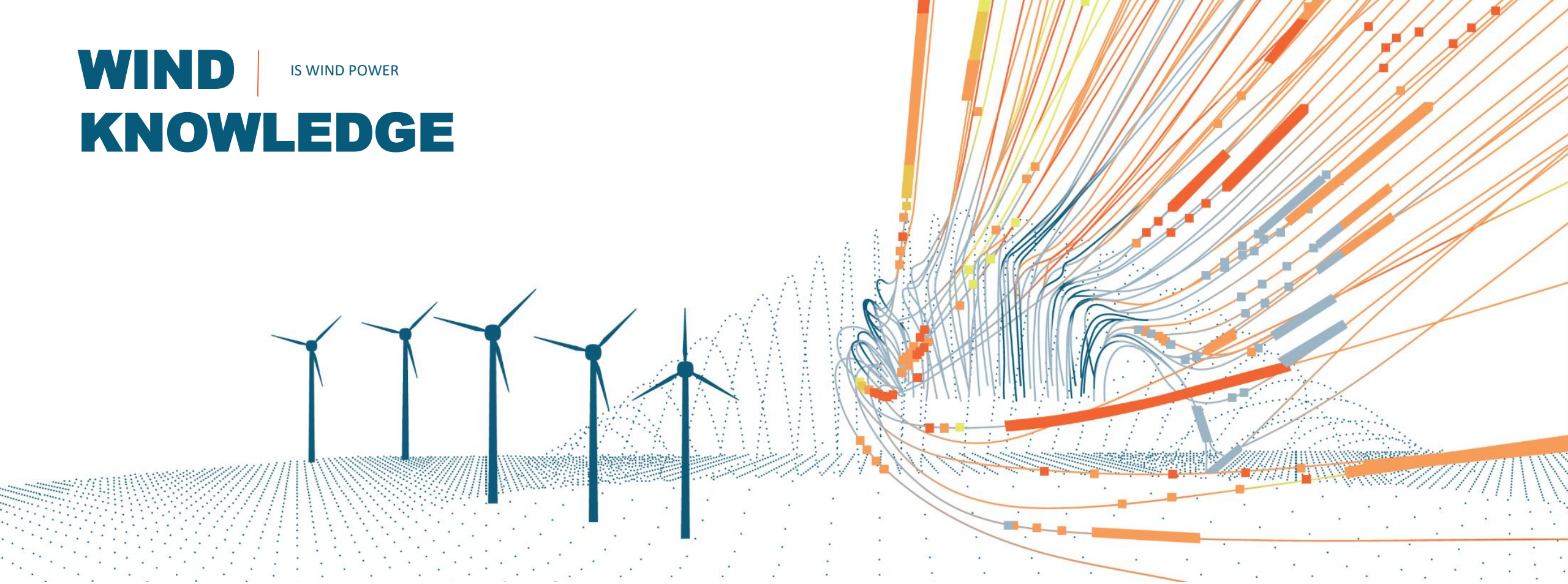


# WIND KNOWLEDGE

IS WIND POWER



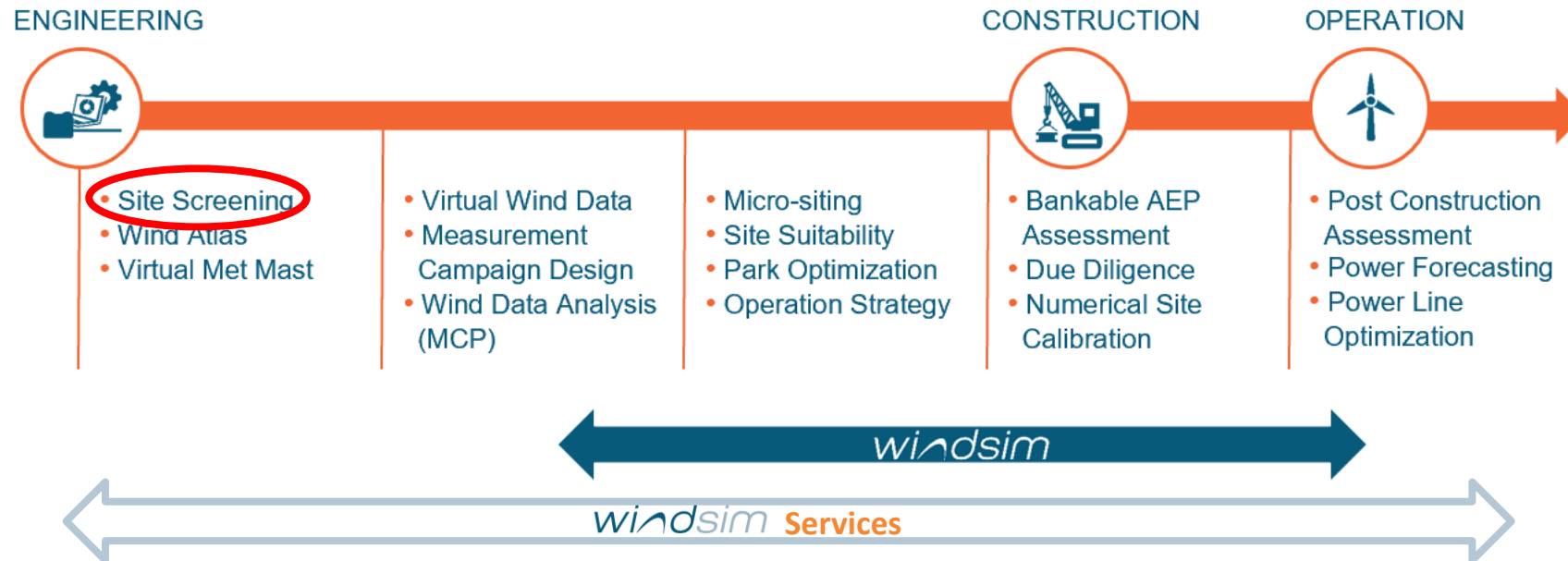
## Site screening using Machine learning and the New European Wind Atlas

PRESENTED BY: Pablo Duran

*windsim*

# Introduction

- WindSim has identified site screening as a potential area to grow the business



- The current collaboration with Vindr has procured the funding to develop a site screening product/service based on WindSim's technology
- The core of the methodology is to downscale the New European Wind Atlas (NEWA; resolution: 3x3 km) to a resolution of 100 m, using CFD

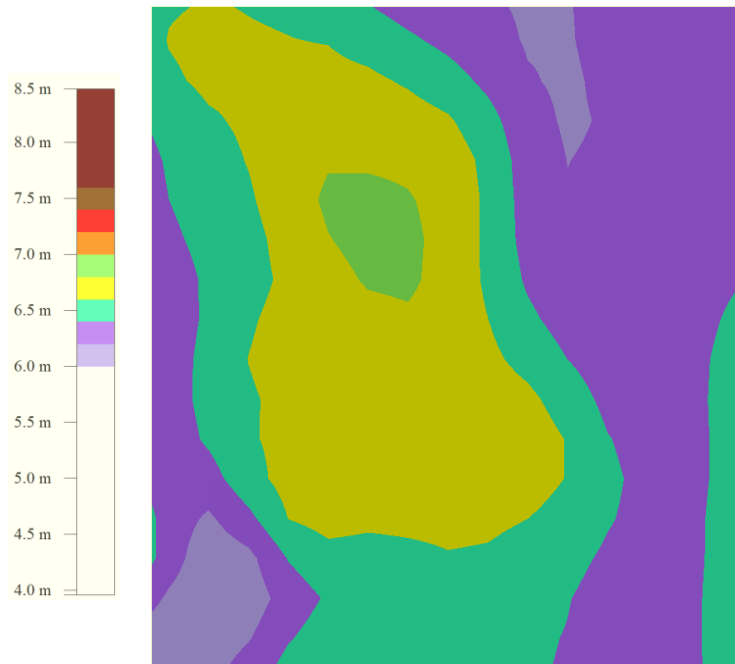
# The benefits of screening with CFD

**More pronounced extreme values**, higher maximum and lower minimum wind speeds

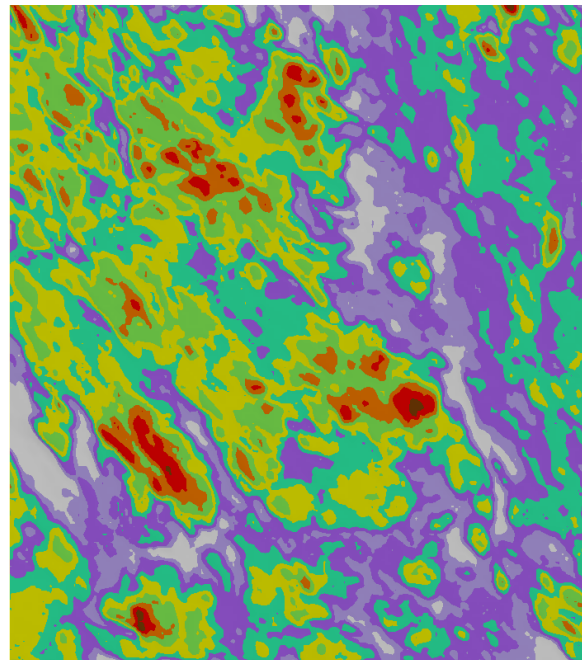
**Higher Annual Energy Production**

**Better information to deal with landowners**

NVE 1 km resolution map



WindSim 100 m resolution map



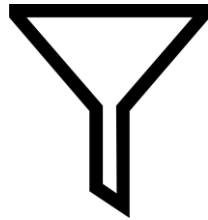
- ✓ **Early identification of high-wind spots**
- ✓ **Better consideration of terrain**

# Methodology version 1.0 – Overview

Wind data

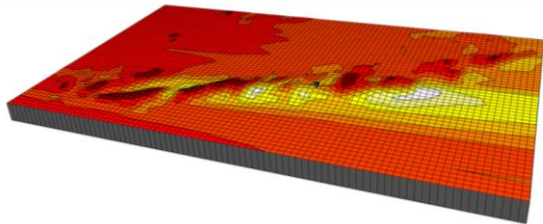


Data filtering

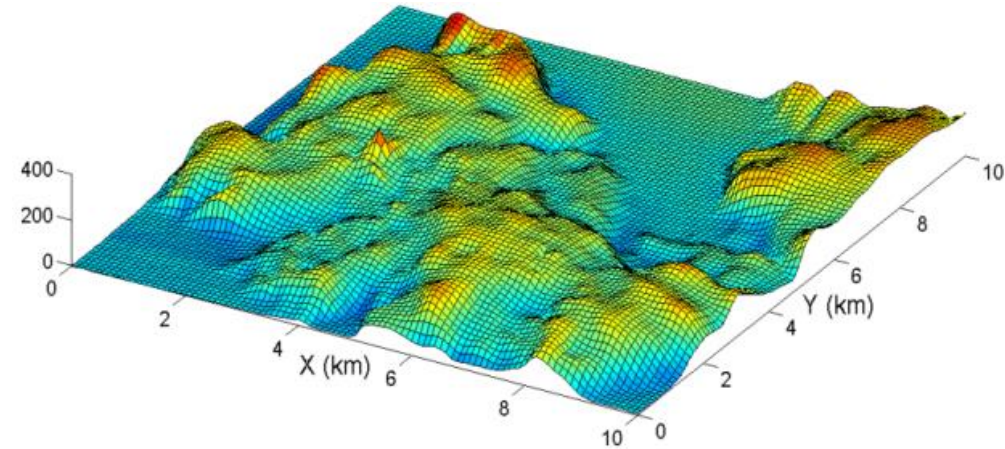


+

Wind flow simulation

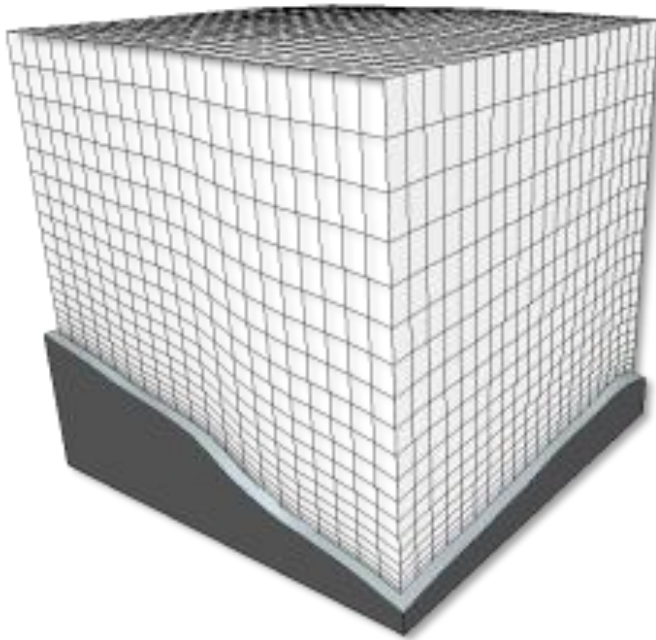


Wind resource map



## Methodology version 1.0 – CFD configuration

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- ✓ **Fast obtention of CFD results**
- ✓ **Streamlined setup**

- **Fixed grid and simulation setup**
- **Domain size: 44x44 km.**
- **Refinement area of 24x24 km with 100 m resolution**
- **7 levels of forest (every 5 meters from 10 to 40m)**
- **Neutral simulations. RNG k-e model. 500 iterations is typically sufficient to converge with criteria of 0.0005**
- **One sector takes some hours in our machines (3.0 GHz processor)**

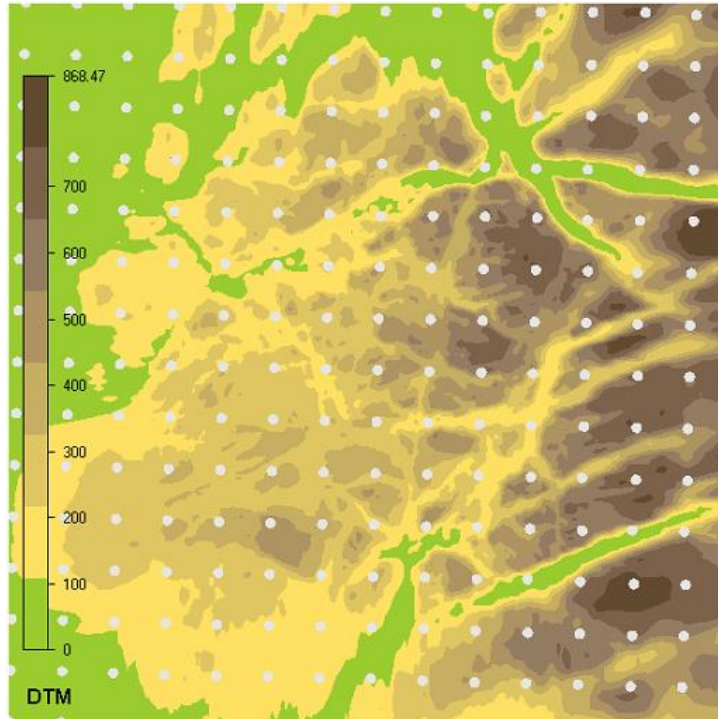
# Methodology version 1.0 – NEWA downloading

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- **Coverage for complete Europe**
- **Wind data every ~3km  
(~200 points within CFD model)**
- **10 years timeseries  
(2009 to 2018)**
- **Vertical levels from 50 m to 500 m**

# Methodology version 1.0 – Wind data filtering



Terrain map and NEWA  
wind data points (white dots)

Many available points:

- ✓ Some lead to **very accurate** wind resource prediction (Error ~0 m/s)
- ❖ But others lead to **very inaccurate** predictions (Error ~20 m/s) (!)

To filter the bad points, without losing too many good ones, WindSim has developed an inhouse filtering methodology. In a nutshell the method chooses points that have:

1. Similar elevation and roughness between CFD model and NEWA
2. Low terrain inclination
3. High agreement in the wind resource prediction with each other

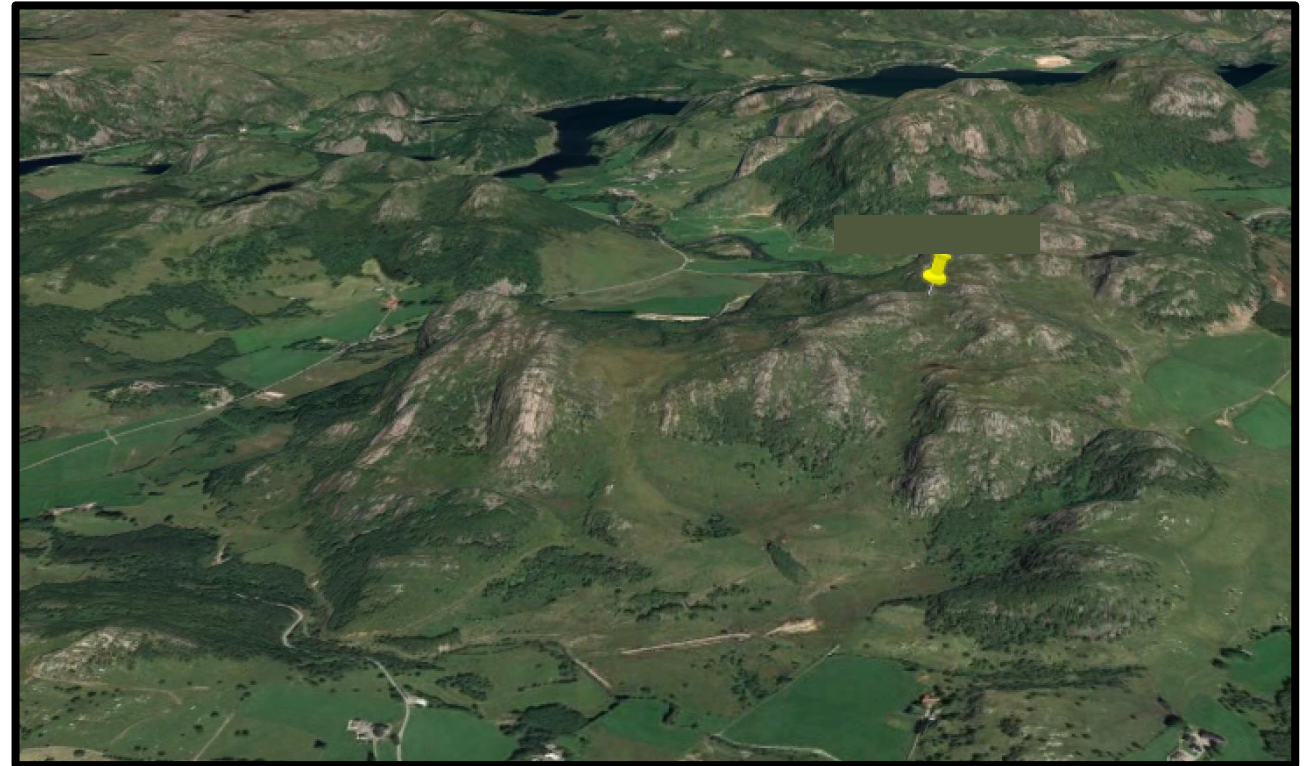
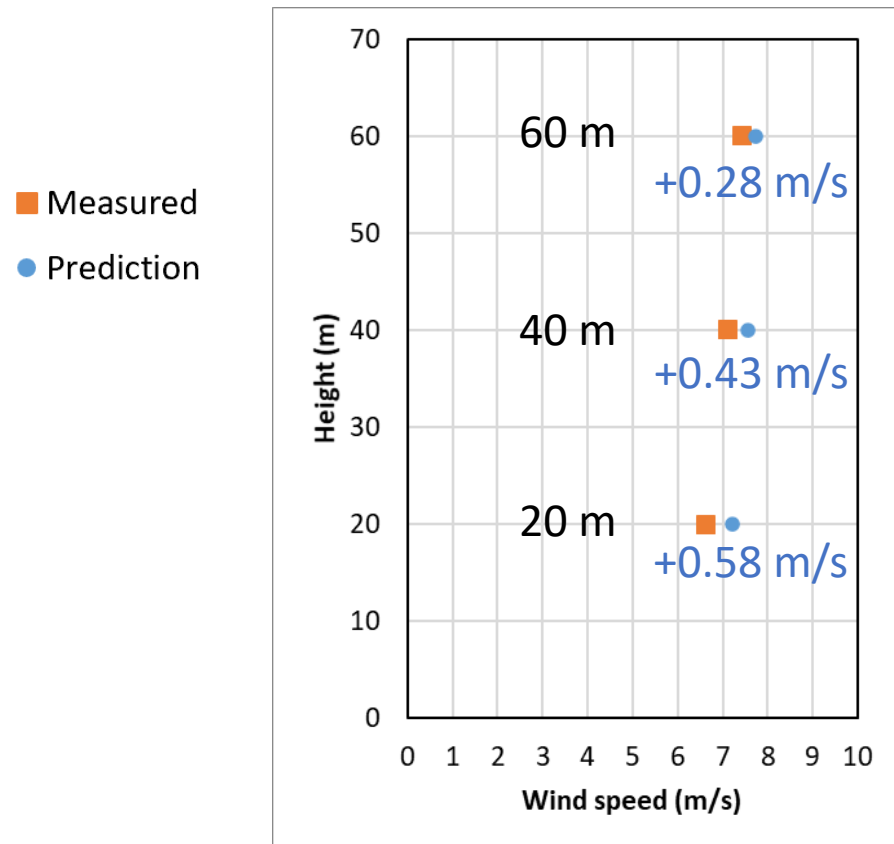
# Methodology version 1.0 – First validation

## 3 validation sites:

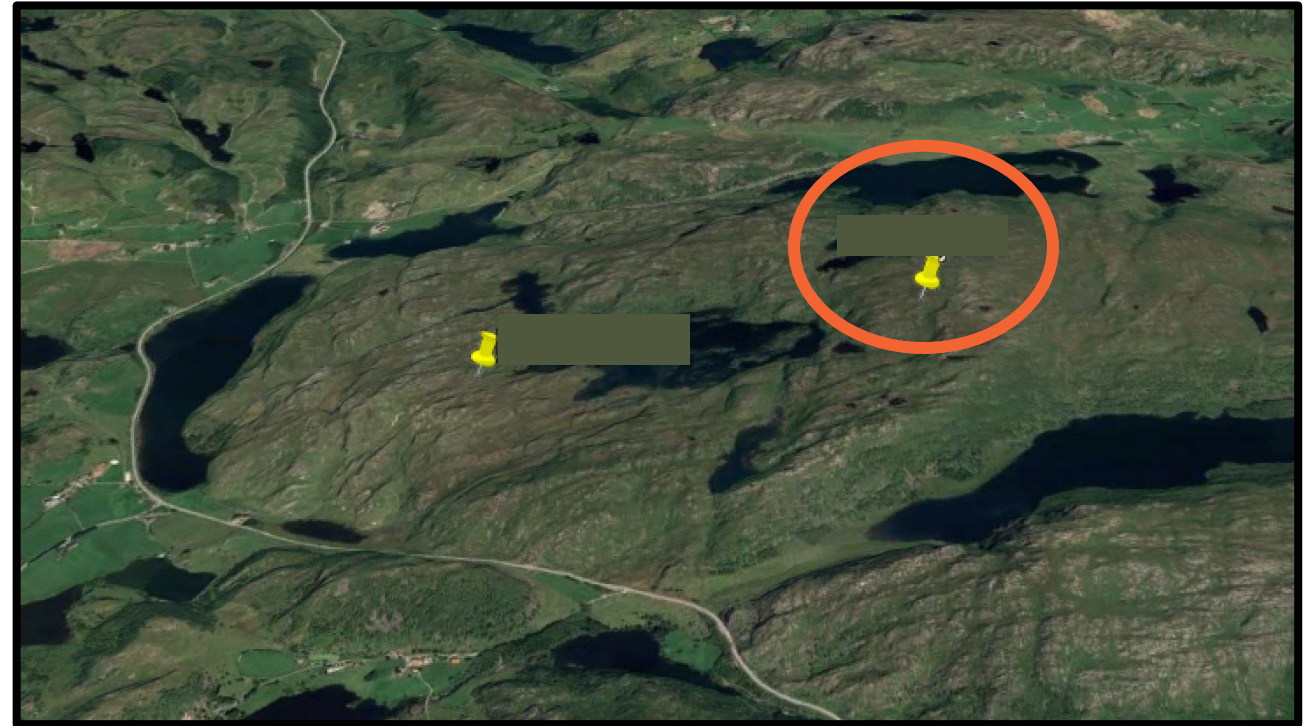
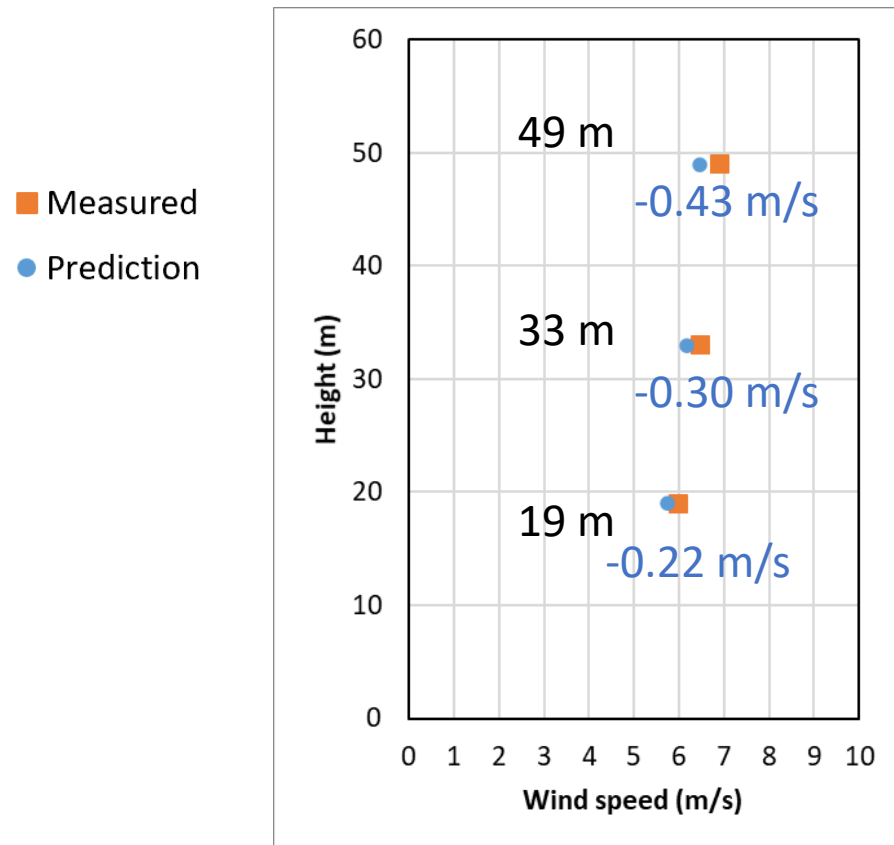
- Metmasts of 50 to 60 m.
- 1 year
- Measurements at 3 vertical levels
- NRG and Thies anemometers



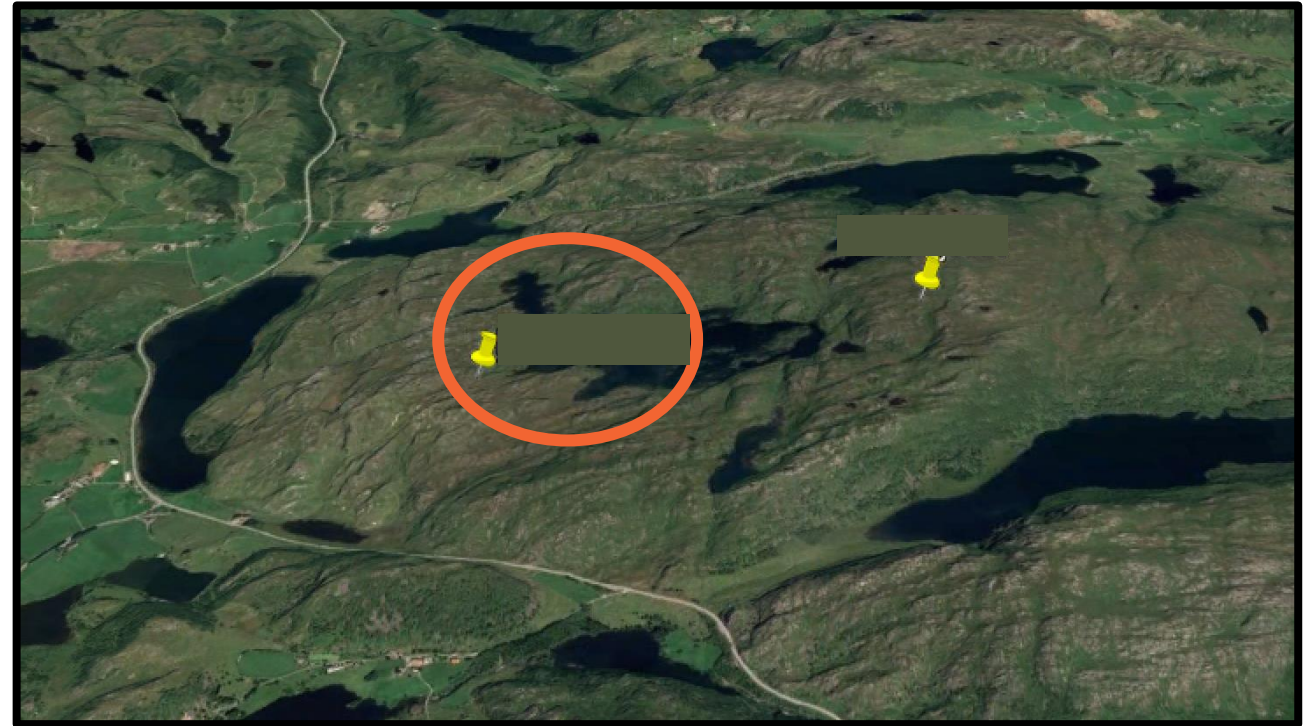
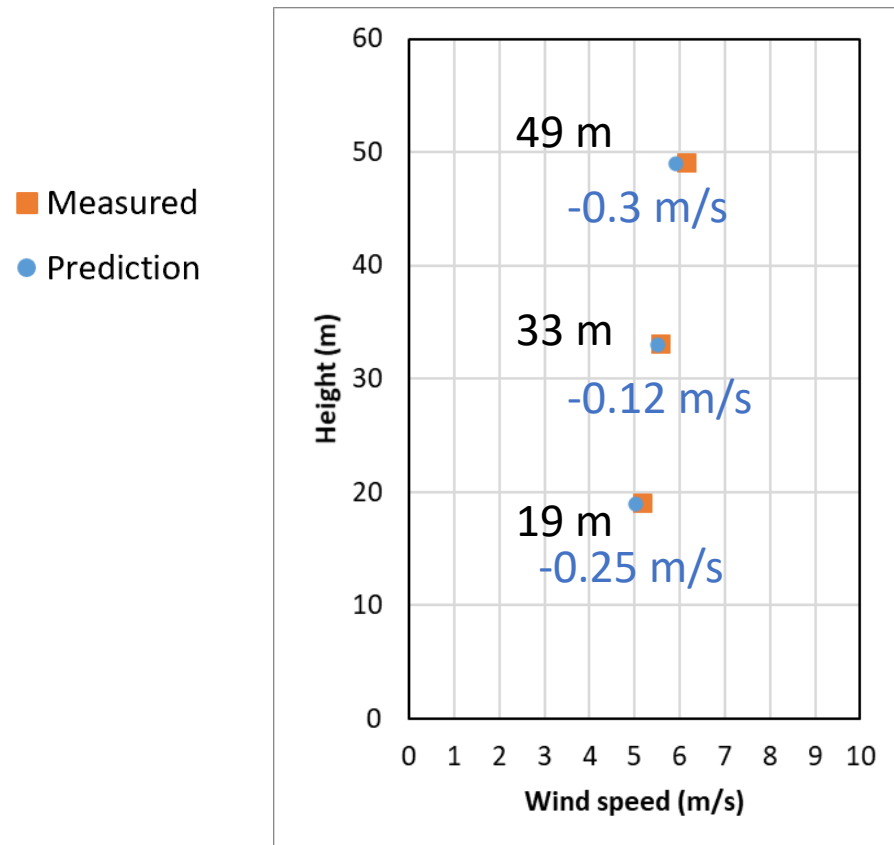
# Methodology version 1.0 – First validation



# Methodology version 1.0 – First validation



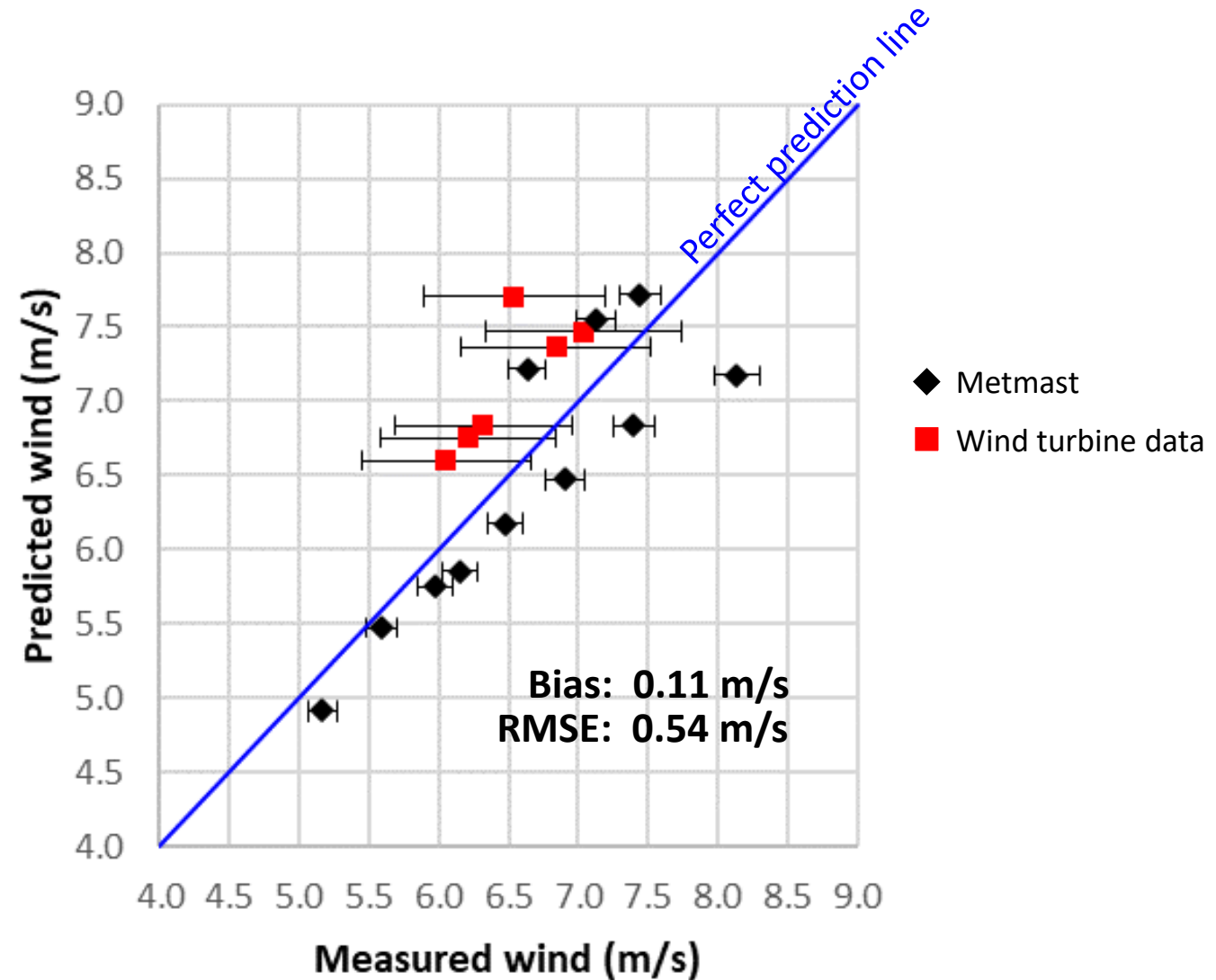
# Methodology version 1.0 – First validation



# Methodology version 1.0 – Further validation

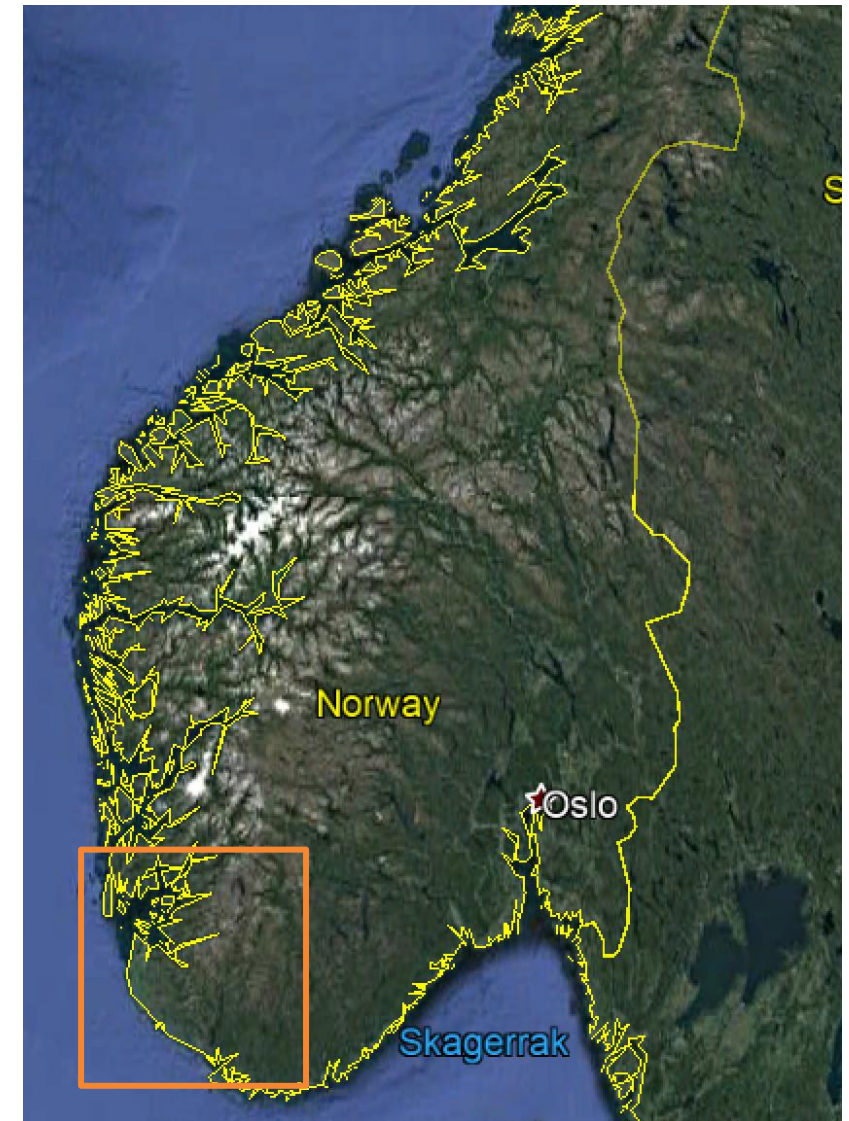
## 17 validation points:

- 11 metmast – 2% of uncertainty assumed
- 6 wind turbine data – 10% of uncertainty assumed



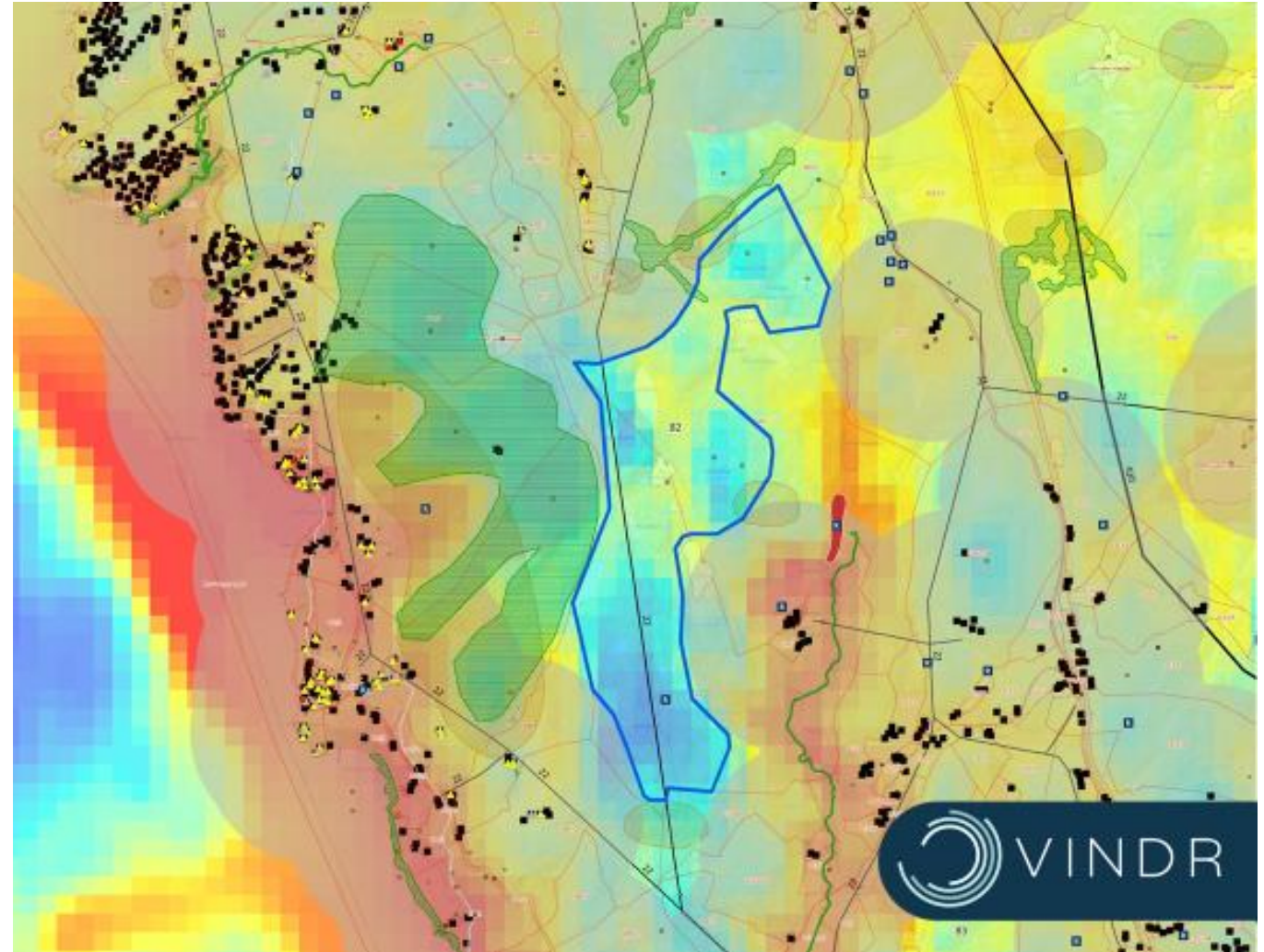
# Methodology version 1.0 – Comparison with public sources

Product	Microscale model	Resolution	Error metrics (m/s)	
			Bias	RMSE
WindSim	CFD	100m	<b>-0.038</b>	<b>0.348</b>
NEWA microscale	WAsP	100m	0.205	2.654
Global Wind Atlas	WAsP	250m	1.605	2.176
NVE	N/A	1km	-0.547	1.405



# Methodology version 1.0 – Business case

**Screening service provided  
for 26 sites across Norway  
and Sweden**

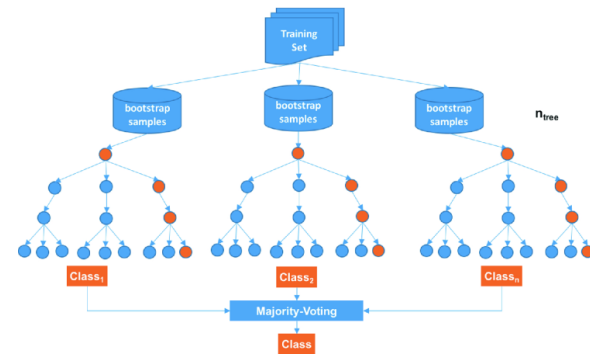


# Methodology version 2.0 – Overview

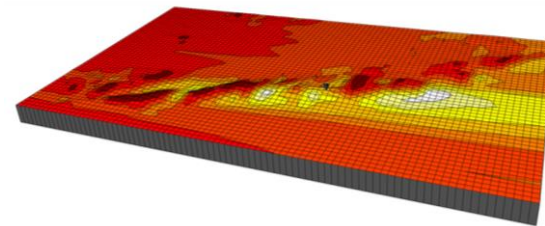
## Wind data



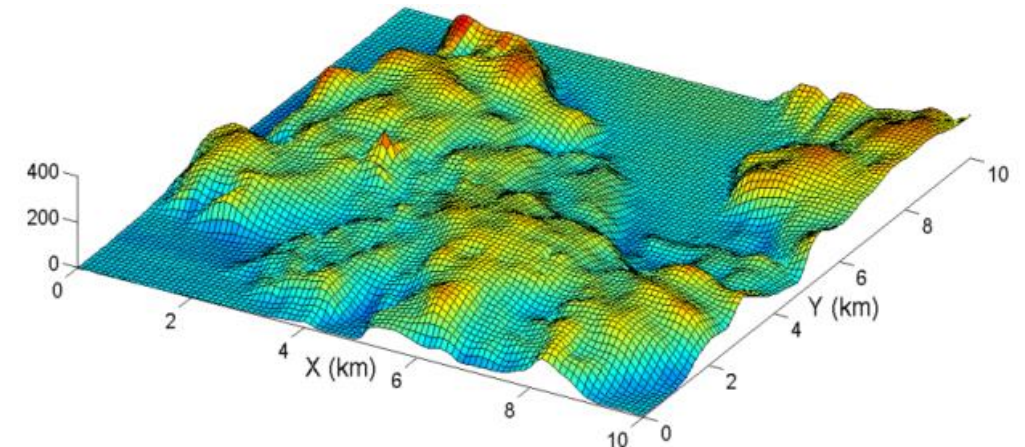
## Data selection



## Wind flow simulation

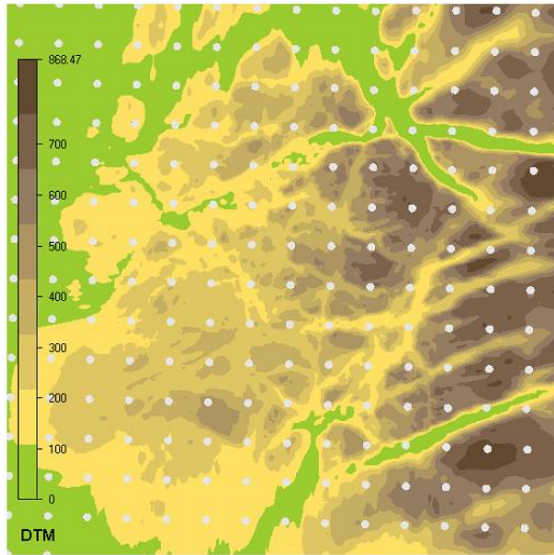


## Wind resource map



- At some sites, the filtering method might filter too much
- To address this, we have developed a method that selects the best point using ML

# Methodology version 2.0 – Wind data selection



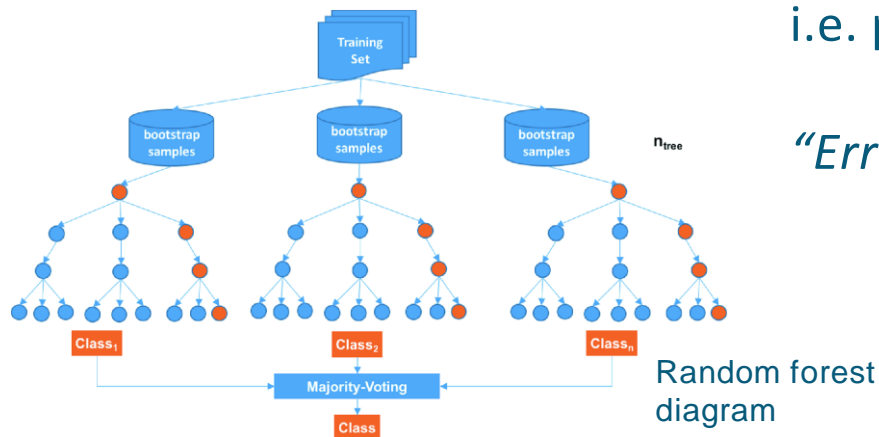
Terrain map and NEWA  
wind data points (white dots)

The machine learning technique Random Forest Regression is trained using a couple of validation sites. The input information is:

1. Elevation and roughness differences between CFD model and NEWA
2. Terrain inclination
3. Agreement in the wind resource prediction with each other
4. Wind resource prediction ranking

The training parameters are chosen to make the selection robust, i.e. predictions can be generalized to other sites.

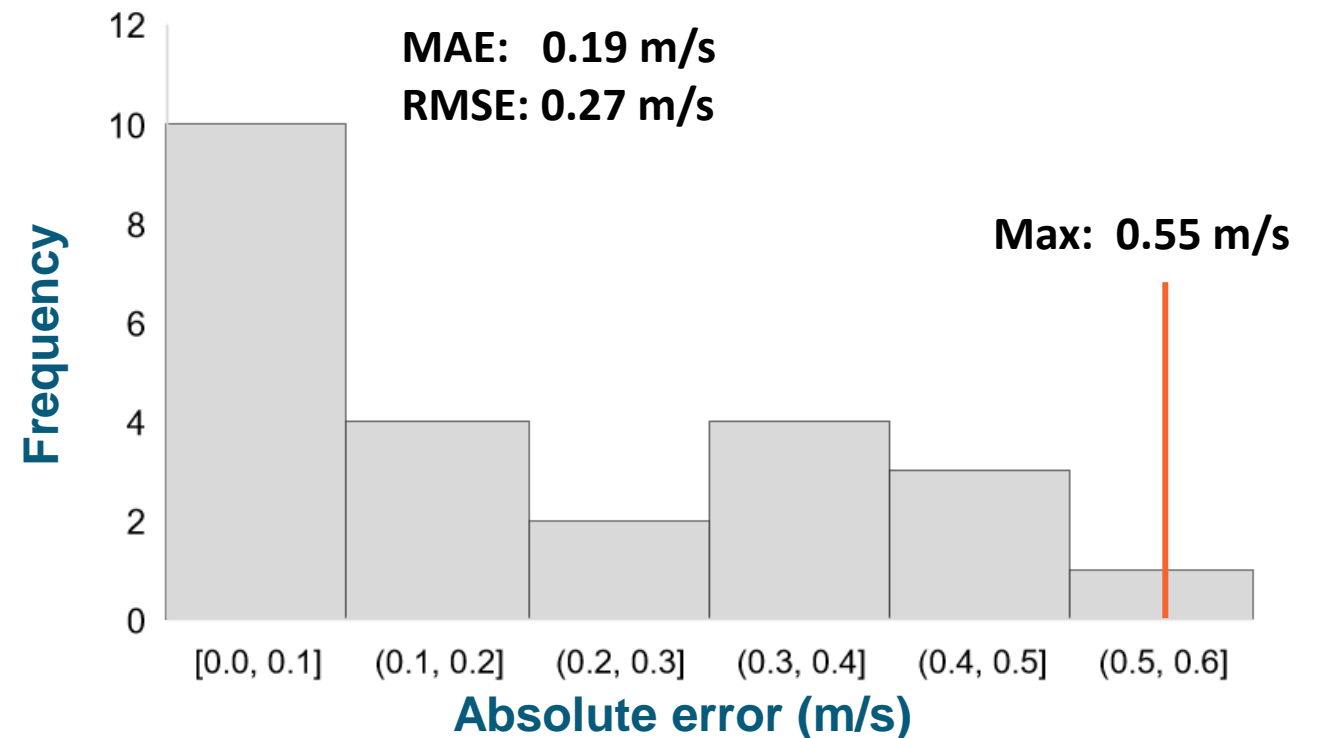
*“Error consistently low”*



# Methodology version 2.0 – Preliminary validation

## 24 validation metmasts:

- Sites in Norway, Sweden and Switzerland
- Quality of wind speed measurements for WRA
- 20m to 100m



# Thank you



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