

# Off-shore wind energy mapping using satellite SAR

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## Aims of research

To improve off-shore wind resource mapping through use of satellite SAR imagery.

Off-shore wind energy is an attractive energy source due to the very high wind power potentials at sea. The cost of establishment of wind farms is high and therefore include a careful cost-benefit analysis. Long-term meteorological observations and atmospheric model results are used to predict wind resources. Satellite SAR data may be a useful additional data source (Hasager, 2000).

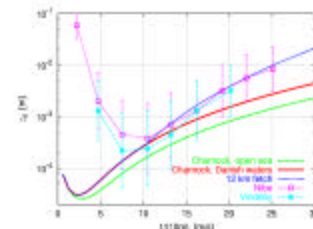
Satellite SAR wind products will be analysed and compared to  
 meteorological data from off-shore and coastal masts  
 model results from Karlsruhe Atmospheric Mesoscale Model (KAMM) for regional wind resources  
 model results from Risø Wind Atlas Analysis and application Programme (WAsP) for local wind resources

## Scientific issues

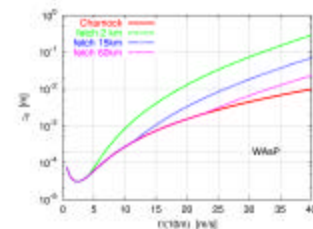
Ocean wind speeds are derived for open seas based upon NOAA buoys time series and e.g. ECMWF model results. Hence the empirical algorithms (e.g. CMOD IFRE2, CMOD4) are valid in open seas. In fetch-limited seas, the roughness is known to be modified due to a number of causes: wave age, fetch, the size in roughness step change from land to sea, land-sea surface temperature differences, slicks, tidal currents, water depth, low-level jets and atmospheric stability.

The investigation will address these issues. The figures to the right demonstrate data and model results in regard to fetch. Atmospheric stability correction is important when extrapolating wind speeds from 10 m to the hub-height of modern off-shore wind turbines, i.e. at 50-100 m.

Wind speed accuracy is essential as the wind power potential (E) varies with wind speed to the third power.



Sea surface roughness ( $z_0$ ) as a function of wind speed ( $U$ ) calculated by Charnock's relation for open seas and near-shore Danish waters and calculated by a model by Frank *et al.* 2000, and measured off-shore at Vindeby (1 year) and coastal site Nibe (12 years).



Sea surface roughness as a function of wind speed at 10 m at different fetch from Charnock's relation for fetch-limited seas and with the above model as a function of fetch. The roughness used in WAsP is indicated.

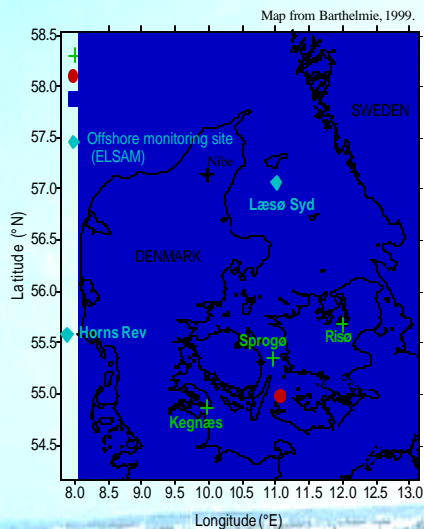


Photo of Vindeby Wind Farm installed in 1991  
 11 Bonus 450 kW turbines

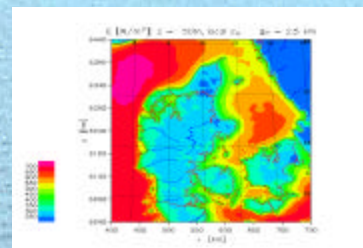


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## References

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Wind resource map calculated from KAMM