

# GreenLab

**Green & circular industrial park – Technology enabler – International research platform**

# Who are GreenLab R&E?



**Mathias Mørch**

Education Manager



**Eoghan Rattigan**

Industrial Sustainability  
Scientist



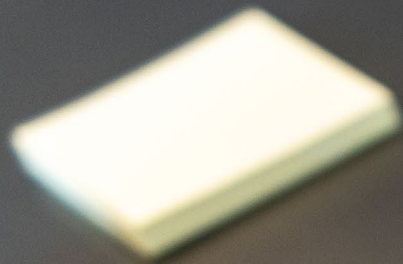
**Lucia Mortensen**

Head of GreenLab  
Research & Education



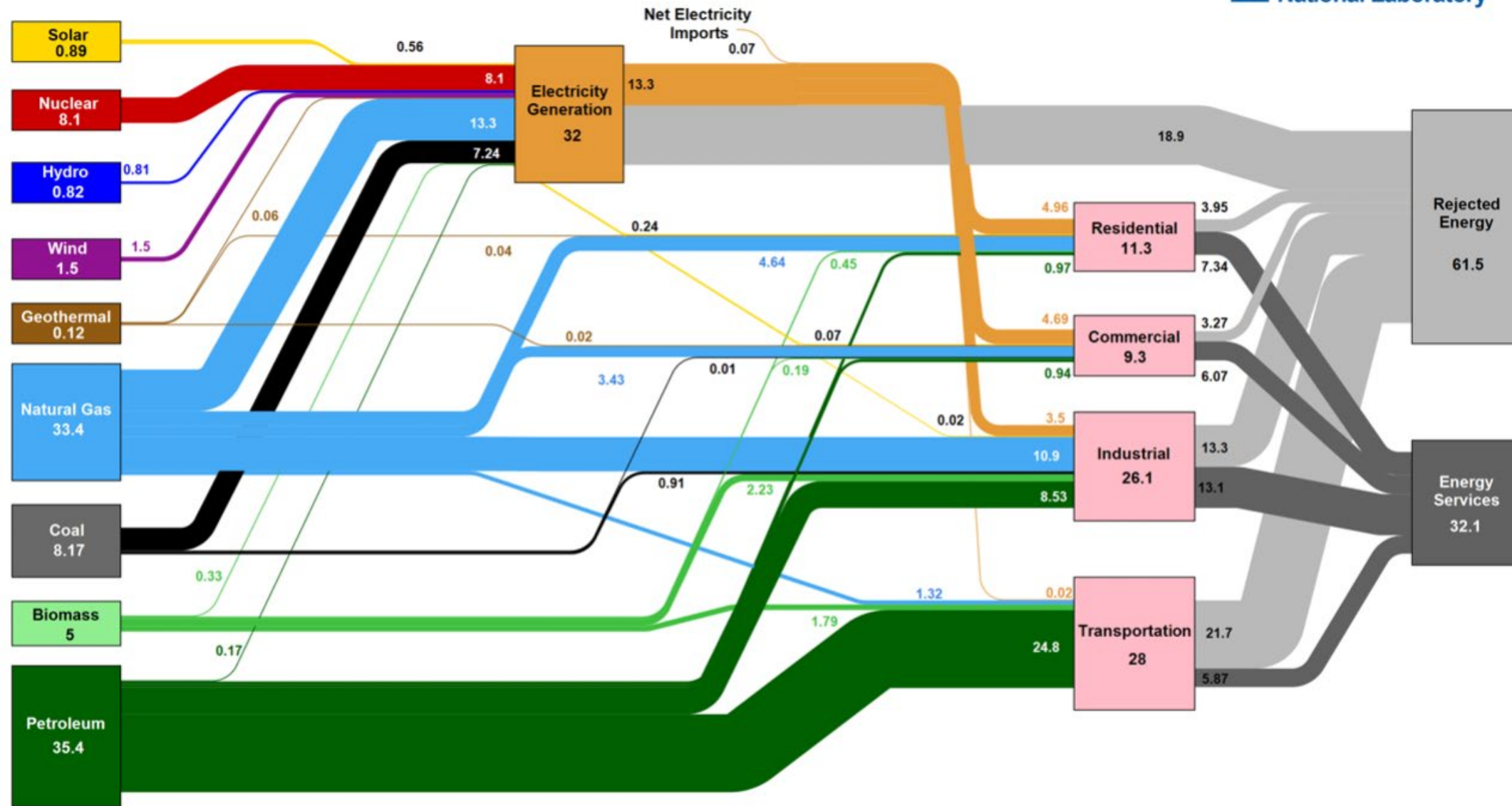
**Leon Aahave**

DTU Liaison officer to  
GreenLab



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## Estimated U.S. Energy Consumption in 2023: 93.6 Quads



# Why Industrial Symbiosis?

What problem needs addressing?

# Green and circular industrial clusters

*- a model for sustainable growth*



**Optimisation of energy through  
co-location**



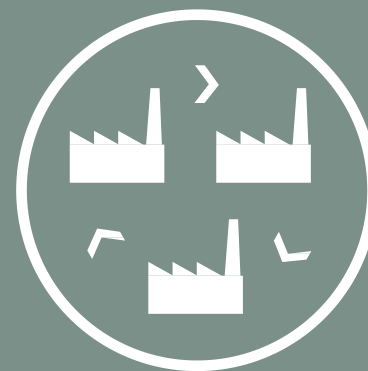
**Circular economy and  
sector integration**

**How do we imagine  
circularity?**



**A replicable model designed to  
scale-up and globalise**

# *Becoming circular with green energy as foundation....*



## **GENERATE**

We generate sustainable energy for our partners

## **STORE**

The green energy is stored in all its forms:  
Electricity, heat, gas and electrofuels

## **SHARE**

The SymbiosisNet™ is an intelligent grid of energy and data that will let our companies share their surplus energy

# Origin and ownership structure

– a truly collaborative public-private-partnership

## PUBLIC

## PUBLIC/PRIVATE

2008

Skive is appointed Denmark's first "Energy city"

2016 - 2018

Skive Municipality establishes two entities to promote green transition. GreenLab Skive Masterplan is developed

2019

GreenLab A/S is capitalised

2021

First donation to Innovation Center through the Foundation for the GreenLab Innovation

2022

Additional funding from ownership

2023

Further donation to Innovation Center



Energibyerne.dk er en del af SmartEnCity Networks, som er støttet af EUs Horizon 2020 program.



75 mDKK

apportindskud



30 mDKK



100 mDKK + 250 mDKK



30 mDKK



150 mDKK

# FROM CONCEPT TO REALITY...

# GreenLab Skive site map

- Planned
- Available
- In operation
- Reserved



Current area

Chapter 1 - 60 hectares

# GreenLab Skive site map

- Planned
- Available
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Expansion area  
Chapter 2-70 hectares

We are here!



# GreenLab Skive site map

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GREEN HYDROGEN SYSTEMS

Eurowind Energy™

ORGANIC FUEL TECHNOLOGY

Stiesdal

Vestjyllands Andel  
Sammen om praktisk innovation

GREENLABskive  
Biogas

NETSELSKABET N1

QUANTAFUEL

nomi4s  
RESSOURCE CENTER

# GreenLab Skive site map

- Planned
- Available
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- Reserved



- »» Est. 2019 co-owned by local farmers and E.ON Energy
- »» Delivers 21 million m<sup>3</sup> of gas annually to the national grid
- »» 500,000 tonnes of biomass are handled annually
- »» Operates separate lines for organic and conventional
- »» Upgrade facility separates the CO<sub>2</sub> from the methane (Biogas: 55% methane 45% CO<sub>2</sub>)

**GREENLAB**skive  
Biogas



## GreenLab Skive site map

- Planned
- Available
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- » Recycles plastic waste through pyrolysis at 450 °C
- » 3 fractions are separated by distillation and sold to BASF
- » The non-condensable gases (10%) are used to power production replacing natural gas
- » They process 20,000 tonnes of plastic annually, 80% of which goes back into production replacing 15 million litres of oil



## GreenLab Skive site map

- Planned
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- »»» AKA the Starfish Factory
- »»» Producing high protein animal feed for local farmers, replacing the need for soy imports
- »»» Takes in marine products such as starfish, prawns and fish offal, heats it to near 300 °C flash evaporating the water producing a powdered feed
- »»» Process also works for grass
- »»» Approx. 7600 tonnes of biomass per year that varies seasonally
- »»» Has installed dual boiler for the use of hydrogen.

## GreenLab Skive site map



- » Startup - inside the Starfish Factory.
- » Extraction of protein from leaves.
- » RuBisCo protein is the most abundant leaf protein source in the world.
- » Very high yield from local clover grass fields
- » From a grass press through two membrane filtration processes to feed and food protein.
- » Waste goes to biogas



## GreenLab Skive site map

- Planned
- Available
- In operation
- Reserved



- ››› SkyClean pilot facility
- ››› Pyrolysis converts biomass into biochar and pyrolysis gas in this 2MW pilot plant
- ››› Full size factory is 20 MW and matches with a biogas facility, fibres from manure as feedstock and the excess heat and gas is used to upgrade the biogas
- ››› 50% of the carbon is sequestered in the biochar
- ››› Pyrolysis oil can be converted to green fuels

**Stiesdal**

# GreenLab Skive site map

- Planned
- Available
- In operation
- Reserved



- >>>Central Utilities building.
- >>>Provides ultrapure water (<10µS) for use in electrolyzers.
- >>>Provides nitrogen to use in electrolyzers and companies.
- >>>Provides instrumental air for actuation.
- >>>Additional services to be provided....

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# GreenLab Skive site map

- Planned
- Available
- In operation
- Reserved

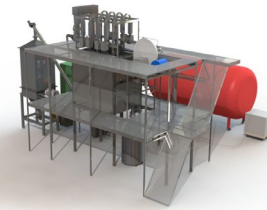


- 》》》 6 MW X-series test site
- 》》》 Pressurized Alkaline Prototype
- 》》》 Outdoor module designed for scale.
- 》》》 Production, H<sub>2</sub>: 107 kg/hour.  
Dynamic range: 100 % to 25% in less than 40 seconds.
- 》》》 Purity of H<sub>2</sub>: 99,97%
- 》》》 Outlet gas pressure: 35 bars.
- 》》》 Ultra pure Water consumption: 1 m<sup>3</sup> pr hour.



## GreenLab Skive site map

- Planned
- Available
- In operation
- Reserved



- 72 kW prototype facility OFT 8
- Microwave cracking technology
- Feedstock: Sludge, rubber, bio-materials.
- Output: Oil, Gas and char.
- Capacity: 400 kg / hour.

**ORGANIC**  
FUEL TECHNOLOGY

# GreenLab Skive site map

- Planned
- Available
- In operation
- Reserved



- »»» 60 kV transformer station
- »»» "Behind the meter" setup.
- »»» 2 x 40 MVA transformer.
- »»» 2 x 60 MVA
- »»» Educational add-on.

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# GreenLab Skive site map

- Planned
- Available
- In operation
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**Planned Infrastructure**

- **Renewable Energy**
- **Purified water**
- **Hydrogen**
- **Heat**



**Current Infrastructure**

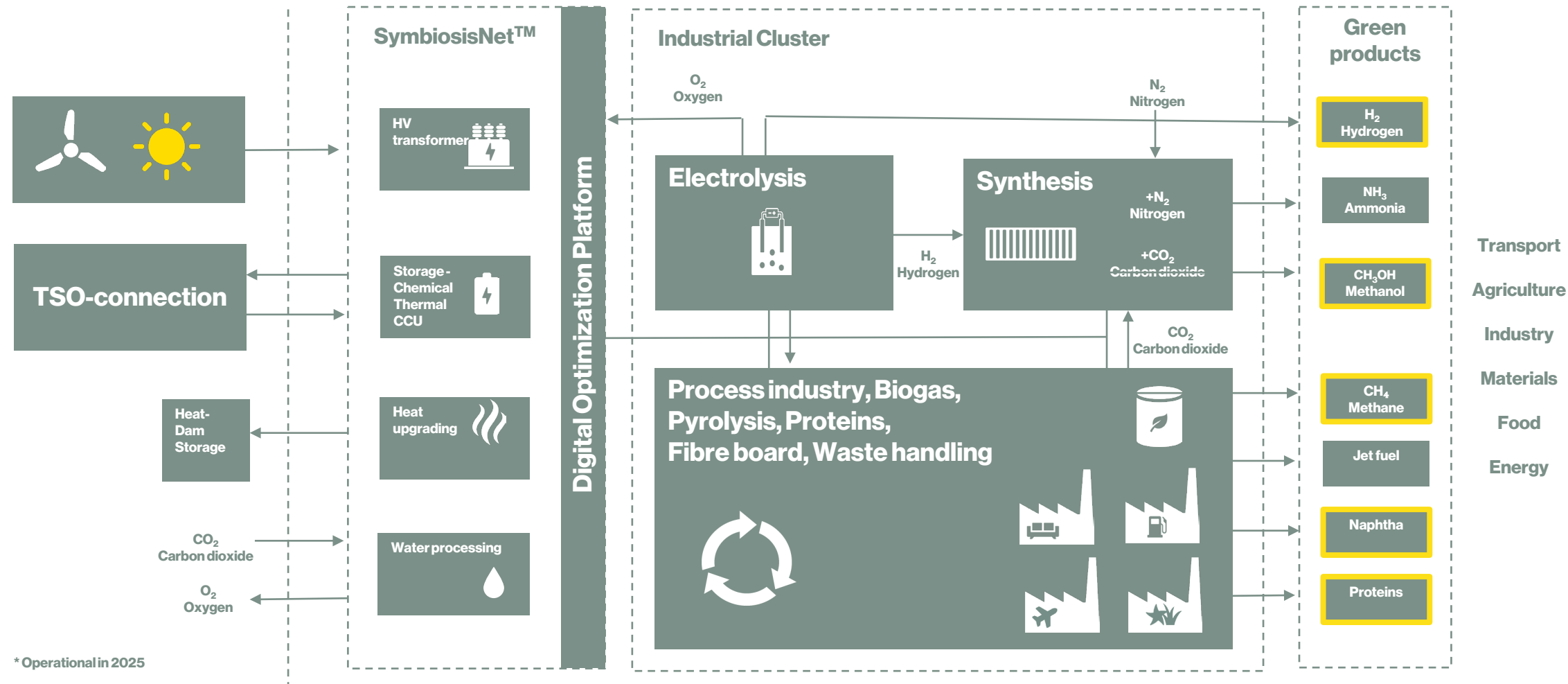
- Renewable Energy
- Purified water
- Hydrogen
- Heat



# GreenLab Skive Energy Park – SymbiosisNet™\*

A National Test Zone for Integrated Energy and Open Innovation

Commercial contracts



# GreenLab's path to success

Here!

## Groundbreaking

### Major milestones

- ››› Maturing land
- ››› Four factories are established
- ››› Research projects underway based on GreenLab

## Development

### Major milestones

- ››› 80 MW renewable energy park (54 MW wind and 26 MW solar) is approved
- ››› 12 MW PtX is granted by the Danish Energy Agency
- ››› National test zone approved by the Danish Energy Agency
- ››› Another factory is established
- ››› 100 MW PtX is granted by the EU
- ››› 20 mDKK grant from the VILLUM FOUNDATION for research. 4 projects selected in the 1st round

## The site becomes operational

### Major milestones

- ››› Five factories in operation
- ››› An 80 MW renewable energy park (54 MW wind and 26 MW solar) is established
- ››› SymbiosisNet comes into operation with heating infrastructure
- ››› 6 MW PtX test facility is operational
- ››› 2. og 3. round research projects are underway

## SymbiosisNet and PtX fully operational

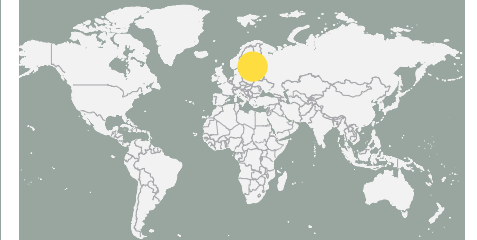
### Major milestones

- ››› SymbiosisNet comes into operation with direct connection to renewable energy park and grid connection and the establishment of hydrogen infrastructure
- ››› 12 MW PtX is operational
- ››› 100 MW GreenHyScale is in operation

## Global partnering

### Major milestones

- ››› International Research and Innovation
- ››› GreenLab Nes, Norway



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# Replicable locally and globally



**WHAT QUESTIONS  
HAVEN'T  
I ANSWERED SO FAR?**

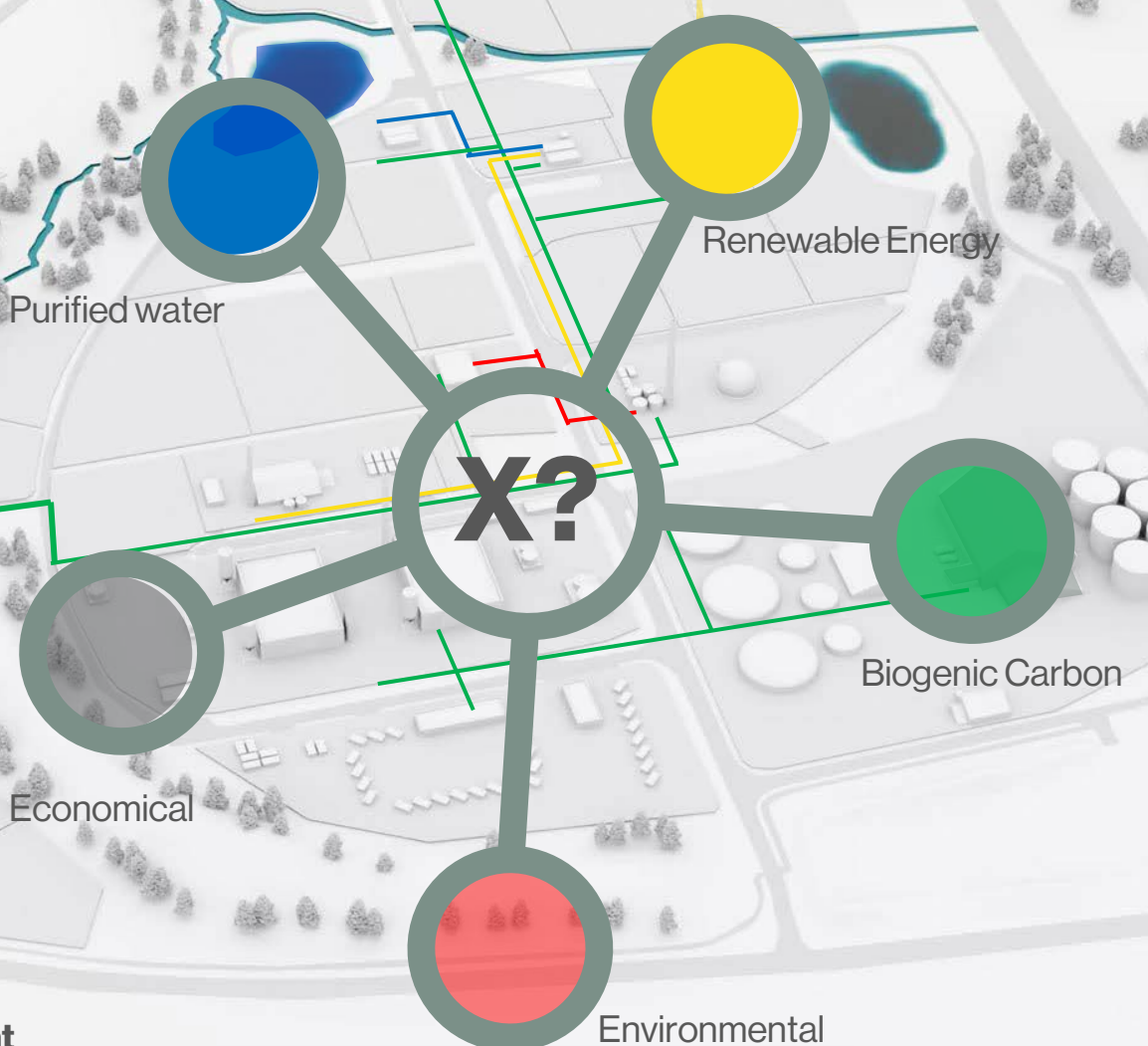
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# CURRENT RESEARCH CHALLENGES



# SUS optimal (System usability scale optimal)

## Challenge A

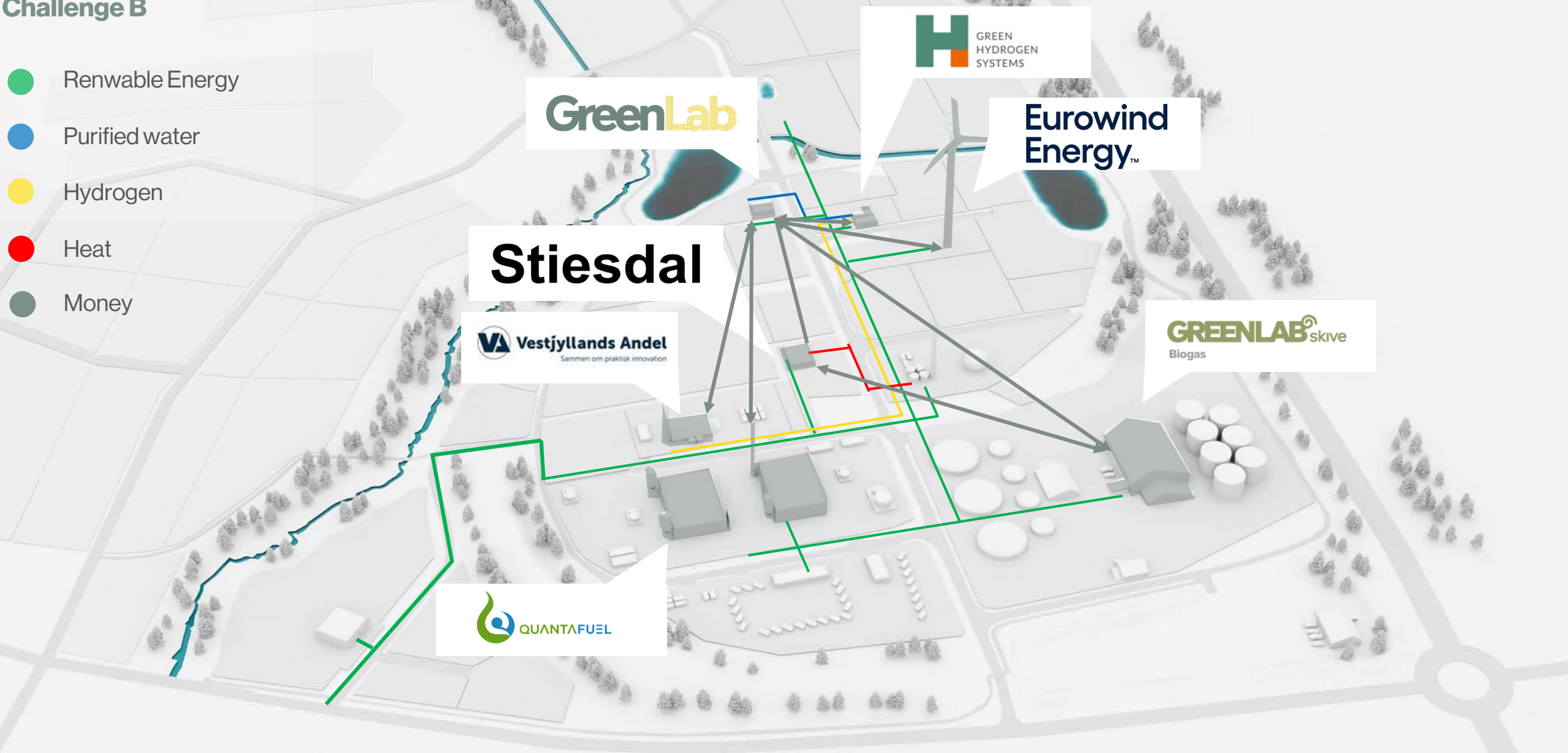


# PWC-t-X Production Network Governance



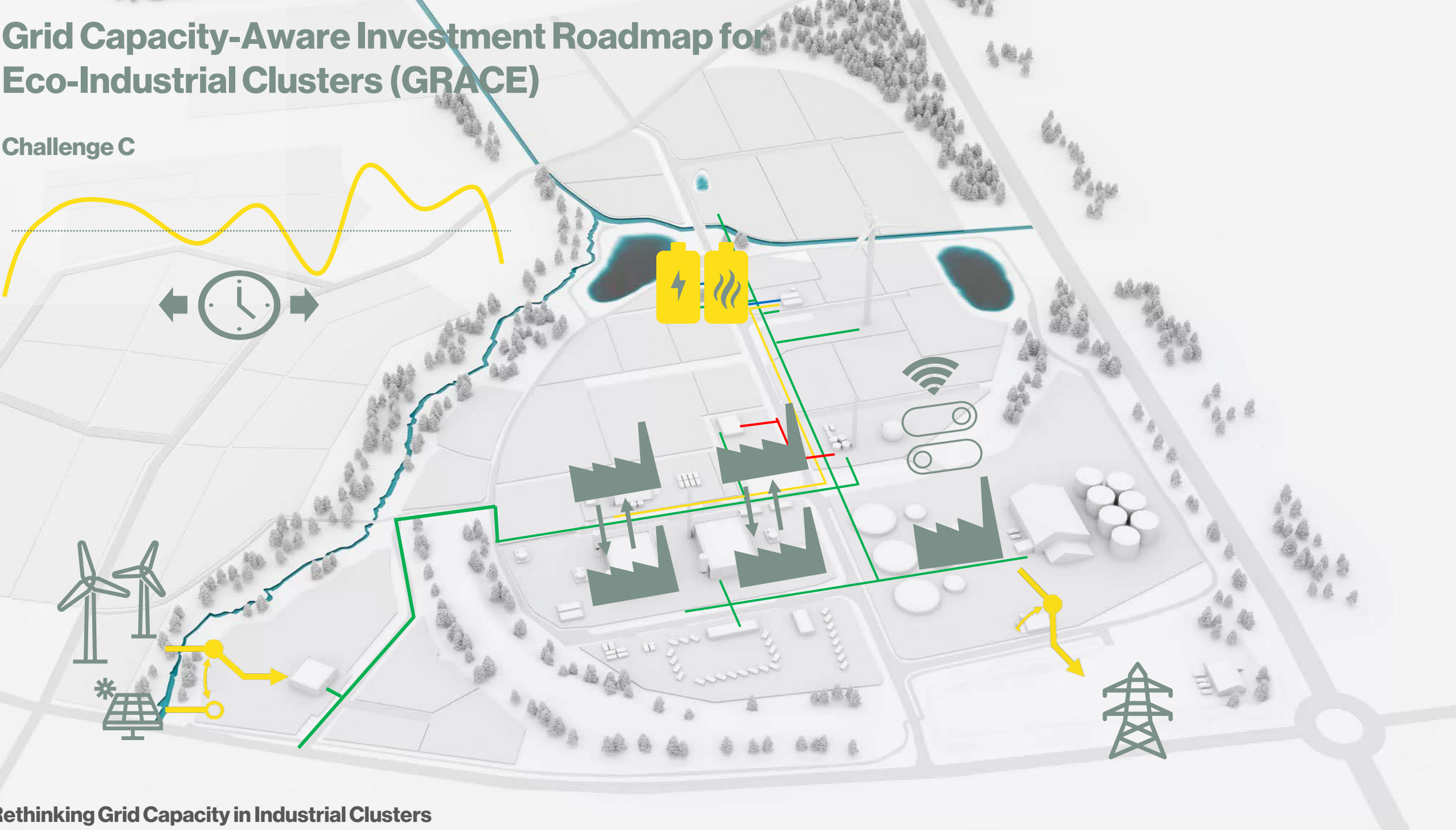
## Challenge B

- Renewable Energy
- Purified water
- Hydrogen
- Heat
- Money



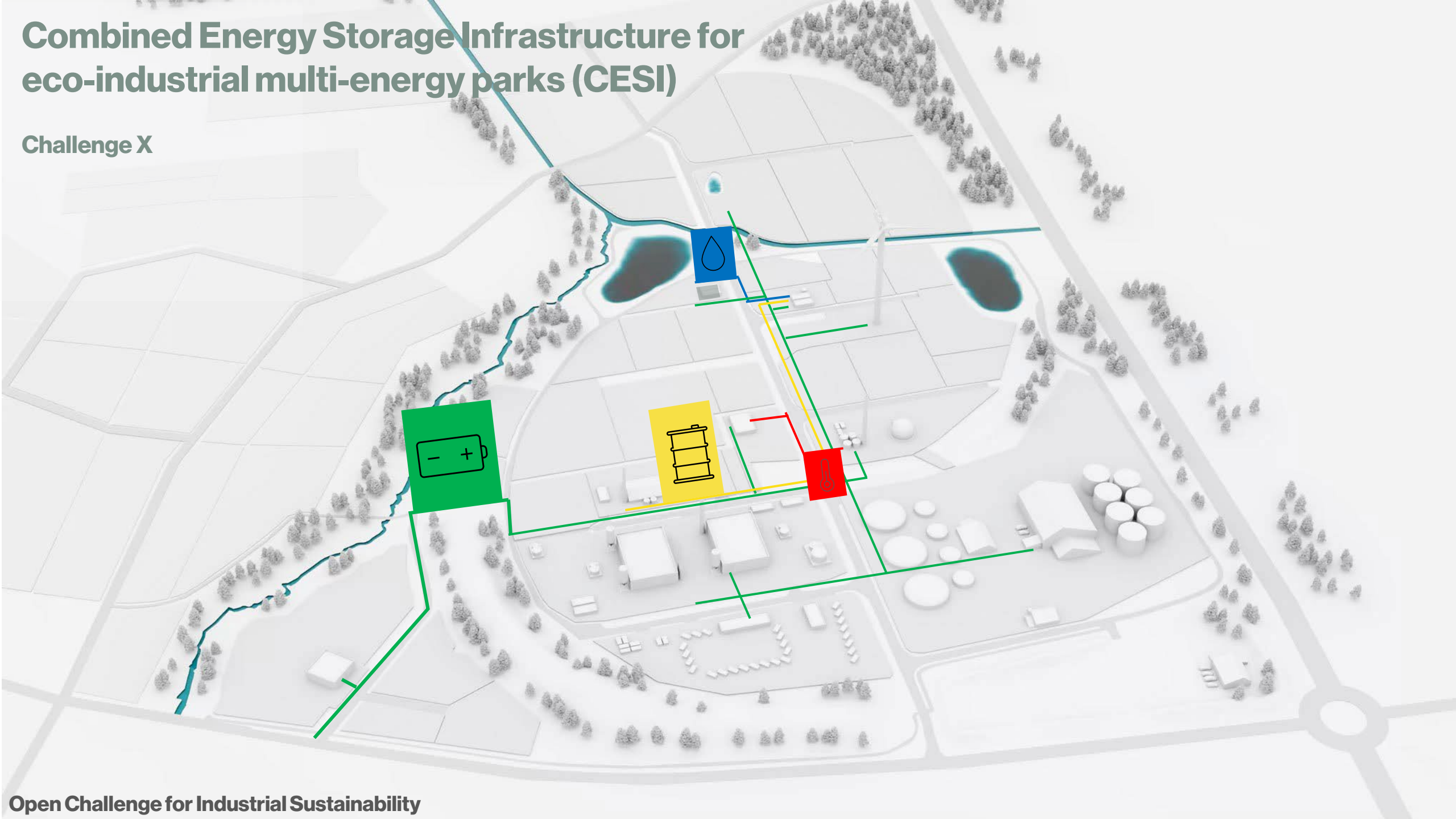
# Grid Capacity-Aware Investment Roadmap for Eco-Industrial Clusters (GRACE)

Challenge C



# Combined Energy Storage Infrastructure for eco-industrial multi-energy parks (CESI)

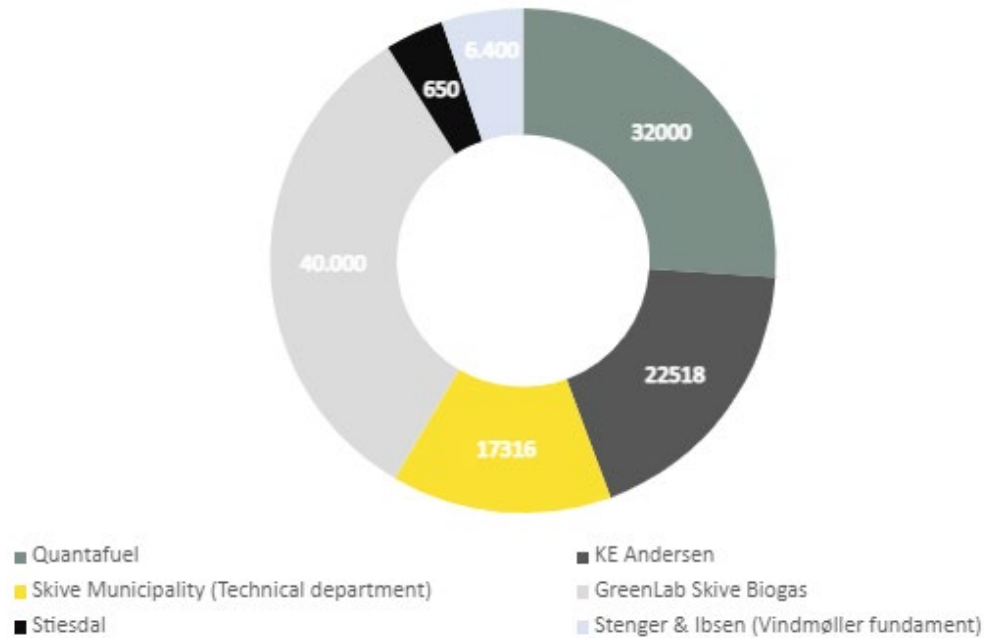
Challenge X



**TOTAL INVESTMENTS**  
**+3 DKK BILLION**

# Local Impact: Green Job Opportunities

## EXTERNAL HOURS ON CONSTRUCTION



### Total

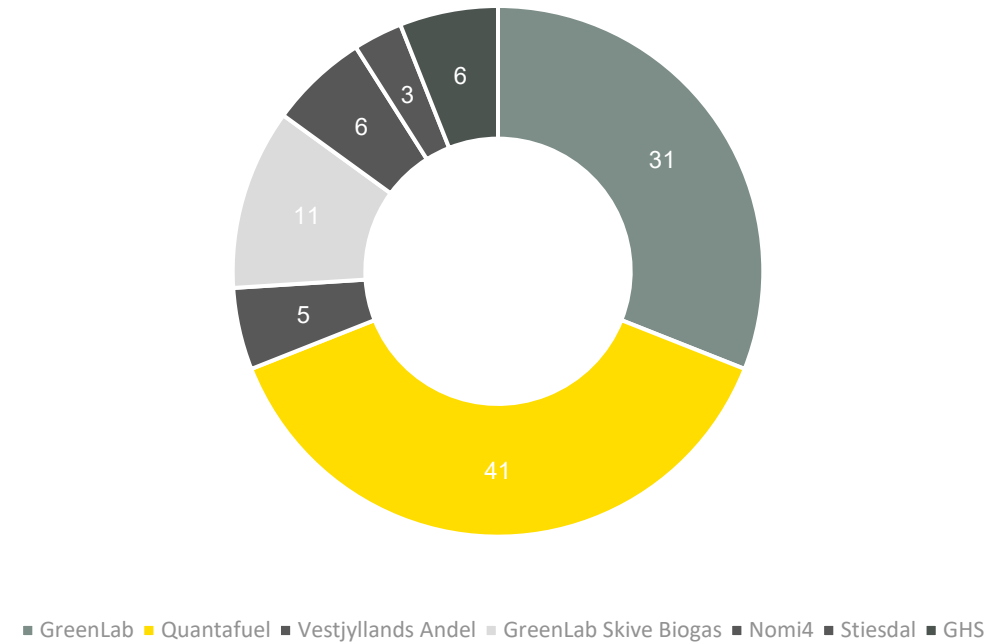
Approx. 122.800 hours (Focus on local businesses)

### Upcoming projects employing local businesses

GreenLab Skive P2X  
Green HyScale (100 MW)  
Unwasted

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## JOBS CREATED IN GREENLAB TODAY



### Total

Approx. +100 FTE positions

### Upcoming projects creating local jobs

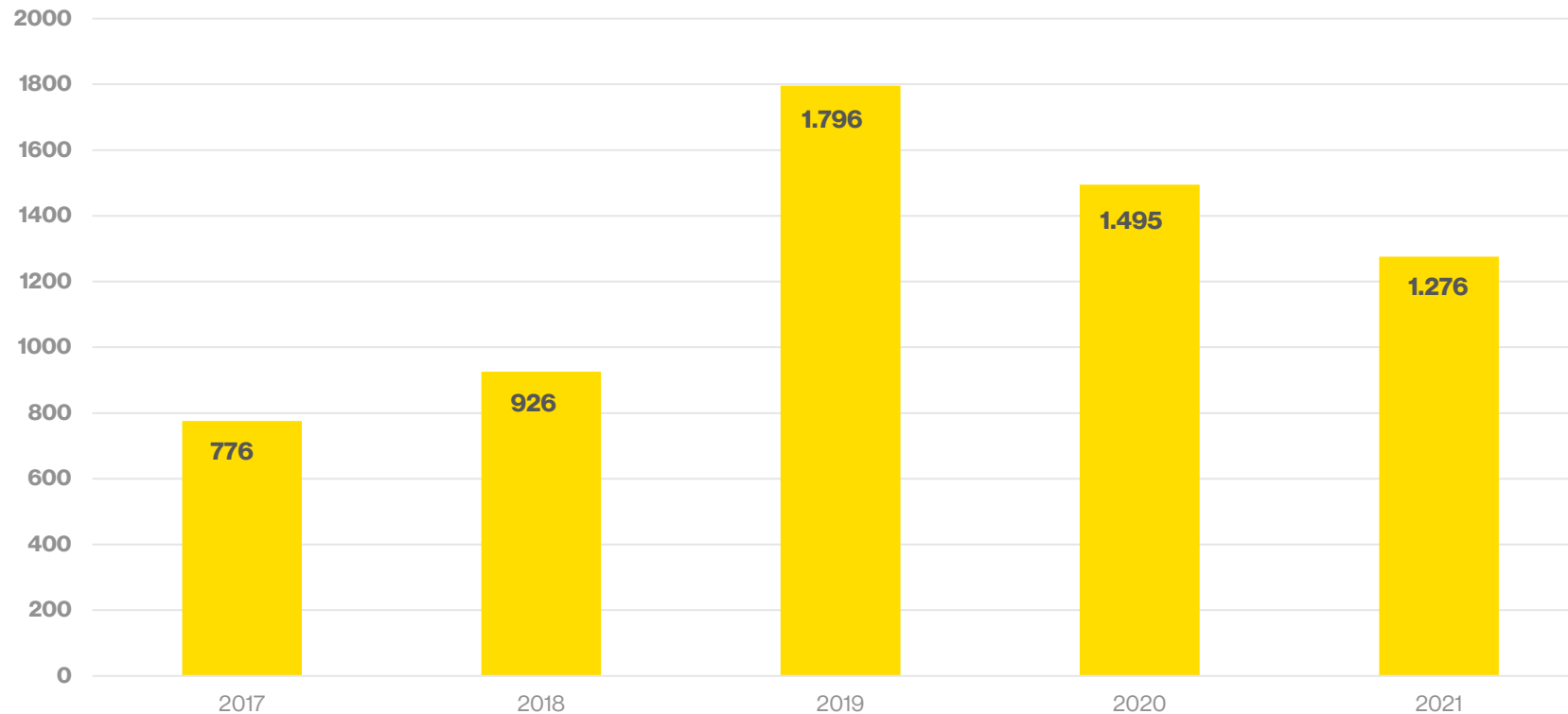
GreenLab Skive P2X 24 MW  
Stiesdal, Unwasted (approx. 100 FTE)  
GreenHyScale (100 MW)

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# Local Impact: Business tourism

GreenLab focus is to integrate business initiatives that ensure a forward-looking influx of visitors to the local community – "Green Growth"

Greenlab related nights in hotels



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# WHAT ARE THE CHALLENGES FROM YOUR PERSPECTIVE?

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# GreenLab Innovation Center



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DESIGN PROPOSAL



**LET'S CREATE  
A POWER SHIFT**

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