



Christian Michelsen Research

# Wind turbines for urban use

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## Forskningsprosjekter

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**Space**



**Renewable Energy**



**Environment and Marine**



**Oil & Gas**

Keywords: Sustainable growth, carbon footprint, technology systems

# Small wind turbines



# Wind turbines in urban environment



	Sol (PV, 5 kWp, 55 m2)	Vind (5 kW, Evance R9000)
Hamar (Hedmark)	~ 7 300 kWh	~ 3 000 kWh
Mandal (Vest-Agder)	~ 8 000 kWh	~ 13 500 kWh
Hankø (Østfold)	~ 8 100 kWh	~ 13 300 kWh
Byrknes (Sogn og Fjordane)	~ 6 100 kWh	~ 19 500 kWh
Tromsø (Troms)	~ 6 900 kWh	~ 9 000 kWh

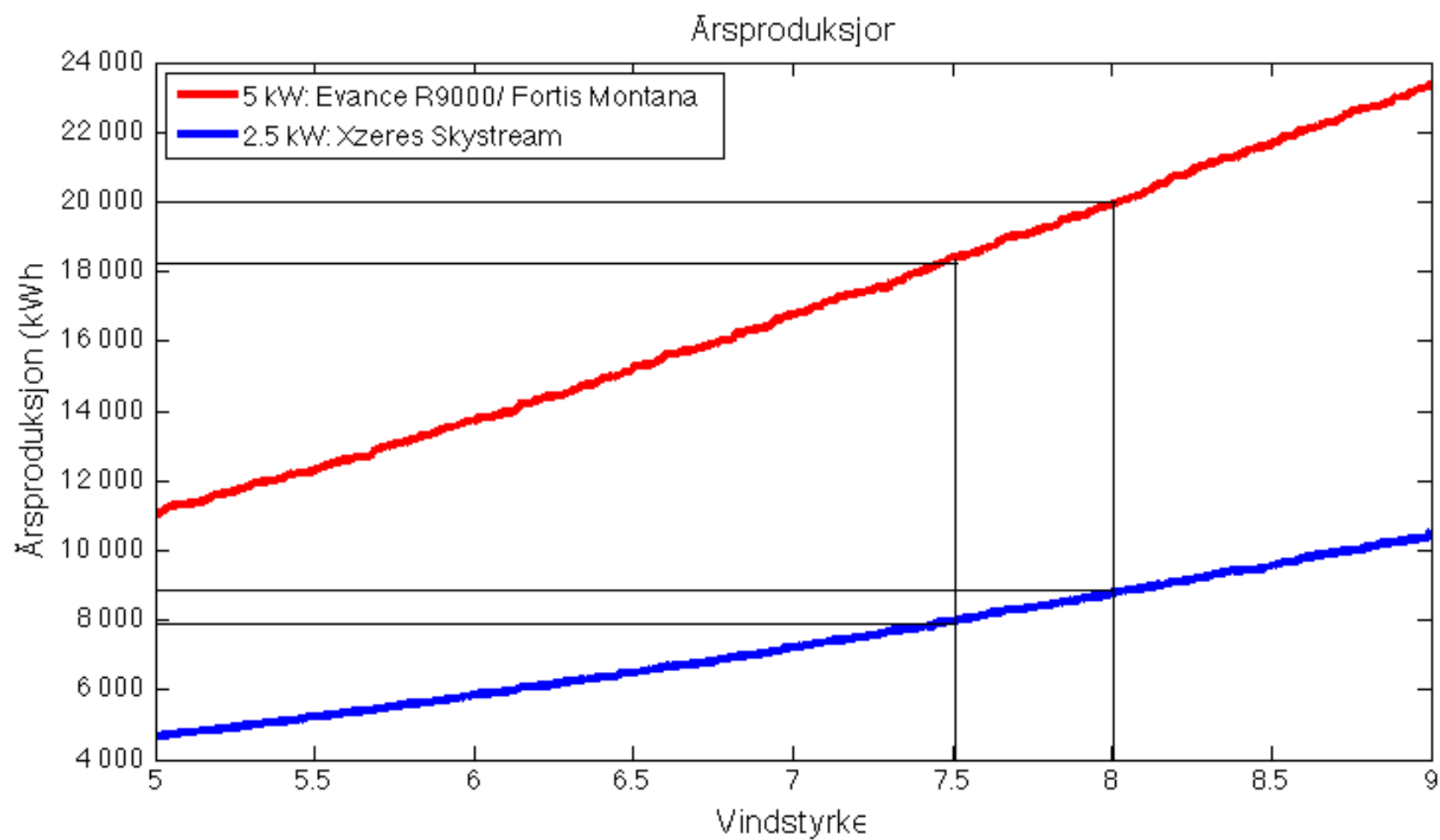
Bakke, 2015



# Evance R9000 - specifications

- Tower Heights – 12m, 15m & 18m
- Tower Type - Monopole
- Architecture – Upwind
- Cut in wind speed – 2.5m/s
- Cut out wind speed – None
- Survival wind speed – 60m/s
- Rotor Diameter – 5.4m
- Yaw Control – Passive Tail Vane & Rotor
- Design Life – 20 years minimum (Annual Service Inspection)





Lat  Lon

From  To  ?

Solar PV >

Wind v

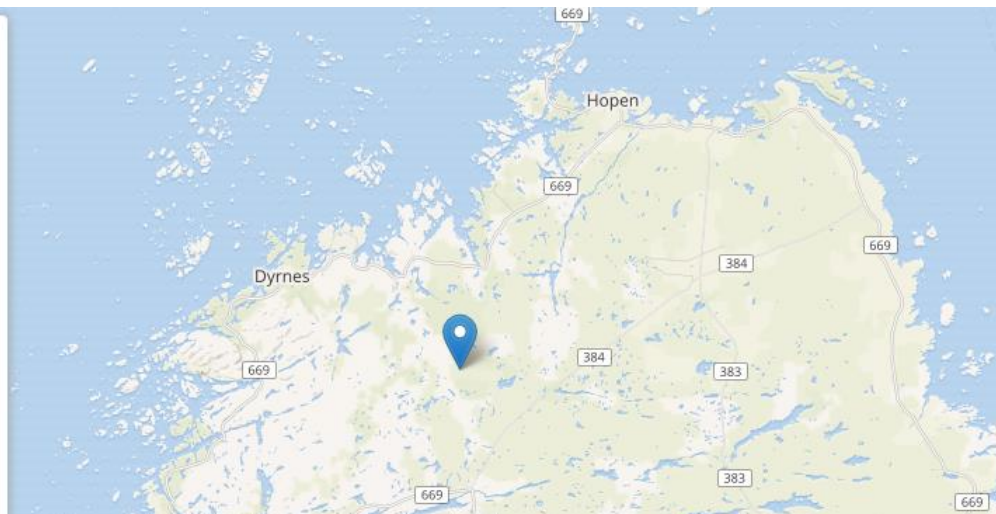
Capacity (kW)

Hub height (m)  ?

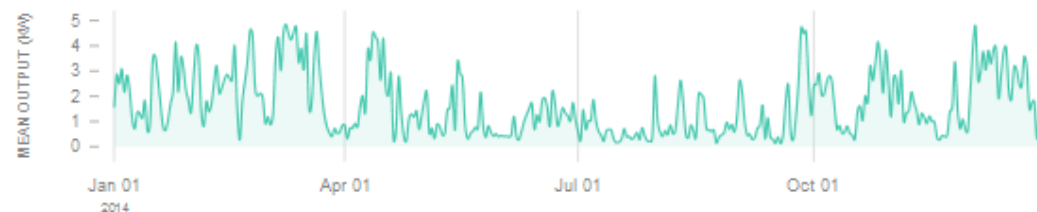
Turbine model  v ?

☐ Include raw data ?

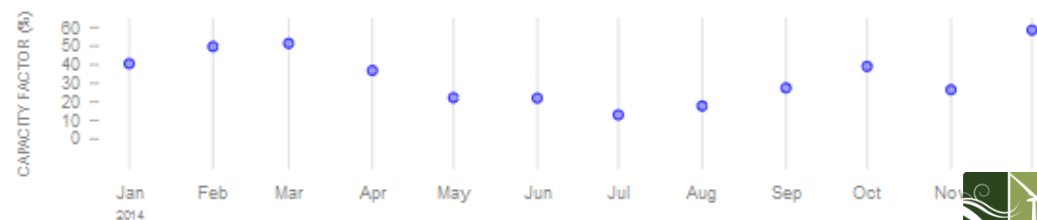
Run



## Daily mean output

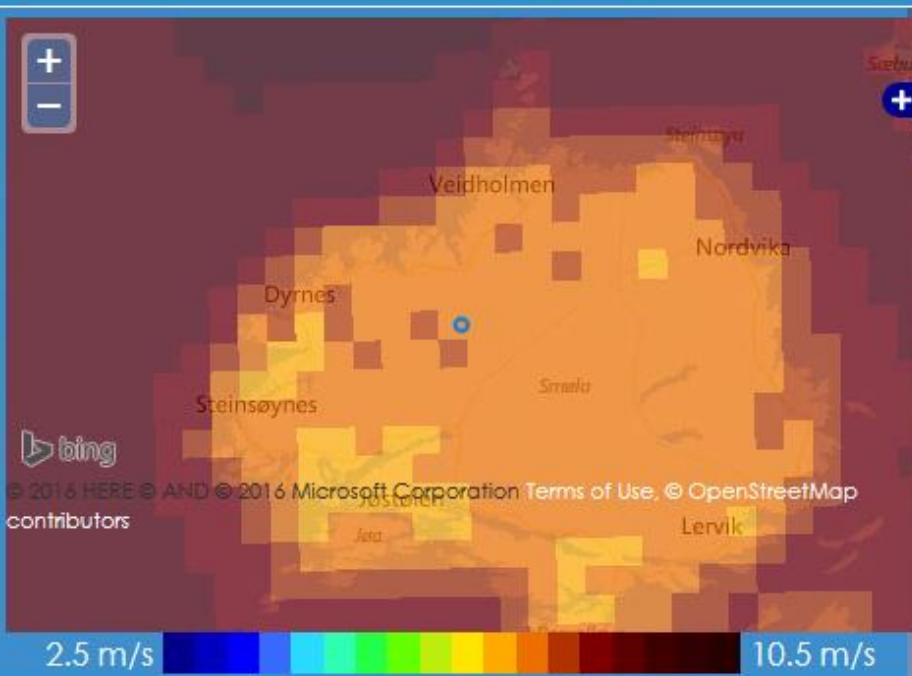


## Monthly capacity factor



Total mean capacity factor: 33.8%





The shown result is a map of the wind resource at your selected location in height of 50 m (Global Wind Resource map). This map does not take local obstacles and surface roughness into account.

These obstacles (buildings, trees, shelterbelts etc.) can greatly reduce the annual energy production. Sometimes up to 30%

Do you want even more precise results?



Calculate how nearby obstacles like trees and buildings impact the energy yield.



Find the best position for your turbine to maximize the energy production.



Calculate the costs and income of investing in a domestic turbine.



Get a report for a smoother building permit process.

Introduction price

**59 EUR**

VAT included

**Upgrade**

# Challenges: Wind resource and turbulence

What is the local  
wind resource?

Wind measurements at site

Turbulence and fatigue

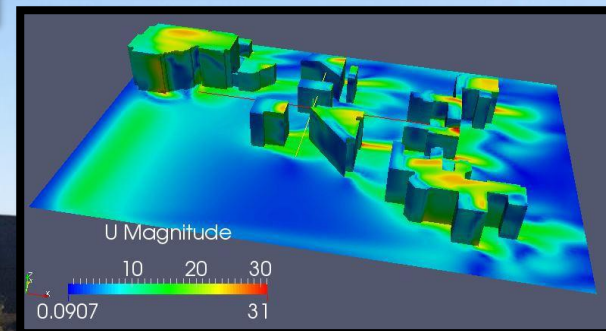
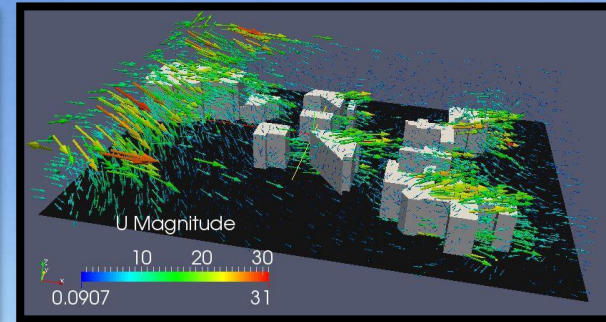
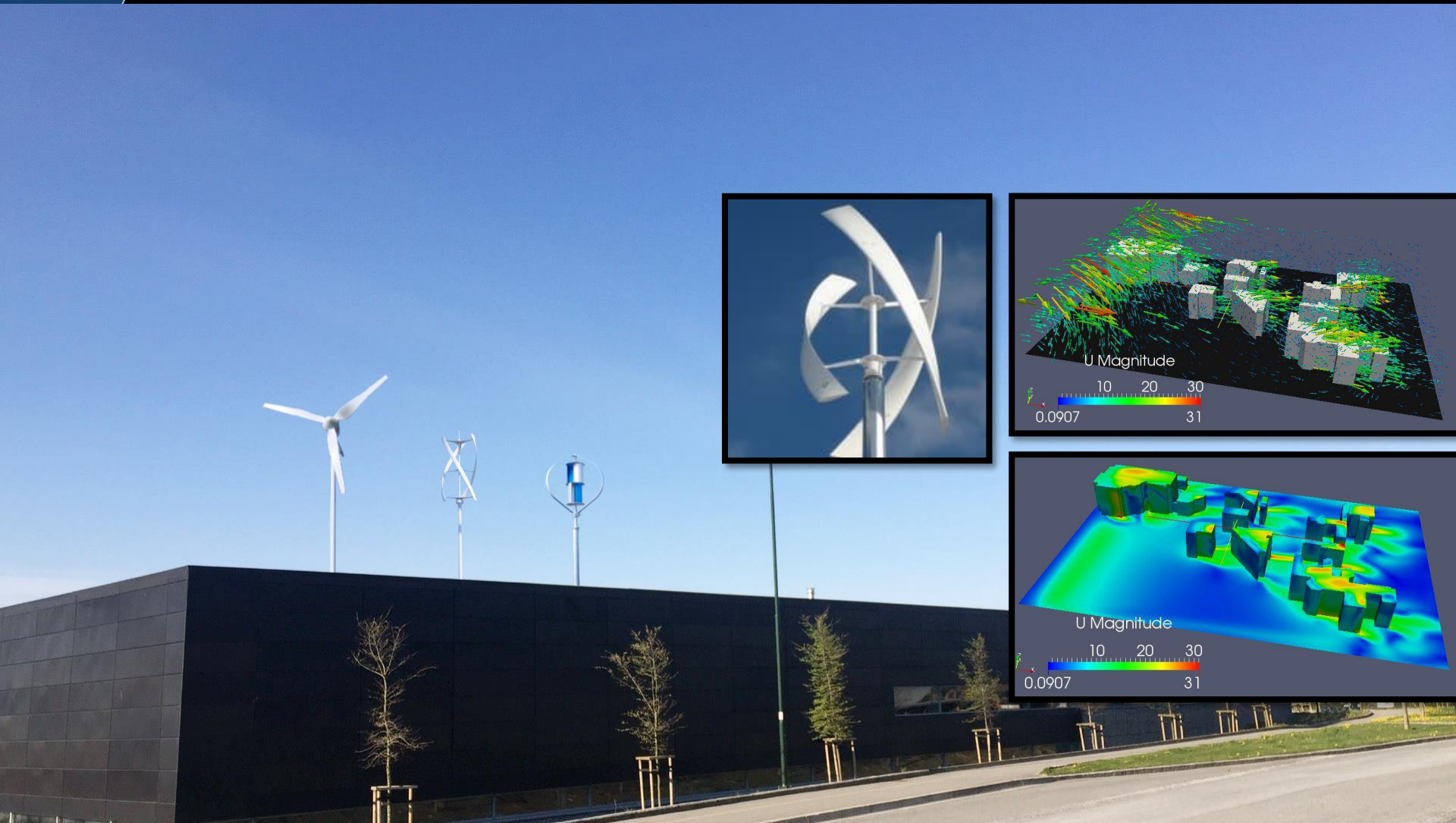


# Challenges

- Fast and reliable local wind resource assessment methods
- Wind measurement (low cost and reliable)
- Complicated wind conditions in urban areas
- Economic aspects
- Visual impact
- Selection of turbine type
- Small wind turbines in the city are often considered as a statement piece



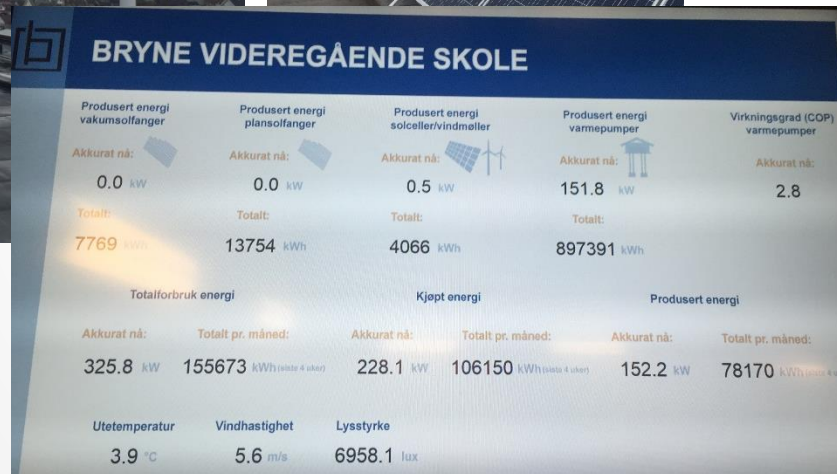
# Smart Energy Lab. at UiS



Inspirert av Bryne nye videregående skole!

Realfagssamarbeid i fornybar energi

UiS + Bryne videregående skole



Sweco, Asplan Viac, Norconsult,  
DNF og Rogaland Fylkeskommune:

34 geobrønner  
4 vindmøller  
Solfangere og solceller



# Further development

- Reliable and low cost methods for wind measurements and wind resource assessment
- Learn from the current wind turbine owners
- Reliable information about turbine types (lifetime, power curve, etc)
- The investment must be profitable
- Consider wind turbines when new suburbs are planned, integration.





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Thank you for your attention!

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