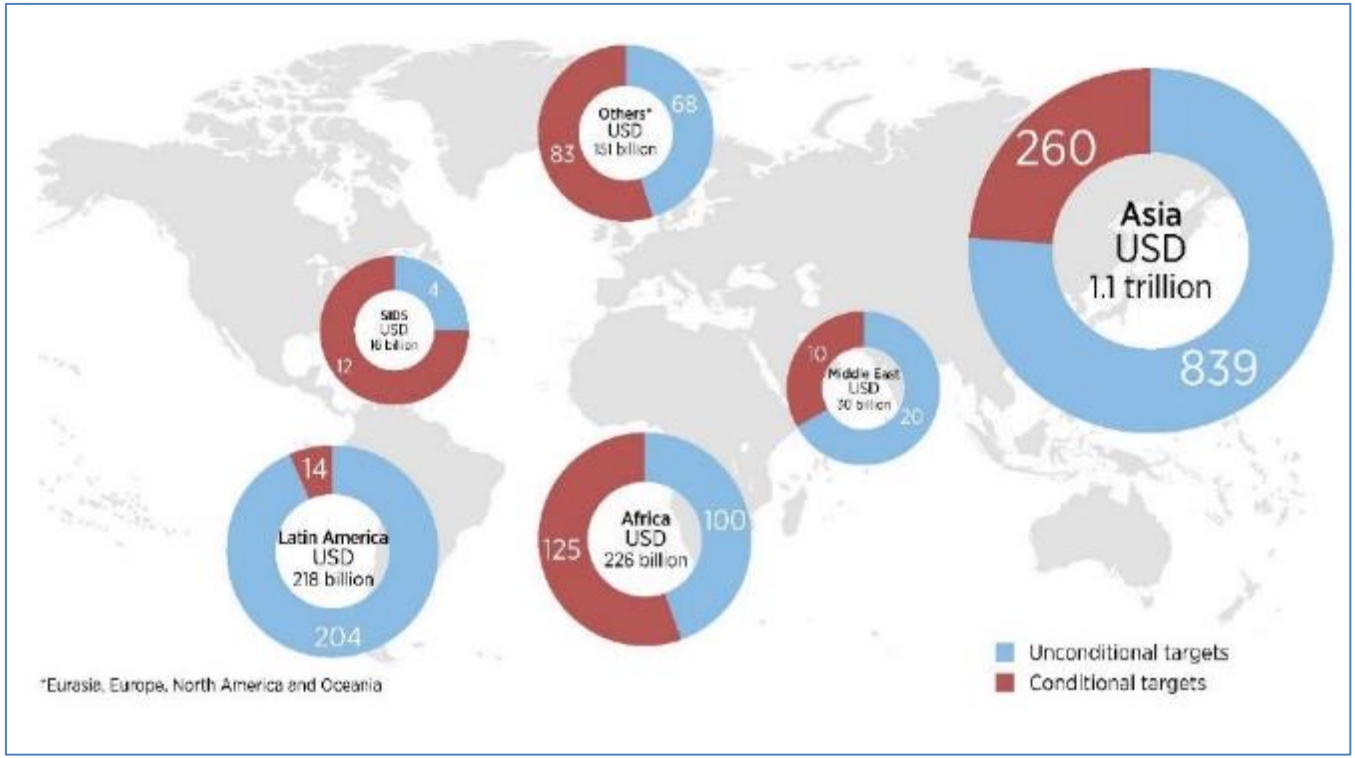
Missing Links in the Green Transition of the Energy Sector

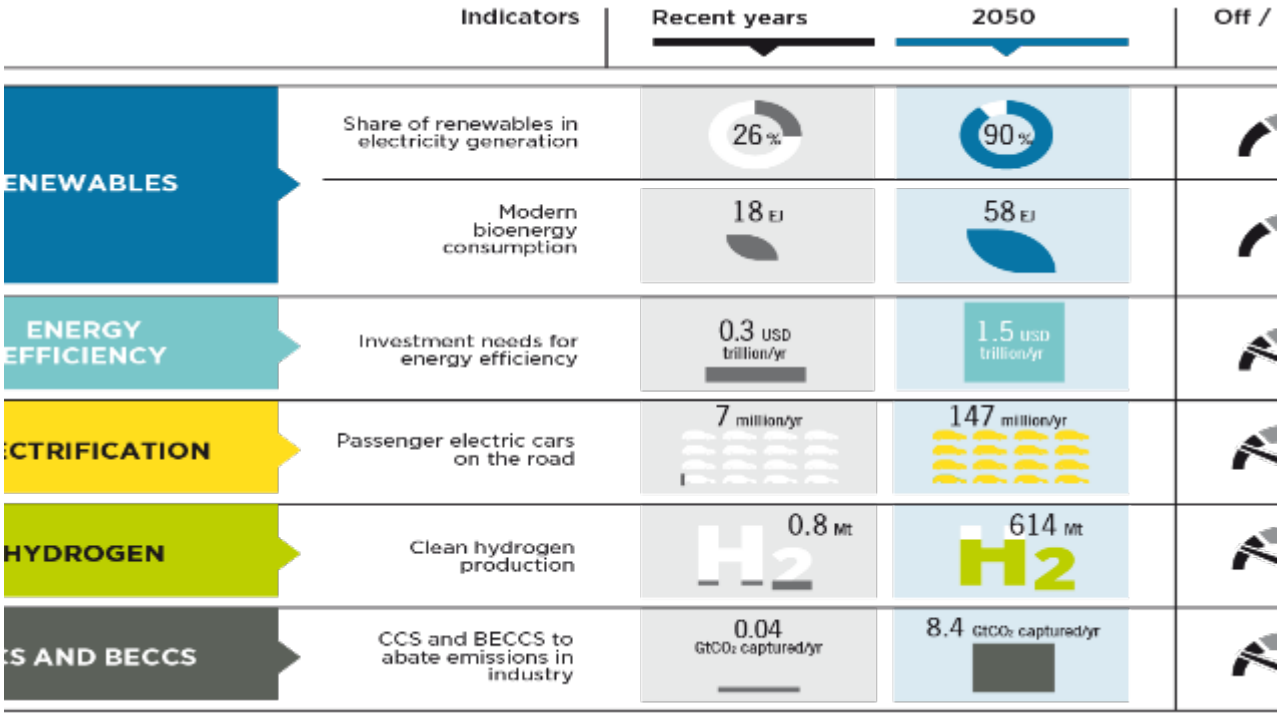
Jacob Nørgaard Andersen, September 8th, 2022

The need to act –
This summer showed extremes beyond climate model predictions

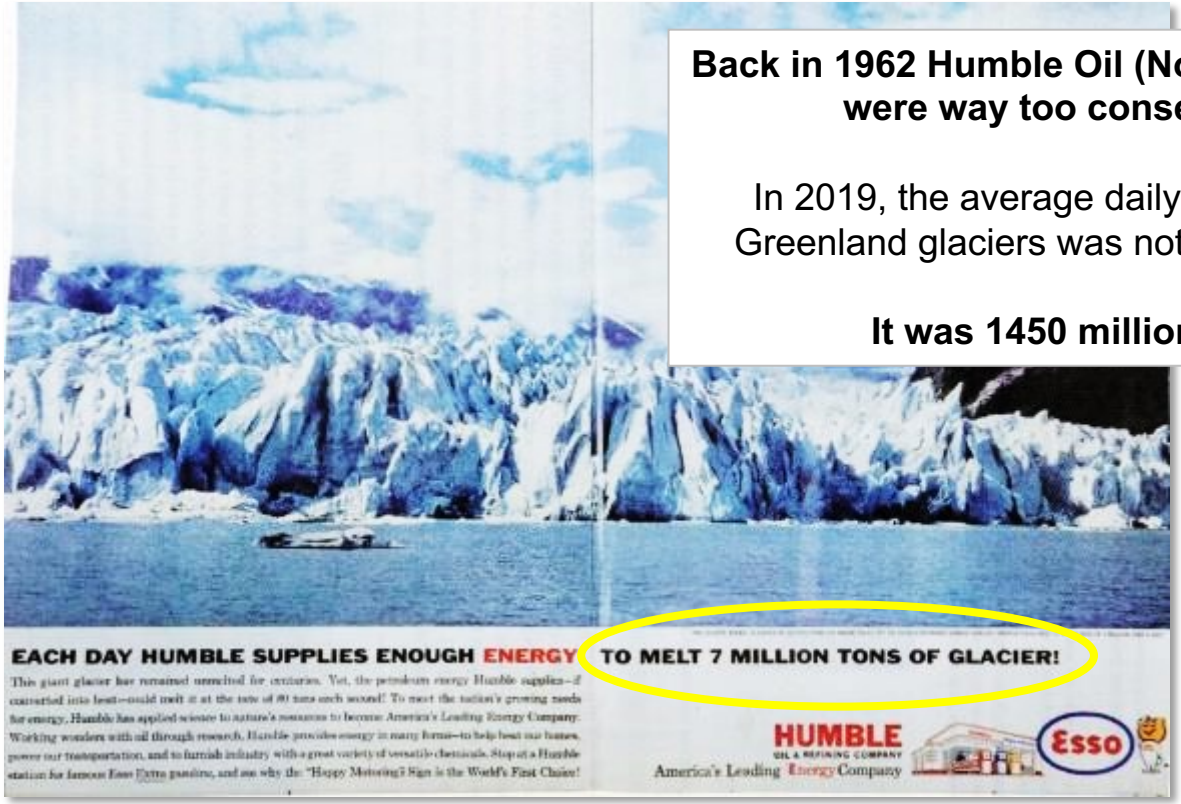
Giant investment needs, particularly in Asia



Despite some progress, the energy transition is far from being on track



The past – and the present



Back in 1962 Humble Oil (Now Exxon Mobil) were way too conservative

In 2019, the average daily ice melt from Greenland glaciers was not 7 million tons.

It was 1450 million tons

Source: Life Magazine, 1962

Fortunately, the world is now taking serious action

Macro trends drive action

- The world is experiencing a positive climate action feedback loop between public policy, technology advancement, investor preference and societal preferences.

The driver: low-cost renewables

- The pathway to a carbon free energy future is clear – wind and solar PV will be primary electricity sources, extending into other sectors with hydrogen-based PtX fuels.

Cleanup with carbon capture

- Climate scenarios capable of keeping global warming within the Paris Agreement limits all rely on large-scale application of large-scale removal of CO_2 from the atmosphere.

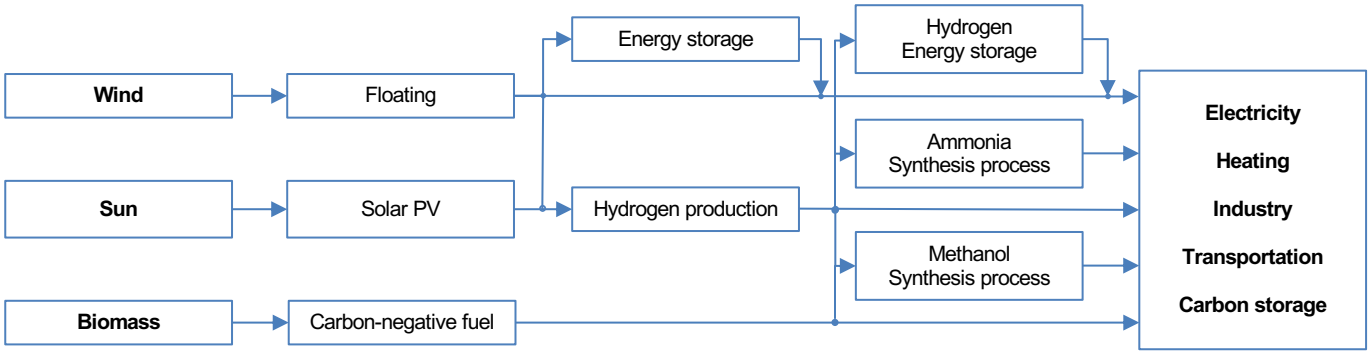
From relative reduction targets, to science based, to net-zero to net-negative

Stiesdal - Purpose

Climate change mitigation

The main purpose of the company is to develop and commercialize climate change mitigation technologies

Missing Links



Timing and approach

Company Overview

Stiesdal Offshore

- Offshore wind power systems
- Main focus:

  Tetra floating foundations

Stiesdal Storage

- Electric energy storage systems
- Main focus:

  GridScale thermal storage systems

Stiesdal Hydrogen

- Hydrogen and Power-to-X systems
- Main focus:

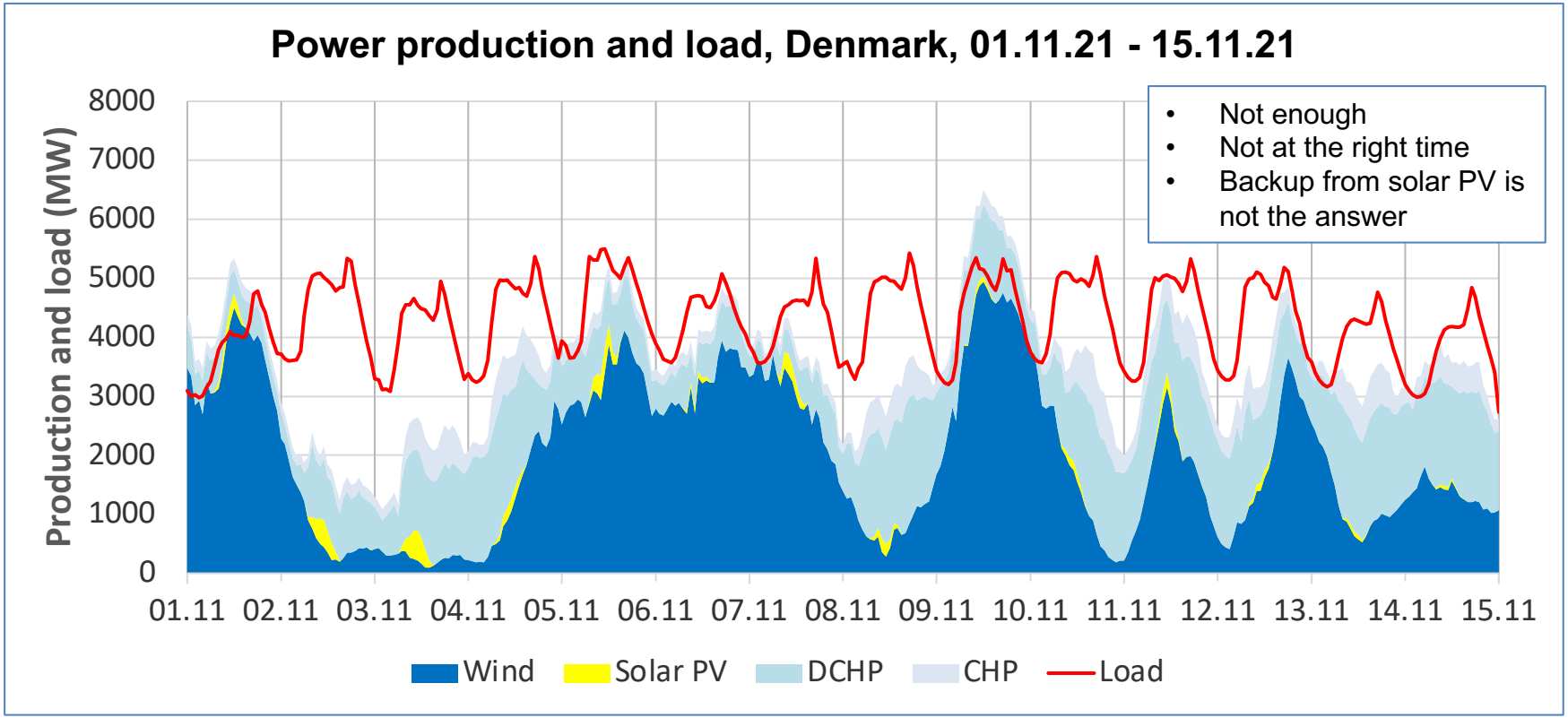
  HydroGen electrolyzers

Stiesdal SkyClean

- CO_2 sequestration with fuel production
- Main focus:

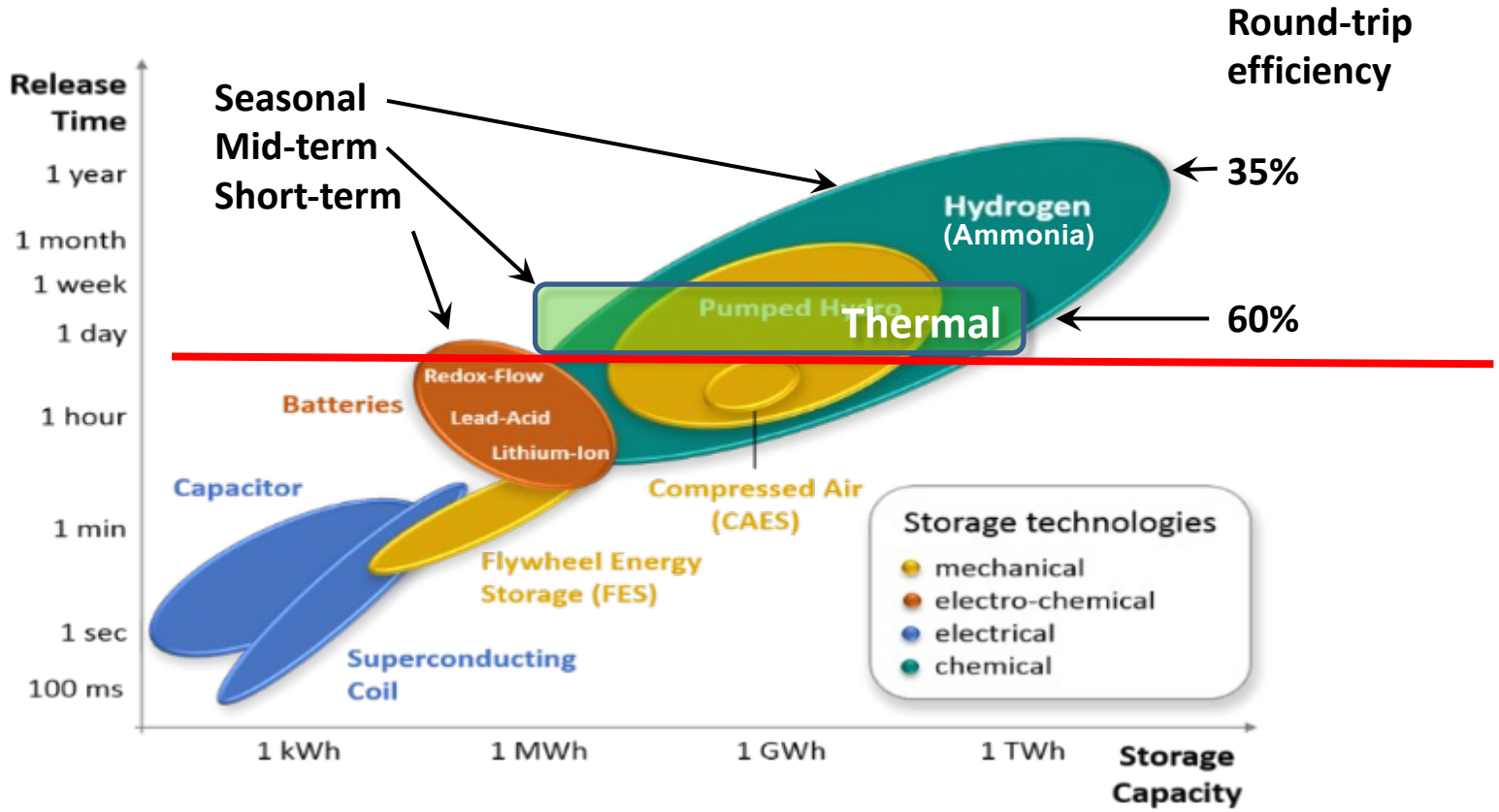
  SkyClean pyrolysis systems

The electricity challenge - the system for two weeks



Source: Energinet

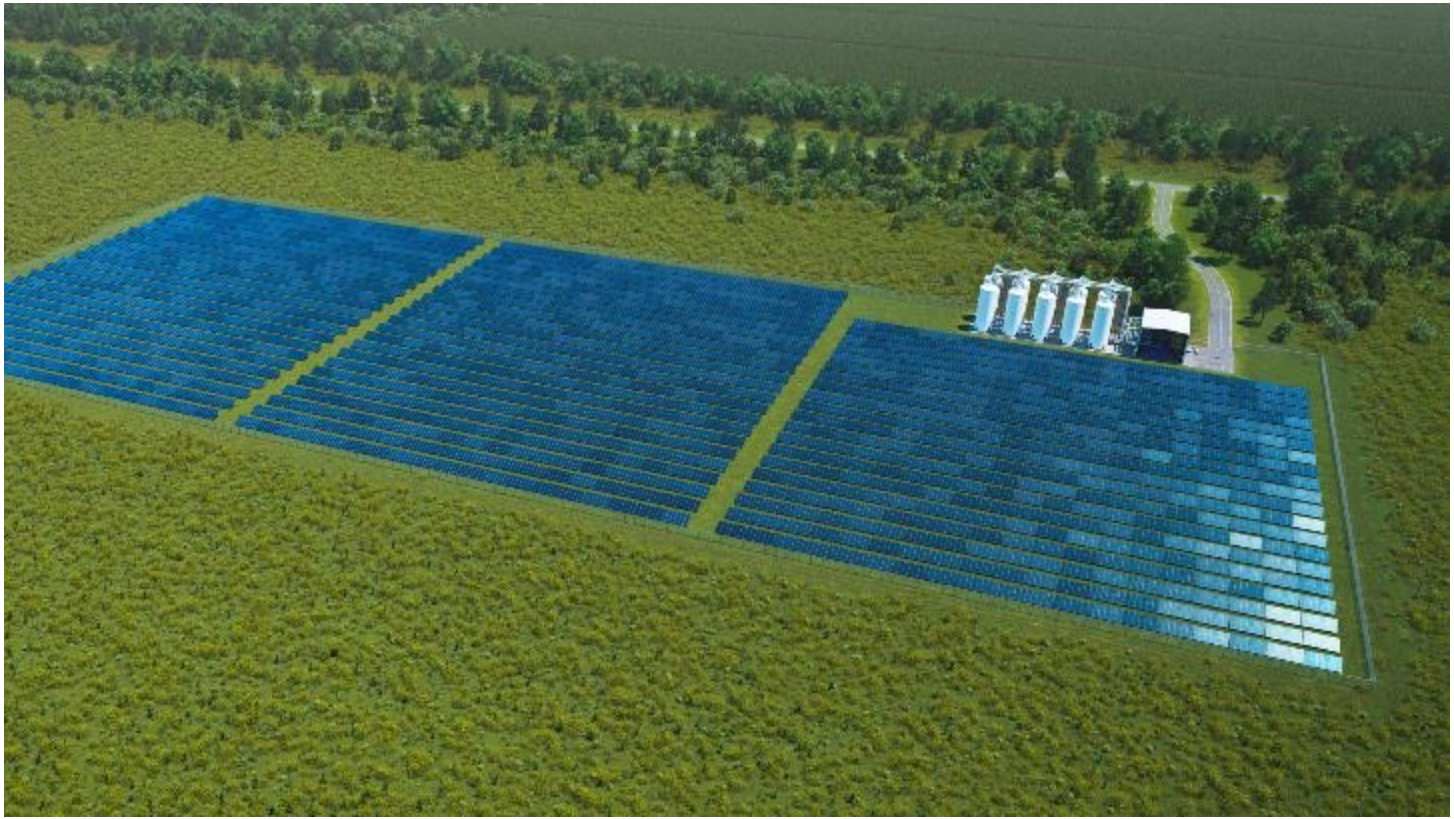
The key storage technologies



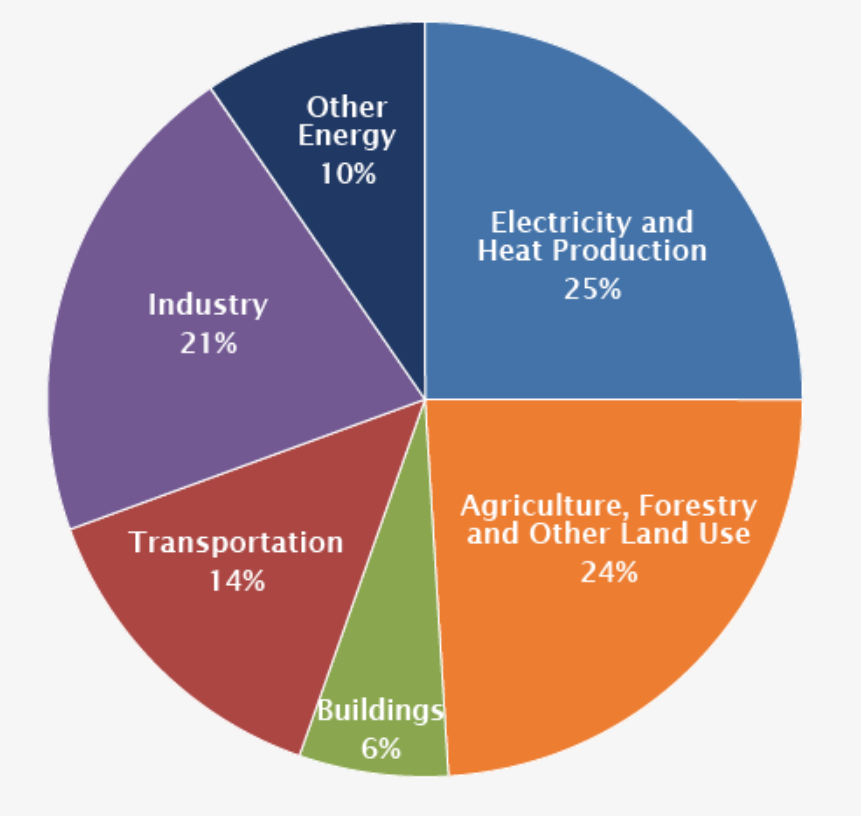
Source: IIDST

GridScale

Behind-the-meter application in solar farms

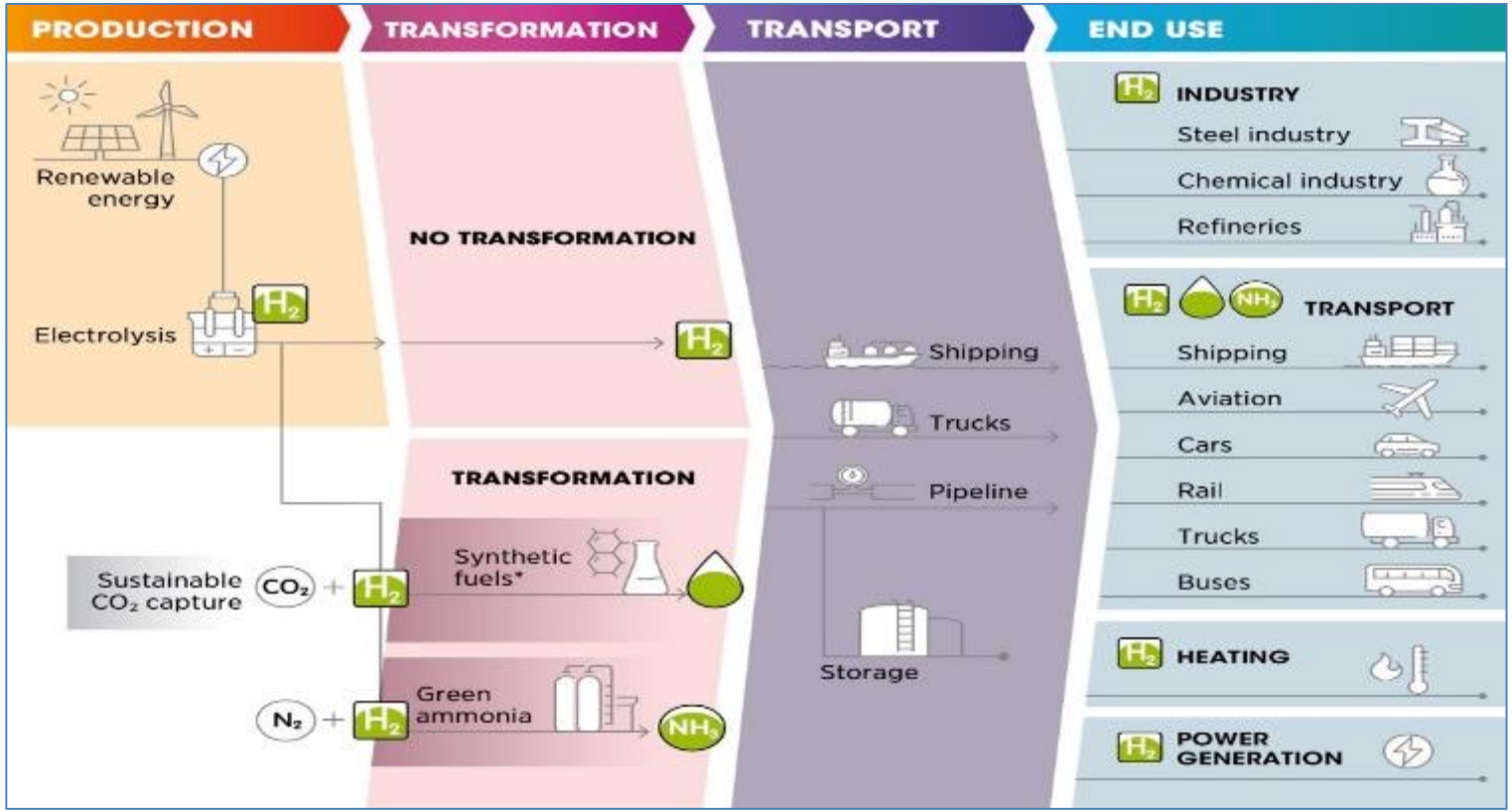


Much more than just electricity



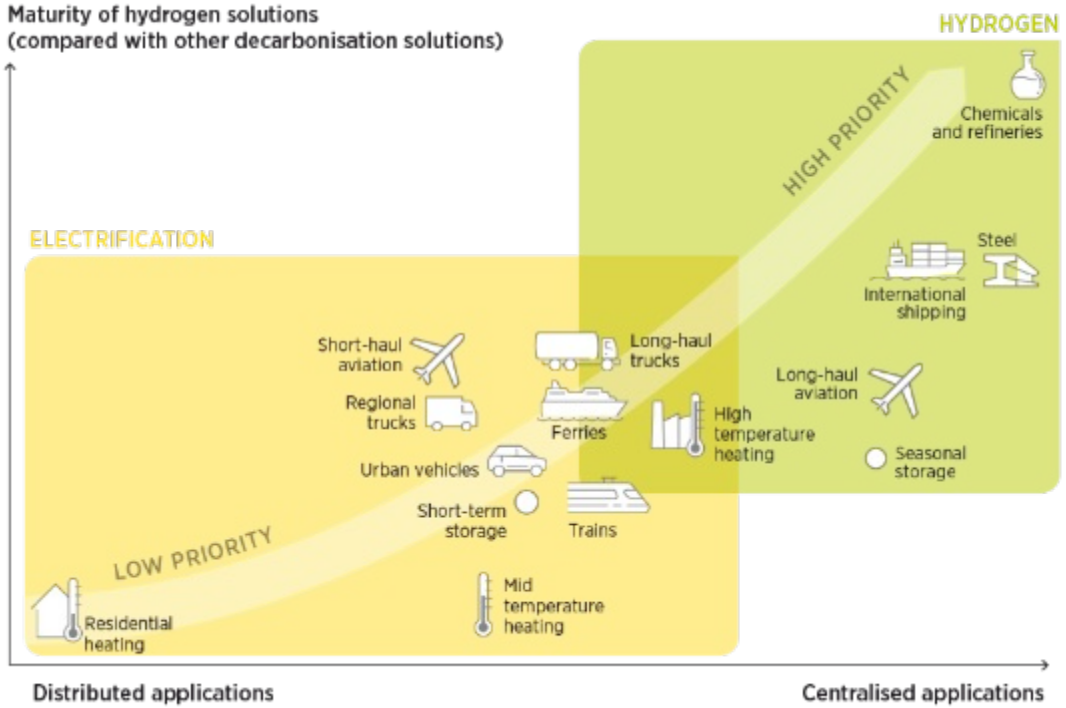
Source: IPCC

It all begins with hydrogen

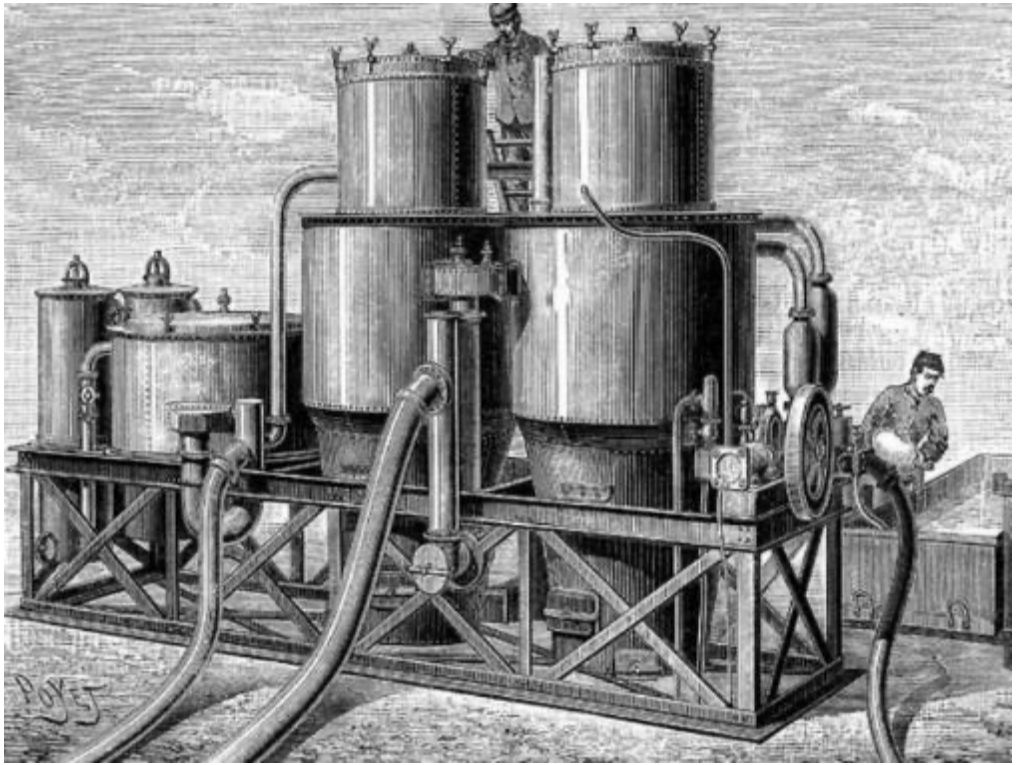


Source: IRENA

Green hydrogen needs to move from niche to mainstream by 2030

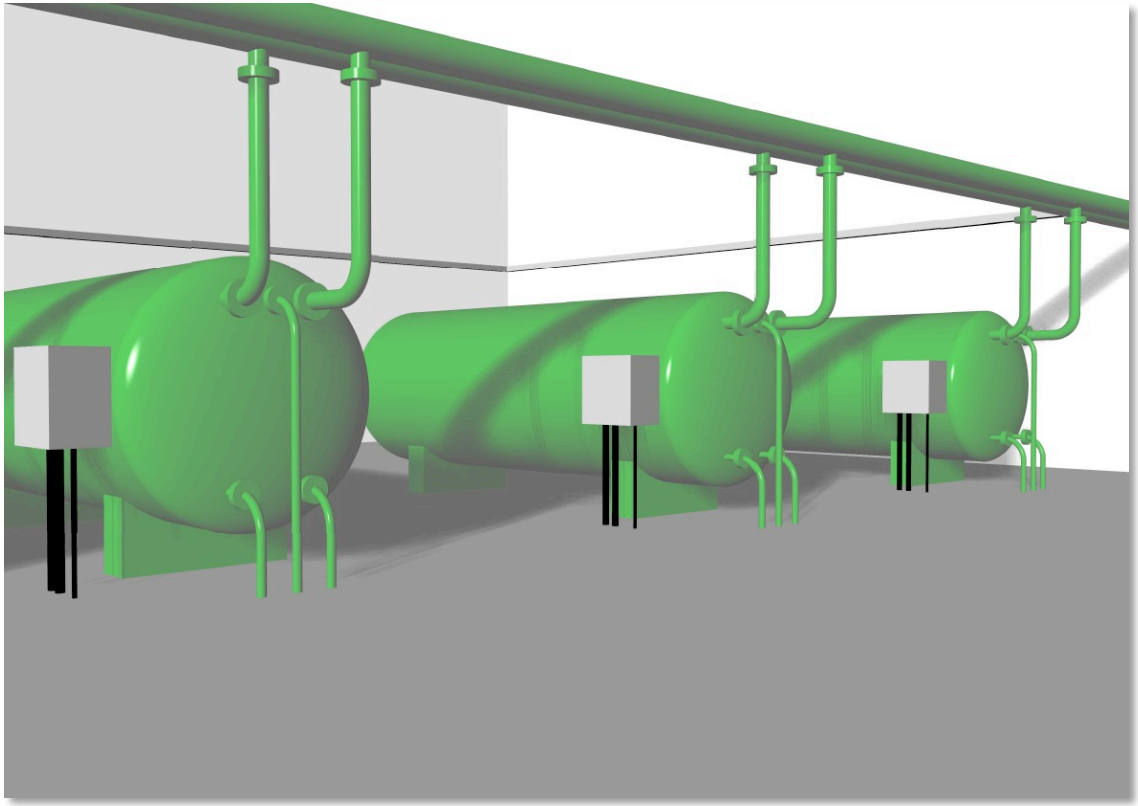


Hydrogen gas production apparatus. 19th-century illustration of an apparatus used to produce hydrogen gas for balloons



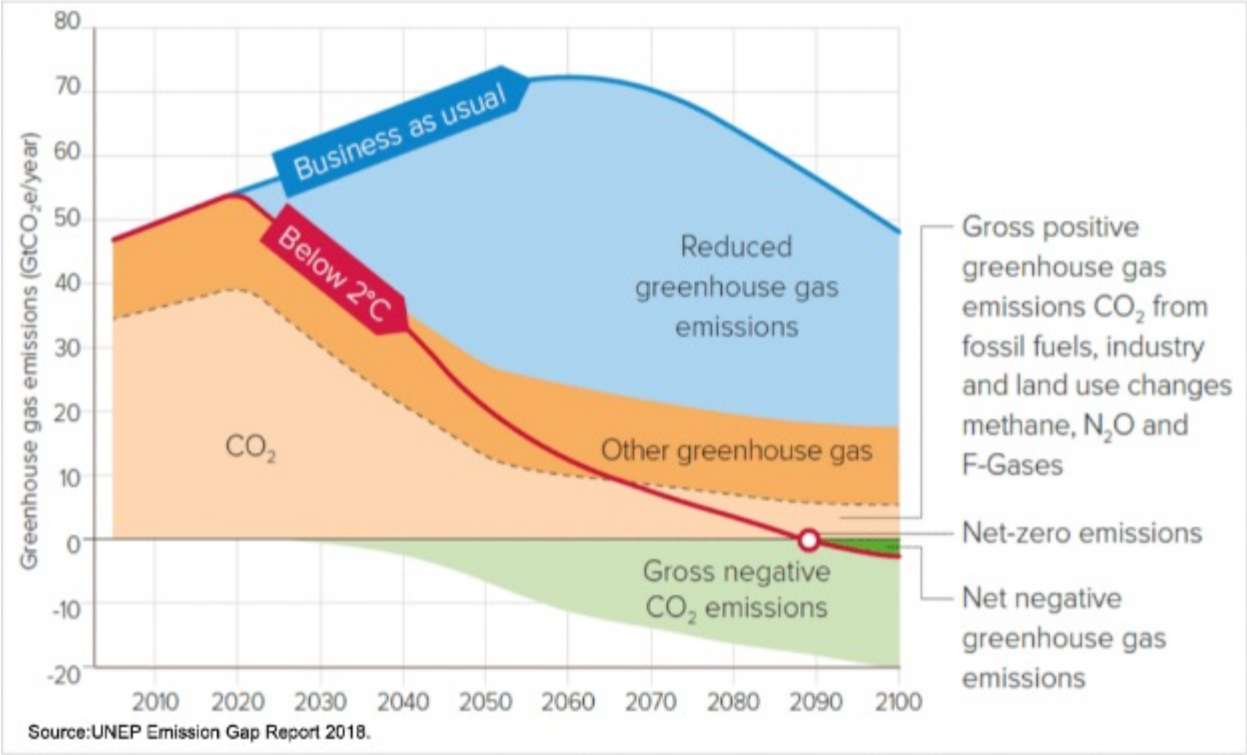
Hydrogen Electrolyzer systems are complex

But it doesn’t need to be?

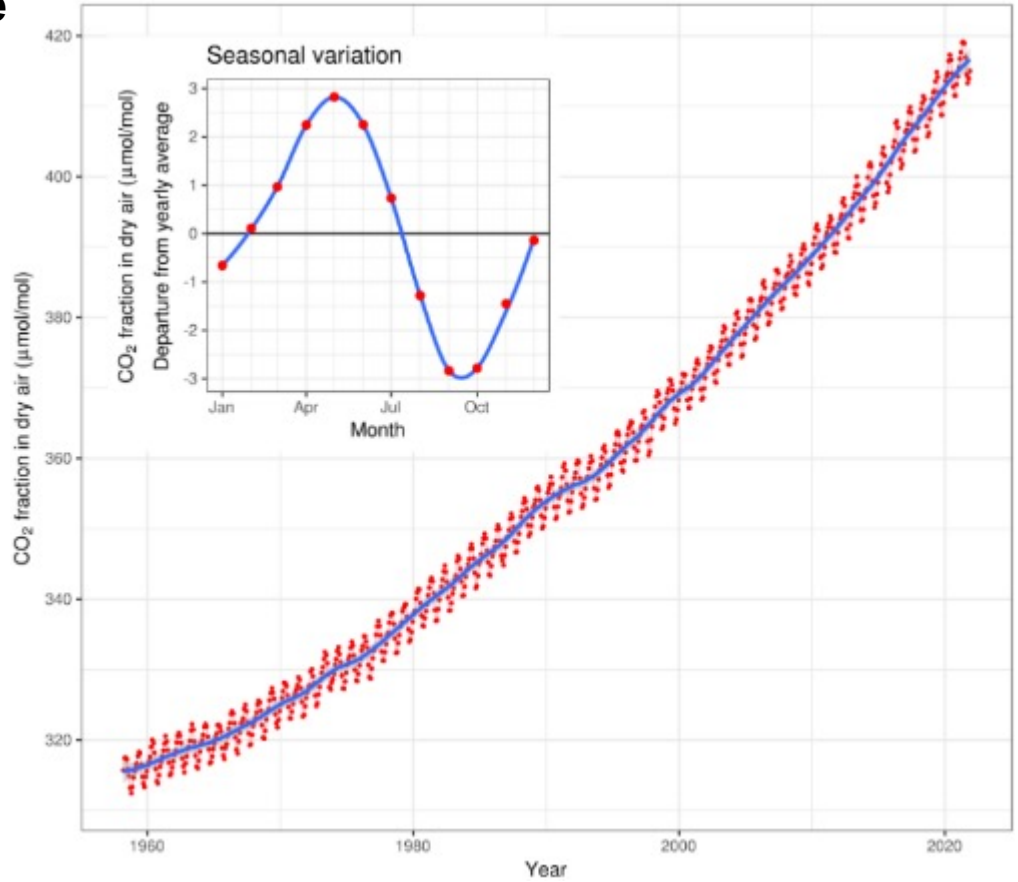


3 MW HydroGen units for solar PV and wind

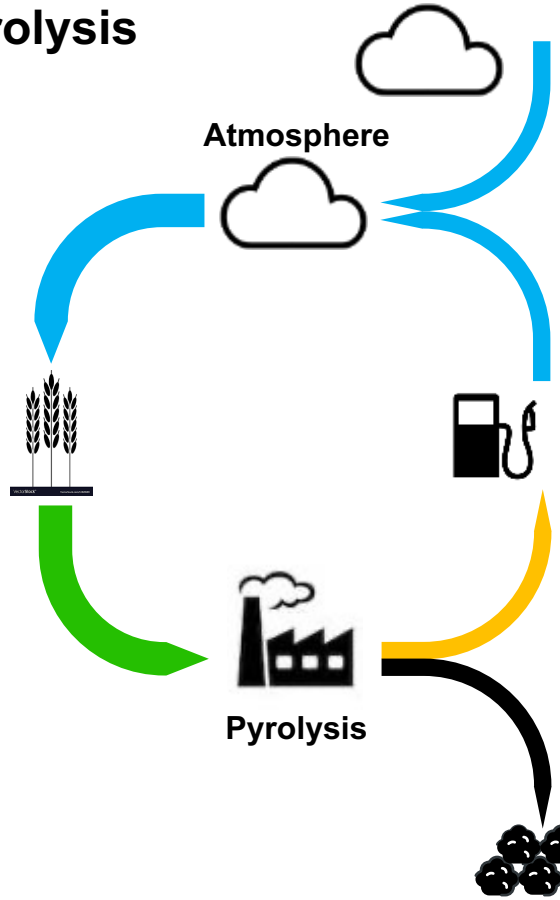
Technologies facilitating net-zero



Keeling Curve



Carbon cycle with Pyrolysis



Source

50% of additional carbon in the form of CO_2 required to run cycle again

100% of plant carbon captured as CO_2 through photosynthesis

50% of plant waste carbon emitted to atmosphere as CO_2 by combustion

100% of plant carbon in waste products captured as CO_2 through photosynthesis

50% of plant waste carbon supplied as fuel (gas and oil)

Sink

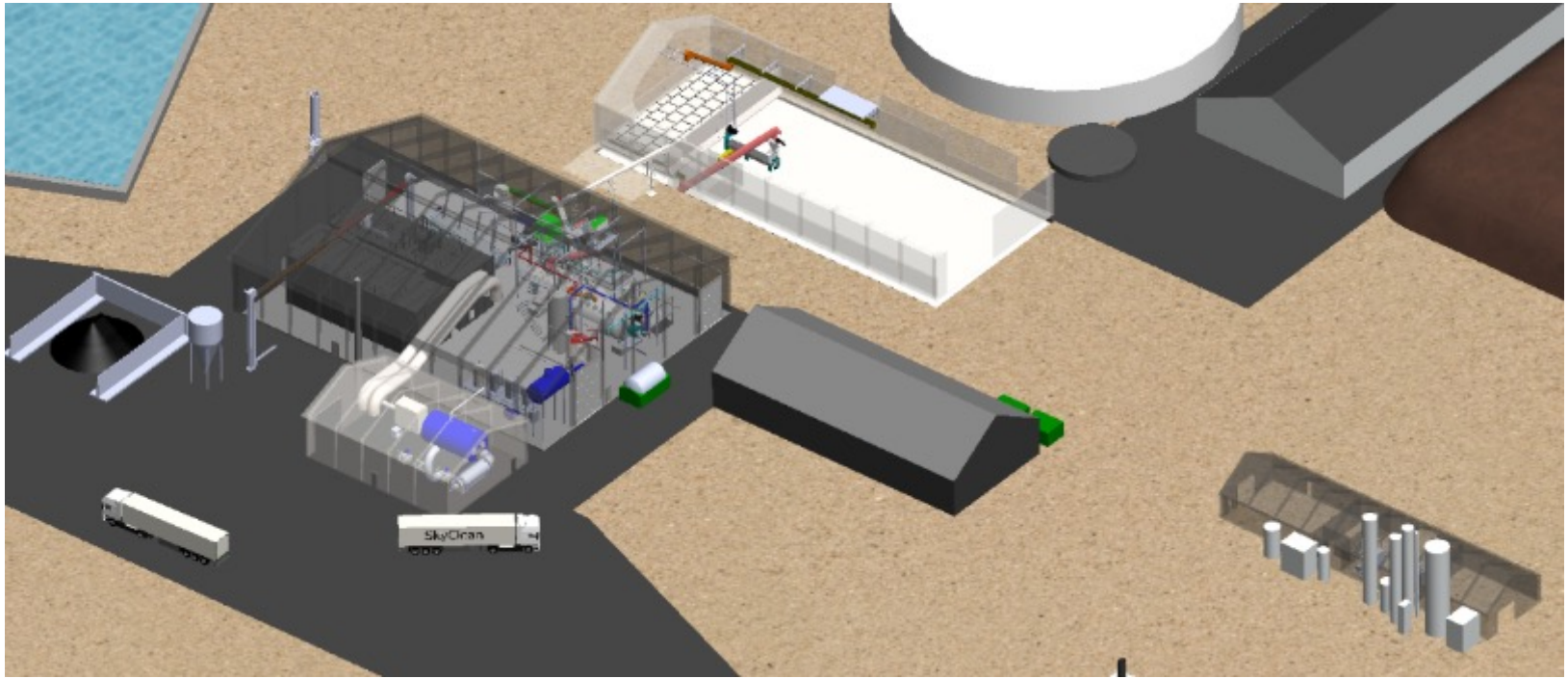
50% of plant waste carbon sequestered as biochar

We are well under way

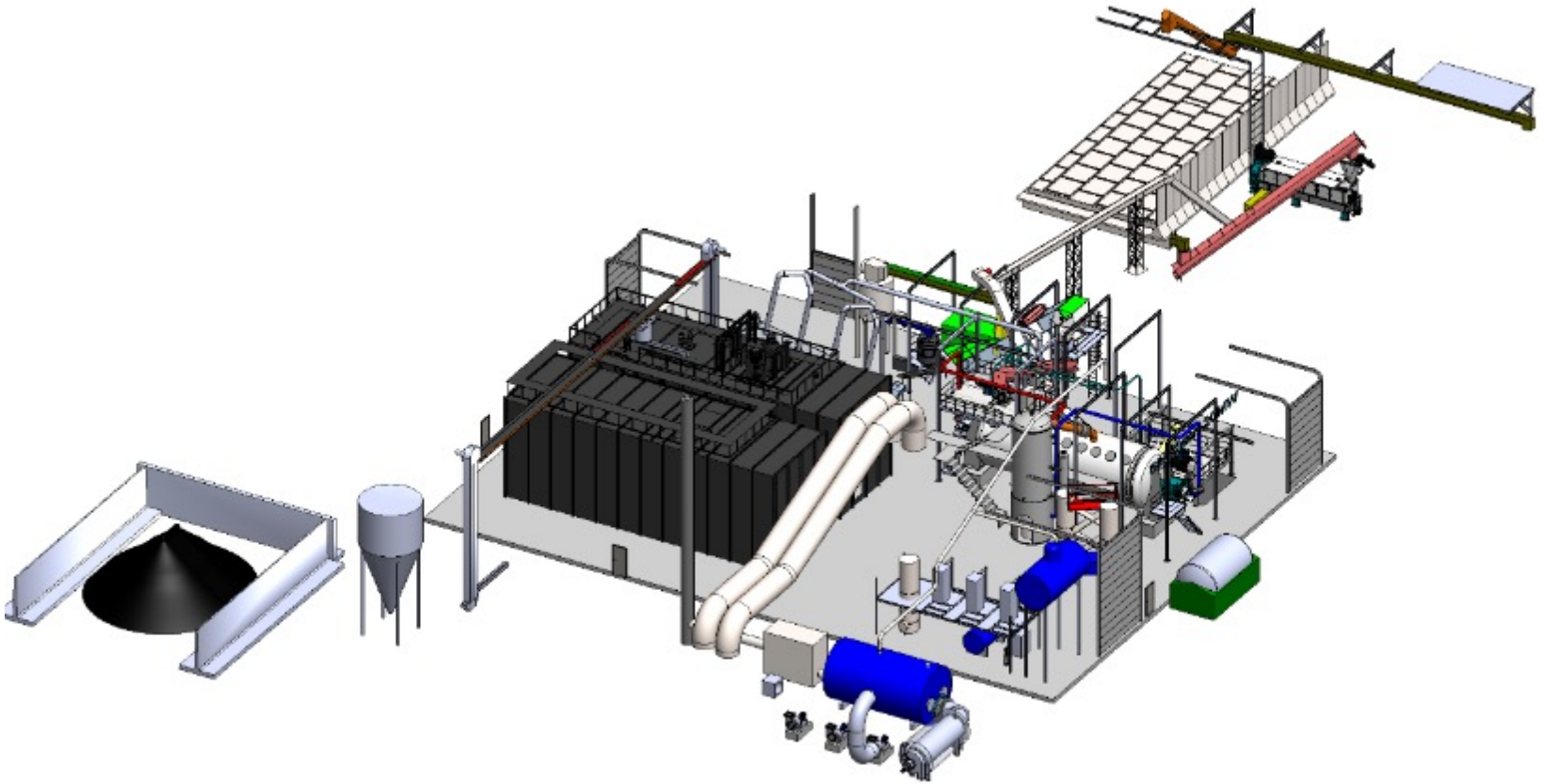
2 MW SkyClean test unit, commissioned March 2022

2 MW SkyClean test unit, commissioned March 2022

20 MW SkyClean unit



20 MW SkyClean layout

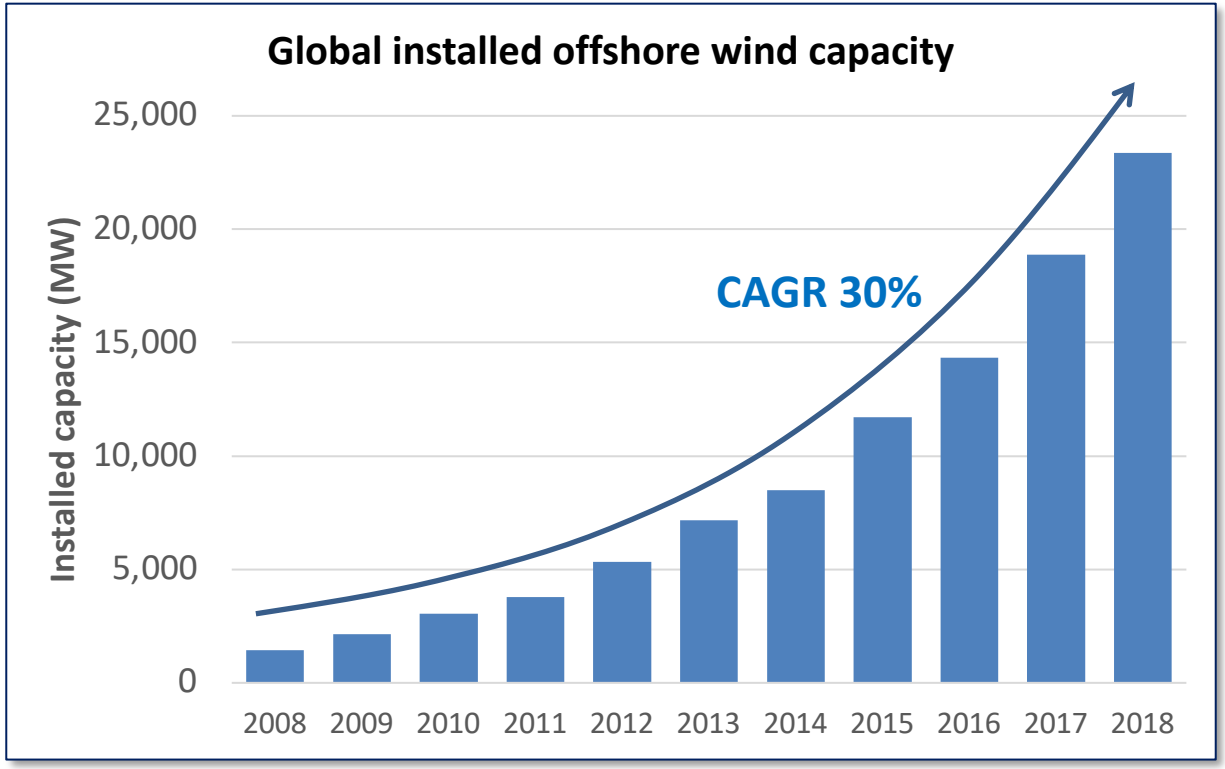


300

Microsoft

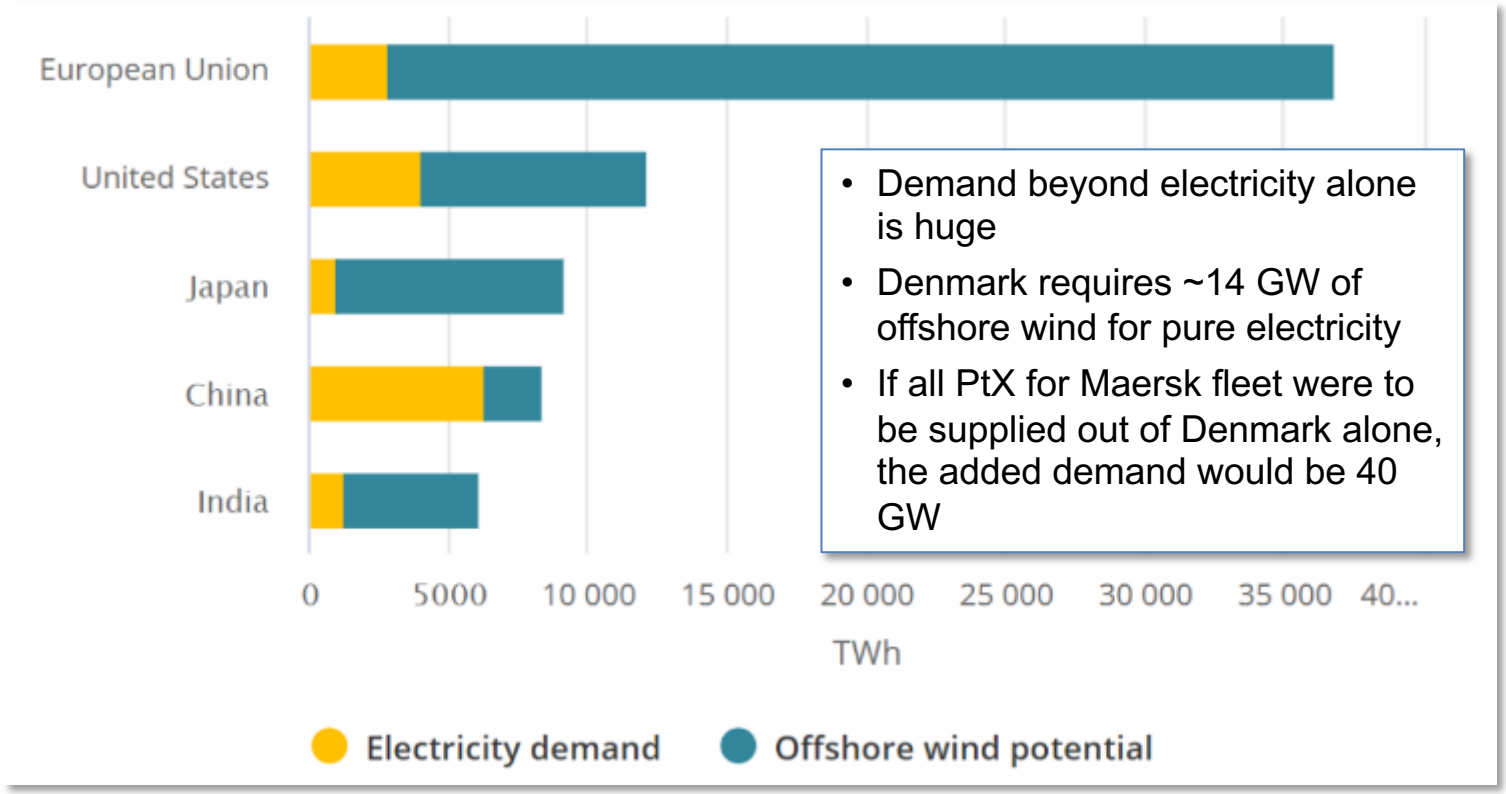
#skycleans to offset Microsoft's climate debt by 2050

Over three decades we have come to master Offshore Wind



Source: GWEC

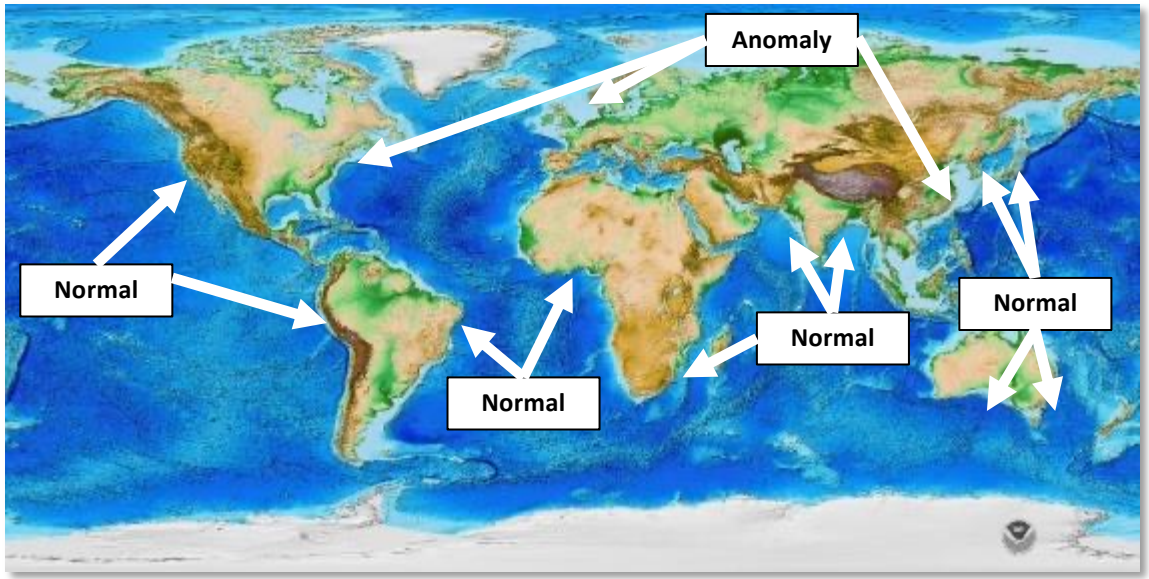
We need a lot of electricity!



- Demand beyond electricity alone is huge
- Denmark requires ~14 GW of offshore wind for pure electricity
- If all PtX for Maersk fleet were to be supplied out of Denmark alone, the added demand would be 40 GW

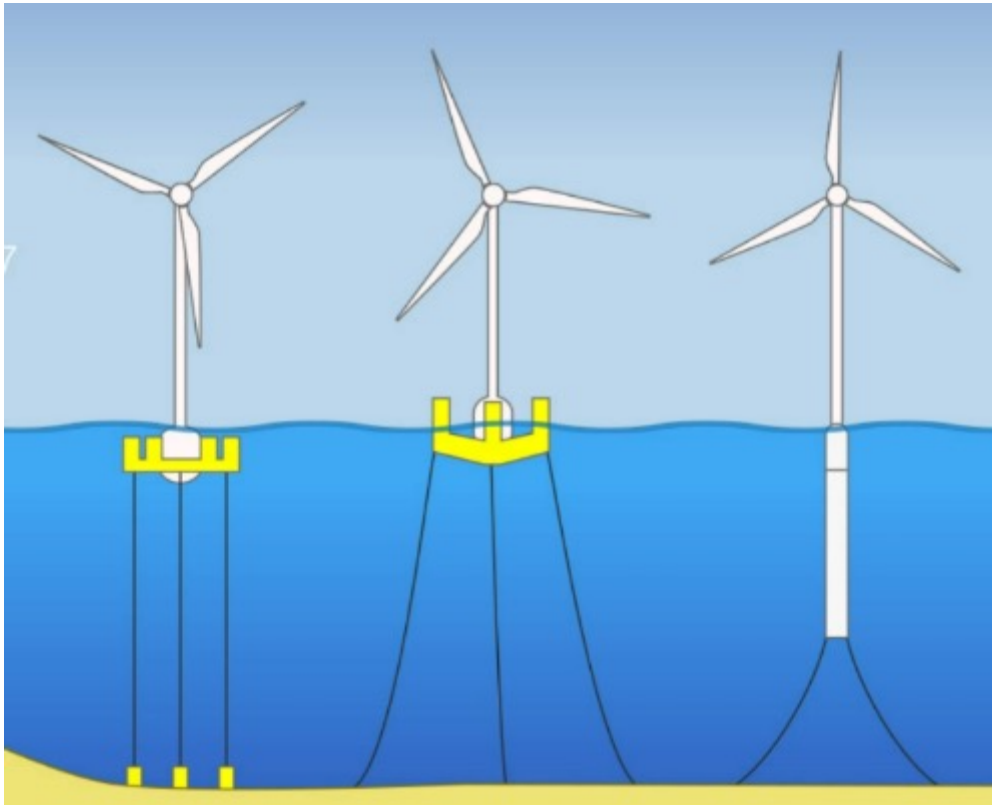
Source: IEA, Offshore Wind Potlook 2019

But there is a problem -



Source: NOAA

The solution is obvious – floating offshore wind



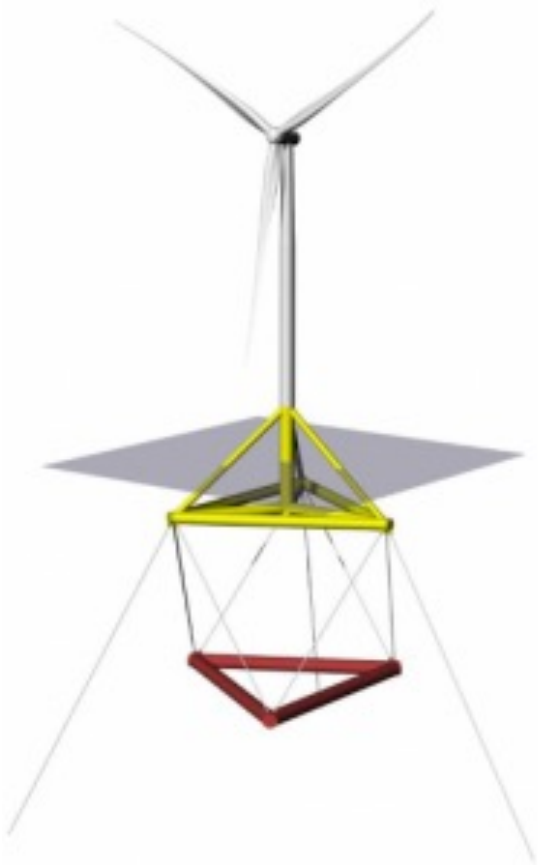
Industrialized floating wind power

Conventional thinking

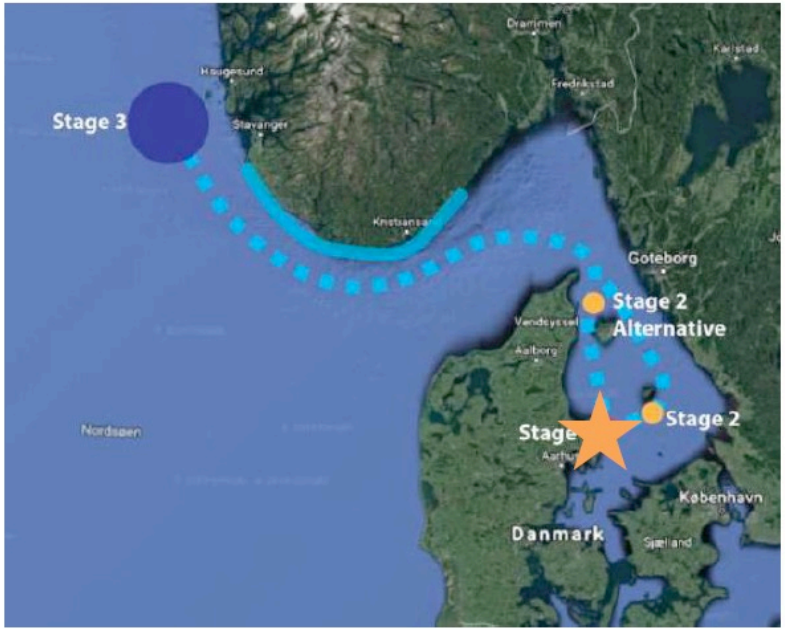
- We have designed this structure – now, how do we build it?

Necessary way of thinking

- We need to manufacture this way – now, how do we design it?



Construction port and towing route



Source: TetraSpar Demo

Center column manufacturing

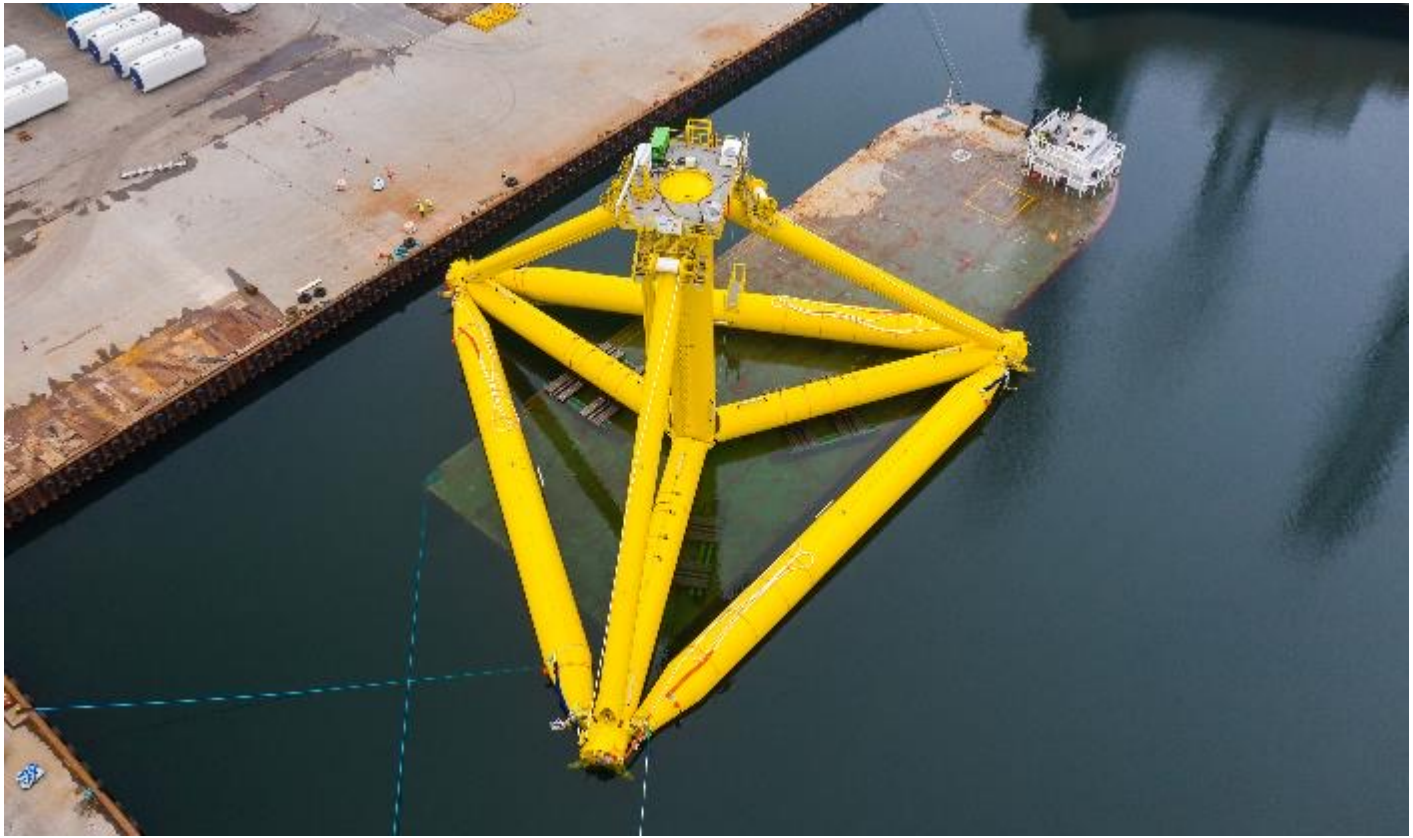
Transportation

Upending of center column

Mounting of diagonal

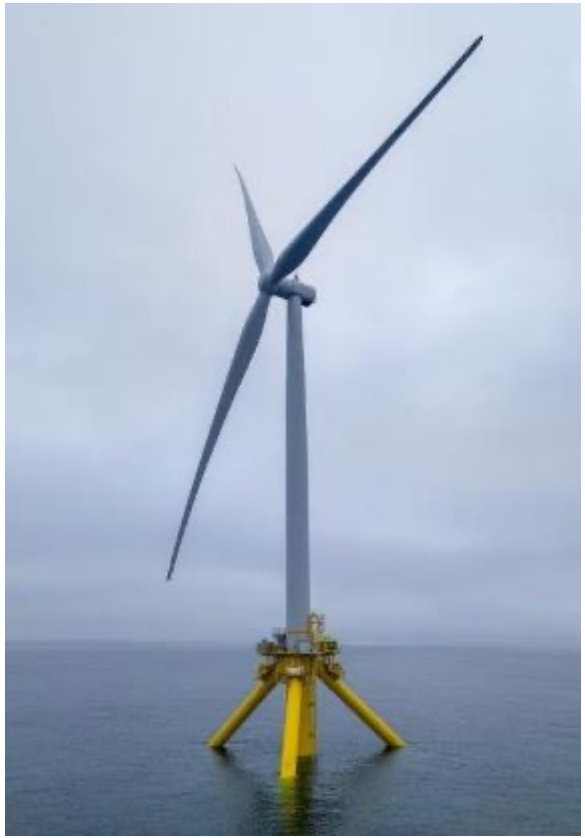
Floater and keel

Barge submerging

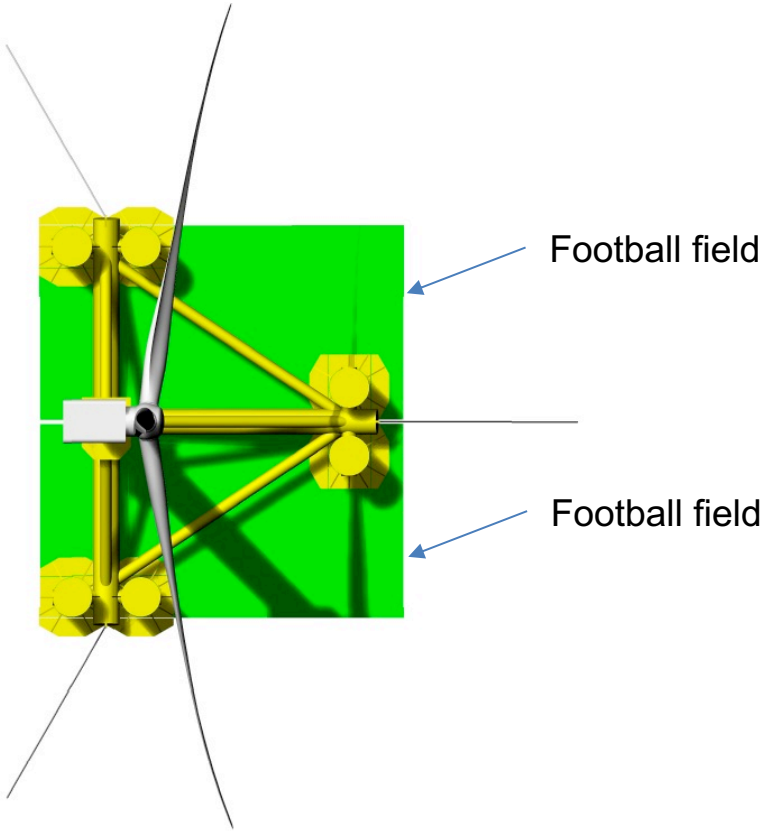


Towing

In operation



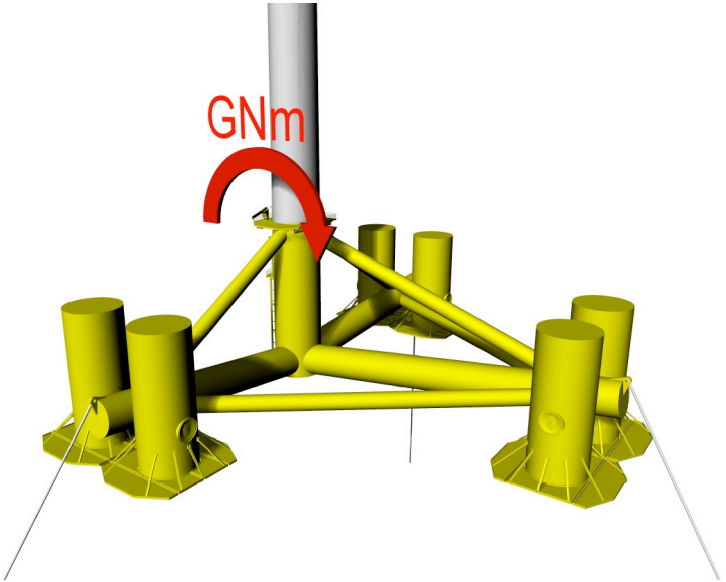
The TetraSub for 15 MW turbine, scheduled for 2025 installation



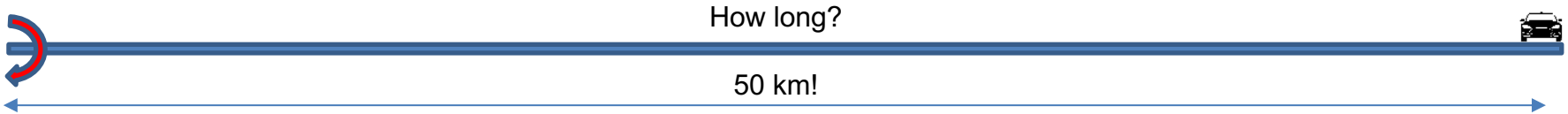
Our challenge

Loads are reaching new levels

- We are beginning to operate at load levels that have not yet entered the world of wind power
- Bending moments are measured in GNm
- Axial loads in structural members are measured in tens of MN
- Wave loads are measured in hundreds of MN



1 GNm – how do we get to that?



Stiesdal
Offshore

TetraSpar