

An aerial photograph of a construction site, showing various structures under development and construction equipment. The image is dimmed to allow a semi-transparent logo to be centered over it. The logo consists of the word 'Green' in white, 'Lab' in a yellow grid pattern, and 'skive' in white below it.

GreenLab
skive

Table of contents

1. Who we are – GreenLab Skive
2. Market outlook and situation
3. Our business model
4. Commercial and development partners



1. Who we are – GreenLab Denmark

GreenLab combines green energy and intelligent technology in the world's first truly green symbiosis



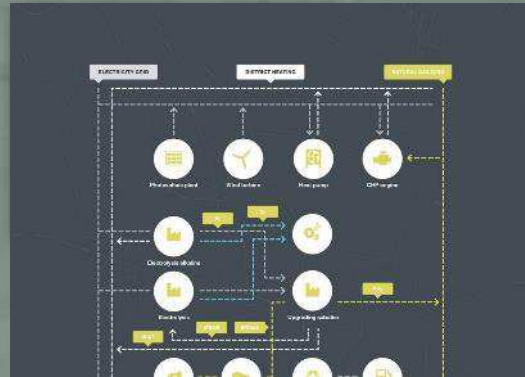
The Site – GreenLab Industrial Energy Park



Located at the **nexus of the national gas and electricity infrastructure** gives an ideal environment to apply **P2X Technology**. The symbiotic grid connects companies that consume and supply **green energy**, fuels, resources and products



A green, full-scale symbiotic network



SymbiosNet© is the world's most advanced and **first truly green commercial symbiosis**. A **fully integrated infrastructure for electricity, gas, fuel, thermal and data distribution** enables the **symbiotic energy network**



Innovation, research & development



Research partnerships with the Danish universities, including two of the **Top 10 engineering universities** in Europe: Aalborg University and DTU to expand the application of renewable energy (RE), **production of clean fuels** and to develop the **intelligent algorithm** at the center of our symbiosis



Global partnerships & regulatory advantages



GreenLab provides solutions to some of the most pressing global challenges and we **create both political and commercial partnerships** with leading international organisations to support the journey towards a **greener future**

GreenLab reconstructs **sustainable production**

Purpose

GreenLab reconstructs sustainable production for a greener future. The future can't wait. We rise now. We are instigating the transition to a sustainable and more collaborative approach to energy for the world of tomorrow.

Vision

GreenLab leads the world's most intelligent energy symbiosis. Our dream is to ignite a global energy revolution, substantiating the belief that green transformation is not only a feasible – but also a profitable – solution.

The intelligent energy symbiosis - **fully operational by 2020**

The Site

- An area of 60 ha. Equals **85 football fields**

Currently present at site




- 40 bar gas grid
- 4 bar distribution net
- 150 kV grid
- Raw biogas
- Landfill gas
- Planned central heating
- Oxygen, Hydrogen, CO2

Symbiotic energy network

- An internal grid that enables the exchange of surplus resource and energy-streams between the entities

Site development



Symbiosis Components	Category	Input	Outcome
	 Site	Infrastructure exchange and grid access	SymbiosNet© energy exchange and grid access
		Business Park	Land ready for building, full service
	 Symbiotic network	Robust operations	Reduce risk, increase production up-time
		Efficiency	Best cost benefit, capex reductions
		Maximize green energy	Hybrid solutions and storage
	 Innovation and R&D	Intelligent systems	Continuous improvement
		Optimization	Maximising utilization of energy forms

Our model is a truly collaborative Public-Private-Partnership

Collaboration between policymakers, utilities, commercial and academic players align incentives and enables change





2. Market outlook and situation

GreenLab enables the green transition



The hydrogen economy, mobility and renewable fuels

- The move towards a hydrogen economy is accelerated in the decarbonisation of the mobility sector
 - Decarbonisation requires new technology, fuels and production methods
 - It cannot be obtained solely through electrification due to barriers and limitations of batteries
- Hydrogen and other electro fuels can replace fossil fuels without significant change in end-use technologies



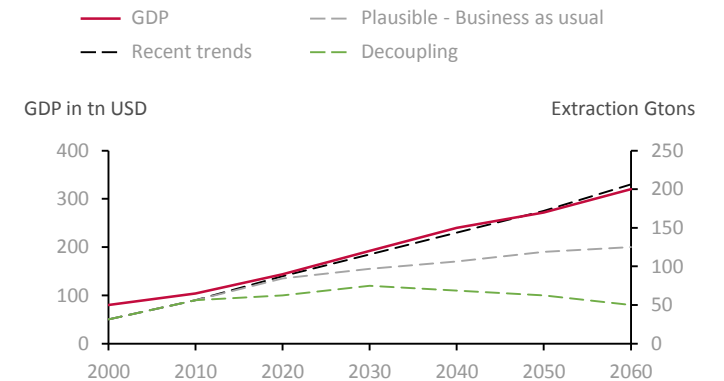
RE use cases and challenges with cyclicity

- To obtain the full potential of RE it is insufficient to focus application solely on electricity grids
- The move from electrons to molecules can expand the use case for RE and contribute to solve the challenges of the increasing share of RE in the national grid
- To apply RE directly to the production of clean end-products
- To allow efficient storage mitigating cyclicity



Increasing resource efficiency through circularity

- It is paramount to decouple GDP growth from material use by increasing our recycle and reuse materials through radical changes via increasing circularity in production



We drive the commercial development of production of truly clean fuels

We power developments of clean energy storage and expand RE application

Our circular production drives resource optimisation with a positive business case

EU RE Directives define **targets for the transition**

EU energy transition main goals

Share of RE in final consumption

- 20% by 2020
- >32% by 2030
- 14% of RE in transport consumption by 2030

Increase in energy efficiency

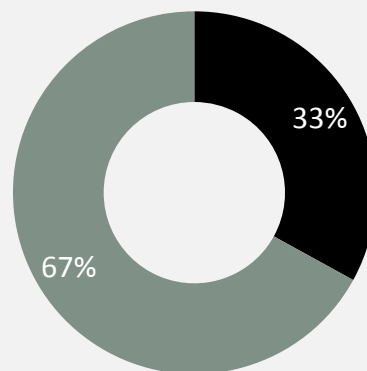
- 20% by 2020
- >32.5% by 2030

Green House Gas reduction

- 20% by 2020
- 40% by 2030

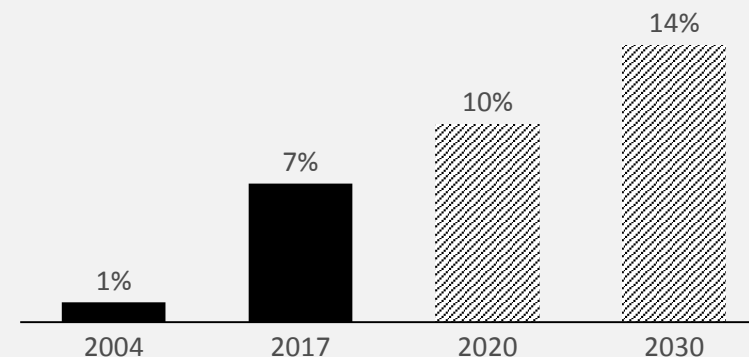
Current state of transport energy consumption in the EU

Final energy consumption EU-28 (2015)



■ Transport ■ Other energy

Share of RE in transport



From 2020 to 2030 the use of RE in transport is expected to jump from 10% to 14%. (CAGR of 3,4%)

RED II stipulates that the 14% target could be reviewed and increased in 2023

Nowadays, conventional biofuels have the highest contribution to the RE content. But share will be capped at 7% to avoid overexploitation of farming lands

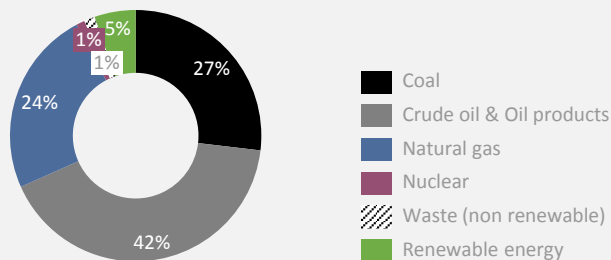
GreenLab enables the application of green types of fuel and energy to fill the gap

Japan is **increasing share of RE** but transitioning slower

Japanese RE targets by 2030

RE goals

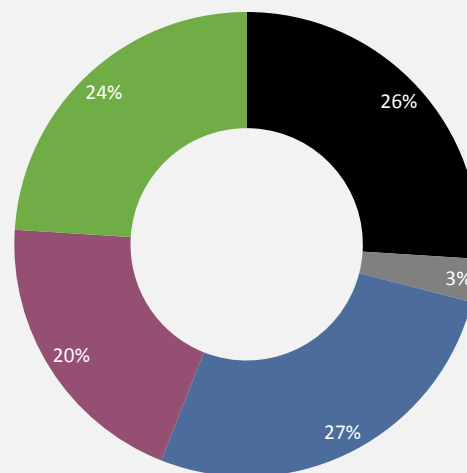
13-14% of primary energy supply by 2030



Japanese electricity production mix by 2030

Energy mix 2030

Nuclear is expected to be a major source

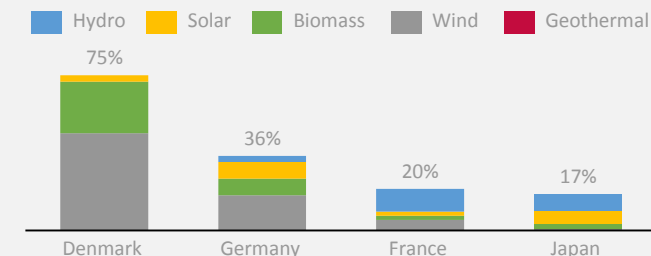


Comparison to selected EU countries

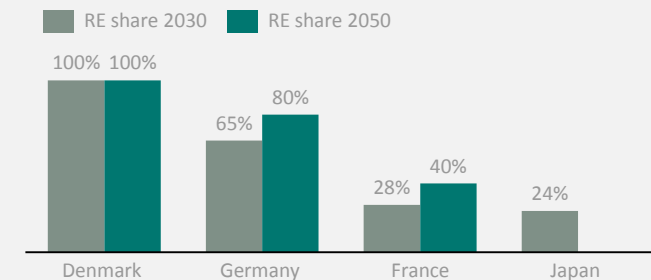
Comparison to EU countries

Renewables in EU is contributing to a larger part of supply

Renewable share of energy mix in selected countries (%)

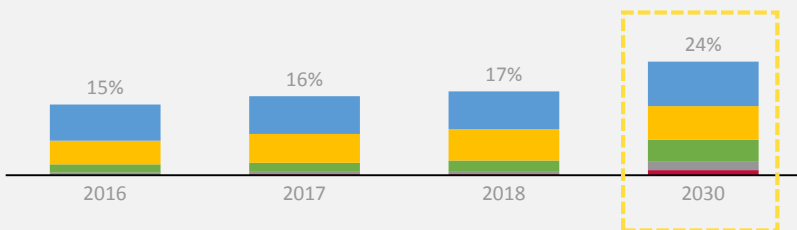
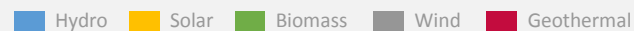


Renewable share of energy mix in selected countries (%)



Increase in energy efficiency

22-24% of total power generation by 2030



GreenLab: the RE fuel production platform of the future

Technology and infrastructure

Partners and Symbiosis

Direct connection to new renewable sources with additional capacity	A biogenic CO ₂ source available on site	Access to the gas grid allows possibilities to sell certificates of origin	Essential partners are already in place and on site
<ul style="list-style-type: none"> The RE production capacity connected to GreenLab is: new, dedicated and directly connected This is a decisive criteria to match regulatory requirements of the production of clean hydrogen and renewable fuel 	<ul style="list-style-type: none"> The connected biogenic CO₂ source makes it possible to take full advantage of power to liquid technologies, thus clean renewable diesel and gasoline We obtain CO₂ from other renewable processes, hence have full certainty or minimal climate impact 	<ul style="list-style-type: none"> The gas connection allow the injection of H₂ production into the national grid GreenLab and partners can trade Guarantees of Origin (GO) by strategically injecting the H₂ production into the gas grid as a 'grey CH₄' molecule This can transfer the attributes of the clean H₂ via GO, to another H₂ user There is an opportunity in the Municipality of Copenhagen's investments in fuel-cell buses that can buy H₂ from any H₂ source and balance their application by the acquisition of GO's from GreenLab Skive 	<ul style="list-style-type: none"> Wind & solar PV capacities are agreed, and fulfil the requirements of additionality and direct connection (from RED II) QuantaFuel, a innovative clean fuel producer, is on-site, and produce fuel to maritime customers Several industrial companies are on-site and able to generate opportunities in resource pooling (heat, cold, electricity, oxygen, electric consumption flexibility, etc.)
<p>RED II requirements</p> <ul style="list-style-type: none"> RE plant comes into operation at the same time as fuel production plant If an RE source is also connected to the grid, a producer shall provide evidence that the electricity was not taken from the national grid* 	<p>RED II requirements</p> <ul style="list-style-type: none"> Regulatory requirements regarding CO₂ source are yet to be defined 	<p>GreenLab and/or partners can trade certificates that give a stable revenue stream with no geographical limitations</p>	<p>Central partners create the backbone of the symbiosis and are committed and provide the foundation of an ideal environment</p>
<p>The GreenLab concept is currently the only system that fulfil requirements to produce 100% renewable fuels</p>	<p>The biogenic CO₂ source ensure climate optimised production and overcome any regulatory uncertainty</p>		

Renewable fuels are needed to fill the gap towards the RE goals, which offers a huge economic potential for the GreenLab Model



3. Our business model

The GreenLab **principles**

- 1. Positive community effect**
Local growth, global view, trust
- 2. Competitive Advantage**
Attract resourceful partners
- 3. Symbiosis to synergy**
Paradigm shift prognosis to products
- 4. Mutual incentives**
Long term engagement
- 5. Sustainable**
Accelerate the circular economy
- 6. Continuous learning and development**
R&D to commercial
- 7. Global frontrunner**
Show it, don't tell it

2018

Groundbreaking

2019

Four sites operational

2020

Full operations

2021




Expansion

The world's first truly green commercial symbiosis

 The Site

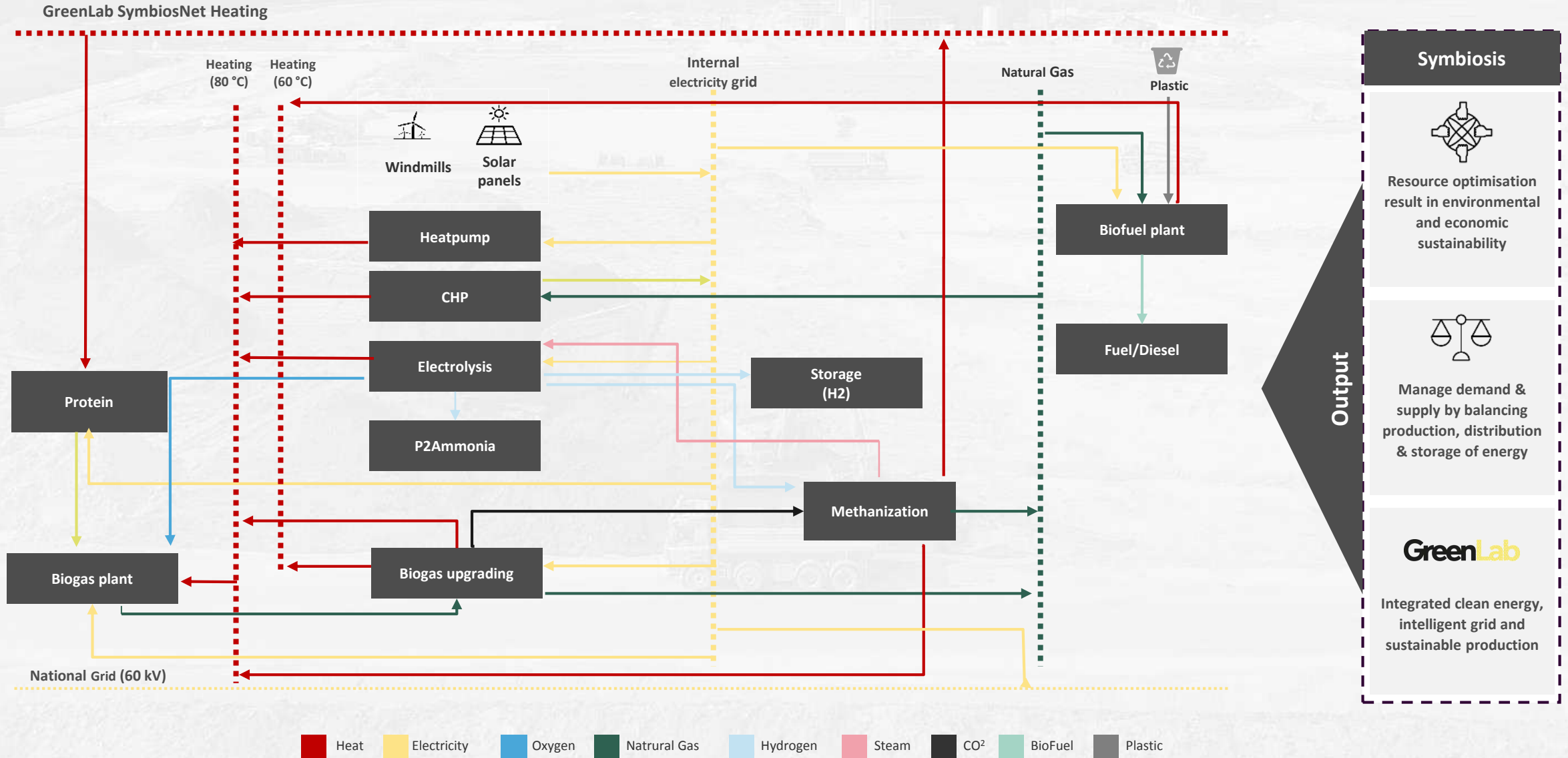
 SymbiosNet©

 Innovation, research & development

	1 Infrastructure	2 Clean energy	3 Energy Conversion	4 Energy Storage	5 Smart Grid	6 Analysis, AI & IOT	Symbiosis
Why	<p>Creating flexibility Contribute to a decarbonization through a positioning and technology that increase flexibility in energy source and timing</p>	<p>Sustainability Push the boundaries by intelligent integration of RE to decarbonize production</p>	<p>Energy flexibility Transforms energy to allow flexibility in the application and to enable the production of a variety of green products</p>	<p>Enabling optimization Overcome the inflexible and the unpredictable nature of RE</p>	<p>Intelligent balancing Maximize the utility of energy</p>	<p>Automation Optimize processes by automation of data collection and processing</p>	<p> Resource optimisation result in environmental and economic sustainability</p>
How	<p>Conversion & optimization The grid integrate electricity, gas, heat, fuels & data exchange, and connect to national grids for supply & consumption</p>	<p>Plug and play platform Engage with a range of actors who plug in to the integrated grid that support sustainable production at scale</p>	<p>Conversion Converts energy to distribute to the optimal off taker</p>	<p>Multiple storage opportunities Energy is stored and applied within the system or sold for use outside the business park</p>	<p>Demand-response Direct the energy to where it has the most use to balance demand throughout the system</p>	<p>Technology & analytics Analysis of energy flows and interaction in system to continue to optimize system load</p>	<p> Manage demand & supply by balancing production, distribution & storage of energy</p>
What	<p>Multiple Grids GreenLab is an electricity, thermal & gas grid able to distribute energy within the system & directly to the national grid</p>	<p>Connection of multiple RE producers Wind, Solar, Thermal, Waste to energy etc.</p>	<p>P2X technology Enable the conversion of power into a variety of forms such as Hydrogen, Ammonia, Methanisation, Thermal</p>	<p>A truly sustainable business park Full storage possibilities for all relevant energy types</p>	<p>Unique software solution A software solution that is able to direct energy within the system</p>	<p>Real-time data & intelligent algorithms Technology provide real-time data on demand, prediction and trading algorithms</p>	<p> Integrated green energy, intelligent grid and sustainable production</p>

Output

The GreenLab concept allowing optimization and balance



1/3 The site is **situated in an ideal location**

The GreenLab site is situated in the nexus between the national electricity and natural gas pipeline

Infrastructure phases

GreenLab Denmark site



National Natural gas pipeline



Existing infrastructure

- Close proximity of three national grids: district heating, natural gas grid and Electricity
- GreenLab is situated at the site of a local waste management plant

Enabling infrastructure

- Internal electricity, heating and gas grid
- Wind and solar park with 80 MW capacity
- Substations allowing connection to national Electricity grid
- Heat pump and boiler allowing connection to district heating grid
- Pipes connecting to natural gas grid

Optimizing/balancing infrastructure

- Power to gas installations
- Combined heat and power plant
- Biogas production facility
- An intelligent collection of partners with synergies between production bi-products and production inputs

National Grid (60 kV)



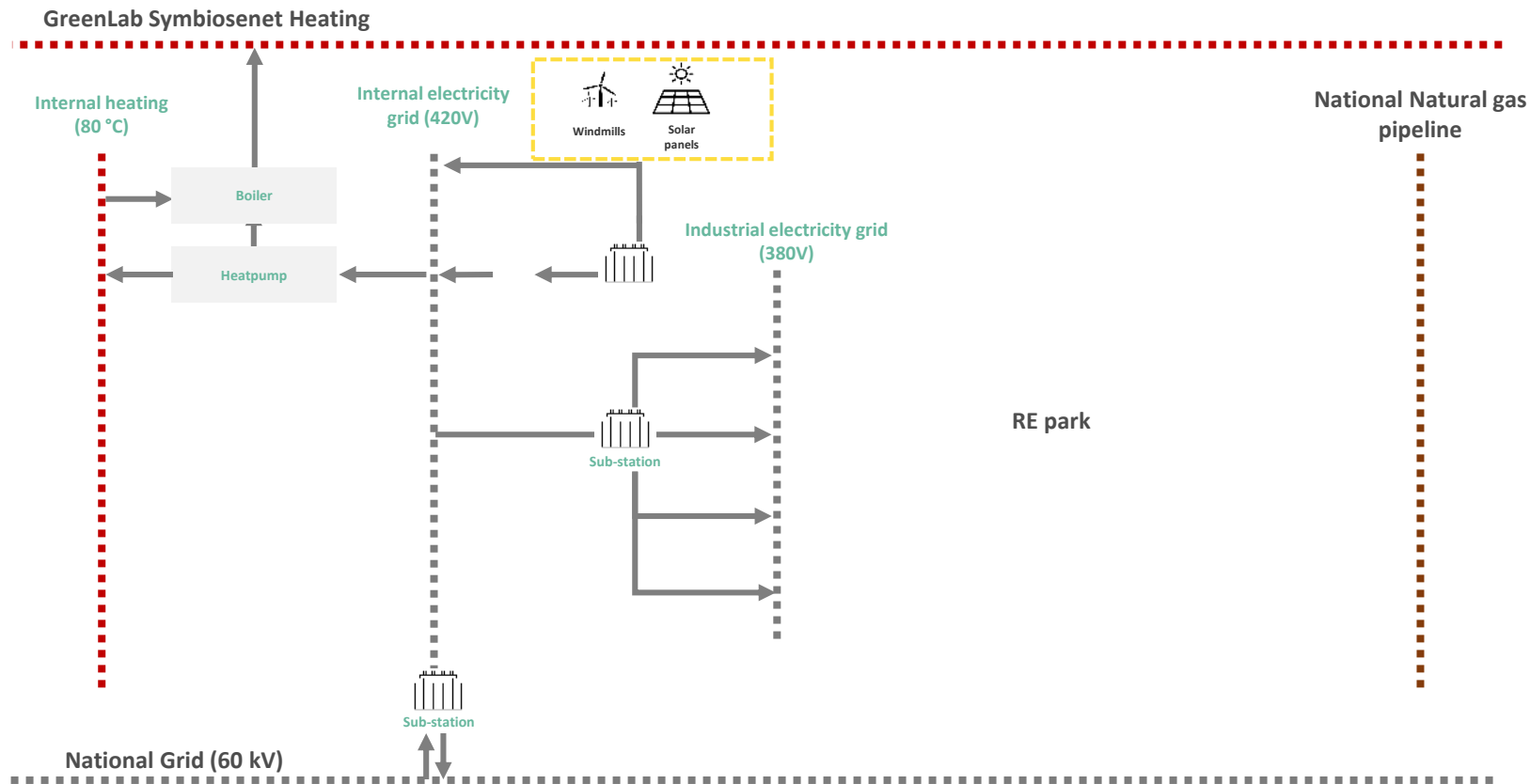
■ or Sub-station = GreenLab's infrastructure need

■ Battery = Potential additional system optimization

2/3 Electricity production and energy distribution infrastructure creates the foundation of the symbiosis

Enabling infrastructure creates the foundation for a symbiosis

Infrastructure phases



Existing infrastructure

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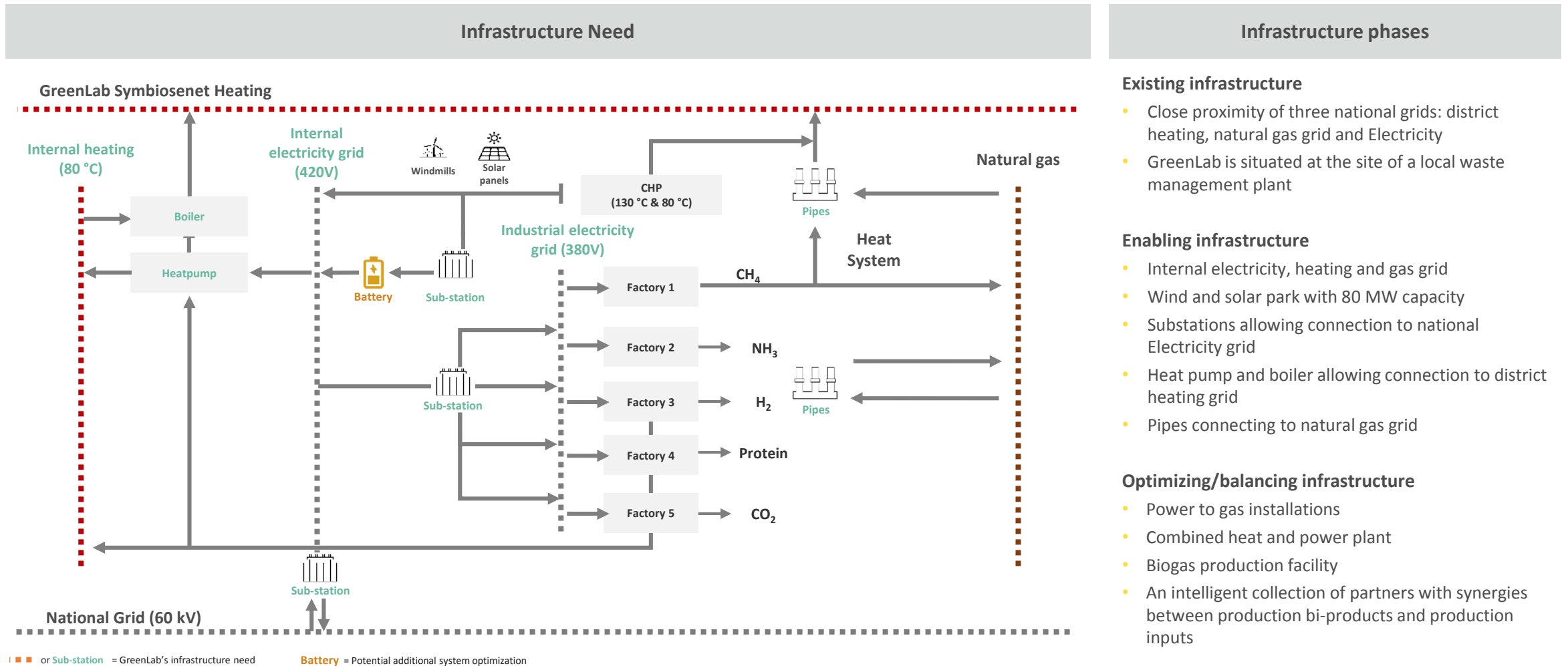
Enabling infrastructure

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Optimizing/balancing infrastructure

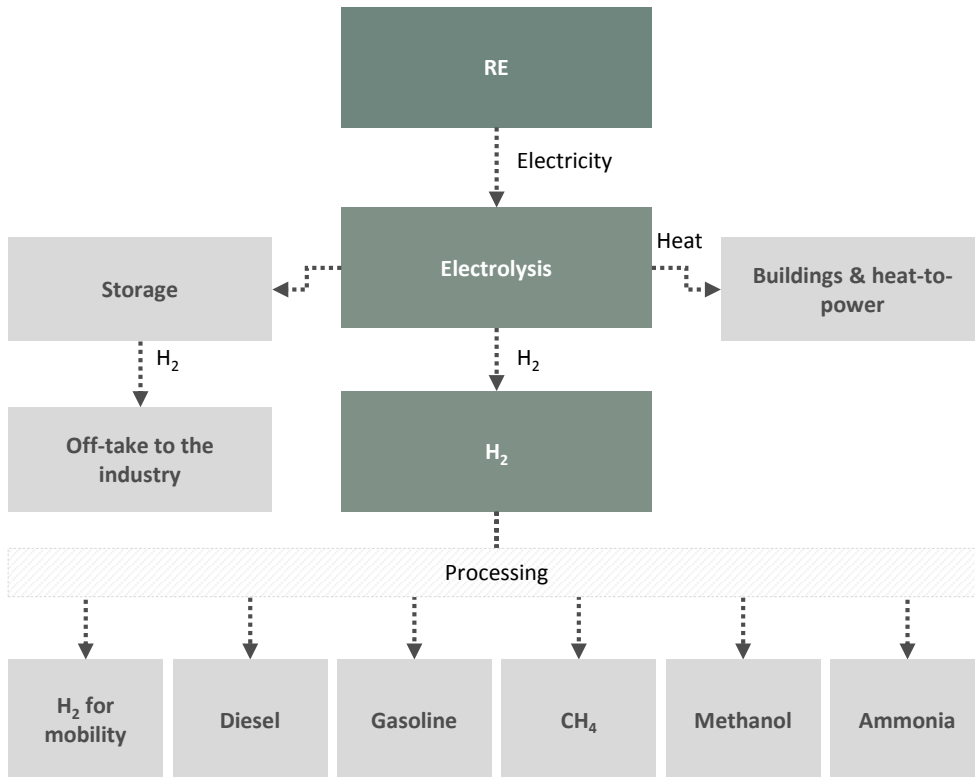
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3/3 Optimizing infrastructure enable that 2+2 becomes 5 for actors within the symbiosis



Power to H₂ opens a wide range of renewable fuel possibilities

Electrolysis is the foundation for renewable fuels



Application possibilities of possible biofuels




Renewable fuel	Light vehicles	Trucks	Buses	Trains	Ships	Comments
H ₂	X	X	X	X	X	Nearby business cases such as Copenhagen fuel-cell buses
Diesel	X	X	X	X	X	Direct compatibility with existing diesel and gasoline engines facilitate the mutualization of supply-chain & customers
Gasoline	X	X	X			
CH ₄	X	X	X		X	Development of CNG mobility reinforces business model
Methanol	X (Drop in fuel)	X (Drop in fuel)	X (Drop in fuel)		X	Compatibility with gasoline production, + early-stage development of 100% methanol transport applications
Ammonia		X	X		X	Early-stage development of new ammonia transport applications – especially within shipping

With electrolysis plants as a core component of GreenLab, we have the optimal conditions for accelerating green transportation



4. Commercial development partners




Commercial interest, R&D **and** academic research

	From electrons to molecules	Circular production is a win-win	Collaborate to push the boundaries
Organisation	 <p>Is a leader in RE, working primarily with +90GW onshore and offshore turbines installed worldwide</p> <p>23.000 employees</p> <p>€ 9,100,000,000 revenue</p>	 <p>Quantafuel produces environmentally friendly, clean and low-cost synthetic diesel from wasted resources through unique and highly effective gas-to-liquid technology</p> <p>\$ 2,697,000 Operating income</p>	 <p>DTU is an international elite technical university where education, scientific advice, and innovation rest on a solid foundation of world-class research</p> <p>10,300 students and 5,800 employees</p>
Case	<ul style="list-style-type: none"> Large buildout of wind power in Denmark challenges turbine producers to find additional application for wind energy By feeling electrolysis with wind generated electricity it becomes possible to move from electrons to molecules In this case producing NH₃ Ammonia that can be applied as fuel in maritime transportation eliminating CO₂ emission and producing useful bi-products 	<ul style="list-style-type: none"> Quantafuel uses locally collected plastic obtained through the municipality's waste recycling plant Quantafuel applies a technical process producing recycled diesel sold to the maritime sector This process generates a large amount of heat, which is collected and distributed Other companies in the Symbios.Net© e.g. Danish Marine Protein off-takes the heat that is applied in production of protein from invasive starfish 	<ul style="list-style-type: none"> Demands to the national energy infrastructure are increasing, to manage an expanding share of renewable electricity production DTU/PowerLabs collaborates with GreenLab to create intelligent algorithms enabling the optimisation of energy use in complex systems Project is backed by €4.000.000 EU funds and will include development of intelligent algorithms applied to RE management
Take away	Expanding application of RE creating sustainable fuel for large scale maritime transport	Recycling heat reduces cooling cost for Quantafuel (heat bi-product) and reduces heat cost for Danish Marine Protein (heat primary process input)	Providing innovative solutions to the intelligent management of RE by combining commercial interest with academic research

GreenLab achieves **full operation in 2020** followed by global expansion




Operations commence and development continue

Major milestones

-  Four sites become operational
-  Implementation of state-of-the-art electric heat pump (heat symbiosis)
-  Partnerships with major off-takers of RE fuels




Moving into the future

Major milestones

-  Renewable energy park with a capacity of 80MW wind and solar
-  Electrolysis installed on site enabling large scale H₂ and NH₃ production
-  Symbiotic energy park is fully operational

Expanding the symbiosis and pushing new boundaries

Major milestones

-  Symbiosis is expanded with new partners
-  Existing partners scale up production, especially within RE fuels
-  State-of-the-art research facility with short go-to-market time

Global expansion

Expansion of the GreenLab concept on a global scale through partnership-model



2019

2020

2021 and beyond

GreenLab provides the energy symbiosis of tomorrow



A unique organisation combining a commercial outlook while bridging the gap between political, academic and commercial actors

Strong knowledge synergies and enable effective decision-making



Direct connection to RE plant and a biogenic CO2 source on site, which enable production of clean fuels

Clean fuel production is essential for decarbonisation, has major commercial potential and no regulatory risk within new EU directives



The symbiotic network enables resource optimisation within the business park

The SymbiosNet© minimise cost and climate impact through maximising resource efficiency and circular resource application



The combination of actors, experimental environment and scale provide a park unique for commercial and academic R&D

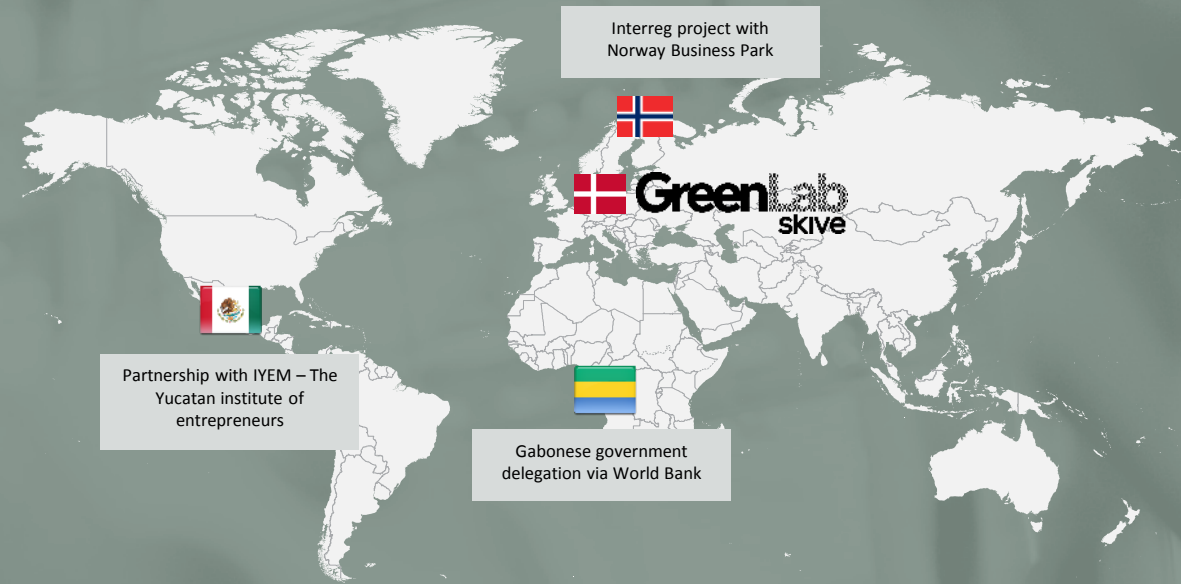
Application of new processes and technologies provides a platform for producing cleaner and more competitive products e.g. RE fuels



GreenLab is relevant on a global scale to drive the change towards a hydrogen economy and broaden the application of circular value chains

Partnership with IYEM – The Yucatan institute of entrepreneurs and recent visit from Gabon indicates a truly global potential GreenLab holds

Contributing to the green transformation on a global scale



SIEMENS Gamesa

e-on HALDOR TOPSOE

PRAXAIR

QUANTAFUEL

Danish Marine Protein

DEIF

PlanEnergi

ALL NRG

DTU Technical University of Denmark

AALBORG UNIVERSITY DENMARK

Skive College

eniig

SKIVEKOMMUNE

SKIVE VAND



GreenLab
skive

Thank you for your time