NORCOWE –highlights and future challenges

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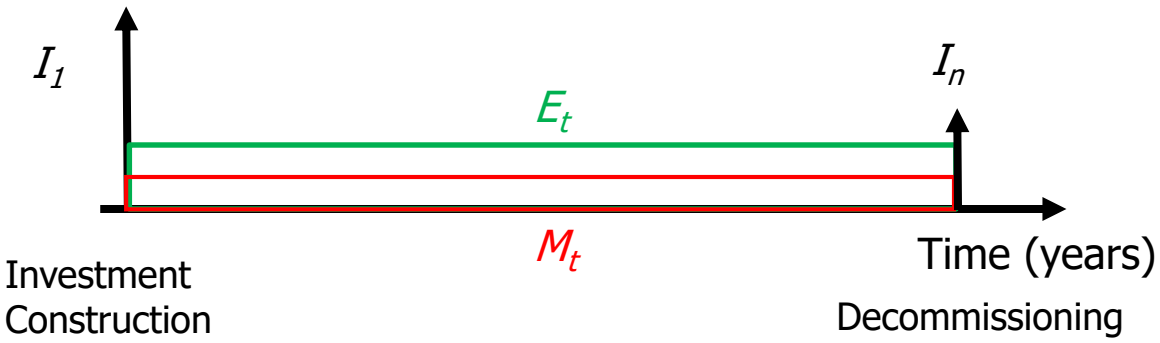
What is the our key challenge?

- Levelized cost of electricity (LCOE)!

$$LCOE = \frac{\sum_{t=1}^{n} \frac{I_t + M_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

t : Year number
n : Lifetime of project (years)
I_t : Investments
M_t: O&M costs
E_t : Energy produced
r : Discount rate

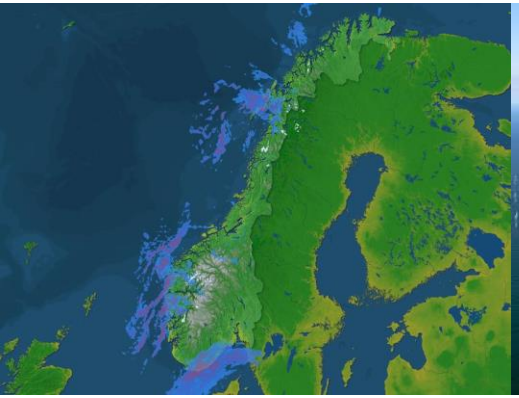
- What are the most important terms?

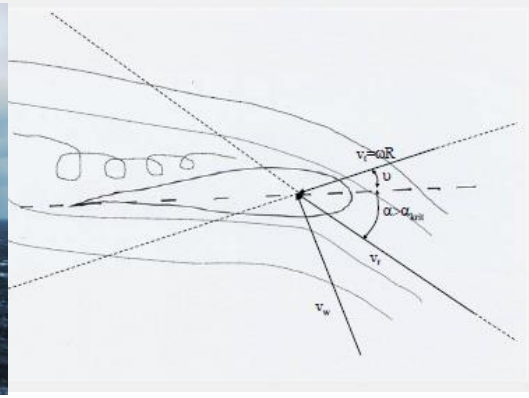


Why NORCOWE?

- Mobilize new Norwegian research groups to address offshore wind (CMR, UiA, UiB, UiS, Uni Research)
- Help to solve current and future challenges for the offshore wind industry
- Help the industry to identify issues that need attention
- Joint effort, cooperation towards common goals
- Add value to the partners: Coordination, network and marketing

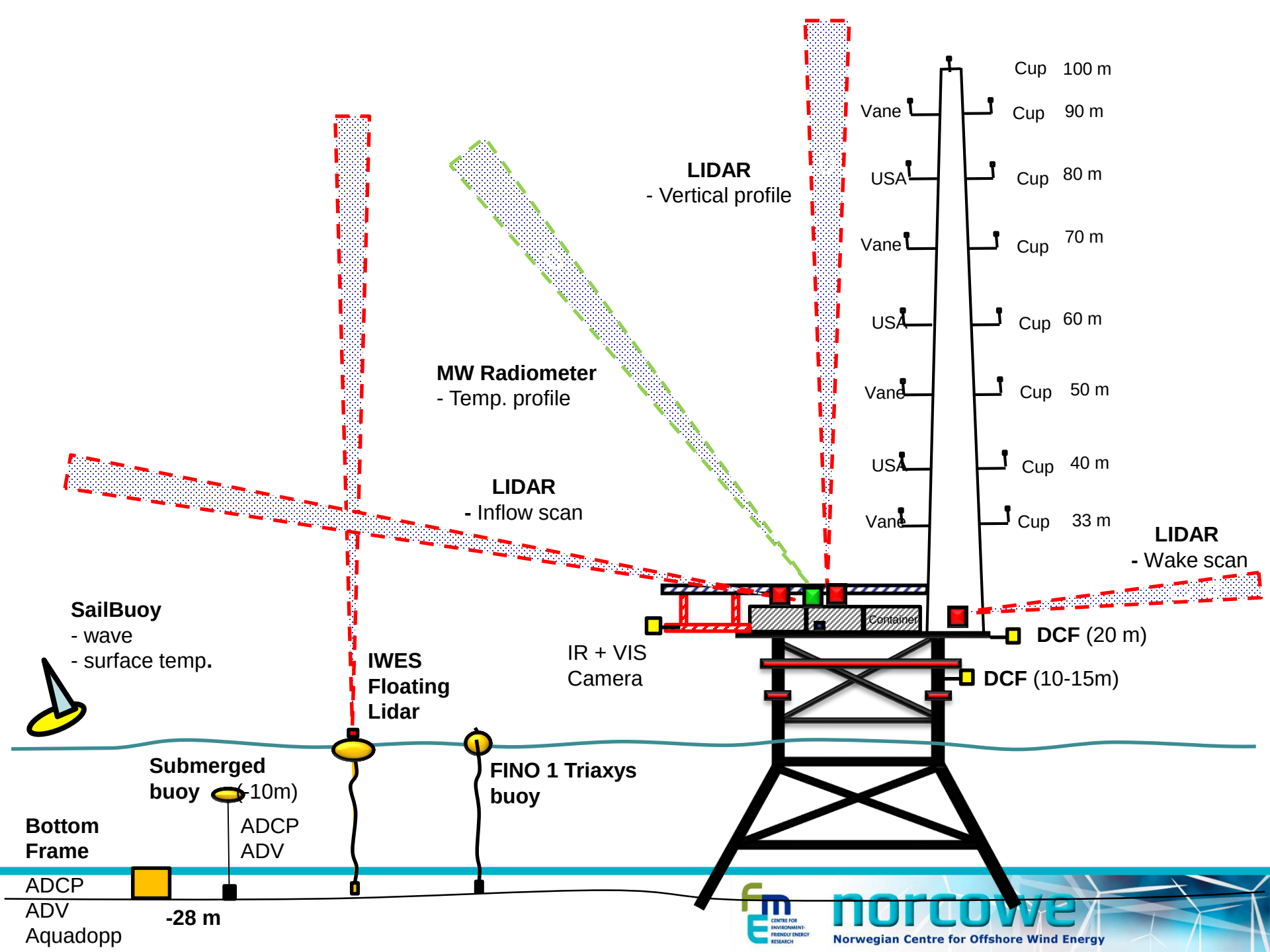
Improve production.
An effort across scales and disciplines.



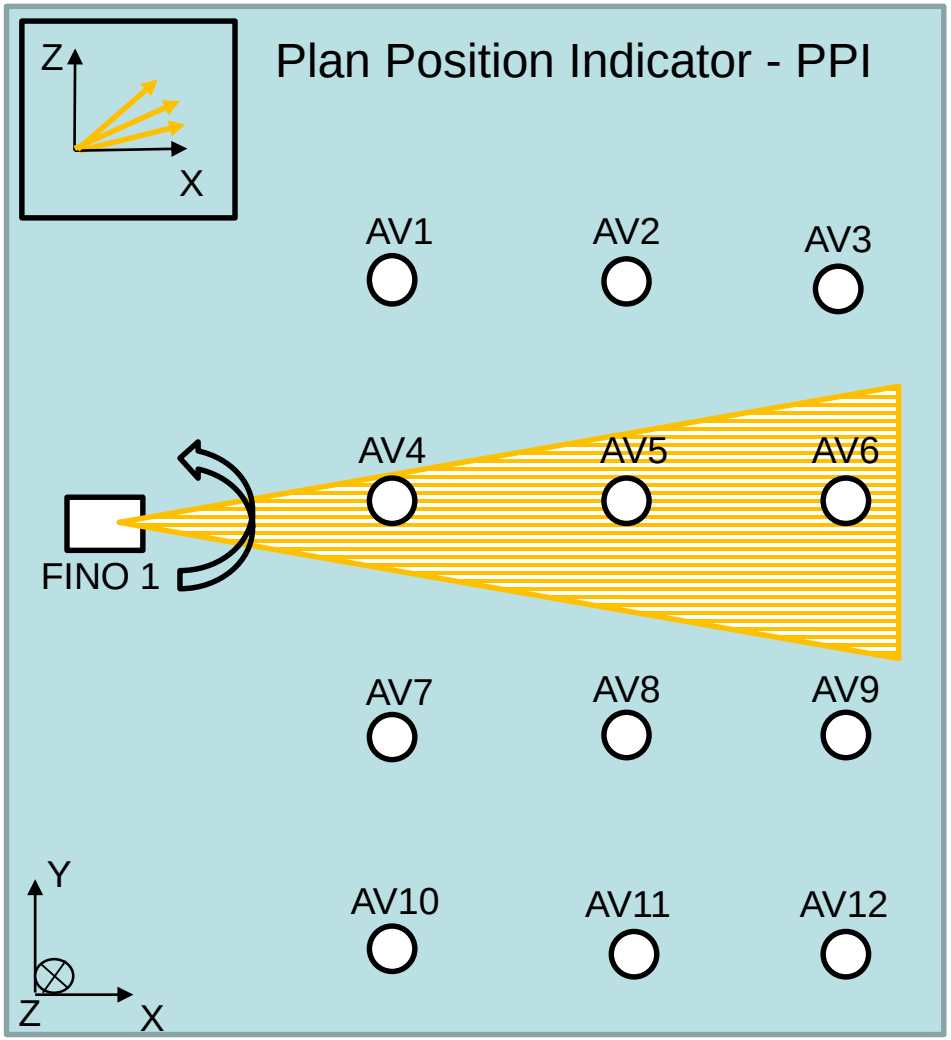



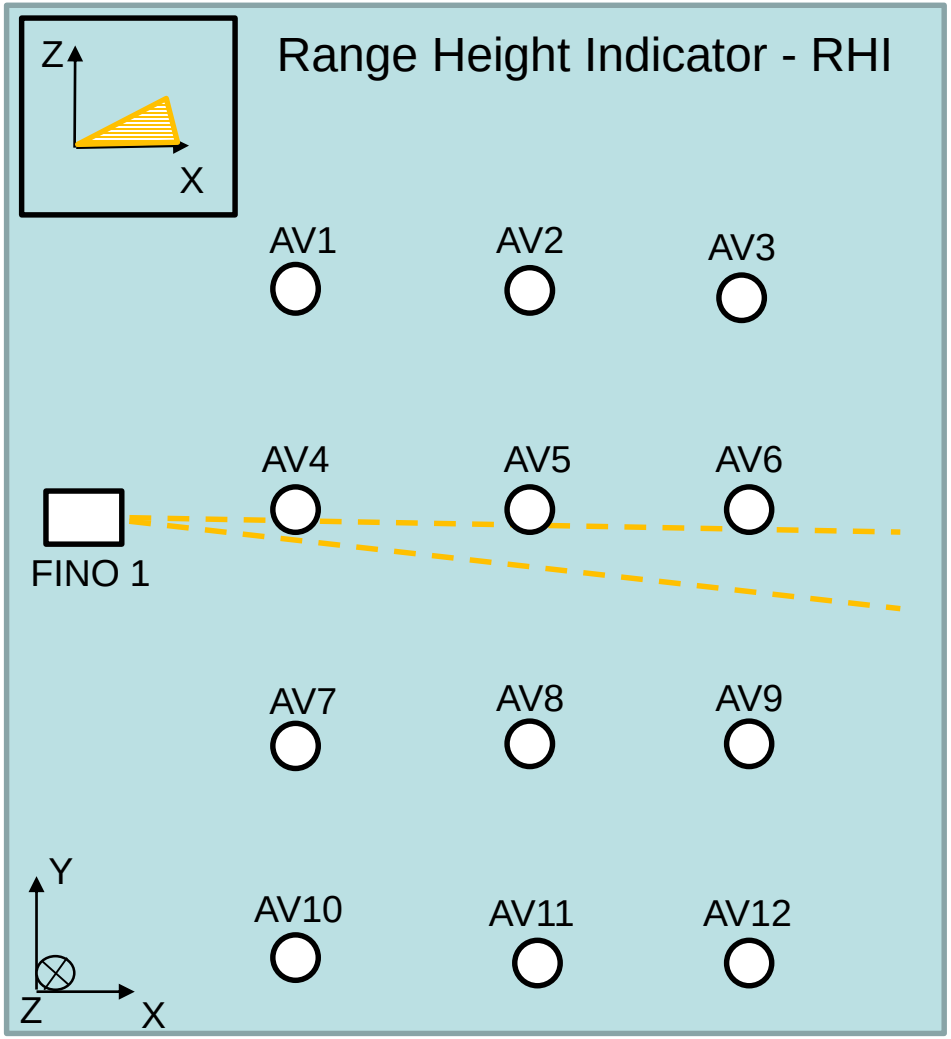
Mesoscale	Park scale	Rotor scale	Blade scale
10000 -10 km	10 -1 km	200 - 50m	5 - .5m
Days -Hours	20 min - 20 sec	10 – 2 sec	0.5 – 0.01 sec

Factor O(20*E06) on time and length scale


LIDAR
- Vertical profile
MW Radiometer
- Temp. profile
LIDAR
- Inflow scan
LIDAR
- Wake scan
Cup 100 m
Vane
Cup 90 m
USA
Cup 80 m
Vane
Cup 70 m
USA
Cup 60 m
Vane
Cup 50 m
USA
Cup 40 m
Vane
Cup 33 m
Container
DCF (20 m)
DCF (10-15m)
IR + VIS
Camera
SailBuoy
- wave
- surface temp.
IWES
Floating
Lidar
Submerged
buoy (-10m)
ADCP
ADV
FINO 1 Triaxys
buoy
Bottom
Frame
ADCP
ADV
Aquadopp
-28 m
CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH
norcowe
Norwegian Centre for Offshore Wind Energy

LiDAR scan pattern at OBLEX-F1



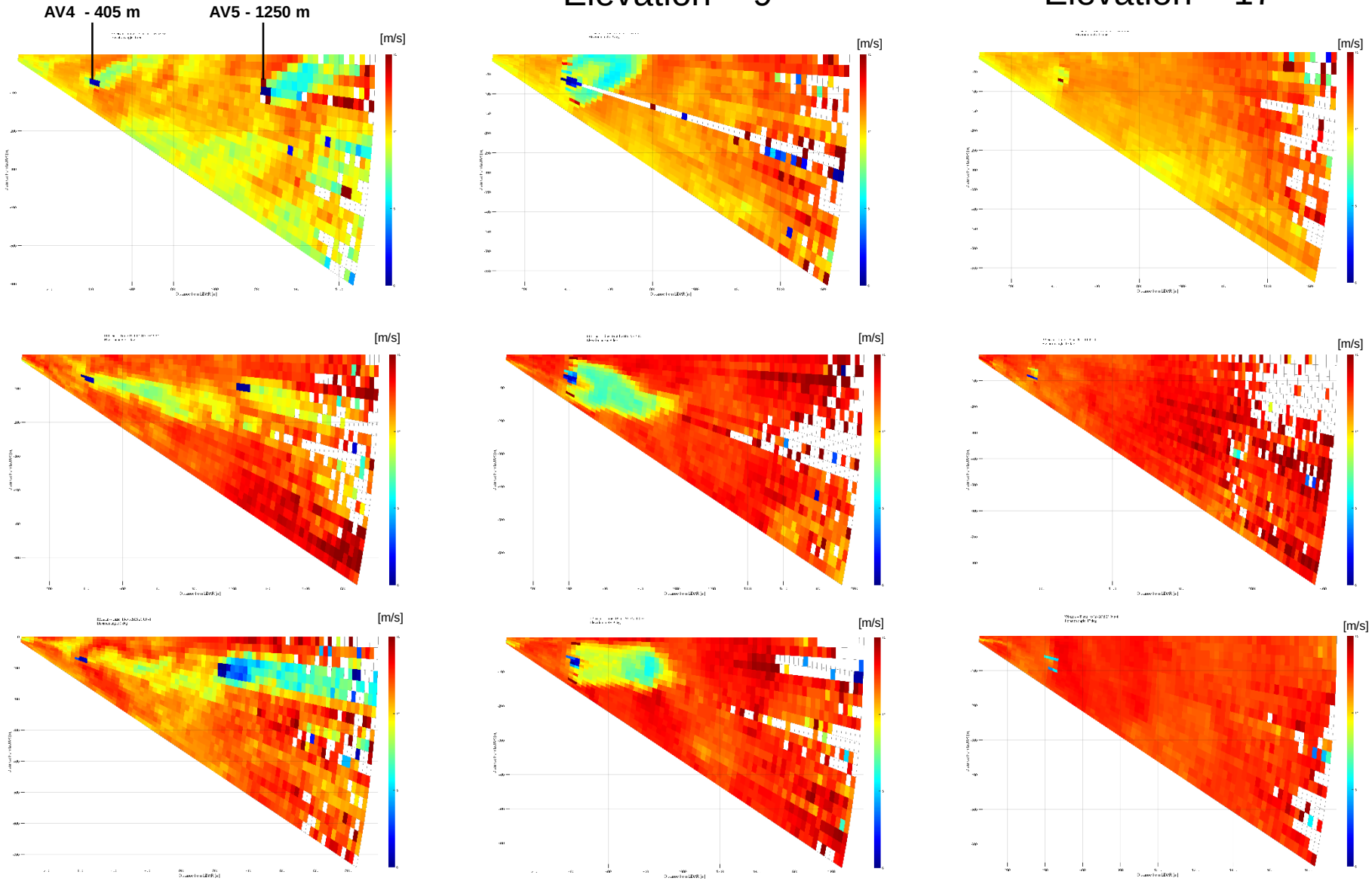


Scanning LiDAR - PPI

Elevation = 1°

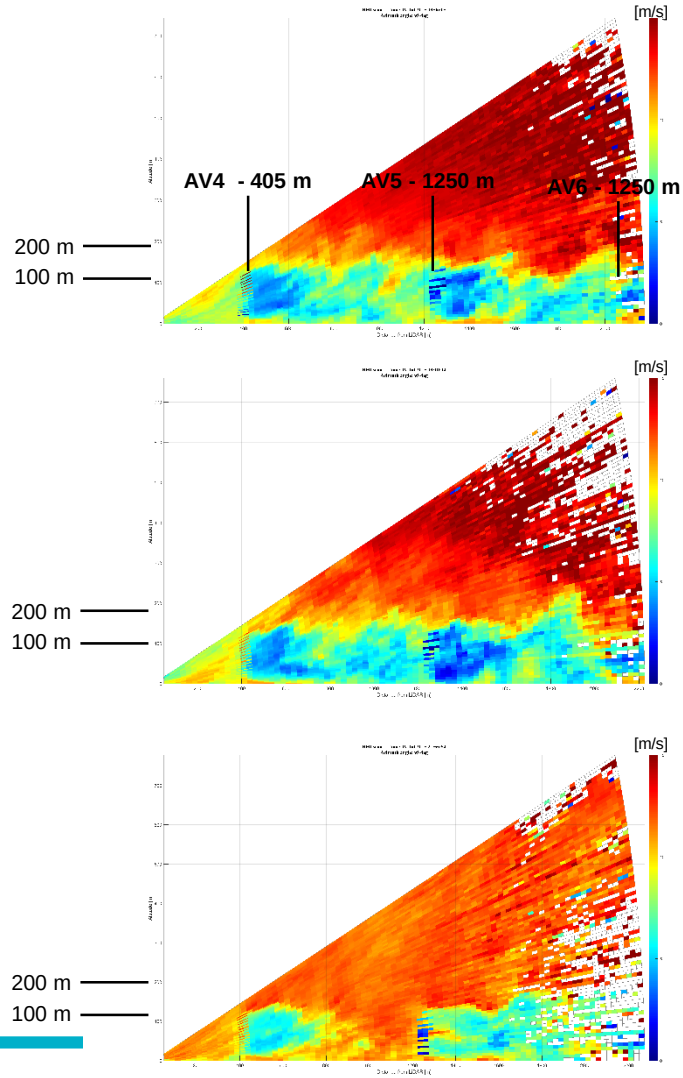
Elevation = 9°

Elevation = 17°

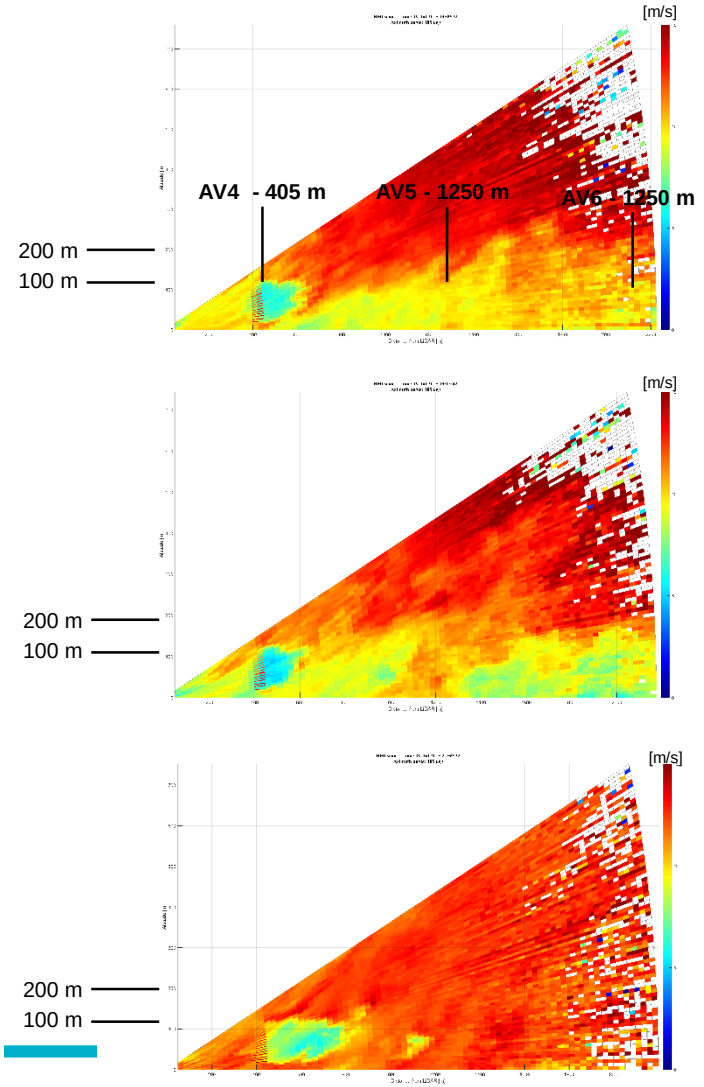


Scanning LiDAR - RHI

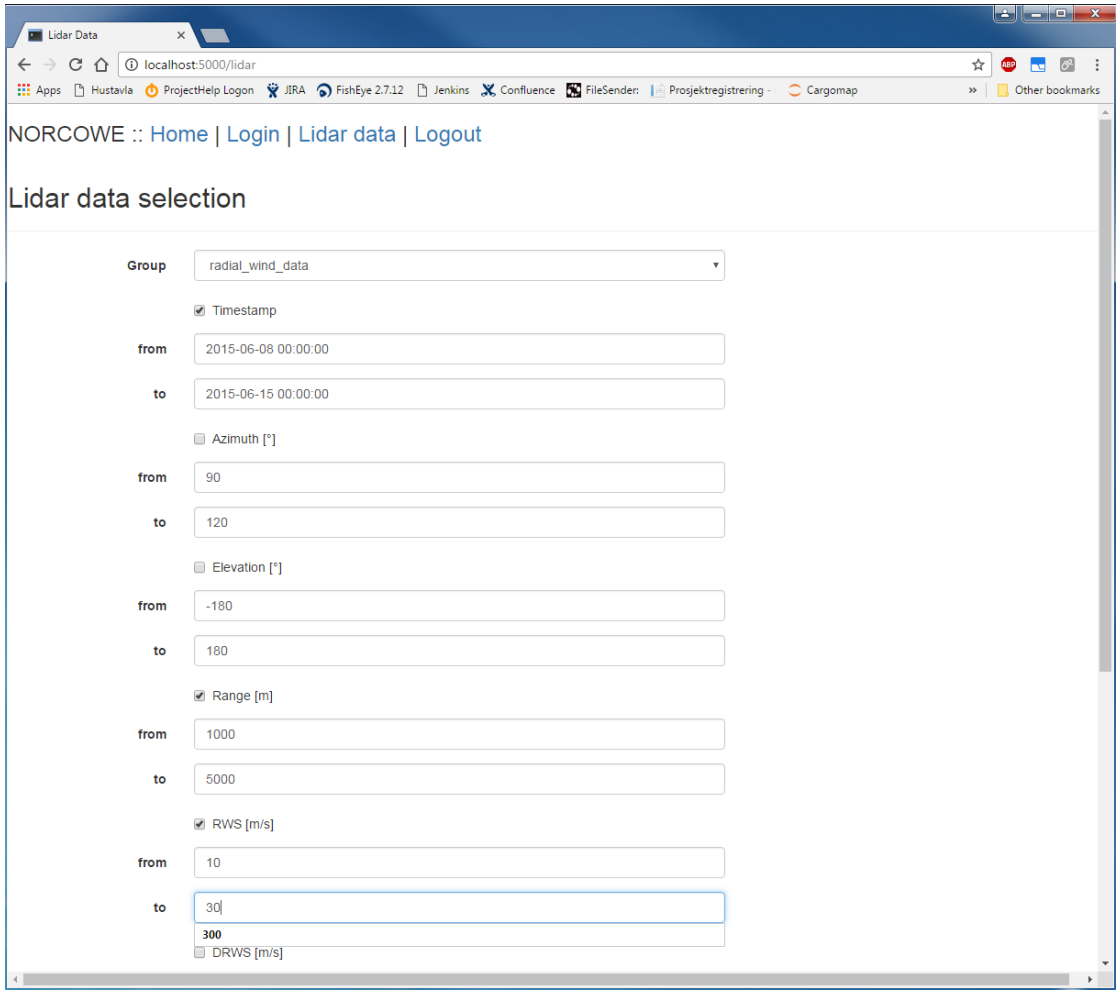
Azimuth = 95°



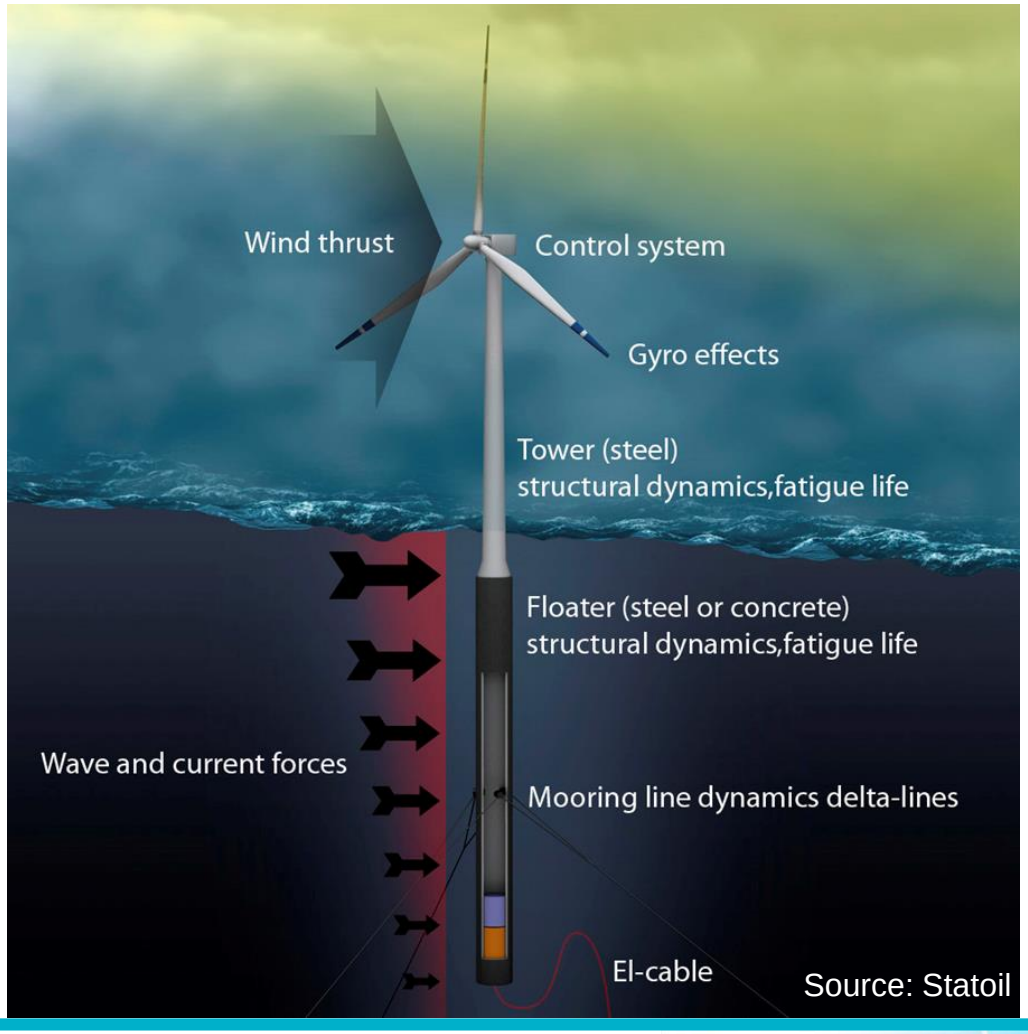
Azimuth = 105°



Web based data portal for OBLEX-F1

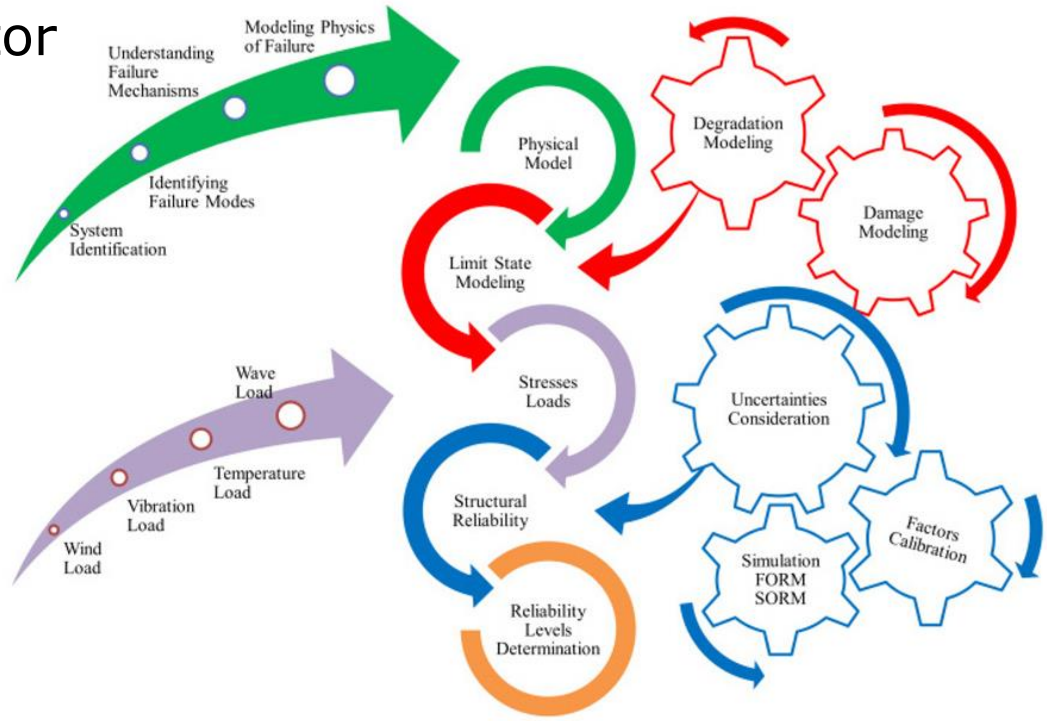


Optimized design and operation. Wind and waves key drivers



Towards the optimum O&M strategy

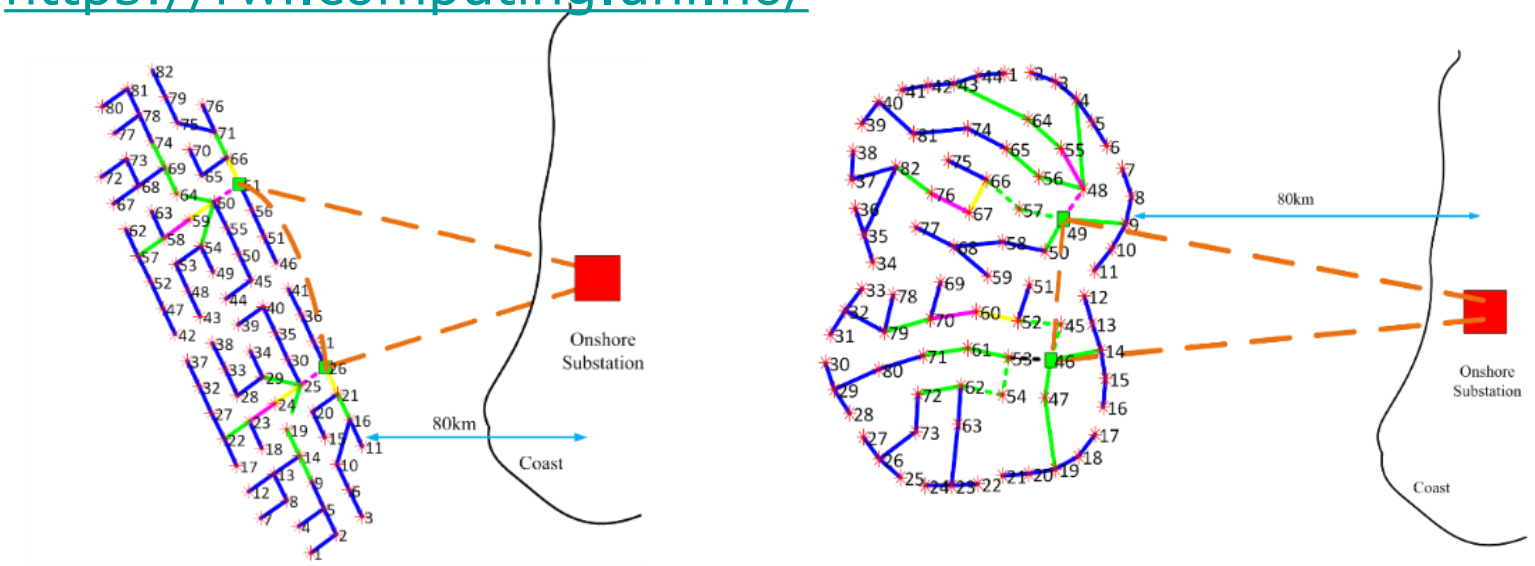
- Integrating load estimates, condition monitoring and failure estimates into reliability based O&M strategies.
- Reduce O&M costs
- Improve capacity factor
- Increase lifetime



Courtesy: John Dalsgaard Sørensen, AAU

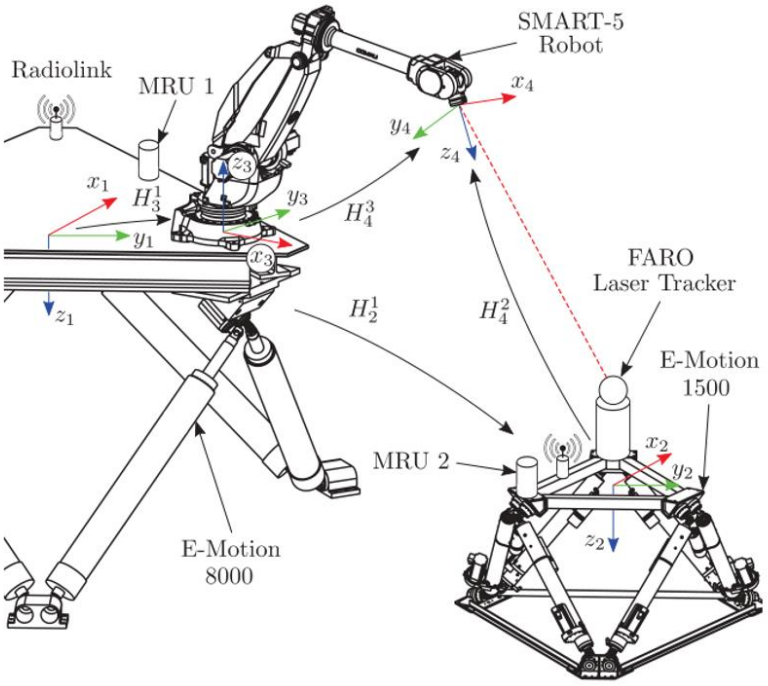
The reference wind farm – a platform for testing tools

- Optimum Wind farm design and operation
- Rules for farm design and operation
- Site wind and wave climatologies
- Levelised cost of energy
- https://rwf.computing.uni.no/



The Motion Lab at UiA – An integrating platform

- Instruments on moving platform
- Concepts for access
- Operation and maintenance



Motion-Lab: Investments

- Funding through NORCOWE: ~ 4 MNOK (2010-2012)
- University of Agder (Building): ~ 10 MNOK (2012-2013)
- Research Council Infrastructure Funding: ~ 8 MNOK (2015)
- University of Agder (Full-time engineer): ~ 0.85 MNOK / year (2016-)

OBLO infrastructure

OBLO (Offshore Boundary Layer Observatory) (http://oblo.uib.no/)

advanced mobile instrumentation for field measurements of meteorological and oceanographic parameters related to offshore wind energy

NORCOWE
Norwegian Centre for Offshore Wind Energy

5 Static lidar wind profilers

3 Leosphere WindCube v1

1 Leosphere WindCube v2 866 (motion compensated)

1 Natural Power ZepIR 300

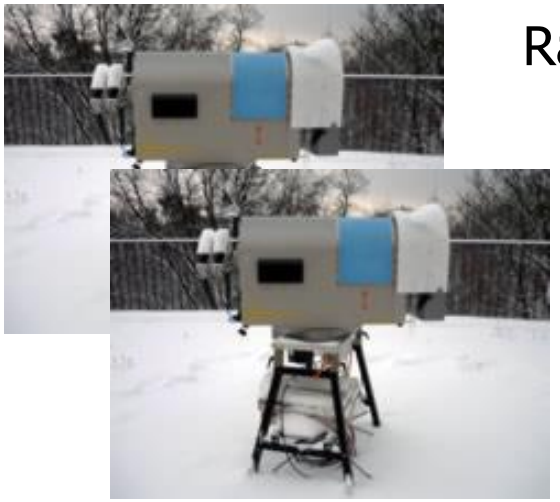
- Profiles of wind speed, wind direction and turbulence intensity between ca. 20 and 300 m above ground
- Vertical resolution 20 m
- Typical applications:
  - Inflow conditions
  - Site characterization
  - Average characteristics of single turbine wakes

3 Scanning wind lidar systems

Leosphere WindCube 100 S

- Characterization of the wind and turbulence conditions up to a distance of 3.5 km from the instrument
- Spatial resolution 50 m
- Typical applications:
  - Inflow conditions
  - Advanced turbulence characterization (e.g. coherence)
  - 3-D structure and dynamics of wind turbine wakes
  - Investigation of wind farm wakes

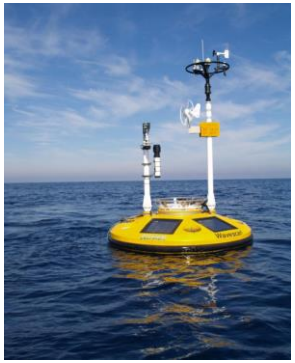
2 passive microwave temperature/humidity profilers



Radiometer Physics HATPRO RG4

- Temperature and humidity profiles up to ca. 5 km above ground
- Liquid water content of clouds
- Vertical resolution 50 m
- Typical applications:
  - Characterization of the stability of the atmosphere (key information for the interpretation of wind profile and wake measurements)

OBLO infrastructure - ocean



Wide range of oceanic instrumentation (sensors) and instrument platforms (bottom frames, surface and submerged buoys, drifters)

- Temperature and salinity profiles
- Current profiles
- Wave characteristics
  - Height
  - Direction
  - Frequency
- Oceanic turbulence
- Air-sea interaction

The legacy of NORCOWE

NORCOWE –reducing LCOE through interdiciplinary research

The legacy of NORCOWE some examples

- LIMECS (at Stavanger Airport)
- WINTWEX-W (at Wieringermeer, ECN)
- OBLEX-F1 (FINO1)
- Shoreline
- Gwind
- Wind farm module in WRF
- OBLO
- Norwegian Motion Lab
- Science Meets Industry (Stavanger and Bergen)
- The NORCOWE network

The legacy of NORCOWE

- **Research Network for Sustainable Energy at UiS and IRIS**

RESEARCH AREA LEADERS

Energy efficientcy
Mohsen Assadi

Sustainable technology
Bjørn Hjertager

Green transition
Oluf Langhelle

Carbon capture, utilisation and storage (CCUS)
Ying Guo

Smart cities
Chunming Rong

- **Energy Lab at University of Bergen**
- The Energy Lab is a forum for exchange of information on research results and activities related to renewable energy and energy transition**.**
- The Energy Lab hosts weekly informal lunch-meetings and larger half-day seminars. These events are free of charge and open to all interested. Future events can be found in the calendar.

Norwegian offshore vessel providers go into offshore wind

Rem Installer

Solstad Offshore has joined the list of offshore vessel providers in Norway that are turning to alternative markets to overcome the challenging circumstances in the offshore support vessel market.

Namely, the company informed on Friday it has entered into a contract with Dong Energy Wind Power for hire of the 2013-built construction support vessel (CSV) Rem Installer for a period of 23 months firm.

DONG Returns to Østensjø Rederi for Hornsea Project One SOV

Source: Astilleros Gondan

DONG Energy has exercised an option for a second Service Operation Vessel (SOV) at Østensjø Rederi, which once built will transfer turbine technicians to the 1.2GW Hornsea Project One wind farm.

The 81-metre long vessel will be delivered in the third quarter of 2018. She is a sister vessel to the SOV ordered by DONG Energy in October last year for the Race Bank wind farm.

The DP2 SOV has 60 single cabins which can accommodate up to 40 wind turbine technicians in addition to a marine crew of 20. The vessel will also have a motion compensated gangway system with an adjustable pedestal.

Special areas and functions of the vessel are made in accordance with the charterer`s requirements. The vessel is expected to be equipped with a helideck.

The SOVs are designed by Rolls Royce in cooperation with Østensjø Rederi. Astilleros Gondan in Spain will again be the builder of the vessel.

"The new award is a further recognition of Østensjø efforts to expand our business into the renewable energy sector, following the strategy to diversify our operations. We are therefore very [illegible] DONG Energy again has awarded us an exciting and important opportunity," said Kenneth Walland, CEO of Østensjø Rederi AS.

Hywind Scotland

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Search

Flere aspekter ved Hywind Scotland har nå i år vært presentert på NORCOWEs konferanser **Science Meets Industry** Stavanger og Bergen. Vi har samlet presentasjonene her:

Hywind Scotland - Assembly and logistics - *Hege Eskild, NorSea Group*

Mooring System for Hywind Scotland - *Jon Høvik, MacGregor*

Hywind Scotland - Marine Operations - *Knut Harald Lien, Statoil*

The SCADA system for Hywind Scotland Pilot Park - *Jon Einar Skjeie Handeland, Origo Solutions*

Statoil Hywind oil & gas concept including battery storage - *Rajnish Sharma, Statoil*

Hywind Scotland Pilot Park - Marine Operations - *Yngve Børstad, Technip*

News

16. 12. 2016
New laser tracker and cameras in place at the Motion Lab...
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28. 11. 2016
Hywind Scotland - samlede presentasjoner tilgjengelige...
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News archive >>

Calendar/ Upcoming Events

18. januar 2017
EERA DeepWind'2017...
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15. februar 2017
Klimafrokost...
read more >>

7. mars 2017
NORCOWE workshop on OBLEX-F1 data...
read more >>

Calendar Archive >>

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Offshore wind in Norway – why?


Kronikk

LES MER PÅ db.no/meninger

Månelanding til sjøs

KRONIKK

John Olav Giæver Tande, Forsker, SINTEF Energiforskning

Geir Moe, Professor, NTNU

Tore Undeland, Professor, NTNU

FRAMTIDSRETTET:

Foto: Norsk Hydro

- Hywind - starting point in 2001: Power supply for oil and gas platforms
- Article from SINTEF/NTNU in 2007
- State budget 2017:

10) Stortinget ber regjeringen senest i forbindelse med statsbudsjettet for 2018 presentere en strategi for kommersiell utvikling av flytende vindmøller, som kan bidra til lønnsom elektrifisering av norsk sokkel

Next generation wind farms

8 MW turbins

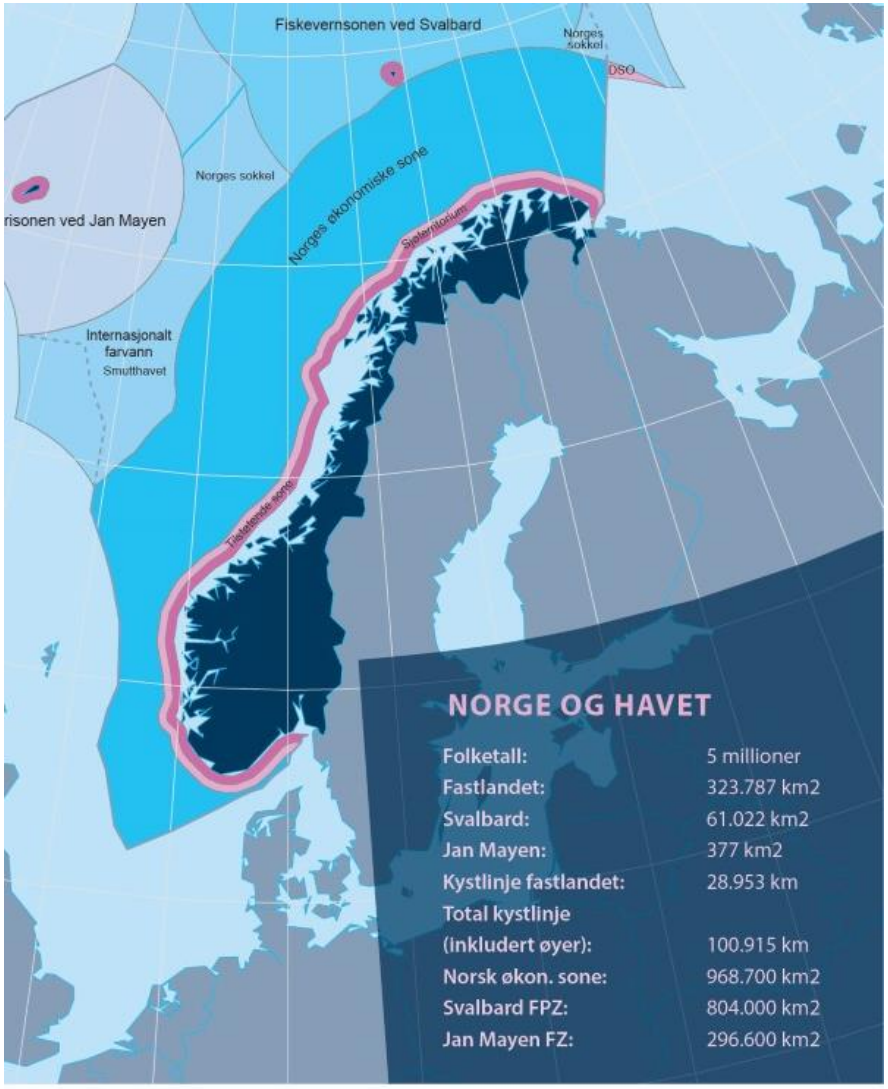
100 turbines in a wind farm

Each farm produces 2.5-3.0 TWh

Placed close to large consumers (cities and industry)

Hydro power as balance

Job creation in a new maritime industry



Source: regjeringen.no

Courtesy: Finn Gunnar Nielsen, UiB

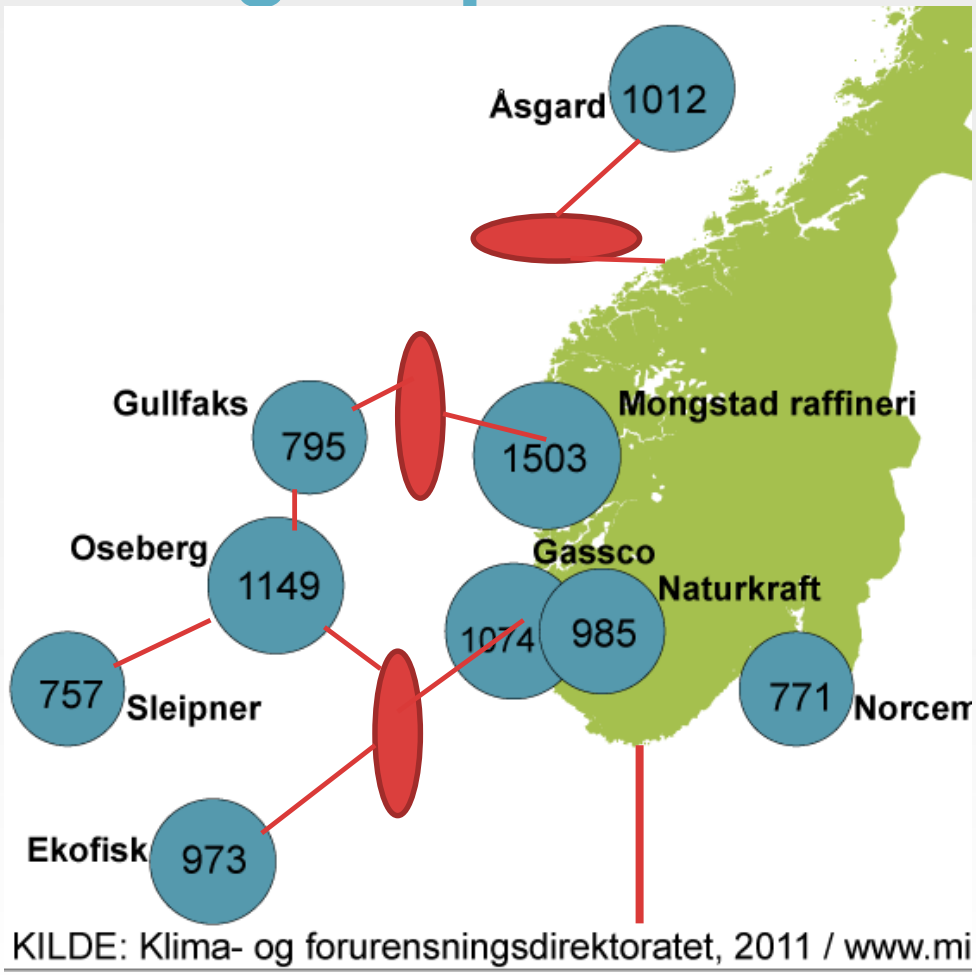
CO_2 emissions in Norway (2015)

Source	Mill. Tons (2015)	Change since 1990 (%)
Total	**53.9**	**4.2**
Oil & gas	15.1	83.3
Industry	11.9	-39.3
Road transportation	10.3	32.6
Other	16.6	3.0

Source: SSB 13.12.16

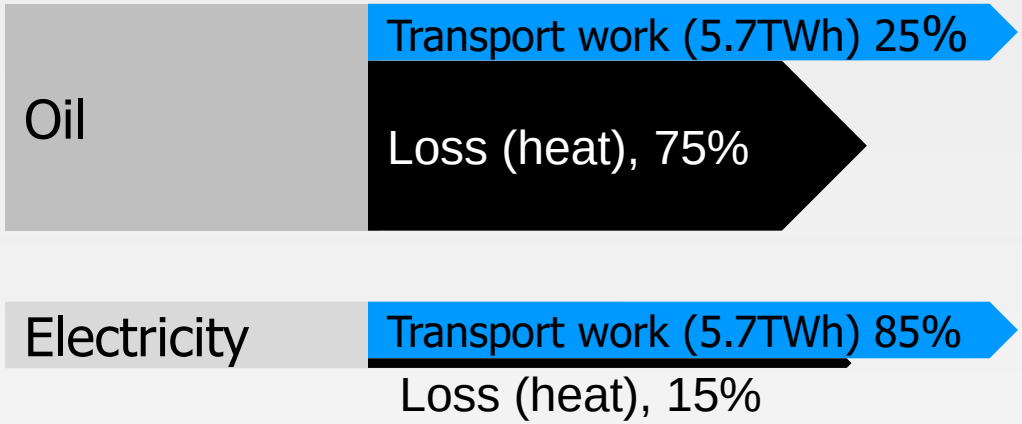
Courtesy: Finn Gunnar Nielsen, UiB

The possibilities
The 10 largest point emissions



Courtesy: Finn Gunnar Nielsen, UiB

Wind power to private cars (W2PC)



- Need 6.7 TWh/y to supply all private cars in Norway
- 2.2 GW wind power.
- Reduces emissions by 6.1 mill tons CO_2 /y. (-59%) relative to 2015, road transportation

Courtesy: Finn Gunnar Nielsen, UiB

What do we achieve?

- Achieve Norwegian emission goals (40% down from the 1990 level in 2030)
- Growth of a new wind / maritime industry
- Keep the swing producer role in Europe

Courtesy: Finn Gunnar Nielsen, UiB

Thank you for your attention!

www.norcowe.no