KITEMILL

ROTARY DISTRIKTSKONFERANSEN

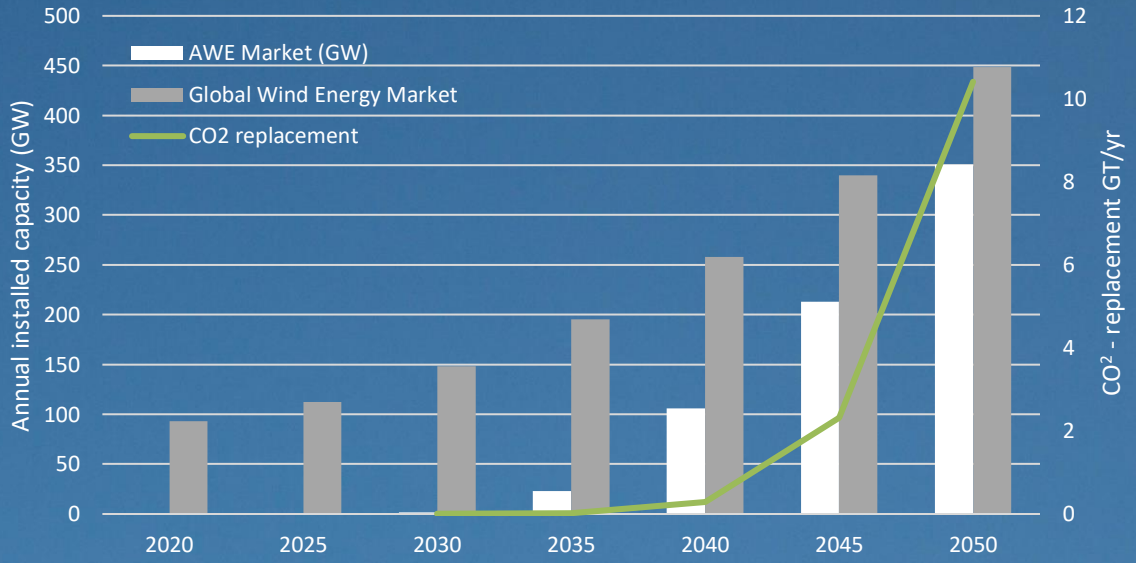
SEPTEMBER 2022, Thomas Hårklau

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 881193

Agenda:

1. AWE introduksjon
2. Kitemill – status
3. AWE for verda og Noreg

AIRBORNE WIND ENERGY ENABLE NET-ZERO IN 2050



-by 2050:

- 350 GW/yr of AWE installed
- Covers 28 % av electricity[1)]
- 10 $^{GT}/_{yr}$ CO^2 abatement[2)]
  (vs. 51 $^{GT}/_{yr}$ global emissions today)

[1)] IEA net zero: electricity consumption 2050: 49 000 TWh, cumulative AWE capacity contribute with 13 000 TWh.

[2)] Based on status in Europe 2019 of 0,275 ton CO2/MWh, Source: European Environment Agency.

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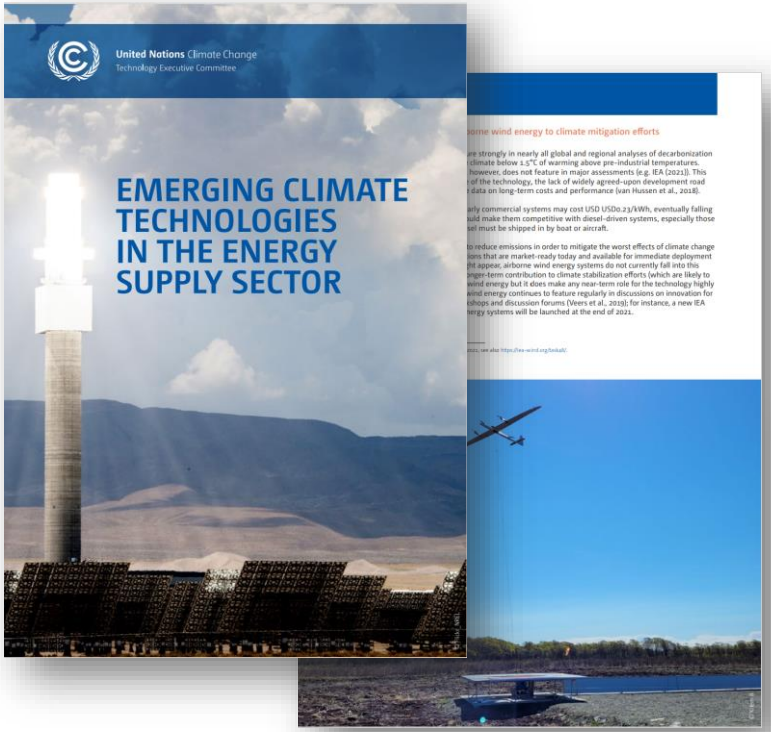
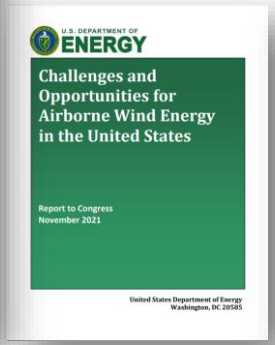
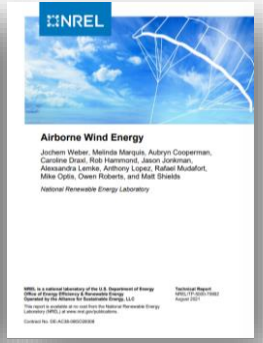
MASSIVE CONCEPT SUPPORT

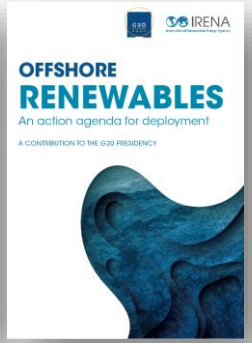


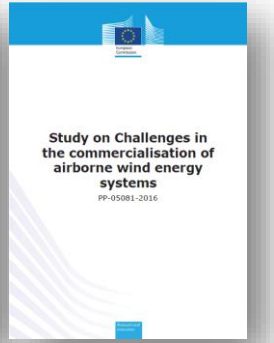
Airborne Wind Energy is recently presented by:

- The International Energy Agency (2020 - ongoing)
- United Nations (2022)
- US's Department of Energy (2021)
- National Renewable Energy Agency (US) (2021)
- International Renewable Energy Association (IRENA) (2021)
- The European Union - study (2016-2018)
- Energi 21 Strategi 22 Nasjonal strategi omtaler AWE

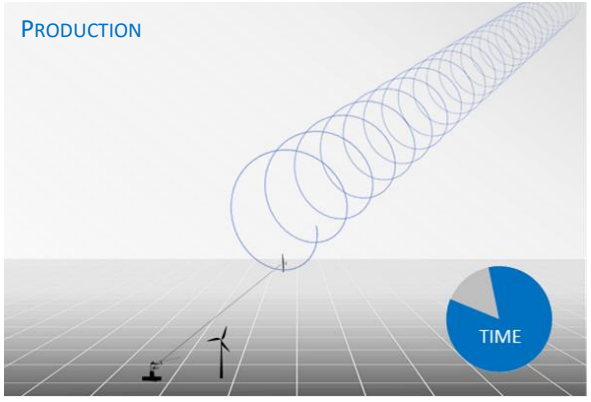


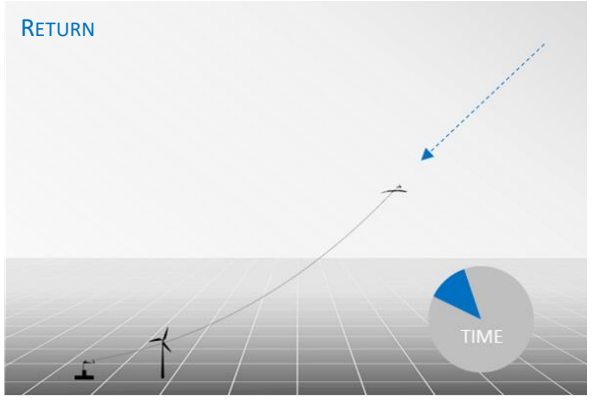






AWE GENERATES ELECTRICITY BY FLYING KITES





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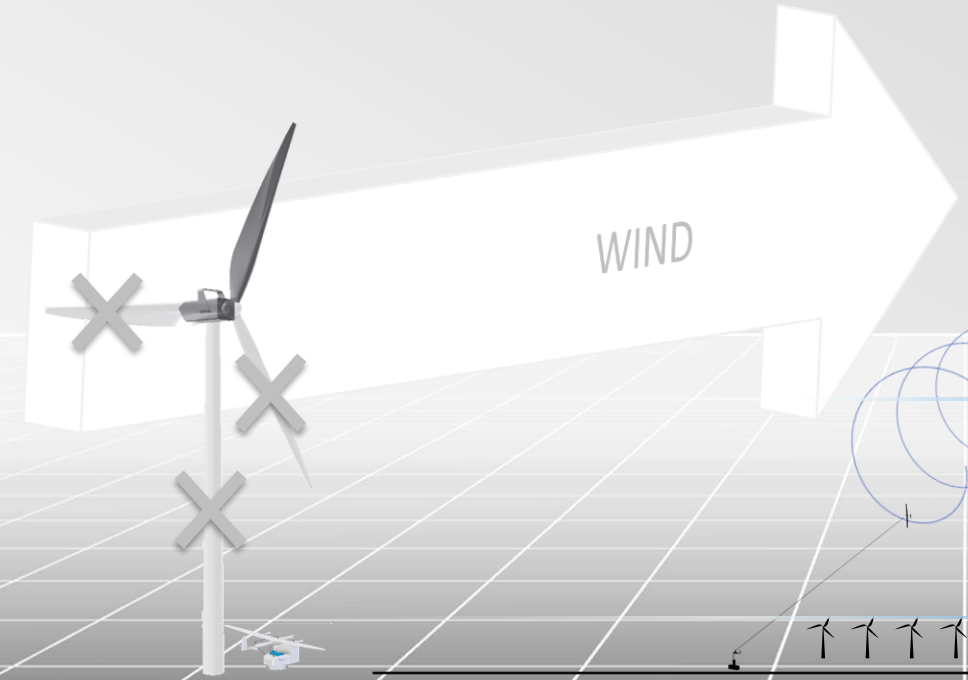
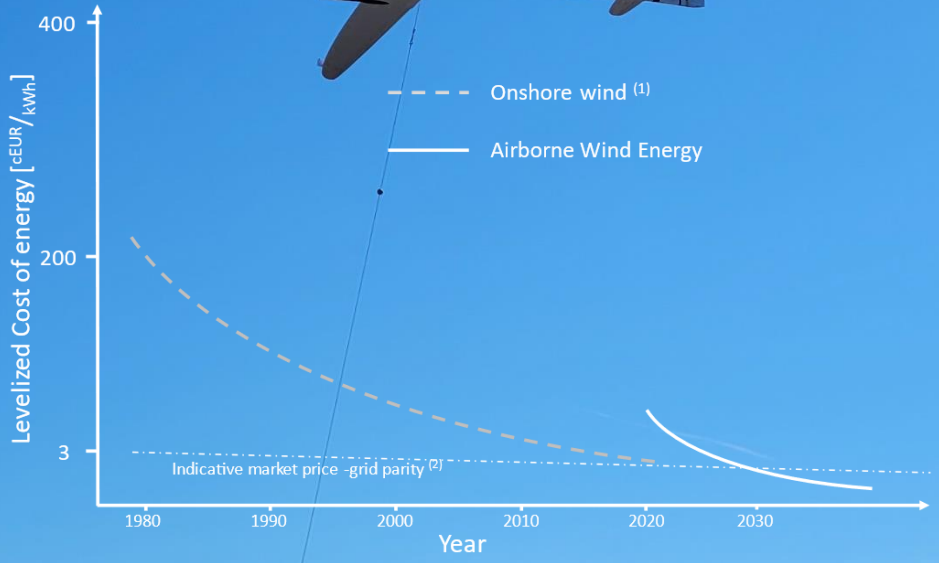
IT CAPTURES STRONGER WINDS AT HIGHER ALTITUDES



HEIGHT	AVERAGE WIND SPEED	AVAILABLE POWER
500 m	11 m/s	580 W/m^2
250 M	8 m/s	320 W/m^2
100 M	6 m/s	80 W/m^2

AWE TO BECOME CHEAPEST, MOST RELIABLE AND VERSATILE FORM OF WIND ENERGY

- **Stable energy output** thanks to high-capacity factor (>60%)
- **>50% lower LCoE** compared to conventional wind
- **Mobility of systems** allowing for temporary and remote installations
- **More potential wind sites** that can be unlocked thanks to harvesting wind at high altitudes



(1) Bloomberg New Energy Finance (-2010) & IRENA - Renewavoidanceable power generation costs in 2019 (2010-2020)
https://ourfiniteworld.com/2011/03/17/how-close-a-link-is-there-between-oil-price-shocks-and-recession/ (1980 global level x1,57 to correct for inflation from 1995 to 2015)

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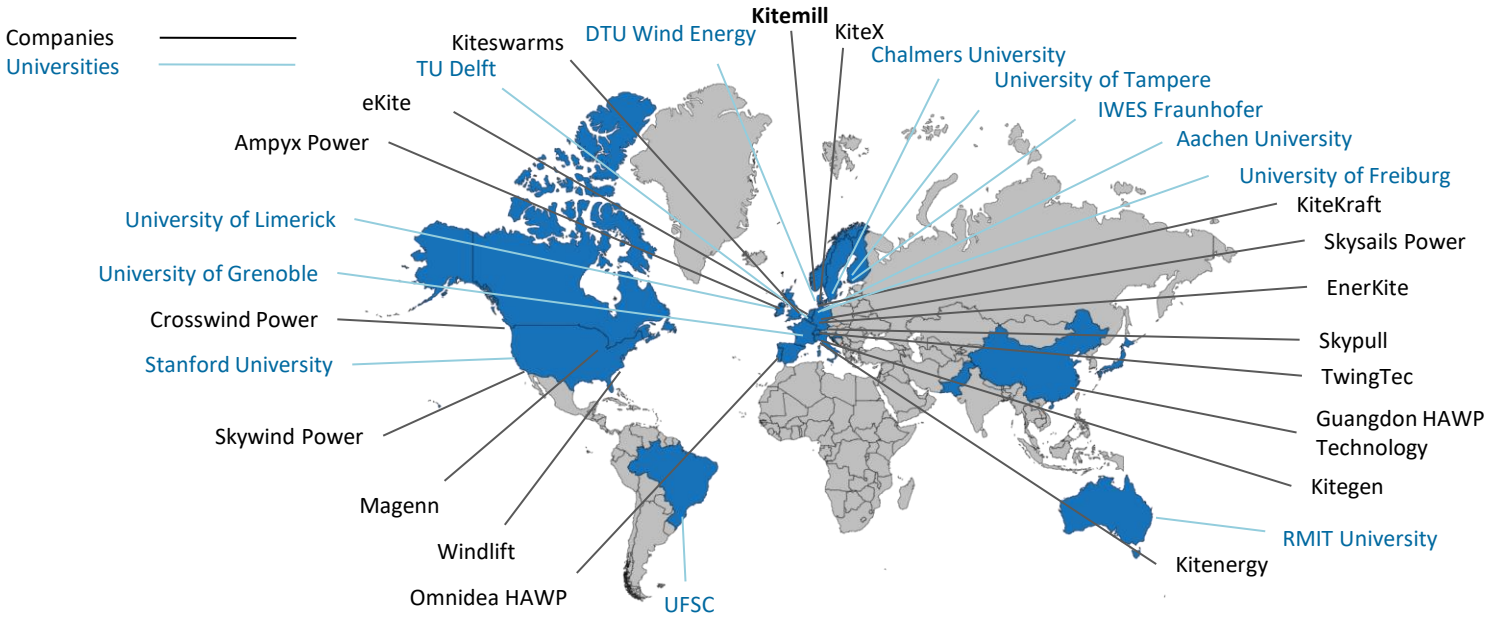
ON THE VERGE OF A BREAKTHROUGH



Source: Delft University www.kitepower.eu, modified by Kitemill.
Commercial sub-suppliers are not included even if their involvement includes investments and thereby «risk taking».

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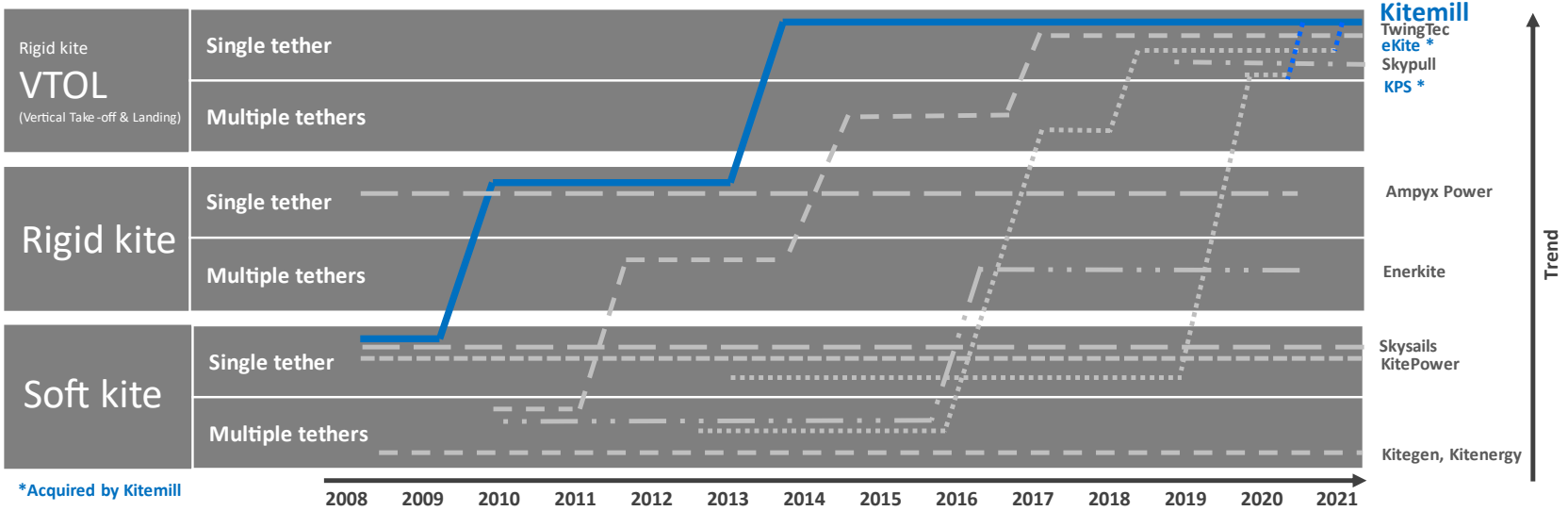
KITEMILL LEADING AND CONSOLIDATING THE AWE SECTOR



Kitemill first in Europe to demonstrate automatic operation in major operational phases.
Kitemill is the first company to have a permanent airspace approved.
Kitemill has 5 granted patents, one design protection and several pending patents.

MAIN FOCUS ON ENABLING AIRBORNE WIND ENERGY, CONSOLIDATION AROUND KITEMILL COOPERATION WITH THE REST.

KITEMILL STATUS

- Organisasjonen
- Infrastruktur
- Strategi kommersialisering
- Teknisk utvikling
- Planer

STRONG TEAM WITH RIGHT SKILLS AND PARTNERS







Core team with strong industrial, commercial and scientific background

Lean and efficient administration

- Backed by strong partners

EXCELLENT AWE R&D FACILITIES

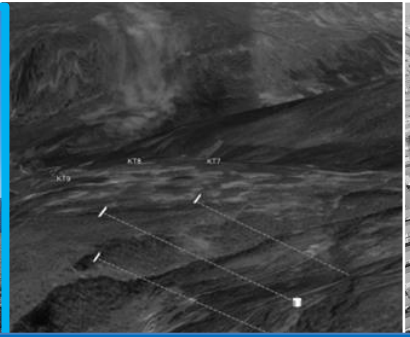
- R&D center with engineering offices, prototype assembly hall and test equipment
- Test site located next to it with permits and grid connection in progress (also for expansion)

STAGED MARKET APPROACH TO BECOME MAINSTREAM

Market segment	Addressable market 2030 for AWE	Opportunity
Demonstration market	10-50 units/yr base case	Enabling AWE / opens up new markets
Weak-grid off-grid market	€ 3,1 bn p.a. (1)	Customer requests received Diesel = 60c€/kWh vs Kite + Diesel = 20 c€/kWh Relocation option allow leasing
Repowering market	€ 7,8 bn p.a. (2)	Introduction through niches: Kite turbine can reuse – offshore foundations
Utility market	€ 141 bn p.a. (3)	Introduction through niches: Combination with conventional wind turbines, solar, hydro, etc.

Source: (1) Navigant study 2017 (2) WindEurope report June 2017 (3) Global Wind Energy report 2021 & Bloomberg New Energy Finance 2020 outlook

BACKED BY CONCRETE PROJECT PIPELINE



Pipeline:

- Sør Energi, Lista (NO)
  - Airspace OK
  - Build permit OK
- CENEC South Africa
  - Project initiated
- GreenFlyway – Intreg
  - Norway + Sweden
  - LoI & Project initiated
- Enerwhere off grid utility
  - LoI singed
- Vattenfall/Ørsted
  - Dialog initiated

Fast track pipeline:

- European Innovation Fund project: 45-60% CAPEX funding of one project with 12 units with the goal increasing ops hours. Project under planning.
  - 40% covered by sale to customers / Kitemill-PPA(s)
- European Innovation Fund project or similar: 60% funding of a project with +/- 50 units in utility scale niche project.
  - 40% covered by utility customer

THE NAWEP PROJECT

NORSE AIRBORNE WIND ENERGY PROJECT - NAWEP

The goal is to operate 12 KM2 units of 100kW power over a 3 year monitoring period

Key project stats:

- Project size €7.5m
- EU Innovation Fund support the project with €3.34m
- Targeting State Aid and PPA
- Financial close targeted H1-2024
- Start operation 2025

PERMITS SECURED FOR DEMO PLANT

In 2020 Kitemill secured the UAS certificate, an audit performed by the CAA was completed verified in a successful implementation. Further Kitemill was granted an permit to build the 5 units for Sør Energi market on the photo.

REAL OPERATIONAL ENVIRONMENT

Flights between the rain clouds.

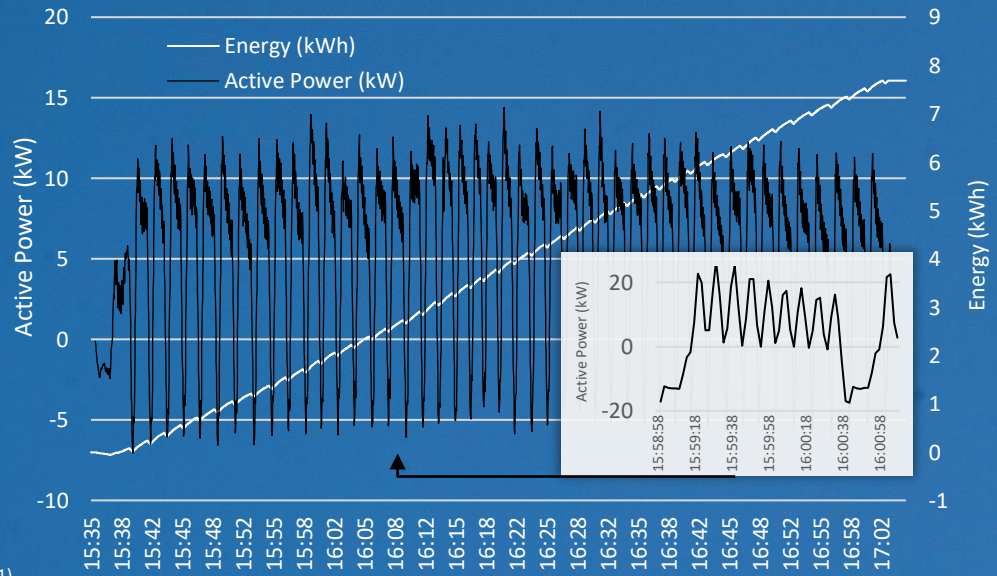
FYING IN CLOUDS

Tests close to the cloud base was performed in November 2020. The clouds came with good wind conditions.

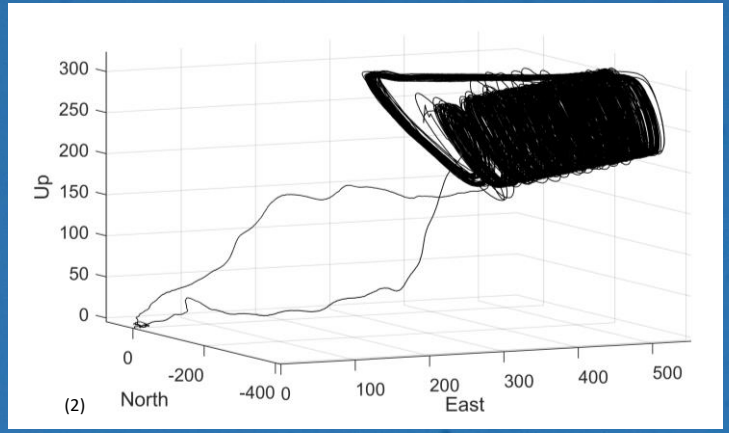
KM1 WITH WINGLOAD

The path to continuous operation is to gradually increase flight time.

RAPIDLY INCREASING PERFORMANCE



(1)



(2)

(1) Flight data showing net positive production over time, wind speed at ground level 12 m/s and measured by Lidar to 15 m/s at trajectory flight

(2) Plot on the right side is from the same flight.

LIDAR MESUREMENT CAMPAIGN

As a part of the LIKE project, a measurement campaign has been carried out using a LIDAR to measure the wind up to a height of 2000 meter and a microwave radiometer to measure the temperature profile, says PhD student Jan Markus Diesel who is responsible for the campaign (right in the picture).

KITEMILL'S PATH TO BECOME LEADER IN WIND ENERGY

1st commercial system

Operating at grid parity

Becoming mainstream

Leader in wind energy

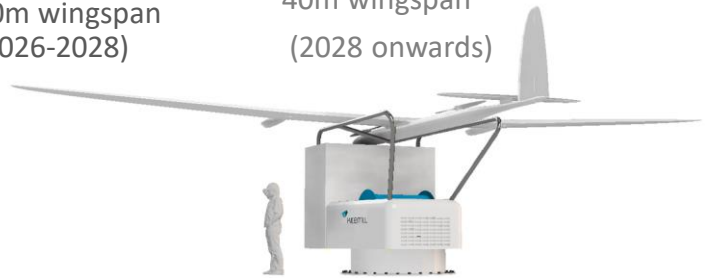
KM1
20kW
7,5m wingspan
Operational experience
(2016 - until KM2 is in operation)

KM2
100 kW
16m wingspan
(2021-2024)

KM3
500 kW
25m wingspan
(2024-2026)

KM4
1500 kW
30m wingspan
(2026-2028)

KM5
3000 kW
40m wingspan
(2028 onwards)



AWE FOR VERDA OG NOREG

- Det alle bør vite når for å vurdere energisituasjonen og løysingene.
- Potensielt innpass for AWE
- Urørt natur og AWE

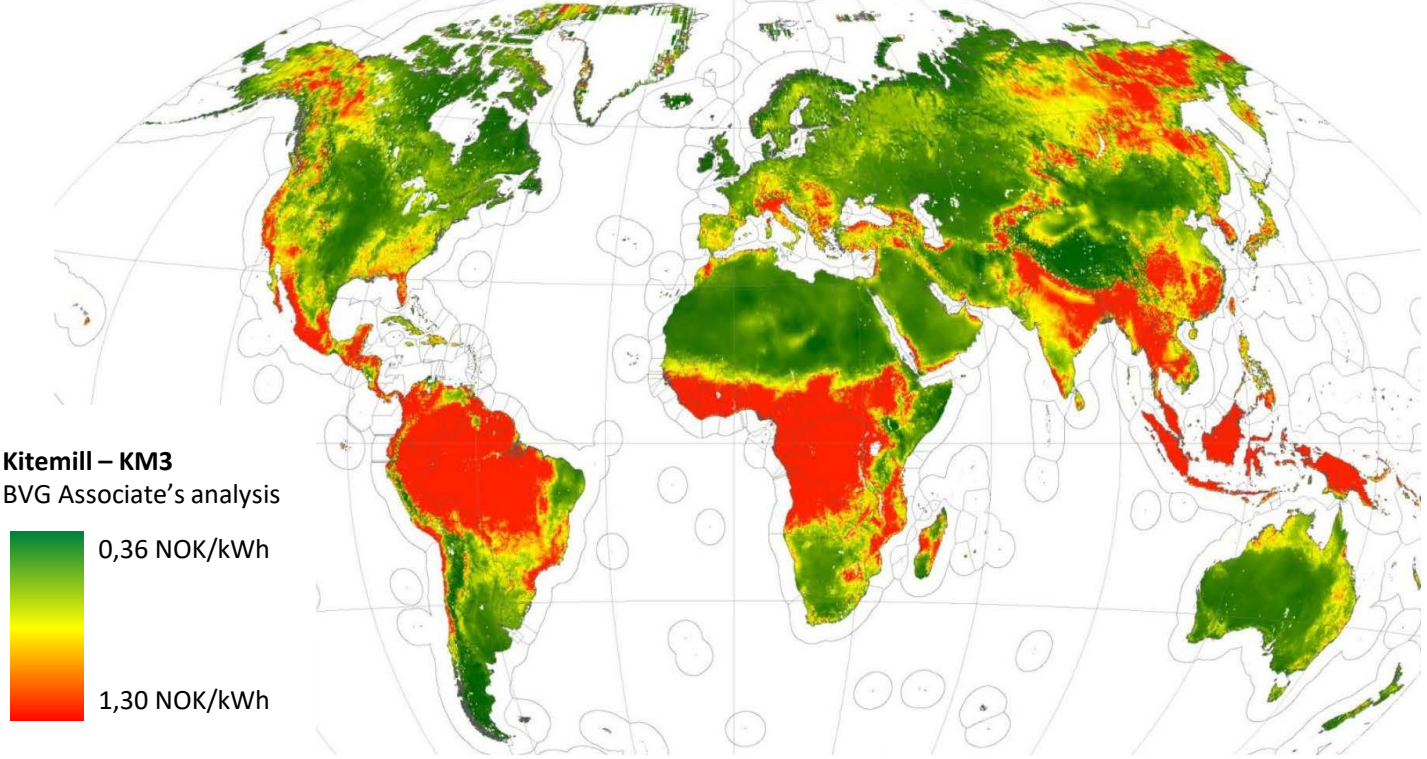
ENERGY SOLUTION

1. *How much of the 51 billion tons are we talking about? ...*
2. *What's your plan for cement? ...*
3. *How much power are we talking about? ...*
4. *How much space do you need? ...*
5. *How much is this going to cost?*

Figures you should make note of about Airborne Wind Energy:

- ✓ Suitable for large scale deployment and savings of 20% of the 51 billions tonnes annual CO2 emissions
- ✓ Material efficient
- ✓ Less intermittent
- ✓ Space efficient, indicative >15MW/km^2

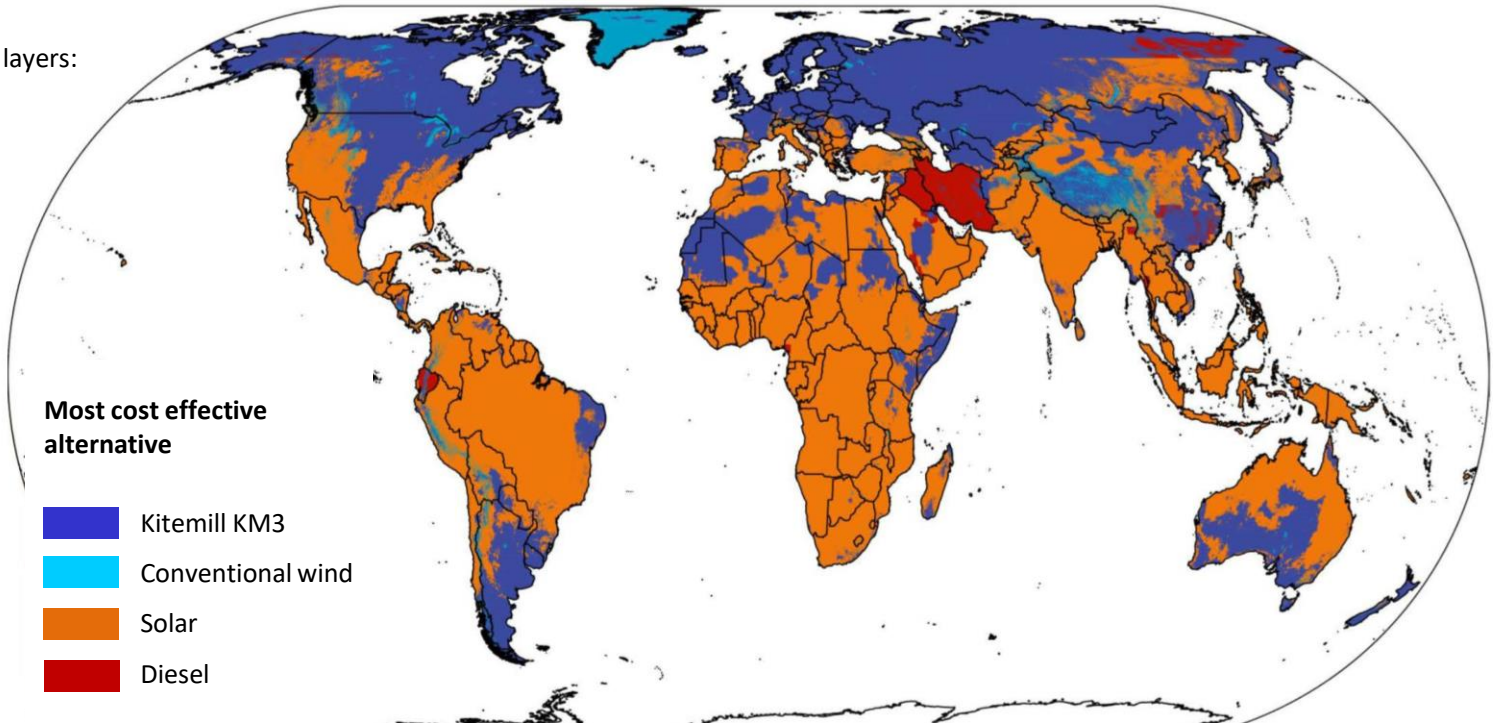
LEVELIZED COST OF ENERGY



AWE THE BEST OPTION AT EARLY SCALE

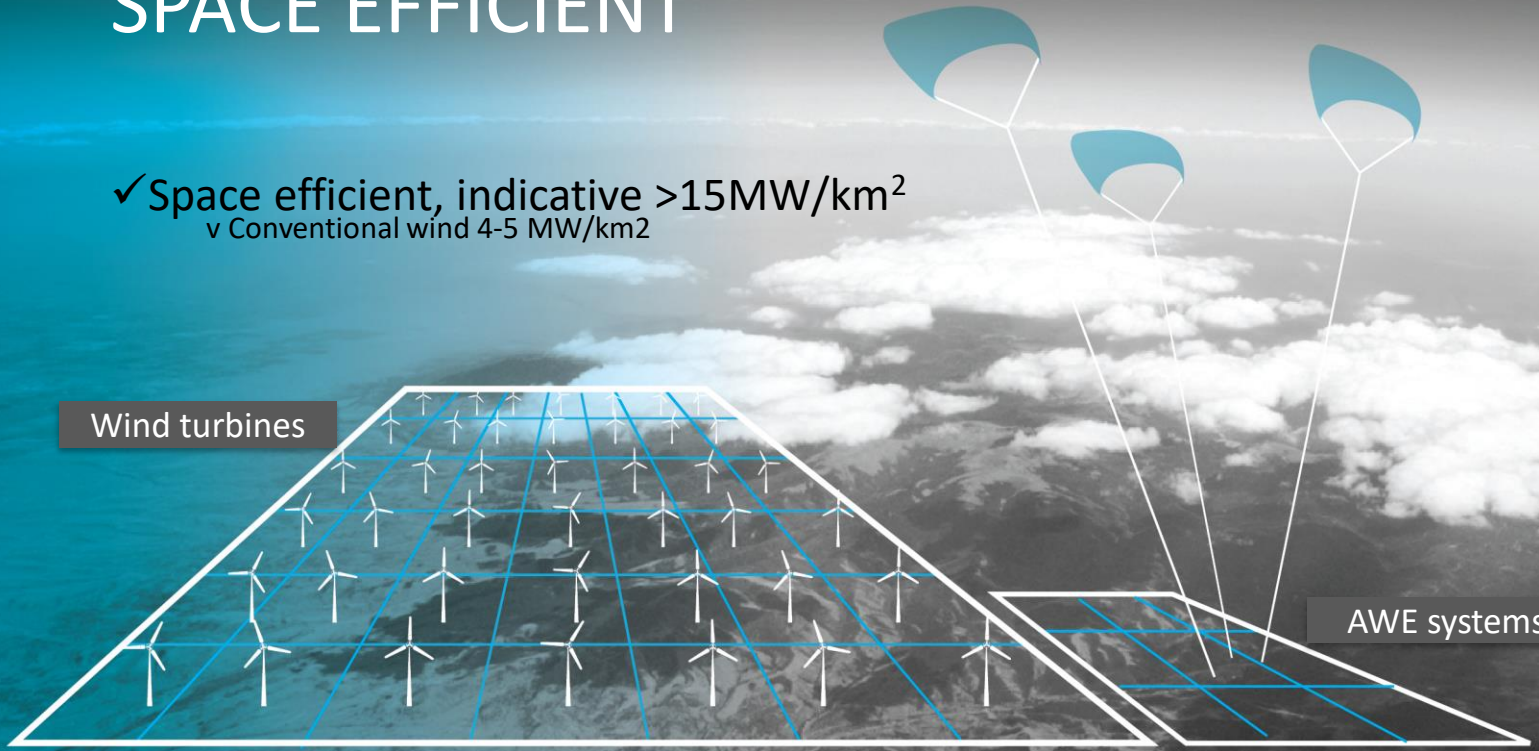
Combined exclusion layers:

- Roads
- Airports
- Elevation
- Slopes
- Land cover
- Urban areas
- Protected areas
- Wind speed



SPACE EFFICIENT

✓Space efficient, indicative >15MW/km^2
v Conventional wind 4-5 MW/km2



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