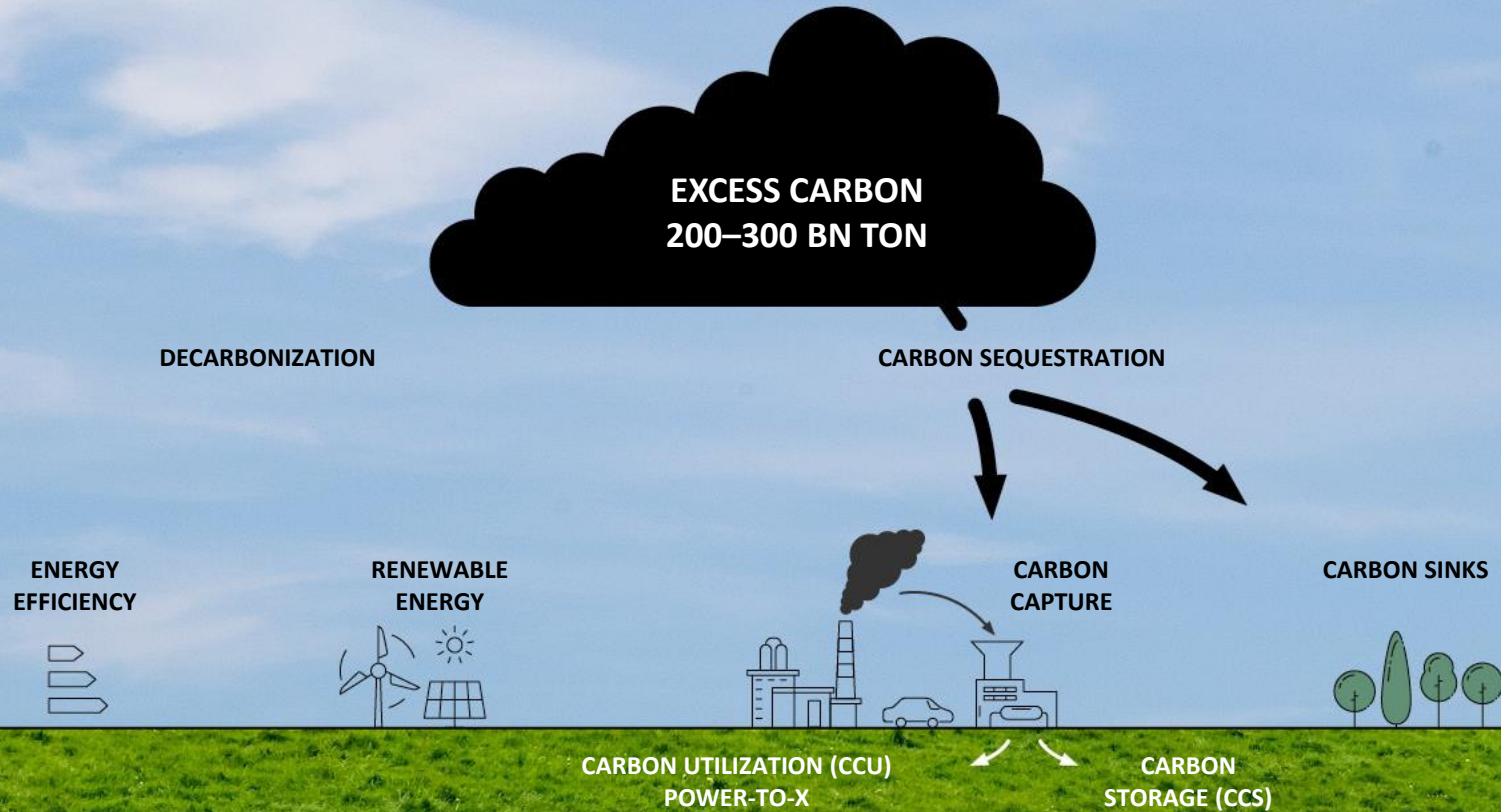


ILLUSTRATIVE PATHWAY OF GLOBAL NET CO₂ EMISSIONS LIMITING GLOBAL WARMING TO 1.5 °C



Source: Global Carbon budget 2019, IATA SSP Database, SSP2-19 and SSP2-baseline scenarios

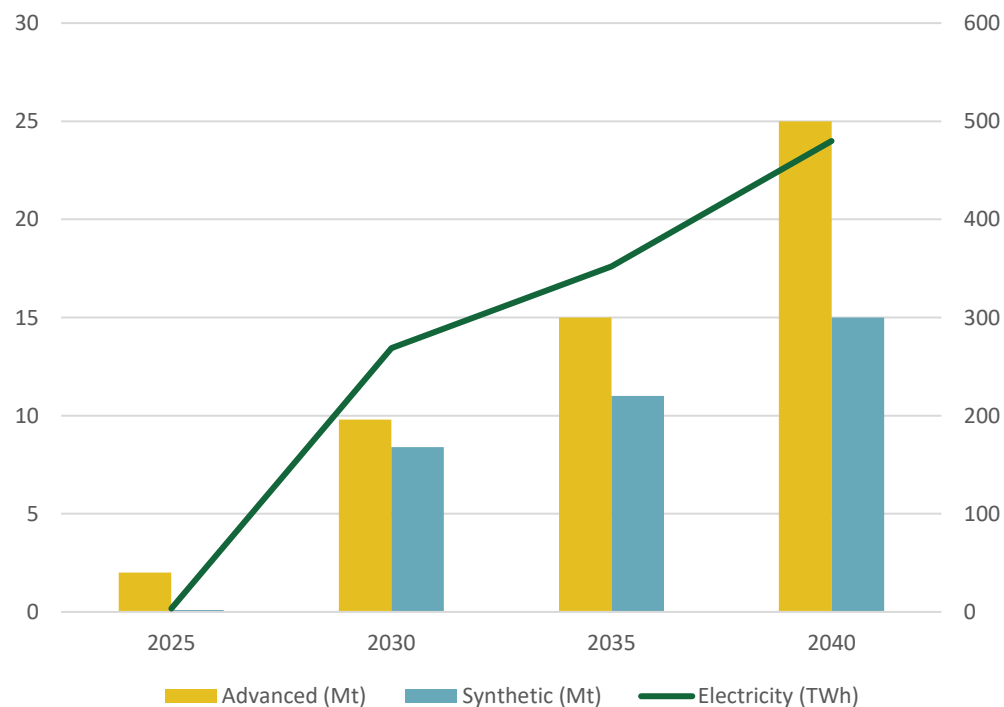
Sustainable carbon cycle requires massive investments in



Keeping fossil reserves underground

EU Fit for 55 package create new demand

Advanced & Synthetic fuels demand from Fit for 55



* Based on 2019 EU consumption 305 Mton (Eustats)

Opportunities & barriers

- Advanced biofuels technologies require Innovation, R&D & investments
 - *currently available feedstocks are not sufficient*
 - *Alternatives are needed to fulfil demand for renewables*
- Synthetic fuels processes must be demonstrated in full value chain
 - *Missing CO₂ & electricity regulation hinders the investments*
- Massive demand for new renewable power to meet synthetic fuels demand
 - *slow permitting process and bottlenecks in grids prevent investments*

The solutions

An aerial photograph of a factory complex with several smokestacks emitting a large, billowing plume of white smoke. The smoke rises into the sky, partially obscuring the landscape below. A large, semi-transparent white '#3' is overlaid on the image, with the smoke plume appearing to pass through the number. The background shows a vast, flat landscape with green fields and some buildings under a clear sky.

#3

Power-to-X process

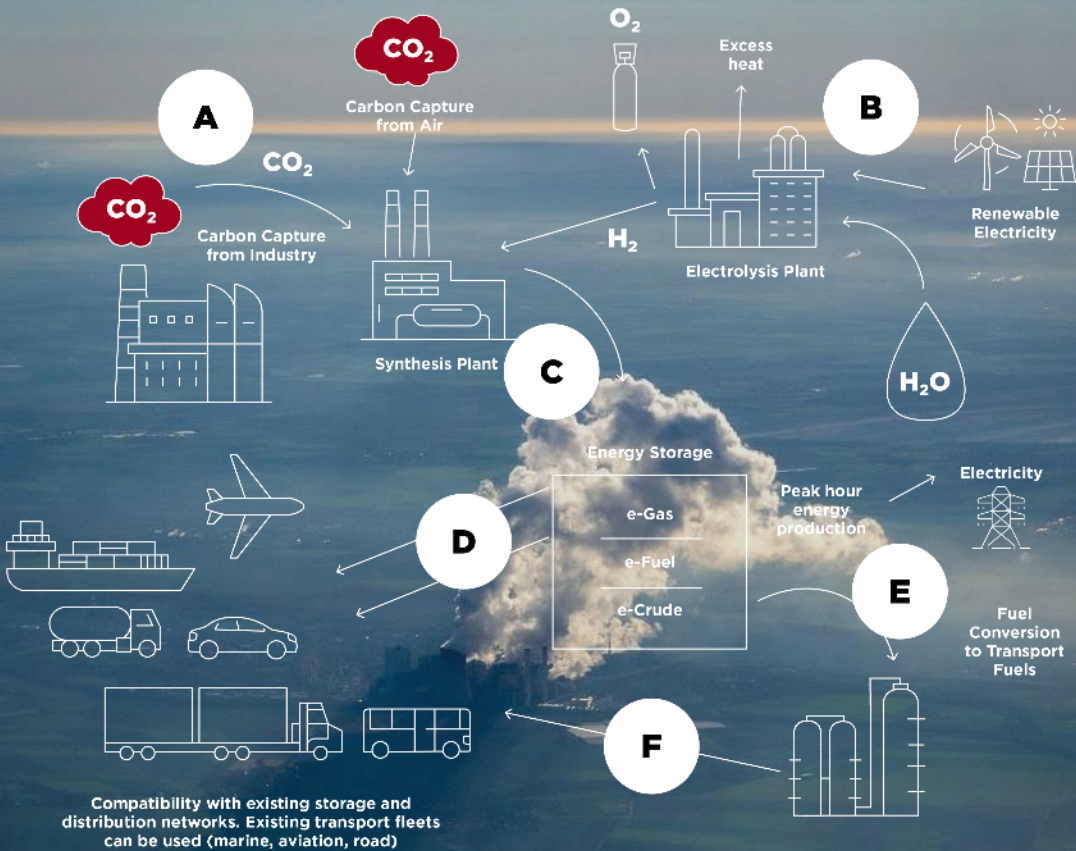


Power-to-X challenges the energy and heavy industry sector to rethink business models

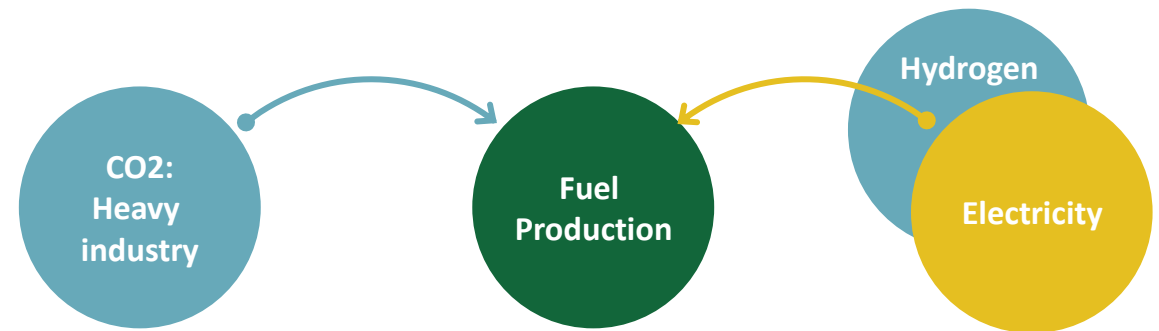
We have active cooperation and projects in synthetic fuel area to move towards first production.

Fundamentals:

- Transferring electricity in time & place
- Requires a lot of additional renewable electricity
- Enables capturing CO₂ and upcycling back into use as energy



- A** Carbon dioxide is captured from air or industrial sites by using carbon capture technologies
- B** Water is split into oxygen and hydrogen by using low-cost renewable electricity. Excess heat can be utilized in district heating networks.
- C** Carbon dioxide and hydrogen are combined into hydrocarbon products
- D** Synthetic hydrocarbon products are stored, thus providing converted solution for electricity storing. Fuels can be used for transportation
- E** e-Crude can replace fossil crude oil in refineries
- F** Refined fuel products for transportation



STEP

FEEDSTOCK SUPPLY

FEEDSTOCK PROCESSING

PRODUCTION

CUSTOMER

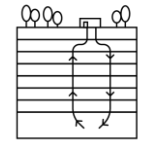


CO2

CO2



Cleaning/
Liquefaction



Electricity



Wind & Solar



Hydrogen



P2X production



Further upgrading in
Refineries



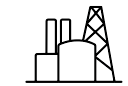
Road transport
Demand



Aviation



Marine

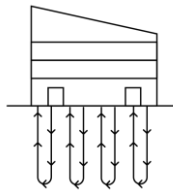


Petrochemical



Customer segment X

Heat storage



EXPO

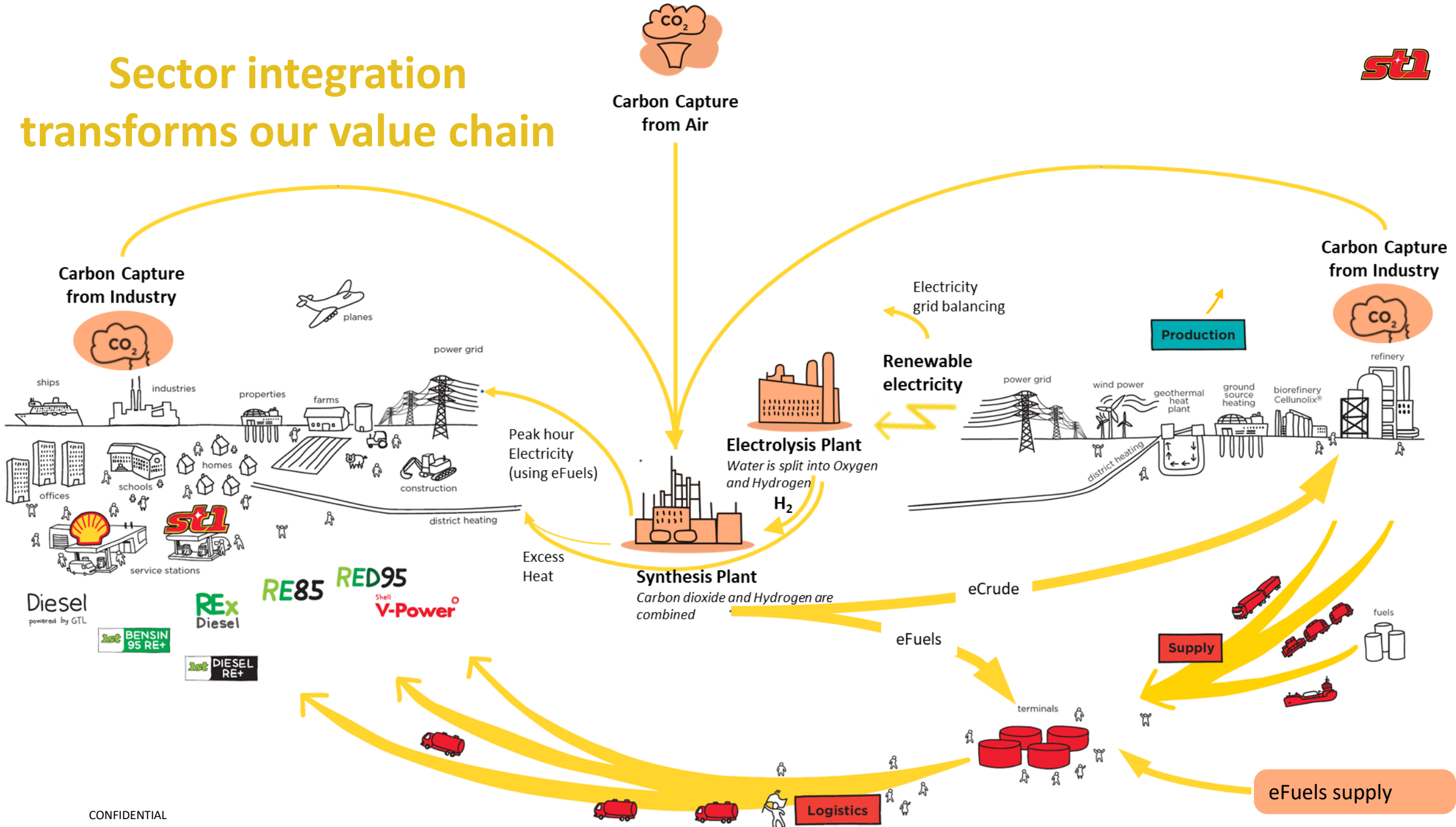
UNIT

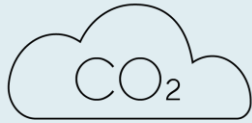
UPSTREAM

PRODUCTION

DOWNSTREAM

Sector integration transforms our value chain





Anaerobic digestion produce mainly methane and CO₂ – raw biogas.

Upgrading biogas to biomethane is basically CO₂ capture

By adding H₂ more biomethane can be produced by either biological or chemical methanation.



Pros:

CO₂ removal already in place

Logistics in place

Speedy deployment



Cons:

Scale – often rather small scale and high specific cost

Power supply and prices not always favorable at current sites

The biogas/ biomethane track

Summing up

An aerial photograph of a factory complex with several smokestacks emitting a large, billowing plume of white smoke. The surrounding landscape is a patchwork of green fields and some buildings. A large, semi-transparent white '#4' is overlaid on the center of the image, partially obscuring the smoke.

#4

Challenges & opportunities

- Definitions on electricity for RFNBOs. Need to be practical and possible to have fuel production operation continuously. DA for RFNBO of utmost importance.
- Power grid development. Currently there is competition for grid access and sufficient capacity in geographically attractive locations.
- Uncertainty regarding CO2 requirements. Fossil or biological make any difference? Accountability for CO2 – for example in CO2 standards new directives Fuel EU Aviation/Maritime. Tailpipe vs WTW
- High targets for RFNBO in 2030 - almost none available today. Time is running!

The background of the slide is a photograph of a diver in a dark, deep-sea environment. The diver is positioned in the center, looking upwards. The water is dark and textured, with a large, white, foamy wave cresting at the top of the frame. The overall mood is mysterious and focused.

Thank you!

St1 - Solving Global Energy Challenges



Read more

www.st1.com/outlook