**PROGRESS REPORT**

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

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

**Reporting Period: 1st Jan, 2020 to 31st Mar, 2020**

**Submitted: Date, 2020**

**WORK PERFORMED UNDER AGREEMENT**

DE-IA0000025

**SUBMITTED BY**

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**SUBMITTED TO**

U. S. Department of Energy

DOE Project Officer: Merrill Smith

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8. **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 recommendations. Our team will validate developed solutions using ten different unique test beds and deploy in pilot phase at 10 different field demonstrations sites in the US and India.*

*The 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 to address 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 (µGEMS) 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 Recommendations |
| 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 include:*

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

1. **Accomplishment Towards the Goals and Objectives**
   1. **Major Accomplishments (for the reporting period):**

Progress made in this quarter is summarized below by each Themes/Objectives:

Provide short text and figures, if applicable for the progress made for specific objectives, task. Use specific organization and names: (e.g. Dr. Singh from TAMU worked on …)

Theme 1:

Theme 2:

**Objective 2.1: Developing Benchmark Test Systems:**

Theme 3:

**Objective 2.2: Modeling and Prototyping Energy Storage:**

**Objective 2.3: Managing and Optimizing Energy Storage:**

Theme 4:

**Objective 2.4: Analyzing Microgrid and Active Distribution System Concepts for DER:**

Theme 5:

**Objective 2.5: Cyber Infrastructure for Microgrid and Active Distribution Network:**

**Objective 2.6: Integrating Cyber-security Measures:**

Theme 6:

**Objective 2.7: DSO Functions for Optimal Operation and Management of DER:**

**Objective 2.9: Integrating DMS and DER Control**

Theme 7:

**Objective 2.8: DSO Functions Considering Regulation and Market Design:**

Theme 8:

**Lab Testing and Validation:**

Theme 9:

Field demonstration will be future activities.

Theme 10:

**Objective 5.1: Impact Analysis**

* 1. **Major Accomplishments (over the course of the project):** Over the course of the project, following accomplishments has been made*:*

*Short description of accomplishments by each over the course of the project.*

In bullet forms, refer to organization names

* 1. **Milestones:** *Milestone are identified and still being finalized after we complete the list of deliverables.*
  2. **Metrics and Benefits:** *metrics identified in the project narrative relates to the technical progress starting Q3 including “Number of technical publications and presentations” as listed later in this report.*
  3. **Upcoming Plans:** *During the next quarter, plan includes:*

*Brief description about upcoming plans by each partner in the reporting quarter (Jan-Mar 2020).*

*In bullet forms, refer to theme, objectives with organization names*

1. **Problems, Significant Changes, or Delays**
2. *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)*

*List any significant changes/delays by each partner as per their committed goals*

1. *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.*

Describe any deviations from committed goals deliverables

1. 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** |
|  | (e.g., High/ Med/Low) | (e.g., Monitoring/ Realized/Mitigating) |  |
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1. **Cost Status**

*Please see the attached excel sheet which contains the “Budget for Current Reporting Period 4/1/19 – 6/30/19” table.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Spending Plan** | | | | |
| **Month** | **Planned Expenditures**  **Federal Share** | **Planned Expenditures**  **CostShare** | **Actual Costs Incurred Federal Share** | **Actual Costs Incurred CostShare** |
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1. **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 that although the percentage of completion is accurate, the costs incurred will not match the percentages because all partners working on each of the Phases have not submitted their invoices for their costs and projected costs. This will update when missing partners are included.***

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **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\* | 98% | 867,867 | 1,085,876 | 186,472 | 30,285 | 8,000 | 3,000 | 100,000 | 500,000 | |
| 2 | R&D | 4/1/18 | 9/30/20 | 50% | 1,069,005 | 1,384,713 | 145,520 | 330,000 | 118,955 | 52,544 | 400,000 | 200.000 | |
| 3 | Testing/ Validation | 10/1/18 | 9/30/21 | 25% | 1,274,285 | 946,110 | 123,714 | 32,698 | 35651 | 16,015 | 300,000 | 150,000 | |
| 4 | Field Validation | 10/1/21 | 9/30/22 | - |  |  |  |  |  |  |  |  | |
| 5 | Impact and Policy | 6/1/18 | 9/30/22 | 35% | 1,434,580 | 75,650 | 277,901 | 77,016 | 35,652 | 16,015 | 200,000 | 100,000 | |
| 6 | Capacity Building/ Training | 10/1/19 | 9/30/22 | - |  |  |  |  |  |  |  |  | |
| Total |  |  |  |  | 4,645,737 | 3,492,349 | 733,607 | 469,999 | 198,258 | 87,574 | 1,000,000 | 950,000 | |

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

* *These are delayed and detailed deliverables list will be provided in future Q report. Note that planned dates have been modified to reflect the expected dates.*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Project Deliverables Log** | | | | |
| **Associated**  **Phase (Task) or Activity** | **Deliverable** | **Planned Completion Date** | **Actual Completion Date** | **Submission Method** |
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1. **Product or Technology Production**

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

1. *Publications; conference papers; conference/meeting presentations, or other public releases (List any pamphlets, etc.). Provide web links or attach copies of public releases.*

*List publications by each partner for the reporting quarter (Jan-Mar 2020)*

1. *Web site or other Internet sites that reflect the results of this project.*

*- Website has been developed: www.uiassist.org*

1. *Networks or collaborations fostered.*

*List collaborative activities by each partner for the reporting quarter (Jan-Mar 2020)*

1. *Other products, such as data or databases, physical collections, audio or video, software or netware, models, educational aid or curricula, instruments or equipment.*

*List products, models, database, etc by each partner for the reporting quarter (Jan-Mar 2020)*

1. **Personnel Updates**

New students, changes in personnel technical or budget:

*List the changes in manpower/team members by each partner for the reporting quarter (Jan-Mar 2020)*