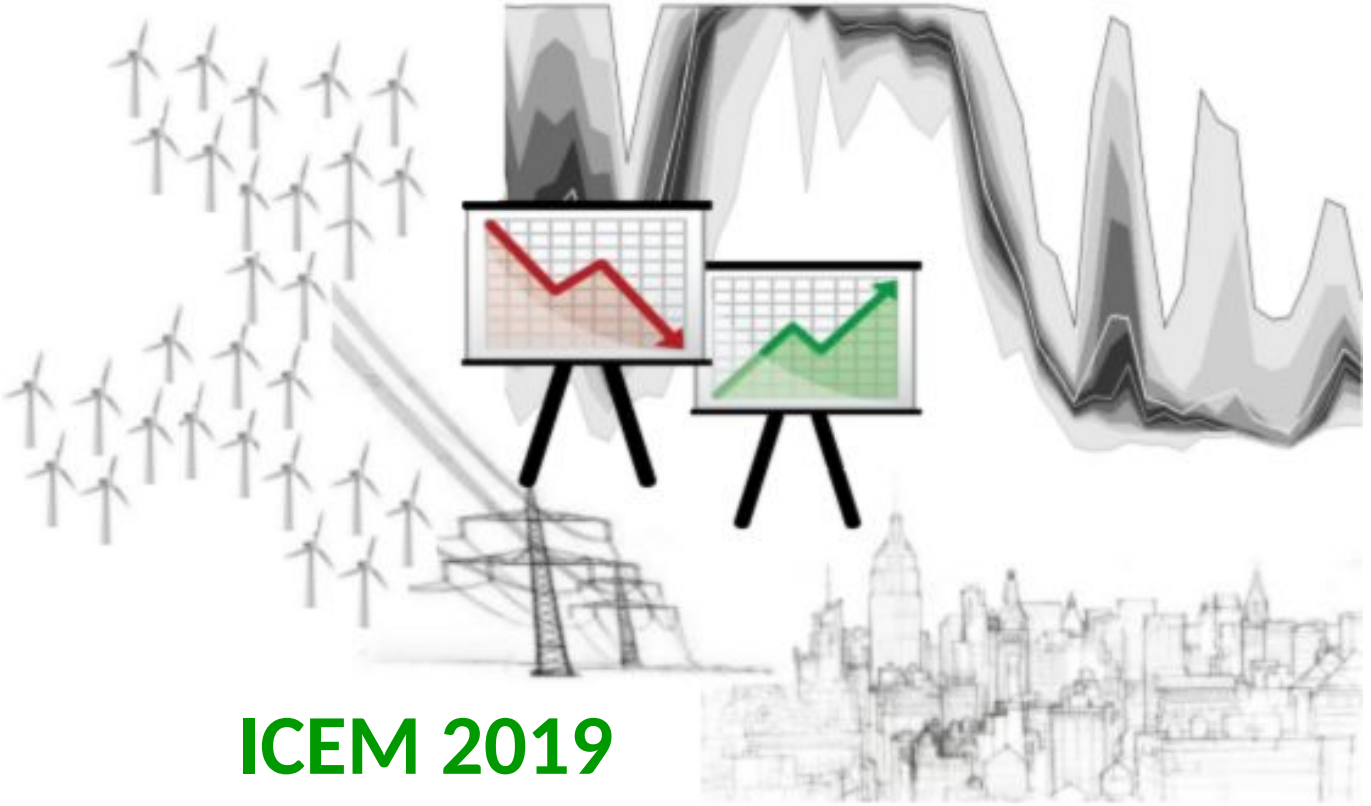
IEA Wind Task 36
"Wind Energy Forecasting"

Open Space Workshop



ICEM 2019

DTU Campus, Lyngby, 26.06.2019

Task Objectives

Task Objective is to encourage improvements in:
1) weather prediction
2) power conversion
3) use of forecasts

Task Organisation is to encourage international collaboration between:
- Research organisations and projects
- Forecast providers
- Policy Makers
- End-users and stakeholders

Task Work is divided into 3 work packages:
WP1: Weather Prediction Improvements inclusive data assimilation
WP2: Development of best practice guidelines
WP3: Communication of best practice in the use of wind power forecasts

Term 1: 2016-2018
Term 2: 2019-2021

3 Information Portals of IEA Wind Task 36

All papers and presentations are publicly available on web:

→ **Webpage: ieawindforecasting.dk**

→ **Research Gate Project**

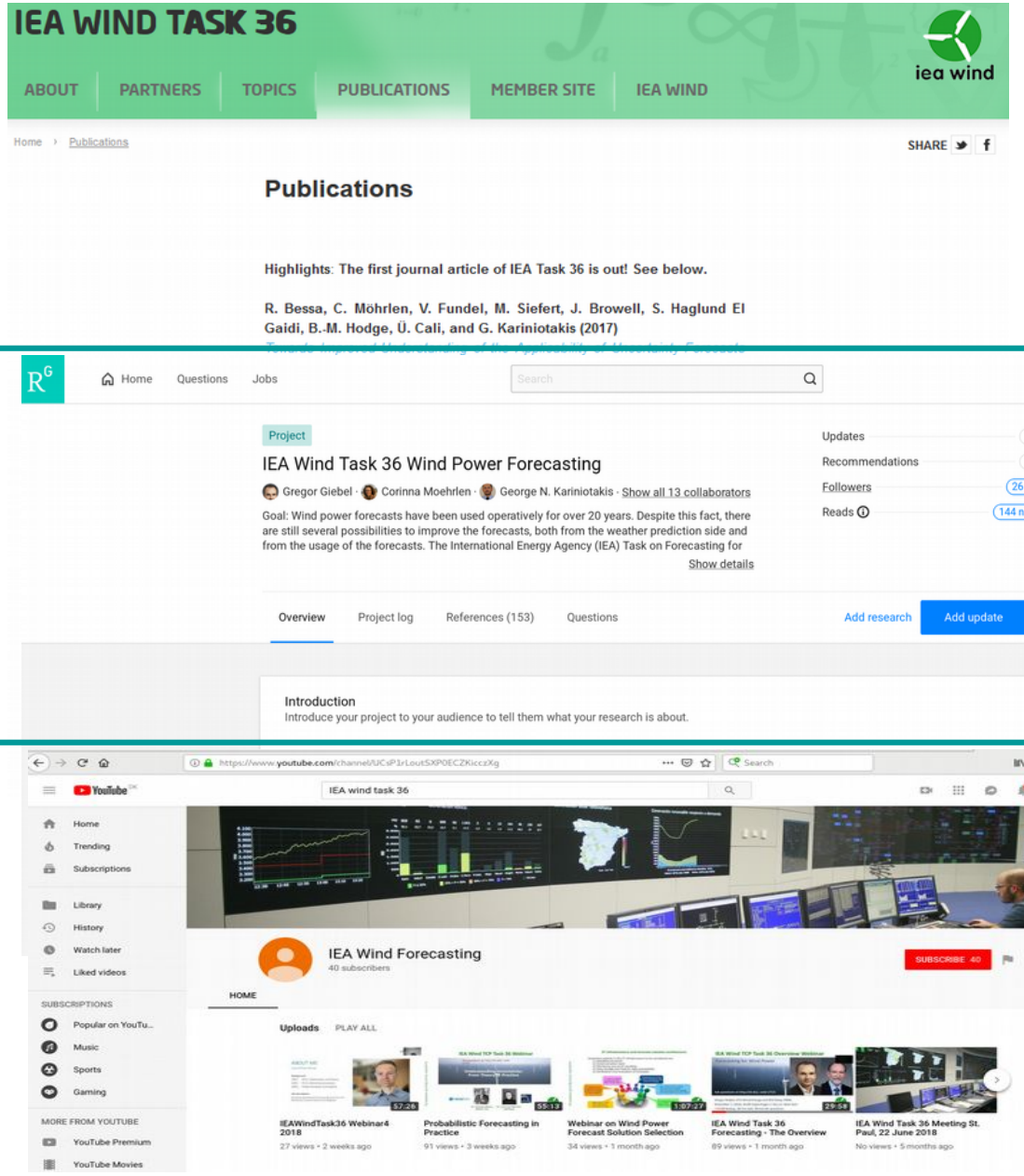
→ **IEA Wind YouTube Channel**

Publications:
→
ieawindforecasting.dk/publications
Journal Articles: 4
Energies, IEEE PES, Jof Physics

ESIG Forecasting Workshop
1 Tutorial
10 Presentations

Windintegration Workshop
2 Workshop Papers
4 Workshop Presentations

YouTube Channel
5 Webinars, 3 Meetings, 1 Workshop



IEA Task 36 Open Space Workshop on Wind Power Forecasting & System Integration Issues

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Organised by:

C. Möhrlen	WEPROG
J. Zack	UL-AWS Truepower
G. Giebel	DTU - Wind
P. Pinson	DTU Electro
M. Westenholz	ENFOR
W. Shaw	PNNL
T. Göçmen	DTU Wind
G. Kariniothakis	MINES Tech Paris
J. Browell	Uni. Strathclyde
H. Frank	DWD

Time	Activity
16:15 - 16:30	Introductory presentation on IEA Wind Task 36 & explanation of workshop format and objectives
16:30 – 17:30	Open Space discussions in 5 groups - participants rotate free among the groups
17:30 – 18:00	Group leaders provide summary of each group to the full group; full group discussion

Open Space Workshop: How We Run It…

Principle	Meaning
Whoever comes is the right people	CHANGE group whenever you think you have said what you wanted or you are no longer interested in the discussion
Law of two feet	You can contribute on any discussion, use this opportunity!
When it's over, it's over	We stop after 30 minutes…use the time to tell about your ideas!
Whenever it starts it starts	Whenever you come to a discussion it is OK to engage and participate
Whatever happens is the only thing that could have happened	No matter who and what is discussed regarding the topic, it's good. Leave if you no longer like the discussion!

Introduction to the Open Space Topics

Topic #	Title
1	Standards and Recommended Practices for Data Exchange and IT Solutions in the Power Industry: Where do we need them?
2	Meteorological Measurements and Instrumentation: Standardization for Integration into Grid Codes
3	Use of Probabilistic Forecasts in the Power Industry: What should a recommended practice contain?
4	IEA Wind Recommended Practices on Forecast Solution Selection: How can it be made more valuable to users?
5	Uncovering Uncertainty Origins and Development through the Modelling Chain

Topic 1: Standards and Recommended Practices for Data Exchange and IT solutions in the Power Industry: Where do we need them ?

A pragmatic solution – the key words are **structure and consistency**

- A foundation based on structured data description
- Aiming for streamlining/stanProcessdardizing 80/20 of user needs
- flexible framework allowing for custom information

2 levels of standardization

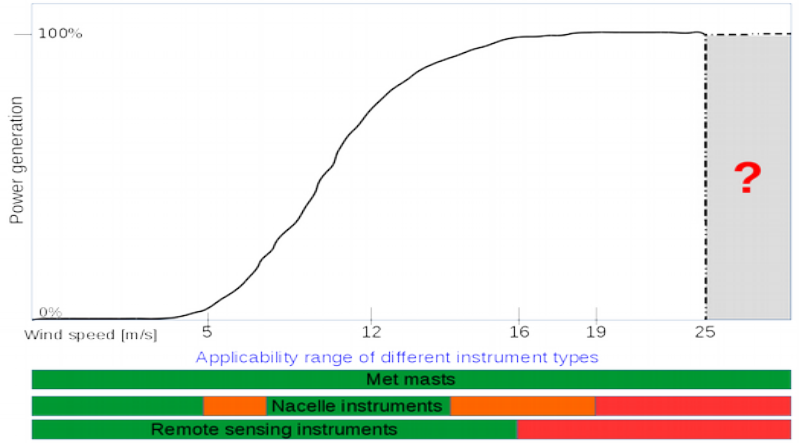
Level 1: logical layer defining terminology
Level 2: data transfer protocol

Suggested development process

Process	Description	Progress
1	Structured process for developing, reviewing and releasing new versions	
2	Key working group as well as reviewers and followers	
3	Forecast providers, users and other projects are invited to join the work	
4	Review of existing and related standards	

Topic 2: Meteorological Measurements and Instrumentation: Standardization for Integration into Grid Codes

The most common instrumentation and their applicability



Met Masts:
- cup/sonic anemometer
- stability/density

Nacelle instrumentation
- cup/sonic anemometer
- wind from dynamic pressure

Remote Sensing
- LIDAR|SODAR|RADAR

Data Quality check

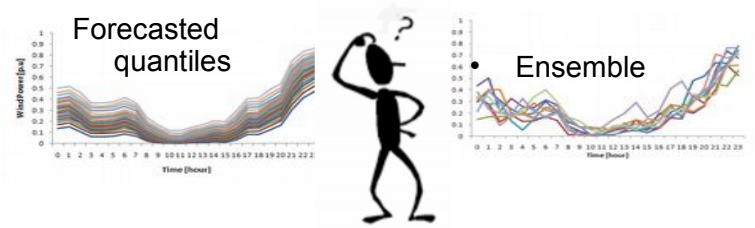
Specific quality requirements...to make this information useful in operation for NWP modelling and short-term forecasting

The missing brick is development of a wind/solar power forecasting specific:

a) standard/reference for suitable instrumentation
b) guideline for setup and maintenance
c) guideline for SCADA and IT system

Topic 3: Use of probabilistic forecasts in the power industry: what should a recommended practice contain?

Current Major Barriers for Discussion



Method being used to provide uncertainty indicators, communication and evaluation of the uncertainty is often unclear and leads to mistrust and wrong choices

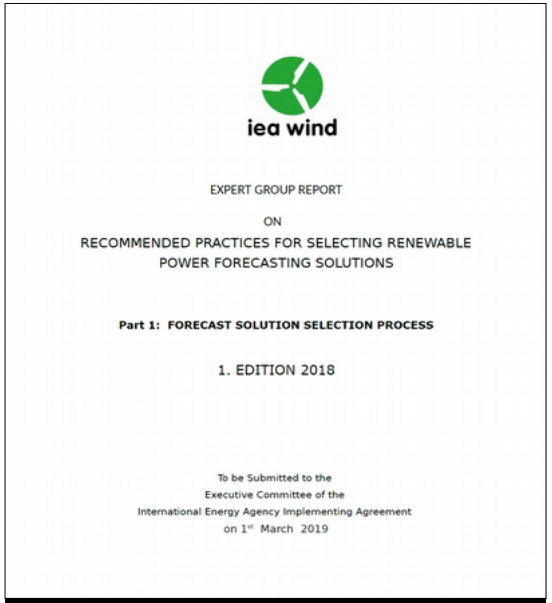
Stochastic optimization tools require high computational time (slow advices to human operators)

Lack of business cases that perform cost-benefit analysis of stochastic approaches for grid management

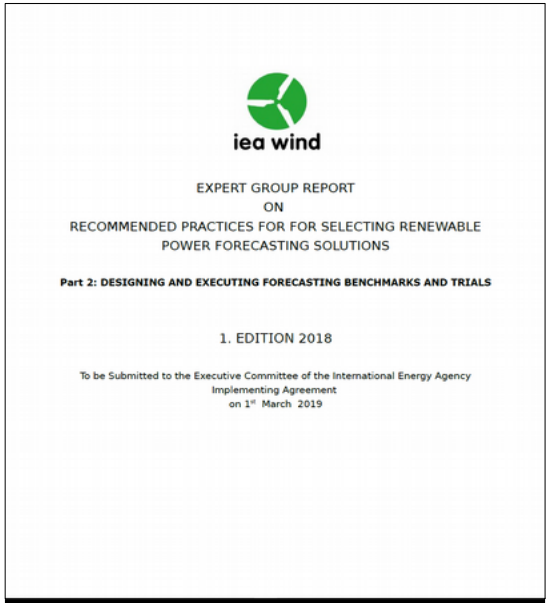
Cognitive load of human operators in the presence of probabilistic information for a large electrical network seems too large – Misunderstanding or lack of communication tools ?

Topic 4: Recommended Practices on Forecast Solution Selection: How can it be made more valuable to users?

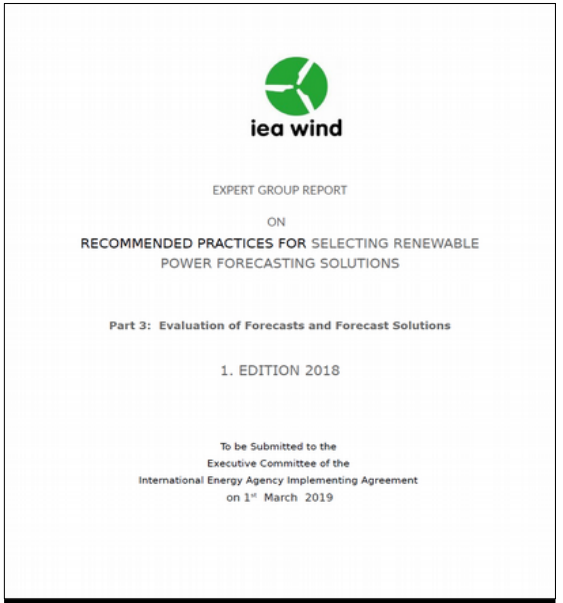
First version of a three-part document series is available on the Task 36 website



- Part 1: Selection of an Optimal Forecast Solution



- Part 2: **Design and Execution of Benchmarks**

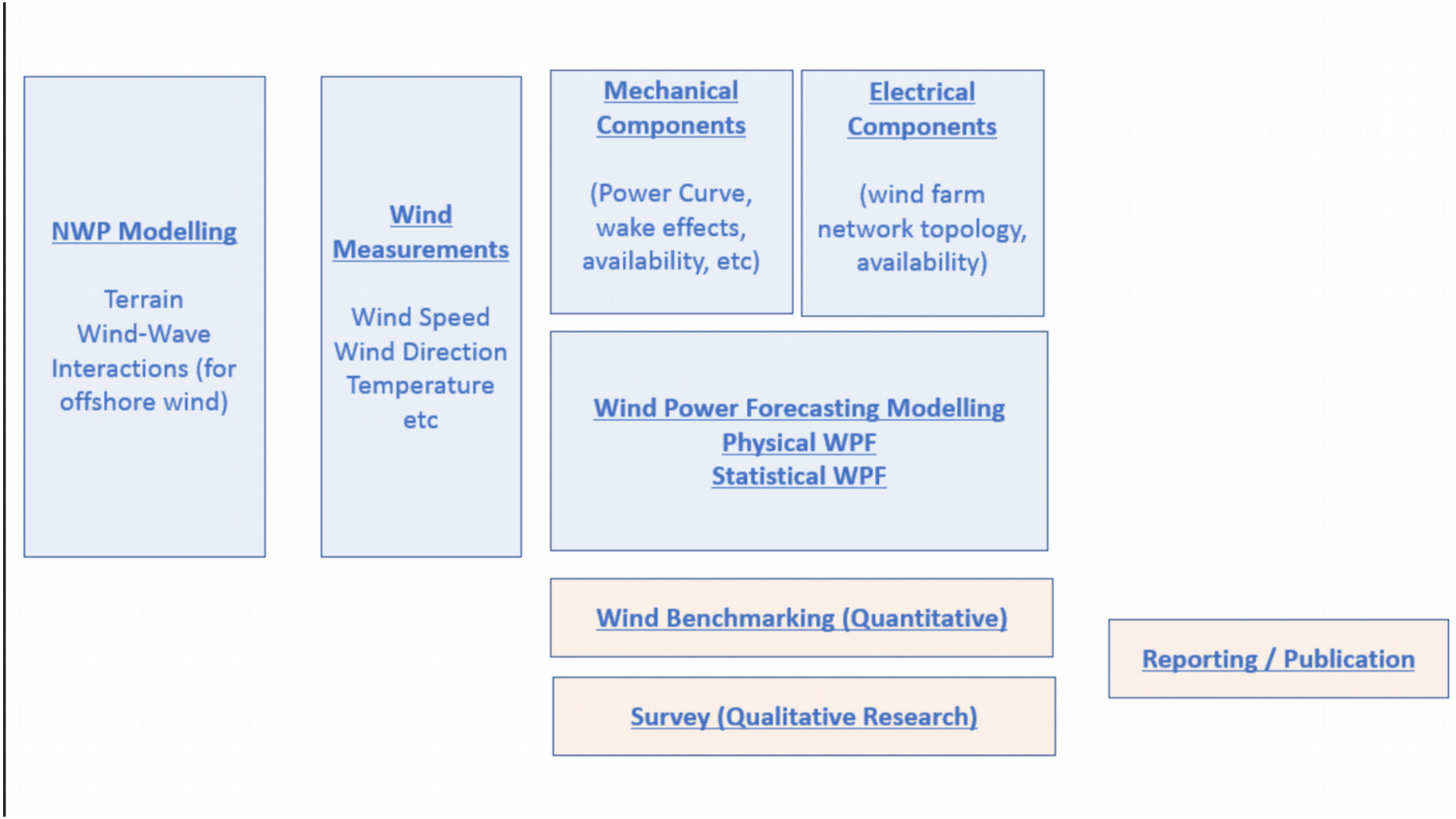


- Part 3: Evaluation of Forecasts and Forecast Solutions

Questions to Start the Discussion

- Would you use these documents? If so, how?
- Which parts do you find especially valuable (or useless)?
- What (e.g. topics, examples, explanations, details, etc.) is missing?
- Would minor or major changes to the format or structure make it more useful?
- Do you have suggestions for (additional or better) examples of key points?

Topic 5: Uncovering Uncertainty Origins and Development through the Modelling Chain



Let's get started….

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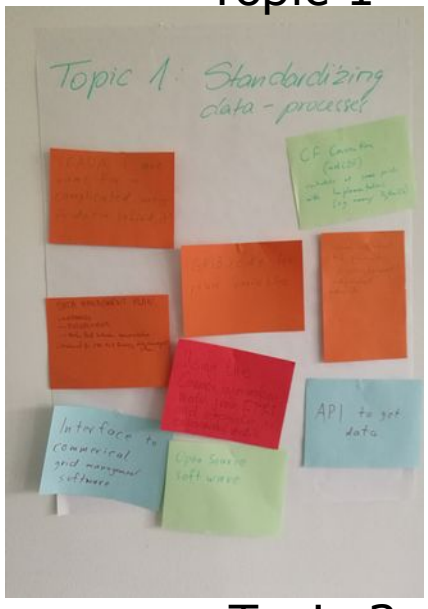
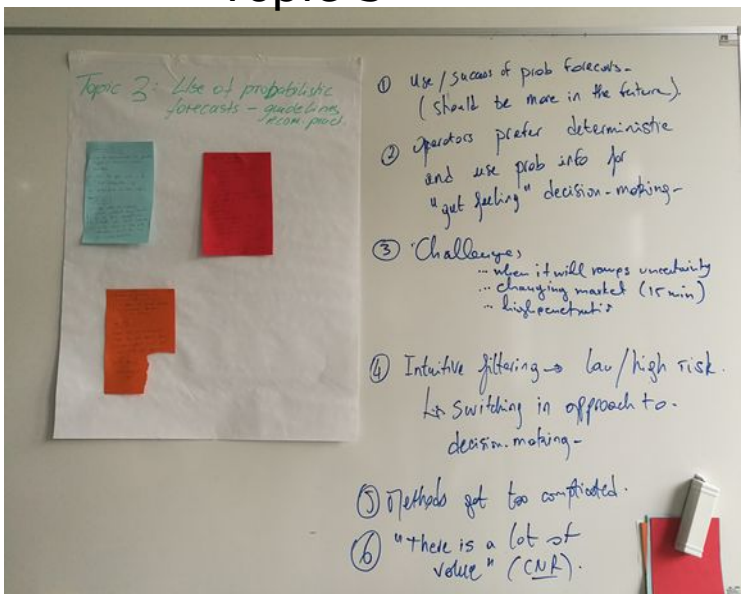
ICEM 2019 IEA Task 36 Open Space Workshop

Topic 1

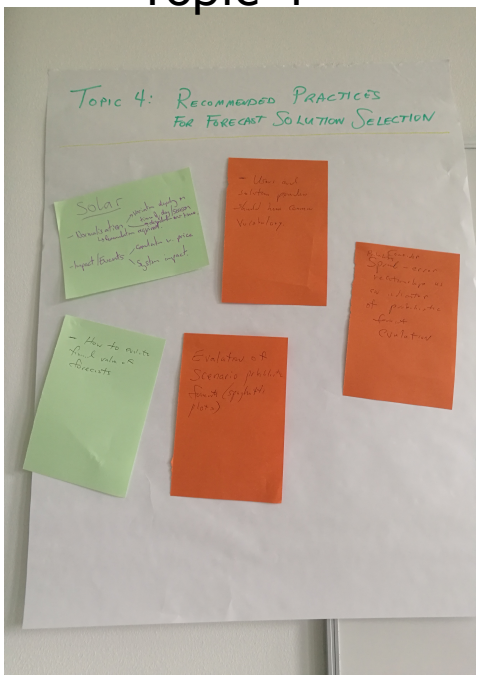


Topic 2

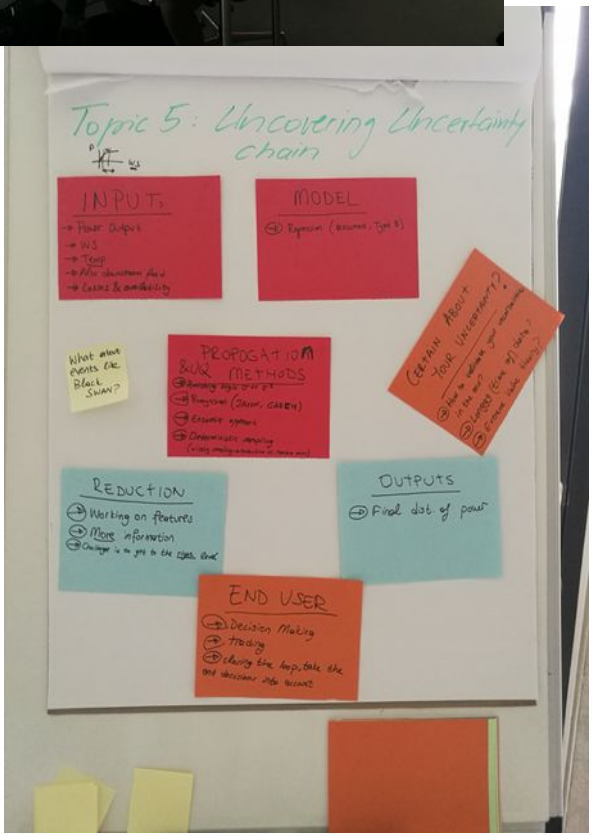
Topic 3



Topic 4



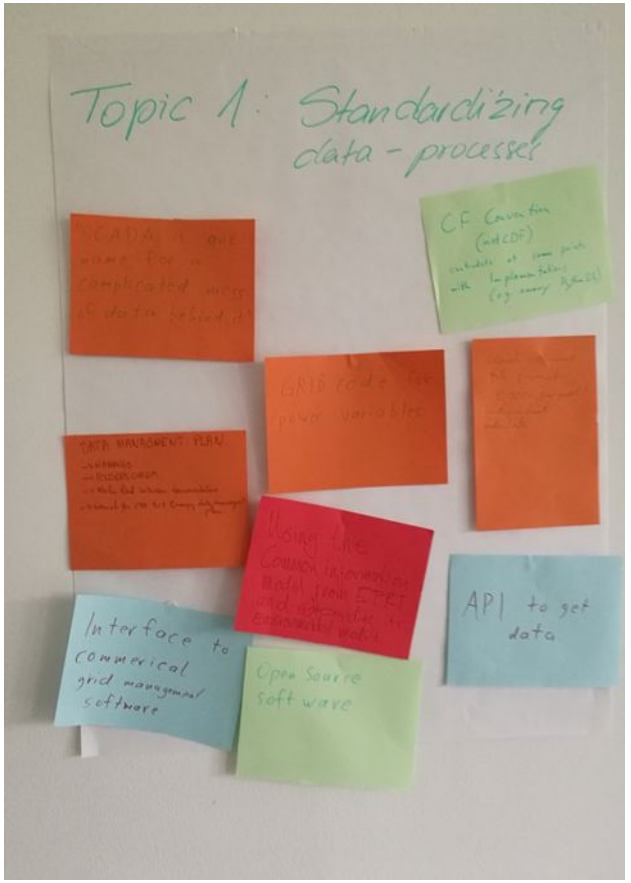
Topic 5



ICEM 2019 Open Space Workshop - Results for Topic 1: Standards

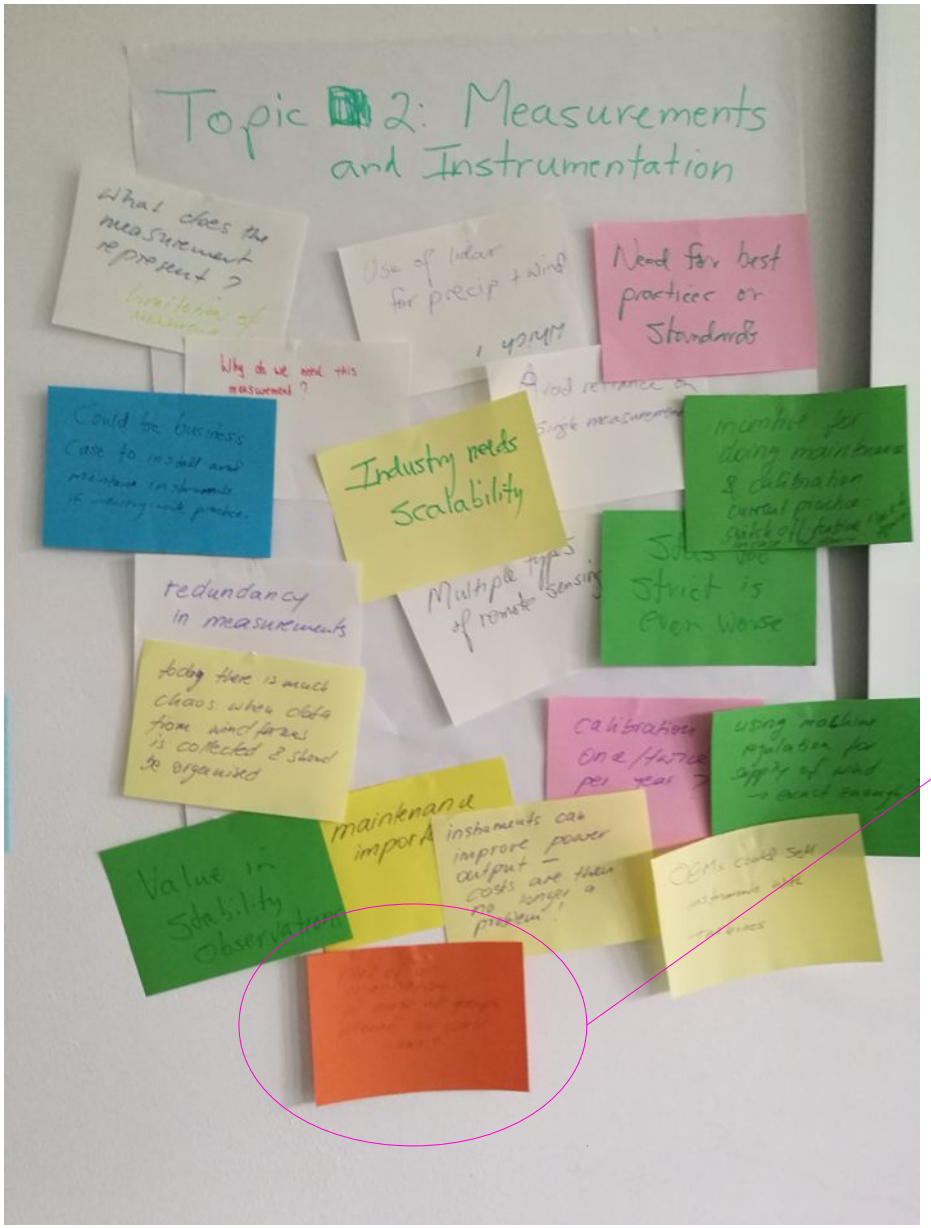
- ➔Interface to commercial grid management
- ➔Open Source Software
- ➔Expanding the common information model from EPRI to environment
- ➔Grib for power data
- ➔CF, netCDF convention contradicts at some points implementation, e.g. with Python

- ➔Data Management Plan:
  - ➔Names
  - ➔Folderorganisation
  - ➔Make links between documentation
  - ➔Search for css, sis, energy data mangement plan



ICEM 2019 Open Space Workshop

- Results for Topic 2: Meteorological Measurements and Instrumentation: Standardization for Integration into Grid Codes



Results from the workshop & conference

...Data exchanges, access and standards need to be organised **globally and from a international organisation** such as WMO

Topic 2: Meteorological Measurements and Instrumentation: Workshop Input

"In this open space session we are seeking for input from the participants. Forecast users with a need of standardising met measurements as well as forecast provides, academics, consultants, engineers with experience of met measurement campaigns of any type are invited to join the discussion and help us with the planning of further work in developing guidelines for meteorological measurements and instrumentation standardization to be integrated into grid codes."

a) What measurements are needed?

- Why do we need this measurement?
- What does the measurement represent? Limitations of measurement
- Redundancy of measurements
- Avoid reliance on single measurement
- There is value in stability observations
- Multiple types of remote sensing
- Multiple kinds of information from remote sensing systems, e.g., both wind and precipitation from lidar

Topic 2: Meteorological Measurements and Instrumentation: Workshop Input

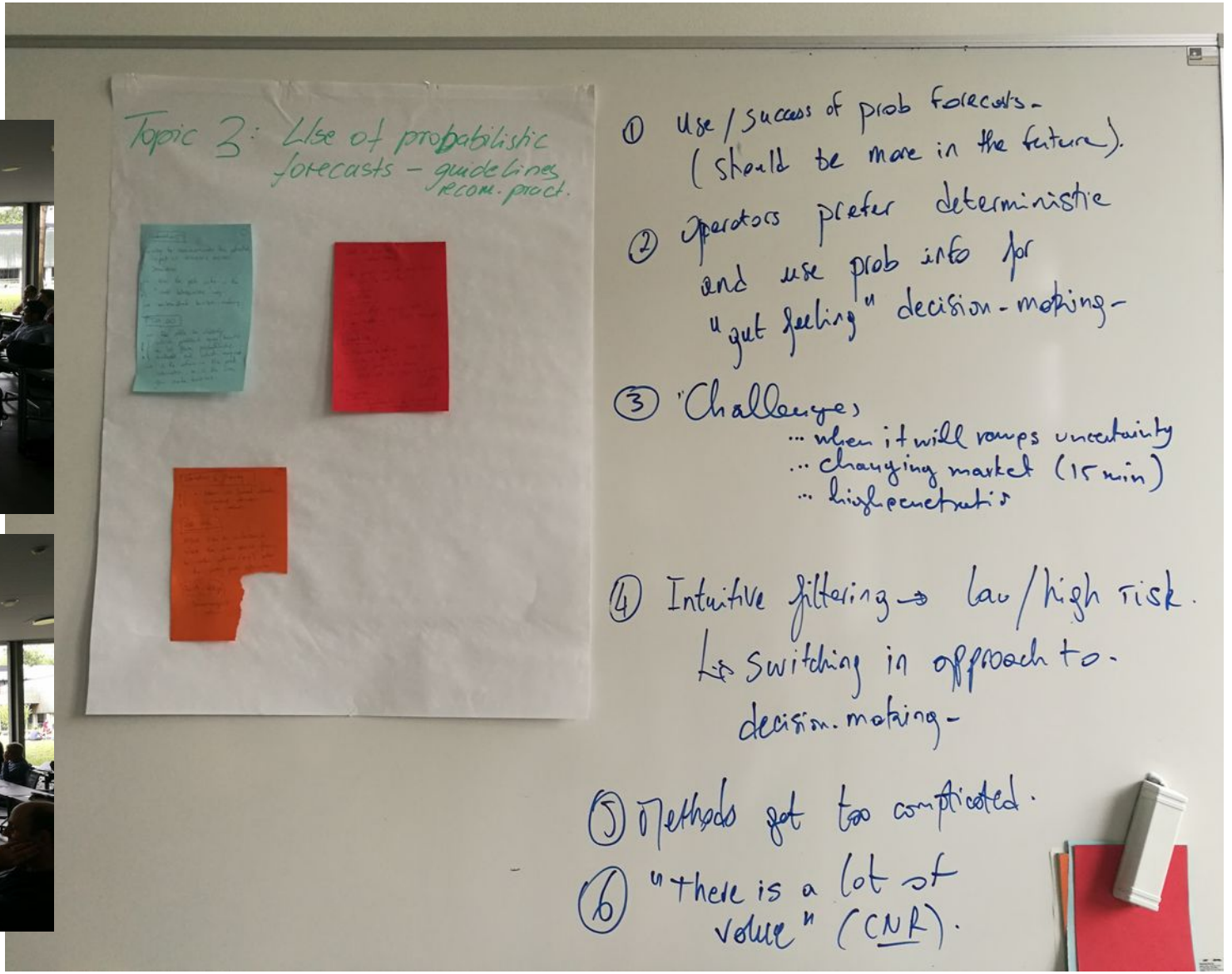
Is there a need for best practices or standards?

- Today there is much chaos when data from wind farms is collected & should be organized
- Instruments can improve power output—costs [of instruments] then no longer a problem!
- Using machine (?) regulation for supply of wind -> exact enough
- Calibration once/twice per year?
- Maintenance important
- Need for best practices or standards
- Need for an organisation to merge all groups around the world; WMO?
- Industry needs scalability

How do we engage industry in common measurement practices?

- Incentive for doing maintenance & calibration; current practice: switch off turbine in case of fault; lack of software (?)
- There could be a business case to install and maintain instruments if it is an industry-wide practice
- Too-strict standards are worse than none at all, since people will give up and do nothing
- OEMs could sell instruments with turbines as part of a package

ICEM 2019 Open Space Workshop
- Results for Topic 3: Use of probabilistic forecasts



ICEM 2019 Open Space Workshop
- Results for Topic 3: Use of probabilistic forecasts

➔ Industry is still not sure how to make use of probabilistic forecasts
Education needed for:
- ➔ Communication of uncertainty
- ➔ Potential impact of decision making
- ➔ Automation of decision making

➔Classification of which problems can benefit from probabilistic forecasts: → is the value in the probabilitic information or the decision making ?

➔ Standardization/industry guidelines for:
- ➔What is the best (methodology) ?
- ➔What does this (methodology) mean ?
- ➔ What tools are available, which are misssing ?

ICEM 2019 Open Space Workshop
- Results for Topic 3: Use of probabilistic forecasts

- Current use of probablistic forecasts
  - Operators still more comfortable with deterministic forecasts
  - Use prob. Forecasts often only for "gut feeling" decision making
  - Intuitive filtering: high/low risk evaluation

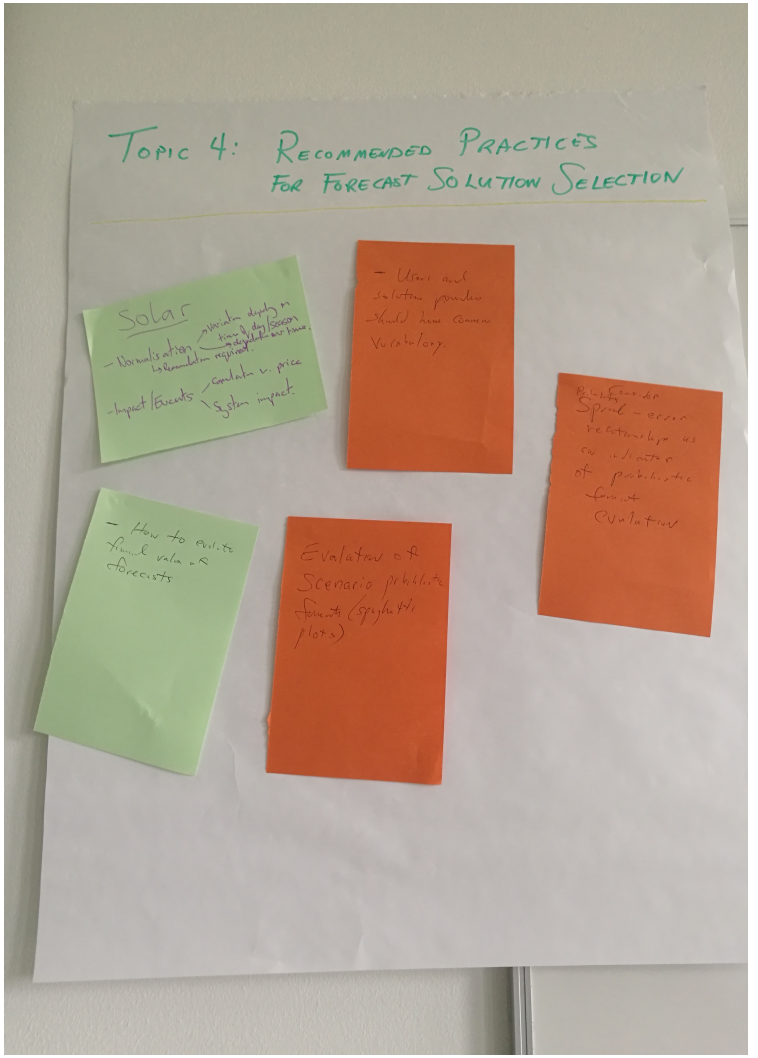
- Practical Challenges
  - Classification of ramp uncertainty / difficult to develop methods
  - Still changing market (structures)
  - Penetration levels – the higher the penetration, the more prob. forecasts are considered useful/necessary

ICEM 2019 Open Space Workshop - Results for Topic 4: Recommended Practices

None of the participants in the Topic 4 discussion had read or even seen any parts of the three documents

Therefore, no comments about the documents were received

Discussion was focused on what participants thought should be in such a document and what they thought were significant issues in forecast solution selection



- ➔Evaluation of scenario prediction formats
- ➔Users and Solution Providers should have common vocabulary
- ➔How to evaluate final value of forecast
- ➔Solar
  - ➔ Impacts/Events:
    - ➔System impact
    - ➔Correction vs. price
  - ➔ Normalisation:
    - ➔ Recommendations required
    - ➔ variation dependent on time of day, season,
    - ➔ Degradation over time

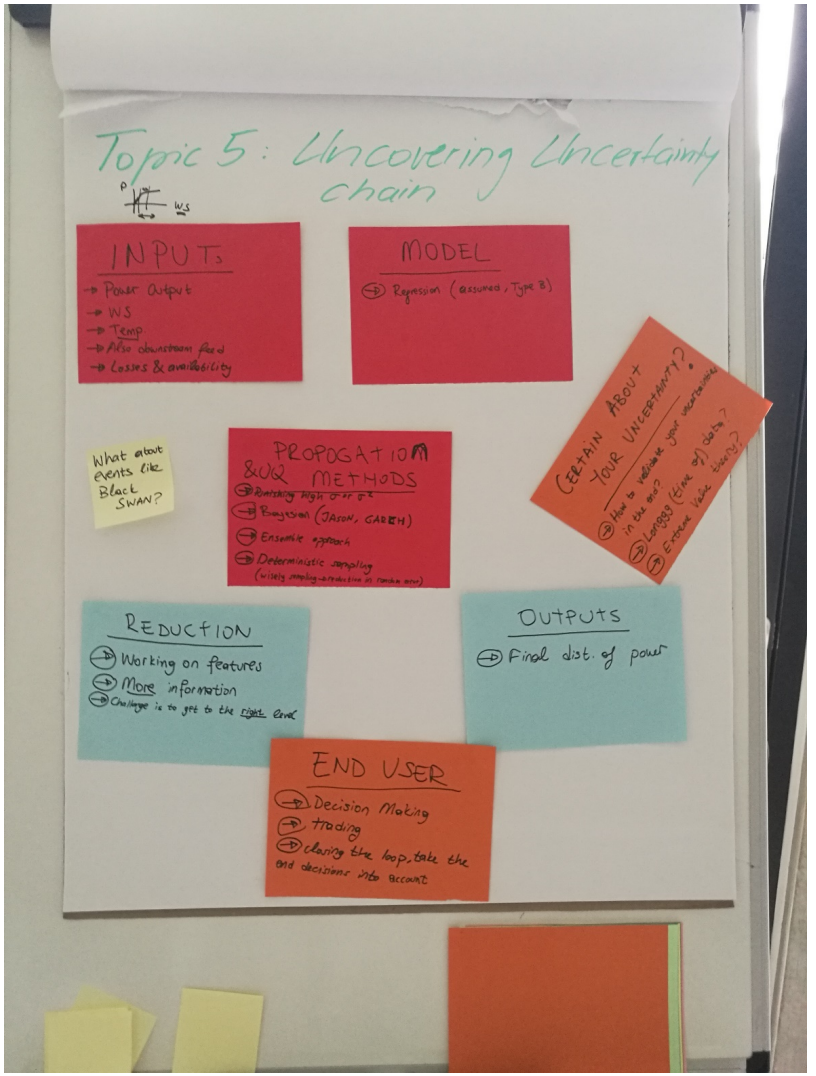
ICEM 2019 Open Space Workshop - Results for Topic 4: Recommended Practices

- Key points from comments
  - Terminology gap between solution providers and users
  - Users need more guidance and examples on how to formulate custom metrics that measure their sensitivity to forecast error
  - Guidance on the evaluation of probabilistic forecasts is needed
    - Need intuitive and transparent metrics for users
    - Evaluation of scenario forecasts was noted as a specific issue within the evaluation of probabilistic forecasts

ICEM 2019 Open Space Workshop - Results for Topic 5: Modelling Uncertainty

2D Category for Uncertainty Mapping (1/2)
Modelling Chain

- **Input UQ**
  - Feature distribution
- **Model Uncertainties**
  - 'Dynamic' fitting of the parameters (*e.g.* within regression)
- **Methods for UQ and propagation**
  - Bayesian Methods
  - Ensemble approach
  - Deterministic Sampling



- **Uncertainty Reduction**
  - More information
    - Feature level & models level
  - Right level of uncertainties
- **End user**
  - Decision Making
  - Close the loop
    - Focus efforts where uncertainty matters

ICEM 2019 Open Space Workshop - Results for Topic 5: Modelling Uncertainty

2D Category for Uncertainty Mapping (2/2)
Application & Evaluation

- **Planning Phase**
  - NWP model and input uncertainty
- **Operation Phase**
  - Wind Resource uncertainty (measurement, SCADA, etc.)
  - Wind-to-Power uncertainty (turbine and WF level Power Curve)
  - Turbine & data availability (curtailment, off-condition operation, communication break down, etc.)
- **Market Phase**
  - Current Trading → value of UQ in WPF
  - Future (flexible) markets
    - Additional unc. due to *unknown*
- **Other**
  - Large vs. small scale → temporal & spatial

- **Certain about your uncertainty?**
  - How to validate the uncertainty in the final WPF?
    - Tests on looooooooonnnnggg dataset?
    - Extreme value theory?

THANK YOU FOR YOUR ATTENTION

Follow us:

Project webpage

http://www.ieawindforecasting.dk/

Task-page:

http://www.ieawindforecasting.dk/topics/workpackage-3/task-3-1

http://www.ieawindforecasting.dk/topics/workpackage-3/task-3-5

Publications:

http://www.ieawindforecasting.dk/publications.html

Contact Workshop Organisator:
Dr. Corinna Möhrlen, WEPROG
com@weprog.com

Operating Agent:
Dr. Gregor Giebel, DTU Wind
grgi@dtu.dk

Organised by:

C. Möhrlen	WEPROG
J. Zack	UL-AWS Truepower
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