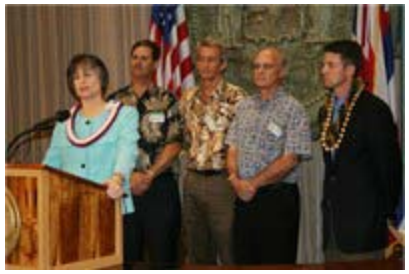
MANAGING DISTRIBUTION SYSTEM RESOURCES FOR IMPROVED SERVICE QUAILTY AND RELIABILTY, TRANSMISSION CONGESTION RELIEF, AND GRID SUPPORT FUNCTIONS

or

MAUI SMART GRID PROJECT



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MAUI SMART GRID PROJECT – Project Objectives

To develop and demonstrate a ***distribution automation*** solution that ***integrates dispatch of distribution assets*** (distributed generation, energy storage, demand response, renewable energy, and distribution automation) ***and bulk power assets*** (central generation, energy storage, renewable energy) to achieve system-level benefits.

- **Reduce distribution peak loading by 15% or more**
- **Improve service quality through integrated volt/var control**
- **Enable consumers to manage their energy use to minimize electric bills and utilize on-site renewable energy**
- **Support grid stability (regulating and spinning reserves)**
- **Enable greater utilization of as-available renewable energy sources**

MAUI SMART GRID PROJECT – Equipment Involved

Bulk Power

- SCADA/EMS
- Central generation through AGC
- Wind farm
- MW-scale energy storage

Distribution

- Distribution management system
- Feeder and substation monitoring
- Switched capacitors and LTC
- Regulators
- Large-scale PV and advanced inverter (tentative)
- Distributed generator (possible)

Customer

- Responsive loads
- Building energy management system
  - Commercial BEMS (tentative)
  - Home energy management system
- "Smart" meter
- Energy use display (dashboard & Web meter options)
- Energy storage
- PV with advanced inverter
- Residential energy efficiency

Maui Smart Grid Functional Diagram

E N M A C

Standard Apps:

- Network Mgmt
- FEP
- SCADA
- Outage Mgmt
- Network Analysis

Demand Mgmt

Home Response Estimation
Shed Capacity Aggregation
Operator Decision
Disaggregation to Nodes
Home Selection

Trans. level grid support

Load-following
Intermittency management
Congestion reduction

Volt/Var Control

Minimize Losses and Control Voltage Profile
Operating Constraints:
- Vmin<Vbus<Vmax
- Minimum number of switching
- Max tap jumping steps

Power Flow Solver
Load Forecasting/Estimation

Deferrable, sheddable load, actual loads deferred/shed

Historical data,, amb temp, cost of gas/elec, grid status. Elec. price forecast.

Home Energy Manager
Optimal thermostat Setpoints for all the thermal zones
Optimal water tank temperature setpoint;
Controlling and managing loads;
Providing total electricity and fuel costs.

On/off → **Cap-banks**

Tap Value → **LTC/VR**

Available generation, load and forecasts, energy price → **DER Manager**
Optimal Dispatch

kW, kVAR, time → **Substation DGs**

kWh, time → **Bulk Storage**

Forecasted kW, wind speed, ramp rate, curtailments

??

Wind plant Management

Available generation, load, energy price, forecasts of all the

Operator

MECO EMS
Economic Dispatch
Unit commitment

MAUI SMART GRID PROJECT – Technical Challenges

Developing a *general* Smart Grid platform and architecture

- **Hierarchical control – system, independent power producer, distribution microgrid substation/feeder, distributed generation and storage (conventional or renewable), customer (residential, commercial, institutional, industrial)**
- **Basic elements of the Smart Grid – data, sensors, communications, controllable equipment, applications (models and commands)**
- **Recognize that applications can run at any level (see "hierarchy"), using data from any level. Applications need to be prioritized to avoid command conflicts.**
- **Incorporating legacy equipment (with proprietary protocols)**

Not overwhelming the system dispatcher

Developing integrated, *secure* communications systems

Maui SMART GRID - Benefits

MECO

- **Improved grid stability**
- **Reduced use of petroleum**
- **Better distribution voltage management**
- **Incorporate more as-available renewable energy**
- **Integration of generation dispatch, IPP, demand response, AMI, distribution management, outage response functions**

IPP

- **Sell more energy**

Customer

- **Improved service quality (voltage management)**
- **Better power purchase agreement for on-site energy (lower energy bills)**

State of Hawaii

- **Less petroleum use**
- **More renewable energy**

DOE

- **Distribution management system for multi-asset active microgrids**
- **Smart Grid architecture – general solution for integrating multiple Smart Grid functions at customer, distribution, transmission, generation, IPP levels**

Maui SMART GRID – Successes to date

Identified demonstration site that had to change due to economic downturn

Data collection and model development

Progress on architecture design – cooperation of utility (planning, operations, customer services), customers, independent power producers, vendors

- **HNEI is moderator / referee**
- **Nobody sent to the penalty box for fighting yet**
- **We are indeed arriving at a solution that meets all stakeholders' objectives**

Maui SMART GRID – Where are we now?

Planning

- Selecting functions, feeders, substations, customer premises, communications
- Choosing equipment and integration/interconnection points

Design

- Smart Grid architecture and control hierarchy
- Information flows and communication links
- Functional specification of the demonstration
- Incorporating MECO and HECO demand response, AMI, AGC, etc. functions

Development – just starting

- Adapting existing equipment, applications (e.g., ENMAC, wind turbine controls)
- Developing and validating feeder models
- Beginning development of one of the residential responsive load options – GE Residential Energy Management optimizer with smart appliances