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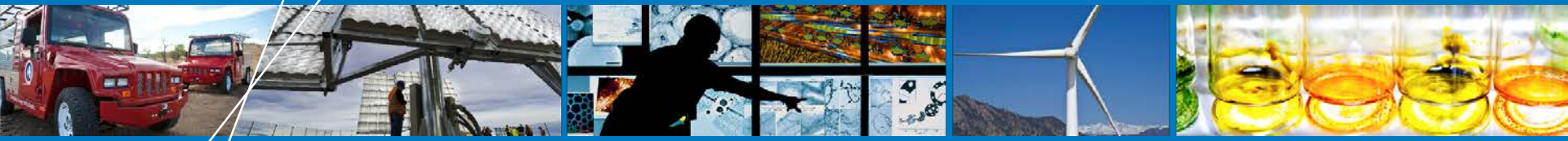
NATIONAL RENEWABLE ENERGY LABORATORY

IEC 61400-15 WG Update



Assessment of Wind Resource, Energy Yield, and Site Suitability Input Conditions for Wind Power Plants

Jason Fields, Secretary

IEC 61400-15

- **CD Expected to be issued late 2018/early 2019**
- **Intended to compliment other IEC standards**
  - 61400-1 (Design)
  - 61400-12 (Power Performance Testing)
  - 61400-50 (Measurement standards)
- **Committee has 55 members (2nd largest wind standard)**
- **Next Meeting: Tokyo, Japan April 2018**

❖ Broad Engagement

- OEM's
- Owner/Operators
- Consultancies
- Research Institutes

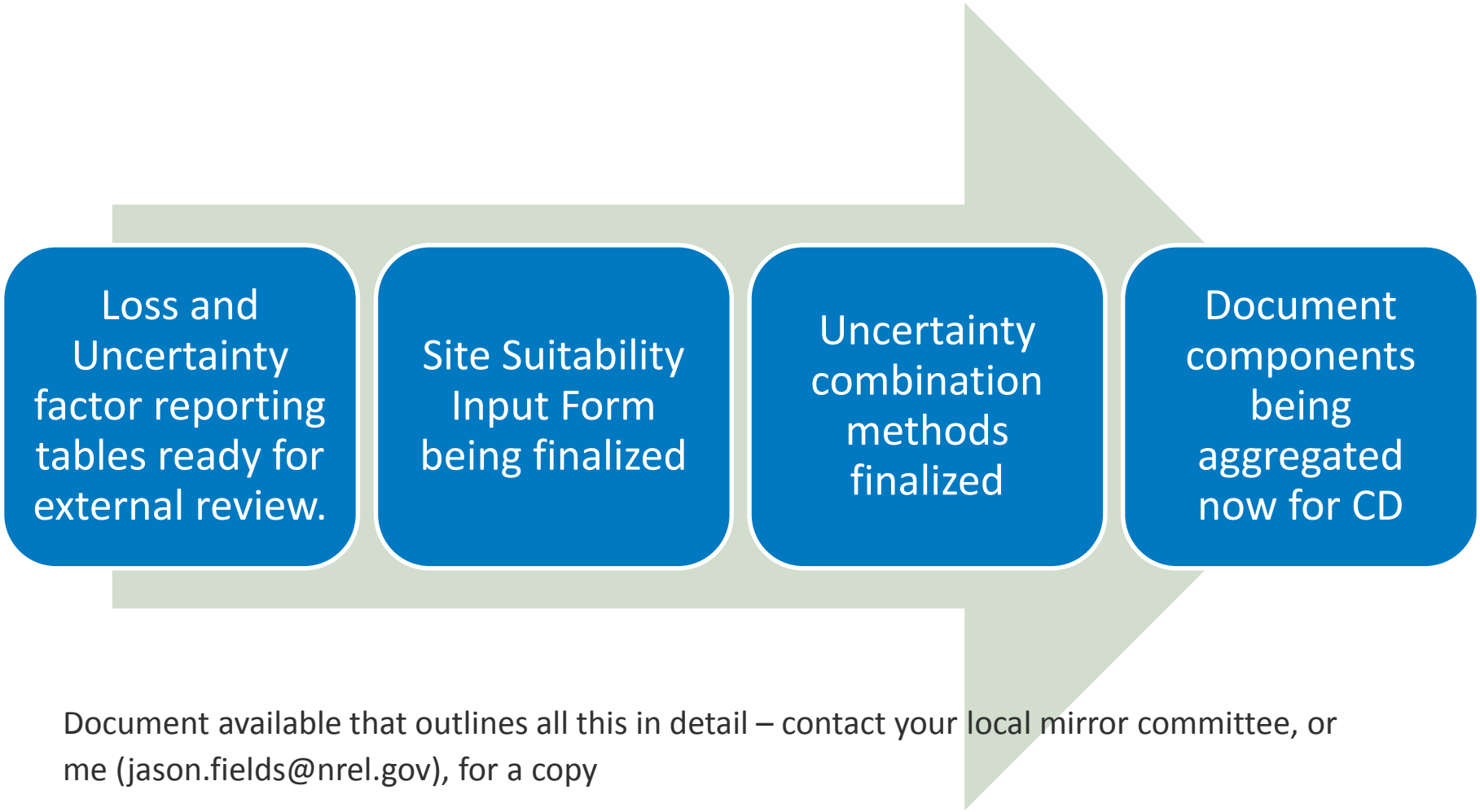
Goals – Normative (Required)

- **Define standards for reporting**
  - A checklist of items that must be considered in an assessment
  - Report must cover the checklist and explain how each item was considered
  - Example: Wind speed predictions at turbine locations
- **Define IEC uncertainty model**
  - Explicit calculation of uncertainty
  - Provides benchmark for readers
  - Organizations can still use their own uncertainty calculation but would need to also report the IEC calculation and explain differences
  - Used as a tool to show what activities can reduce uncertainty
    - Met towers/ Remote Sensing
    - High quality anemometers
- **Define turbine suitability load calculation inputs**
  - Each manufacturer asks for different datasets to run their loads model
  - Standardize the data to improve quality and transparency

Goals – informative (Recommended)

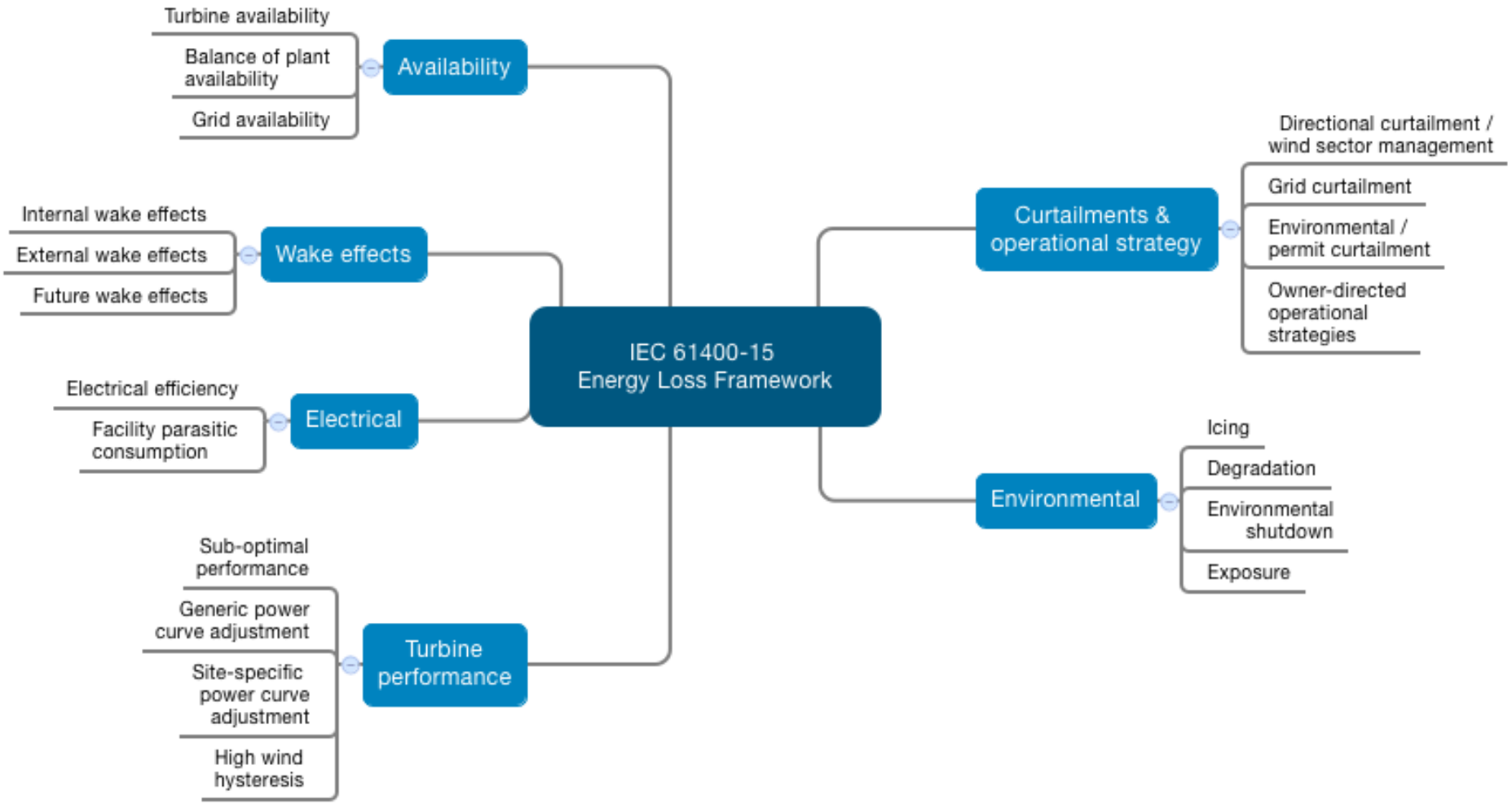
- **Provide industry consensus best practices, including multiple approaches to common problems**
  - Measurement (Local Site Conditions)
    - Measurement strategy
    - Measurement parameters
    - Measurement Devices
      - Meteorological Towers and Instrumentation
      - Remote Sensing
    - Data Management
    - Production data from nearby projects
    - Alternative valid measurements
  - Data Analysis
    - Traceability and Calibration
    - Quality control of data
  - Wind Resource Modeling
    - Gap Filling
    - Long-Term
    - Vertical Extrapolation
    - Horizontal Extrapolation
    - Validation (all of the above)
  - Wind Plant Energy Yield Modeling
    - Ideal Energy Yield
    - Wake
    - Losses
  - Statistical description of measurements
    - Frequency Distributions
    - Wind Roses
    - 8760

Current status

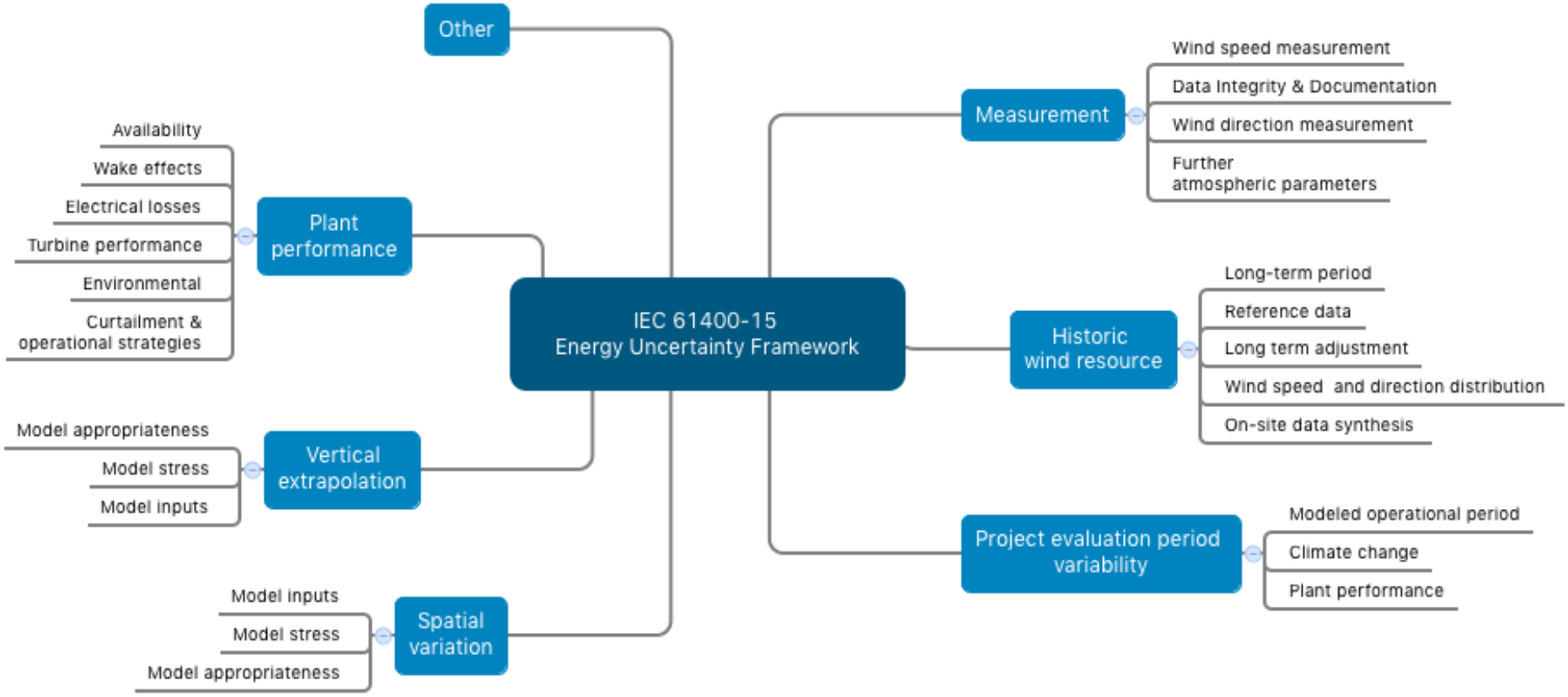


Document available that outlines all this in detail – contact your local mirror committee, or me (jason.fields@nrel.gov), for a copy

Loss Framework



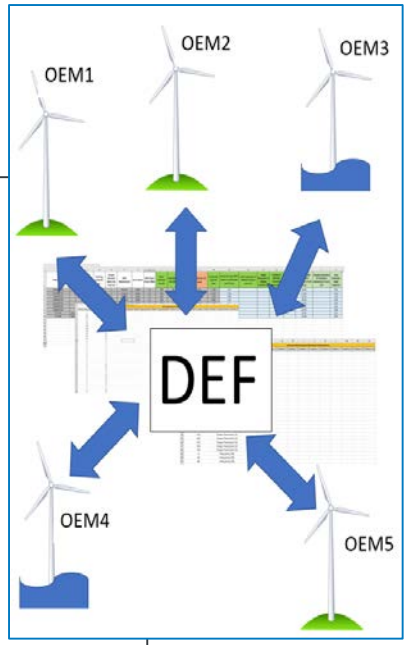
Uncertainty Framework



Formal update document

IEC 61400-15 Working Group

Progress Update #2 – Meeting 13



Wake Effect	
Internal Wake Effects	Wake effects internal to the wind plant
External Wake Effects	Wake effects generated externally to the wind plant
Future Wake Effects	Wake effects that will impact future energy projections based upon either confirmed or predicted new project development or decommissioning
Availability	
Turbine Availability	Turbine availability (energy-based), considering: Warranted availability, non-contractual availability, Restart after grid outage, Site Access, Downtime (or speed) to energy ratio, First Year / Plant start-up Availability
Balance of Plant Availability	Availability of substation and collection system, Other non-turbine availability, Warranted Availability, Site Access, First Year / Plant start-up
Grid Availability	Grid being outside Grid connection agreement operational parameters, actual grid downtime, delays in restart after grid outages.
Electrical	
Electrical Efficiency	Electrical losses between low or medium voltage side of the transformer of WTG(S) and the energy measurement point
Facility Parasitic Consumption	Turbine extreme weather packages, Other turbine and/or plant parasitic electrical losses (while operating or not operating)
Turbine Performance	
Sub-Optimal Performance	Performance deviations from the optimal wind plant performance due to software, instrumentation, and control setting issues
Generic Power Curve Adjustment	Expected deviation between advertised power curve and actual power performance in standard conditions ("inner range"[1])
Site-specific Power Curve Adjustment	Accommodating for inclined flow, TI, density, shear, and other site / project-specific adjustments ("outer range"[3])
High Wind Hysteresis	Energy lost in hysteresis loop between high wind speed cut-out and recut-in.
Environmental	
Icing	Performance degradation and shut down due to icing
Degradation	Blade fouling, efficiency losses, and other environmentally-driven performance degradation
Environmental Loss	High/low Temperature shut down or de-rate, Lightning, hail, and other environmental shut downs

Primary Uncertainty Categories
Historical Wind Resource
Project Evaluation Period Variability
Measurement Uncertainty
Vertical Extrapolation
Horizontal Extrapolation
Plant Performance

20 January 2018

San Diego, California - USA

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Secretary: Jason Fields, NREL – USA

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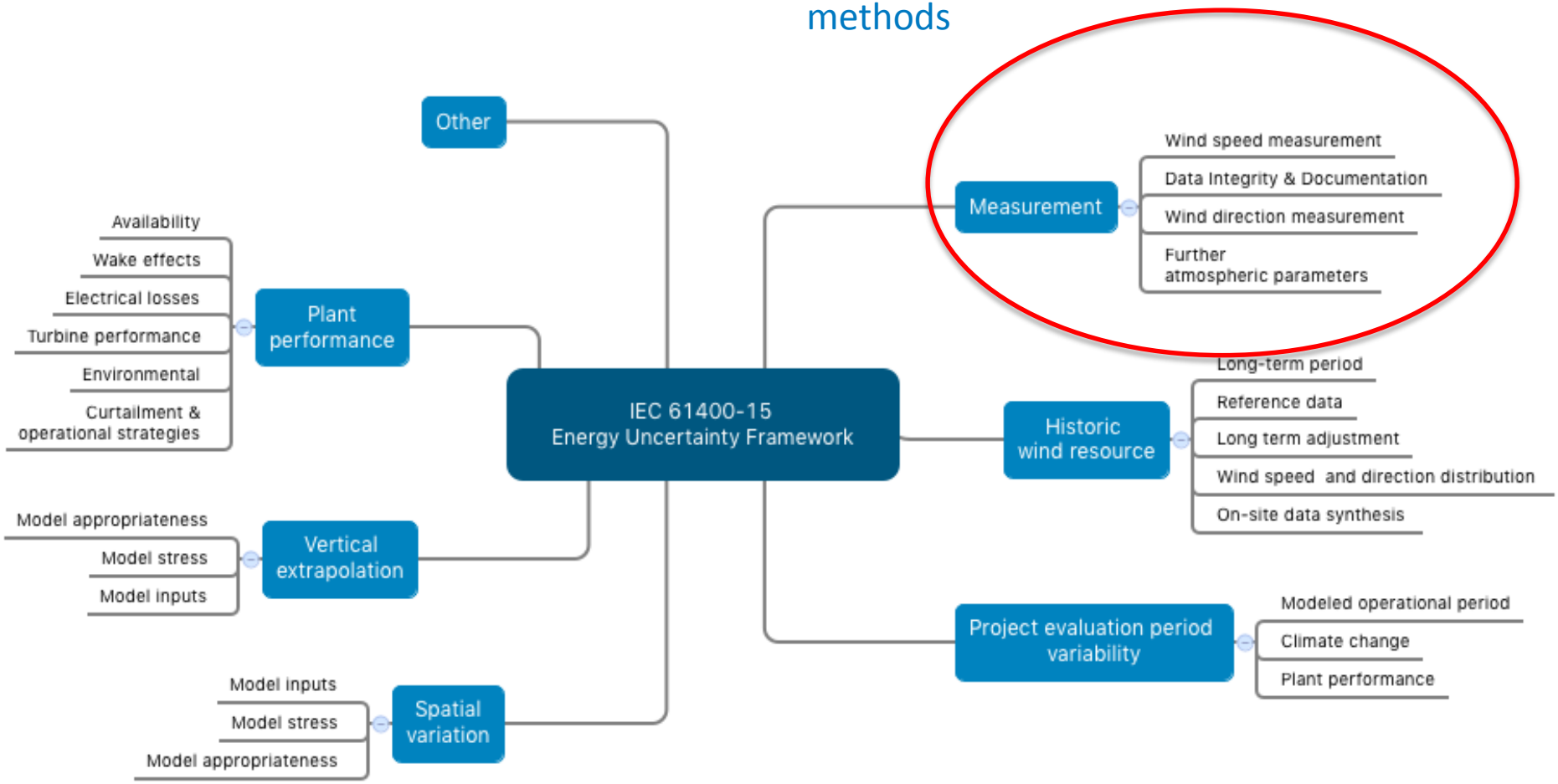
Collaboration Ideas

CFARS:

- Define best practice
- Test existing & new methods



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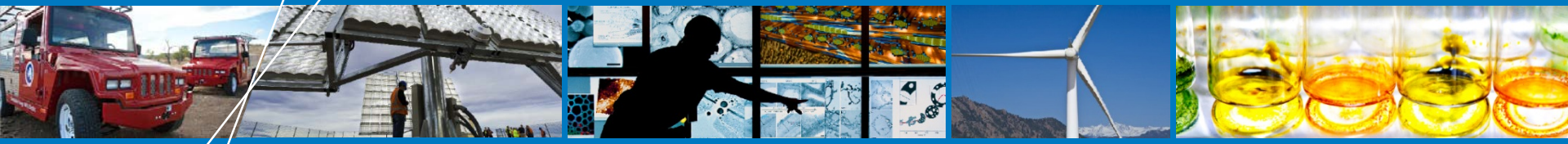

Appendix

Foundational Work

Existing related standards & best practices

- IEC 61400-1,3 Wind Turbine: Design Requirements
- IEC 61400-12-1 Power Performance Testing
- IEC 61400-26 Availability: Technical Specification
- IEC 61400-50 Measurement standards
- MEASNET “Evaluation of site specific winds”

Other documents/collaborations

- Consortium Loss & Uncertainty definitions
- Wind Resource Assessment: A Practical Guide to Developing a Wind Project
- IEA Wind Task 32 Remote Sensing
- IEA Wind Task 31 Windbench and Wakebench
- IEA Task 11 75th meeting on complex terrain
- Power Curve Working Group

Scope of Standard - Approved

The scope of this standard is to define a framework for assessment and reporting of the wind resource, energy yield and site suitability input conditions for both onshore and offshore wind power plants. This includes:

- **1. Definition, measurement, and prediction of the long-term meteorological and wind flow characteristics at the site**
- **2. Integration of the long-term meteorological and wind flow characteristics with wind turbine and balance of plant characteristics to predict net energy yield**
- **3. Characterizing environmental extremes and other relevant plant design drivers**
- **4. Assessing the uncertainty associated with each of these steps**
- **5. Addressing documentation and reporting requirements to help ensure the traceability of the assessment processes**

The framework will be defined such that applicable national norms are considered and industry best practices are utilized.

The meteorological and wind flow characteristics addressed in this document relate to wind conditions, where parameters such as wind speed, wind direction, air density or air temperature are included to the extent that they affect the operation and structural integrity of a wind turbine (WTGS) and energy production analysis.

According to IEC 61400-1 and 61400-3 the site specific conditions can be broken down into wind conditions, other environmental conditions, soil conditions, ocean/lake conditions and electrical conditions. All of these site conditions other than site specific wind conditions and related documents are out of scope for this standard.

This standard is framed to complement and support the scope of related IEC 61400 series standards by defining environmental input conditions. It is not intended to supersede the design and suitability requirements presented in those standards. Specific analytical and modeling procedures as described in IEC 61400-1, 61400-2, and 61400-3 are excluded from this scope.

Scope of standard, Pt 2 (for document)

The basic and fundamental goal is to present consensus methodologies on site assessment and to create a set of standard reporting requirements which detail the measurement campaign, analysis processes, and considerations taken by the author of a wind resource characterization and energy yield assessment. The methodologies presented provide a framework to ensure a high quality set of project data are collected and analyzed to support wind resource and site characterization. The standardized reporting process will provide a discrete list of criteria which must be considered and reported on for all projects. These reporting procedures will provide transparency to report readers about the considerations taken during the analysis, and confidence that the analysis considered all of the key criteria and procedures identified by IEC 61400-15 for wind resource assessment.

At a minimum, the document will prescribe standard reporting elements and considerations during the analysis process, and recommend practices to reduce uncertainty for all elements of the assessment and campaign.

Two additional goals of the standard which should be explored by the committee:

- Develop a standard uncertainty calculation to be used for benchmarking
- Provide standardized inputs for turbine loads calculations

The document will not:

- Qualify or disqualify projects
- Qualify or disqualify consultants/Independent Engineers