Recommended Practices Guidelines for Forecast Solution Selection

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The Problem and an Approach for a Solution

• **Documented Benefits:**
  - Use of forecasts to can lower variable generation integration costs while maintaining the required high system reliability

• **Problem:** A substantial amount of value is not realized due to the use of non-optimal forecast solutions by users
  - wrong forecast performance objective(s)
  - Poorly designed and executed benchmarks/trials
  - Use of non-optimal evaluation metrics

• **Potential Mitigation:**
  - IEA Wind Task 36 – Work Package 2 experts formulated a set of “best practices” for selecting and running wind forecasting solutions
Overview of IEA-WIND Recommended Practice for the Selection of Wind Power Forecasting Solutions (WP 2.1)

**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

- Submitted version available in March 2019 news feed of the Task 36 site: www.ieawindforecasting.dk/news
IEA Best Practice Recommendations for the Selection of a Wind Forecasting Solution: Set of 3 Documents

• Part 1: Selection of an Optimal Forecast Solution
• Part 2: Design and Execution of Benchmarks and Trials
• Part 3: Evaluation of Forecasts and Forecast Solutions

This Presentation

ICEM Poster by Jethro Browell
Part 1: Forecast Solution Selection Process:

- **Key Concept**: the “best” practical forecast solution process for an application depends on the user’s access to knowledge, labor resources and time
  - Conducting a performance trial may not profile useful guidance if not well designed and executed
  - Alternative to trials may be more effective

- **Key Guidance**:
  - Decision Support Tool: guidance to determine the best approach for a specific situation
  - Check lists of information to gather for trials, RFP, RFI
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
Part 2: Designing and Executing
Forecasting Benchmarks and Trials

• **Key Concept**: a benchmark or trial must be carefully designed, executed and evaluated in order to produce information that can be used for meaningful decision-making
  • Many decisions are based on “noise” (random results) produced by benchmarks/trials

• **Key Guidance**:
  • Best practices for the design, execute and evaluation of trial/benchmarks
  • Examples of “pitfalls to avoid”
Getting Meaningful Information from a Trial: An Experiment
(Designed and Executed by Craig Collier DNV GL)

Let’s use real data to simulate a wind forecast trial (and proceeding 12-month performance period)

Experimental Design

• Three (3) independent model solutions to represent 3 independent, unique forecast vendors

• Models have no prior training data, and the same real-time data provided to each at exactly the same time every day during the trial period

• Trial period runs for one (1) month, randomly chosen.

• Forecasts will be provided for 3 actual sites, each separated by ~ 2300 km

• No expectation to predict outages, availability, or curtailments.

• Budget allows for only one vendor to get the contract, based on DA performance.
## Trial Month

### Vendor Performance Relative to Average

#### Day-Ahead Results

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<tr>
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<th>V1</th>
<th>V2</th>
<th>V3</th>
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<tbody>
<tr>
<td><strong>rMAPE</strong></td>
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<tr>
<td>Site 1</td>
<td>-3%</td>
<td>-2%</td>
<td>+6%</td>
</tr>
<tr>
<td>Site 2</td>
<td>-1%</td>
<td>0%</td>
<td>-1%</td>
</tr>
<tr>
<td>Site 3</td>
<td>0%</td>
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<td>Site 1</td>
<td>0.7</td>
<td>0.6</td>
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<tr>
<td>Site 2</td>
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<td>0.5</td>
</tr>
<tr>
<td>Site 3</td>
<td>0.6</td>
<td>0.5</td>
<td>0.7</td>
</tr>
</tbody>
</table>

While Vendors 1 & 3 are nearly a toss-up, Vendor 3 disappoints on site 1 more than Vendor 1 disappoints on site 3.
Reliability: Is Performance Sustained?

Site 1: Best forecasts by rMAPE

Site 2: Best forecasts by rMAPE

Site 3: Best forecasts by rMAPE

12 MONTH CONTRACT TERM

Vendor 1  Vendor 2  Vendor 3
Does Timing Matter?

• In trial month, Vendor 1 exhibited lowest error and greatest range, **BUT**…
  • Delayed 1-2 months: Vendor 3 scores highest for MAPE & Range
  • Delayed 9 months: Vendor 2 scores highest for MAPE & Range

• For this portfolio, the trial selection **repeatable only 40% of the time**

• For a single site, the trial selection repeatable 75-80% of the time

• In a 30-day trial, **reliability of the solution over a 12-month term is difficult to measure**

• Selecting more than 1 vendor increases the probability of reliability
Effect of Trial Duration

Using same vendor for all

Using same vendor for one

Site 1

Vendor 1 Vendor 2 Vendor 3

Site 2

Vendor 1 Vendor 2 Vendor 3

Site 3

Vendor 1 Vendor 2 Vendor 3

Chronological Month Pairing

Month 0-1 Month 1-2 Month 2-3 Month 3-4 Month 4-5 Month 5-6 Month 6-7 Month 7-8 Month 8-9 Month 9-10 Month 10-11 Month 11-12
Sensitivity to Trial Duration

• An extra 30 days changes the outcome for a single portfolio selection. **Vendor 3** would have been the likely selection.

• For this portfolio, the trial selection was repeatable 92% of the time with an extra 30 days.

• For the individual site, the trial selection was repeatable at least 75% of the time.

• Solution **reliability is enhanced by doubling duration** but is **not guaranteed**.

• Need to strongly consider the **costs** for doubling duration.

• What are the accuracy-related costs for settling on one vendor vs. the costs of integrating two?
Conclusions

• A trial is a *sample, limited and constraint*, primarily focused on a single metric (and cost)

• Probability of solution reliability can be enhanced but never guaranteed.

• Diversity of solution mitigates the uncertainty of solution reliability when integration vs. opportunity costs is balanced

• Operational and custom support are not measured in trial – but should be part of the selection process
Part 2: Design and Execution of Forecasting Benchmarks and Trials: Summary

“IEA T36 RP... 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
Where to Get the Details

**Task 36 - RP Publications**

Best Practices Documents
ESIG Forecasting Workshops: 2017/2018
- 2 Sessions
- 10 Presentations

Wind Integration Workshops
- 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](http://ieawindforecasting.dk)

→ Research Gate Project

→ IEA Wind Forecasting YouTube Channel:
  - [www.youtube.com/channel/UCsP1rLoutSXP0ECZKicczXg](http://www.youtube.com/channel/UCsP1rLoutSXP0ECZKicczXg)

**Other Task 36 Activities at ICEM**

Posters
- IEA Wind Task 36 Forecasting – Phase II; Giebel et al
- RP – Part 3: Evaluation of Forecasts and Forecast Solutions; Browell et al

Workshops
- IEA Task 36 Workshop: Wed 1615-1800, Building 101, Room S1
WP 2 – RP 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
    ○ 2 “feedback” workshops at opportunistic geographically diverse venues
    ○ feedback is solicited via presentations at stakeholder gatherings, webinars, etc.
    ○ feedback from IEA Task 36 web site and community feedback
  ✓ Integrating items identified in feedback for updated version of RP
    ○ 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
THANK YOU FOR YOUR ATTENTION

Contact the workpackage leaders
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Project webpage
http://www.ieawindforecasting.dk/

Publications:
http://www.ieawindforecasting.dk/publications
Additional detailed information
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 – Work Package (WP) 2 to formulate a set of documents that specify the “best practices” for selecting a wind forecasting solution.
More detailed conclusions on trial example

• Forecast trials are not answering the questions for which users need answers due to the inherent constraints of trial design. A trial is a sample, primarily focused on a single metric (and cost).

• Probability of solution reliability can be enhanced but never guaranteed. For a total portfolio / single vendor approach, probability is enhanced by trial duration, but for single site/single vendor, 30 days likely sufficient.

• Diversity of solution mitigates the uncertainty of solution reliability – but user-integration cost should be balanced against opportunity cost of single provider.

• Operational and custom support are not measured in trial – but probabilities of occurrence in operation are not zero and should never be considered zero.