Distributed Energy Resource Controller Produces Distribution Powerflow Forecast

Version 1.1

January 6, 2010

1 Descriptions of Function

This function describes the sequence of activities required for forecasting generation and load by segment on the distribution system.

1.1 Function Name

Distributed Energy Resource Controller Produces Distribution Powerflow Forecast

1.2 Function ID

IECSA identification number of the function

1.3 Brief Description

This function describes the sequence of activities required for forecasting generation and load by segment on the distribution system. An accurate load/generation forecast is essential for the operation of the system at high penetration levels. This is part of the normal operation, but is broken out as a separate use case as it warrants more detail.

1.4 Narrative

As distributed energy resources become more prevalent in electric power systems, comprehensive and detailed forecasting of their contribution to that power system will become more critical. In the event that distributed energy resources become a proxy for transmission, as some people seem to believe is possible, that forecasting will be critical to the stability of the system as a whole. Renewables in particular offer significant challenges at all levels due to the transitory nature of their output. On the distribution system, where this could create major changes in power flow, it is a particular issue. Tuning relay settings so that they provide the best protection of equipment and customer, while minimizing nuisance trips is exacerbated by changes in power flow on the distribution grid. Further, as utilities attempt to both reduce carbon impact and manage the impact of renewable resources on the distribution grid, distributed storage solutions are going to become more common place as a critical component of the solution. It will be important to time the charging of these storage devices to both minimize system impact and maximize the renewable component of their recharge.

The DER forecast is based primarily on a detailed weather forecast, since weather influences both the loads and the generation. Typical regional forecasts, while sufficient for normal load forecasting, however, do not meet the needs of predicting energy flows on discrete distribution line segments. In order to meet these needs, it will be necessary to further process the data from the regional forecast and do a microclimate forecast for smaller zones within the region. The size of the zones will be dependent on both geography and load/generation density. There are a number of systems currently available that are able to accurately calculate temperature cloud cover, and wind speeds at various heights with a high degree of fidelity for areas of a few square miles.

An economic forecast must be made as well. The probable price of power may not effect the generation available from renewable sources, which typically must generate whenever possible to make their return, but the price will have an impact on non-renewable generation embedded within the distribution network, and it will have an impact to a lesser degree on the load forecast.

Once the micro climate forecast is complete, traditional methods may be applied to predict the load model. The steps below allow for a self learning heuristic system (i.e. the system will factor success at previous forecasts to better tune future forecasts).

At the same time the loads are being forecast by network segment, generation will also be calculated using the same detailed weather data. There are already well established models available that can give reasonable levels of accuracy given detailed wind speed data for wind turbines, and there are solar models as well.

Based on the various forecasts an economic dispatch plan is generated by segment. In the case of a deregulated market, a much more complex process is likely to be necessary. While the steps in this use case are presented sequentially, the actual implementation may require multiple iterations in order for the system to converge on a solution. Once a solution is derived, the individual Distributed Energy Resource Controllers at the substation or lower level will have to have some autonomy to maintain stability and respect the limits of the power system. The concept here is that they will have a pick list by resource by segment with weighting. This allows the DERC to have the flexibility required.

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*
DER Actors		*Actors used by DER Use Cases*
Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
AMI Interface	Device	Interface between AMI system and other field systems. The assumption is that the AMI interface would not require communications to travel all the way to the AMI Head end system and back to the field. Ideally, the AMI interface allows peer to peer communications to AMI network devices in the field with distribution automation devices and systems also physically located in the field.
DER Economic Dispatcher	System	This system calculates the optimal mix of generation from DER sources based on not only on system constraints, but also based on economic or regulatory.
DER Forecaster	System	This is a coordinating system that manages the DER Load Forecaster, DER Non-Renewable Forecaster, DER Solar Generation Forecaster, and the DER Wind Generation Forecaster
DER Load Forecaster		This system forecasts load at a network segment level.
DER Non-Renewable Forecaster	System	This system calculates the expected capacity that will be represented by non renewable resources on the distribution system. This would include co-generation and diesel units among others. This “capacity” in this sense is highly dependent on economic factors such that the expectation is such that these units will not be available if the economics are not there for a particular day.
DER Solar Generation Forecaster	System	This system calculates the expected capacity that will be represented by solar resources on the distribution system by segment. This is a forecast of capacity only.
DER Wind Generation Forecaster	System	This system calculates the expected capacity that will be represented by wind resources on the distribution system by segment. This is a forecast of capacity only.
Distributed Energy Resource Controller (DERC)	System	System located in the substation that coordinates Distributed Energy Resources. Monitors operations schedules, status and controls operation of DER Device Equipment.
Historic Load Forecast Database	System	Previous Load Forecasts. Ideally hold inputs to the forecast. Can be compared to actual outcomes to adjust stochastic components of the forecast.
Micro Climate	System	The Micro Climate Forecasts use the regional weather forecast and predict the

Grouping (Community)		*Group Description*
DER Actors		*Actors used by DER Use Cases*
Actor Name	*Actor Type (person, device, system etc.)*	*Actor Description*
Forecaster		weather conditions for smaller geographic regions allowing the opportunity to predict energy flows on discrete distribution line segments. The size of the zones will be dependent on both geography and load/generation density.
Power Exchange (PX)	Organization	Organization responsible for setting dynamic prices for generation
National Weather Service	Agency	National Weather Service providing Regional Weather Forecasts

Replicate this table for each logic group.

1.6 Information exchanged

Describe any information exchanged in this template.

Information Object Name	*Information Object Description*
Previous 24 hour Load History	Load history for previous 24 hrs from the AMI Interface.
Previous 24 Hour Generation History	Generation history for previous 24 hrs from the AMI Interface.
Previous 24 Hour Weather History	Weather history from sensors.
National or Regional Weather Forecast	Output data from Weather Service. Generally predicts temperature and humidity
15 minute Micro Climate Forecasts for smaller regions (network segments)	Detailed weather forecast that predicts winds speeds, temperature, cloud cover etc in fifteen minute intervals for a small area (i.e. a few square miles)

Information Object Name	*Information Object Description*
Forecasted costs of power for the next 24 hour period	Forecasted cost of power for the next 24 hour period
Forecasted DER Solar generation by network segment	Forecasted solar generation by network segment for the next 24 hour period
Forecasted DER Wind generation by network segment	Forecasted wind generation by network segment for the next 24 hour period
Forecasted DER Load by network segment	Forecasted DER Load by network segment for the next 24 hour period
Forecasted DER Non Renewable generation by network segment	Forecasted DER Non-Renewable generation by network segment for the next 24 hour period
DER Predicted Load/Available Generation Forecast	Predicted DER Load/Available Generation for the next 24 hour period
Calculated Optimal Generation Mix	DER Economic Dispatcher Calculates the Optimal Generation Mix based on economic factors
Optimized Generation Pick List	The Optimized Generation Pick List contains the DER Device Equipment chosen to provide the predicted service necessary to meet the system needs.

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*

Activity/Service Name	*Activities/Services Provided*

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 (Steps to implement function, Preconditions and Assumptions, Steps normal sequence, Post-conditions) and provide each copy with its own sequence name.

2.1 Steps to implement function – Name of Sequence

DER Forecasting

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*
Electric Power System	Operating Normally
Distributed Energy Resource Controller	Assumes historical information is available

2.1.2 Steps – Name of 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.

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
#	*Triggering event? Identify the name of the event.*[1]	*What other actors are primarily responsible for the Process/Activity? Actors are defined in section0.*	*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 section0.*	*What other actors are primarily responsible for Receiving the information? Actors are defined in section0.* *(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	Normal Planning Operations	DER Forecaster	Load History Update	DER Forecaster updates its load history based on previous 24 hours	AMI Interface	DER Forecaster	Previous 24 hour Load History		
1.2		DER Forecaster	Generation History Update	DER Forecaster updates its generation history based on previous 24 hours	AMI Interface	DER Forecaster	Previous 24 Hour Generation History		
1.3		DER Forecaster	Weather History Update	DER Forecaster updates its weather history based on previous 24 hours	Weather Sensors	DER Forecaster	Previous 24 Hour Weather History	Sensors can be connected to AMI, IEDs and third party sources	
2.1		Weather Service	Regional Weather Forecast	National or regional Weather service generates Regional Weather Forecast and delivers it to the Micro Climate Forecaster	NWS	Micro Climate Forecaster	National or Regional Weather Forecast		

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

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
2.2		Micro Climate Forecaster	Micro Climate Forecast	The Micro Climate Forecaster generates a forecast that predicts ambient temperature, wind speeds and direction, humidity and cloud cover for small areas (network segments) in quarter hour increments and delivers it to the DER Forecaster	Micro Climate Forecast	DER Forecaster	15 minute Micro Climate Forecasts for smaller regions (network segments)		
3.1		PX	Economic Forecast	PX forecasts cost of power based on the system history and forecasted weather and delivers it to the DER Forecaster	PX	DER Forecaster	Forecasted costs of power for the next 24 hour period		
3.2		DER Solar Generation Forecaster	Solar Generation Forecast	DER Solar Generation Forecaster forecasts generation by network segment based on Micro Climate Forecast using the solar generator characteristics database and delivers it to the DER Economic Dispatcher	DER Solar Generation Forecaster	DER Economic Dispatcher	Forecasted DER Solar generation by network segment	Forecast is based not only on raw mfrs specs, but past history (heuristics)	

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
3.3		DER Wind Generation Forecaster	Wind Generation Forecast	DER Wind Generation Forecaster forecasts generation by network segment based on Micro Climate Forecast using the wind generator characteristics database and delivers it to the DER Economic Dispatcher	DER Wind Generation Forecaster	DER Economic Dispatcher	Forecasted DER Wind generation by network segment	Forecast is based not only on raw mfrs specs, but past history (heuristics)	
3.4		DER Load Forecaster	DER Load Forecast	DER Load Forecaster forecasts load by network segment based on Micro Climate Forecast using the wind generator characteristics database and delivers it to the DER Economic Dispatcher	DER Load Forecaster	DER Economic Dispatcher	Forecasted DER Load by network segment	Forecast is based not only on raw mfrs specs, but past history (heuristics)	

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
3.5		DER Non Renewable Forecaster	DER Non Renewable Forecast	DER Non Renewable Generation Forecaster forecasts generation by network segment based on PX Economic (price) forecast in conjunction with estimated generation costs and delivers it to the DER Economic Dispatcher	DER Non Renewable Forecaster	DER Economic Dispatcher	Forecasted DER Non Renewable generation by network segment	Requires heuristic model, fuel costs etc.	
4.0		DER Load Forecaster	Forecast Push	DER Predicted Load/Available Generation Forecast is pushed to DER Economic Dispatcher	DER Load Forecaster	DER Economic Dispatcher	DER Predicted Load/Available Generation Forecast		
5.1		DER Economic Dispatcher	Economic Dispatch	DER Economic Dispatcher Calculates optimal generation mix based on economic factors (including must take, carbon impact and financial)	DER Economic Dispatcher	DER Economic Dispatcher	Calculated Optimal Generation Mix		

#	Event	Primary Actor	Name of Process/Activity	Description of Process/Activity	Information Producer	Information Receiver	Name of Info Exchanged	Additional Notes	IECSA Environment
5.2		DER Economic Dispatcher	Economic Dispatch Push	DER Economic Dispatcher pushes optimized generation pick list based on economic factors (including must take, carbon impact and financial) to the DERC	DER Economic Dispatcher	DERC	Optimized Generation Pick List		

2.1.3 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.

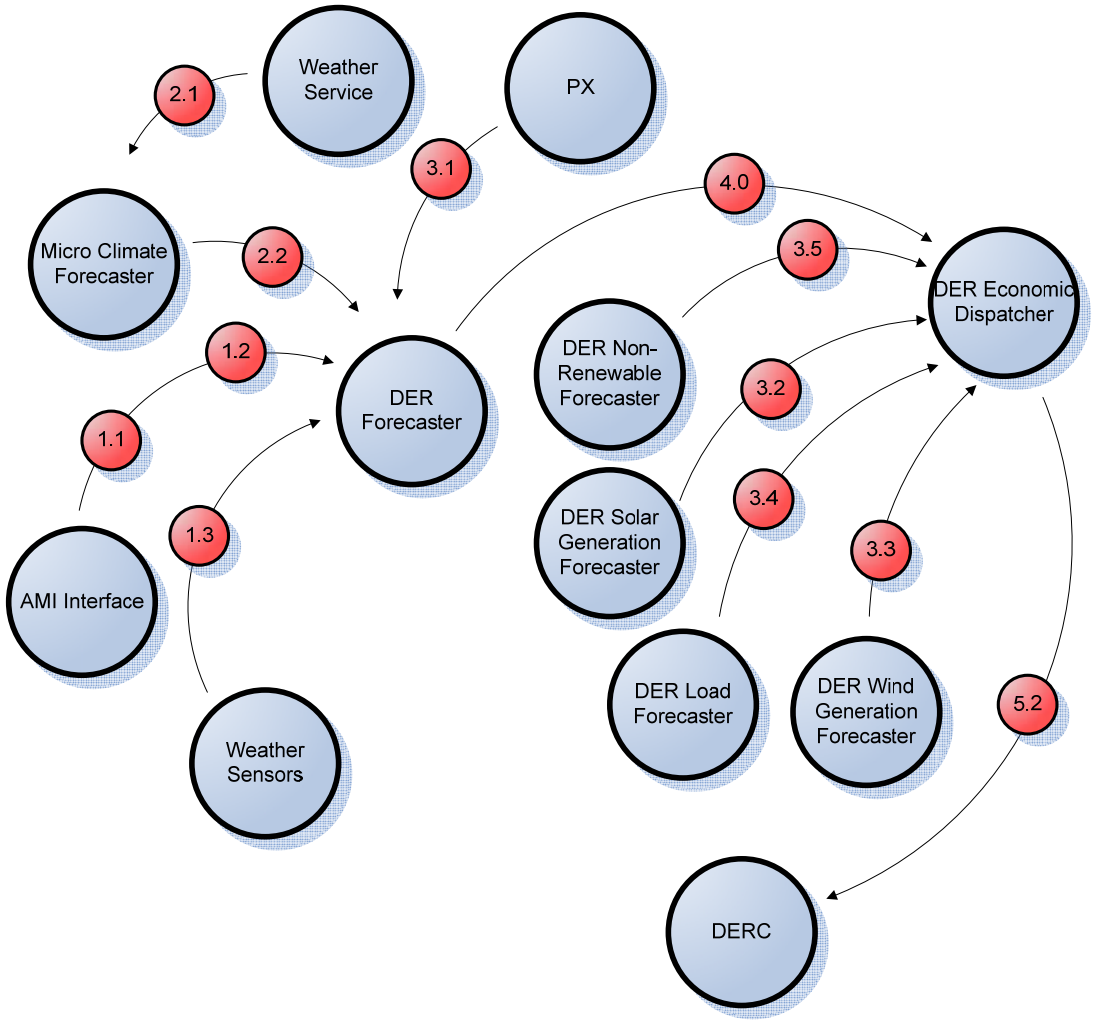
Describe any significant results from the Function

Actor/Activity	*Post-conditions Description and Results*

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. Double click on the embedded excel file – record the changes and save the excel file (this updates the embedded attachment).

2.3 Diagram


Weather Service
PX
2.1
3.1
4.0
Micro Climate Forecaster
2.2
3.5
DER Economic Dispatcher
1.2
DER Non-Renewable Forecaster
DER Forecaster
1.1
3.2
3.4
1.3
DER Solar Generation Forecaster
3.3
AMI Interface
DER Load Forecaster
DER Wind Generation Forecaster
5.2
Weather Sensors
DERC

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]		

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]		

3.3 Revision History

No	Date	Author	Description
1.0	10/24/2009	Charles Vincent	Original DER Forecasting Use Case
1.1	1/6/2010	Brian D. Green	Minor changes to Actors Lists and diagram