



International Energy Agency (IEA)
Implementing Agreement for Co-operation in the Research and Development
of Wind Energy Systems (IEA Wind)

Recommended Practices Guidelines for Forecast Solution Selection

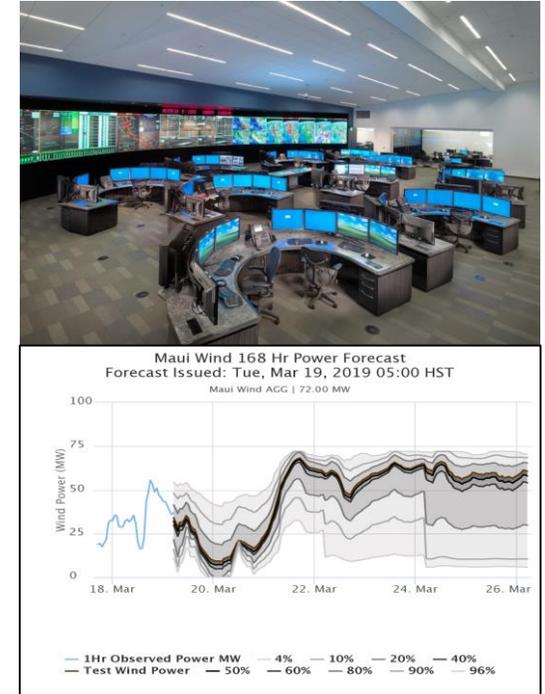
John Zack
AWS Truepower,
a UL Company

Jeff Lerner
Vaisala

Meteorology & Market Design for Grid Services Workshop
Denver, CO
June 4-6, 2019

The Problem and an Approach for a Solution

- **Documented Benefits:** Use of forecasts to assist in the management of the variability of wind-based (and solar-based) generation can lower variable generation integration (system) costs while maintaining the required high system reliability
- **Problem:** A substantial amount of the potential value of forecasting is not realized due to the **use of non-optimal forecast solutions by users**
 - Specification of the wrong forecast performance objective(s)
 - Poorly designed and executed benchmarks/trials of alternative solutions
 - Use of non-optimal evaluation metrics for forecast evaluation
- **Potential Mitigation:** International group of experts have interacted under the framework of IEA Wind Task 36 to formulate a set of documents that specify the “best practices” for selecting a wind forecasting solution



Overview of IEA-WIND Recommended Practice for the Selection of Wind Power Forecasting Solutions (Task 2.1)

Task lead: Corinna Mohrlen, WEPROG

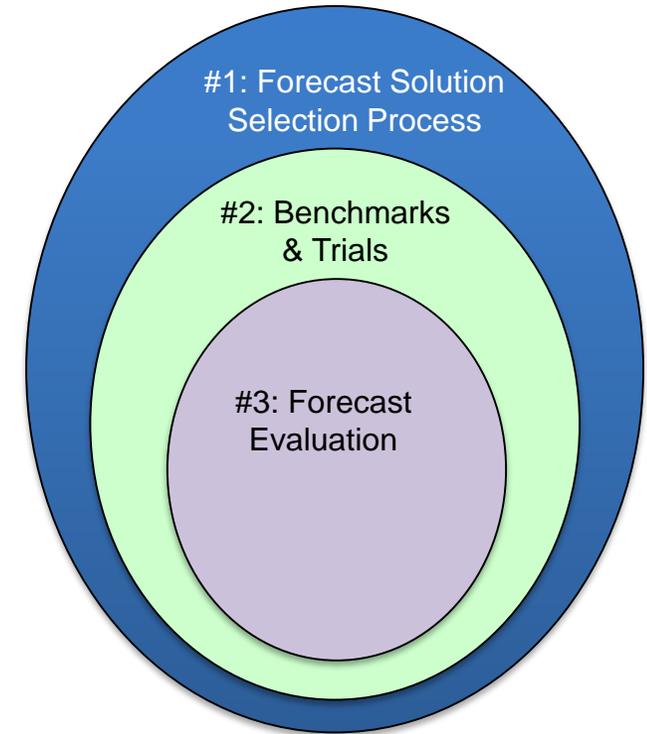


Target: Compile guidance for the implementation of renewable energy forecasting into system operation

Approach: Develop a set of 3 documents that specify IEA Wind Recommended Practices for:

1. Forecast Solution Selection Process
2. Design and Execution of Benchmarks and Trials
3. Evaluation of Forecasts and Forecast Solutions

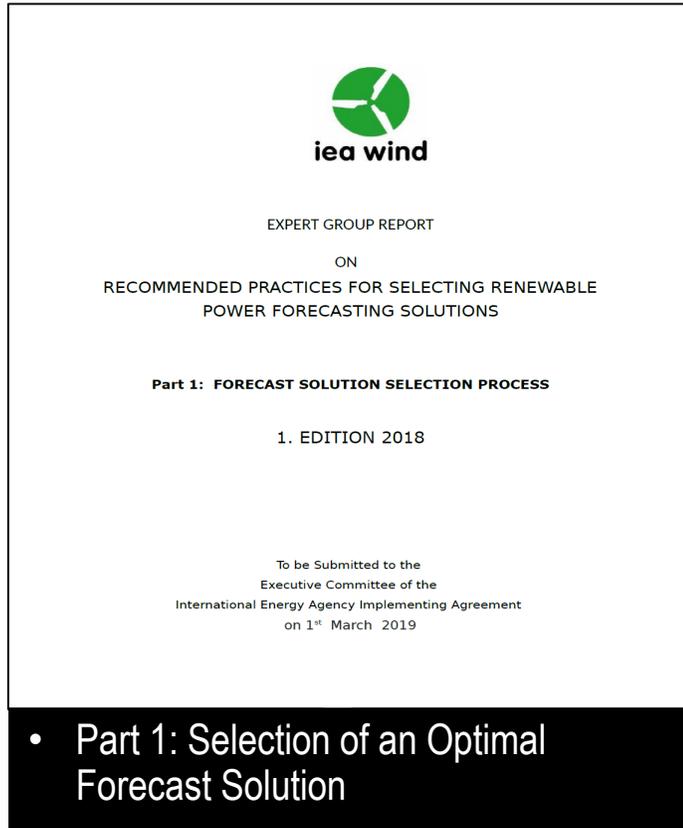
Current Status: Version 1 submitted to IEA Wind ExCo for approval



The best practices guidelines are based on many years of industry experience and are intended to achieve maximum benefit for all parties involved in the forecasting area.

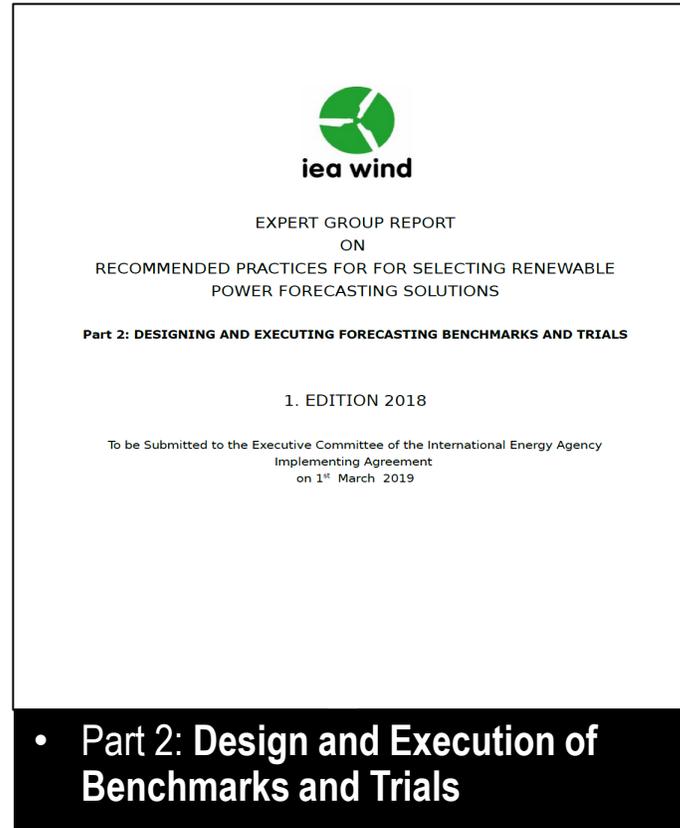
Task 2.1 page: <http://www.ieawindforecasting.dk/topics/workpackage-2/task-2-1>

IEA Best Practice Recommendations for the Selection of a Wind Forecasting Solution: Set of 3 Documents



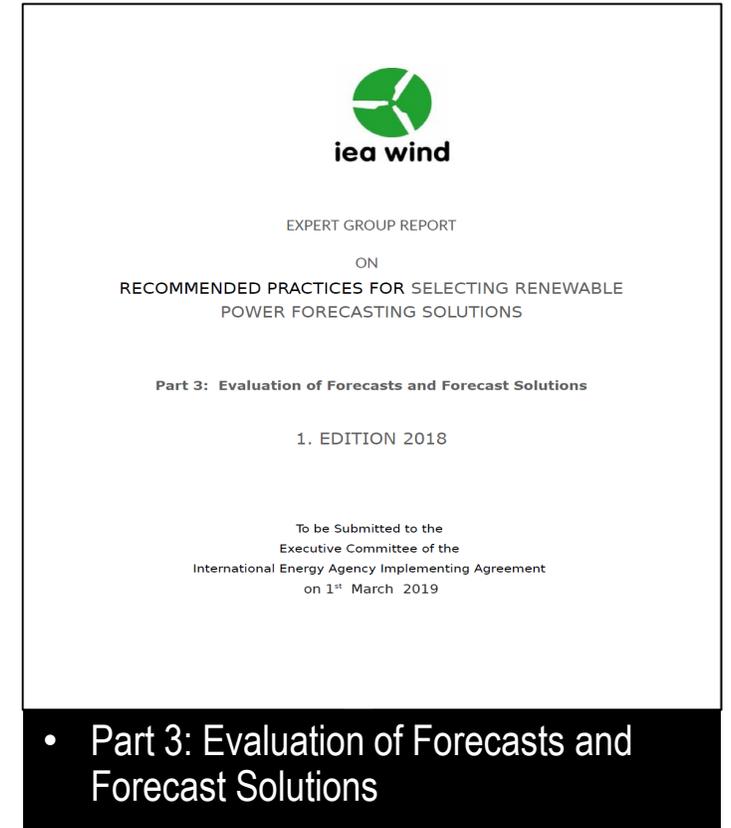
The cover of Part 1 features the IEA Wind logo at the top. Below it, the text reads: "EXPERT GROUP REPORT ON RECOMMENDED PRACTICES FOR SELECTING RENEWABLE POWER FORECASTING SOLUTIONS". The title "Part 1: FORECAST SOLUTION SELECTION PROCESS" is centered. Below that is "1. EDITION 2018". At the bottom, it states: "To be Submitted to the Executive Committee of the International Energy Agency Implementing Agreement on 1st March 2019".

- Part 1: Selection of an Optimal Forecast Solution



The cover of Part 2 features the IEA Wind logo at the top. Below it, the text reads: "EXPERT GROUP REPORT ON RECOMMENDED PRACTICES FOR FOR SELECTING RENEWABLE POWER FORECASTING SOLUTIONS". The title "Part 2: DESIGNING AND EXECUTING FORECASTING BENCHMARKS AND TRIALS" is centered. Below that is "1. EDITION 2018". At the bottom, it states: "To be Submitted to the Executive Committee of the International Energy Agency Implementing Agreement on 1st March 2019".

- Part 2: Design and Execution of Benchmarks and Trials



The cover of Part 3 features the IEA Wind logo at the top. Below it, the text reads: "EXPERT GROUP REPORT ON RECOMMENDED PRACTICES FOR SELECTING RENEWABLE POWER FORECASTING SOLUTIONS". The title "Part 3: Evaluation of Forecasts and Forecast Solutions" is centered. Below that is "1. EDITION 2018". At the bottom, it states: "To be Submitted to the Executive Committee of the International Energy Agency Implementing Agreement on 1st March 2019".

- Part 3: Evaluation of Forecasts and Forecast Solutions

- **Submitted version available in March 2019 news feed of the Task 36 site: www.ieawindforecasting.dk/news**
- Final version will be available in the publications section of the Task 36 site

Forecast Solution Selection Process

1. Motivation and Objective
2. Document Structure
3. Key Takeaway: Decision Support Tool



Forecast Solution Selection Process: Motivation & Objectives

- Motivation

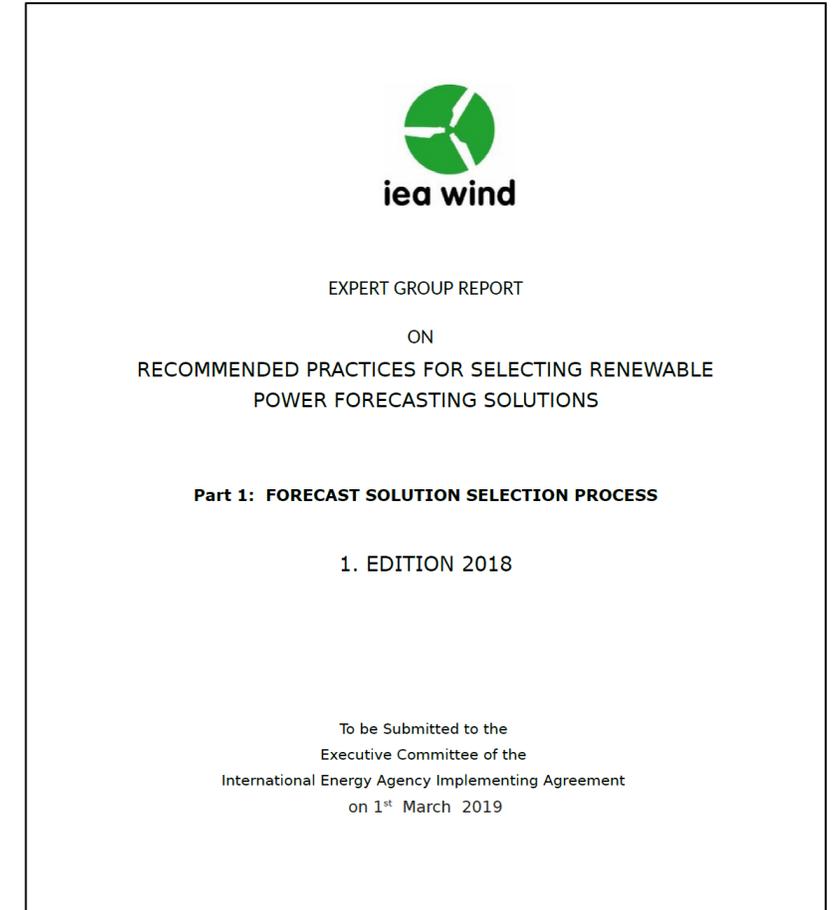
- ✓ Forecast solutions are often selected via flawed procedures that often result in the selection of less than optimal solutions for specific applications
- ✓ Users often feel that they should run performance trials to identify the best solution but poorly designed and executed trials typically provide worse guidance than not conducting a trial
- ✓ The best solution selection approach may be to NOT conduct a performance trial and instead use alternative approaches if adequate resources and time are not available to conduct a high quality trial

- Objective

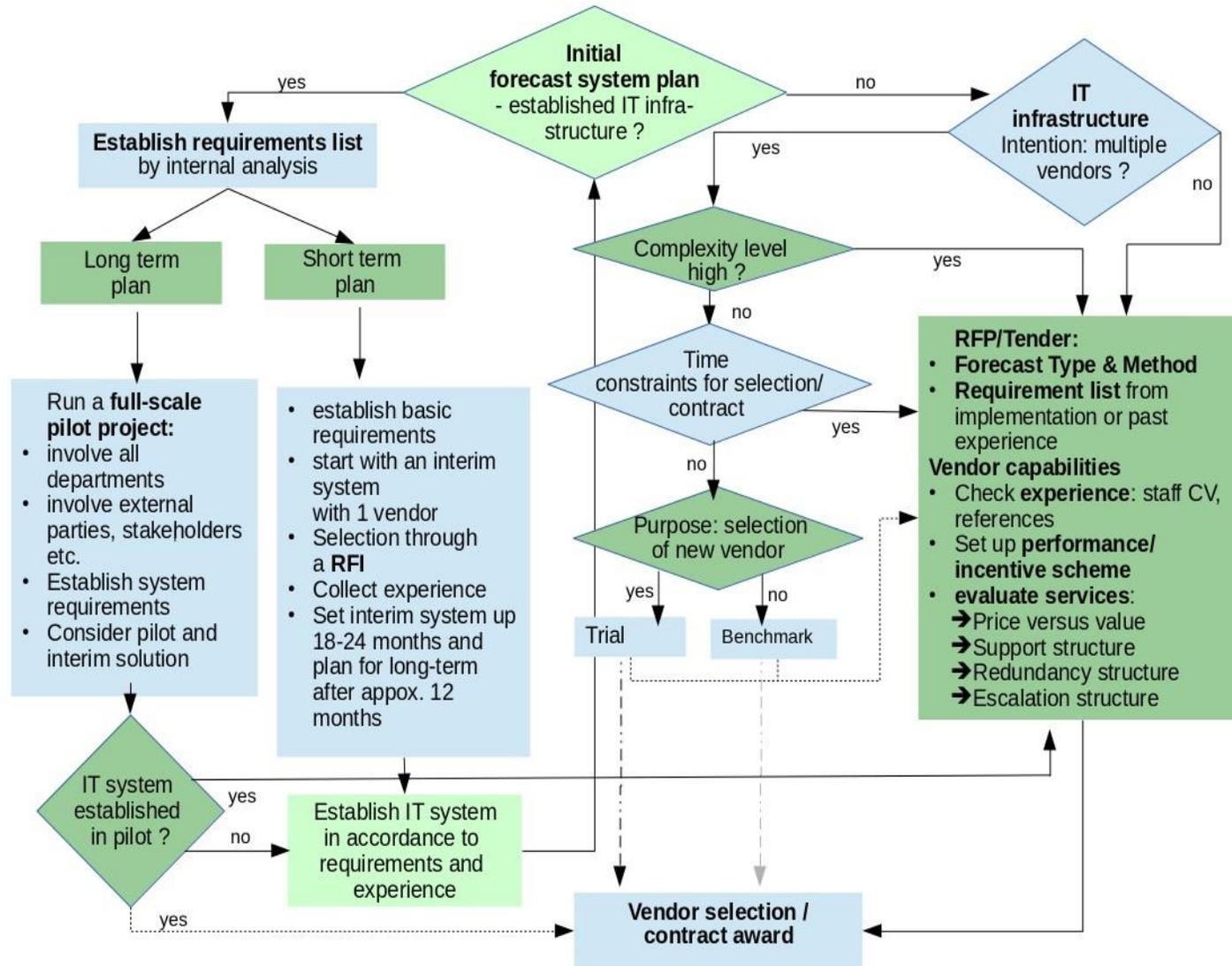
- Provide guidance to stakeholders on alternative procedures for the selection of an optimal forecast solution and a framework to decide which procedure is most appropriate for a specific situation – a Decision Support Tool.

Forecast Solution Selection Process: Document Structure

- Initial Considerations
- Decision Support Tool
 - ✓ Initial forecast system planning
 - ✓ IT infrastructure considerations
 - ✓ Establishment of Requirements
 - ✓ Short-term solution
 - ✓ Long-term solution
 - ✓ Going forward with an established IT system
 - ✓ Complexity level of an existing IT solution
 - ✓ New vendor selection vs. existing vendor benchmarking
 - ✓ RFP evaluation criteria for a forecast solution
- Clarification questions for a forecast solution
- Typical RFI questions prior to or in an RFP



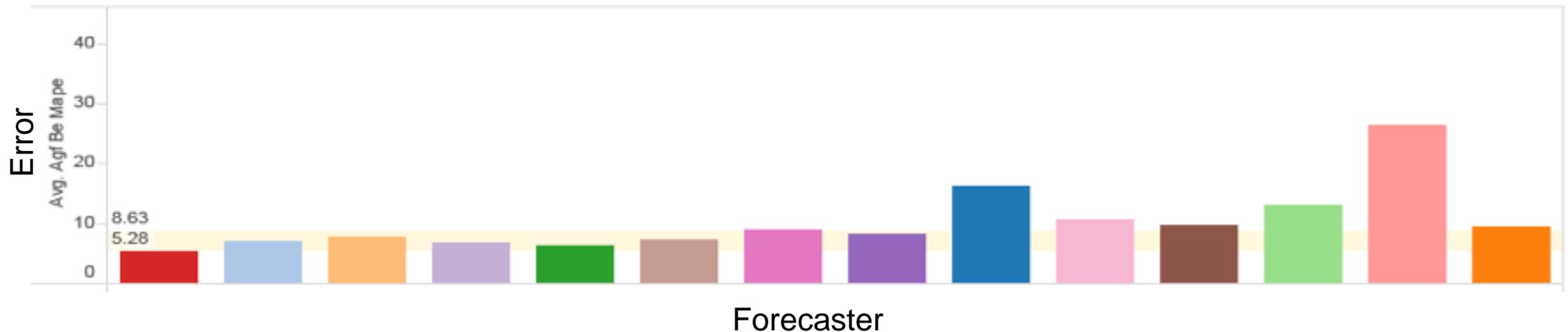
Decision Support Tool for the Process of Selecting a Forecasting Solution



- Provides guidance and practical examples for:
 - the formulation of a process to select an optimal forecasting solution
 - analysis and formulation of forecasting requirements
 - assessing vendor capabilities with and without trials

Designing and Executing Forecasting Benchmarks and Trials

1. Background
2. Objective
3. Document Structure
4. Key Takeaways



Designing and Executing Forecasting Benchmarks and Trials : Background

- Key component of the Forecast Solution Selection process
- Stakeholder meetings held since 2016 soliciting ideas on how to make a lasting recommended practice document accessible to all
- Much of the input came from experienced forecast providers
- Motivations
 - ✓ lack of online resources to help industry
 - ✓ document the pros/cons of trials/benchmarks
 - ✓ promote competition, improved forecast accuracy, and actionable forecasts
 - ✓ provide examples of what a successful trial/benchmark looks like
 - ✓ improve efficiencies in the trial/benchmark process

Ultimately Make It Easier and More Cost Effective to Integrate Renewables!

Designing and Executing Forecasting Benchmarks and Trials : Objectives

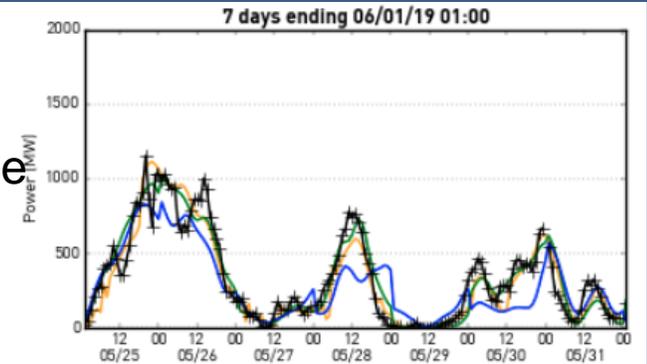
“...compile a guidance and a standard for private industry, academics and government in executing a renewable energy forecasting benchmark or trial”

- ✓ *Running an efficient trial or benchmark → short term cost savings*
- ✓ *Find which forecast solution(s) fits best → long term cost savings*



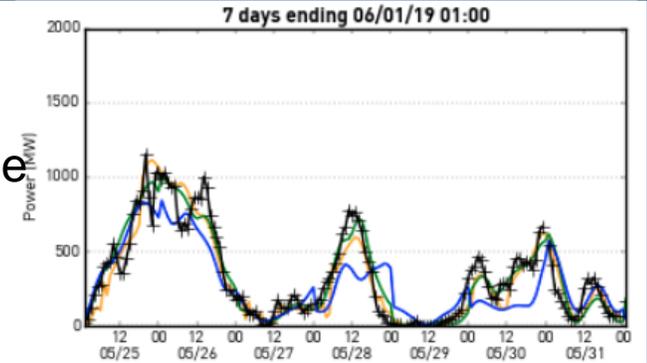
10% RMSE
\$15,000
99.8% uptime

F1



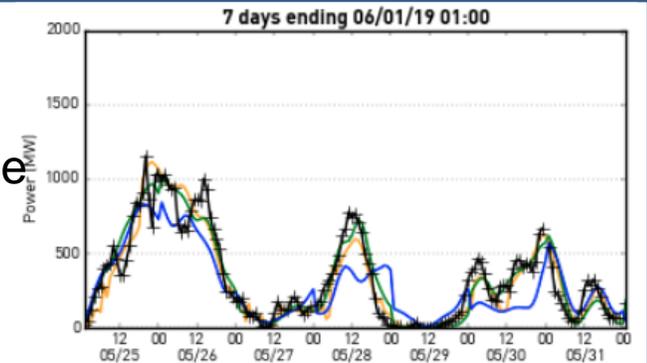
11% RMSE
\$14,000
99.6% uptime

F2



8% RMSE
\$16,500
99.9% uptime

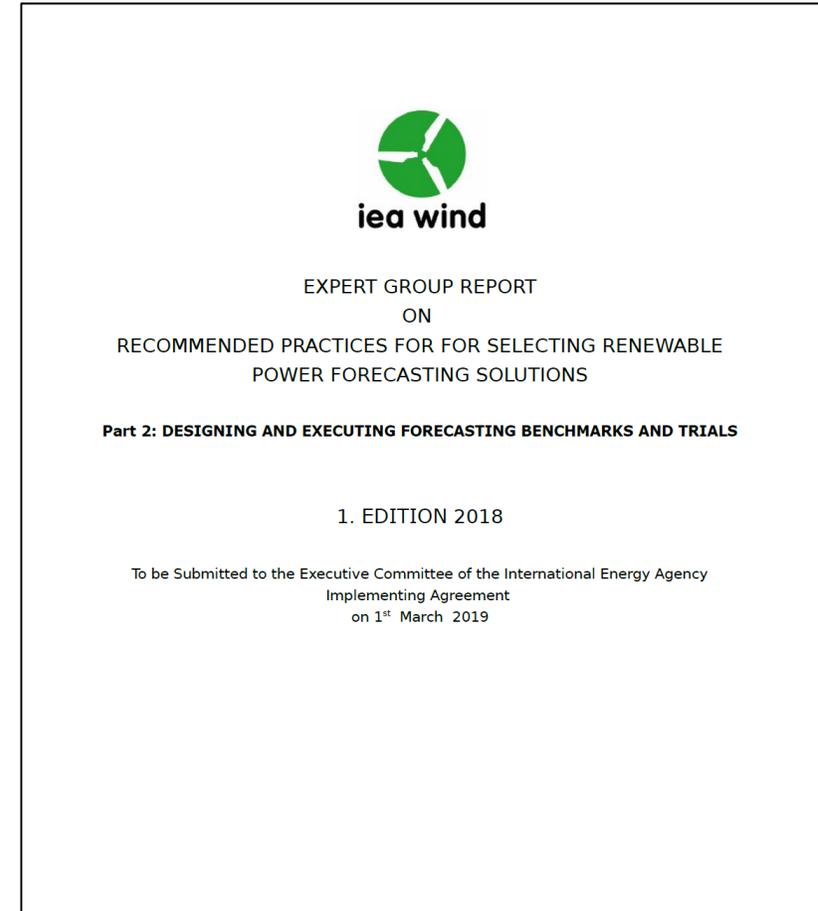
F3



Designing and Executing Forecasting Benchmarks and Trials : Document Structure

Trial or Benchmark....

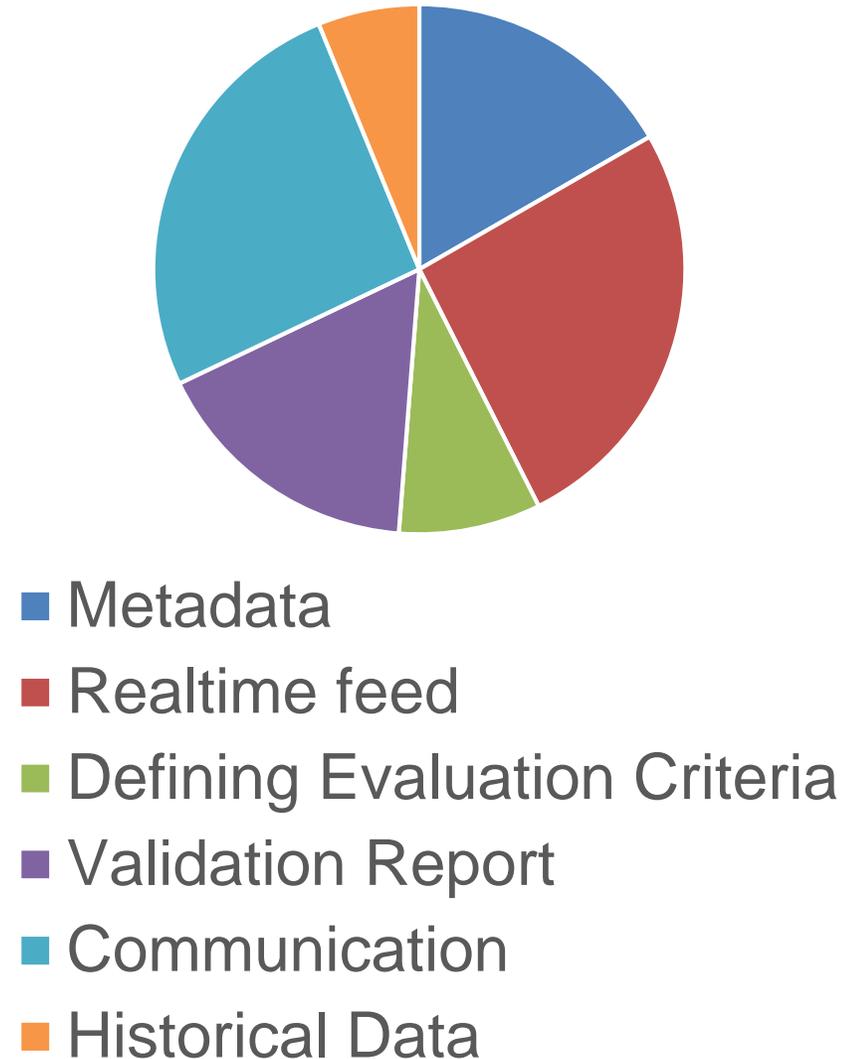
- Benefits/Limitations
- Time line / planning considerations
- 1-page “cheat sheet” for execution
- Detailed phase descriptions
- Successful characteristics
- Pitfalls to avoid
- Appendices with example file format, data structure, metadata fields



Designing and Executing Forecasting Benchmarks and Trials : **Key Takeaways**

- Emphasis on the time commitment to get meaningful results
- Understanding resource requirements needed to simulate something resembling “operations”
- What has worked and not worked in the past
- Use of examples/templates (e.g., file formats, data structures, data delivery, communication practices)

Trial Components



Evaluation of Forecasts and Forecast Solutions: Motivation & Objectives

- Motivation

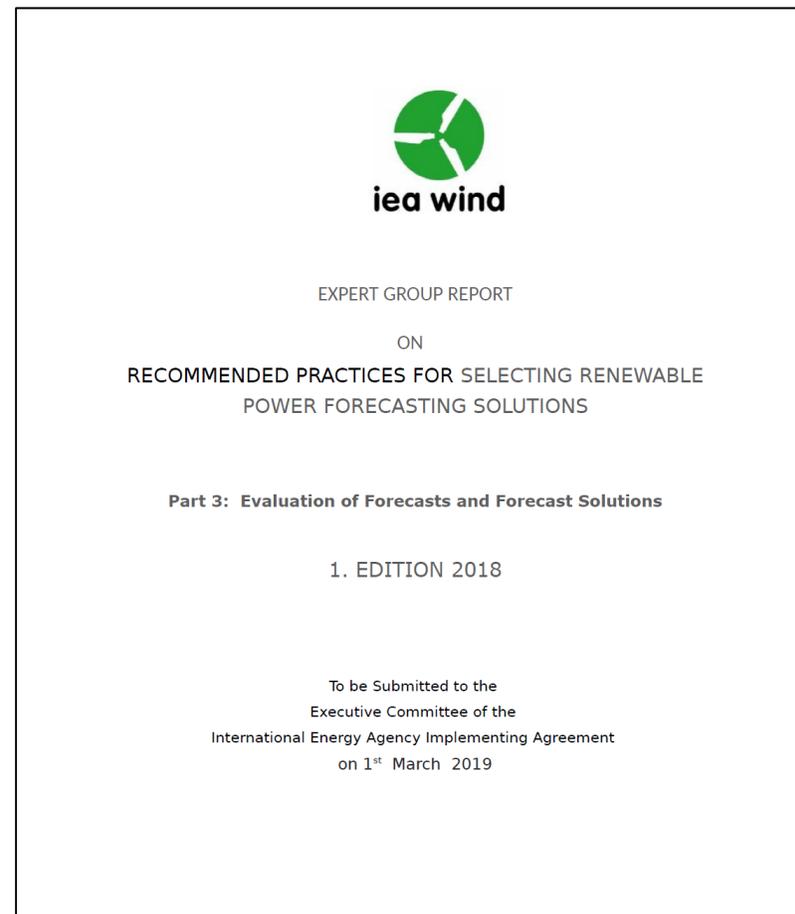
- ✓ Evaluations of forecast performance often do not provide meaningful information about the value of a forecast solution for a specific application because of issues with (1) representativeness, (2) significance or (3) relevance of the evaluation
- ✓ Forecast users often employ simple and widely used performance metrics because that is the de facto standard in the stakeholder community
- ✓ There is little consideration that all performance evaluations have an inherent uncertainty which should be understood and quantified

- Objective

- ✓ Provide information and guidelines about the effective evaluation of forecasts, forecast solutions and benchmarks and trials
- ✓ Focus on two concepts
 - *Impact of forecast accuracy on application*
 - *Cost-loss relationship of forecasts*

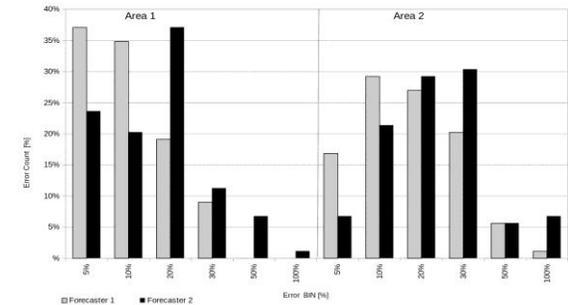
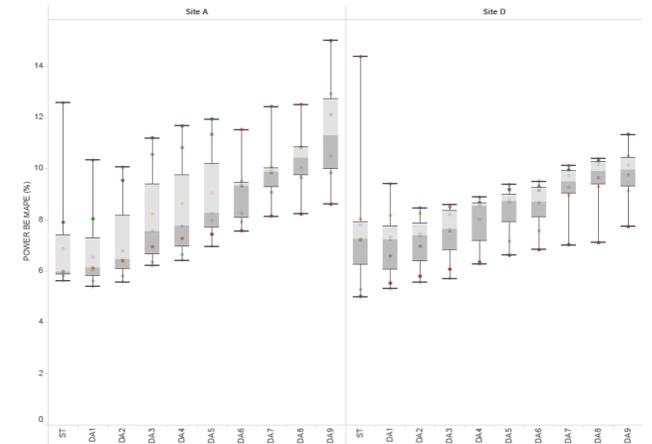
Evaluation of Forecasts and Forecast Solutions: Document Structure

- **Overview of Evaluation Uncertainty**
 - ✓ Representativeness
 - ✓ Significance
 - ✓ Relevance
- **Measurement Data Processing and Control**
- **Assessment of Forecast Performance**
 - ✓ Forecast attributes and metric selection
 - ✓ Metric-based forecast optimization
- **Best Practice Recommendations**
 - ✓ Development of an evaluation framework
 - ✓ Operational forecast value maximization
 - ✓ Evaluation of benchmarks and trials
 - ✓ Evaluation of development techniques
 - ✓ Use cases



Evaluation of Forecasts and Forecast Solutions: : Key Takeaways

- All *performance evaluations* of potential or ongoing forecast solutions have a degree of *uncertainty*
- The *uncertainty* is associated with three attributes of the performance evaluation process: (1) *representativeness*, (2) *significance* and (3) *relevance*
- A carefully designed and implemented evaluation process that considers the key issues in each of these three attributes can minimize the uncertainty and yield the most meaningful evaluation results
- A *disregard of these issues is likely to lead to decisions based on unrepresentative information*



Where to Get the Details

Work Package 2 Publications

Best Practices Documents

ESIG Forecasting Workshop
2017 and 2018

2 Sessions

10 Presentations

Wind Integration Workshop

2 Workshop Papers

4 Workshop Presentations

YouTube Channel

1 Webinar

All papers and presentations are publicly available on the web:

→ Task 36 site

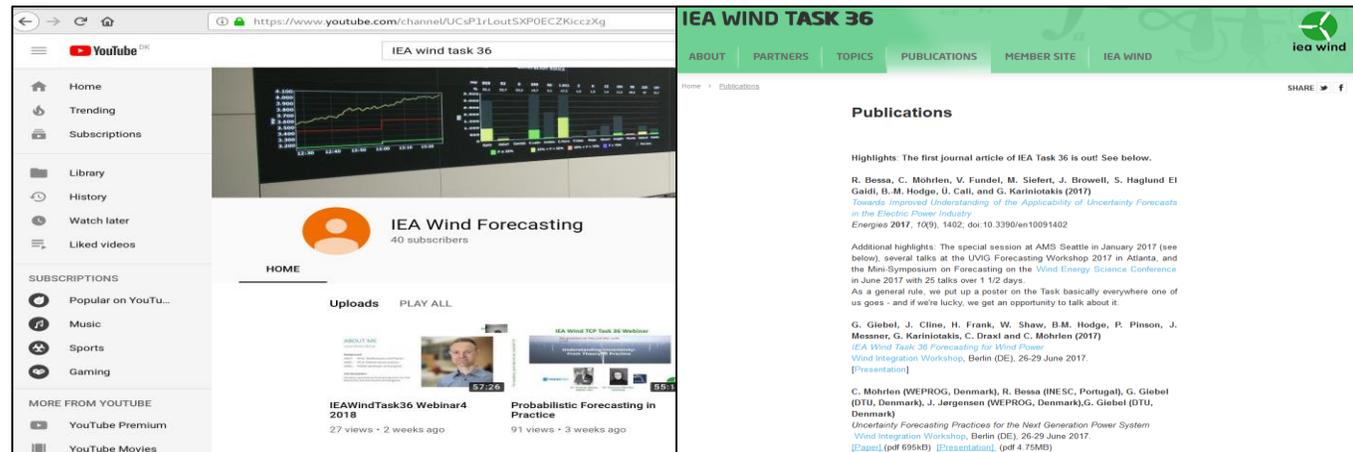
- ieawindforecasting.dk

→ Research Gate Project

- www.researchgate.net/project/IEA-Wind-Task-36-Wind-Power-Forecasting

→ IEA Wind Forecasting YouTube Channel:

- www.youtube.com/channel/UCsP1rLoutSXP0ECZKicczXg



The image shows two side-by-side screenshots. The left screenshot is a browser view of the YouTube channel 'IEA wind task 36' (channel ID: UCsP1rLoutSXP0ECZKicczXg). The channel page displays a video player with a graph, the channel name 'IEA Wind Forecasting' with 40 subscribers, and a list of uploads including 'IEAWindTask36 Webinar4 2018' and 'Probabilistic Forecasting in Practice'. The right screenshot is the 'IEA WIND TASK 36' website. The website has a navigation menu with 'ABOUT', 'PARTNERS', 'TOPICS', 'PUBLICATIONS', 'MEMBER SITE', and 'IEA WIND'. The 'Publications' section features a 'Highlights' section with a link to a journal article and 'Additional highlights' listing various workshops and conferences. Below this, there are links to specific publications, such as 'IEA Wind Task 36 Forecasting for Wind Power Wind Integration Workshop, Berlin (DE), 26-29 June 2017' and 'C. Mohrlen (WEPROG, Denmark), R. Bessa (INESC, Portugal), G. Giebel (DTU, Denmark), J. Jørgensen (WEPROG, Denmark), G. Giebel (DTU, Denmark) Uncertainty Forecasting Practices for the Next Generation Power System Wind Integration Workshop, Berlin (DE), 26-29 June 2017'.

Plans for Phase 2

- **Objective**

- ✓ **Create a 2nd version of the RP document that more effectively targets the needs of the stakeholder community, especially end-users of forecasts**

- **Approach**

- ✓ **Obtain broader community feedback on first version of RP documents**

- conduct “feedback” workshops at opportunistic geographically diverse venues
- solicit feedback via presentations at stakeholder gatherings, webinars, etc.
- provide opportunity to give feedback via IEA Task 36 web site

- ✓ **Decide how (whether) to address items identified in initial feedback**

- best practices for optimal selection of probabilistic forecast solutions
- background information on the sources of uncertainty in state-of-the-art forecasts
- recommendations for contracting with third parties to execute trials and benchmarks
- guidance for the process of obtaining NDAs and NDA templates
- examples and key attributes of successful forecasting solution selection processes
- examples and critical errors of flawed forecasting solution selection processes

