Exhibit A - Statement of Work

This Research Statement of Work is made and entered into effective the 1st day of January, 2018 by Eversource Energy Service Company, for itself and as agent for its affiliates, having principal offices at 107 Selden Street, Berlin, CT 06037 ("Company") and UNIVERSITY OF CONNECTICUT ("University") pursuant to the terms of the SECOND AMENDED AND RESTATED SPONSOR RESEARCH AND SERVICES AGREEMENT between Company and University dated May 1st, 2015 (the "Sponsor Research Agreement").

Both Parties agree to participate in Research to be conducted in accordance with the terms and conditions of the Sponsor Research Agreement and this Research Statement of Work, provided however, that in the event of a conflict between the terms and conditions of the Sponsor Research Agreement and this Research Statement of Work, the terms of the Sponsor Research Agreement shall be controlling.

1. **Title of Research/Project:**
   Grid-Side System Enhancements to Integrate Distributed Energy Resources (Phase II)
2. **Research/Project Description:**
   - **A. Problem Statement**
   - **B. Proposal Objectives**
   - **C. Methodology**
   - **D. Data requirements**
   - **E. Project Deliverables**
   - **E. Project Timetable and Milestones**

University of Connecticut

By PI: Peng Zhang

Printed Name: _Peng Zhang___________

Title:_____Professor___________________

Date: 12/18/2017

The Connecticut Light and Power Company doing business as Eversource Energy

By: [signature]

Printed Name: Samuel Woolard

Title: Director

Date: 1-22-18

By Sponsored Program Services: [signature]

Printed Name: Laura Kozma

Title: Director Date: 12/20/17

Research/Project Description: Grid-Side System Enhancements to Integrate Distributed Energy Resources (Phase II)...

PI/Co-Is: PI: Peng Zhang Co-Is: Marina Astitha, Efthymios Nikolopoulos ...

A. Problem Statement

Power distribution grids in the U.S. are being impacted by the increasingly deep integration of distributed energy sources (DERs). For instance, as of 2016, there were 1.9 gigawatts of grid-tied DERs within Eversource Energy's service territory, including over 18,000 residential solar photovoltaic (PV) projects installed in Connecticut and over 2,000 additional projects in progress. This number is projected to be quadrupled within the next four years. Nationwide, a new PV was interconnected to the distribution grids every two minutes in 2015, a speed that is likely to increase in the future due to the significant drop in PV costs. It is therefore critical to enhance the distribution system infrastructure and to investigate novel technologies to enable the deployment of more DERs while maintaining the grid reliability and resilience.

PV output is determined by PV panels characteristics (type, model specifications, manufacturer, etc.) and various meteorological factors (solar irradiance, cloud cover, humidity, air temperature, wind speed, etc.), making PV system's peak power generation often deviates from its nameplate capacity. Obtaining high fidelity PV capacity factor (peak power/nameplate capacity) for PV systems in any specific region and any specific time interval has become critically important for the grid-side resilience enhancement to accommodate deep integration of DERs. It is useful for advanced feeder loading analysis and forecasting, hosting capacity analysis and mapping, energy storage management, and advanced distribution management, protection and control, to name just a few.

B. Project Objectives

Through a collaboration with CT Green Bank, the UConn team is collecting high resolution 2015-2016 PV data for hundreds of PV sites. Through big data analytics, the team aims to 1) develop a representation-learning-based zone partitioning method to automatically divide utility service territory for PV capacity factor analysis; 2) establish an Extreme Value Theory (EVT) for quantifying PV capacity factor; and 2) develop a deep structured learning method is being built for the forecast of the PV capacity factors.

The team will continue to enhance the functionality of N^2NDZ tool to enable accurate unintentional islanding risk assessment for the selected Eversource Energy feeders.

C. Methodology – Project tasks

In the Unintentional Islanding project, we have devised a DER-Driven Non-Detection Zone (D^2NDZ) method[1], which is then implemented through a data-driven, learning-based approach. Test results indicate that D^2NDZ can quickly and effectively estimate the unintentional islanding risks for any given distribution feeders without numerous and time-consuming electromagnetic transient simulations. A D^2NDZ software tool has been deployed in Eversource Energy. In practice, D^2NDZ reduces utilities engineers' case study time from months to just a few minutes.

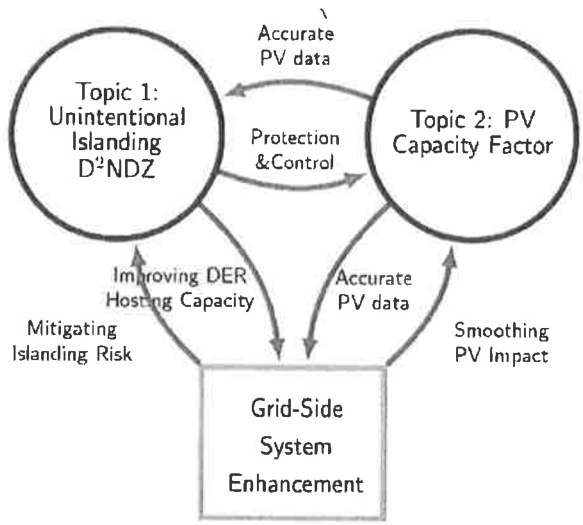

Fig. 4 Relationship between topics

Given the D^2NDZ tool, the PV capacity factors can be used to provide more accurate PV data to better predict the islanding risks for DER interconnection projects. Besides, D^2NDZ can also be used to explore the interaction of energy storage on the NDZ and help quantify the resilience benefit of energy storage projects. Therefore, both the islanding and the PV capacity projects can be continued in combination with the energy storage research. The continuation plan includes the following major topics.

Topic 1 – Unintentional Islanding Phase II (01/18-06/19)

- **Task 1: Upgrade D^2NDZ software tool for Eversource Energy (01/18-06/18)**
  - Update the D^2NDZ tool: 1) Build simple and easy-to-use Excel GUI; 2) Enable the input of PV and DER sizes (e.g. through dialog box)
- **Task 2: Model unbalanced PV systems and 3-phase unbalanced distribution feeders in D^2NDZ (04/18-09/18)**
  - Model single phase and three phase PV inverters and other unbalanced DERs; quantify the probability of islanding risks
  - Model unbalanced feeders and loads; quantify the probability of islanding risks
- **Task 3: Model battery storage system in D^2NDZ and quantify the impact of energy storage on islanding risks (07/18-12/18)**
  - Build energy storage and inverter controls; quantify their impacts on islanding risks
  - Establish a machine learning approach which can automatically quantify energy storage effects on islanding risks without time-consuming simulations and complicated modeling

[1] Y. Li, P. Zhang, W. Li, J. N. Debs, D. A. Ferrante, D. J. Kane, S. N. Woolard, R. Kalbfleisch, and K. B. Bowes, "Non-Detection Zone Analytics for Unintentional Islanding in Distribution Grid Integrated with Distributed Energy Resources," *IEEE Transactions on Sustainable Energy*, under review.

- **Task 4: Model DER fault-ride-through (FRT) capabilities in D^{2}NDZ and quantify their impact on islanding risks (10/18-03/19)**
  - Implement different FRT strategies (e.g., double synchronous reference frame vector control (DSRFVC) or direct phase coordinate FRT approach (DPC-FRT)) in PV inverter models; quantify the probability of islanding risks
  - Establish a machine learning approach which can automatically quantify FRT effects on islanding risks without time-consuming simulations and complicated inverter modeling
- **Task 5: Documentation and D^{2}NDZ tests (01/19-06/19)**
  - Validate D^{2}NDZ on Eversource feeders
  - Document the D^{2}NDZ software tool
  - Submit conference papers to IEEE PESGM and DistribuTECH as well as journal papers to IEEE Transactions on Smart Grid

Topic 2 – PV Capacity Factor Phase II (07/18-12/19)

- **Task 1: Develop a software tool for PV capacity factor calculations (07/18-12/18)**
  - Build an easy-to-use tool (e.g. in Excel) for PV capacity prediction
- **Task 2: Improve statistical modeling of extreme values (10/18-03/19)**
  - Establish novel extreme value distributions (such as max-stable processes) and parameter estimation methods (e.g. Least Squares formulation for support vector machine, deep neural networks) to better represent the extreme values of PV capacity factor
  - Implement the extreme value models in the PV capacity factor prediction tool
- **Task 3: Analysis of meteorological controls of extreme PV capacity factor values (01/19-06/19)**
  - Analyze antecedent space/time characteristics (e.g. magnitude and persistence) of meteorological factors leading to extreme PV capacity factor values.
- **Task 4: Develop a formal verification tool for islanding risk mitigation (04/19-09/19)**
  - Establish a formal analysis tool[2] that can enclose all possible uncertainties (e.g. ranges of PV outputs obtained from PV capacity factors) in islanding risks analysis
  - Using UConn's formal analysis tool[3], obtain control strategies that provide formal guarantees for risk level satisfaction and safety in Eversource Energy feeders
- **Task 5: Documentation and PV capacity factor prediction tool tests (07/19-12/19)**
  - Validate PV capacity factor prediction tool on CT PV data

[2] Neither traditional power system simulations nor Monte Carlo simulations are formal methods because they cannot cover all possible uncertainties in their calculations. Our Formal Analysis tool is able to incorporate the effects of all possible uncertainties in just one calculation by using a novel reachable set theory and convex zonotope modeling.
[3] Y. Li, P. Zhang, "DFA: A Distributed Formal Analysis for power networks with deep integration of distributed energy resources," IEEE Transactions on Power Systems, invited paper, under preparation.

- Document the PV capacity factor software tool
- Submit conference papers to IEEE PESGM and DistribuTECH as well as journal papers to and IEEE Transactions on Sustainable Energy

D. Data Requirements

Eversource Energy will provide models for typical circuit(s) and metering data (15 minutes average or higher resolution if available) for grid-tied PV systems.

Connecticut Green Bank has agreed to provide the team access to the multi-year, high resolution data (5 or 15-minute interval AC, DC voltage, current, real power and reactive power, and ambient data) in Locus database for a subset of the 15,000 PV systems installed in CT.

Other data and parameters necessary for this project may be requested during the study process. Typical data from the industry may be used in the study if actual data is unavailable, missing or incomplete.

E. Project Deliverables and Timeline

	Year I				Year II				Budget
Topic and Tasks Quarter	1	2	3	4	1	2	3	4	
Topic 1.0 – Unintentional Islanding Phase II									**$100,000**
i. Upgrade D^2NDZ software tool									$20,000
ii. Model unbalanced PV systems and 3-phase unbalanced distribution feeders in D^2NDZ									$20,000
iii. Model storage system in D^2NDZ and quantify the impact of energy storage on islanding risks									$20,000
iv. Model DER fault-ride-through capabilities in D^2NDZ and quantify their impact on islanding risks									$20,000
v. Documentation and D^2NDZ tests									$20,000
Topic 2.0 PV Capacity Factor Phase II									**$100,000**
i. Develop a software tool for PV capacity factor calculations									$20,000
ii. Improve statistical modeling of extreme values									$20,000
iii. Analysis of meteorological controls of extreme PV capacity factor values									$20,000
iv. Develop a formal verification tool for islanding risk mitigation									$20,000
v. Documentation and PV capacity factor prediction tool tests									$20,000
Total Budget									**$200,000**

F. Acceptance Criteria:

The Grid-Side System Enhancements deliverables will be presented at update meetings with Eversource Energy leadership. Feedback and comments from Eversource management and engineers will be incorporated and implemented in the analysis deliverables. Acceptance of the analysis results will be based on the delivery of a methodology by which the probability for non-detection zone and PV capacity factor are quantified and can be repeated by utilization of the models. The model will be used in the distribution asset management, interconnection studies and planning processes at Eversource going forward.

G. Project significance:

The methods developed in the projects Unintentional Islanding and Photovoltaic Capacity Factor will help Connecticut utilities save millions in unnecessary expenditures in infrastructure hardening and significantly increase distributed energy resource (DER) utilization as well as electricity resilience and safety in Connecticut.

H. Project Team:

The team to be engaged in this research is as follows:

Joseph Debs, Distributed Resources Program Manager, Eversource Energy, is the industry advisor for this project.

David Ferrante, Manager of Distributed Energy Resources and Technology, Eversource Energy, is the industry advisor for this project.

Peng Zhang, Associate Professor of Electrical Engineering, University of Connecticut, leads the project as the PI at UConn and provides advice for the PV capacity factor and islanding methods development and the research components during the phases of the project.

Marina Astitha, Assistant Professor of Civil and Environmental Engineering, is responsible for meteorological modeling for PV forecasting.

Efthymios Nikolopoulos, Assistant Research Professor, conducts research on statistical modeling for PV analytics.

One PhD student will work on PV capacity factor analysis, unintentional islanding analytics and frequency response research.

I. Budget

The total budget will be $200,000 with the breakdown of costs per topics summarized below for projects dates Jan. 1, 2018 through Dec. 31, 2019.

Date (mm/yy)	Task	Budget
01/18	Task 1	$70,000
08/18	Tasks 1, 2	$50,000
01/19	Task 1, 2	$50,000
08/19	Task 2	$30,000
Total		$200,000