

## Category 1 (Foundational/Regional) Project Final Report

**Report Completion Date: 4/20/2020**

### Section 1: Project Information

Project Information	
Control #: Title:	<b>1.2.5.1 Sensing and Measurement Strategy Task 1 Extended Grid State</b>
Project Title:	<b>Extended Grid State Definition</b>
Project PI Name and Lab Affiliation: Project Co-PI (plus-one) and Lab Affiliation:	<b>Jeffrey Taft, PNNL Emma Stuart, LLNL</b>
DOE Project Manager(s):	<b>Kerry Cheung, Marina Sofos</b>
Period of Performance:	<b>April 2016 to Dec 2019</b>
Date Closed:	<b>Jan 6, 2020</b>

### Section 2: Project Assessment and Checklist

Project Assessment and Checklist	Y/N	Confirmation Date	Comments
Have all quarterly reports been submitted?	<b>Y</b>		<b>Reports have been provided for every quarter of the project. Also phone conversations and demonstrations have been held with the DOE PMs.</b>
Have all milestones have been delivered?	<b>Y</b>		
Are all products finalized (e.g. technical reports, journal articles)?	<b>Y</b>		
Have all project products been finalized and presented/submitted to DOE Project Manager(s) and/or GMI Leadership?	<b>Y</b>		<b>Reports for task 1 has been submitted to both DOE PMs and GMI Leadership for review/approval.</b>
Have all potential sensitivities been identified and addressed with DOE Project Managers and/or GMI Leadership?	<b>N</b>		<b>The report for task 1 is still in review by GMI Leadership.</b>
Has the project team received feedback from Project Stakeholders (e.g. advisory group)?	<b>Y</b>		Feedback was received from project stakeholders throughout the project period via

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			webinars other online consultations.
Are there any open or pending costs?	N		

### Section 3: Outcomes, Deliverables, Publications

Provide the following:

*\*In addition to titles, provide links to any websites or other repositories where deliverables and/or other information will be available after the project has been completed*

*\*Publications available for public release, URLs, etc. listed here should be uploaded to GMLC Open Point*

1. **List of Outcomes:** Create the extended grid state definition and taxonomy. Develop software to validate portions of the taxonomy.
2. **List of Deliverables:**

**Technical Report: Extended Grid State Report: entitled “Extended Grid State Definition Document, Version 3.3”, PNNL-SA-141027, February 2019.**

**Technical Report: Determining Distribution Grid State Coverage Computationally, PNNL-29338, November 2019.**

3. **List of Publications:**
4. **List of Awards or Recognition:** The software that calculates visibility, observability and graphically illustrates islands of observability has been well received by utility and vendors who have seen it, resulting in requests to have or license the software for their use.
5. **List any ROIs – Software, Intellectual Property, Licensing, Patents, Etc.**  
A patent is in the process of being filed on the observability software.

### Section 4: Final Costing

Each Lab Financial POC Complete Final Costing Spreadsheet and attach to final report

### Section 5: Final Thoughts/Comments

**Most of the advanced ideas for distribution grid modernization are not actually feasible because distribution grids are not able to support the advanced functions. Lack of instrumentation (visibility, transportability, observability) is one key gap but there are others and they must be systematically addressed before modernization can be more than a patchwork of partially functioning projects. Addressing them in an organized and unified fashion means applying Grid Architecture concepts as well as practicalities like ensuring**

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compatibility with GridApps-D.

Final Thoughts	Comments
Lessons Learned	<p><b>The proper way to deal with observability and therefore with sensor allocation on distribution grids involve the use of analytics methods (symbolic algebra and graph theory) and must consider system model inaccuracies and communication network transportability, as well as being able to handle existing sensors on any particular grid. It should be compatible with GridApps-D and be part of a comprehensive strategy for distribution grid sensing, not just a standalone</b></p>
Opportunities for Improvement	<p><b>Include representations for sensor allocation strategies and an engine for executing them on a grid; incorporation of graph theory measures to characterize communication network data transportability.</b></p>
Future Projects: Ideas for future work? Possible next steps and research direction?	<p><b>Extension of this work is already underway as part of a comprehensive distribution sensing and analytics framework.</b></p>
Other:	<p><b>Approaches like co-simulation do not yield results that can be considered complete because it is never possible to ensure that a complete set of simulation use cases has been chosen. The place for simulations is <i>after</i> the architecture and planning work have been completed (and therefore after analytical planning tools have been employed) and during the engineering design stage of distribution grid upgrade.</b></p>