CO2-fangst fra Jenbacher gasgeneratorer på VandcenterSyd kombineret med brint produktion

Temadag i brancheforeningen for Decentral Kraftvarme
31. maj 2022

Søren G. Larsen og Klaus Damm

ESTECH
PART OF PURETEQ GROUP

Introduction to PureteQ Group

ESTECH
PART OF PURETEQ GROUP

- PureteQ Group consist of:

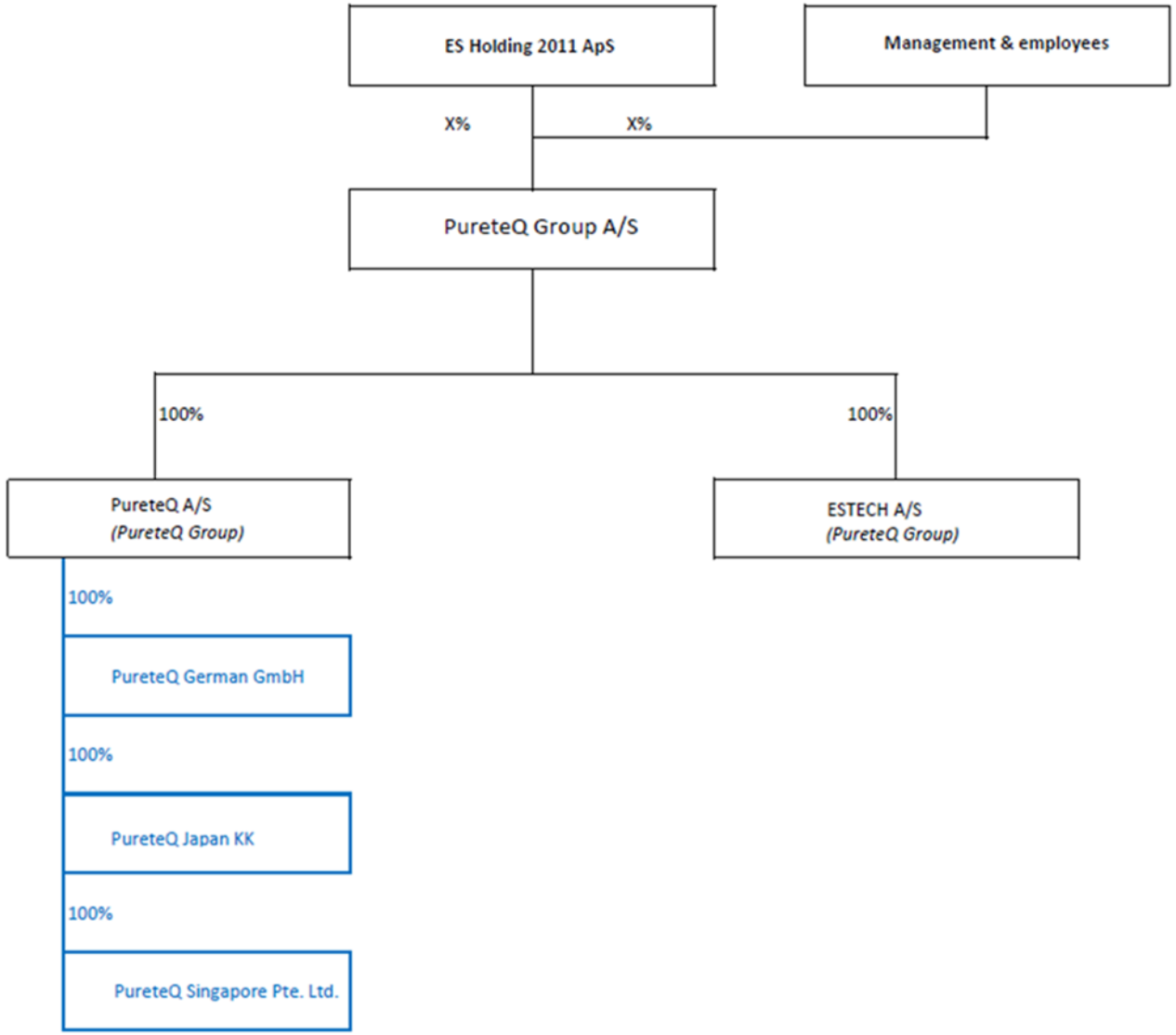
- PureteQ A/S

  An engineering company. The primary activity is design, production, installation, commissioning and servicing of exhaust gas cleaning systems (scrubbers) for the shipping industry worldwide.

- ESTECH A/S

  An engineering and development company, developing sustainable environmental technologies.

- Both companies are located in Svendborg (DK) with administration, design, development, testing centre and production facilities



PureteQ A/S Gas Cleaning System

ESTECH
PART OF PURETEQ GROUP

- PureteQ was established in 2010 to invent and patent technologies that could transform Environmental issues into sustainable solutions.
- Owned by the Danish entrepreneur and industrialist Erik Skjaerbaek and some of the employees.
- Since 2014 development of patented SOx scrubbers for maritime application.
- 1st Hybrid Scrubber system installed and commissioned in spring of 2015. Since then, more than 100 operational and approved scrubbers have been delivered.

PureteQ In-Line Open Tower Exhaust Gas Cleaning System

ESTECH
PART OF PURETEQ GROUP

- Open Tower – no packed bed – low back pressure
- High alloy for long life
- Hydrodynamic fluid distribution
- Best energy performance in the market
- Superior Control System with remote access
- Now available as Generation II for reduction of total cost of installation.

Outperforms traditional **scrubber** systems

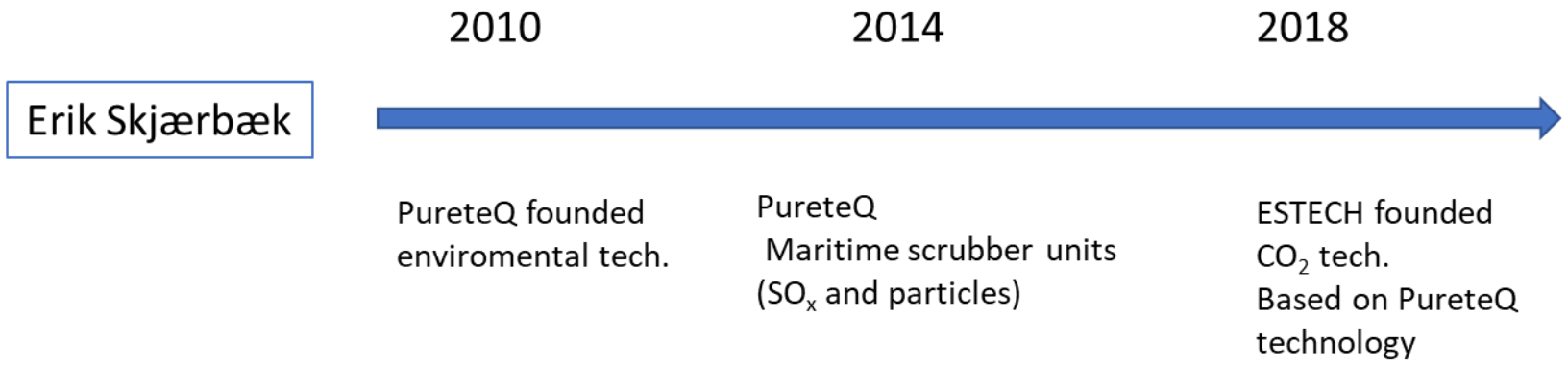
PureteQ Scrubber systems

ESTECH
PART OF PURETEQ GROUP

Introduction to ESTECH A/S

ESTECH
PART OF PURETEQ GROUP

- ESTECH A/S, established in late 2018, is an engineering and development company, developing sustainable environmental technologies. Currently CCUS and PtX technologies are the sole focus.
- ESTECH A/S has developed a patented Combined Carbon Capture Hydrogen production (CCCH2) technology based on the vast scrubber experience from PureteQ A/S



Why Carbon Capture

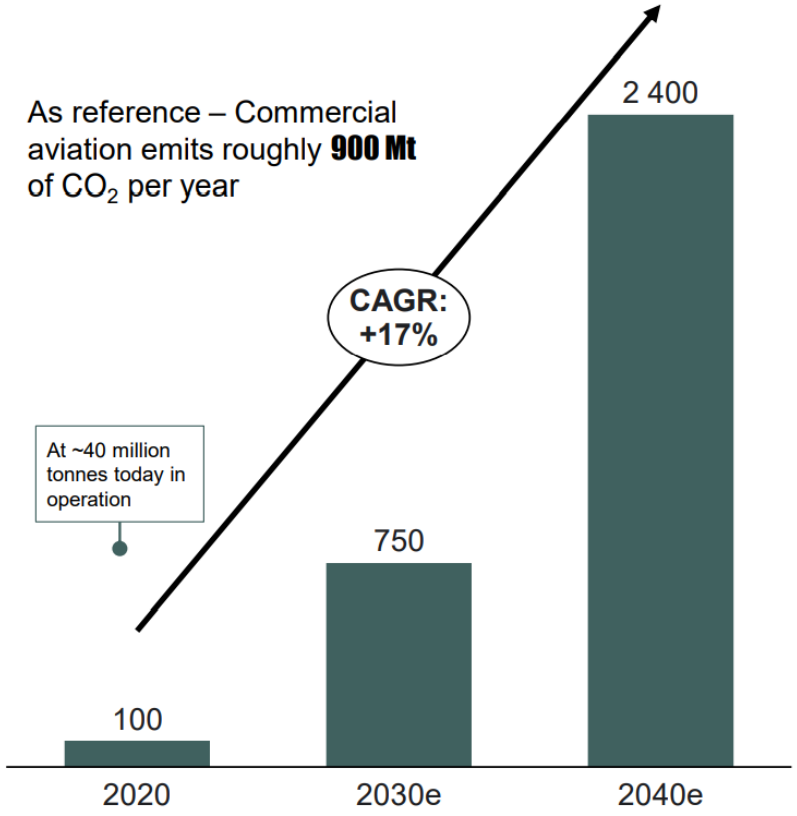
ESTECH
PART OF PURETEQ GROUP

Carbon capture plays an important role in mitigating climate change and will act as a key measure to reduce global CO_2 emissions

IM

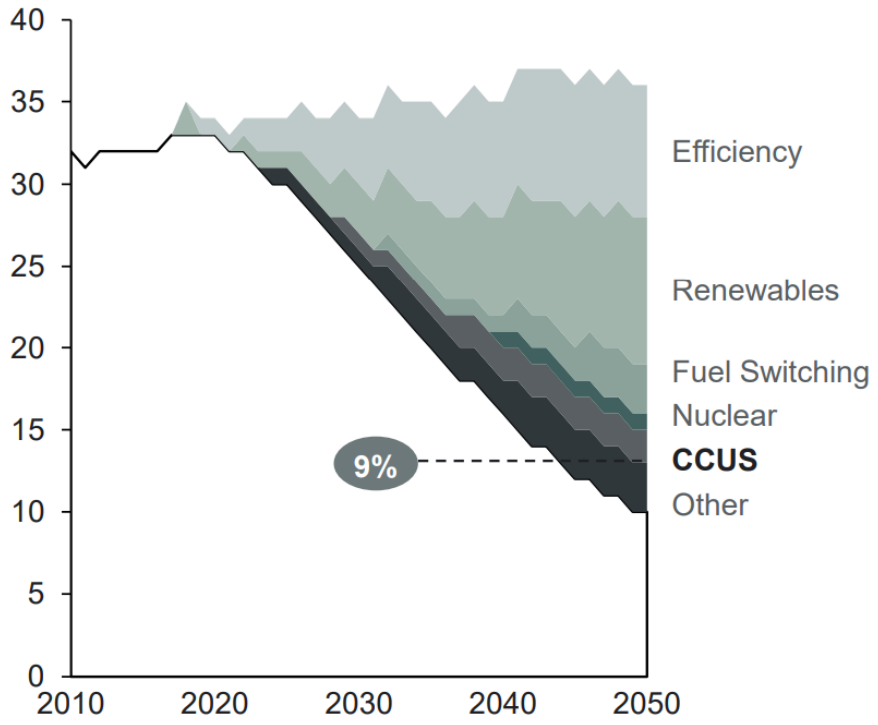
Carbon capture capacity of 2 400 million tonnes / year is needed by 2040 to meet Paris Agreement of 1.5 degrees

Carbon capture capacity to meet Paris Agreement, million tonnes



9% of all CO_2 reductions to reach Paris Agreement is expected to come from CCUS according to IEA[1]

CO_2 emission reductions, in Gt CO_2

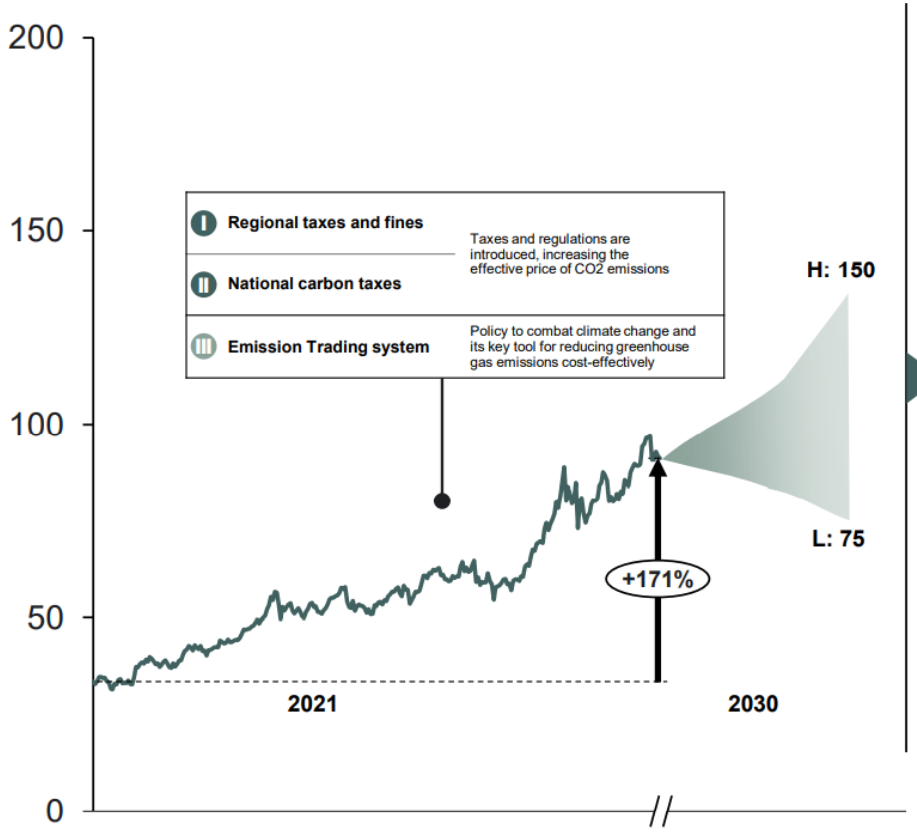


Source: IEA, ICCT, Implement analysis
(1) CO2 emissions reductions by measure in the Sustainable Development Scenario relative to the Stated Policies Scenario, 2010-2050

New regulation is driving the market price for carbon upwards with record levels set during 2021

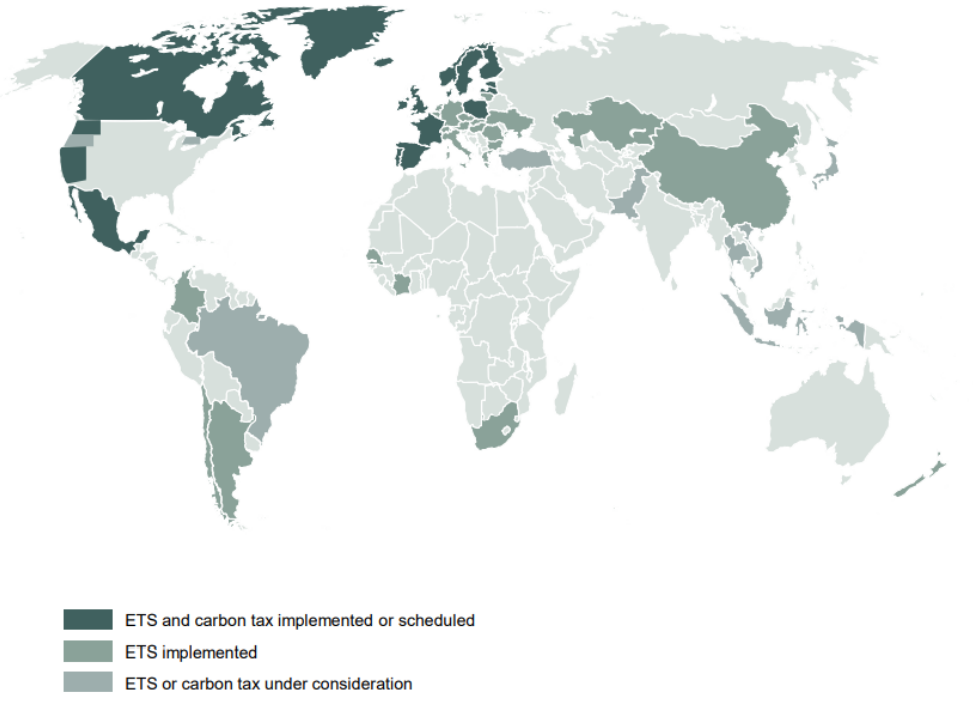
Cost of CO_2 almost three folded during 2021 with analysts expecting continued growth going forward…

EUA futures prices, EUR/tonnes



…cost increases mainly driven by different national and regional pricing initiatives across the world

Map of carbon taxes and emission trading systems, 2021



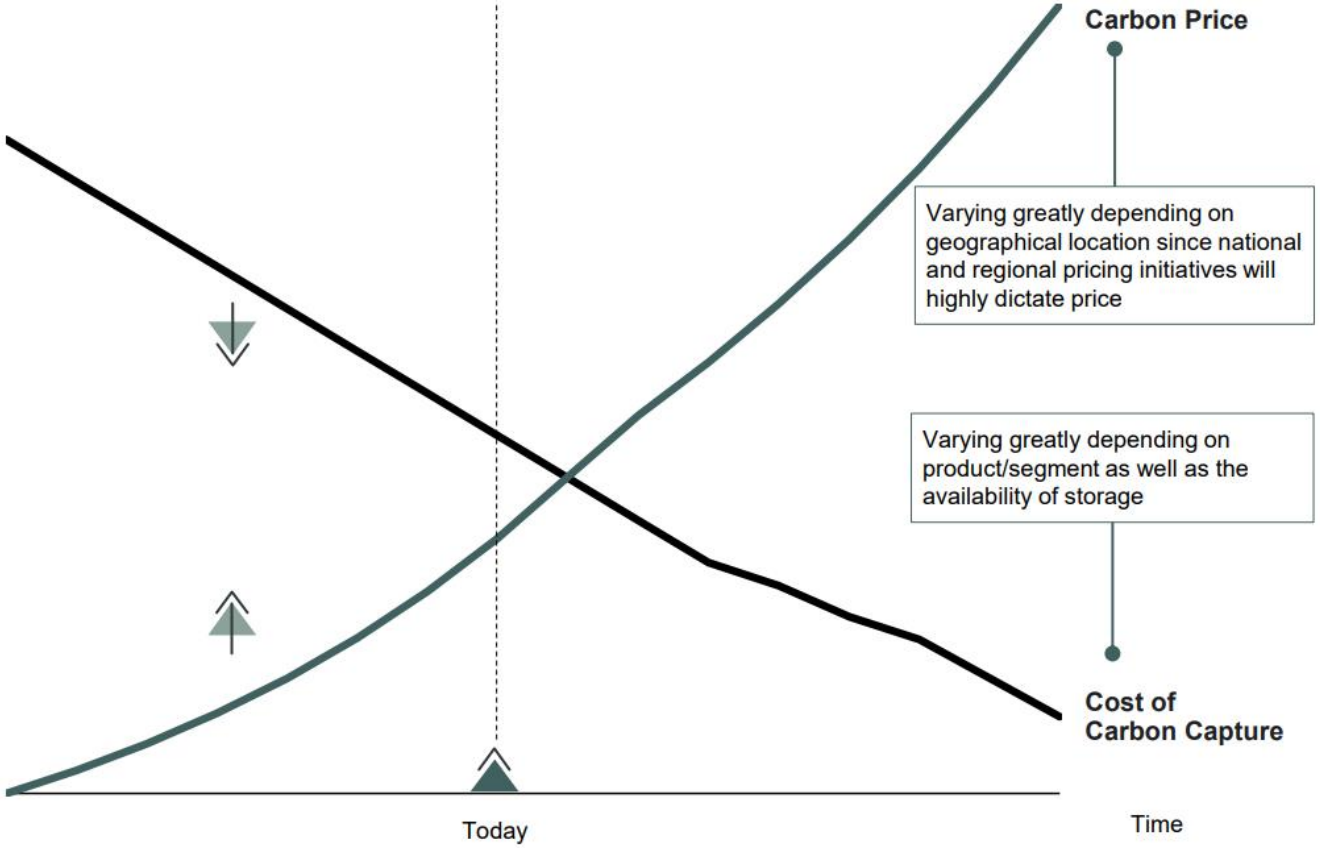
Source: IEA, The World Bank, Implement analysis

Project economics expected to turn positive as price for carbon capture decreases and price for carbon increases

ESTECH
PART OF PURETEQ GROUP

Carbon Capture expected to soon reach an inflection point

illustrative



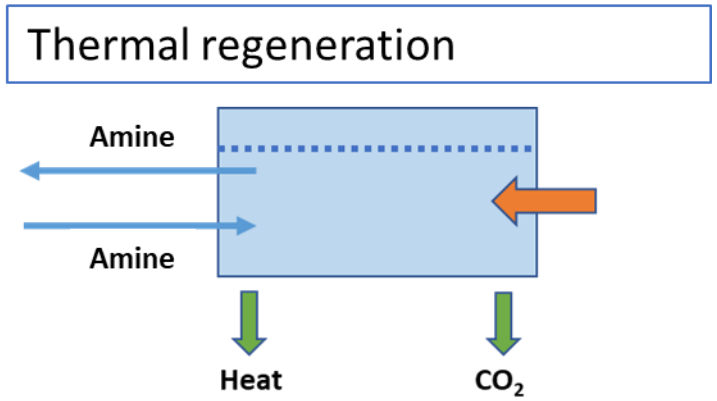
- The market is overall moving towards CCUS becoming economically viable in the near future
- Increases in carbon prices due to regulations and incentives along side the decreases in the cost of Carbon Capture due to technology and supply chain development will result in the economics for CCUS projects becoming positive
- Serving as the first step towards the novel CCUS industry starting to become a mature industry

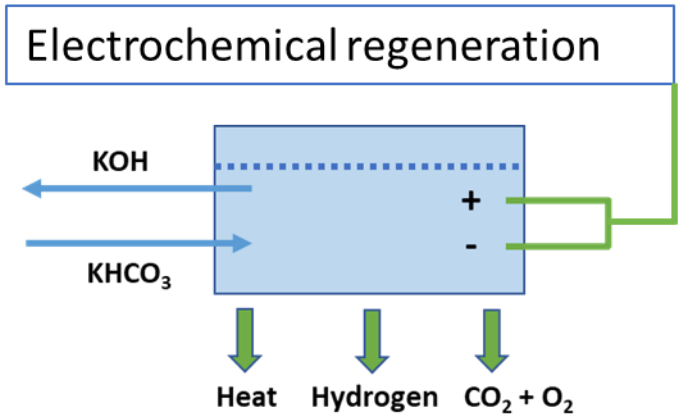
Carbon Capture Technologies

ESTECH
PART OF PURETEQ GROUP

Carbon capture a future necessity
Many old and new technologies exist

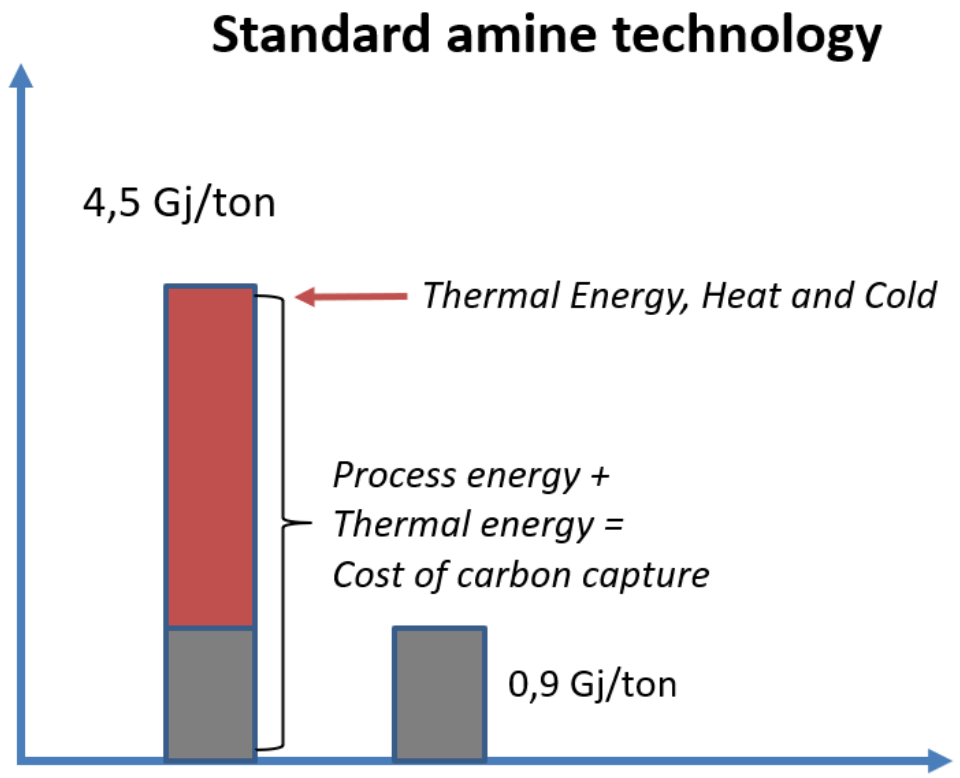
- Amine-based process (ARC)
- Carbonation/calcination (Direct Air capture)
- ESTECH CCCH2 Electrolyzing

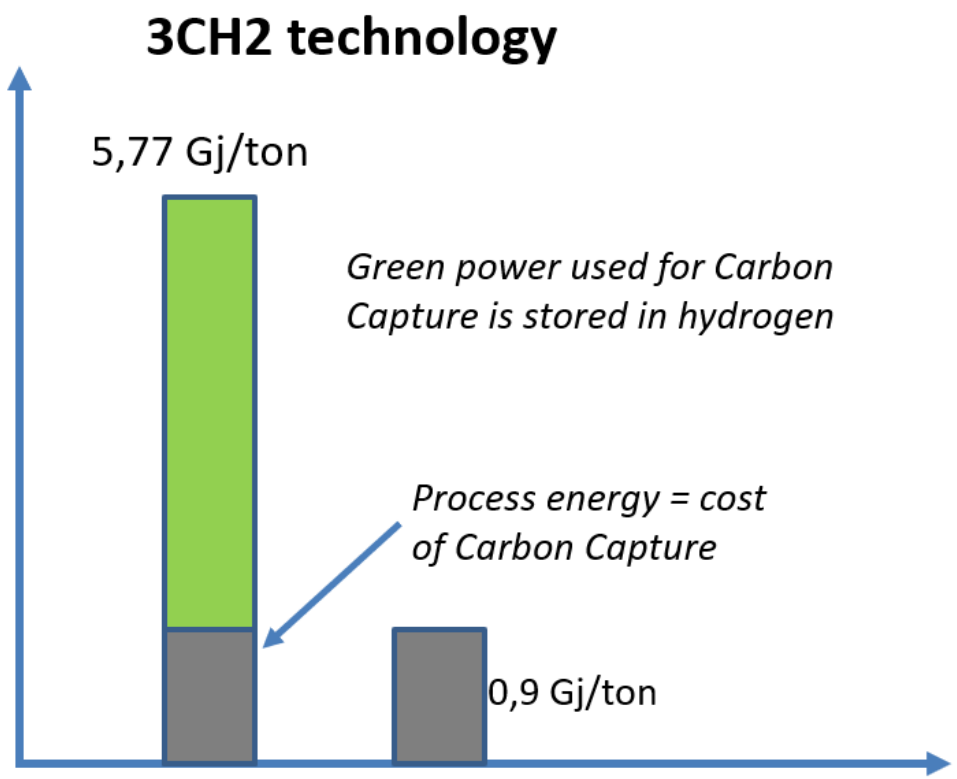




Comparison of Energy Consumption

ESTECH
PART OF PURETEQ GROUP

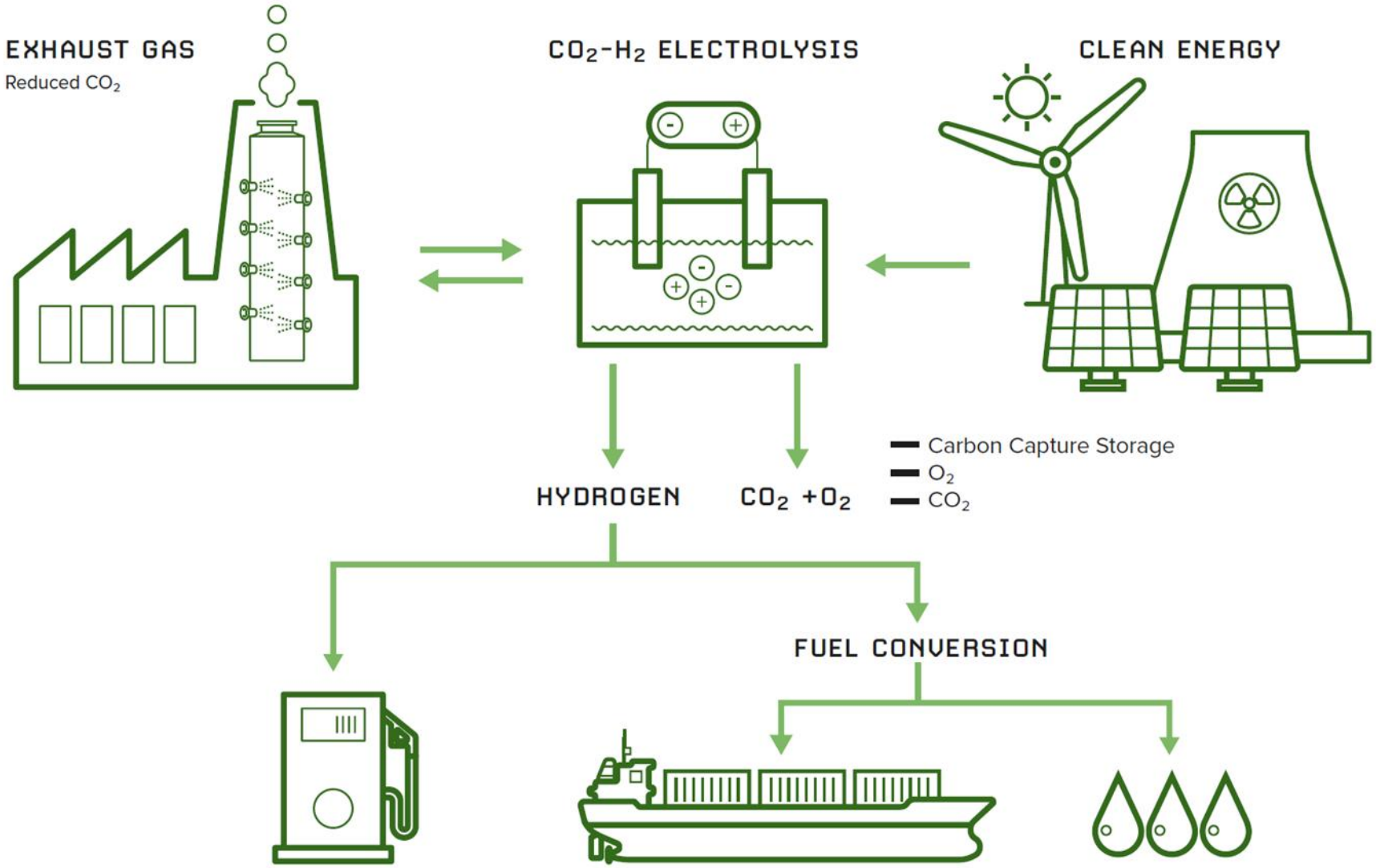




As may be seen on the above comparison, the total amount of energy needed for the 3CH2 technology is bigger than that of a standard amine process. However, most of the energy is stored in the hydrogen produced in the 3CH2, thus making the 3CH2 technology much more economical attractive.

ESTECH Technology

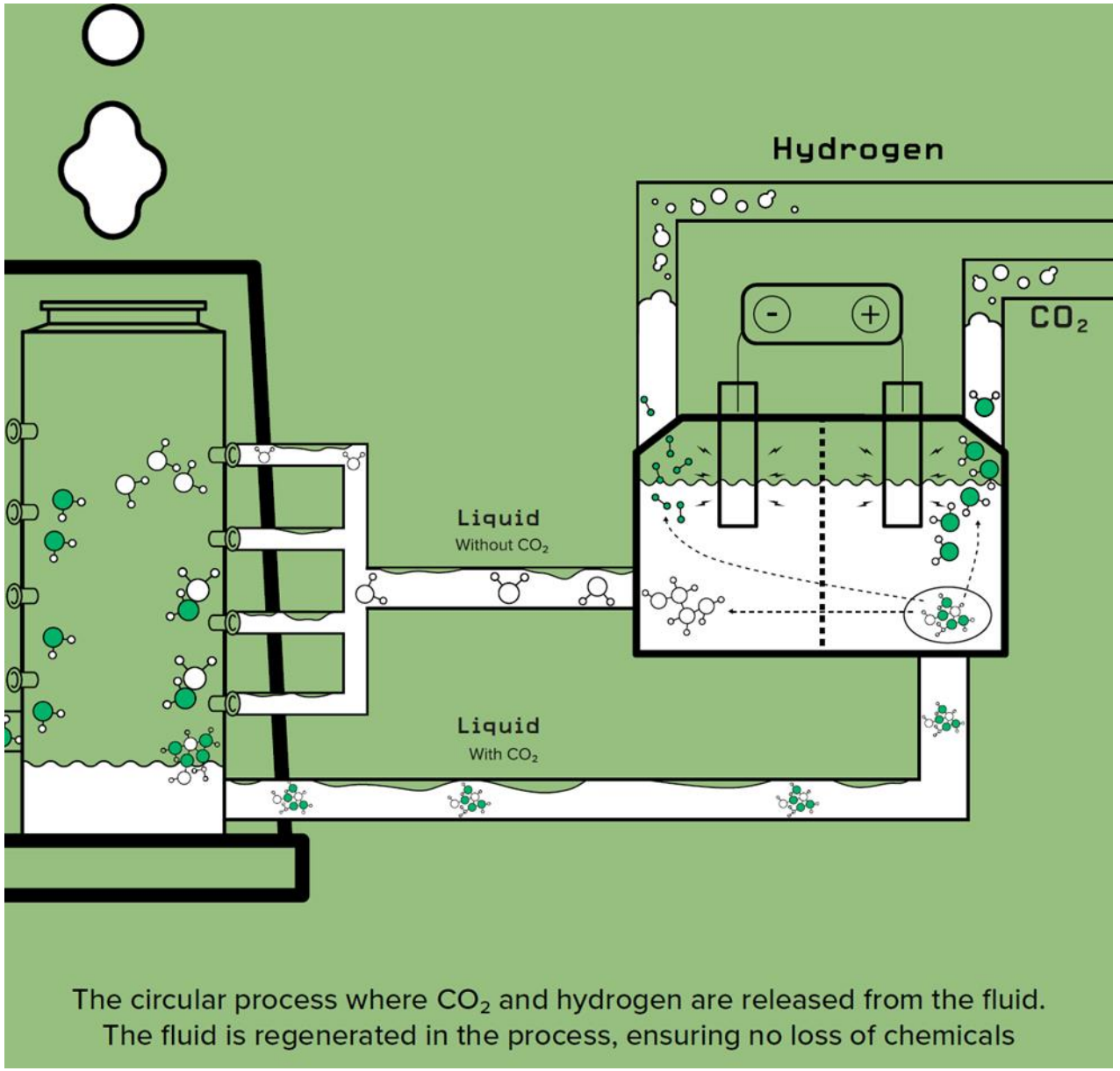
ESTECH
PART OF PURETEQ GROUP



Technology details

ESTECH
PART OF PURETEQ GROUP

- Step 1: CO_2 absorption in unloaded fluid
- Step 2: CO_2 loaded fluid can be stored
- Step 3: CO_2 loaded fluid can be transferred to electrolyzer
- Step 4: CO_2 is electrochemically released, and the fluid is regenerated



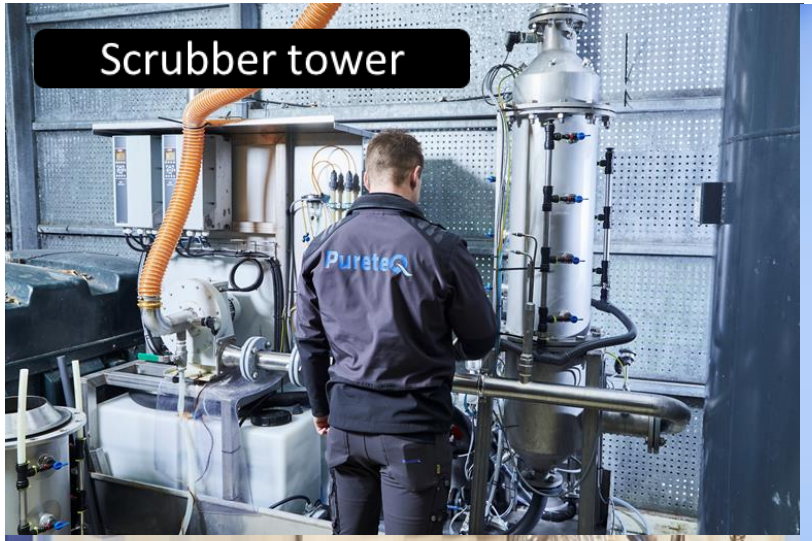
The circular process where CO_2 and hydrogen are released from the fluid. The fluid is regenerated in the process, ensuring no loss of chemicals

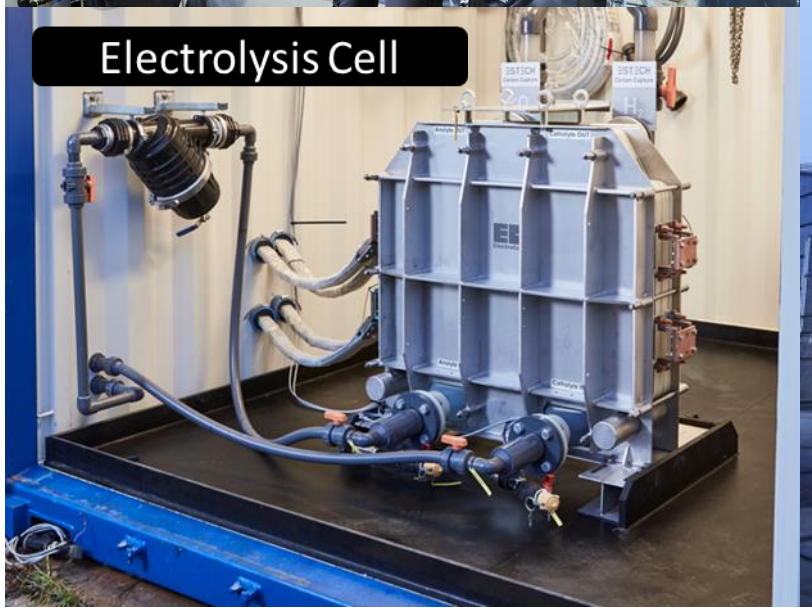
CO2 capture at VandCenterSyd

ESTECH
PART OF PURETEQ GROUP

- **The ESTECH CO_2 pilot plant:**

- Scrubber tower: PureteQ design.
- Installed January 2021
- Electrolysis unit:
- In house design of tanks/pumps/control
  - Commercial Electrolyzer
  - Installed June 2021
- Process optimization and verification, gas purities verified, 24/7 operation, lifetime demonstration
- Supported by the Innobooster programme





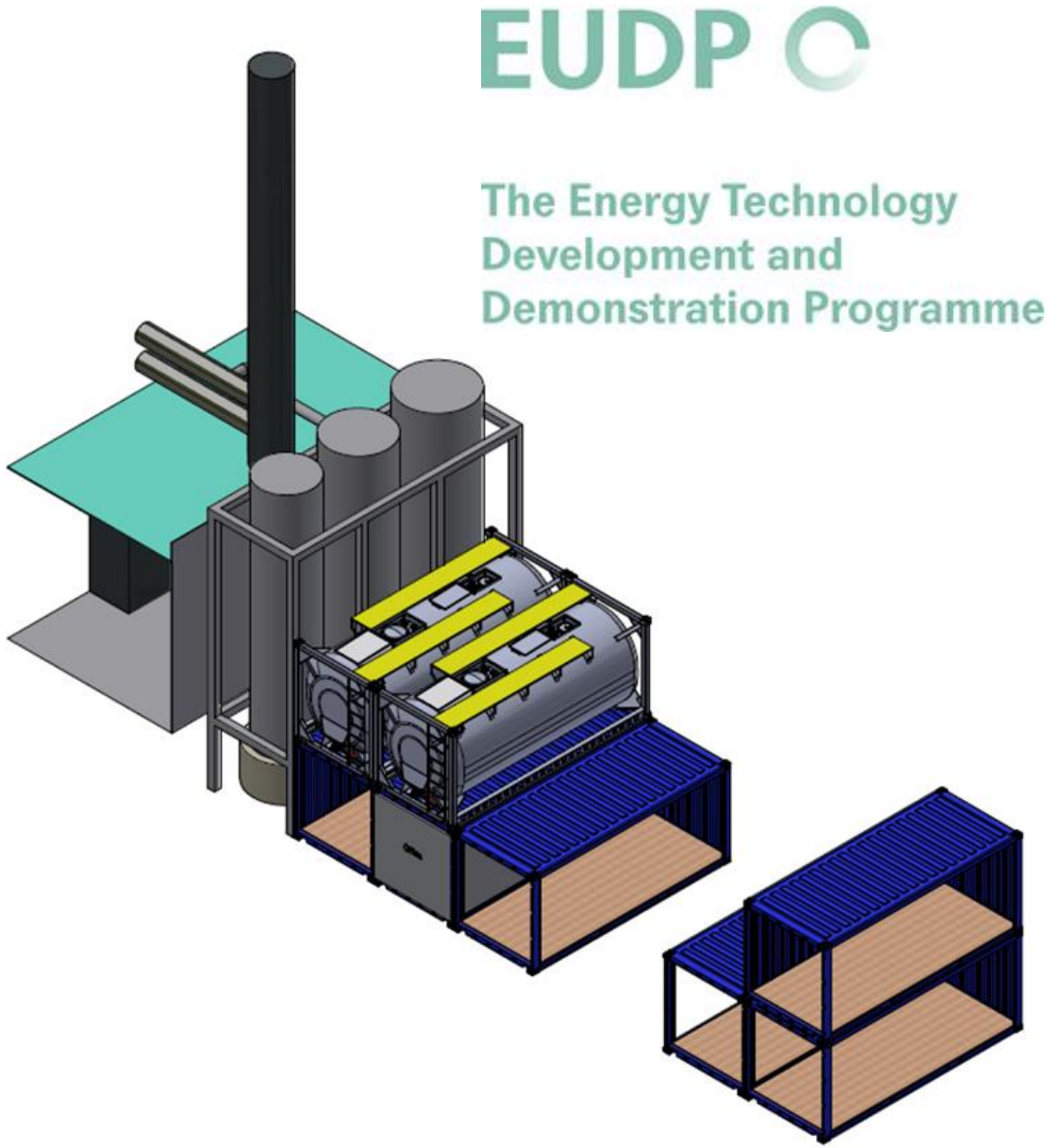
CO2 capture at VandCenterSyd – demonstration plant

ESTECH
PART OF PURETEQ GROUP

- **The ESTECH CO_2 Demonstration plant:**

- > 200 kg CO_2 /hour
- To be installed May 2023
- Supported by EUDP
- Partners: DTU, VCS and DGC

	Pilot	Demonstration
	EST1020 Innobooster	EST1030 EUDP design
1 CO2 scrubber/absorber tower	✓	✓
2 Water treatment		✓
3 Control – pumps – tanks	✓	✓
4 Electrolyzer	✓	✓
5 CO_2 – O_2 Separation		✓
6 H_2 treatment		✓

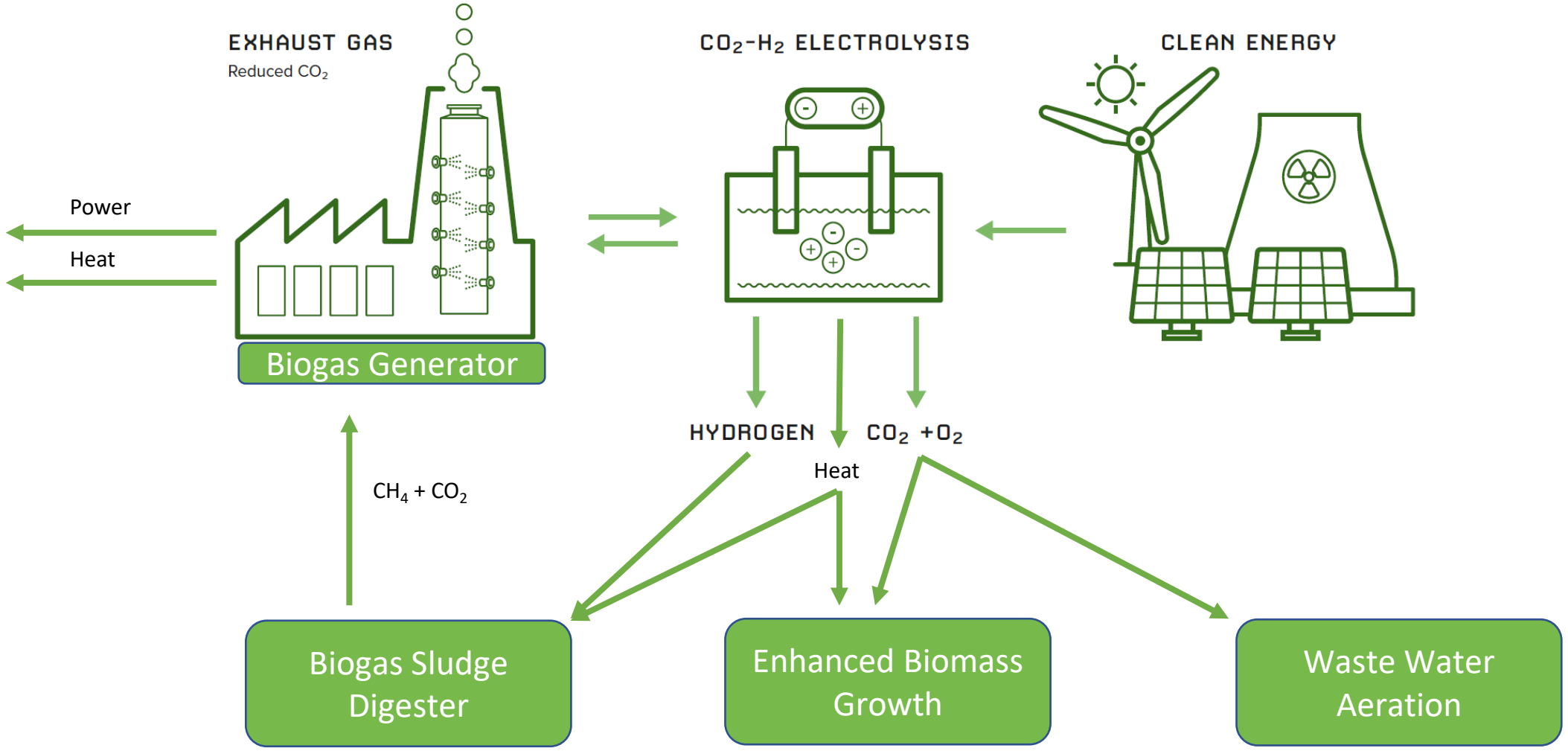


EST1030 EUDP Installation

ESTECH
PART OF PURETEQ GROUP

The coupling case at VandCenterSyd

ESTECH
PART OF PURETEQ GROUP



Business case and test results

ESTECH
PART OF PURETEQ GROUP

Business case is very depending on the following:

- Cost of Clean or Green electrical power
- CO_2 quota (Carbon Credit) or tax cost
- Hydrogen sales price

Cost comparison between known Carbon capture Technology based on amines and the 3CH2 technology based on lye and an electrochemical process shows:

- Standard amine technology:

  Euro 54-80/ton CO_2 captured

- 3CH2 Technology:

  Euro 22-28/ton CO_2 captured

TEST RESULTS:

83% CO_2 captured

DGC have tested the hydrogen produced and the calorific value is very good

DGC

Gasanalyse, udvalgte sporstoffer i hydrogen

Målerapport:	749.54/21.317
Rekvirent:	Estech Att. Jan Stougaard Jakobsen Sverigesvej 13 5700 Svendborg
Beskrivelse:	Gasprøve fra test-anlæg hos Vandcenter Syd, udtaget af Brian Ildved, DGC, 07.07.2021.

Gassammensætning #	
hydrogen	99.44 mol-%
nitrogen	0.34 mol-%
ilt	0.20 mol-%
kuldioxid	3 ppm
metan	<1 ppm
øvrige kulbrinter ##	187 ppm C
Beregnede værdier	
øvre brændværdi	12.69 MJ/Nm^3
nedre brændværdi	10.74 MJ/Nm^3

gassammensætning på tør basis

bl.a. tetrahydrofuran, 2-butanon, 3-methyl-2-butanon og cyclohexanon

Hørsholm, 12.07.21

Leo van Gruijthuijsen

Elektronisk udstedt rapport. Kun gyldig med OCES digital signatur for Leo van Gruijthuijsen, Dansk Gasteknisk Center.

Thank you for your attention

ESTECH
PART OF PURETEQ GROUP

- Questions