

PROGRESS REPORT

UI-ASSIST: US-India collAborative for smart diStribution System wlth Storage

Project Period of Performance: 2nd October, 2017 to 30th September, 2022

Reporting Period: 1st January, 2018 to 31st March 2018

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WORK PERFORMED UNDER AGREEMENT

DE-IA0000025

SUBMITTED BY

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U. S. Department of Energy

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8. 1. Executive Summary and Technical Approach

The overall objective of this project is to evolve the future distribution grid that will allow the continuing increase of Distributed Energy Resources (DER) penetration towards a carbon-free electricity system. Project work will lead to the fully conceptualized smart distribution grid that optimally utilizes energy storage and distributed generation supported by well-planned workforce development and policy recommendation. Our team will validate developed solutions using ten different unique test beds and deployed in pilot phase at 10 different field demonstrations sites in US and India.

Project goal is to develop and demonstrate the Distribution System Operator (DSO) functions for optimal utilization and management of DER by interfacing with DER control and microgrid control system as well as analysis of prototype feeders with high penetration of energy storage. The project also aims at addressing communication needs; data needs; security, including cyber-security; economy and resiliency issues; social issues; workforce requirements; policy recommendations; and suitable DSO functions considering seamless integration of microgrid energy management system (μ GEMS) and distribution management system (DMS) functions. Project work will be accomplished in 6 phases as described here:

Phases and Objectives
Phase I: Kickoff and Finalizing Overall Project Management Architecture Objective 1.1: Finalize project management plan Objective 1.2: Finalize agreements for project management
Phase II: Research and Development Activities Objective 2.1: Developing Benchmark Test Systems Objective 2.2: Modeling and Prototyping Energy Storage Objective 2.3: Managing and Optimizing Energy Storage Objective 2.4: Analyzing Microgrid and Active Distribution System Concepts for DER Objective 2.5: Cyber Infrastructure for Microgrid and Active Distribution Network Objective 2.6: Integrating Cyber-security Measures Objective 2.7: DSO Functions for Optimal Operation and Management of DER Objective 2.8: DSO Functions Considering Regulation and Market Design Objective 2.9: Integrating DMS and DER Control
Phase III: Lab testing and Validation Objective 3.1: Validation using analysis tools Objective 3.2: Validation using Real Time Simulators and HIL Testbed Objective 3.3: Testing and Validation using Lab Scale Distribution System
Phase IV: Pilot Level Field Implementation Objective 4.1: Field Implementation for Rural Feeders Objective 4.2: Field Implementation for Semi-Urban Feeders Objective 4.3: Field Implementation for Urban Feeders
Phase V: Impact Analysis and Policy recommendation Objective 5.1: Policy Challenges and Recommendations Objective 5.2: Social Issues and Recommendation
Phase VI: Capacity Building and Workforce Development Objective 6.1: Advancing Existing Power Professionals Objective 6.2: Creating Next Generation of Power Professionals

Expected results by end of this project includes:

- i) Open source distribution feeder models with DER including storage based on real-work utility scenarios.*
- ii) Detailed models of real distribution feeders with high DER penetrations in real time simulator.*
- iii) Demonstrate low-cost, high-resolution distributed solar forecasting technology.*
- iv) Expansion of existing microgrid and smart city demonstration sites as well as new demonstration sites to cover the diverse distribution environments;*
- v) DSO/ADMS (Advance DMS) functionality developed using open source tools;*
- vi) Co-simulation platform for power and communication network;*
- vii) Intrusion and anomaly detection tools using machine learning techniques;*
- viii) Storage charging and discharging estimation tools using fast adaptive observers*
- ix) Volt-var control using properties of hybrid systems and adaptive systems*
- x) Robust approaches to model the renewables and storage at the bulk power system level, which do not need the exact system uncertainty information*
- xi) DER-CAM to generate charging/discharging schedules and maximize the economic value by reducing on-peak consumption and managing tariff demand charges*
- xii) Internet of Things (IoT) communication portal for remote monitoring and control*
- xiii) Cyber-physical interface matrix based reliability analysis*
- xiv) Cyber-secure block-chain based control of DER*
- xv) Threat modeling and defense mechanism for cybersecurity*
- xvi) Report on reference guidelines for cybersecurity for μ GEMS and DMS*
- xvii) Short time transactive interface and transactive control based distribution system market design*
- xviii) Novel edge-computing based distributed voltage control mechanism; and*
- xix) Setting-less protection design and coordination in AC and DC microgrids and in active distribution networks.*
- xx) Quantitative and qualitative social surveys for maximizing social impact and technology adoption*
- xxi) New course development, senior design team involvement, workshops, social networking website for workforce development and dissemination*
- xxii) Multiple demonstration pilot projects carefully selected to demonstrate scalability and flexibility of the developed solutions.*
- xxiii) Workforce development plan to train undergraduate, graduate students, industry personnel, researchers, policy makers and other stakeholders.*
- xxiv) Dissemination plan for broader impact in sustainable electricity development and meeting societal needs.*

1. Accomplishment Towards the Goals and Objectives

a. Major Accomplishments (for the reporting period):

In this quarter, focus was continued on Phase I objectives. We also had students begin work on projects and making some progress on feeder development. We staffed project manager Dianne Daley Laursen and research faculty Pratim Kundu at WSU, who are helping with consortium-wide activities. We made progress on finalizing plans for the first face to face meeting in August for all the project partners and sponsors in Portland, OR on August 3, 2018. Other

activities include finalizing MOU (attachment A) and Theme Leader assignments and guidelines (attachment B).

Our team also made progress on: **1.1.1)** organizing monthly budget meetings, monthly technical meetings with partners; monthly update meetings with DOE, as well as, with Indian Partners; **1.1.2)** instituted team management plan and theme lead responsibilities; **1.1.3)** project progress monitoring and project direction plan through list of deliverables and project management site **1.1.4)** finalizing intellectual property and commercialization plan; **1.1.5)** knowledge distribution, promotional material, and workforce development plans; and **1.1.6)** project management plan and project management portal; **1.2.1)** business agreement with industry members as part of MoU; **1.2.2)** non-disclosure agreements as part of MOU agreement; **1.2.3)** charter for advisory board and revised membership; **1.2.4)** website design and information sharing agreements; **1.2.5)** finalized all the paperwork for awards and agreements with DOE/ DST.

- b. Major Accomplishments (over the course of the project):** Over the course of the project, the major accomplishments are the same as section 2.a. given that first quarter was delayed with DOE paperwork processing.
- c. Milestones:** Milestones are identified and still being finalized after we complete the list of deliverables.
- d. Metrics and Benefits:** metrics identified in the project narrative relates to the technical progress starting Q3. Metrics for Q1 and Q2 will be completed documents identified in section 2.a of this report.
- e. Upcoming Plans:** In next quarter, we plan to complete all the documents listed in section 2.a, finalize the subcontract with all the project partners and start on technical activities for phase II. An update will be provided in early June for phase I activities.

2. Problems, Significant Changes, or Delays

- a.** List any actual or anticipated problems or delays, or any other items impacting project execution that should be brought to the attention of the DOE Project Officer, and describe steps being taken to resolve the problems or delays. (narrative)
 - Paperwork processing has been delayed due to receipt of delayed comments from Indian partners on IP agreements. This resulted in delay in processing the sub-awards to our project partners. MOU final version has been signed by all Indian partners receiving DST funding and forwarded to all US partners.
- b.** Describe any planned or actual changes in technical approach and reasons for these changes. Include impact that these changes could have on expenditures, schedule, milestones, tasks/activities, or deliverables. Identify any changes to

the planned performance site originally identified in technical narrative. Note that significant changes in objectives and scope require prior approval from the project officer and may warrant updating and resubmitting the technical narrative.

- We still plan to complete deliverables as planned but some of the deliverables are delayed due to late paperwork processing. Expenditures are slower than expected but we expect to burn at a faster rate in this quarter and next quarter to accomplish deliverables as planned as well as summer expenditures and reporting of academic year 17-18 cost-share support.

- c. Risk Monitoring.** *Provide the status of each risk identified in the technical narrative, and identify any new or emerging risks:*

Risk Management Log			
E Program/Risk	Impact	Status	Mitigation Method
	<i>(e.g., High/Med/Low)</i>	<i>(e.g., Monitoring/Realized/Mitigating)</i>	
Agreements with partners not finalized	Med	Realized, contract with sub-contracts are being processed	Closely follow up to process the paperwork and frequent updates to sponsors and project partners

Detailed risk monitoring log will be developed with project management plan and will be included in future Q reports.

3. Cost Status

- a.** *Show approved project budget and spend plan compared to the actual costs incurred.*
- b.** *Provide a Spending Plan table showing planned and actual monthly expenditures of Federal funds and cost share.*
- c.** *Provide an explanation for any discrepancies between planned and actual budget execution (narrative).*

Please see the attached excel sheet report “Budget for Current Reporting Period 10/2/17 – 3/31/18”.

Please note: Due to the late set-up of the award within the WSU system, the Year 1 Quarter 1 Progress Report contained estimated costs for the budget period 10/2/17 – 12/31/17. However, WSU was unable to invoice for that period because the award was not fully setup in the WSU system. The current Budget for Current Reporting Period covers both the first and second quarters of the project and are reflected on the current SF-425 recently submitted.

Spending Plan				
Month	Planned Expenditures Federal Share	Planned Expenditures CostShare	Actual Costs Incurred Federal Share	Actual Costs Incurred CostShare
October	123,981	155,125	6,383.04	3,635.06
November	123,981	155,125	1,823.54	3,635.07
December	123,981	155,125	1,822.87	3,636.07
January	123,981	155,125	17,640.57	0
February	123,981	155,125	14,962.32	0
March	123,981	155,125	14,250.60	0
April	123,981	155,126	0	0
May	123,981	155,126	0	0
June	123,981	155,126	0	0
July	123,981	155,126	0	0
August	123,981	155,126	0	0
September	123,981	155,126	0	0
Total	1,487,772	1,861,506	56,882.94	10,905.20

Due to a delay in establishing subaward agreements, some costs which would have been reported during this quarter, will not be reported until the third quarter. Additionally, although graduate students were working on this project, salary adjustments were not in place in time to be reflected in this quarter and will be reflected in the third quarter. Additionally, cost share effort committed during this quarter will not be reflected in the WSU system until Q3.

4. Schedule Status

Provide the schedule status for each task and activity, baselined against the schedule contained in the current technical narrative. The schedule status shall include for each task and activity, a start date, planned completion date, percent complete, cost for current quarter, and project costs for next quarter.

Please note – because the cost share amounts for this period will not be reported until the next quarter, the projected and actual costs incurred will not be reflective of the percentage of the project completed. Even if the % completed may reflect 100% - cost share committed in this period will not be reflected until the next quarter. The table below reflects budget period 10/2/17-3/31/18.

Project Schedule & Cost

Phase	Title or Description	Start Date	Comp. Date	% Comp	Total Planned Cost Fed	Total Planned Cost CS	Prior Cumul Costs Fed	Prior Cumul Costs CS	Cost for Current Q Fed	Cost for Current Q CS	Projected Cost for Next Q Fed	Projected Cost for Next Q CS
1	PMP	10/2/17	5/30/18	75%	867,867	1,085,876	0	0	56,882.94	10,905.20	56,882.94	10,905.20
2	R&D	4/1/18	9/30/20									
3	Testing/ Validation	10/1/18	9/30/21									
4	Field Validation	10/1/21	9/30/22									
5	Impact and Policy	6/1/18	9/30/22									
6	Capacity Building/ Training	10/1/19	9/30/22									
Total					867,867	1,085,876	0	0	56,882.94	10,905.20	56,882.94	10,905.20

Provide a Project Deliverables Log that lists the major project-specific deliverables (e.g., technical reports, interim status reports, etc.) by task and subtask.:

Project Deliverables Log

Associated Phase (Task) or Activity	Deliverable	Planned Completion Date	Actual Completion Date	Submission Method
1.1.1	Organize kick-off meetings;	12/31/17	10/16/17	Email Slides
1.1.2	team management plan;	3/31/18	-	
1.1.3	project progress monitoring and project direction plan;	3/31/18	-	
1.1.4	intellectual property and commercialization plan;	3/31/18	-	
1.1.5	knowledge distribution, promotional material, and workforce development plans; and	3/31/18	-	
1.1.6	project management plan;	3/31/18	-	
1.2.1	business agreement with industry members;	3/31/18	-	
1.2.2	non-disclosure agreements;	3/31/18	-	
1.2.3	charter for advisory board;	3/31/18	-	
1.2.4	website design and information sharing agreements;	3/31/18	-	
1.2.5	initiate agreements with DOE/ DST and steering committee.	3/31/18	-	

5. Product or Technology Production

Provide a description of any product produced or technology transfer activities accomplished during this reporting period, such as:

- a. *Publications; conference papers; conference/meeting presentations, or other public releases (List any pamphlets, etc.). Provide web links or attach copies of public releases.*
 - *None (paper from last quarter attached)*
- b. *Web site or other Internet sites that reflect the results of this project.*
 - *Preliminary website has been developed: www.uiassist.org*
- c. *Networks or collaborations fostered.*
 - *Further discussion with PNNL and including Carl Imhoff in advisory board*
- d. *Other products, such as data or databases, physical collections, audio or video, software or netware, models, educational aid or curricula, instruments or equipment.*
 - *None*

6. Personnel Updates

There have been couple of changes in personnel:

- a) *Fernando Dias, Co-PI with INL, has taken another position away from INL and the new Co-PI on the project is Mayank Panwar.*
- b) *We are confirming all technical personnel for each partner for inclusion on intranet information sharing site by early May, so a more comprehensive update will be available in quarter 3 report.*