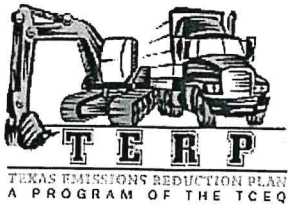

Texas Commission on Environmental Quality
New Technology Implementation Grant (NTIG) Program

City of Austin Pilot ESS and Adjacent Solar PV Facility

Task 7 Deliverable Report / Final Task Report

for:

New Technology Implementation Grant (NTIG) Program

582-15-54066-1471

Submitted by:

City of Austin – Austin Energy

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Final Status Report Overview/Task Deliverables

This Deliverable Report documents City of Austin - Austin Energy's (Austin Energy or AE) completion of Task 7 under the Grant Activities (Scope of Work) described in the New Technology Implementation Grant (NTIG) Contract No. 582-15-54066-1471 (Award). To complete this task, AE is responsible for submitting quarterly status reports through March 31, 2018 and a final report that "summarize[s] all aspects of the project based on data from the task completion reports, and [verifies] final completion of the facility." This report describes AE's completion of the task including photographic documentation of the completed PV and ESS facilities.

Introduction/Background

Established in 1895, Austin Energy (AE) is the 8th largest municipally owned electric utility in the United States, providing electrical power to more than 480,000 customers in a service territory approximately 437 square miles in and around the city of Austin, Texas. AE has a lengthy track record of utility innovation, particularly in solar photovoltaics (PV) and smart grid technologies.

Twelve years ago, AE was first in Texas to launch a PV incentive program to encourage the adoption of solar power by both residential and commercial markets. At the time, the incentive was among the highest in the nation and provided net metering for all customers. AE also pioneered the Value of Solar residential rate, providing customers a mechanism to continue receiving financial credit for PV production while also ensuring financial soundness for the electrical grid infrastructure. AE has also invested in larger scale solar arrays throughout the service territory as well as entered into Purchase Power Agreements (PPAs) for solar power generation. As solar penetration grows, AE has continued to study innovative ways to safely and reliably integrate renewables into the grid. This project involves AE's first assessment of grid scale battery storage to support solar PV generation.

In this solar plus storage project, AE continues to realize its vision of "driving customer value in energy services with innovative technology and environmental

leadership." As a result of this effort, AE is the owner and operator of the Pilot Energy Storage System (ESS), an integrated lithium-ion (li-ion) battery, power conversion system (PCS), and site-level management and control system providing 1.5 megawatts (MW) of electric output and storing up to 3.0 megawatt-hours (MWh) of energy. AE has contracted for an adjacent 2.6 MW solar PV facility constructed, commissioned, maintained, and operated by a selected vendor. Both facilities are located at AE's Kingsbery substation (KB), located in east Austin, as shown in Figure 1 below. See the Task 5 and Task 6 Deliverable Reports for further details on the installation and energization of the adjacent solar facility and the Pilot ESS, respectively.

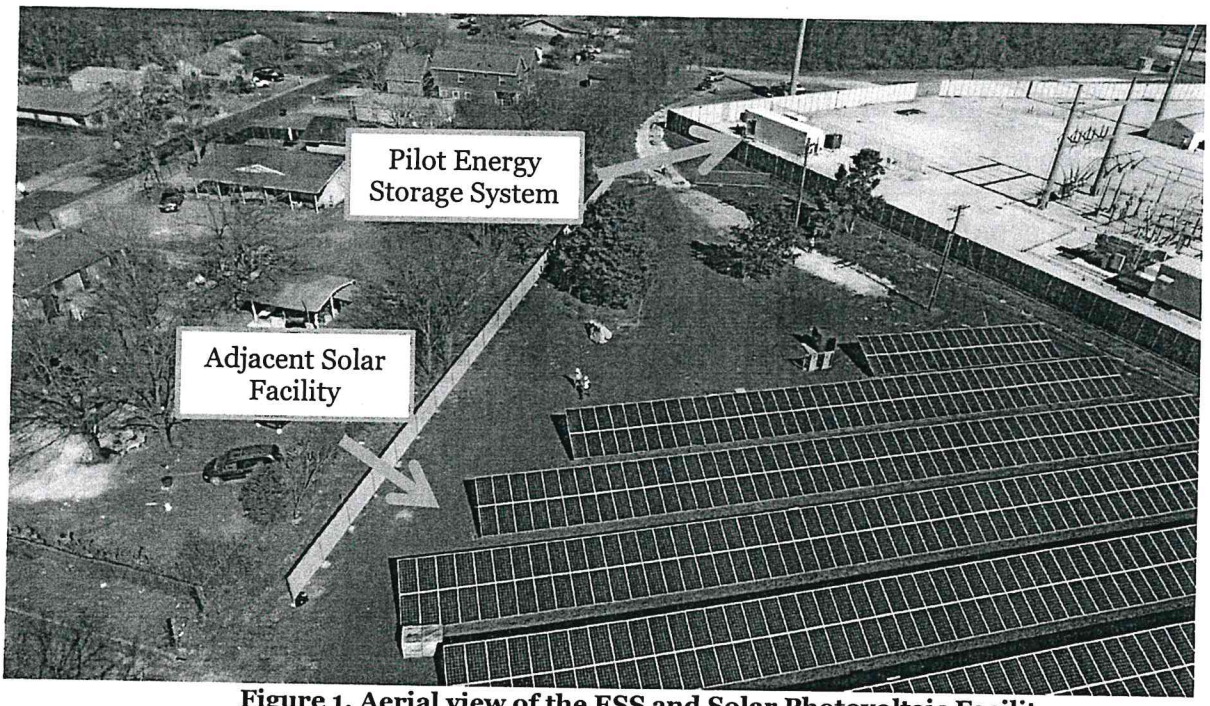

Figure 1. Aerial view of the ESS and Solar Photovoltaic Facility

Project Objectives/Technical Approach

The project will demonstrate how battery storage deployed at the distribution feeder level can integrate higher penetrations of solar PV to help support Austin Energy's goals of reaching 200 MW of local solar photovoltaics by 2020. In addition, the

project tests the feasibility of using storage to support power quality on the distribution feeder, participate in the ERCOT market, and reduce demand during peak periods.

Specific objectives include:

- Demonstrate the use of distributed storage to support power quality on a distribution feeder with a high penetration of PV.
- Demonstrate peak shaving with energy storage.
- Demonstrate the potential for storage to provide energy arbitrage.
- Demonstrate the Modular Energy Storage Architecture (MESA) open standard for communications to energy storage systems.
- Model the potential for storage to enable higher penetrations of photovoltaics at the distribution feeder level within Austin Energy's service area.
- Model the economic potential for storage deployment within the Austin Energy service area as it relates to the ERCOT market.
- Evaluate the business case for adding more storage to Austin Energy's service area when these multiple benefits streams are added together.

Tasks

The Grant Activities (Scope of Work) outlines nine tasks for the design, deployment and demonstration of the Pilot ESS and adjacent solar PV facility as further described below.

Task 1	Approve final design & project plan; provide relevant documentation
Task 2	Solar PV site plan
Task 3	Secure all necessary permits to install and operate project
Task 4	Prepare site for ESS construction
Task 5	Complete and commission adjacent solar PV facility

Task 6 Procure, install, test and energize storage system

Task 7 Implementation reporting

Task 8 Document system performance

Task 9 Reporting Period

This Deliverable Report documents completion of Task 7, the final task of the Implementation Period, as defined in the Award.

Task 7

For reference, the following excerpt from the Grant Activities (Scope of Work) describes Task 7.

> *2.7. Task Statement: Prepare and submit quarterly detailed project reports and a final report while ensuring compliance with all TCEQ program requirements.*
>
> > *2.7.1. PERFORMING PARTY will coordinate all project resources to ensure compliance with program requirements while providing deliverables on-schedule and on-budget.*
> >
> > *2.7.2. PERFORMING PARTY will generate quarterly progress reports and a final report.*
> >
> > *2.7.3. Schedule: PERFORMING PARTY will submit quarterly reports to the TCEQ on March 31, June 30, September 30, and December 31 of each year of the Implementation Period of the contract. PERFORMING PARTY will submit the final report to complete this task by March 31, 2018.*
> >
> > *2.7.4. Deliverables: PERFORMING PARTY will submit quarterly progress reports with associated billing statements and a final implementation report to the TCEQ upon completion of this task. The final report will: summarize all aspects of the project based on data from the task completion reports, and verify final completion of the facility. All reports will be made publically available on an informational website.*

Discussion/Observations

Objectives and Results

The objective of Task 7 is to complete reporting to the TCEQ during the Implementation Period. AE accomplished this objective in two ways: (1) providing quarterly status reports and (2) providing task deliverable reports, both in accordance with deadlines set forth in the Award.

Quarterly Status Reports

Austin Energy provided quarterly reports as required by Section 2.7.3 of the Scope of Work. The requirement is for the Performing Party to submit reports no later than the final day of each calendar quarter for each year of the Implementation Period. As such, AE provided quarterly reports from July 1, 2015 through March 31, 2018. Reports followed the TCEQ provided template and highlighted accomplishments and problems/solutions for the reporting period as well as goals and issues for the succeeding period. AE submitted reports on the following dates:

- September 30, 2015
- December 31, 2015
- March 31, 2016
- June 30, 2016
- September 30, 2016
- December 29, 2016
- March 30, 2017
- June 30, 2017
- September 30, 2017
- December 31, 2017
- March 30, 2018
- June 30, 2018*
- September 30, 2018*

Note: AE also submitted a quarterly status report on June 30, 2018 and plans on submitting a final one on September 30, 2018 to cover the time period until this Task 7 deliverable report was submitted.

Task Deliverable Reports

The Award describes seven tasks during the Implementation Period (Task 1 through Task 7). Each has a specified due date, and AE provided deliverable reports

accordingly. The goal of this final report for the Implementation Period is to summarize all aspects of the project based on data from the task completion reports and verify final completion of the facility. The following sections highlight, task-by-task, the goal, deliverable, task deliverable report submittal date, and a summary of the work completed. Collectively, this information demonstrates completion of Task 7.

Task 1: Approve final design & project plan; provide relevant documentation

A. **Goal:** Finalize all project plans for site control, design, construction, assembly, commissioning, and permitting
B. **Deliverable:** Submit a report to document task completion including the Complete System Design and Project Plan, documentation of site control, and permitting plans
C. **Submittal Date:** August 31, 2017
D. **Task Accomplishment and Completion:** AE worked with Doosan GridTech (Doosan), the ESS integrator, to finalize the overall ESS designs for substantial completion. In the deliverable report submitted in August 2017, AE provided the electrical one-line of the system and the civil design of the existing substation and the ESS. The system is composed of batteries, inverter or Power Conversion System (PCS), disconnect switch, distribution-sized transformer, primary metering cabinet for ERCOT-Polled Settlement (EPS) meters, and a pole-mounted recloser. The report described how the ESS would be installed inside Austin Energy's Kingsbery (KB) substation in southeast Austin. This substation site is owned and under AE's jurisdiction. It also specified that the new ESS project would also be owned by AE once title was transferred from Doosan just before full operations. AE System Maintenance and Restoration and Electrician crews will be responsible for ESS maintenance during years when this system is operating.

   Since the system will be installed in an existing, and already permitted substation, a complete site plan application was not required by the City of

Austin. However, AE made plans to obtain a site plan permit exemption for the ESS. The only requirement by the City was that the additional impervious cover area would stay under 1,080 square feet. The site added 900 square feet of impervious cover to the existing substation. Permitting activities are further documented as part of Task 3.

Regarding the project plan, the Task 1 deliverable report describes how AE and Doosan coordinated efforts for site construction, equipment procurement and delivery, and ESS assembly and commissioning. The report also included the latest project schedule at the time.

Task 2: Solar PV site plan

A. **Goal:** Select a vendor for construction and operation of adjacent solar PV facility to be integrated with the grid
B. **Deliverable:** Submit a report to document task completion including an overview of the adjacent solar PV facility's construction and integration with the grid, and a Gantt chart or timeline illustrating major project milestones
C. **Submittal Date:** November 30, 2016
D. **Task Accomplishment and Completion:** At the time of submitting its NTIG application, AE was beginning the review phase for responses to a Request for Proposals (RFP) to secure a PPA for a solar PV facility to be located on a 29-acre site surrounding the Kingsbery substation. Based upon the responses received, Austin executed an agreement with PowerFin ASL 1, LLC ("PowerFin") in May 2015. The Task 2 deliverable report described how AE had been working collaboratively with PowerFin through the initial stages of project completion including a zoning change request, site studies, adjustments to the location of the solar arrays to avoid heritage and protected trees as well as an existing gas line easement, and submittal of a Site Plan to the City of Austin for review and approval.

   At the time of the deliverable report detailed engineering/final design work was underway. AE and PowerFin were working on the interconnection process to

connect the solar PV facility to the distribution grid. This involved several AE workgroups including Solar, System Engineering, Distribution Planning, Distribution Design, and Complex Metering. The solar PV facility was designed to connect directly to AE's 12.47kV distribution circuit at Kingsbery, close to the feeder head. System protection design includes switchgear, a recloser and transfer trip relaying. Given its capacity, PowerFin was responsible for registering the solar PV facility with ERCOT, the independent system operator. Additionally, the task deliverable report included the latest project schedule at the time.

Task 3: Secure all necessary permits to install and operate project

A. **Goal:** Secure all necessary permits to install and operate ESS
B. **Deliverable:** submit copies of the approved permits, if any, upon completion of this task, or notification that permitting was not applicable to this portion of the project
C. **Submittal Date:** August 31, 2017
D. **Task Accomplishment and Completion:** Austin Energy worked with Stanley Consultants Inc. to get the ESS permitted. The Task 3 deliverable report described how the system would be installed inside the Kingsbery (KB) substation in southeast Austin and comply with local, state, and national regulations for safety and operation, like any other equipment installed in AE's substations. The system was considered by the City of Austin as an addition to the substation, and thus AE was required to apply for a site plan exemption. The only requirement for the exemption was to design the system to have no more than 1,080 square feet of impervious cover and the civil design met this requirement. The site plan exemption was approved by the City of Austin on February 1, 2017. A copy is available via online search at https://abc.austintexas.gov/web/permit/public-search-other?reset=true under Permit Number: 2017-011788 DA. The report includes a screenshot of the

approved exemption. No other permits are required for the installation and operation of the ESS.

Task 4: Prepare site for ESS construction

A. **Goal:** Prepare substation site for installation ESS and test communications between battery systems, Austin SCADA and ESS
B. **Deliverable:** Submit a report to document task completion including photographic documentation of physical site modifications
C. **Submittal Date:** October 31, 2017
D. **Task Accomplishment and Completion:** The Task 4 deliverable report describes how AE's civil and distribution work groups completed the civil site preparation for the Kingsbery ESS. AE and Doosan completed the designs for conduit layout and stub-outs, as well as foundation detail designs for the interconnection equipment and the ESS, respectively. This design was used to complete the civil and distribution work required to pour concrete slabs, install "tails" to connect the new equipment to the existing grounding grid for the substation, and lay conduit for the power and fiber cables required for the proper installation and operation of the system. Once all slabs were poured with the required conduit stub-outs, Doosan visited the site to complete an inspection of the civil work and confirm that the slabs were built per the designs prior to the shipment of the ESS equipment (battery enclosure, Power Conversion System, and disconnect switch cabinet). After Doosan completed measurements and performed a site walk through, AE and Doosan coordinated the time for equipment delivery and placement on the slabs.

   On October 19, 2017 all ESS equipment was placed on the slabs. At the time of the report, installation on of the remaining interconnection equipment (transformer, primary metering cabinet, etc.) was underway. Once all equipment was installed on-site, AE crews pulled power and fiber cables between equipment, and the civil group anchored the equipment prior to final inspection and energization for testing.

The Task 4 deliverable report includes several photos to demonstrate completion of the site preparation work for ESS construction.

Task 5: Complete and commission adjacent solar PV facility

A. **Goal:** Monitor and report on construction, completion, and activation of the adjacent generating facility
B. **Deliverable:** Submit a report to document task completion including photographic documentation of the completed generating facility
C. **Submittal Date:** January 31, 2018
D. **Task Accomplishment and Completion:** The Task 5 deliverable report describes how AE worked extensively with PowerFin through the final efforts to energize the Solar Facility. Through the month of December 2017 and early January 2018, AE and PowerFin worked to construct the Interconnection Facilities that serve the Solar Facility. These efforts included the installation of the several pieces of equipment and involvement of many AE workgroups collaborating with PowerFin's Field Crews. The report describes how PowerFin worked through the installation of 9054 solar modules, 43 solar inverters, 5 transformers, and a switchgear. The aggressive construction schedule yielded in the completion of the Interconnection Facilities and Solar Facility on January 25, 2018, which also included approval from the following regulatory bodies: Electric Reliability of Council of Texas (ERCOT) and City of Austin's Fire, Electrical, Structural, and Solar purviews. The final testing/inspection associated with both AE and PowerFin's System Protection components, occurred on January 26, 2018, when AE verified direct transfer trip function at the switchgear (in accordance with IEEE 1547 and AE's Interconnection Guide Requirements), as well as control and operation of the pole mounted recloser. All AE required testing was successful, and the approval to bring the Facility online was subsequently given to PowerFin. On January 27, 2018, PowerFin was able to bring the 2.6 MW system online, successfully delivering power to the 12.47 kV distribution circuit located at the Kingsbery site.

The Task 5 deliverable report includes several appendices to demonstrate completion and commissioning of the adjacent solar facility.

Further, and in accordance with the Award, the Task 5 deliverable report includes AE's request for TCEQ written approval to proceed with further tasks to be eligible for funding under the Award.

Task 6: Procure, install, test and energize storage system

A. **Goal:** Complete purchase, installation, testing, and commissioning of ESS
B. **Deliverable:** Submit documentation of equipment purchase and delivery as well as a report to document task completion including overviews of the installation and commissioning of the security system and the assembly, commissioning, and energizing of the ESS
C. **Submittal Date:** April 30, 2018
D. **Task Accomplishment and Completion:** The Task 6 deliverable report describes how AE worked extensively with Doosan through the final efforts to commission, energize, and test the ESS. By early January 2018, the team successfully energized the system for preliminary testing. Several AE workgroups collaborated with Doosan's engineers and project managers to troubleshoot and successfully interconnect the system with the grid. Also, Doosan and its vendors provided on-site training of the system to the aforementioned AE Work Groups.

   The report explains the system components of the ESS and how they fit together. It also describes battery racking activities, electrical installation within the battery container, security system installation, approval from ERCOT for energization, and site-level control software.

   For several weeks following the initial system energization, Doosan and their vendors completed commissioning of the ESS components. Once complete, Doosan spent approximately four weeks conducting Final Acceptance Testing which consisted of power and communication tests to guarantee the system was functional per design and prior to transferring title to AE. This testing was

witnessed by a third-party. The report included the Final Acceptance Test Report for reference.

The Task 6 deliverable report includes several figures and appendices to demonstrate purchase, installation, testing, and commissioning of the ESS.

Task 7: Implementation Reporting

A. **Goal:** Prepare and submit quarterly detailed project reports and a final report while ensuring compliance with all TCEQ program requirements.
B. **Deliverable:** Submit quarterly progress reports with associated billing statements and a final implementation report to the TCEQ upon completion of this task
C. **Submittal Date:** September 28, 2018
D. **Task Accomplishment and Completion:** This Task 7 deliverable report describes how AE complied with the Implementation Reporting requirements of the Award. Collectively, the information included in this Section summarizes all aspects of the project based on data from the task completion reports and verifies final completion of the facility.

Critical issues/Technical goals and barriers

During the course of the Implementation Period, AE experienced several setbacks or limitations. These items are best described in the quarterly status reports; however, the following paragraphs describe a selection of the most relevant barriers to completion. Each of these resulted in delays to project schedule. In each case, AE reported the delay and coordinated with TCEQ to address this issue through amendments to the project schedule.

- Technology provider did not meet requirements - Early in the Implementation Period, AE identified that the original battery supplier would not fully meet the requirements for the Modular Energy Storage Architecture (MESA) standard for energy storage which is a critical requirement to meet AE's operational and

safety needs. Switching vendors resulted in a delay in putting the contract in place with the battery integrator, Doosan.

- Permit and site studies delayed project activities - During site studies associated with the adjacent solar PV facility, AE and PowerFin encountered several challenges to project development including results of the site's tree survey, discovery of a misplaced gas line easement, extended reviews related to transportation/sidewalk/roadway designs, and critical water quality zones (thriving invertebrate populations were found in runoff areas on the site, resulting in their designation as critical water quality zones which could not be developed upon). Mitigation of these issues resulted in a need for adjustments to the project layout and design.
- Equipment changes and associated lead time delayed project activities - PowerFin's original design for the adjacent solar facility included interconnection equipment that was no longer available during the course of the project. Redesign, procurement and equipment lead time added additional delays to project activities.
- Unexpected weather conditions delayed installation activities - Heavy rains in December 2017 created conditions unsuitable for installation of solar PV and ESS equipment causing a need for extension of the project deadlines.
- Final Acceptance Testing required more time than scheduled - During final stages of the ESS commissioning work, AE identified the need to review and revisit several test activities before accepting the system. This resulted in longer than expected completion times, but it also led to higher confidence in the final delivered ESS.

The issues described above relate to the Implementation Period. Technical barriers to project objectives will be further studied during the Reporting Period, which includes performance analysis of the installed ESS and adjacent solar facility.

Scope for future work

The remaining work under the Award involves analyzing and reporting on system performance as described in Tasks 8 and 9. This will be completed over the next five years through several reporting mechanisms.

- A report to the TCEQ on the physical and economic performance of the ESS after one year of performance. The ESS began normal operations in September 2018, so AE intends to submit the first year performance report no later than September 30, 2019.
- Annual operation status reports submitted no later than August 31 of each year between 2019 and 2022.
- A final operations report submitted in 2023 upon completion of the Reporting Period.

Summary/Conclusions

As described in this Deliverable Report, AE as successfully met the requirements of Task 7 and thus completed the Implementation Period.

Acknowledgments

AE acknowledges the support and funding from the Texas Commission on Environmental Quality (TCEQ) through its New Technology Implementation Grant (NTIG) Program.

AE also acknowledges the contributions of project partners Doosan GridTech and PowerFin Partners.

Additional funding for the Cost Match components of the project budget comes from the U.S. Department of Energy (DOE) Cooperative Agreement Award No. DE-EE0007177. TCEQ acknowledged and agreed to this funding in email correspondence on August 16, 2017.