Managing DER Impacts

The GRID20/20 OptaNODE® Solution enables continuous increase
of distributed PV Solar deployments in Hawaii

GRID20/20, Inc.

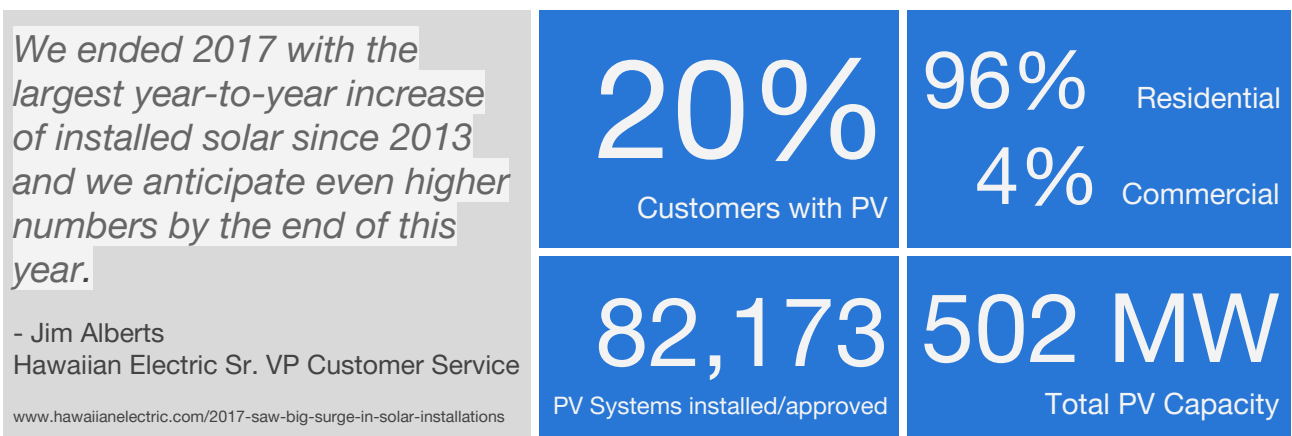*January 2018*

Executive Summary

Given high electricity prices due to imported fossil fuel generation dependency, and incentives such us tax credits and net metering, Hawaii boasts record levels of Distributed Energy Resources (DER). Effectively handling leading levels of DER adoption can be considered both a remarkable achievement and a serious challenge, as the Hawaiian Electric Companies have discovered.

The unprecedented growth in rooftop solar installations has caused certain neighborhood circuits to reach extremely high levels of photovoltaic (PV) penetration. Oftentimes this leads to voltages that exceed regulated maximums, or creates additional impacts at the circuit level. The occurrence of substantial PV-influenced effects has caused Hawaiian Electric to recognize the need to actively address new Distribution Grid challenges not yet experienced by others.

Without intra-grid visibility, it is unclear if the distribution grid can safely and reliably handle increased distributed generation. Hawaiian Electric embraced GRID20/20's OptaNODE solution, which delivered the required visibility into the Distribution Grid to properly manage DER. Using this emerging intra-grid sensor technology, Hawaiian Electric is paving the way for peer utilities around the world.

The GRID20/20 OptaNODE solution:

✓ Provided accurate Voltage and Energy Flow information.
✓ Allowed for critical Distribution Planning models validation.
✓ Enabled an expedited approval process of new rooftop solar installations.

> *We ended 2017 with the largest year-to-year increase of installed solar since 2013 and we anticipate even higher numbers by the end of this year.*
>
> - Jim Alberts
> Hawaiian Electric Sr. VP Customer Service
>
> www.hawaiianelectric.com/2017-saw-big-surge-in-solar-installations

20% Customers with PV	**96%** Residential **4%** Commercial
82,173 PV Systems installed/approved	**502 MW** Total PV Capacity

Hawaiian Electric PV Solar statistics

Challenges

The need for sustainable generation, Greenhouse Gas reduction, and improved energy efficiency has favored the development of Distributed Energy Resources (DER). But, increasing DER penetration in Distribution Grids can cause serious problems, such us voltage instability, asset degradation, reliability concerns, and increased operating costs.

Hawaiian Electric is experiencing enough PV solar coming onto an increasing quantity of circuits to back-feed power into their Distribution Grid on sunny days, and to drive system-wide demand curves below zero on peak days. Excess energy from a high influx of PV can back-feed into the circuits, causing overvoltage, reverse overloading, and other problems. PV-influenced effects become a concern because circuits that send power back up to Distribution Transformers and Substations create various technical and operational challenges. And, these impacts can be dangerous for utility crews and customers, as well as create harmful effects upon utility assets and consumer equipment. Excessive PV can also cause flickers or outages, thus decreasing the quality and reliability of service, which customers expect and deserve.

Traditionally, Distribution Grids were modeled and designed for unidirectional energy flow. Using this one-way energy flow model, Voltage Regulators were deployed and adjusted as necessary to compensate for voltage drops based on feeder lengths and other grid architecture characteristics. However, the Distribution Grid was never conceived, or designed to convey power in two directions. And while DER delivers many benefits, it creates Distribution Grid impacts never imagined when Planning Engineers originally determined asset placement and sizing.

Distribution Grid Planning Engineers are now faced with the task of determining how much PV circuits can handle before suffering overvoltage and reliability issues that drive safety concerns, and additional cost burdens for utilities. Without Voltage or Power Flow information, Hawaiian Electric struggled to validate Distribution Grid models (i.e. corroborate if the Distribution Grid was performing as planned, delivering electricity within stipulated voltage levels, and operating safely).

Solution

The GRID20/20 OptaNODE® Distribution Transformer Monitors were strategically deployed along Distribution Grid circuits. Hawaiian Electric appreciated the straight forward, non-intrusive nature of the OptaNODE installations. Fast deployments of the intra-grid sensors allowed Hawaiian

Electric to immediately benefit from accurate, unique, timely, granular information from within the heart of the Distribution Grid. The GRID20/20 patented intra-grid sensor design allowed Hawaiian Electric to avoid the need to impose disruptive power outages that otherwise would have negatively impacted customers and caused burdensome economic impacts upon the community.


OptaNODE® DTM sensor installed on overhead Distribution Transformer - Oahu, HI

Voltage and Power Flow information, among other critical data points provided by the OptaNODE solution, is now being used as key inputs in Distribution Grid modeling. This unique data allows Hawaiian Electric to correlate critical planning information. The combination of GRID20/20's patented sensors and robust software solution has allowed for vital circuit analysis. This has provided Distribution Planning Engineers the flexibility to model the power Distribution Grid in full detail from the substation to the customer, and confidently validate the outputs of such models.

Accurate distribution models validated by timely field data from within the intra-grid now enable Hawaiian Electric to identify areas where further studies or possible implementation of corrective measures or upgrades are needed. This information allows Planning Engineers to safely and reliably protect grid assets before new PV systems are interconnected to the grid. In turn, Hawaiian Electric's valued customers and rooftop solar installers now enjoy faster PV approvals, while the distribution grid itself is carefully monitored and managed to ensure that safety and reliability expectations are continually achieved and maintained.

Using the unique, accurate, granular, timely data provided only by intra-grid sensors, Hawaiian Electric can now confidently administer grid corrections such as replacing conductors, adding new distribution transformers, adjusting Voltage regulators, or changing transformer tap settings.
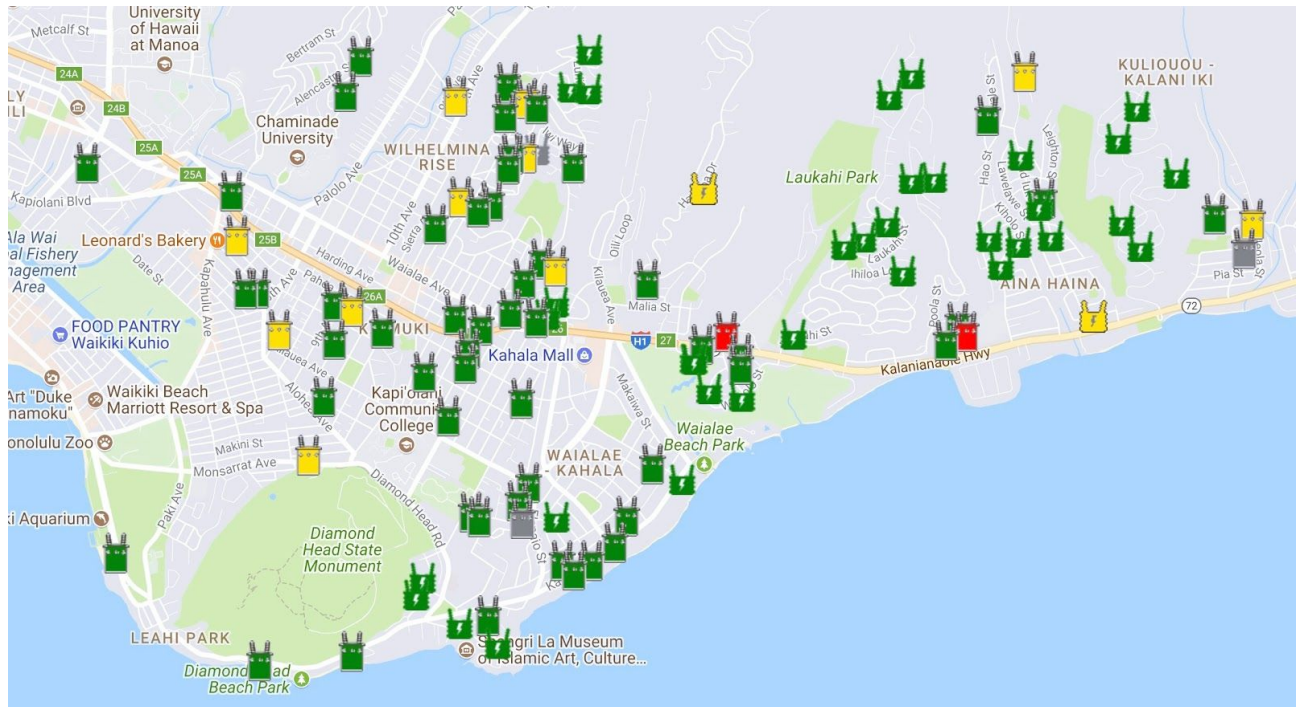

Partial view of OptaNODE® DTM devices operating at Hawaiian Electric

Results

With leading concentrations of solar PV, Hawaiian Electric is at the forefront of understanding how much DER the distribution grid can truly handle. This pioneering effort by Hawaiian Electric is paving the way for peer utilities to similarly manage DER impacts. Hawaiian Electric bears an added pressure associated with proper DER management; presently, Hawaii is pursuing one of the most ambitious renewable energy mandates in the U.S. Hawaii's goal is to achieve 100 percent power generation via renewable resources by 2045.

Hawaiian Electric's customers collectively represent the highest PV penetration percentage of any utility on the mainland, now leading the entire U.S. in both solar watts per customer and solar installations per customer. Yet, it is clear that many utilities will similarly be faced with DER impacts. DER's unplanned, unimagined, and unknown effects upon the assets that comprise the distribution architecture, and the Distribution Grid as a whole, require proper technology to aid in

safe and reliable grid management. Clearly, given the significant DER push, Hawaii is not alone; they are merely the pioneer of the DER realities that many utilities must now begin to face. No longer can utilities simply add DER onto their grids without also truly understanding the intra-grid impacts that subsequently effect the distribution grid. Intra-grid sensors solve this need.
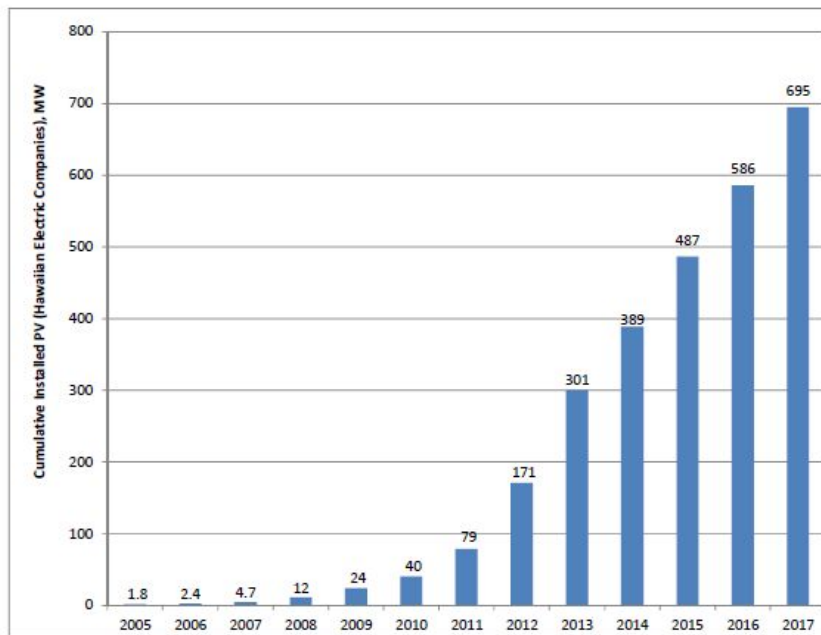
Cumulative Installed PV in Hawaii, as of Dec. 31, 2017

The GRID20/20 OptaNODE solution has proven to be a reliable, technologically-advanced, cost effective tool, enabling Hawaiian Electric to address DER impacts. GRID20/20's advanced technology has enabled Hawaiian Electric to further ensure grid stability and safety, which clearly represents top priority interests for every electricity provider.

It is increasingly clear that DER impacts have the ability to destabilize the intra-grid, thereby eroding reliability, accelerating asset degradation, increasing operating expenses, and decreasing revenues for utilities. These fundamental grid management realities have oftentimes been overlooked or unrealized as most attention and awareness has predominantly been directed toward embracing and expanding renewable, clean energy sources at the grid edge. But, as Hawaiian Electric has validated, utilities must leverage intra-grid sensor technology to better understand and address the otherwise unknown impacts associated with advancing DER.

+100 MW

new PV Solar installed

19%

increase from 2016

Power equivalent to that used by about **32,000** homes.

2017 PV statistics - totals for Hawaiian Electric Companies' service territories

Private rooftop solar installations, and approvals as a percentage of total customers increased in 2017. Hawaiian Electric anticipates continued growth in the private rooftop solar sector. As the cost of rooftop solar decreases making installations more appealing, and as DER further aligns with the popular interest to embrace cleantech advancements, utilities will be faced with real challenges, and key decisions. Hawaiian Electric has provided the industry with a valuable Case Study. As a result, utilities can now begin to monitor and understand existing DER impacts while proactively planning for and ensuring the safe and efficient embracement of imminent DER expansion. Through its cost-effective OptaNODE intra-grid solution, GRID20/20 is now assisting utilities such as Hawaiian Electric to properly address the key infrastructure and operational challenges presented by the emerging CleanTech SuperGrid™.

Electric Utilities face an ongoing struggle to maintain safe, reliable, and profitable operations among increasing consumer demands and regulatory oversight pressures. Distribution Grid operating efficiency and improved reliability are critical elements concerning utility profitability.

As utilities shift to a new paradigm, now becoming focused on Distributed Energy Resources, Greenhouse Gas reduction and genuine Energy Efficiency, advanced technologies such us the OptaNODE solution are becoming part of this accelerating transformation.

The GRID20/20 OptaNODE solution represents an intrinsic component of the emerging Clean Tech SuperGrid™.

About Hawaiian Electric Company

For more than 125 years, Hawaiian Electric Company has provided the energy that has fueled the islands' development from a Hawaiian kingdom to a modern state. Hawaiian Electric Company, and its subsidiaries, Maui Electric Company, and Hawaii Electric Light Company, serve 95 percent of the state's 1.4 million residents on the islands of Oahu, Maui, Hawaii Island, Lanai and Molokai.

About GRID20/20

GRID20/20 is a leading Distribution Transformer Monitoring provider possessing patented intra-grid sensors to reveal unique, accurate, granular, timely information from within electricity distribution grids. The versatility of GRID20/20's solution creates a myriad of operational and energy efficiency gains for utility operators. The growing list of value propositions yielded by GRID20/20 includes improved DER integration, Greenhouse Gas Reduction, Loss Identification, Outage Reduction, Improved Reliability, Accelerated Outage Restoration, enhanced Energy Purchase Cost Reduction opportunity, Asset Loading information, and increased Metered Revenues. GRID20/20 presents a globally relevant solution to address globally persistent distribution grid management challenges.

For more information visit www.grid2020.com.