Database Technology Group

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TECHNISCHE UNIVERSITÄT DRESDEN

EnDM 2014

ECAST: A Benchmark Framework for Renewable Energy Forecasting Systems

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ReEF Renewable Energy Forecasting

Gefördert aus Mitteln der Europäischen Union

Europa fördert Sachsen. EFRE Europäischer Fonds für regionale Entwicklung

> Motivation

Renewable energy sources characteristics like …

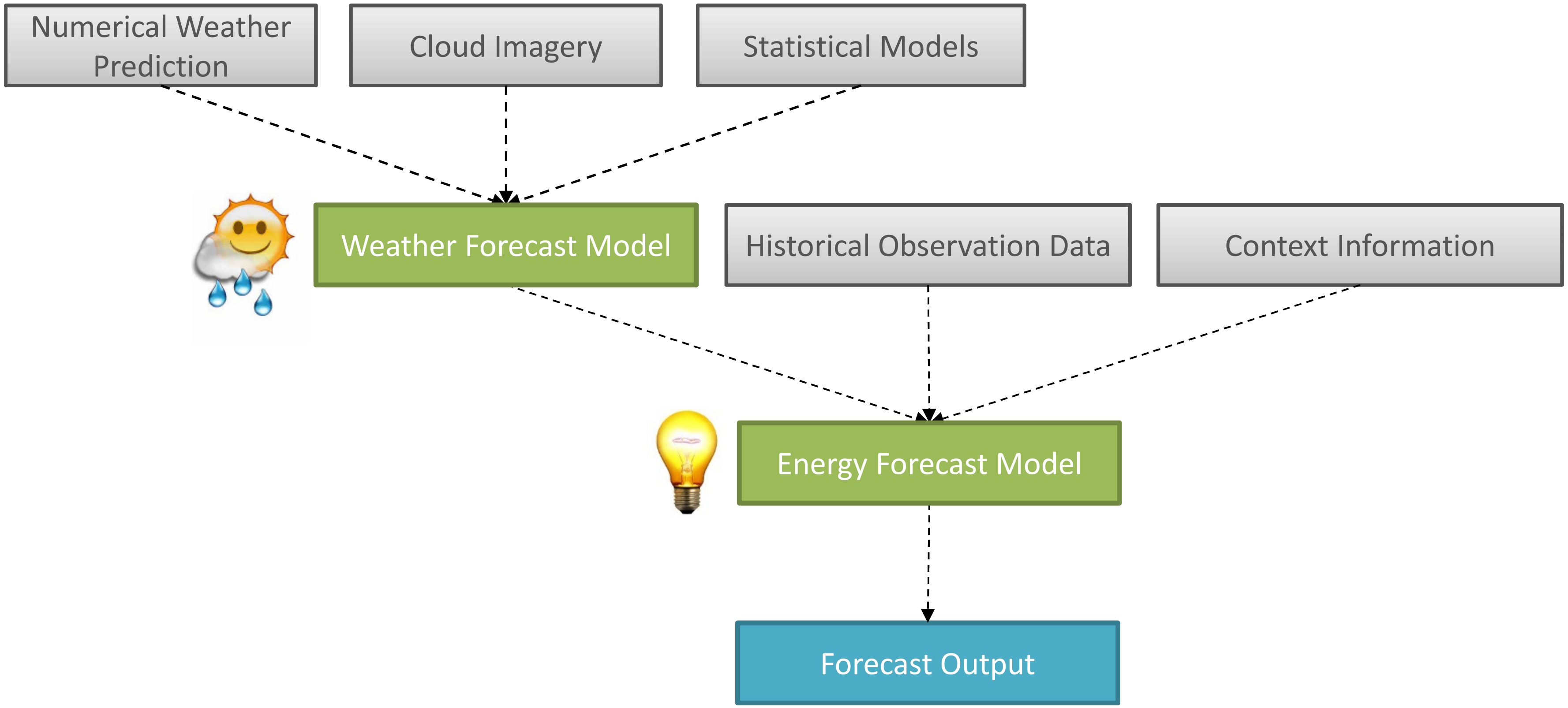
- Increasing share on total energy production
- Fluctuating output
- Strongly depending on exogenous influences
- Decentralized allocation

… lead to challenges because …

- Network stability requires foresightful balancing of demand and supply
- Surplus electricity cannot be stored efficiently
- Conventional energy production becomes less attractive
- Little context information is available

Reliable energy forecasts are needed!

> Typical Energy Forecasting Approach



> Why do we need Benchmarks?

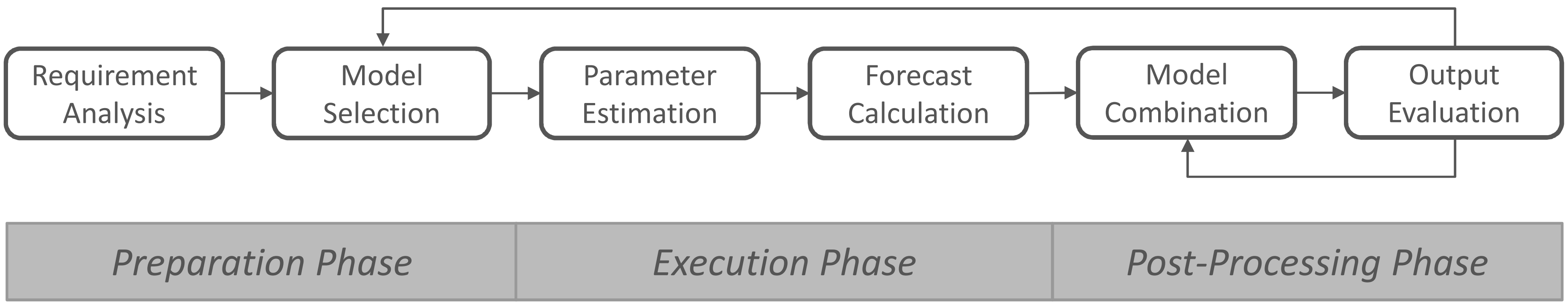
The problems:

- Energy forecasting is still demand-focused
- Mismatch between scientific models and implementations in the energy domain
- Great varity of proposed solutions
- No all-embracing benchmarks available
- Domination of time-intensive Trial-and-Error approaches

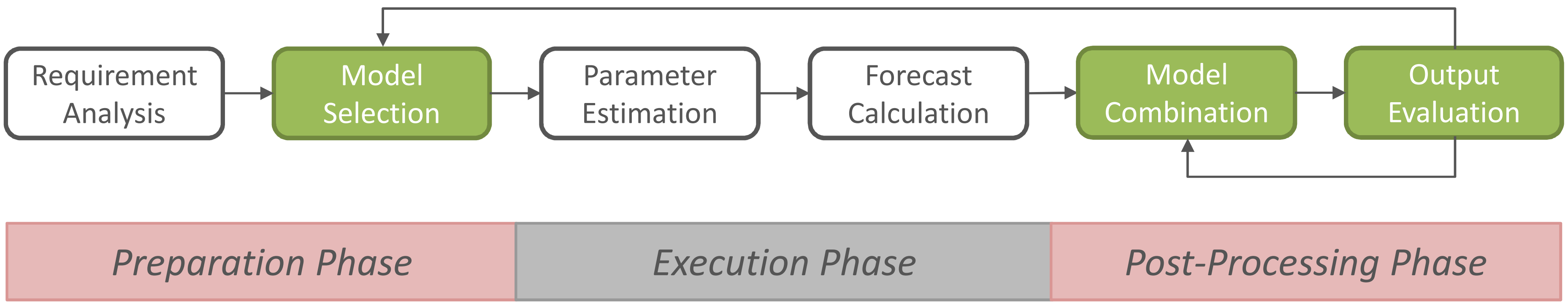
Our solution:

- **System integration approach!**

> Forecasting Process



> Forecasting Process



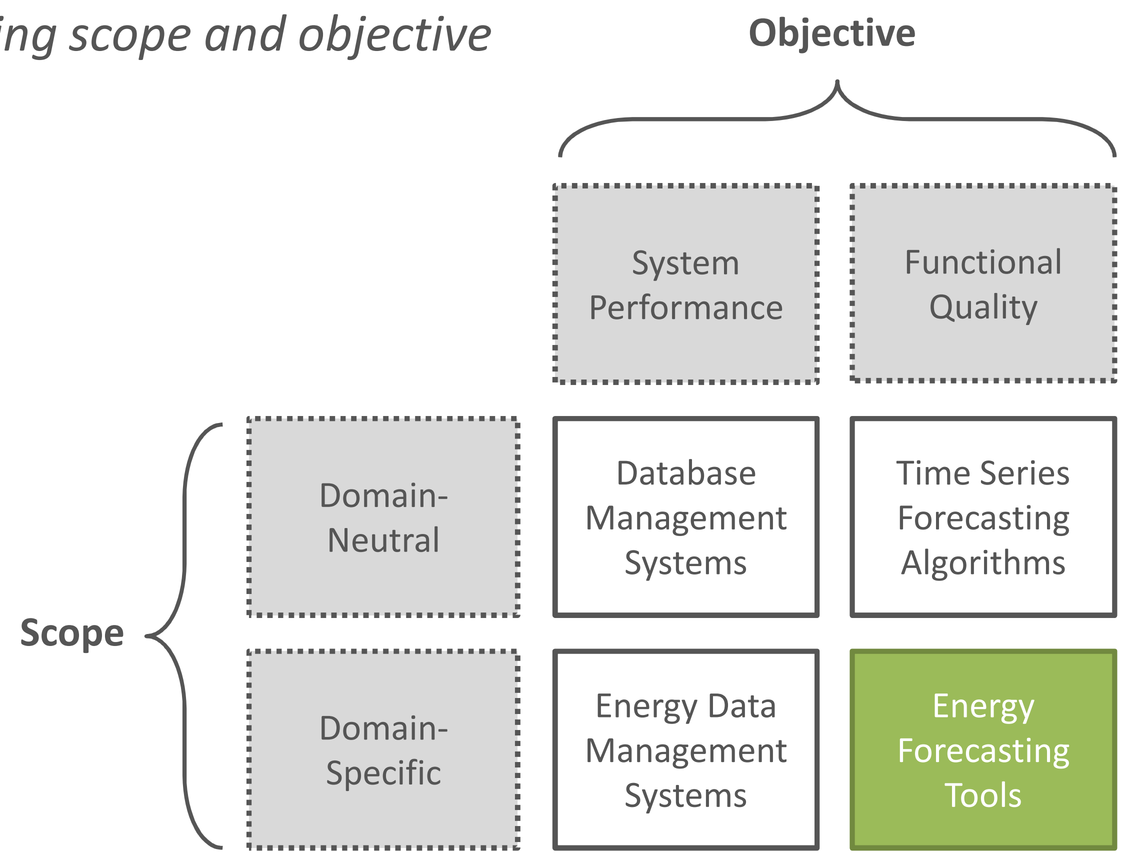
What do we want to do:

- Systematically support Model Selection, Model Combination and Output Evaluation

> Benchmark Design Methodology

What do we want to know:

- Defining scope and objective



> Benchmark Requirements

- **Conditions:** Define experimental setup (e.g. forecasting horizon, time series periods, validation methods, ...) and eliminate bias
- **Data:** Simulate coherent business context using appropiate use cases based on real-world, synthetic or analogous data sets
- **Transparency:** Disclose implementation details (if possible) and allow for replication tests
- **Result Evaluation:** Choose a simple, easy to explain and decision-related evaluation metric
- **Limitations:** Restricted to forecasting accuracy. Excluding usability, result presentation and range of functions -> no cost-benefit analysis

[J. Armstrong. Evaluating Forecasting Methods. In: *Principles of Forecasting,* 2001]

Principal Components

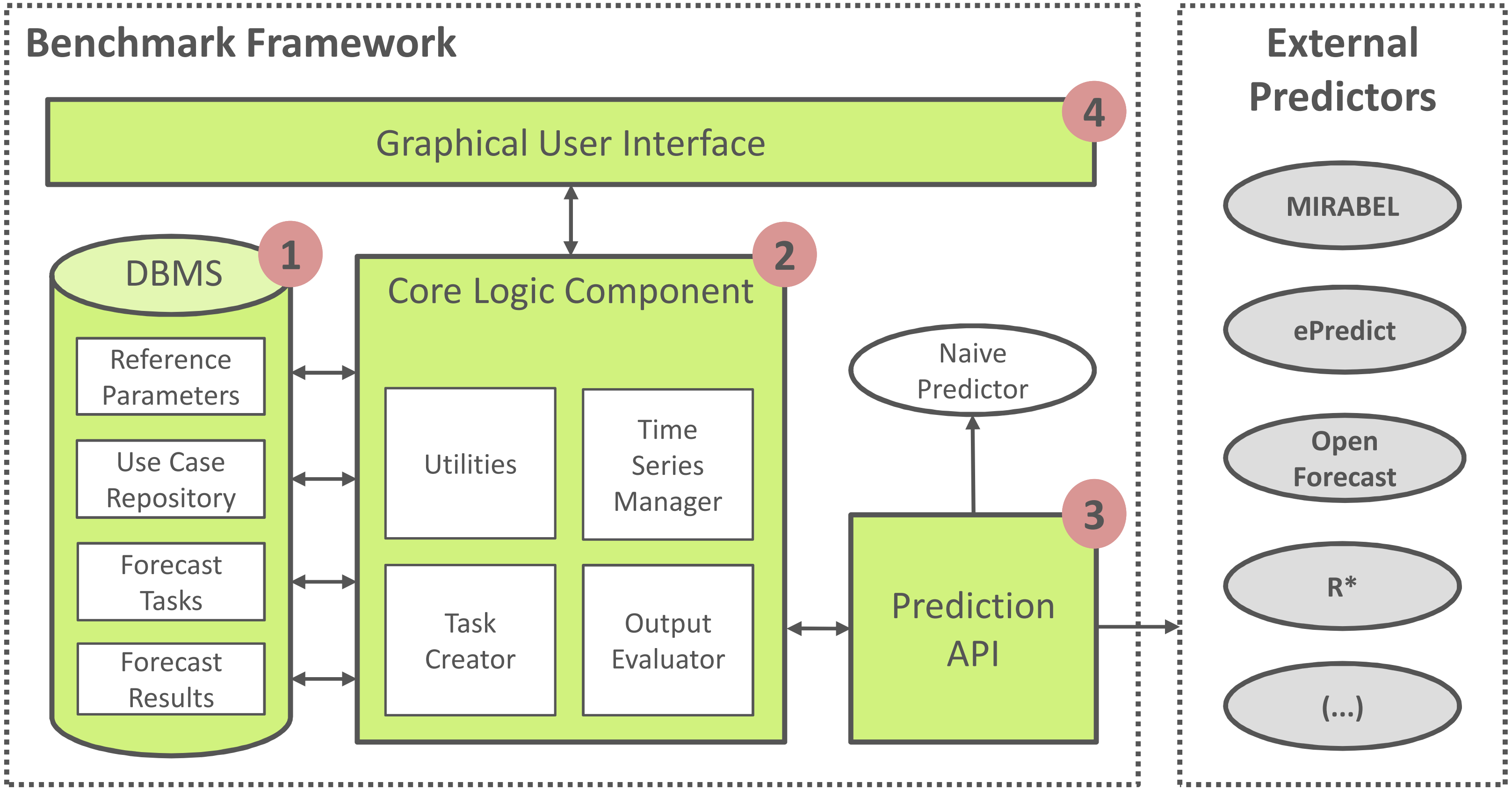
1 **DMBS:** Storage unit for reference parameters, source time series, forecasting tasks and results using relational data structures

2 **Core Logic Component:** System functions such as time series management, task creation and execution and output evaluation

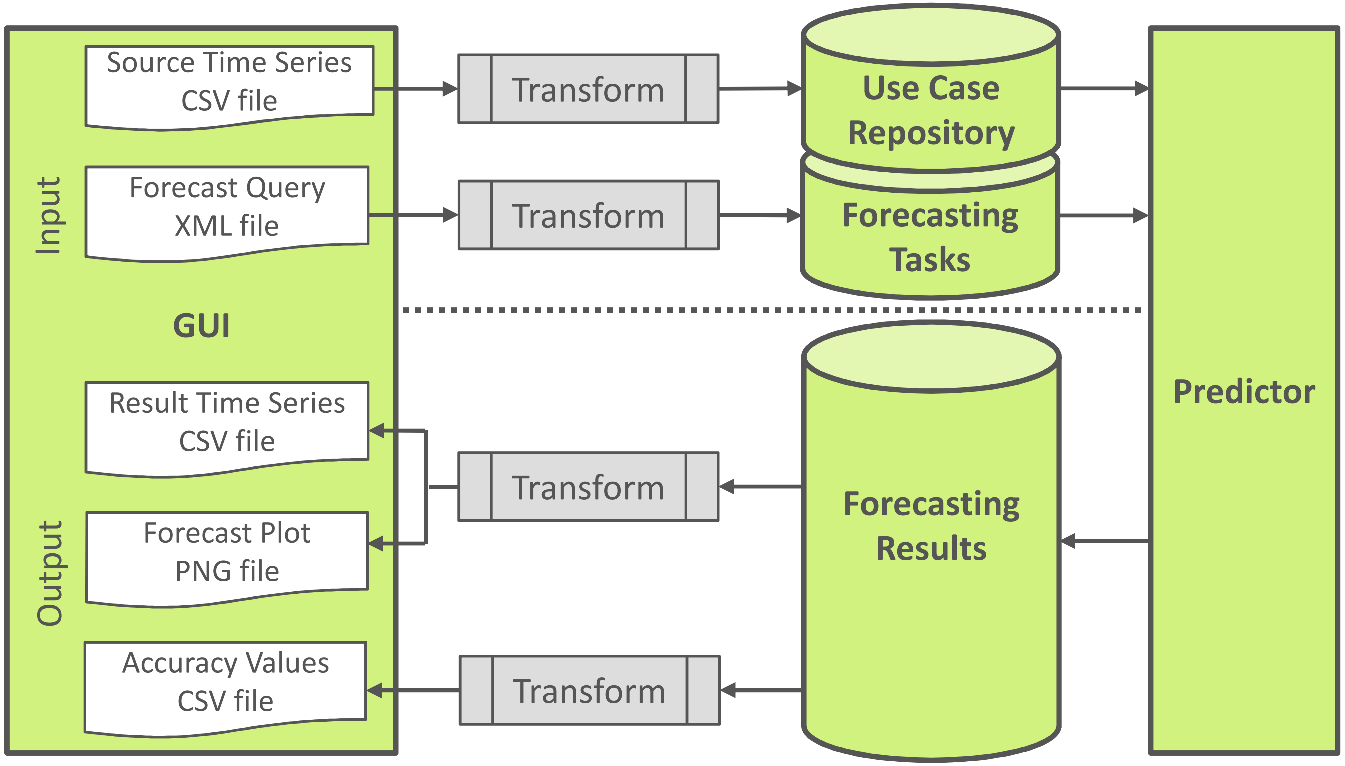
3 **Prediction API:** Generic connector to internal (naive) and external predictors, used for method calling and output retrieval

4 **Graphical User Interface:** Supports experimental setup procedure and coherent result presentation

System architecture



Logical data flows



> Evaluated Predictors

1. Naive
- Internal reference model
- Diurnal persistence

2. Mirabel
- PCA and multiple linear regression
- Academic prototyp

3. ePredict
- Multiple non-linear regression (MARS)
- Commercial library

4. OpenForecast
- Multiple linear regression
- Domain-neutral OpenSource library

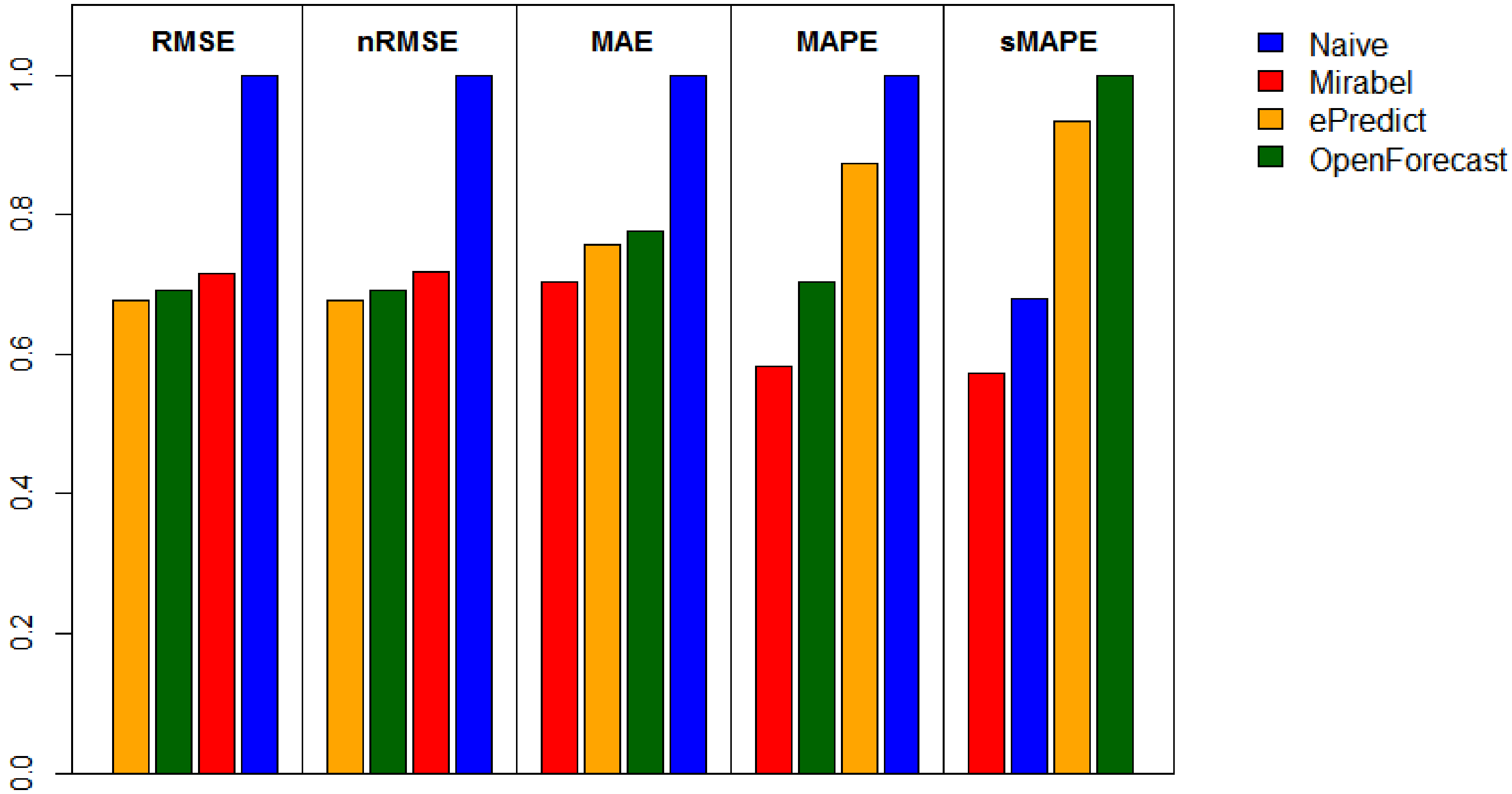
> Experimental Settings

	Use Case 1	Use Case 2
Energy Type	PV	Wind
Location	Central Germany	Unknown
Available History	12 months	18 months
Resolution	15min	1h
Available Influences	Global Irradiance Temperature Wind Speed	Wind Speed
Normalized	No	Yes
Source	Local DSO	GEFCom

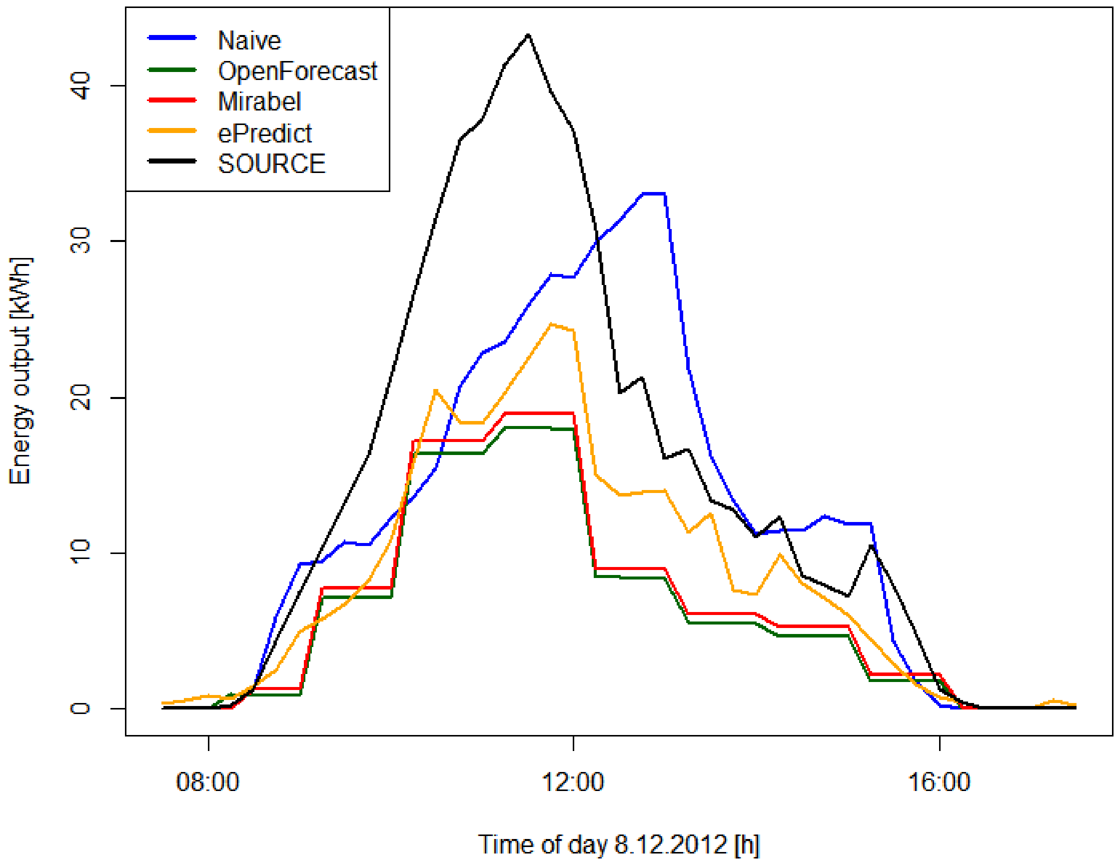
Forecast Horizon	24h	24h
Training Period	11 months	17 months
Forecast Period	1 month	1 month
Origin	Moving	Moving

> Output Evaluation

And the winner is .... ??



Comparision of typical dayplots



> Summary

- Forecasting principles are considered in ECAST system architecture
- Automated task creation and execution allow for efficient, systematic and time independent forecasting benchmarks
- Persisting raw data, settings and results guarantees successful replication tests
- Energy-specific forecasting tools really offer additional value by providing superior results in terms of accuracy
- Selection of evaluation criteria is crucial for ranking

> What next?

- **Repository extension:** Offer more use cases
- **Benchmark scope:** Integration of methods for physical models and machine learning methods in prediction API
- **Adding intelligence**: Derive systematical recommendations for model selection and -combination criteria from historical forecasting results using e.g. Case-Based Reasoning
- **Standardization:** Propose industry standard for output evaluation criteria tailored to the decisions to be derived from results
- **Transparency:** Provide public access to data and results via web interface

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