Wide-Area Wind Generation Forecasting

1 Descriptions of Function

All prior work (intellectual property of the company or individual) or proprietary (non-publicly available) work should be so noted.

1.1 Function Name

Wide-Area or Control Area Wind Generation Forecasting

1.2 Function ID

IECSA identification number of the function

M-5.1,G-2.2.1,G-2.2.2,G-2.2.3,G-2.2.4,G-2.2.5,G-3.2.1,G-3.2.2,G-3.2.3,G-3.8.1,G-3.8.2,G-4.4,G-4.5,G-5.1,G-5.3,C-7

1.3 Brief Description

Wind generation is primarily an energy resource, and cannot dispatched like conventional generation. In more traditional utility operations, predictions of system load for the next hour, day, week, etc. are essential for deploying supply resources such as total costs are minimized while maintaining system reliability and security. Incremental costs due to the uncertainty in the timing and quantity of energy delivery from wind generation facilities in operational time frames can be reduced with better short-term wind generation forecasts and appropriate use of those predictions by control area operators and power markets in scheduling functions and real-time operating practices.

In situations where resource decisions are made by according to various market signals, prediction of wind generation will be important for those who operate the markets and are charged with responsibility for system security and reliability.

1.4 Narrative

Whether by direct action of an operating entity or in response to market signals, electric supply resources in an electric power control area must be managed, scheduled, and operated to provide for the desired levels of system reliability and security. Furthermore, to minimize the overall cost of electricity to consumers in the control area, the supply resources must be deployed in a manner that leads

to the lowest total production cost. Meeting these objectives and at the same time honoring the myriad constraints on individual generating units and resulting from contractual obligations requires the ability to continually assess the present state of the system and predict probable states hours or days in advance.

Uncertainty in the operational planning time frame can lead to defensive operating strategies and higher costs. Wind generation can only increase the uncertainty in the short-term forecasts utilized to commit and schedule generation, and may lead to higher operating costs. In real-time operation, additional reserves might be allocated to cover the uncertainty in the hours-ahead time frame, again with higher costs.

In control areas with multiple wind generation facilities, forecasts must be generated for each plant on schedules appropriate for real-time management of the control area as well as short-term operational planning activities such as unit commitment or reliability monitoring. Given that the plants in a single control area are exposed to the same general meteorological conditions, a wider geographical perspective on wind resource conditions for forecasting is essential. As a result, the stakeholder groups involved in wide-area wind generation forecasting are defined as follows:

- Operators of the individual wind plants
- Control area personnel responsible for "real-time" operations, i.e. within the hour and possibly for several hours ahead
- Control area personnel, which might include the power marketing functions, responsible for short-term planning activities, including unit commitment and scheduling, interchange scheduling, power purchases and sales, etc.
- Control area or RTO personnel responsible for monitoring system security, where generation dispatch decisions are made for technical reasons related to system integrity rather than economics
- A third party that produces forecasts of wind conditions and possibly wind generation for plants in the control area.

Individual wind plant operator

- Provides information on turbine availability and other plant status indications to forecasting entity
- Provides local meteorological information from plant sensors to forecasting entity
- Receives plant forecast information from forecasting entity

Real-time operators

- Receives wind generation forecast information from forecasting entity and utilizes for planning on an hours-ahead basis
- Receives notification from individual wind plant operators as to planned changes in status or availability
- Notifies individual plant operators of system conditions that may require certain actions on the part of the wind generation facility

PowerMarketer

- Receives wind generation forecasts from forecasting entity to make decisions about generating unit commitment and scheduling

Reliability and security monitors (RTO)

- Utilizes short-term wind generation forecast information to assess future system security and make decisions regarding remedial actions

Forecasting entity

- Collects meteorological information from public and private sensors
- Executes regional meteorological model to forecast wind speed for hours and days ahead
- Collects information from individual plant operators necessary to forecast production for plant
- Collects information from reliability monitors
- Develops wind generation forecast for individual plants and for aggregate wind generation in control area on the basis of wind plant information and wind speed forecasts
- Provides wind generation forecast to individual wind plant operators, real-time system operators, power marketers and reliability and security monitors (RTO)

1.5 Actor (Stakeholder) Roles

Describe all the people (their job), systems, databases, organizations, and devices involved in or affected by the Function (e.g. operators, system administrators, technicians, end users, service personnel, executives, SCADA system, real-time database, RTO, RTU, IED, power system). Typically, these actors are logically grouped by organization or functional boundaries or just for collaboration purpose of this use case. We need

to identify these groupings and their relevant roles and understand the constituency. The same actor could play different roles in different Functions, but only one role in one Function. If the same actor (e.g. the same person) does play multiple roles in one Function, list these different actor-roles as separate rows.

Grouping (Community)		***Group Description***
Wind Forecasting Top Level Actors		***Top Level Actors***
Actor Name	***Actor Type (person, device, system etc.)***	***Actor Description***
IndividualWindPlantOperator	Person or organization	• Provides information on turbine availability and other plant status indications to forecasting entity • Provides local meteorological information from plant sensors to forecasting entity • Receives plant forecast information from forecasting entity
Real time operators	Person or organization	• Receives wind generation forecast information from forecasting entity and utilizes for planning on an hours-ahead basis • Receives notification from individual wind plant operators as to planned changes in status or availability • Notifies individual plant operators of system conditions that may require certain actions on the part of the wind generation facility
PowerMarketer	Person or organization	• Receives wind generation forecasts from forecasting entity to make decisions about generating unit commitment and scheduling
Reliability and security monitors (RTO)	Person or organization	• Utilizes short-term wind generation forecast information to assess future system security and make decisions regarding remedial actions
Forecasting Entity	Person or organization	• Collects meteorological information from public and private sensors

Grouping (Community)		*Group Description*
Wind Forecasting Top Level Actors		*Top Level Actors*
Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
		• Executes regional meteorological model to forecast wind speed for hours and days ahead • Collects information from individual plant operators necessary to forecast production for plant • Collects information from reliability monitors (RTO) • Develops wind generation forecast for individual plants and for aggregate wind generation in control area on the basis of wind plant information and wind speed forecasts • Provides wind generation forecast to individual wind plant operators, real-time system operators, and power marketers
SensorDevice	Device	• Provides meteorological data etc. to forecasting entity

Replicate this table for each logic group.

1.6 Information exchanged

Describe any information exchanged in this template.

Information Object Name	*Information Object Description*
Sensor data	Data from sensors used to create forecasts
Local data	Local turbine and sensor data from wind plant operators

Information Object Name	*Information Object Description*
Wind generation forecasts	Forecasts of wind generator

1.7 Activities/Services

Describe or list the activities and services involved in this Function (in the context of this Function). An activity or service can be provided by a computer system, a set of applications, or manual procedures. These activities/services should be described at an appropriate level, with the understanding that sub-activities and services should be described if they are important for operational issues, automation needs, and implementation reasons. Other sub-activities/services could be left for later analysis.

Activity/Service Name	*Activities/Services Provided*
Wind generation forecast	Provides forecast of wind generation to be used by various entities

1.8 Contracts/Regulations

Identify any overall (human-initiated) contracts, regulations, policies, financial considerations, engineering constraints, pollution constraints, and other environmental quality issues that affect the design and requirements of the Function.

Contract/Regulation	*Impact of Contract/Regulation on Function*

Policy	*From Actor*	*May*	*Shall Not*	*Shall*	*Description (verb)*	*To Actor*

Constraint	*Type*	*Description*	*Applies to*

2 Step by Step Analysis of Function

Describe steps that implement the function. If there is more than one set of steps that are relevant, make a copy of the following section grouping (Preconditions and Assumptions, Steps normal sequence, and Steps alternate or exceptional sequence, Post conditions)

2.1 Steps to implement function

Name of this sequence.

2.1.1 Preconditions and Assumptions

Describe conditions that must exist prior to the initiation of the Function, such as prior state of the actors and activities

Identify any assumptions, such as what systems already exist, what contractual relations exist, and what configurations of systems are probably in place

Identify any initial states of information exchanged in the steps in the next section. For example, if a purchase order is exchanged in an activity, its precondition to the activity might be 'filled in but unapproved'.

Actor/System/Information/Contract	***Preconditions or Assumptions***
IndividualWindPlantOperators	Has turbines ready to operate and has provided sufficient information for operators to calculate forecasts, etc.

2.1.2 Steps – Normal Sequence

Describe the normal sequence of events, focusing on steps that identify new types of information or new information exchanges or new interface issues to address. Should the sequence require detailed steps that are also used by other functions, consider creating a new "sub" function, then referring to that "subroutine" in this function. Remember that the focus should be less on the algorithms of the applications and more on the interactions and information flows between "entities", e.g. people, systems, applications, data bases, etc. There should be a direct link between the narrative and these steps.

The numbering of the sequence steps conveys the order and concurrency and iteration of the steps occur. Using a Dewey Decimal scheme, each level of nested procedure call is separated by a dot '.'. Within a level, the sequence number comprises an optional letter and an integer number. The letter specifies a concurrent sequence within the next higher level; all letter sequences are concurrent with other letter sequences. The number specifies the sequencing of messages in a given letter sequence. The absence of a letter is treated as a default 'main sequence' in parallel with the lettered sequences.

Sequence 1:

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1.1 - Do step 1
1.2A.1 - In parallel to activity 2 B do step 1
1.2A.2 - In parallel to activity 2 B do step 2
1.2B.1 - In parallel to activity 2 A do step 1
1.2B.2 - In parallel to activity 2 A do step 2
1.3 - Do step 3
1.3.1 - nested step 3.1
1.3.2 - nested step 3.2
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Sequence 2:

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2.1 - Do step 1
2.2 – Do step 2
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#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environments
#	*Triggering event? Identify the name of the event.*[1]	*What other actors are primarily responsible for the Process/Activity? Actors are defined in section1.5.*	*Label that would appear in a process diagram. Use action verbs when naming activity.*	*Describe the actions that take place in active and present tense. The step should be a descriptive noun/verb phrase that portrays an outline summary of the step. "If …Then…Else" scenarios can be captured as multiple Actions or as separate steps.*	*What other actors are primarily responsible for Producing the information? Actors are defined in section1.5.*	*What other actors are primarily responsible for Receiving the information? Actors are defined in section1.5.* *(Note – May leave blank if same as Primary Actor)*	*Name of the information object. Information objects are defined in section 1.6*	*Elaborate architectural issues using attached spreadsheet. Use this column to elaborate details that aren't captured in the spreadsheet.*	*Reference the applicable IECSA Environment containing this data exchange. Only one environment per step.*
1.1	Provide Data	IndividualWindPlantOperator	Provide Data	IndividualWindPlantOperator provides information on turbine availability and local sensor data to forecasting entity	IndividualWindPlantOperator	Forecasting Entity	Local Data		Control Center / Corporations
1.2	Collect Sensor Data	SensorDevice	Collect Sensor Data	Forecasting entity collects meteorological data from public and private sensors	SensorDevice	Forecasting Entity	Sensor Data		Lower Security DAC
1.3	Make Forecast	Forecasting Entity	Make Forecast	Forecasting entity runs models and creates forecast	Forecasting Entity	IndividualWindPlantOperators, PowerMarketer, Real time operators, Reliability and Security Monitors (RTO)	Wind Generation Forecasts		Control Center / Corporations

[1] Note – A triggering event is not necessary if the completion of the prior step – leads to the transition of the following step.

2.1.3 Steps – Alternative / Exception Sequences

Describe any alternative or exception sequences that may be required that deviate from the normal course of activities. Note instructions are found in previous table.

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environments

2.1.4 Post-conditions and Significant Results

Describe conditions that must exist at the conclusion of the Function. Identify significant items similar to that in the preconditions section.

Describe any significant results from the Function

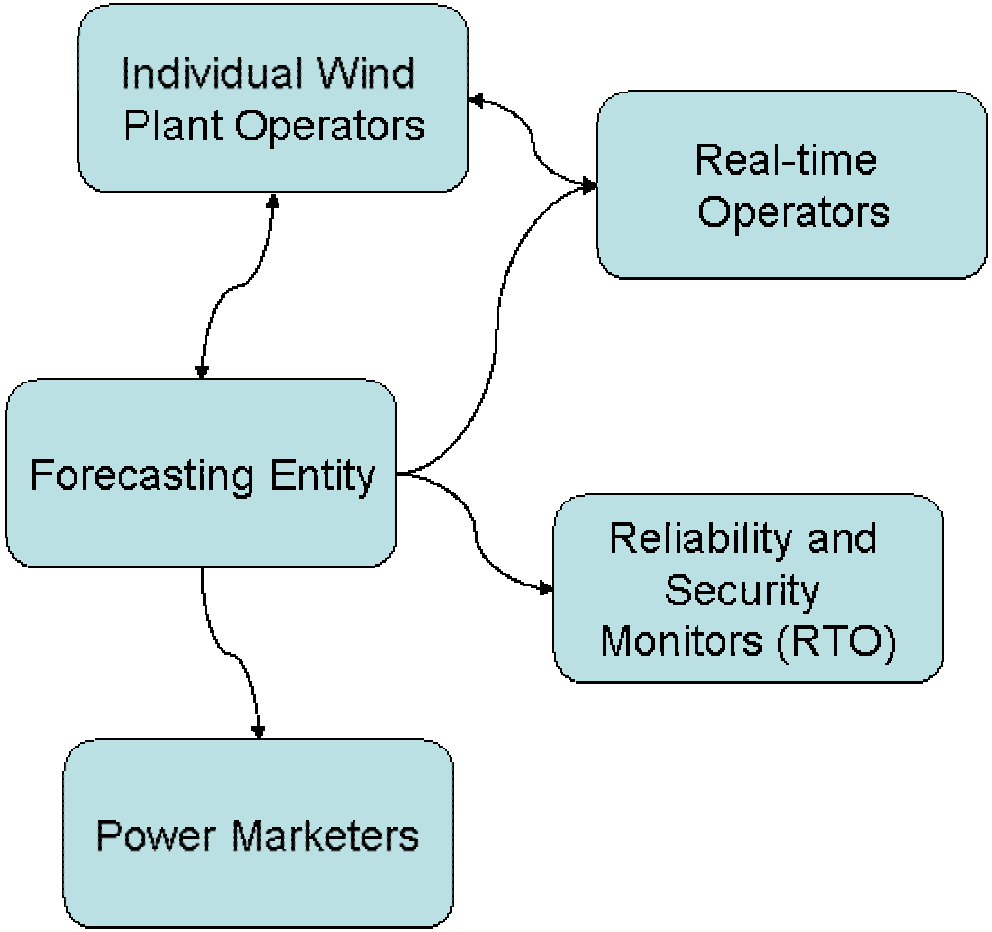
Actor/Activity	***Post-conditions Description and Results***
IndividualWindPlantOperators	Has turbines ready to operate and has provided sufficient information for operators to calculate forecasts, etc.

2.2 Architectural Issues in Interactions

Elaborate on all architectural issues in each of the steps outlined in each of the sequences above. Reference the Step by number..

Diagram

For clarification, draw (by hand, by Power Point, by UML diagram) the interactions, identifying the Steps where possible.



3 Auxiliary Issues

3.1 References and contacts

Documents and individuals or organizations used as background to the function described; other functions referenced by this function, or acting as "sub" functions; or other documentation that clarifies the requirements or activities described. All prior work (intellectual property of the company or individual) or proprietary (non-publicly available) work must be so noted.

ID	Title or contact	Reference or contact information
[1]		
[2]		

3.2 Action Item List

As the function is developed, identify issues that still need clarification, resolution, or other notice taken of them. This can act as an Action Item list.

ID	Description	Status
[1]		
[2]		

3.3 Revision History

For reference and tracking purposes, indicate who worked on describing this function, and what aspect they undertook.

No	Date	Author	Description
0.			