ENERGY TRANSITION INITIATIVE
Islands

Playbook Lesson Learned
Phase 6: Process Improvement

Integrated Distribution Planning Helps Hawaii Chart the Course for Ongoing Growth in Distributed Generation

A home in Oahu's Kaupuni Village, the first net-zero affordable housing community in Hawaii. *Photo by Adam Warren, NREL 34717.*

In 2015, Hawaii became the first U.S. state to establish a renewable portfolio standard (RPS) target of 100% by 2045. Having set its sights higher, the state faces near-term challenges to meeting its goals, including interim RPS targets of 30% by 2020 and 40% by 2030. To address these challenges, Hawaii is applying lessons learned from past experience that may prove relevant to other islands pursuing aggressive renewable energy goals.

Since the launch of the Hawaii Clean Energy Initiative (HCEI) in 2008, Hawaii has made substantial progress toward its initial goal of meeting 70% of its energy needs with clean energy by 2030, but not without encountering significant hurdles along the way. As distributed generation (DG) increases in the later phases of an island energy transition, grid integration challenges can arise. The modeling and analysis Hawaii is conducting to plan for future growth of distributed energy resources (DERs) and anticipate future limitations of its six islanded grids exemplify proactive measures to address these challenges. As other island communities seek to strike a balance between maintaining project momentum and ensuring system reliability through process improvements, they can learn from Hawaii.

Challenge

Although scenario planning and solar and wind integration studies[1] were instrumental in informing and guiding utilities and decision makers as to how far and fast energy transformation could reasonably proceed in Hawaii, the planning process has been continually outpaced by events. In Hawaii's rapid progress toward high rates of renewable penetration, particularly in the area of DG, the state's utilities, regulators, and policymakers became misaligned in efforts to address the most challenging aspects of energy transformation.

[1] See, e.g., HNEI Renewable Grid Integration Studies: *http://www.hnei.hawaii.edu/projects#GI*

Early-stage growth in the Hawaii market was primarily driven by customer participation in the net energy metering (NEM) and standard interconnection agreement programs. Together, these two programs account for more than 90% of the DG capacity installed in the Hawaiian Electric Company service territories, and the feed-in tariff program accounts for the remainder. These market mechanisms were established to encourage customers to install DG with standardized agreements and relatively simple compensation mechanisms. While the NEM program was successful in creating a local market for DG, it also spurred growth that outpaced initial expectations.

As demand for rooftop solar accelerated in the first 5 years of HCEI, the interconnection process became a source of friction between customers requesting to install photovoltaic (PV) systems and utilities concerned about maintaining a safe and reliable electricity system. Significant backlogs of interconnection requests accumulated as new technical concerns were raised about growing levels of rooftop solar.

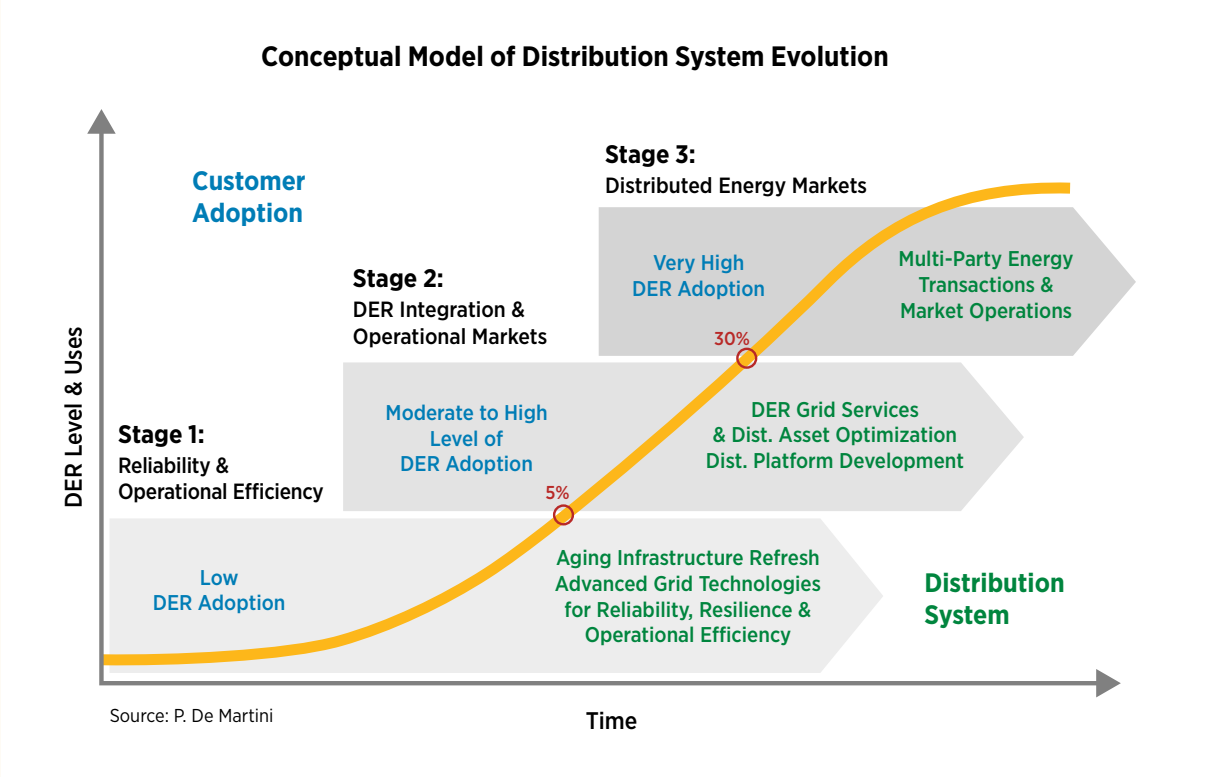
Another concern arising from the prevalence of NEM systems involved the continued financial health of the utility; as NEM systems increased, they offset more and more energy consumption, reducing utility revenues and potentially stressing the existing business model.

In this environment, decision makers faced a challenge in deciding how and when to transition to new market options. Regulators found themselves in the uncomfortable position of making Hawaii one of the first states in the country to close an NEM program—one that had amassed considerable popularity among the solar industry and its customers in Hawaii. This followed disagreement among Hawaii's energy stakeholders on whether the fledgling feed-in tariff program would continue to be part of the transition path. Without a clear consensus among energy stakeholders intervening in the DER docket, the Public Utilities Commission (PUC) decided to phase Hawaii out of NEM, adopting a nonexport option as an interim course until the parties could work out a more permanent solution.

After the discontinuation of Hawaii's NEM program in October 2015, Hawaii faced a difficult transition to several new market options set forth by the PUC. The "self-supply" nonexport option featured a battery, inverter, PV solution that the market was not quite ready to supply. This, along with the interconnection backlog, has contributed to a marked decline in DER adoption since 2013.

These types of challenges arise when the market has to catch up to policy changes for which technology and regulations are not yet in place. At the same time, utilities proceed cautiously because of the technical and financial risk they face in seeking to strike a balance between integrating increasing levels of renewable generation and maintaining both system reliability and bottom line growth. The lesson learned from this experience is that in rapidly changing energy markets, analysis and planning are key to striking this delicate balance in advance of deployment decisions.

"In hindsight, proactive and collaborative planning that integrated both system- and distribution-level generation and infrastructure beyond the traditional, utility-driven integrated resource planning paradigm could have better anticipated and addressed some of Hawaii's challenges," said Mark Glick, former administrator of the Hawaii State Energy Office, who now leads policy and innovation efforts at the Hawaii Natural Energy Institute (HNEI). "Future efforts to apply this lesson learned through a more integrated approach to planning is gaining traction in Hawaii, and is likely to enhance our ability to effectively manage DER growth going forward."



A three-stage diagram of distribution system evolution that Hawaii is customizing to its unique circumstances and applying to its electricity distribution planning efforts. *Source: P. De Martini.*

Solution

Managing DER growth while ensuring electricity system reliability and maintaining utility financial resilience is a common challenge faced by energy transition leaders. Hawaii is addressing this challenge with a two-pronged approach to distribution system reforms.

First, planners in Hawaii have proposed a conceptual model for the evolution of distribution systems, to be followed by a summary of the key planning, operations, and market functions that are required to support increasing levels of DERs as the state progresses toward its 2045 goal. The PUC is also continuing to advise the utilities to work more closely with energy stakeholders in the various open dockets, including the new grid modernization proceedings. Although a truly collaborative approach to integrated distribution planning is relatively new, a methodical, three-stage evolutionary model developed by Paul De Martini, a visiting scholar at the California Institute of Technology, and Lorenzo Kristov, California Independent System Operator's Principal on Market and Infrastructure Policy, suggested to Hawaii another way to plan for seamlessly integrating increasing amounts of DERs into the energy ecosystem.[2]

The model includes functional and market objectives deemed best suited to support each stage of distribution system evolution. By anticipating functional requirements of the system caused by increasing amounts of DERs, utility investments in planning, operations, and markets can be staged and phased more economically. HNEI is working collaboratively with the nonprofit More Than Smart to adapt the model to Hawaii's unique market structure, operational characteristics, and utility specifications, and establish appropriate functional objectives for Hawaii.

[2] De Martini, Paul, and Lorenzo Kristov. 2015. *Distribution Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight*. LBNL-1003797 Berkeley, CA: Lawrence Berkeley National Laboratory. *https://emp.lbl.gov/sites/all/files/lbnl-1003797.pdf.*

The second pillar of Hawaii's approach to distribution system reform consists of PUC-mandated hosting capacity studies that quantify the technical limits of each island and circuit to integrate additional distributed solar based on current infrastructure. The intent is to provide a transparent, quantitative basis for understanding current and projected grid limitations.

The results of this analysis indicated that mitigating power quality violations on certain circuits is a near-term issue for future growth of DER systems. However, given the aggregate impacts of increasingly high rates of renewable energy overproduction during daytime hours fueling concerns about system stability based on recent system-level analysis, system constraints are now being taken as seriously as a limitation to overall growth as circuit constraints.

Key Takeaways

Cost-effectively meeting Hawaii's pioneering clean energy goals will require a modern distribution system that can support broad adoption of emerging clean energy technologies and ensure safe and reliable operation of its islanded electric grids. This means the design and implementation of a functional distribution system platform in Hawaii should adhere to criteria supporting state energy goals for operating with progressively higher penetrations of renewables on the grid network—with a significant share coming from distributed energy resources.

Other key takeaways include:

- In Hawaii, the pace of DER market adoption surpassed technical understanding of the capability to integrate DERs into the existing grid infrastructure and to incorporate new technical solutions, such as advanced inverters. Under this dynamic, the interconnection process frequently became a bottleneck for DER adoption and caused significant frustration for customers and DER providers.
- The next growth phase of DER systems will require a more systematic transition to "Smart DER" systems because each island is nearing limitations to add more rooftop PV without advanced capabilities during peak solar hours.

Through the modeling and analysis performed as part of Hawaii's effort to improve processes, regulators, utilities, and other stakeholders are applying lessons learned to address the common challenge of maintaining system reliability and utility health as DG increases with the evolution of the energy transition. Their data-driven approach to process improvements may prove useful for other island communities.

As Hawaii looks ahead to a new growth phase of more advanced DER technologies and increasing the levels of variable renewables, the lessons from this recent experience and best practices from other jurisdictions can be incorporated in future planning efforts.

This lesson learned is one of many provided in the Energy Transition Initiative Islands Playbook—an action-oriented guide to help island communities successfully initiate, plan, and complete a transition to a clean energy system and eliminate dependence on imported fuels. See the full Islands Playbook at **www.eere.energy.gov/islandsplaybook**.

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ENERGY TRANSITION INITIATIVE Islands

The Energy Transition Initiative leverages the experiences of islands, states, and cities that have established a long-term vision for energy transformation and are successfully implementing energy efficiency and renewable energy projects to achieve established clean energy goals. Through the initiative, the U.S. Department of Energy and its partners provide government entities and other stakeholders with a proven framework, objective guidance, and technical tools and resources for transitioning to a clean energy system/economy that relies on local resources to substantially reduce reliance on fossil fuels.