Task 36

19th Wind Integration Workshop
Virtual Session 6A
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Practical Application Examples from the Recommended Practices for Forecast Solution Selection

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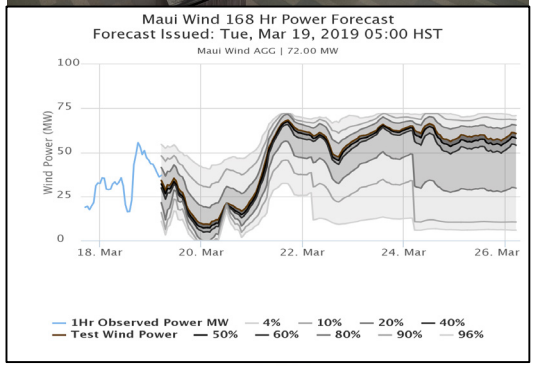
Overview

1. Background: The Problem and an Approach for a Solution
2. Overview: IEA Recommended Practices (RP) for Forecasting Solution Selection
3. Some Key Points from the RP Documents (focus on forecast evaluation process)
4. Where to Get the More Information

The Problem

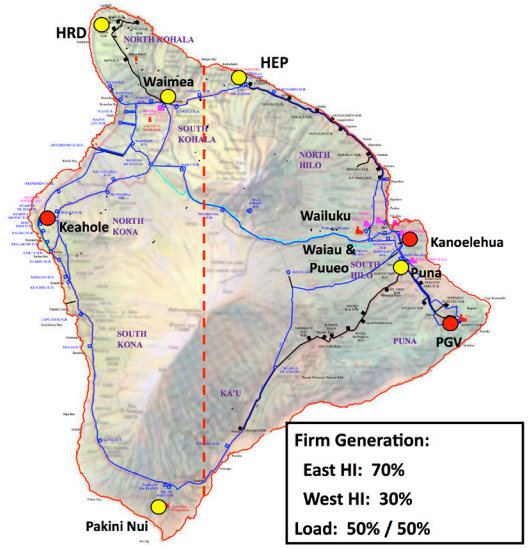
- **Documented Benefits:**
  - lower costs of variable generation integration (system)
  - high system reliability

- **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



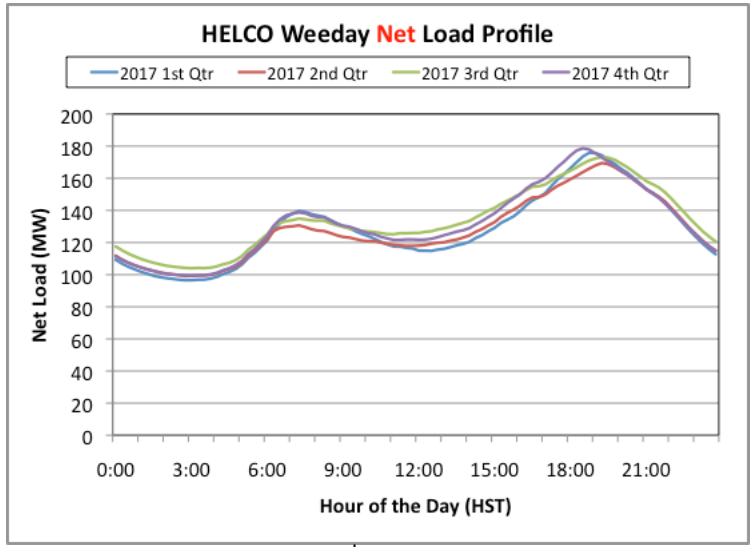
Misaligned Forecast Objectives: An Example from the "Big Island" of Hawaii

SYSTEM OVERVIEW



Renewable Resource	Capacity
Geothermal (1 facility)	38 MW
Hydro (3 facilities)	16.2 MW
Wind (2 facilities)	31 MW
Solar (BTM Distributed)	90 MW

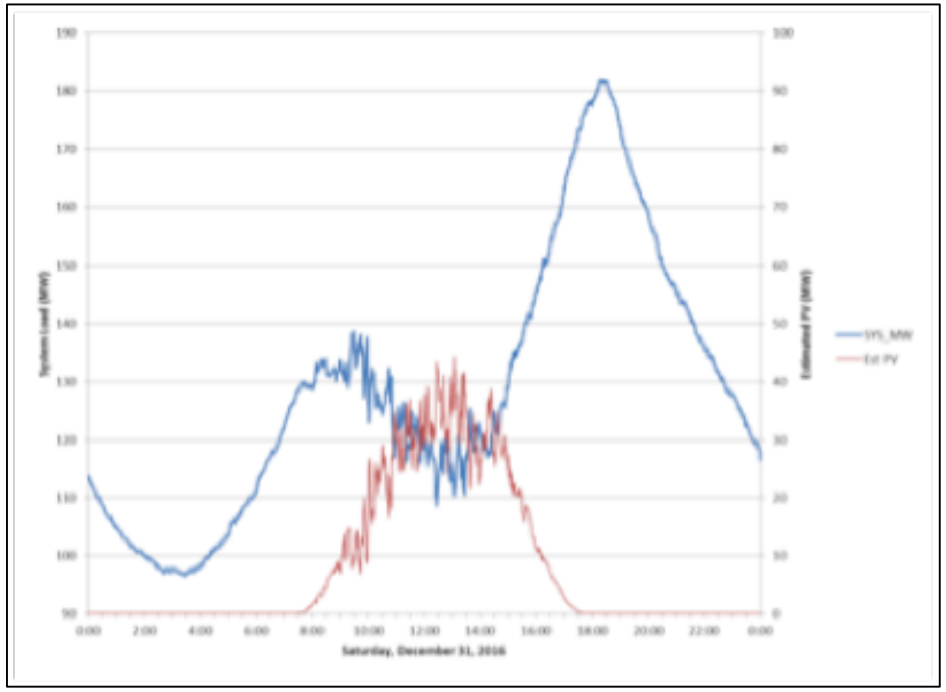
- **Weekday Net load: 2 daily peaks**
  - Morning (~0800): 130-140 MW
    - Morning rise in gross load followed by morning rise in PV production
  - Evening (~1800): 170-180 MW
- **Weekday Net load: 2 daily minima**
  - Nighttime (~0300): 95-105 MW
  - Daytime (~1200): 115-125 MW
    - Associated with peak of distributed PV



Misaligned Forecast Objectives: An Example from the "Big Island" of Hawaii

WHAT THEY REQUESTED VS. WHAT THEY NEED

ISSUE: large mid-day net load variability driven by distributed PV variability



- REQUESTED Forecast:
- **Multi-method forecast** (NWP, statistical, satellite cloud advection)
- Two Forecast Time Frames
  - **Intra-day**
    - 0-6 hrs ahead in 15-min time steps
    - 15-min updates
  - **Multiple Day**
    - 0-7 days ahead in 1-hr time steps
    - 1 hr updates

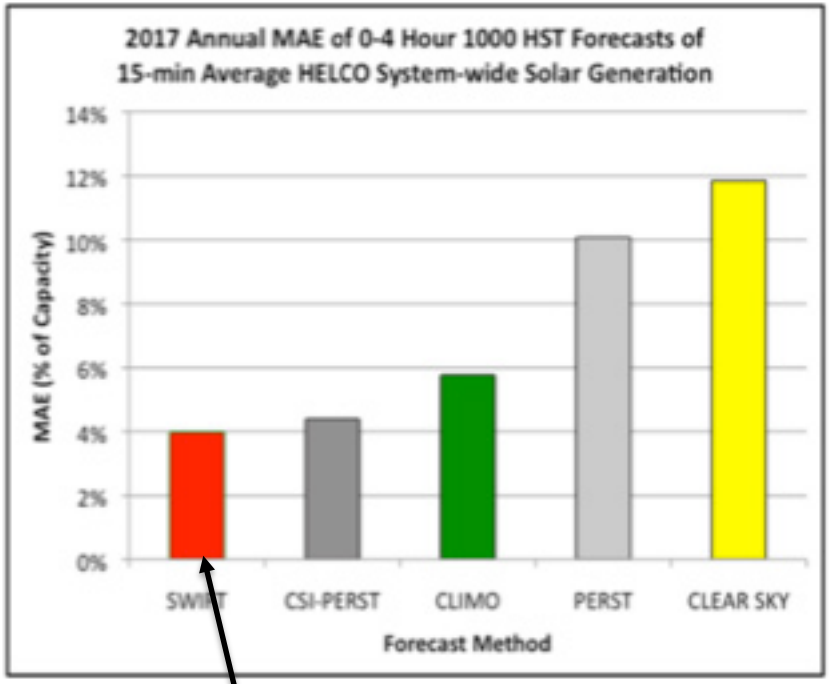
NEED: Mid-day (1000-1400) range of variability forecast (generation envelope)

PROVIDED: Forecasts that minimize the squared error for every 15-min interval

Misaligned Forecast Objectives: An Example from the "Big Island" of Hawaii

THE RESULT

Mean Absolute Error (or RMSE) looks good!

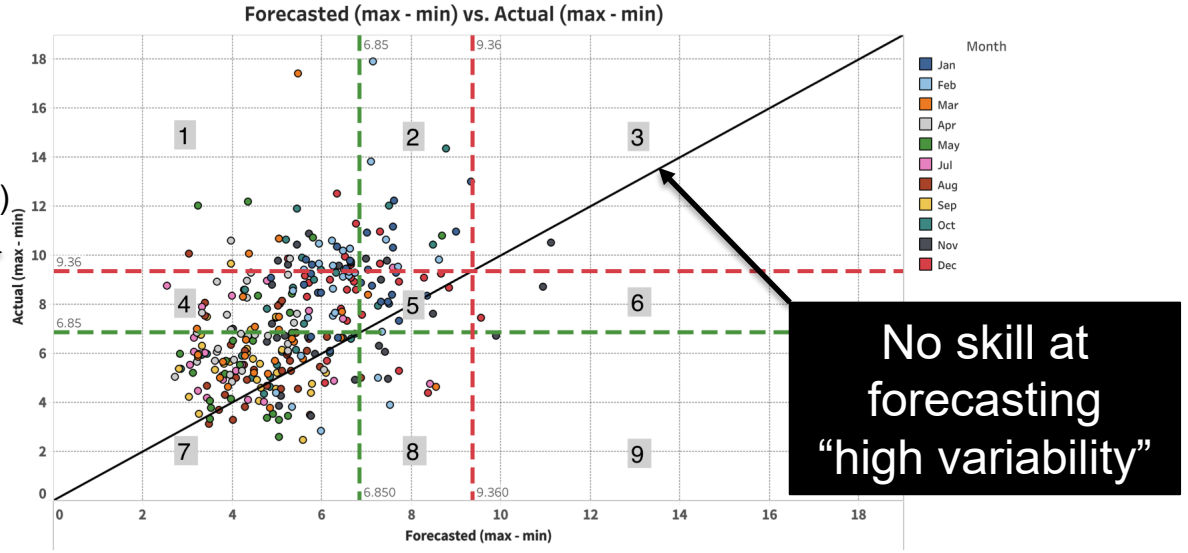


MAE for 0-4 hr forecasts for mid-day period is 4 % of Capacity and 15% lower than "smart persistence"

Same period (2017)

Prediction of Variability is Inadequate for Decision-Making on Mid-day Reserves

Actual vs Forecasted Mid-day Range of 15-min Solar Gen (MW)



No skill at forecasting "high variability"

Count		Forecasted			
Observed	Category	Low	Moderate	High	Obs %
	High	40	21	1	20.0%
	Moderate	72	20	2	30.3%
	Low	143	10	1	49.7%
	Forecast %	82.3%	16.5%	1.3%	100.0%

To Address this Issue: 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 renewable energy forecasting solution…….

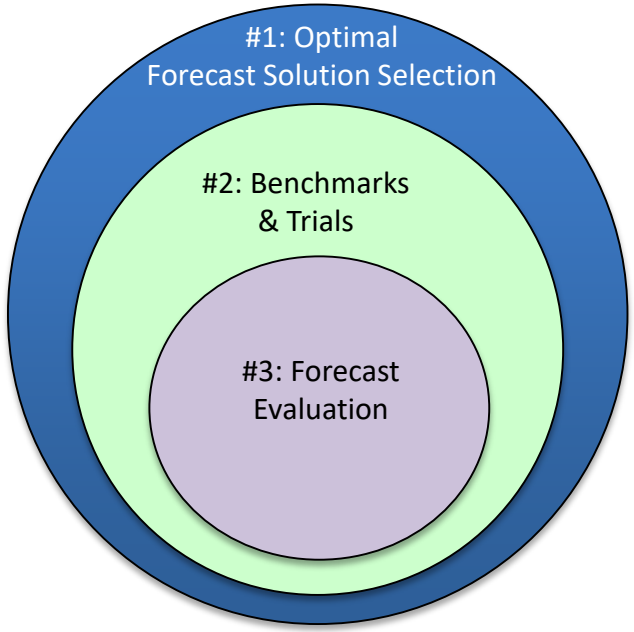
IEA-WIND Task 36: RECOMMENDED PRACTICES for the Selection of Renewable Energy Forecasting Solutions

Target: Guidance for the optimal selection of renewable energy forecasting solutions for a wide range of user types and applications

Phase 1 (2016-2018) Result: Set of 3 documents specifying IEA Wind Task 36 Recommended Practices for:

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

Current Status: Version 1 accepted by IEA Wind ExCo & published

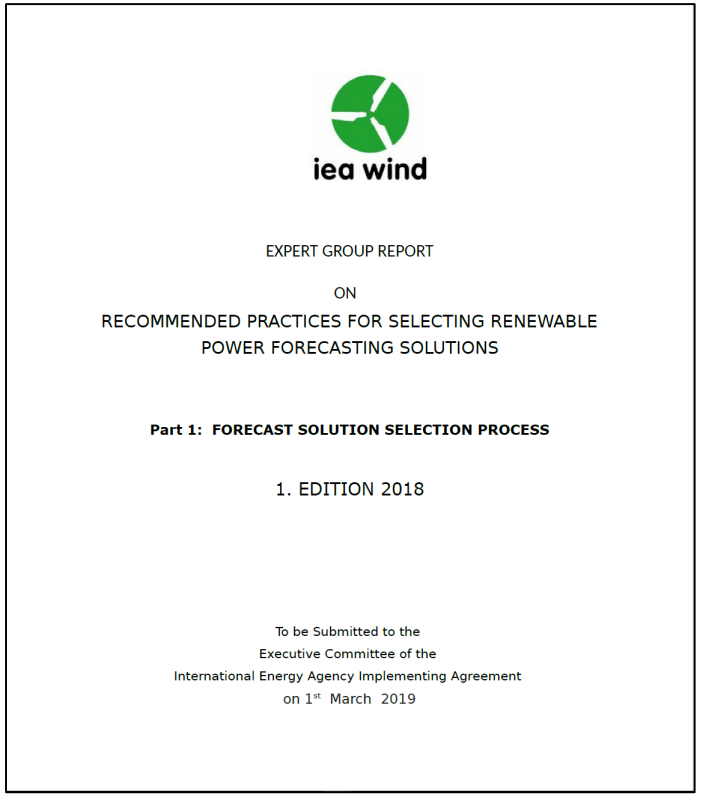


Download:

http://www.ieawindforecasting.dk/Publications/RecommendedPractice

Part 1: Selection of an Optimal Forecast Solution

- Presents an overview of the factors that should be considered in the forecast solution selection process
- Discusses the issues associated with each selection factor
- Provides a “decision support tool” to assist users in the design and execution of a solution selection process
- Provides practical lists and FAQ’s for formulation of the RFI/RFP tendering process



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EXPERT GROUP REPORT

ON

RECOMMENDED PRACTICES FOR SELECTING RENEWABLE POWER FORECASTING SOLUTIONS

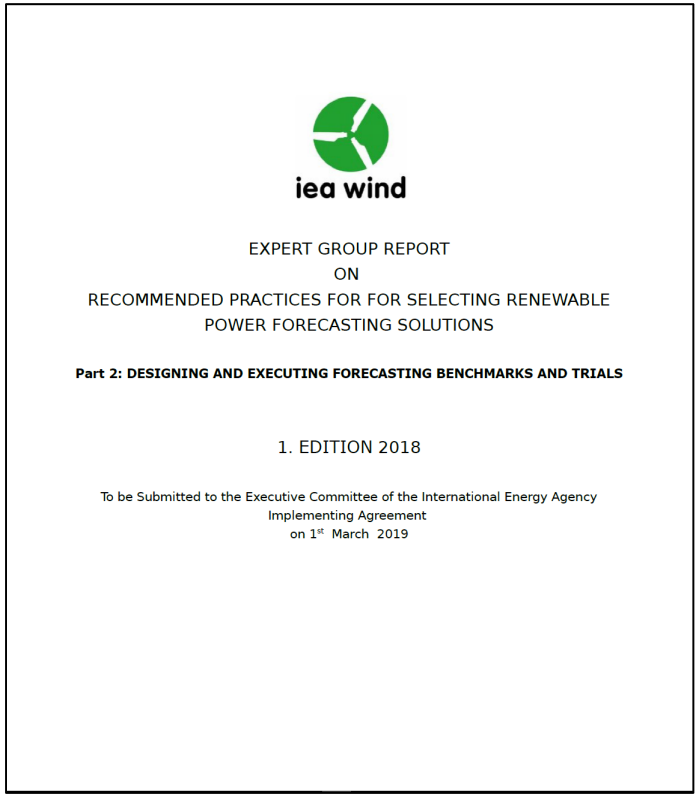
Part 1: FORECAST SOLUTION SELECTION PROCESS

1. EDITION 2018

To be Submitted to the
Executive Committee of the
International Energy Agency Implementing Agreement
on 1st March 2019

Part 2: Conducting a Benchmark or Trial

- Describes the three phases of a forecasting benchmark or trial
  - Planning
  - Execution
  - Analysis
- Discusses the factors and issues that should be considered in each phase
- Provides a list of pitfalls to avoid



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EXPERT GROUP REPORT
ON
RECOMMENDED PRACTICES FOR FOR SELECTING RENEWABLE POWER FORECASTING SOLUTIONS

Part 2: DESIGNING AND EXECUTING FORECASTING BENCHMARKS AND TRIALS

1. EDITION 2018

To be Submitted to the Executive Committee of the International Energy Agency Implementing Agreement
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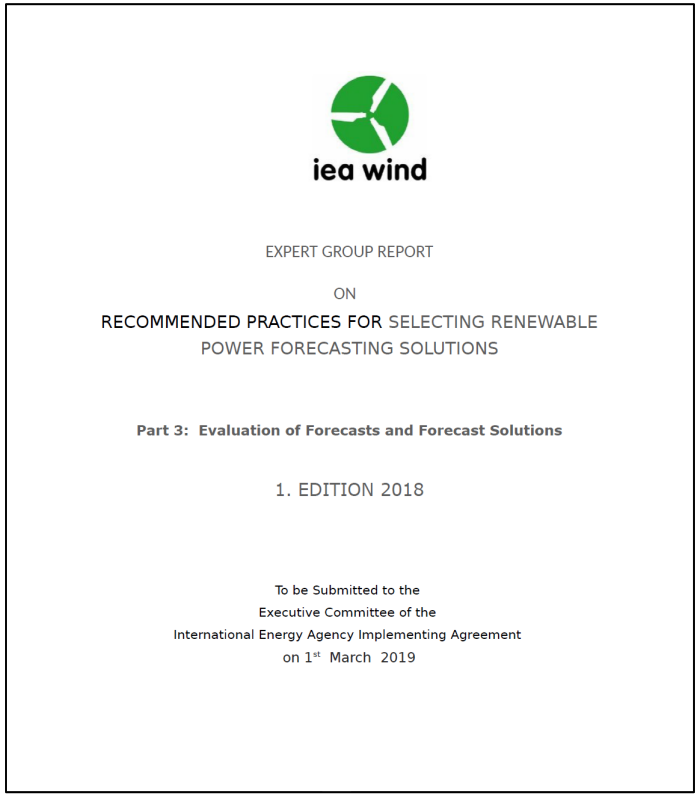
Part 3: Evaluation

- Describes three key attributes of an evaluation process
  - Representativeness
  - Significance
  - Relevance
- Discusses the factors and issues that should be considered for each attribute
- Provides recommendations for conducting a high quality and meaningful evaluation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EXPERT GROUP REPORT

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RECOMMENDED PRACTICES FOR SELECTING RENEWABLE POWER FORECASTING SOLUTIONS

Part 3: Evaluation of Forecasts and Forecast Solutions

1. EDITION 2018

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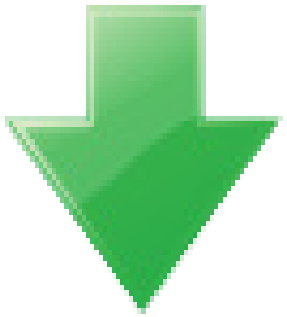
RP-related Plans for Phase 2: 2019-2021

- *We obtained feedback on the usefulness of the RP from the community via workshops & personal feedback*
  - *Task 36 Open Space workshops held at WIW-2019, ICEM-2019, Task 36 Meeting in Glasgow 2020*

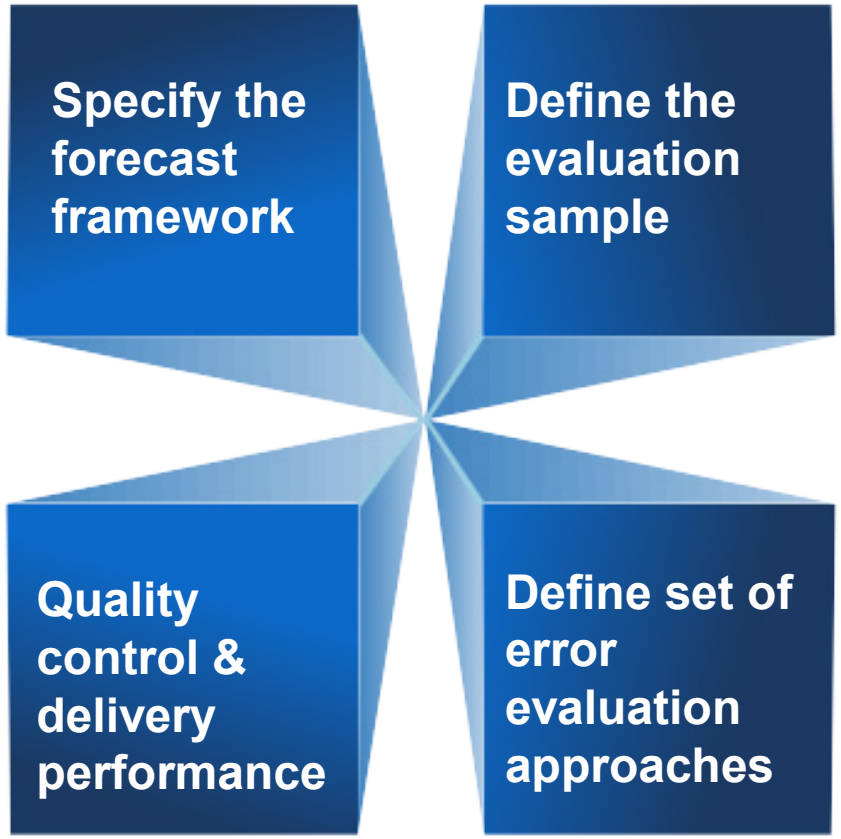


- *Result: Planned Expansion of the Scope of the RP documents*
  - *Include material on probabilistic forecast use and evaluation*
  - *Include material on solar forecasting*
  - *Better explanations and **examples** of solutions and the evaluation process*

Establishing an Evaluation Framework:
Key Components

(1) the forecast application
(2) the key forecast time frames
(3) a ranking of the importance of forecast performance attributes

(1) Strategy to deal with missing or erroneous data & forecasts
(2) Specify evaluation criteria on delivery performance

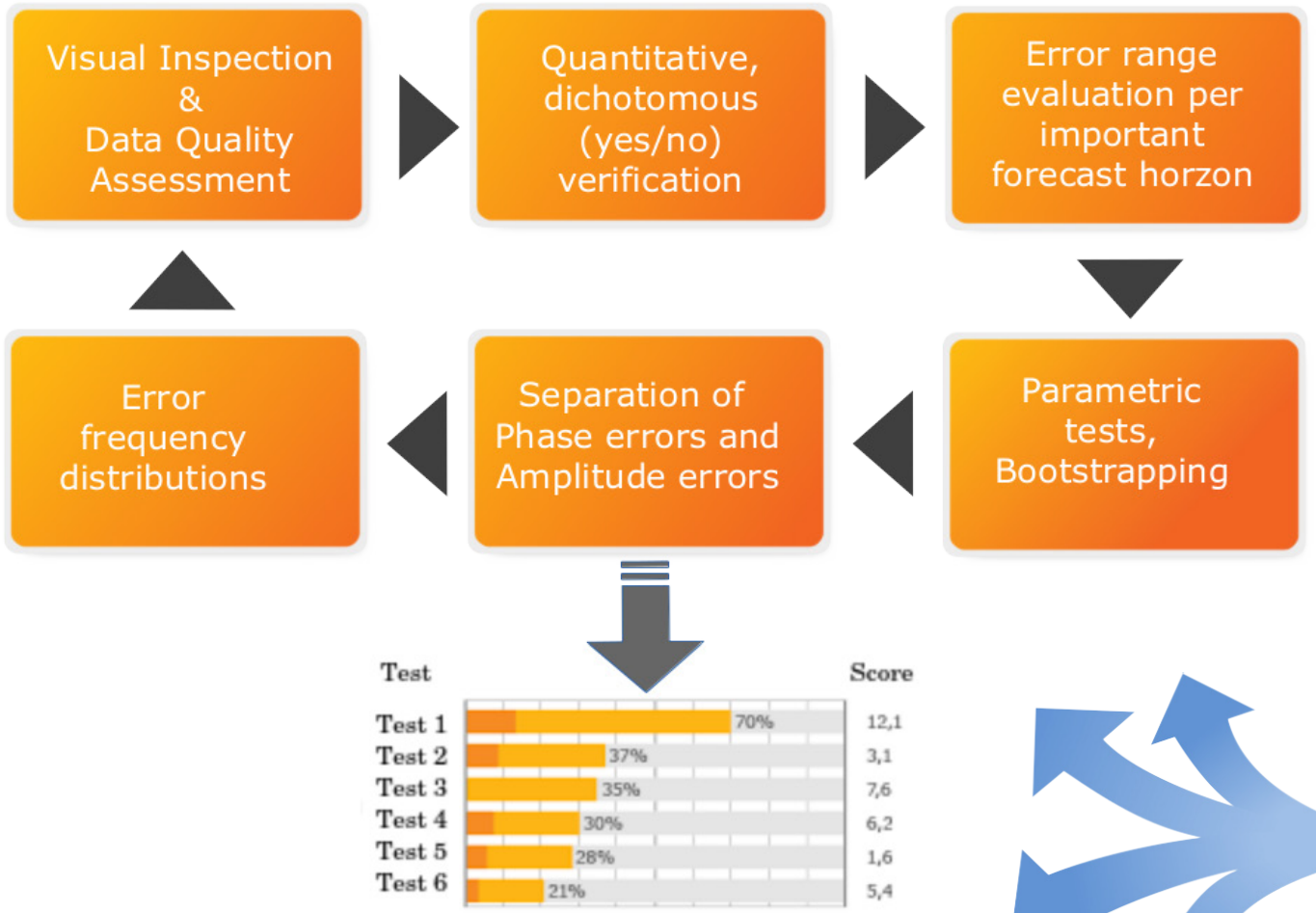


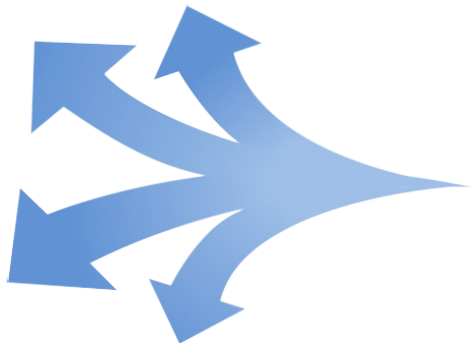
(1) Choose a time period likely to produce a representative sample of relevant weather patterns
(2) Choose a sufficient and well-defined evaluation time frame (e.g. 3 months, 1 year, ...)

(1) visual inspection
(2) use of more specific metrics: SDE, SDBIAS, StDev, VAR, CORR
(3) use of histogram or box plot for evaluation of outliers
(4) use of contingency tables for specific event analysis
(5) use of improvement scores relative to a relevant reference forecast

Establishing an Evaluation Framework:
Creating a Composite Evaluation Score

Error Evaluation Approaches





Establish a scoring system to create a composite of the different evaluation approaches

Examples of Evaluation Frameworks: Customized Sets of Metrics

Forecast Application	Target	Metric
Forecast to system operator for grid operation	Penalty for squared errors in the time frame 12-24h > ±20% of installed capacity	RMSE on time frame 12-24h
	Size of forecast error important due to reserve restrictions (1) 0-5% MAE/RMSE (2) 6-10% MAE/RMSE (3) 11-15% MAE/RMSE (4) 16-25% MAE/RMSE (5) 25-50% MAE/RMSE (6) 51-100% MAE/RMSE	MAE/RMSE 1 (5% penalty) MAE/RMSE 2 (5% penalty) MAE/RMSE 3 (10% penalty) MAE/RMSE 4 (20% penalty) MAE/RMSE 5 (20% penalty) MAE/RMSE 6 (40% penalty)
	Size of generation ramps due to reserve restrictions	Dichotomous verification: contingency table, critical success index (CSI), split up of • RMSE, SDBIAS, BIAS, StDEV, CORRELATION (split amplitude & phase!)
	High-speed shutdown prediction error due to costs associated with curtailment	Dichotomous verification: contingency table with associated scores e.g.: • Bias score, Probability of detection (POD), Probability of false detection (POFD), Perfect score, Success ratio, etc.

Examples of Evaluation Frameworks:
Customized Sets of Metrics

Forecast Application	Target	Metric
Forecast to power exchange for day-ahead market (bid)	Absolute error of forecast versus production in the time frame 24-48h	MAE
	Distinguish errors at different times due to pricing of balancing power (1) 6-10h (2) 12-14h (3) 17-19h	MAE 1 (45% penalty) MAE 2 (20% penalty) MAE 3 (35% penalty)
Forecast to power exchange for intra-day market (bid)	Absolute error for short-term forecasts 1-3h	BIAS, MAE at 1-3h horizon

Where to Get More Information

IEA Wind Task 36 Session Topic 4: Request for Feedback on Version 1 of the Recommended Practices for Forecast Solution Selection

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RP-related Publications

RP Documents: http://www.ieawindforecasting.dk/Publications/RecommendedPractice

2019 Wind Integration Workshop (Dublin)
Paper in Proceedings
Presentation

2019 (Denver) & 2020 ESIG Workshops
Presentations

YouTube Channel
Webinar on Recommended Practices

Task 36 Information

→ **Task 36 site**
- ieawindforecasting.dk → Publications

→ **Research Gate Project**
- www.researchgate.net/project/IEA-Wind-Task-36-Wind-Power-Forecasting

→ **IEA Wind Forecasting YouTube Channel:**
- www.youtube.com/channel/UCsP1rLoutSXP0ECZKicczXg