Doosan GridTech®

AUSTIN SHINES

Achieving Sustainable and Holistic
Integration of Energy Storage and Solar PV

Case Study

DOOSAN

EXECUTIVE SUMMARY

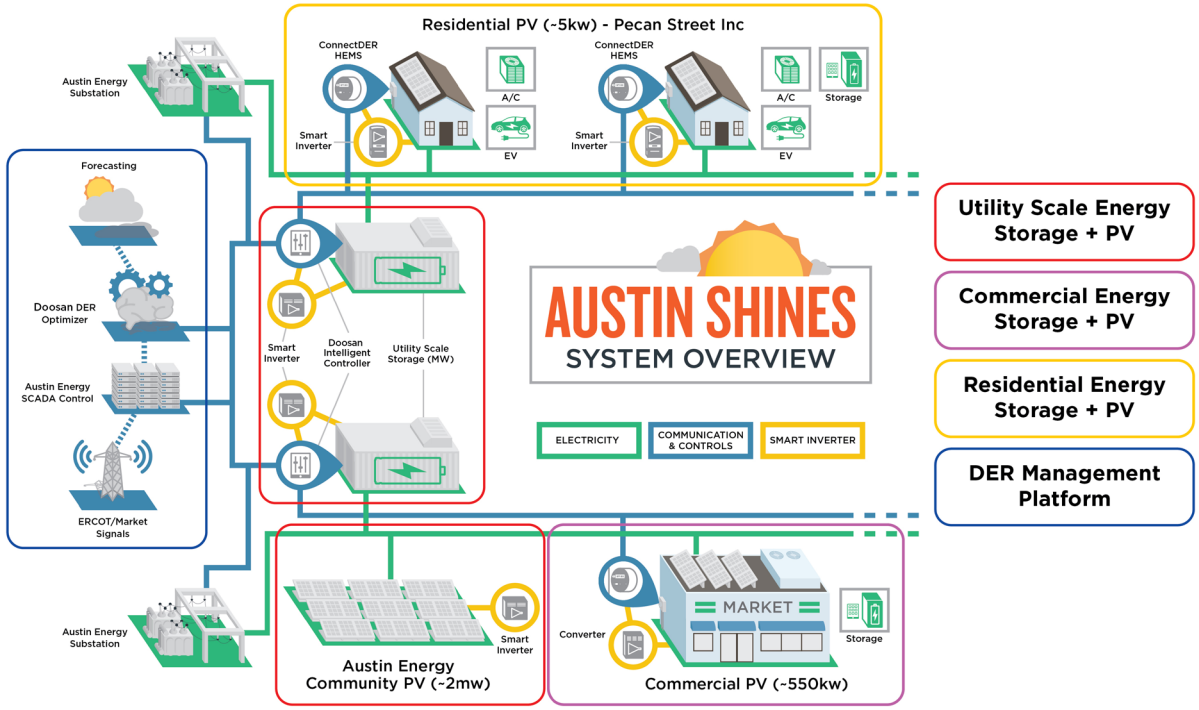
Doosan GridTech worked hand-in-hand with Austin Energy to form the guiding vision behind Austin SHINES' Distributed Energy Resource Management System (DERMS) which ultimately proved that holistic integration of utility scale, commercial and residential resources can work together to return value to both the utility and its customers. The firm not only played a part in launching this landmark DER control and optimization methodology, but also helped develop what is now a replicable and configurable model to serve other utilities' DER integration needs in keeping with DOE's original mission for the Austin Shines program.

PROGRAM OVERVIEW

Austin Energy is rapidly transitioning into a utility with significantly high levels of renewable resources. In 2015, only 20 percent of electricity supplied to customers came from renewable resources; by 2016, the number was 30 percent. As it approaches the tipping point of majority renewable resources – the next major milestone is 65 percent renewable energy by 2027 – the transformation becomes profound. Local consumer adoption of renewables further increases the presence of distributed energy resources and their impact on the distribution grid. As a large, vertically integrated public utility in a deregulated wholesale energy-only market, the change requires addressing complex and interrelated challenges that are both economic and operational.

Recognizing that versions of the same dilemmas are playing out for utilities across the country in many different markets, geographies and regulatory climates, Austin Energy sought funding from the U.S. Department of Energy SETO (Solar Energy Technologies Office) program to take an approach that could establish a model for other utilities. In 2016, it gained partial funding when it was granted $4.3 million, the largest award to date under the Sustainable and Holistic Integration of Energy Storage and Solar PV (SHINES) program. Austin SHINES defined objectives for the project that not only help achieve Austin Energy goals but also contribute to advancing utility knowledge for the industry at large. These project goals include:

1. To provide a template DER management platform demonstrating repeatable operational methodologies relevant to any region;
2. To maximize the penetration of distributed solar PV, valued with a reliability factor, to meet consumer wants and needs;
3. To enable distribution utilities to mitigate potential negative impacts of high penetration levels of PV and other renewable resources;
4. To provide a system-wide levelized cost of energy (SLCOE) metric for evaluating the grid's optimal mix of resources in any region or market structure.



ASSEMBLING THE DER

The long game for Austin Energy is to meet the renewable goals it has set, which reflect the Austin community's values of environmental stewardship and conservation, while balancing them against reliability and affordability for the utility and its 460,000 customers. These goals include:

- Offsetting 65 percent of customer load with renewable resources by 2027;
- Recording 1000 MW of savings from energy efficiency and demand response by 2027;
- Deploying 750 MW utility-scale solar and 200 MW of local solar, including 100 MW customer-sited PV by 2025;
- Integrating 10 MW battery storage and 20 MW thermal energy storage by 2025;
- Achieving net-zero community-wide greenhouse gases by 2050.

The SHINES project, in a sense, set out to make things complicated. It sought to include the widest possible variety of resources to rigorously study, test and evaluate the best approach and allow flexibility for different platforms even as it continued (and continues) to add renewable resources. Throughout 2016-2017, the utility considered and collaborated with multiple partners to assemble what eventually came to include nearly 6 MW of resources on both sides of the meter to be managed within the SHINES program. These include:

- **Utility scale energy storage + PV**: A 2.6 MW community solar farm and two energy storage systems (each 1.5 MW / 3 MWh Li-Ion).
- **Commercial energy storage + PV**: Aggregated storage installations at three sites, one with 18 kW / 36 kWh Li-Ion battery storage and two with 72 kW / 144 kWh Li-Ion battery storage. All sites have existing solar (300+ kW).
- **Residential energy storage + PV**: Aggregated storage installations at six homes (10 kWh each) plus one electric vehicle connected in vehicle-to-grid fashion (28kWh available for grid dispatch). An additional twelve homes with utility-controlled solar (via smart inverters) and six homes with autonomous settings on their solar smart inverters.

DERIVING VALUE FROM THE WHOLE

Why were these DER selected? Each was chosen for its ability to test and measure an important use case and value proposition. Austin Energy identified three main categories of value: contributions to system reliability, enhancement of customer satisfaction; and market-related economic benefits.

Designed by Doosan GridTech, the grid-scale energy storage systems at both the Kingsbery and Mueller locations, for example, provide market benefits through two different types of control applications. They can participate in day-ahead energy arbitrage and realize economic value through the price differential. The utility can also apply real-time price dispatching to gain value by reacting to price spikes as they happen. In terms of reliability, the Kingsbery and Mueller ESS also participate in voltage support programs, reducing losses and increasing the amount of solar generation that can be deployed. Similarly, by managing distribution congestion with the ESS at both locations, the utility safeguards local grid reliability.

The aggregated energy storage systems at residential customer locations also participate in the applications noted above – and have the additional benefit of being able to be used for peak load reduction. Far from seeing residential DER as a threat to the utility, Austin Energy is finding a "win-win" in which customers' storage can be tapped to help lower the utility's transmission cost obligations. Similarly, through the aggregated energy storage at commercial locations, the utility is reducing demand charges – lowering the customer's bills while realizing system benefits.

At this time, the aggregated ESS at commercial locations is able to deliver all the economic benefits (utility peak load reduction, day-ahead arbitrage, and real-time price dispatch), but it is not set up to realize reliability benefits. Some of this is because of the nature of aggregation, where the location of assets is not necessarily known to utility control systems. Voltage support and congestion management can be highly location-specific, and under certain control structures, this value may be difficult for certain assets to realize. This is a case where the technology is capable, but the costs of deploying a program could outweigh the benefits provided.

Overall, while some of the DER contribute value in nearly all areas, others may offer more streamlined benefits. For example, voltage support is the only application use case for the utility-controlled residential solar PV. However, when viewed together, the assets deliver a cohesive and comprehensive impact – if they are controlled and dispatched optimally.

Austin SHINES Assets and Applications Mix

Benefit Type	Control Application	Distributed Resource				
		Kingsbery ESS Grid-Scale	Mueller ESS Grid-Scale	Aggregated ESS Commercial	Aggregated ESS Residential	Utility -Controlled Solar PV Residential
Economic	Utility Peak Load Reduction			Yes	Yes	
	Day-Ahead Energy Arbitrage	Yes	Yes	Yes	Yes	
	Real-Time Price Dispatch	Yes	Yes	Yes	Yes	
Reliability	Voltage Support	Yes	Yes		Yes	Yes
	Distribution Congestion Management	Yes	Yes		Yes	
Customer	Demand Charge Reduction			Yes		

THE CONTROL SYSTEMS – LAYERS OF INTELLIGENCE

The heart of the project is the DERMS control system, really a system of systems, which combines local and distributed intelligent controls in an approach collaboratively designed with Doosan GridTech.

Distributed Intelligent Control

At the grid edge, Austin Energy uses local control units (Doosan GridTech Intelligent Controller® or DG-IC® for grid-scale storage; Smart ConnectDER™ for residential solar) and aggregator platforms, each capable of managing DER assets in real-time. These local controllers also provide data to inform centralized operations. These distributed controllers are "smart" and autonomous, so they can operate independently or collaboratively through a centralized control system. Today, this provides flexibility to adapt to different scenarios as the utility observes and defines the best control protocols for different use cases. In the future, the local controllers' ability to act independently could enable the utility to "island" its energy resources if it wanted to run microgrids in emergency situations.

Austin Energy is also using the local control systems to address power quality needs. The controllers help prioritize operating modes for real power use-cases such as power smoothing and frequency response and for reactive power use-cases like power factor correction and Volt/VAR support. The utility is studying the most effective ways to address the impact of several different types of renewable resources on power quality around points of intertie with the grid.

The local control units and aggregator platforms communicate using open standards, allowing Austin Energy to engage securely and reliably with multiple present and future technologies. This is especially important at the grid edge, where the utility faces an ever-expanding number and type of (potentially) connected resources associated with commercial and residential consumers and prosumers.

Centralized Smart Control

Within Austin Energy's operations centers, DERO® (Doosan Gridtech's Distributed Energy Resources Optimizer®) acts as the central DERMS platform, informed by the utility's existing control systems, including SCADA. It receives asset data, like resource status and availability, fed to it by the local control units and aggregator platforms. It also acquires data from many other sources, including weather, price and load forecasts and real-time market prices.

Austin Energy uses DERO to facilitate a two-way flow of data that encompasses all resources and accommodates multiple schedules and intervals of data production. Like the distributed control systems, this centralized system also uses the open standards that Austin Energy sees as critical to its plan to scale up as more DER comes online.

CALCULATING FOR VALUE AND RELIABILITY

Within the control centers, DERO gets down to the business of "optimizing" assets. What does this mean? The DERMS acts continuously (as well as on command) to perform analysis of data to yield actionable findings to inform distribution system operators and power schedulers. The value is in the details, where analysis of precise timing and the impact of aggregating resources can yield powerful insights. Which distributed resources should be dispatched in which way to deliver optimal value? What amount of data is necessary to achieve sufficient results? How extensively should we distribute sensors or controls? DERO answers these questions, effectively aggregating and optimizing the value of DER while applying a value for reliability in accordance with user preferences. System LCOE encompasses the cost and performance value of all assets within a defined distribution circuit.

$$\text{System LCOE to serve load (\$/kWh)} = \frac{\text{[Capital cost of all system eqpt (\$)] + [Operating cost of all system eqpt (\$)] + [Net value of energy, capacity \& services that cross system boundary (\$)]}}{\text{[All load served in the system (kWh)]}}$$

By synthesizing the streams of operational and market-based information, DERO derives a system-wide schedule or dispatch plan. It issues ongoing recommendations to grid operators and power schedules and acts upon those recommendations according to user preferences. DERO then makes real-time adjustments in response to the changing grid, market and resource conditions throughout each day and night.

Austin Energy is using DERO to dig into the complexities beyond a single use case. It is not just knowing the value of one asset or set of assets but understanding how they can be used optimally to extract value that benefits the utility, its customers and other engaged stakeholders of DER. The solutions worked out daily are informing a practice and approach to be applied over time and at scale.

FINDINGS & PRINCIPLES

The knowledge outputs of the project will include Austin Energy's defined plan to scale DER integration across its enterprise according to the optimal design and configuration; details on the utility's control and ownership use-case findings; shareable principles extracted from the system-wide levelized cost of energy methodology; and observations on the performance of the DERO platform. Clarity is emerging around an approach built on the principles of unified control systems with centralized and distributed intelligence and the need for holistic analysis that blends technical and economic objectives. As the utility operates and observes, it is building a model to address one of the industry's key challenges -- how to best maximize value and reduce the levelized cost of energy across an entire enterprise populated with DER.

PROJECT PHOTOS

Doosan designed the utility-owned energy storage systems and conducted the overall system integration among the utility scale, residential and commercial assets. The firm also installed its energy storage control platform to manage the Kingsbery and Mueller sites and its DERMS platform to collectively manage and optimize front-of-the meter and behind-the-meter assets.

Austin SHINES – Kingsbery ESS 1.5 MW / 3MWh with La Loma Community Solar Farm

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Austin SHINES – Mueller ESS 1.5 MW / 3MWh

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At Doosan GridTech®, we believe that enduring economic growth and environmental healing start with a resilient, low-carbon power grid. We are a multi-disciplined team of power system engineers, software developers, and turnkey energy storage specialists. We help utility-scale power producers evaluate, procure, integrate, control, and optimize energy storage, solar power, and other renewable power resources. Our battery storage experts in Seattle, Melbourne, and Seoul have designed and built over 35 installations in the Americas and Asian-Pacific regions – representing over 453MW of capacity.