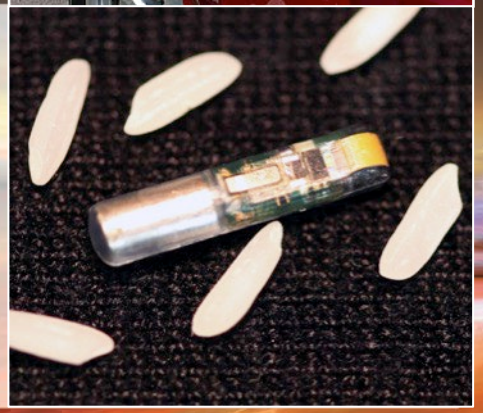


Pacific Northwest
NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Hawaiian Electric Companies (HECO) Demand Response Tool

Di Wu
Staff Engineer

Other members of the project team: Patrick Balducci, Kendall Mongird, Yong Yuan, Dhruv Bhatnagar (HECO)

DOE OE Energy Storage Peer Review
Santa Fe, New Mexico
September 25, 2018

DISCOVERY *in Action*

U.S. DEPARTMENT OF
ENERGY

Hawaiian Electric Companies (HECO) Demand Response Tool

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Objectives

- Develop a comprehensive tool to evaluate photovoltaics (PV) and energy storage systems (ESS) engaged in behind-the-meter (BTM) applications
- Evaluate customer-side benefits for HECO's demand response (DR) program

Phases

Phase 1: **Define Methods and Data Req.** → ***Phase 2:*** **DR Assessment, Data collection** → ***Phase 3:*** **Tool Development** → ***Phase 4:*** **Expand Tool Capabilities**

1) Define Methods and Data Requirements
2) Data Collection; Evaluate HECO's current DR program
3) Development of HECO Demand Response (DR) Tool with Graphical User Interface (GUI)
4) Expand tool's capabilities based on HECO feedback

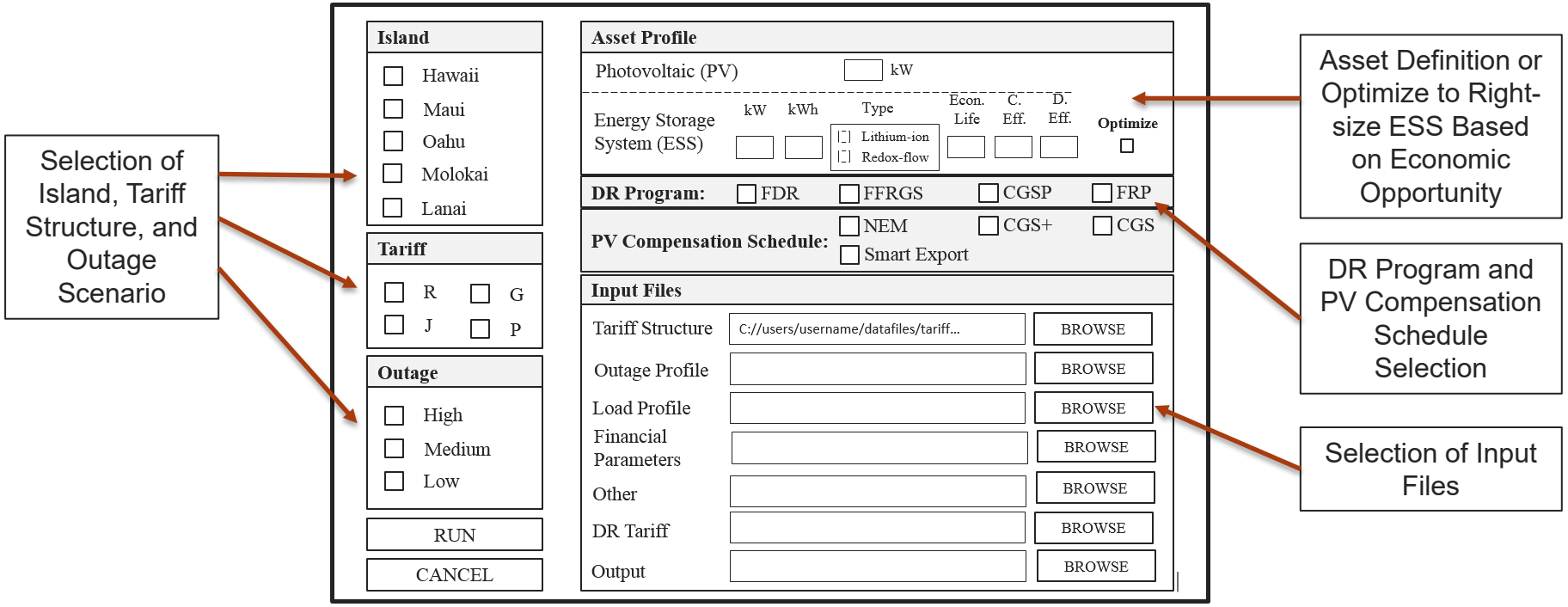
Pacific Northwest NATIONAL LABORATORY

Hawaiian Electric
Maui Electric
Hawai'i Electric Light

HECO Demand Response (DR) Tool Overview

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

- The tool can evaluate the benefits of PV and ESSs, generate optimal hourly battery activity and optimize sizing of BTM energy storage for customers participating in HECO's DR program.



HECO DR Tool GUI (Preliminary Design)

Model Input

- Load and PV Production Data
- Tariff Structure: Residential, General Service Non-Demand (Small C&I), General Service Demand (Medium C&I), and Large Power Service (Large C&I)
- Solar PV Compensation Programs: Net Energy Metering (NEM), Customer Grid Supply (CGS), Customer Grid Supply+ (CGS+), and Smart Export.
- DR Programs (Potential Program Designs, Not Yet Implemented)
  - Fast Demand Response
  - Fast Frequency Response (FFR) Grid Service (GS) Program
  - Capacity Grid Service Program
  - Frequency Regulation Program
- Outage Data

Methodology

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

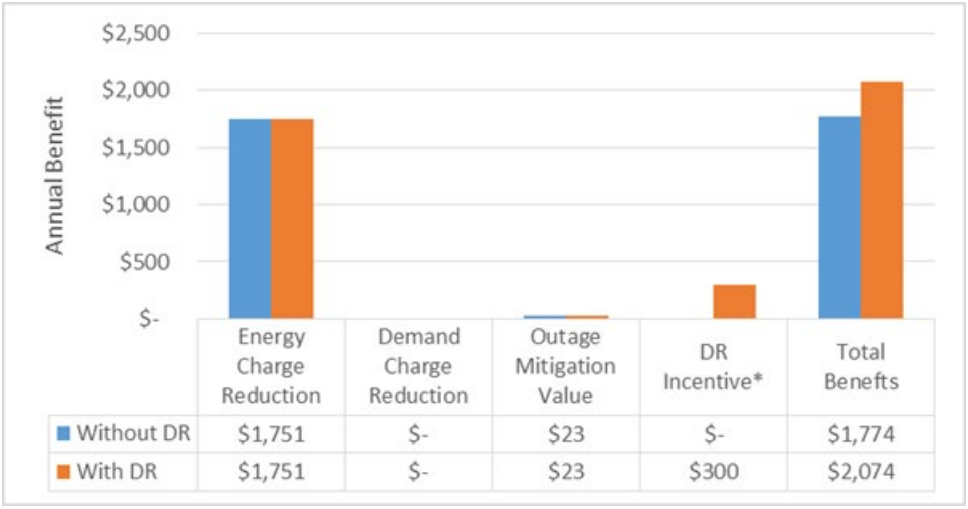
- Formulate optimization problem to determine the optimal battery dispatch and maximize the benefits from battery storage from bill minimization, outage mitigation, and DR.
- Objective: maximize benefits to HECO customers including:
  - Energy charge reduction
  - Demand charge reduction (commercial and industrial customers only)
  - Outage mitigation benefits
  - DR payments
- Constraints:
  - Battery power and energy limits
  - Dynamics of SOC
  - System level constraints
  - Service requirement

Residential Customer Example

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Parameter	Selection
Island	Hawaii
Tariff Schedule	R: Residential
PV Compensation	Net Energy Metering
ESS	5kW/13.5kWh
DR Program	Fast Demand Response Fast Frequency Response (FFR) Grid Service Capacity Grid Service Program Frequency Regulation Program
Other Services	Outage mitigation
Bill Components	Customer Charge, Demand Charge, Energy Charge

Tool demonstrates impact to customer benefits of choosing to participate in HECO's DR programs under varying potential future DR program structures.



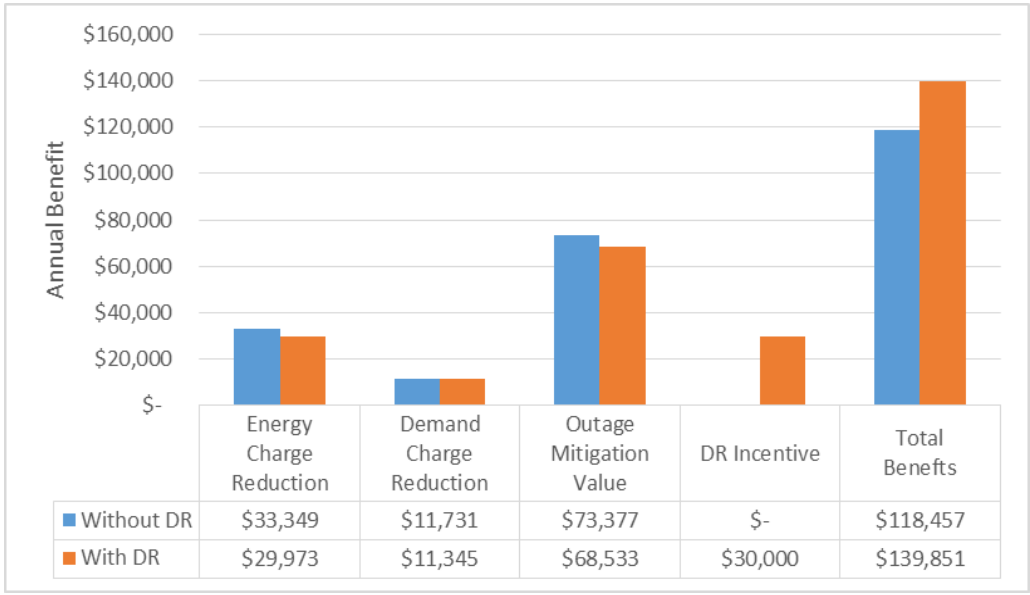
Annual Benefits of PV and ESS

C&I Customer Example

Pacific Northwest NATIONAL LABORATORY
Proudly Operated by Battelle Since 1965

Parameter	Selection
Island	Hawaii
Tariff Schedule	P: Large C&I
PV Compensation	Net Energy Metering
ESS	0.5MW/2MWh
DR Program	Fast Demand Response Fast Frequency Response (FFR) Grid Service Capacity Grid Service Program Frequency Regulation Program
Other Services	Outage mitigation
Bill Components	Customer Charge, Demand Charge, Energy Charge

DR participation generates additional $21,000 in annual benefits to the customer



	Energy Charge Reduction	Demand Charge Reduction	Outage Mitigation Value	DR Incentive	Total Benefts
Without DR	$33,349	$11,731	$73,377	$-	$118,457
With DR	$29,973	$11,345	$68,533	$30,000	$139,851

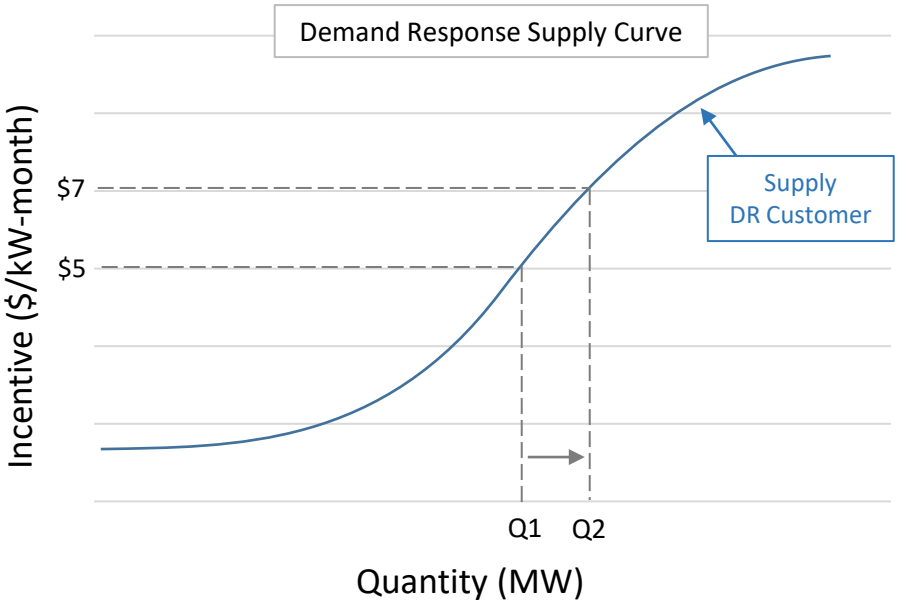
Annual Benefits of PV and ESS

Behavioral Analysis of Demand Response

- There are multiple types of incentivized DR programs, including:
  - **Direct Load Control (DLC)**

    Involves the utility directly controlling customer assets to achieve load reduction. Could include thermostat control, water heater control, cycling of HVAC equipment, or other programs.
  - **Load Reduction using Distributed Energy Resources (DERs)**

    Participants receive an incentive for actively reducing their load using assets during peak events. This could include demand reduction using battery storage, generators, photovoltaics, or other distributed energy resources.
- The supply elasticity of demand response assets changes in response to payout rates.
- Participation is often influenced by factors such as:
  1. Incentive value
  2. Minimum load reduction required by the participant
  3. Inconvenience/discomfort factors for loss of load
  4. Risk taken on with the depletion of backup asset energy
  5. Knowledge regarding program and participation requirements



Summary

- HECO DR tool evaluates the benefits of PV and ESSs and helps customer to understand their cost and benefits by participating in different DR programs provided by HECO
- While the tool focuses on customer side benefits, HECO would also benefit in understanding how the resources may be best operated in aggregation to provide grid services, while ensuring customer value
- The tool provides insight into benefits landscape for HECO customers; When combined with behavior data regarding the price elasticity of supply, HECO can define DR incentive rates that will lead to economically efficient outcomes to the utility and the customers it serves

Acknowledgements

- Dr. Imre Gyuk, Energy Storage Program Manager, Office of Electricity Delivery and Energy Reliability at the U.S. Department of Energy,