Energikommissjonen

This is an English translation of Kitemill's policy recommended to the Norwegian Energy Commission.

12th May 2022

AIRBORNE WIND ENERGY FOR NORWAY

- Norway lacks renewable energy to achieve the climate goals and at the same time create new sustainable industry and jobs necessary for the future.

- The energy industry must remain a large export industry, also after oil and gas being phased out. It will be both smart and profitable to use the ongoing energy transition to position Norway for the export of new energy technology. See the potential in Figure 4.

- No other energy technology shows such great potential for changing our energy supply as AWE. AWE uses significantly less materials compared to conventional wind power, which reduces investment costs. At the same time, new natural resources from higher altitude winds are made available and increase production per installed capacity. These conditions address energy costs, CO_2 accounting, land use, supply stability, etc.

- If we gradually let AWE replace or compliment the wind power capacity we have today, the capacity until 2050 can increase from 10 TWh to 50 TWh without us using more areas. At the same time, we would see that the price falls and that the price variations become smaller. See explanation in figure 2.

- The International Energy Agency (IEA)[i], the European Union (EU)[ii] and the National Energy Laboratory (NREL)[iii] are all involved in AWE. The EU has shown great faith in AWE by supporting projects worth more than NOK 100 million for Kitemill alone. The United Nations (UN)'s latest report on new energy technologies[iv] featured AWE used an image from Kitemill. The report points out, among other things, that the public sector must play a major role in the introduction of new energy technology.

- Through Kitemill as the leading AWE environment in the world, Norway can take an industrial leadership within AWE. Kitemill collaborates with many other Norwegian companies to develop the industry in Norway, including the industrial cluster at Kongsberg, Flekkefjord Elektro, Einar Øgrey Farsund, the Norwegian winch industry, DNV and the composite industry. Kitemill aims for NOK 40 billion in turnover in 2035, which is still early in a growth period where the vision is to become a leader in wind power.

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Advantages compared to traditional wind power:

- Significantly higher stability of power supplies
- Significantly smaller footprints in nature
- Significantly reduced cost of energy (LCoE)

Figure 1 Kitemill's production facility at Lista, in Agder.

About Airborne Wind Energy

AWE is a wind power technology under development. By using an airborne wind turbine, a kite, one can reach new and more stable wind resources at an altitude of 200 - 1,000 meters.

This will result in a higher capacity utilization (capacity factor) as wind resources increase with altitude both on land and at sea. It is expected to achieve more than 5 times higher power per area compared to wind farms being built today. The table below shows power per area in combination with higher capacity utilization compared with energy per area:

Energy source	Power per area	Energy per area
Solar	5 – 20 MW/km^2	8 - 32 GWh/km^2
Conventional wind	4 – 5 MW/km^2	12 - 15 GWh/km^2
Airborne Wind Energy	**~15** MW/km^2	**~72** GWh/km^2

Figure 2 Arealbruk for energiteknologier, estimat av Kitemill.

AWE can also be established along with conventional wind turbines as hybrid turbines or as stand-alone installations within established area for existing wind farms, both on land and at sea.

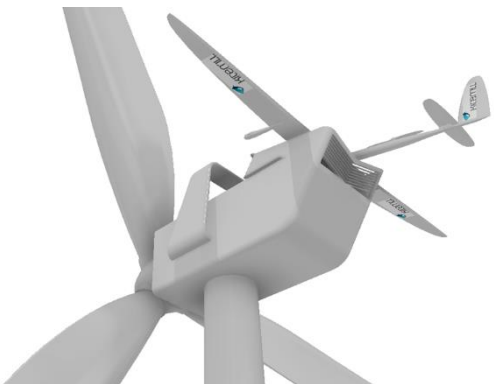

Figure 3 Example of a kite docked at a hybrid wind turbine.

AWE must go through an enabling/maturing phase and a scaling phase. However, AWE does not need to reach the same scale as conventional wind power to be competitive. A study done by BVG Associates, published on Kitemill's website[v], shows that an early phase model

in size> 500 kW / unit could be the most cost-effective energy production technology over large parts of the world, see map:

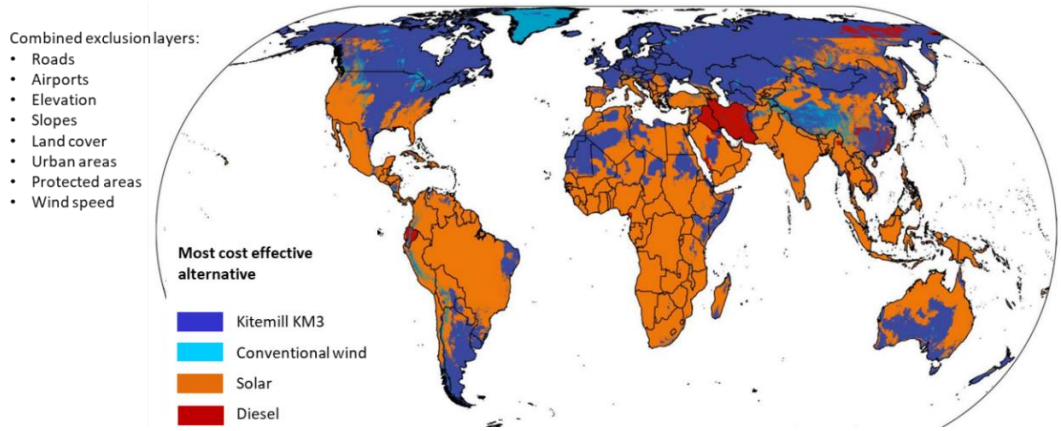

Figure 4 Geo-study of where AWE in mature form can become the most affordable energy production technology

Norway's position in AWE today:

Kitemill AS, FEcreate AS, Metcenter and Diinef AS are exemplary commercial players who have directly individually become involved in AWE. Furthermore, Norwegian universities such as UiB, UiA, NTNU, UiT, UiS, and others have contributed to AWE either via Kitemill or directly to other players in the AWE sector.

As the only OEM (Original Equipment Manufacture) in Norway, Kitemill is the largest national player with 13 full-time employees. Kitemill was established in 2008, is Kongsberg Innovation's largest single investment and builds on technology from, among others, the arms industry, and the oil sector. In 2020 Kitemill took over the IP and assets of the Scottish company KPS and in 2021 Kitemill bought the Dutch company e-Kite. It is estimated that Kitemill, including KPS and e-Kite, has secured close to NOK 300 million in investments. Something we are very proud of, but which is still a long way from the budgets normally required to develop a new commercial aircraft or a new iteration of a conventional wind turbine. Kitemill has received good help from SkatteFUNN (SF) and Innovation Norway, as well as contributions from the Regional Research Fund and the Research Council, in addition to SF, but increasingly sees that the sums we need are not available in generic schemes and should be adapted to AWE specifically. **With a stronger anchoring in the national strategy, it may be easier for them to contribute to Kitemill and other players in AWE in the future.**

Kitemill participates in several major EU projects. Kitemill contributed to AWESCO which was a Marie Skłodowska-Curie project where doctoral candidates worked at Kitemill. We are now a commercial partner in LIKE as another project under the same program where the R&D partner is the University of Bergen.

In 2019, Kitemill received an award under the EU's program the SME Instrument (now EIC Accelerator) for the project «AWE» and is considered one of Europe's leading small and medium enterprises.

We also collaborate with the Norwegian-Swedish EU-supported INTREG project, Green Flyway. As a result of this collaboration, Kitemill secured a project with the EU's Innovation Fund of 75 MNOK in

total budget for demonstration of the technology in Norway, the project has the acronym NAWEP. The project presupposes a contribution from the Norwegian policy instruments. The project will receive great international attention and be the subject of various research activities. The project made Kitemill secure the single largest round of financing of private capital so far in the company's history.

Figure 5 - Technology development at Lista, where Kitemill operates a pilot plant together with the energy company Sør Energi at Farsund Airport. The operation takes place as of May 2022 on daily basis as part of Kitemill's test program, the system operates automatically and produces energy at a satisfactory level in relation to the scale. The operating time will be gradually increased, and a building permit is available for a further 4 units, where the second system currently being installed.

Supply security:

AWE can play the following roles in the development towards the zero-emission society and contribute to a cost-effective and flexible security of supply in the short and long term:

- AWE has the potential to become the most socio-economic solution in the long term with higher area density, higher accessibility.
- AWE addresses the challenges of cost-effective floating wind power. Kitemill has contributed to a study that shows a significant potential in floating offshore wind. In 2020, IRENA[vi] ranked AWE as the 3rd most important technology for achieving the cost targets for floating offshore wind, which was re-quoted by the US Department of Energy in 2021[vii].
- AWE can contribute to a flexible renewable energy system. An AWE system has a smaller share of the investment related to location, and there is a significantly smaller impact on nature (for example, it is not necessary to build roads to a wind farm with AWE systems). Therefore, it is possible to move the plant during the economic life. This in turn makes it possible to establish temporary capacity. Temporary capacity does not require the same impact assessment as permanent solutions and can ensure supply in the time until a more parliamentary solution is available. This will increase our ability to adapt to the zero-emission society more quickly.

Timing:

Much is still unclear at AWE. It is now it is possible to secure industrial leadership.

An example is the result of the Danish wind power investment from the early introduction phase of wind power. In 2019, Danish exports of wind energy technology were estimated at DKK 66.5 billion. Wind power still accounts for only 2% of the global energy regime and there is a significant upside in employment and value creation in the export of energy technology. Norway has a similar opportunity as Denmark had in the 1980s when it comes to floating offshore wind and AWE.

Few nations have managed to position themselves industrially as Denmark in the introduction of new energy technology. But it does not happen often either, over the last 100 years we have seen four technologies; nuclear power, wind power and solar have become new significant technologies in the energy mix, offshore wind, which globally accounted for 10% of new wind power in 2019, is on its way to becoming the fourth. Securing industrial leadership is one of the main goals of the EU, which will support an initiative in Norway as an EEA member state.

Base:

Advantages Norway has in relation to AWE and reasons to include AWE in the national strategy:

a. A strong commercial representation.
b. Need for new renewable capacity. Norway needs more renewable capacity in the long run, AWE can become a competitive advantage for Norwegian energy players, power-intensive industry, and society in general.
c. Areas - if we compare Norway with the other countries in Europe that have strong representation in the AWE sector, Norway stands out in that we have larger areas that are necessary to initially mature the technology. Small measures here can ensure that large parts of the commercial AWE sector turn their attention to Norway.
d. Reduced land use in relation to other alternatives will in the long run be the result of us maturing AWE. With reference to Figure 2. AWE can be combined with conventional wind turbines as hybrid turbines.
e. AWE can reduce the cost of offshore wind. It will be a new strong card for Norway to secure a position in floating offshore wind both in terms of own production and exports.
f. Norway has regulatory authorities that can facilitate restructuring, few AWE players have been treated as well as Kitemill by national aviation authorities. New European regulations are being introduced these days and work remains, but it is possible for Norway to retain this competitive advantage.

This is needed:

1. The Energy Commission must recommend that AWE be included in Energy 21 strategy.
2. Business interests and especially positioning for industrial leadership should be better linked in the Energy Commission's recommendations.

3. AWE must be included in Norwegian energy plans and strategies and thus open for instruments. To do this, NVE and other Norwegian key players in energy and business development must be given guidelines on mapping AWE's potential for Norway.
4. AWE must be treated explicitly, and Norway should compete for pre-commercial and commercial activities. Norwegian policy instruments must be given guidelines on identifying / establishing schemes that are suitable for AWE, as well as promoting these to technology players nationally and globally.
5. The Energy Commission must recommend that Norway join Wind Task 48 at the International Energy Agency. Norway has one of the strongest commercial representations within AWE globally and must contribute.
6. The Energy Commission can recommend that Norway, and regional authorities, work together with other nations to ensure regional, Nordic, and European-industrial leadership.

We hope that this input is well received, and we are ready to contribute further to ensure that new technology in general and AWE specifically, can become part of Norway's strategy for the energy sector.

Sincerely

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References:

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