Storages of electricity in molecules

WinterWind Feb 2020

Finn Daugaard Madsen, Siemens Gamesa Renewable Energy

February, 2020

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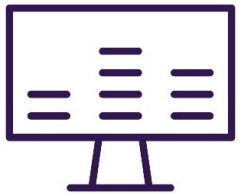
Siemens Gamesa – Key Facts*

95 GW
Globally Installed

+23,000
Employees

€9.1 B
Annual Revenue

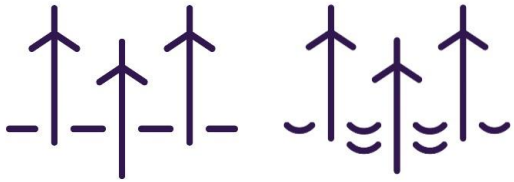


€10 B
Market Capitalization

€25.1 B
Order Book

Offshore
- #1 in global Offshore market

Onshore
- #2 in global Onshore market
- #1 in Africa & LatAm



Portfolio covering all requirements

* End of June 2019

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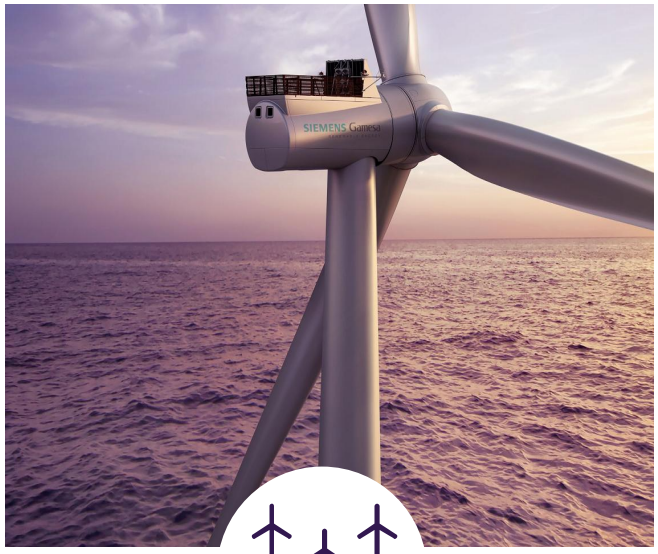
Three business units strongly positioned in the market

Onshore

84 GW installed since 1979

The **technological partner of choice** for Onshore wind power projects.



Offshore

15 GW installed since 1991

Most experienced offshore wind company with the most reliable product portfolio in the market.

Service

60 GW maintained

Commitment beyond the supply of the wind turbine **to reach the profitability goals**.

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Leading player with ~13 GW[1] installed base in strongest growing market

1) As of June 2019

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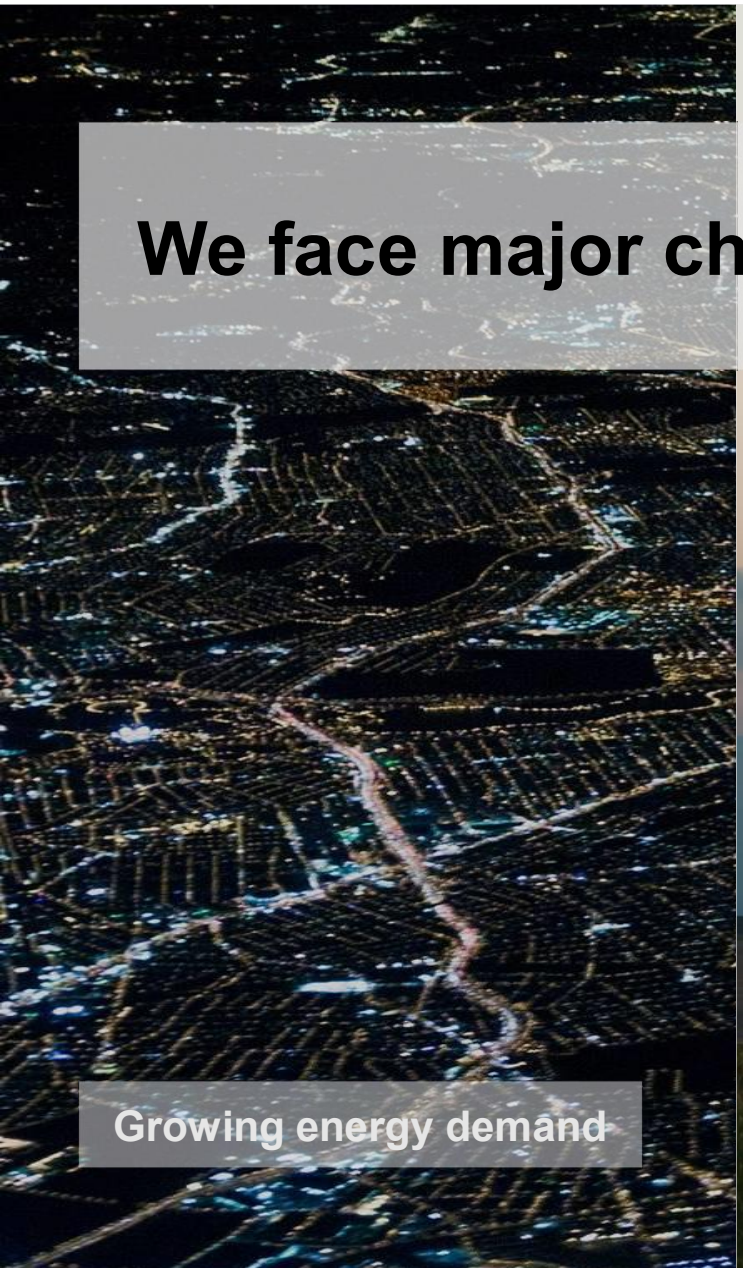
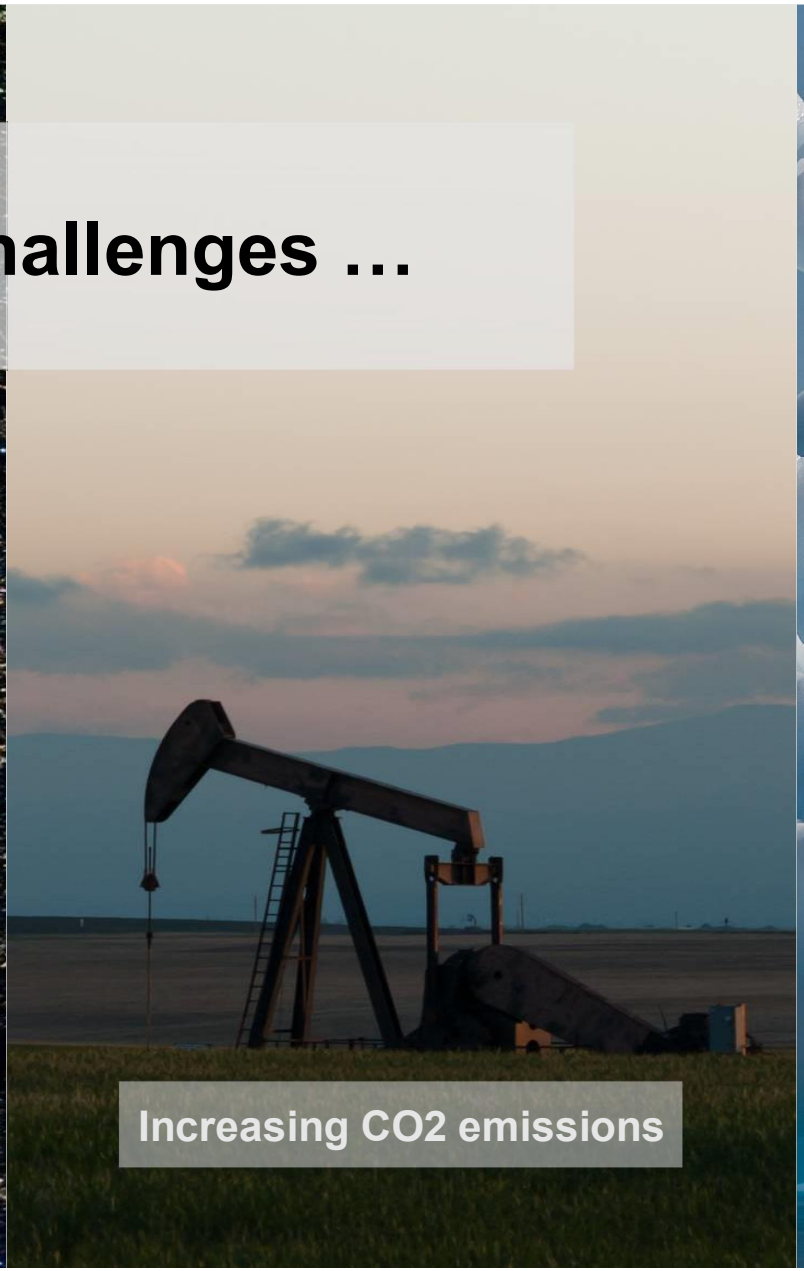
The world is in a fundamental transformation.

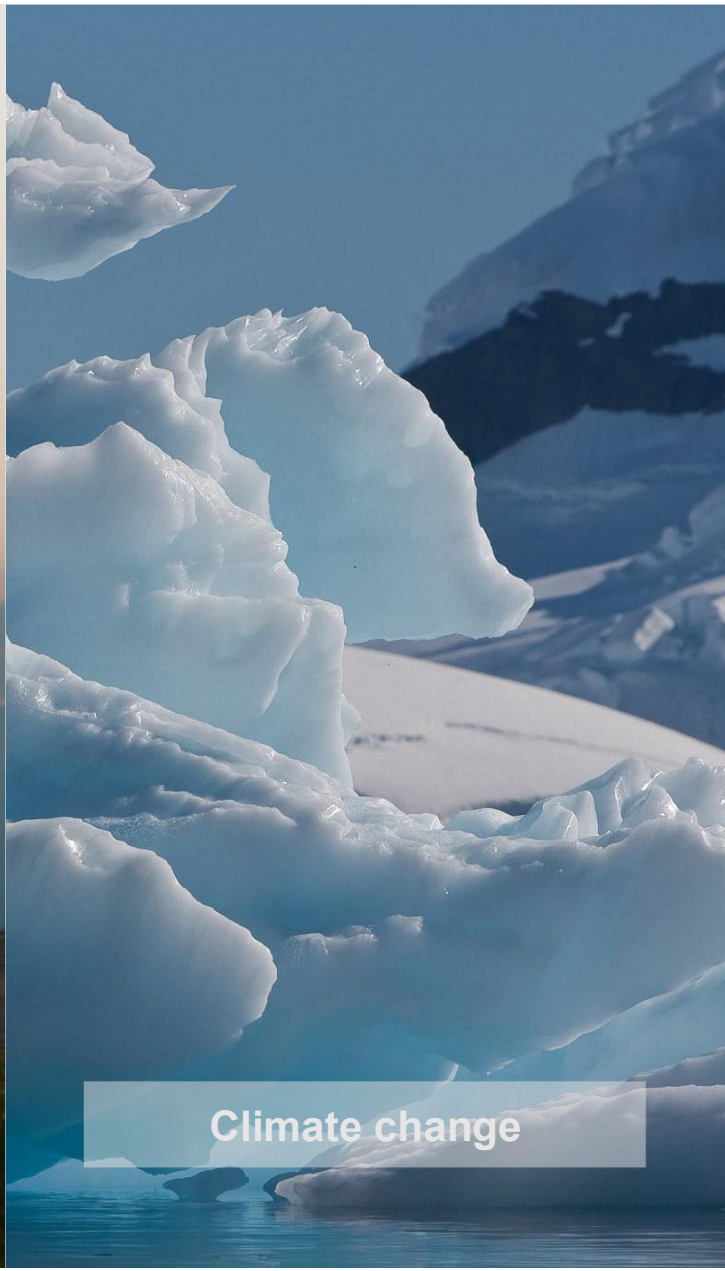
We face major challenges …



Growing energy demand



Increasing CO2 emissions



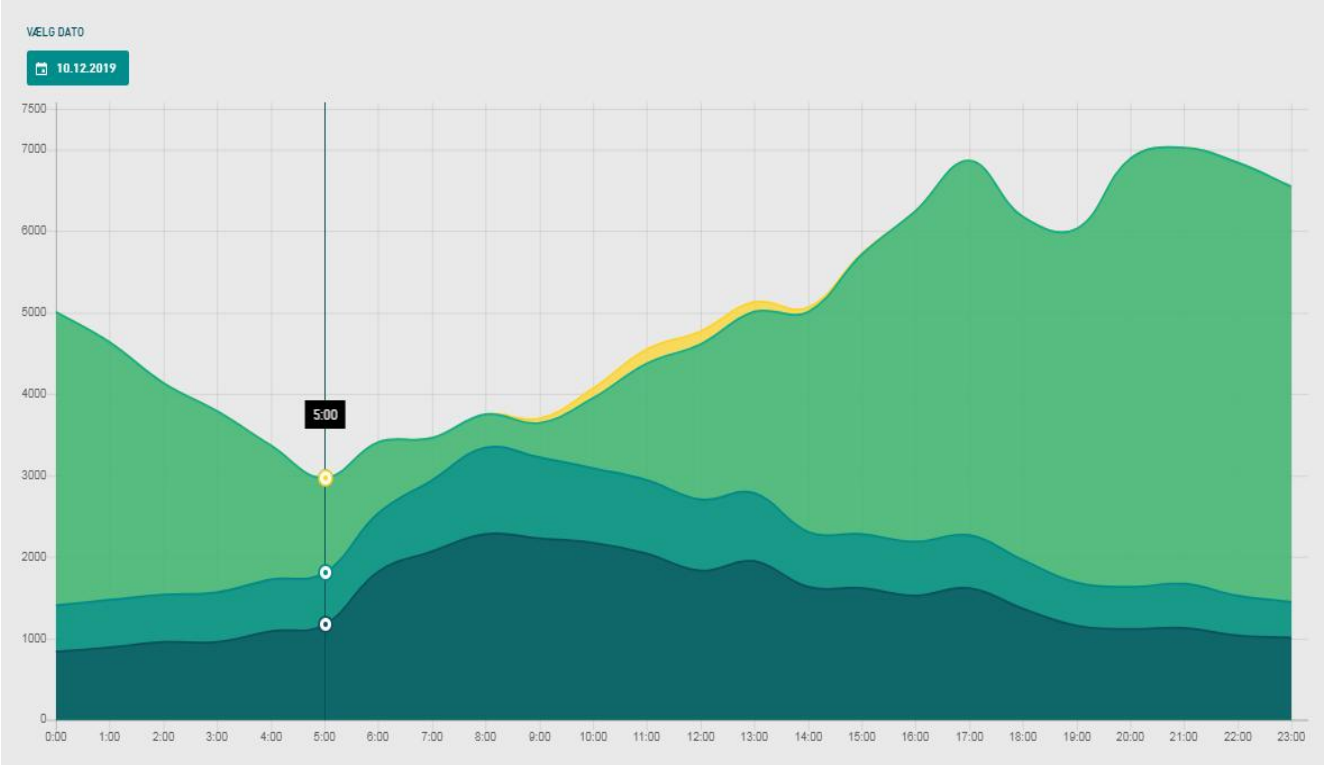
Climate change


We have a solution.
More Wind Power

We have a solution.

More Wind Power - but there are challenges

Fluctuating renewable energy – photovoltaic (PV) and Wind in Denmark



Energinet.dk

Screenshot from
10 December 2019 at 05:00 PM

Consumptions 3708 MW

Wind production 1165 MW = 31%

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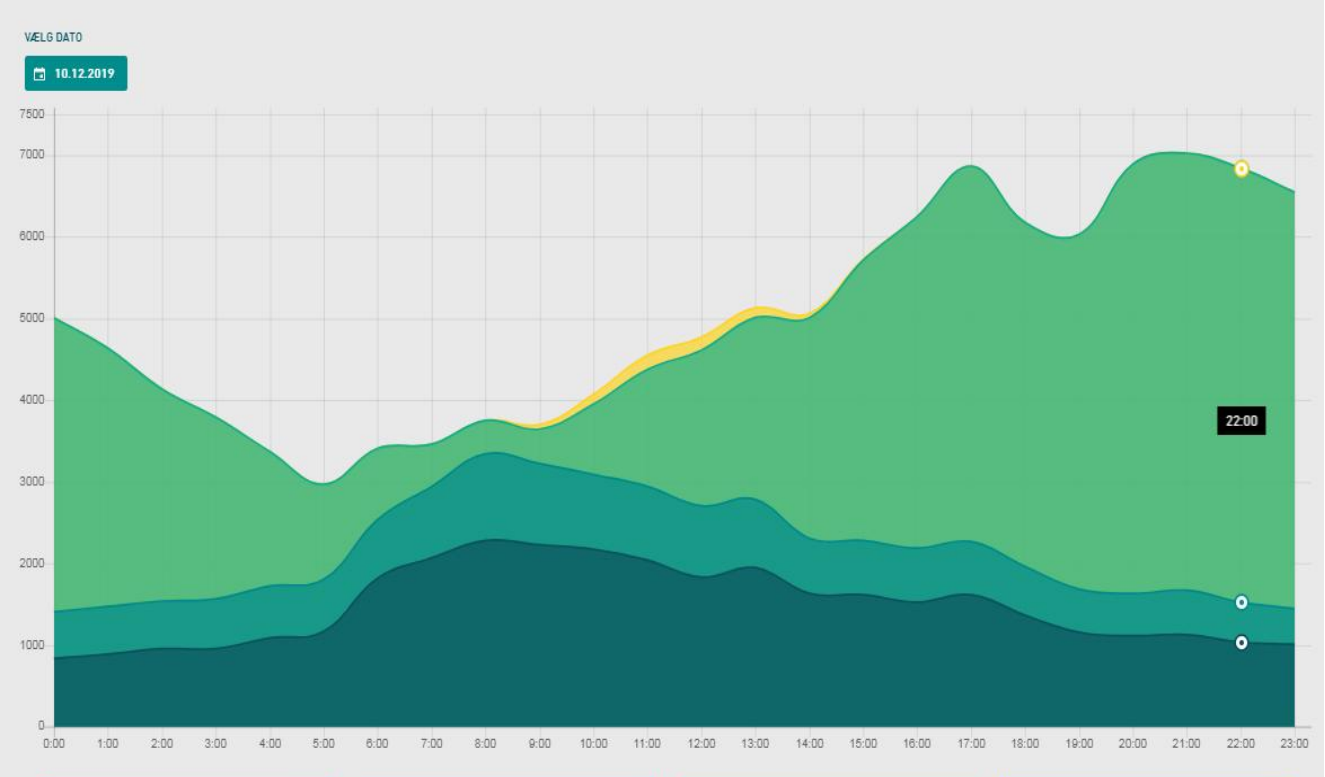
Fluctuating renewable energy – photovoltaic (PV) and Wind in Denmark



Energinet.dk

Screenshot from
10 December 2019 at 22:00 AM

Consumptions 4126 MW

Wind Power – 5320 MW = 129 %

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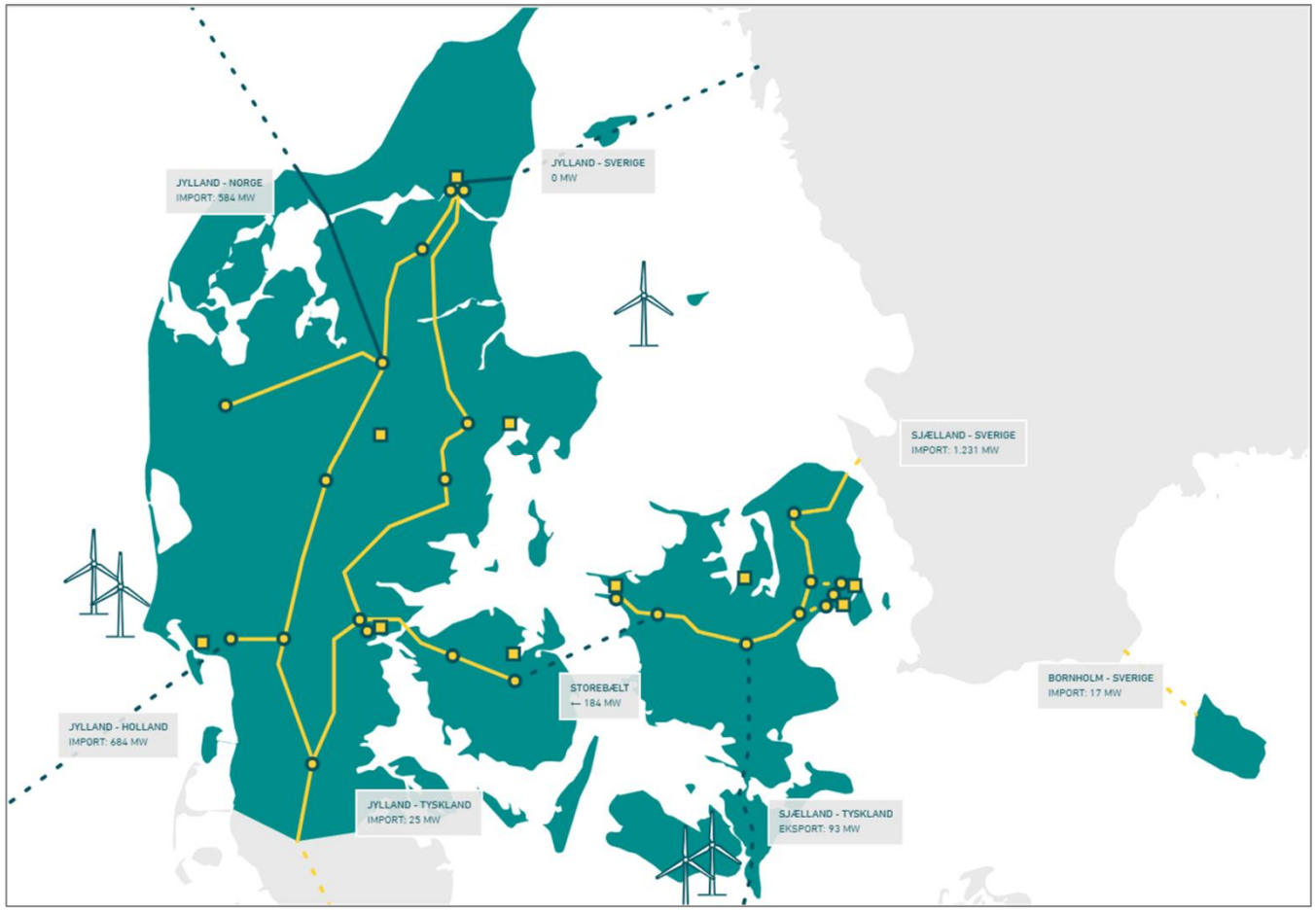
Fluctuating renewable energy – photovoltaic (PV) and Wind



Denmark is today using Norway, Sweden and Germany as a “battery”

Can all EU countries follow the same strategy ?

Could we instead use “real” storage ?

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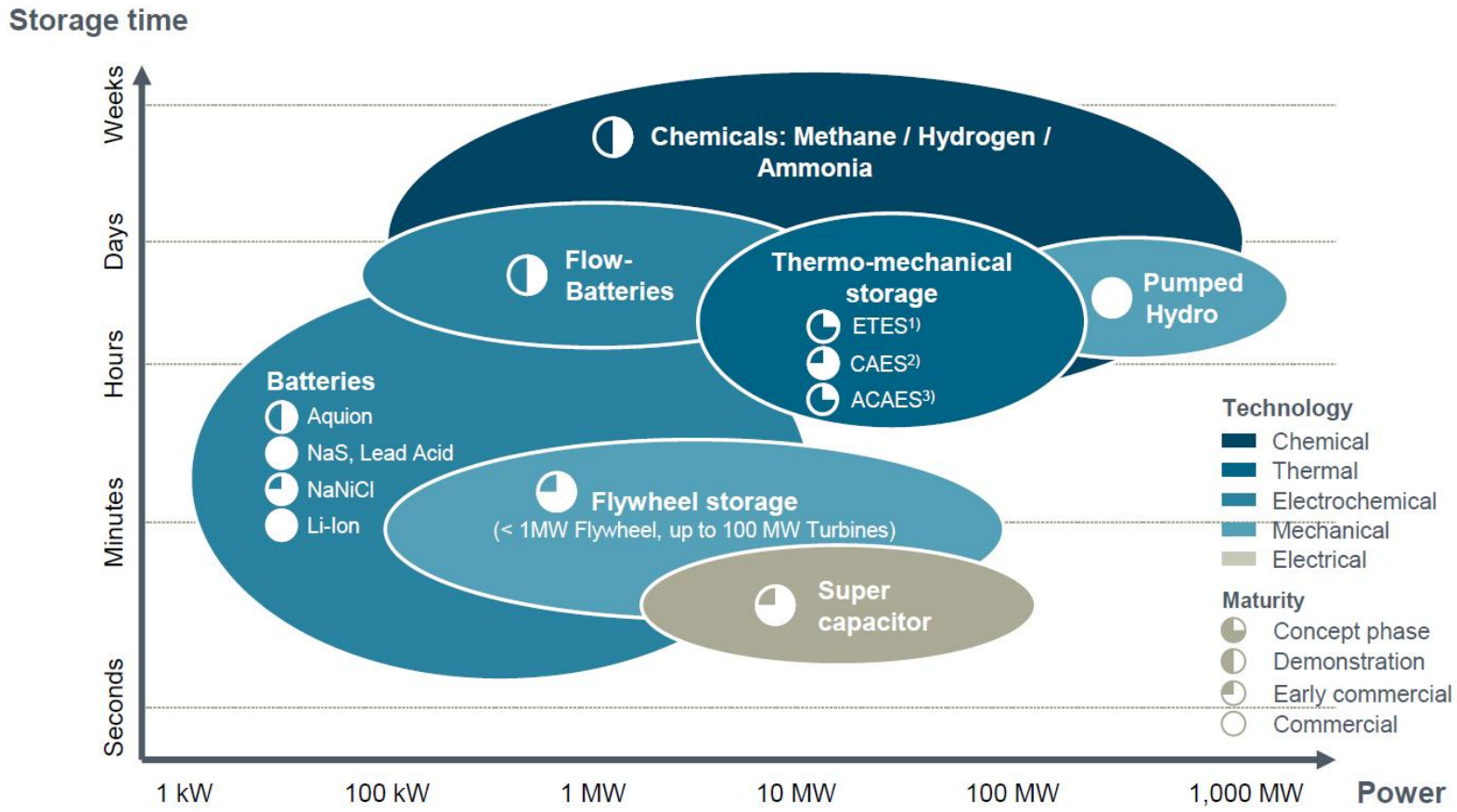
Energy storage technologies, capacity/time



Slide credit: Siemens A/S

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Hornsdale Power Reserve Australian

At 100MW/129MWh, the Hornsdale Power Reserve is the largest lithium-ion battery in the world, and provides network security services to South Australian electricity consumers in concert with the South Australian Government and the Australian Energy Market Operator (AEMO)

To balance Denmark´s energy “unbalance” it will require 20.000 Hornsdale plants.

Construction cost: € 31 million

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Siemens Gamesa ETES in Hamburg – (Electric Thermal Energy Storage)

ETES draws electricity from the power grid and uses it to heat volcanic stones to temperatures of 600°C and higher.

The Electric Thermal Energy Storage system can store up to 130MWh of thermal energy for a week, which can be converted back into electrical energy using a 1.4MW steam turbine generator that can produce electricity for up to 24 hours.

The system can function alone, be added to an existing heat cycle or convert a thermal power plant into a storage plant.

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Application and Market: Evaluation of Hydrogen Application across major Transport Applications

Transport type		Predicted end-fuel
Light transport		kWh
Cars		kWh + $\mathbf{H}_2$ + Biofuels
Trucks		kWh + $\mathbf{H}_2$ + $N\mathbf{H}_3$ + Biofuels
Trains		kWh + $\mathbf{H}_2$
Ships		kWh + $N\mathbf{H}_3$
Air planes		kWh + Carbon based synthetic fuel ($\mathbf{H}_2$)

Take out

- Electricity is dominant energy source for light weight transport and short hauls
- Chemicals evaluated dominating energy source for heavy transport, marine transport and longer hauls.
- Hydrogen (H_2) component across dominating chemical fuel types

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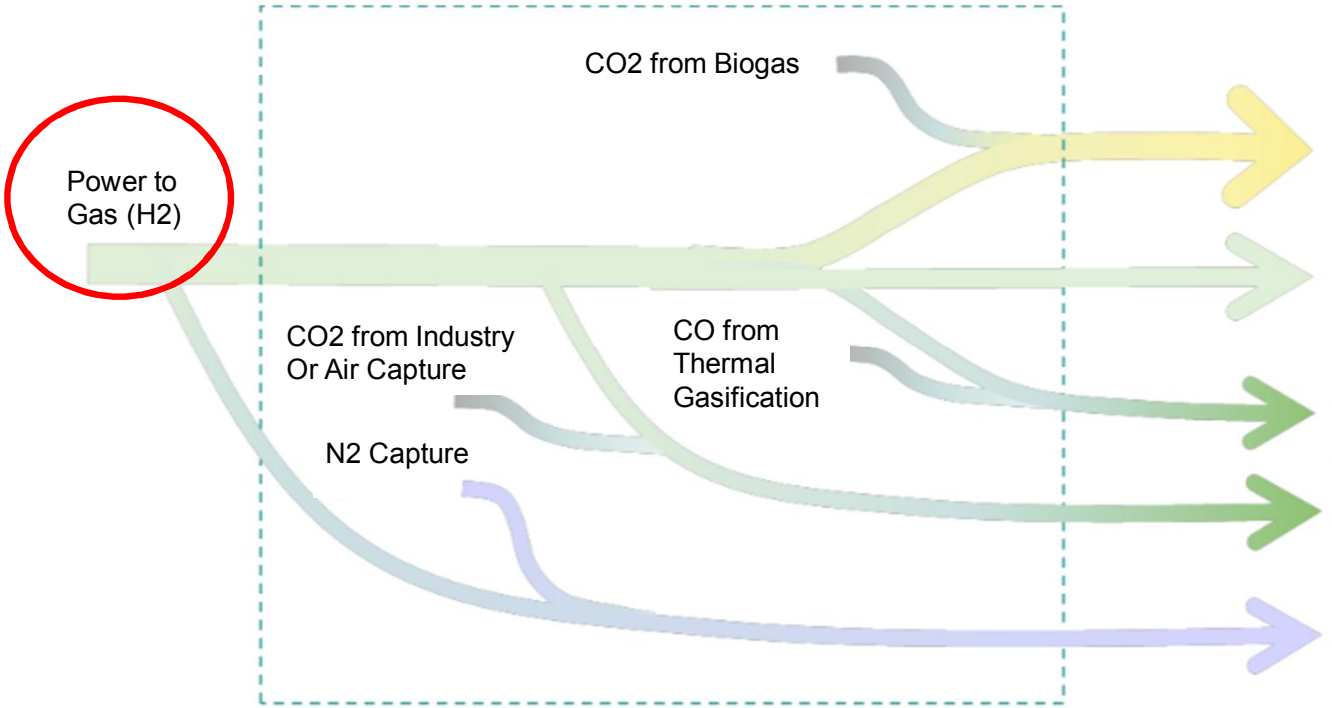
Hydrogen (H2) is the Key Component in Power to X



Power to X products

Methane

Direct use for
Transportation, Industry
or for the Gas Grid

Green
fuels

Polyolefins

Ammonia

Source: Energinet: Systemperspektiv 2035

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Carbon capture

Carbon capture is possible

– but costly

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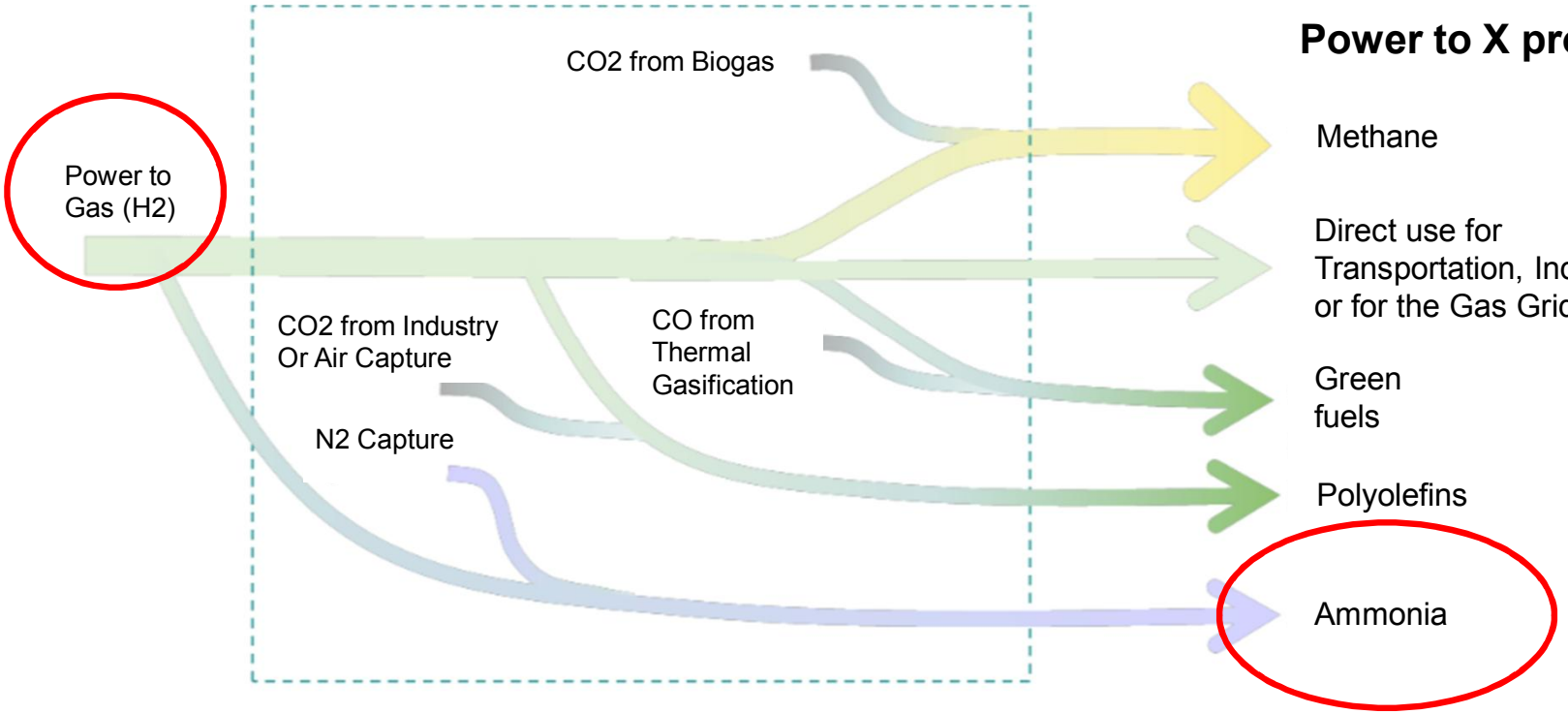
Hydrogen (H2) is the Key Component



Ammonia is interesting

Could be used as fertilizer but also as Fuel

Source: Energinet: Systemperspektiv 2035

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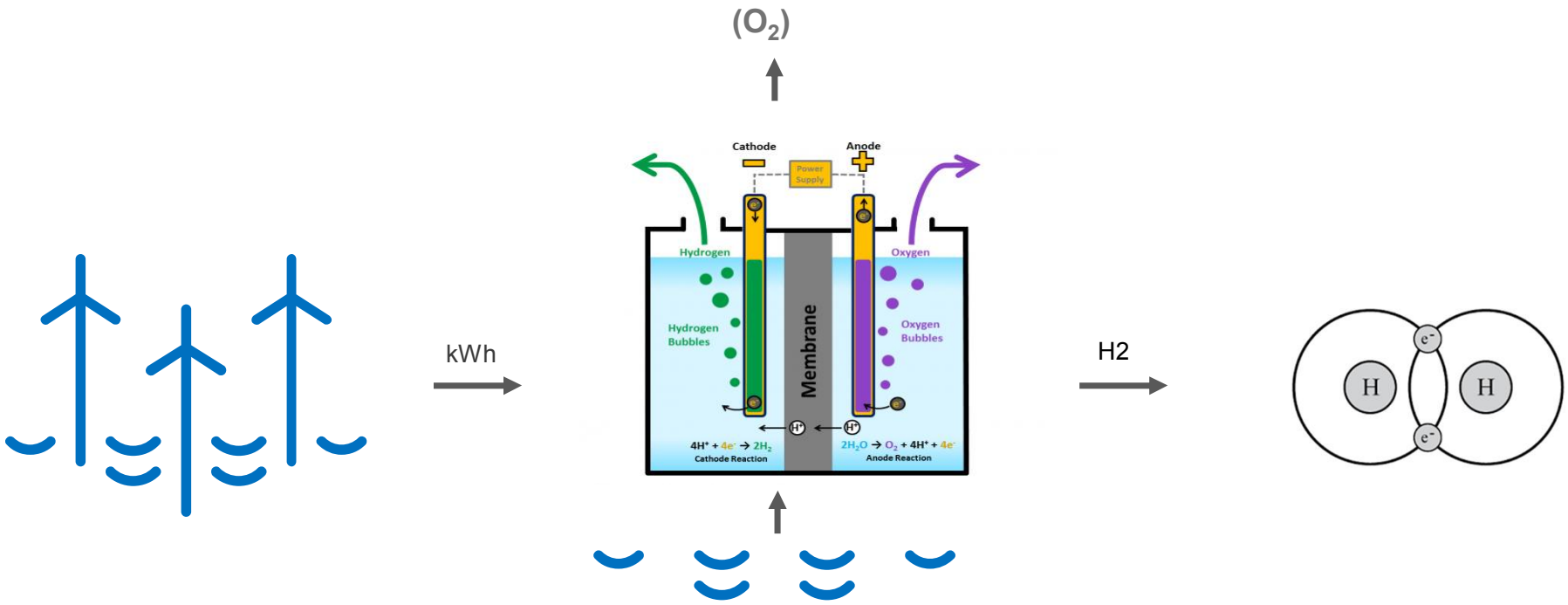
Wind to Chemistry – How to make Hydrogen (H_2)



Wind **(kWh)**

Water **(H_2O)**

Hydrogen) (H_2)

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Different Electrolyzer Systems

PEM
Proton-Exchange-Membran

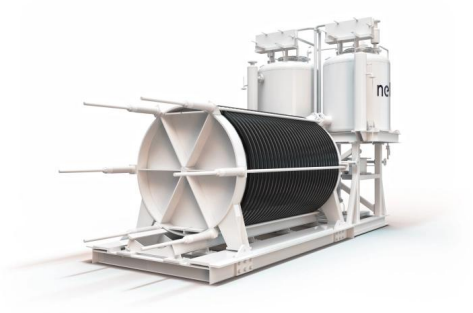
Siemens SILYZER 200
1.2 MW

Siemens SILYZER 300
Modelized

ALC
Alkaline Elektrolyse

GreenHydrogen
HyProvide™ A-Series

NEL
2.2 MW per stack



SOEC
Solid-Oxid

Haldor Topsø

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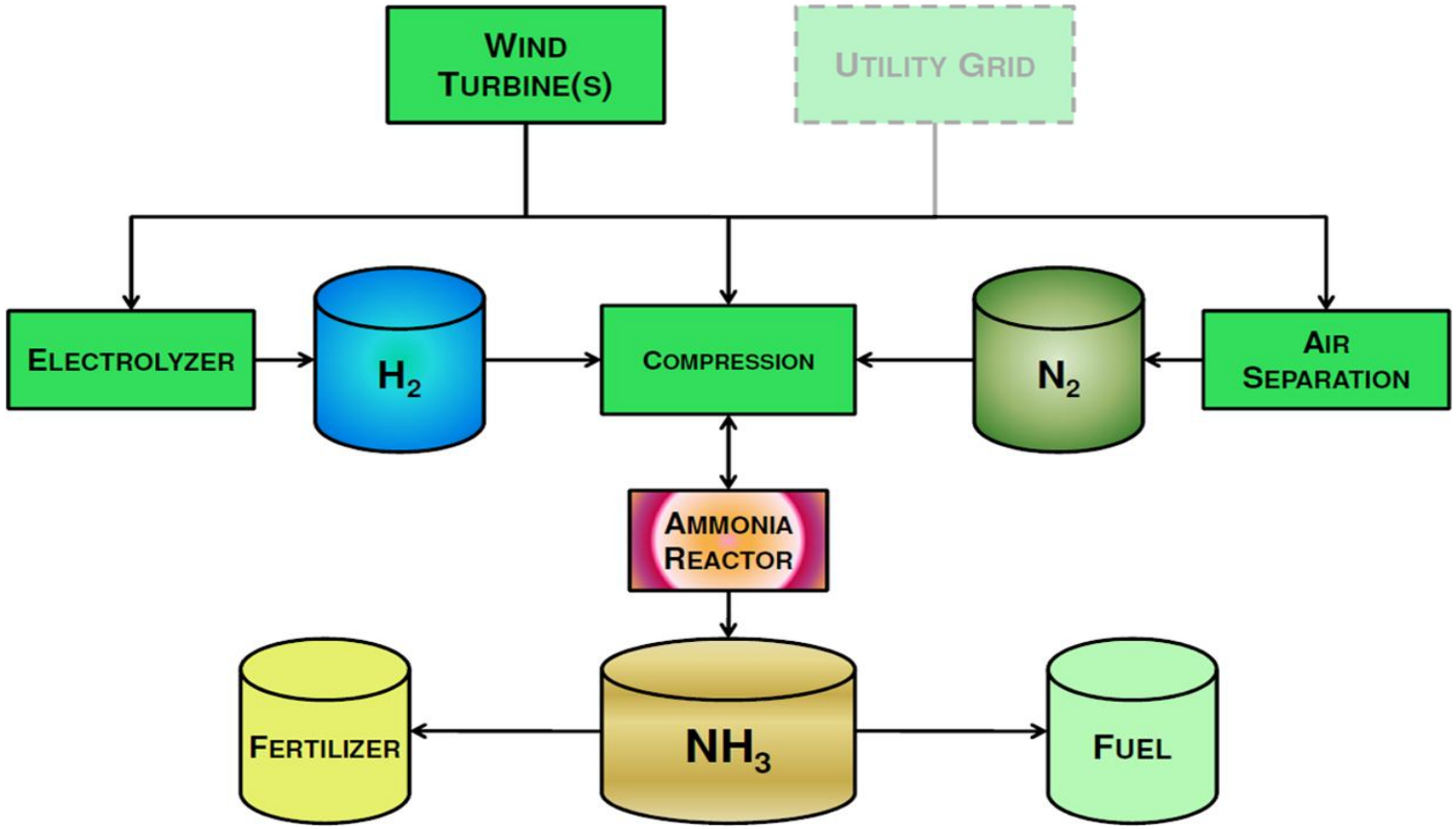
Ammonia, NH3 as Green Fertilizer/Fuel produced with Renewable Energy



Sustainable Ammonia Production from U.S. Offshore Wind Farms: A Techno-Economic Review
Group 73 − Energy Systems, MIT Lincoln Laboratory, S1-257, Lexington, Massachusetts 02420-9176, United States

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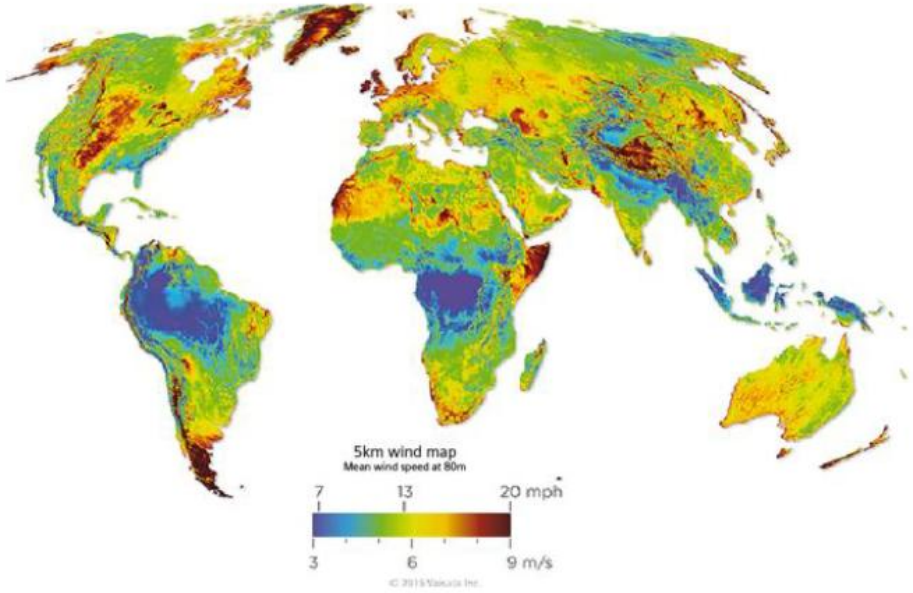
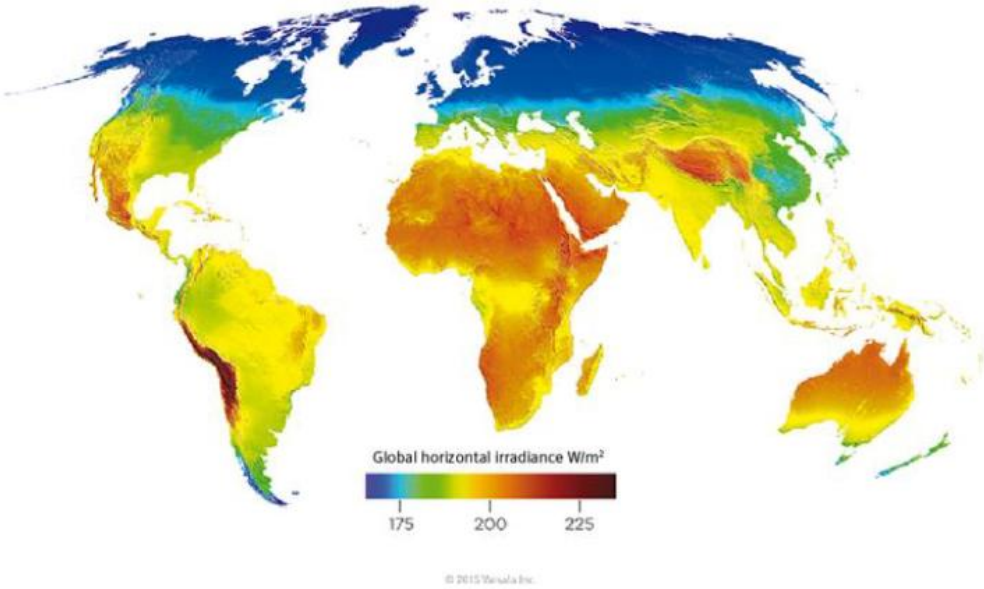
If large amounts of Green Ammonia is to be produced in Europe, Offshore Wind will be the most competitive solution



Global wind map



Global solar map

Graphics from Tanja Siegel – independent-medien-design.de

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Easter morning, Fifth Avenue, New York City, 1900

Can we do it

Spot the car

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Easter morning, Fifth Avenue, New York City, 1913

We can do it

Spot the horse

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Thank you.
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