Hawai‘i Natural Energy Institute Research Highlights

Grid Integration

Analysis of TOU Rates and Load Flexibility

OBJECTIVE AND SIGNIFICANCE: Time-of-use (TOU) rates – electric rates that vary based on the time of consumption – are currently being developed and implemented on a trial basis by HECO and the Hawai‘i Public Utilities Commission (HPUC). Under the new rate structure, electricity prices during evening peak demand periods would be three times that in the middle of the day. The objective of this study was to assess whether the load shifting intended from the implementation of time-of-use rates would reduce grid operating costs given recent deployment of battery storage. Preliminary results of this study were presented to HECO and shared with the HPUC in 2023. HNEI has continued to monitor the activities throughout 2024.

KEY RESULTS: TOU rates are a tool that uses price signals to encourage load shift to the middle of the day. Analysis of O‘ahu grid operations show that shifting load from the 5pm to 9pm peak period to the daytime would not meaningfully reduce the overall cost of generation (i.e. production cost) once significant amounts of grid-scale batteries are added. The analysis showed that the operational restrictions limiting the integration of more solar and the need for expensive peak demand resources are both diminished as a result of the addition of grid-scale batteries. As a result, the cost savings expected by swapping expensive peak generation with low-cost solar generation no longer exists.

BACKGROUND: With advances in distributed energy resources (DER) technologies and the proliferation of smart devices, customer load can adjust to better align with the capabilities of the power system. The HPUC and HECO has pursued a variety of initiatives to provide load flexibility or to shift load, including advanced rate design (time-of-use rates), DER Phase 3 program design, and a competitive solicitation of grid services (i.e. Maui Grid Services RFP, which received no bids). While having a common goal of managing load, each of these programs impacts the power system differently.

TOU rates, like those currently being proposed have been under development by HECO in 2012 (TOU-R). Since then, the power system has changed remarkably and the type of load shifting needed has changed. Between 2023-2025, each of the HECO grids will see large increases in battery storage – both in standalone projects as well as utility-scale solar + storage hybrid projects.

HECO and the HPUC have already committed to these large battery projects in recent procurements and most of them are either already operating or under construction. On O‘ahu, for example, battery storage will soon reach 400 MW of capacity, over one-third of evening peak load, with more coming in the current procurements. The storage deployment on other islands is similar or even more pronounced on a proportional basis.

The objective of this analysis is to evaluate and compare the system cost savings of TOU rates in legacy grid systems with those in systems that have a high penetration of batteries.

PROJECT STATUS/RESULTS: The HNEI-Telos team analyzed the impacts of TOU rates on O‘ahu’s system, a variety of load flexibility options on Maui’s system, and, as a final step, assessed how the proposed rates may shift costs across ratepayers.

The evaluation of the potential benefits of TOU rates on O‘ahu focused on the potential fuel cost savings assuming a 20% shift of residential evening load to the middle of the day. An evaluation of potential reliability benefits and impacts on oil plant retirements attainable due to reduced peak load has also been initiated. This summary will focus on the cost issues.

To assess the impact of TOU, system production costs were evaluated across three scenarios: 1) grid operations prior to utility-scale storage additions; 2) a “2025” grid that includes the currently planned solar and storage additions; and 3) a higher solar and storage portfolio representative of the state’s 2040 goals. The evaluation of these three scenarios allows for a quantitative comparison of benefits of potential load shifting.

The study found that TOU rates offer minimal fuel cost savings on O‘ahu. The reason for this is two-fold. First, while solar generation is abundant in the middle of the day, there is limited curtailment in all three scenarios. Therefore, shifted load will be served almost exclusively by oil generation, not by the uptake of curtailed solar, albeit with a modest

improvement in fuel efficiency. Second, energy losses from load shifting (via behind-the-meter batteries, pre-cooling of evening air conditioning, or otherwise) leads to a slightly increased electricity usage overall, tending to balance the modest efficiency gains.

TOU rates are designed, in large part, to reduce the need for "peaking" generators that are built to run sparingly, in times of high load and when needed for reliability. In theory, any resulting load shifting could reduce peak demand and avoid the need for new "peakers" or enable oil plant retirements. However, especially in the near-term and future scenarios, the peak capacity needs will be met with already approved and under construction battery storage additions.

It has been proposed that TOU rates that discourage energy use from 5pm to 9pm could reduce the risk of resource shortfalls. However, preliminary results indicated that with significant battery deployment, risk is spread evenly across the day and load shifting would have minimal impact on reliability. Further work to assess firm power needs under differing load profiles is continuing.

Similar analysis has been conducted for Maui. While the current resource mix on Maui does not yet include large amounts of energy storage, significant additions are planned under the Stage 1, Stage 2, and Stage 3 procurements resulting in minimal impacts from load shifting due to TOU rates. In light of the expected retirements of a significant part of Maui's generation, analysis is ongoing to evaluate the impact of all types of load flexibility on reliability.

Rate Impact: While TOU rates will have limited system benefits once the planned battery systems are deployed, they will create significant changes to the way electricity is billed, and potentially create equity concerns. To evaluate this further, the study assessed individual customer impacts of the proposed TOU rates. This included a review of individual 15-minute advanced metering data across 60,000 customers for a single month. The results showed that large proportions (85+%) of non-PV customers would be Structural Winners – those who would get a cheaper bill just from switching to TOU rates, even without changing their behavior.

Customers with PV, in contrast, would see a significant increase in monthly bills (62% or $82/month on average) if they were required to switch to TOU rates (note that forcing legacy PV owners to switch to the new rate is highly unlikely). Even if the TOU rate successfully encourages behavior change, the only outcome is that some customers save money, but provide limited system benefits. The reduced revenues would have to be made up with increased rates overall to maintain revenue neutrality, disproportionately affecting customers with less ability to shift consumption during low price periods.

HNEI plans to continue to refine this analysis, with the goal of supporting decision makers at HPUC and HECO as they continue to design customer programs to support evolving grid needs. HNEI plans to assess the value of load flexibility in deferring distribution grid upgrades in a future version of this analysis.

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