

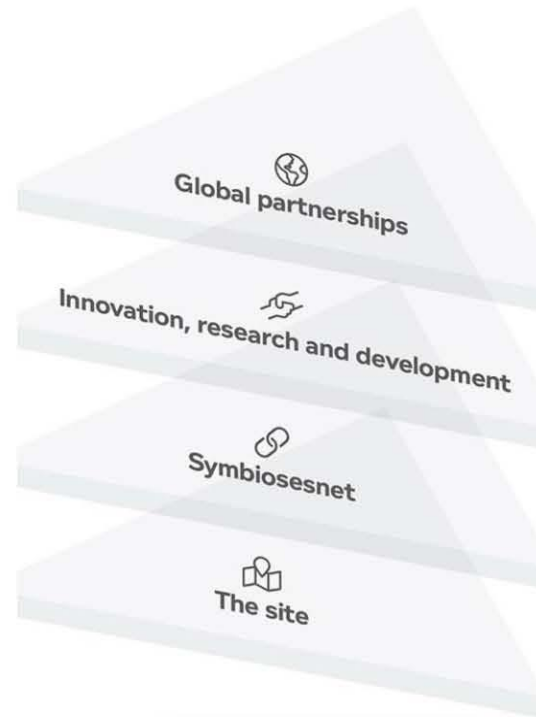


The Future of Energy is our Business

GreenLab Skive

The future of energy is our business

- GreenLab Skive is a unique park for businesses working actively with integrated renewable energy, energy storage and resource efficiency.
- GreenLab Skive's ambitious aim: to become the leading centre for integrated green energy, intelligent grid and sustainable production.
- The business park is located at the nexus of Denmark's national electricity and gas infrastructure.
- Businesses and research entities that join GreenLab Skive will have the advantage of a facilitated industrial symbiosis that develops and explores the new opportunities for technology and business.





A physical space
An innovation center
for research and
development



The GreenLab Skive Principles

- Positive community effect
- Competitive Advantage
- Symbiosis to synergy
- Mutual incentives
- Sustainable
- Continuous learning
- Local growth, Global perspective

GreenLab
skive

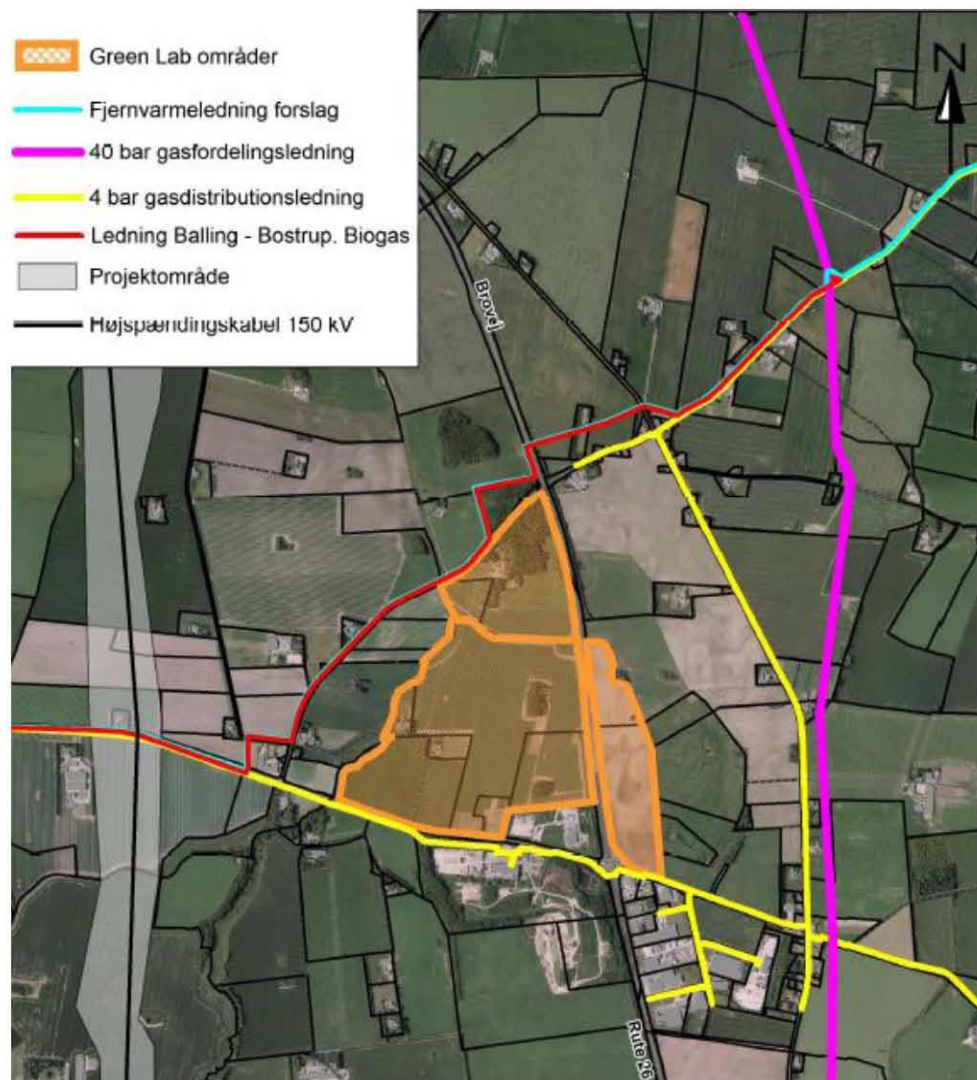
GreenLab Skive

- A total area of 60 ha.
Equals 85 football fields

Present at the area:

- 40 bar gas grid
- 4 bar distribution net
- 150 kV grid
- Raw biogas
- Landfill gas
- Planned central heating
- Symbiosenet

Development of an internal grid for





Opening event November 2017

Quantafuel A/S





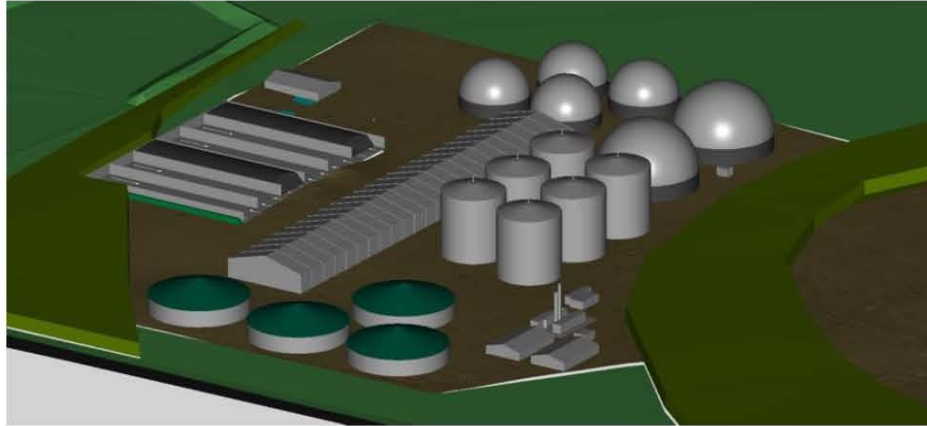
On Quantafuel

- The company Quantafuel, with its headquarters in Norway, is building worlds first full-scale factory for the conversion of synthetic plastic waste plastics.
- The plant has a groundbreaking pyrolysis technique that enables 60 ton of waste plastic to convert to about 48 tons liters of synthetic fuel on a daily basis.
- The production of synthetic waste from waste plastics is a greener form of production than normal diesel production, and the plant in GreenLab Skive could reduce CO2 emissions by up to 80% in the production stage in terms of traditional diesel production.
- Construction work started in April 2018 and is expected to be in operation December 2019
- Planning to triple the plant by 2021
- Demand for Green Hydrogen from windturbines



On GreenLab Skive Biogas

- Plans to establish a biogas plant with a capacity of 20 million cubic meters of biogas.
- Jointly owned company between E.ON and GreenLab Skive Biogas supplier company, consisting of local farmers.
- The plant is given both a line for both organic and conventional production.
- Central element of the Symbiosis set, as well as in the development of Power-2-Gas.
- Expect to start production in December 2019.





Patent: The present invention relates to the provision of leaf protein concentrate and food grade soluble functional proteins and possibly other high value products and fibers from a green plant material. The method further provides for the possibility obtaining fermentation products as biogas and finally fertilizer.



Worlds First blue protein production



On Danish Marine Protein - Groundbreak 2018

- Danish Marine Protein works to harvest and dry starfish from the Limfjord, where they are an increasing problem for mussel production
- The production plant will be Denmark's and the world's first of its kind in full scale.
- Danish Marine Protein is part of innovation collaborations with other participants in GreenLab Skive.



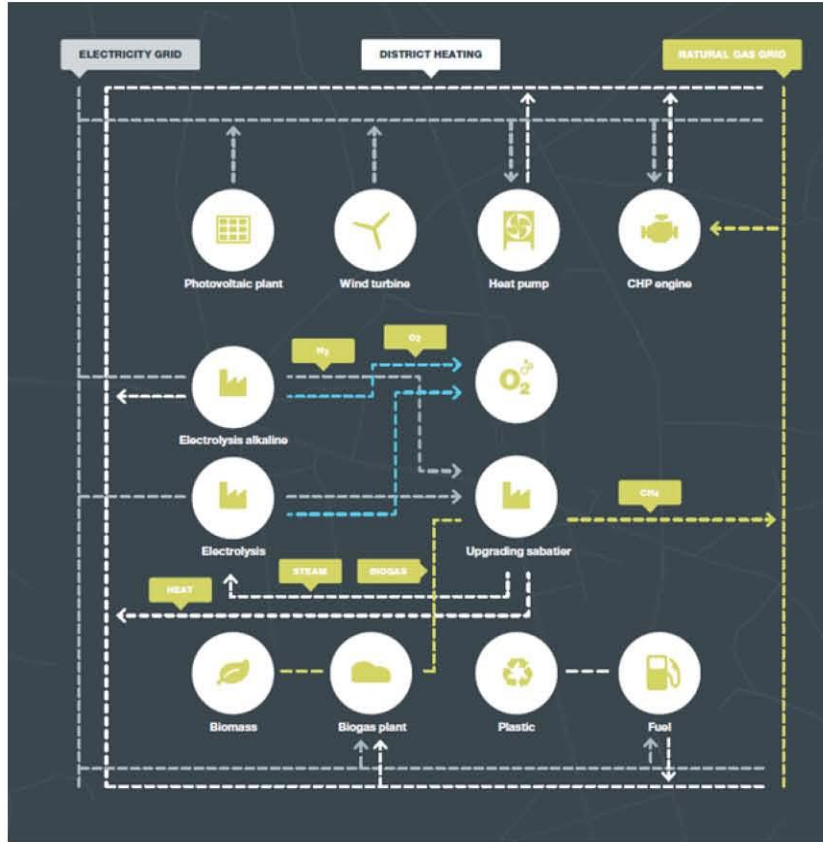
Windturbines - 55 MW - 2020



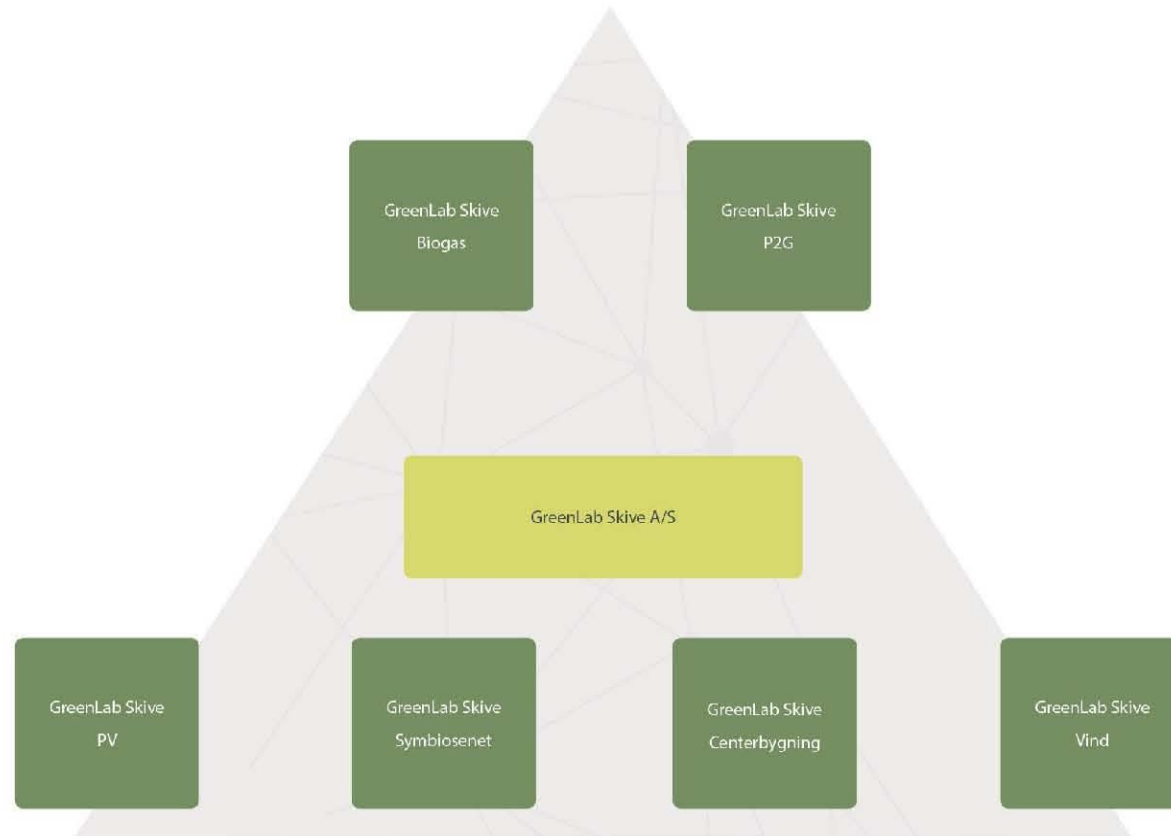
PV – 20 MW construction in 2020



A commercial community



A Multibusiness Model



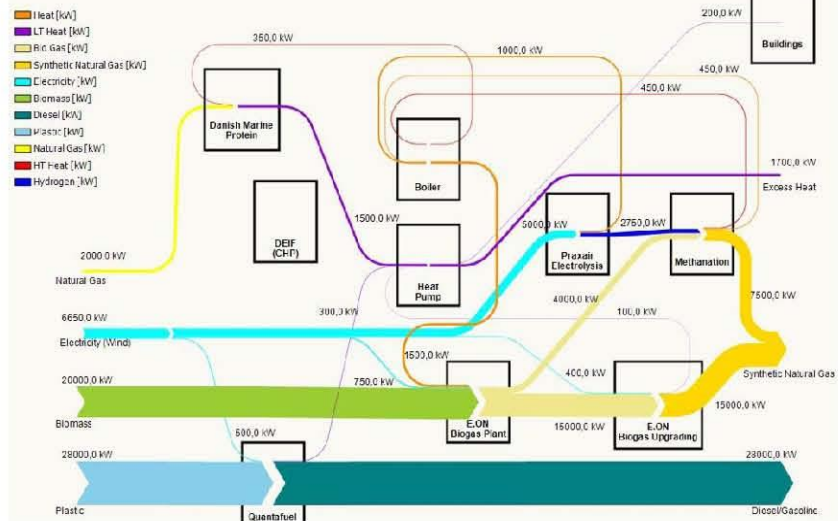
Synblasenet, GreenLab Skive 2018.03.26	
Product	Dimension
Heat	Various, see drawing
Natural Gas	ø200
Synthetic Natural Gas	ø200
Biogas	ø160
Landfill Gas	ø125
Oxygen	ø125
Hydrogen	ø160



Sustainable Economics for Sustainable Energy

GreenLab Skive

5 MW Alkaline Electrolysis



- Aligned with Energinet and government energy strategy
- Showcase for regulatory and legal frameworks, incentives
- A global showcase to develop and deliver intelligent green energy solutions

- Learning systems → continuous improvement
- Optimization → maximizing utilization of energy forms
- Efficiency → best cost-benefit, capex reductions
- Maximize green energy → hybrid solutions and storage
- Robust operations → reduce risk, increase production, up-time
- Infrastructure → Symbiosenet energy exchange and grid access
- Business Park → land ready for building, full service

Technical University of Denmark - DTU

- The Technical University of Denmark (DTU) and GreenLab Skive signed a formal agreement for strategic collaboration on Denmark's national goals to promote energy storage.
- The platform for the partnerships and innovation co-operation is under way and under continuous development. Examples include:
 - Intelligent energy and microgrids
 - SuperP2G



GreenLab - Research Platform for Integrated Intelligent Energy and Storage

Chaired by: Søren Linderoth, Prof. Head of Dept., DTU Energy and Steen Harding Hintze, CEO, Energifonden Skive

“GreenLabs international consortium with world-leading technologies gives us a unique opportunity to establish a platform for large-scale R&D. GreenLab will invite all interested parties to help co-create the goals and design of our GreenLab Research Platform, making it a long-term operational lab for Integrated Intelligent Energy.”



Preliminary R&D activities in GreenLab Skive

Mounting

- MECO1 – Development for Multi Energy Carrier Optimisation
- MECO2 – Business models for Multi Energy Carrier Optimisation
- National Centre for intelligent energy and storage
- Pilot project with methanol production in GreenLab

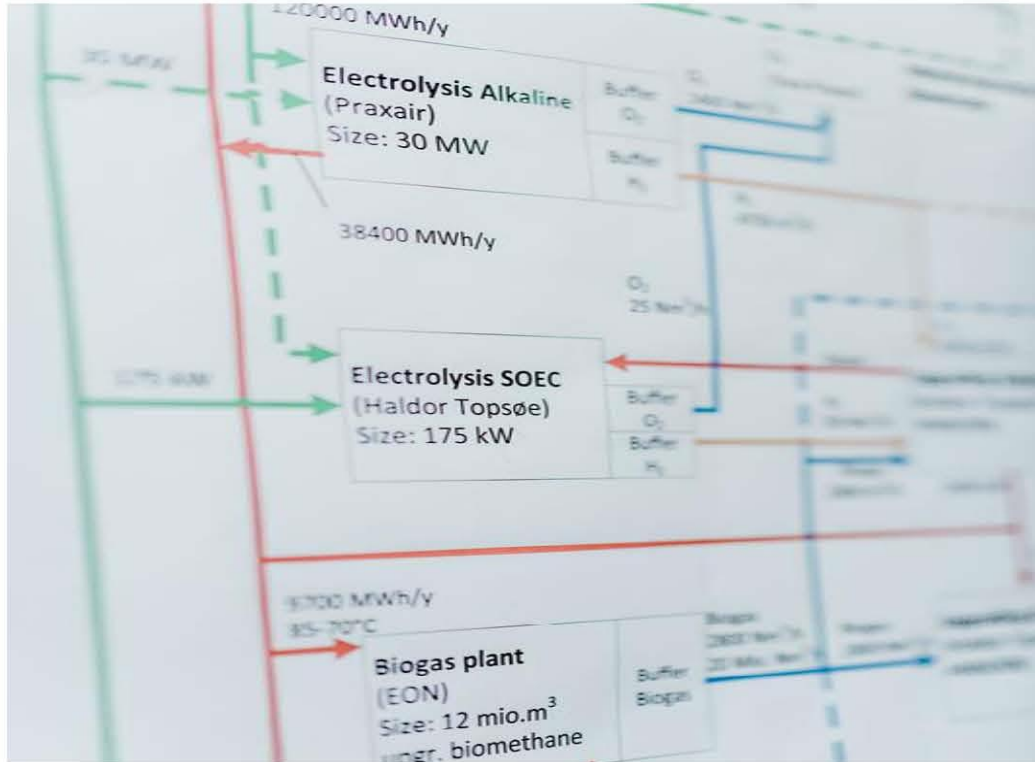
Pending approval

- SmartRouter - an integrated electrolysis/battery solution enabling cost effective and reliable energy routing between electricity and gas

Approved

- Digital Energy Lab under Powerlab.dk
- SuperP2G – ERA-NET
- CISKA - Interreg
- Centre for Energy storage – Region Midt

P2G - P2X - Business Development



KEY TAKEAWAYS

WHY CHOOSE GREENLAB SKIVE? AN IDEAL LOCATION FOR PRODUCTION OF GREEN FUELS

RED II

The Renewable Energy Directive II is a strong driver for energy transition and will increase the need for new generation fuels

RFNBOs*

Biofuels, advanced biofuels, electricity, and recycled carbon fuels, will not be sufficient to reach the 14% share of renewable energy in transports targeted by RED II: RFNBO will be needed to fill the gap towards 14% and this offer a huge economic potential

SKIVE

GreenLab Skive is a perfect ecosystem to produce renewable fuels: thanks to onsite wind generation, the set up in Skive will be compliant with RED II requirements for the production of RFNBOs counting towards the 14% target. Moreover, the site already has a (biogenic) CO₂ source for producing e-fuels from renewable hydrogen

ECOSYSTEM

In addition to the above assets, on-site companies are active in developing a e-fuels offer, providing commercial and operational synergies. This reinforces GreenLab's economic business model

*Renewable Fuels from of Non-Biological Origin

In GreenLab Skive, a relevant business model exists with RFNBOs production due the fit with RED II requirements, the presence of potential suppliers, partners and links to customers

WHY SKIVE?

**AN EXISTING AND POTENTIAL INFRASTRUCTURE
MATCHING RED II REQUIREMENTS**



Direct connection to new renewable plants

RE production capacity in GreenLab Skive are new, dedicated and can be directly connected. This is a decisive criteria to match RED II 'additionality' requirement.



Biogenic CO2 source available

As the methodology for calculating GHG emission reductions of RFNBOs is not in place yet, CCU from industrial CO2 sources could potentially not be allowed. GreenLab Skive's biogenic CO2 source overcomes this regulatory uncertainty.



Access to gas grid

This connection allows GreenLab Skive, or its partners, to inject H₂ production in gas grid.

Certificates are tradable products which can be sold separately from the physical product: e.g. a H₂ consumer who uses H₂ from a Steam Methane Reformer unit ("Grey H₂") can cancel a H₂ certificate and transfer to attribute of the GO to the H₂ consumed. Having a physical outlet of H₂ produced is why injection option becomes strategic.

Power-to-Ammonia

'Green' Ammonia

Green ammonia is key to meeting the twin challenges of the 21st century.



By 2050 there will be ten billion people on the planet.



Using ammonia as fertilizer makes land more productive. Increasingly vital as the population grows and living standards improve.

SIEMENS

People need food and energy and it must be CO₂ free – that's where green ammonia comes in.

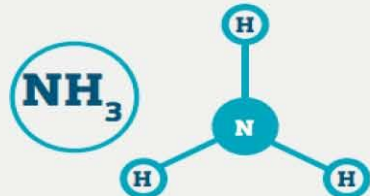
Ammonia

Ammonia is a compound made of nitrogen and hydrogen. Chemical formula NH₃. Ammonia's main use is in fertilizer.



Nitrogen is a harmless odourless gas that makes up 78% of the air around us.

Hydrogen is the most abundant element in the universe. There are 2 hydrogen atoms in every molecule of water.



By using water electrolysis and renewable electricity, ammonia production can be made completely carbon-free.

Ammonia

180 Million Tonnes



Ammonia feeds the world: 180 million tonnes were produced in 2015, mainly for use in fertilizers. Growing demand for food means this must rise 3% each year.



Today, ammonia is made using the Haber-Bosch process invented and perfected in the early 1900s. Its two inventors won Nobel prizes in 1918 and 1931.

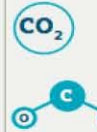


In the Haber-Bosch process hydrogen and nitrogen are converted to ammonia using high temperature and a catalyst.



The global trade in ammonia means we already know how to transport and store it safely.

But there is a problem



Today the lowest cost way to get hydrogen is from natural gas but this produces carbon-dioxide (CO₂) which is a cause of manmade climate change.



Over 1%

Ammonia production requires energy, and today this energy also comes from fossil fuels. Together with the fossil hydrogen feedstock, current ammonia production accounts for over 1% of global CO₂ emissions.

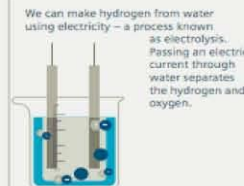


To keep under 2 degrees warming humans must emit no more than 600 billion tonnes more CO₂. That's less than 25 years at the rate today.



Once CO₂ is released into the atmosphere it will change the climate for the next 10,000 years.

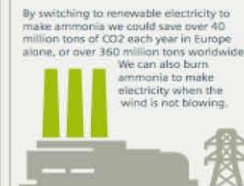
The good news – innovating to create carbon free "green" ammonia



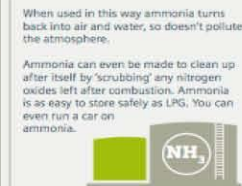
We can make hydrogen from water using electricity – a process known as electrolysis. Passing an electric current through water separates the hydrogen and oxygen.



Green ammonia can support the business case for renewables, by providing an alternative revenue stream that is not dependent on a grid connection (particularly relevant in remote areas), and by being used for load-balancing.



By switching to renewable electricity to make ammonia we could save over 40 million tons of CO₂ each year in Europe alone, or over 360 million tons worldwide. We can also burn ammonia to make electricity when the wind is not blowing.



When used in this way ammonia turns back into air and water, so doesn't pollute the atmosphere. Ammonia can even be made to clean up after itself by 'scrubbing' any nitrogen oxides left after combustion. Ammonia is as easy to store safely as LPG. You can even run a car on ammonia.

Support from regional and national level



GREENLAB SKIVE

CENTER FOR ENERGIINTEGRATION OG -LAGER

GreenLab Skives formål er at fremme integrationen af vedvarende energi i den samlede energiforsyning. Med en stadig stigende el-produktion fra vindmøller bliver behovet for lagring stadig større. GreenLab arbejder hovedsagligt med lagring af el og integration af el- og gassystemerne. Det skal ske ved at omdanne el til lagerbar gas, samt gennem etablering af et fuldskala el-lager i samarbejde med vindmølleindustrien.

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GreenLab Global

