

## Accurate flow modelling at affordable cost

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## Screenplay

VoE, Need for precision and accuracy

Demand for speed and computing affordability

High fidelity simulations

Reduced order modelling

Life-time long microclimate assessment



## Value of Energy

New demands on prediction and predictability



- B4B maximized
- Time-varying price
- Predictable maintenance
- Other services

#### Cost

- Buying (CAPEX)
- Operating (OPEX)

#### Production

• AEP

Predictable Relationships Presumed

## Technologiical target

#### Support plant design and operational strategies

Ref Mast: WS 9.5 m/s - WD 100.2 deg





## Intra-farm variability

Load management, wake mitigation

#### **Use scenarios**

- Design for minimal wind farm blockage
- Smart curtailment
- ...



#### SOWFA. NREL

https://www.youtube.com/watch?v=yuvjMdBUKwo



# Achieving similar (sufficient) accuracy and precision faster/cheaper

Reduced order CFD



OPWIND: Research Council of Norway, Statoil, Vattenfall, Vestas





## Life-time continuous microclimate

Composed Co

# Continuous

- Mast data
- LTC
- Flow model
- Sector-wise
- Neutral or classes
- Neglections
- Assumptions
- Average TI, Shear, ...

- Time dimension
- Consistent pysical variables
- Wind & Solar
- Shear and speed-up
- Matching
  - Electricity market price
  - Demand
- Computationally expensive. Or is it?

## 20 years high-resolution flow

Step 1: downscaling



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**Vestas** 

0.995 -0.99 0.985 0.98 0.975 0.97

Flow auto-correlation with mast location

# 20 years high-resolution flow Step 2: calibrating with mast data



## **Vestas**

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