Northwest Power and Conservation Council

September 1, 2011

MEMORANDUM

TO: Council Members

FROM: Ken Corum, Ken Dragoon

SUBJECT: Ecofys US Presentation on BPA Technology Innovation Project No. 220: "Smart End-Use Energy Storage and Integration of Renewable Energy"

There are several pilot programs underway in the Pacific Northwest that are testing and demonstrating demand response. The largest of these is the Smart Grid Demonstration Program, which involves Bonneville, Battelle Richland, 11 NW utilities, and several vender team members. The Demo Program includes demand response components but is largely focused on demonstration of smart grid communication and coordination technology. Bonneville also is conducting pilot programs focused on demand response in the residential, commercial, and irrigation sectors, with 6 utilities participating in the residential pilot program, two utilities participating in the commercial program, and one utility participating in the irrigation program. Puget Sound Energy is also conducting demand response pilot programs in both the residential and commercial sectors.

The pilot project that Diane Broad of Ecofys will describe to the Council is separate from the above projects, and is specifically designed to test the concept of managing electricity use to provide load and wind balancing. Ecofys is coordinating this project, which is an excellent match with the 6th Power Plan's Action Plan item DR-2 and is getting attention from elsewhere in the country for its innovative approach.

Bonneville is the major funder of this project, with the Council contributing $25,000 as well. The project uses space and water heating equipment and refrigerated warehouses to store and release energy and to act as virtual batteries allowing Bonneville to respond to variations in load and generation over time periods of minutes. Besides Ecofys, EnerNOC, Spirae Inc, Pacific NW National Lab, and Steffes Corporation are participating in the project.

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Smart End-Use Energy Storage and Integration of Renewable Energy

BPA TI Project #220

Northwest Power & Conservation Council Council Meeting

Astoria, OR Sept. 13, 2011

Diane Broad, P.E.

Ecofys US

ECOFYS

Develop and deploy controllable end-use loads in the residential and C&I sectors

- Project Purpose: demonstrate that these flexible resources can provide both balancing services to BPA and localized benefits to BPA's customer utilities
- Scope: 1MW to 3MW of demand response (DR) with energy storage
- Technologies - Residential: Steffes Interactive Water Heater Controls (iWHC) on 50 and 105 gal. water heaters, Carina WISE water heater controls, and Steffes Electric Thermal Storage (ETS) whole-house furnaces with ASHP
- Technologies - C&I: EnerNOC DemandSMART in cold storage warehouses, Cypress wireless pneumatic thermostat controls in commercial and public buildings, and Steffes ETS furnaces with ASHP in commercial buildings

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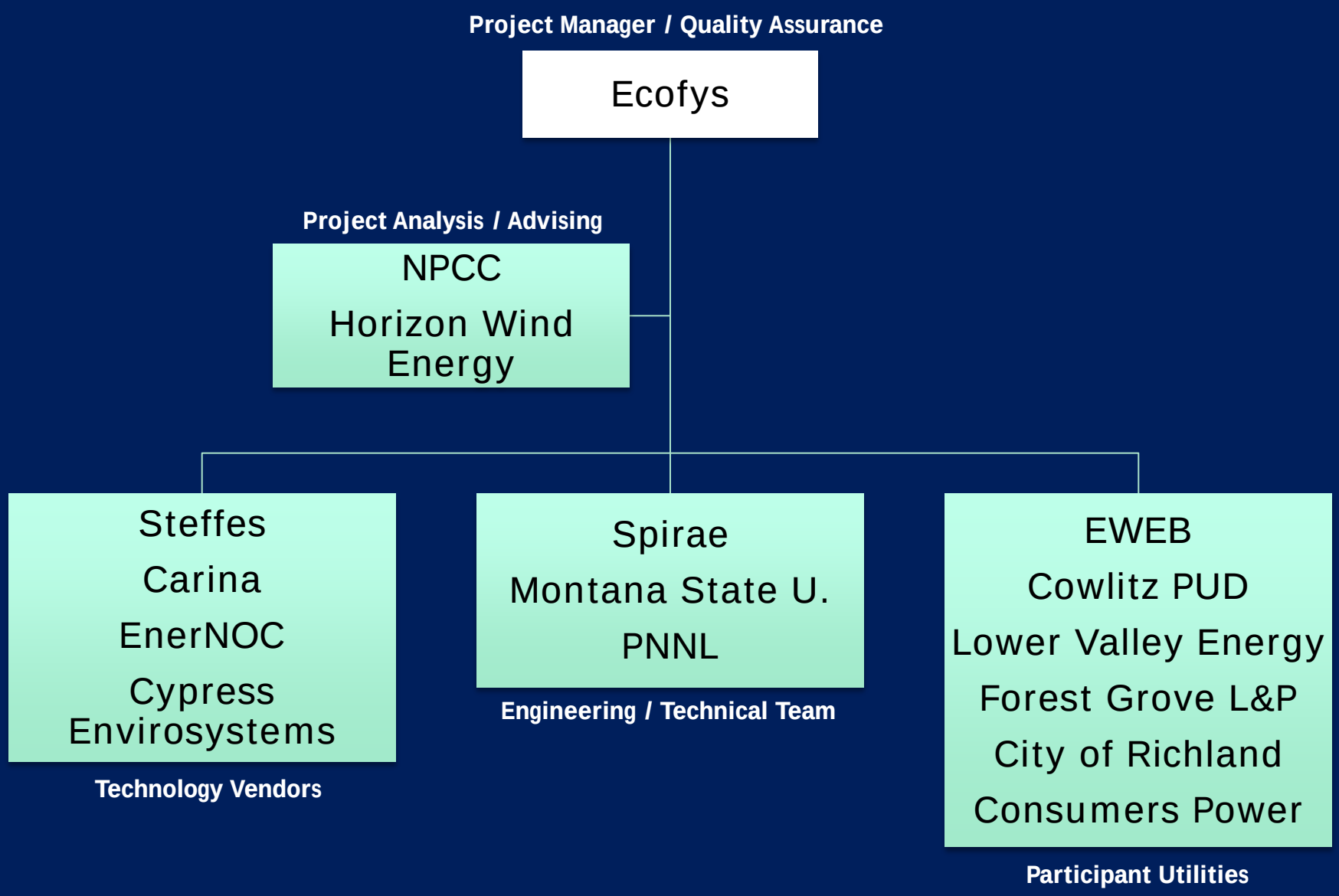
Develop and deploy controllable end-use loads in the residential and C&I sectors

- Control & Dispatch: control to both *increase and decrease* loads (different from other BPA DR pilots); test several control methods, control signals and dispatch options
- Produce Guidebook for Regional Utilities: technology survey and customized business case tool (Excel-based)
- Deployed in Public Power Territories: Participant Utilities in OR, WA and WY
- Cooperative Project with BPA Technology Innovation and the Energy Efficiency/DR Group

Project Team



105 gal. water heater with iWHC can be thought of as a thermal battery – heats water to 170˚ F with a mixing valve for consumer safety

ETS Furnace, Forced Air or Hydronic, is equivalent to a 10x larger battery – coupling it with an air-source heat pump increases efficiency

Adjust target temperature and input wattage

Commercial & Industrial

EnerNOC Site Server (ESS)

At customer sites, EnerNOC installs an ESS, a gateway device that establishes communication with the network and provides near-real time visibility into end-user energy consumption.

The ESS also allows the Network Operations Center (NOC) to remotely control loads in order to deliver demand response capacity.

Energy Network Operations Center

EnerNOC's two Network Operations Centers, staffed 24x7x365, feature advanced technology and specialized staff to ensure that load reductions happen quickly, efficiently, and consistently for both the utility and end users.

PowerTrak®

EnerNOC's web-based energy management platform monitors energy consumption and enables end-user load control.

DemandSMART also provides end-users with a web portal, and utilities with the ability to view load increase or decrease during demand response events.

Results – Marketing & Site Selection

Lower Valley Energy – 7 Steffes ETS residential and commercial furnaces

- Marketing effort was simple: 2 newspaper ads
- 40+ respondents, interviewed and "weeded out" by LVE staff
- 1 ETS furnace was installed in Jan. 2011; the remaining residential furnaces will be installed in September; commercial furnace in October

Cowlitz PUD – 70 105-gal. & 50-gal. water heaters with Steffes iWHC

- Marketing: direct mailing to 267 customers in one neighborhood, 120+ respondents
- 40 water heaters installations complete in August; 30 additional installations to be complete in October

EWEB – 10 105-gal. + 10 50-gal. water heaters with Steffes iWHC, and 30 Carina WISE water heater controllers using 50-gal. tanks

- Marketing plan: direct mailing to ~2000 customers in City of Eugene
- 500 responses (response rate of 25%) – higher than expected
- EWEB staff used online tools to narrow down pool of respondents to ~100; from these, the best 20 sites were selected
- Steffes installations complete in August; Carina installations will be completed in early 2012

EnerNOC – Cold-storage warehouses

- Five sites have been selected; total controllable resource is ~1MW (approx. 20% of load per site)
- Enablement is complete at four sites, site 5 will be enabled in late 2011
- At first four sites initial testing has begun
- Participating utilities are:
  1) City of Richland, Richland, WA
  2) Consumer's Power, Philomath, OR
  3) City of Forest Grove L&P, Forest Grove, OR
  4) Eugene Water & Electric Board, Eugene, OR

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Reference for Several Northwest Utilities

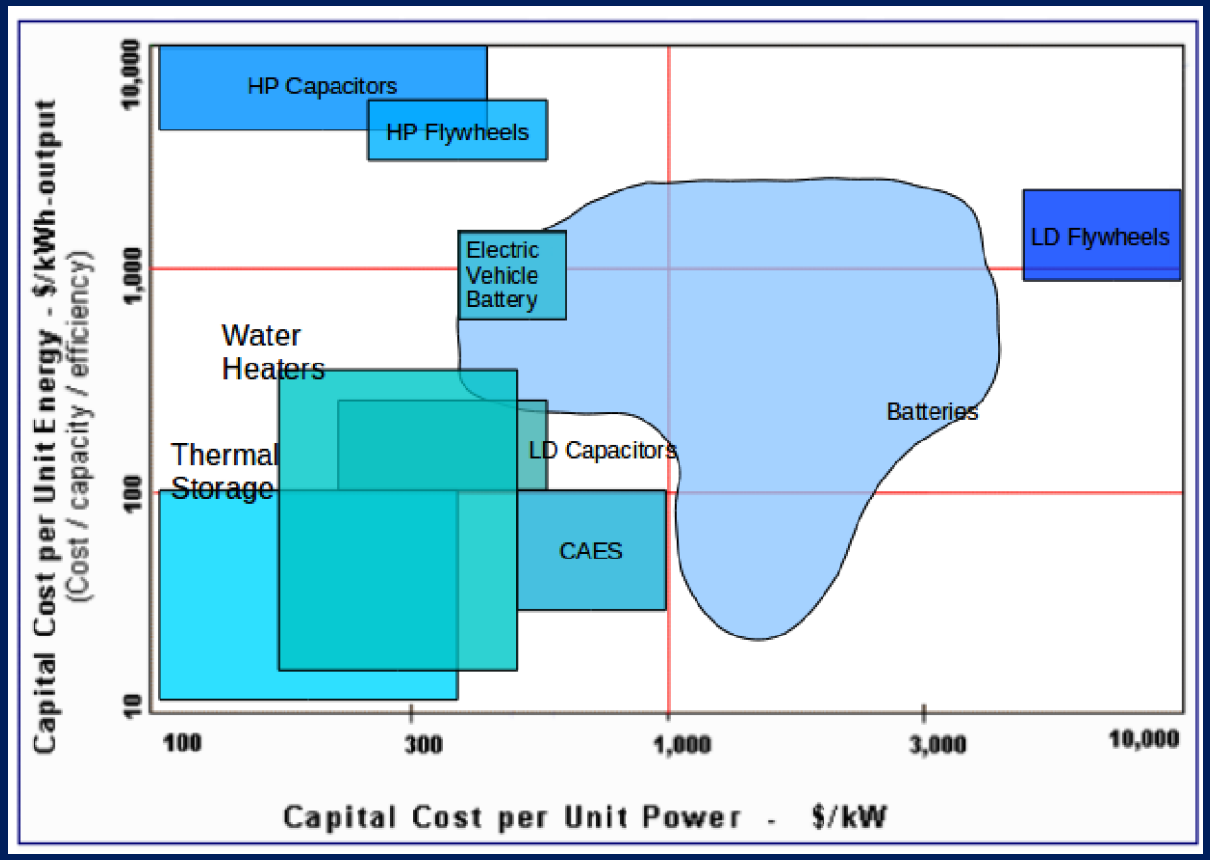
Main elements: technology overview and business case, providing:

1) utilities with assistance in examining the potential for pilot DR programs in their service territory
2) project participants a theoretical model for program evaluation

Focus is on DR with “smart” control and energy storage

1) Technologies/devices
2) Communications and control

Northwest utilities are moving into smart grid/DR – Guidebook assists in evaluating the marginal cost of more advanced technologies that can provide multiple value streams beyond simple peak load reductions



Cost of Storage (Sandia Nat'l Lab, EPRI)

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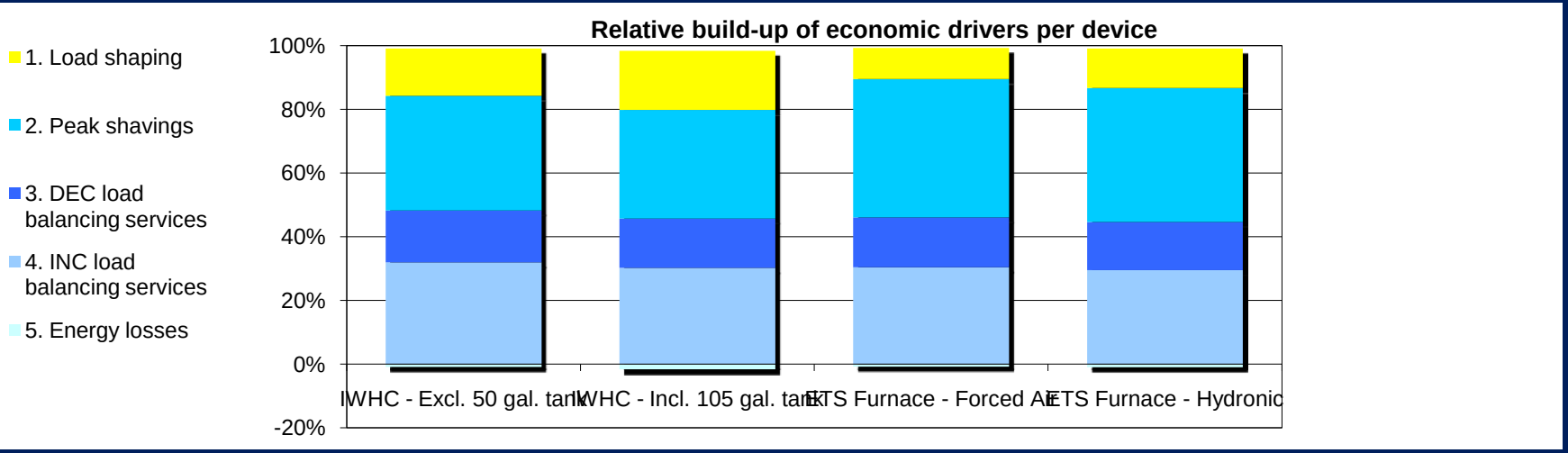
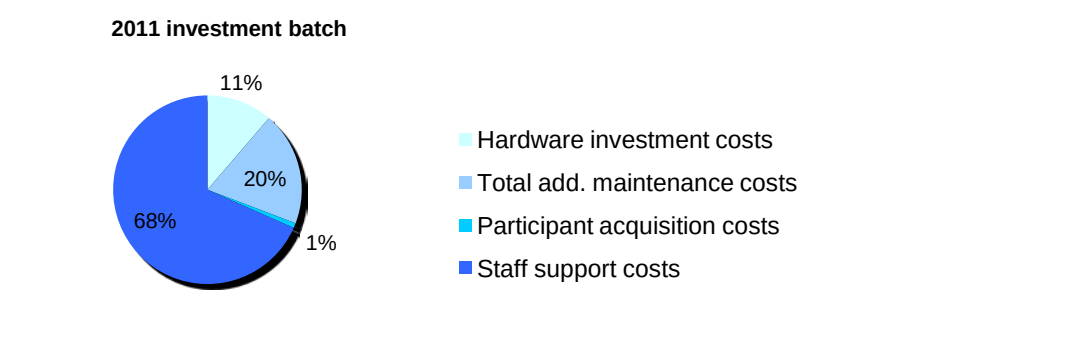
Inputs to Business Case

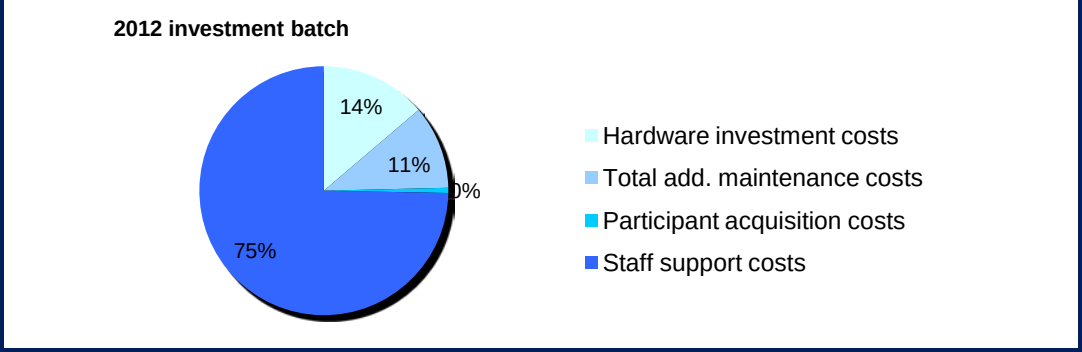
Price overview - inputs in yellow		reference	Avg. price	Jan
Heavy Load Price	$/kWh	BP-12-E-BPA-09, page 6	$ 0.045	$ 0.046
Light Load Price	$/kWh		$ 0.033	$ 0.035
Demand rate	$/kW-Month	BP-12-E-BPA-09, page 5	$ 9.568	$ 9.74
DEC load balancing fee	$/kW-Month	BP-12-E-BPA-05, page 143-147	$ 1.23	$ 1.23
INC load balancing fee	$/kW-Month		$ 7.93	$ 7.93
Average electricity price	$/kWh		$ 0.039	$ 0.040

Output of Business Case

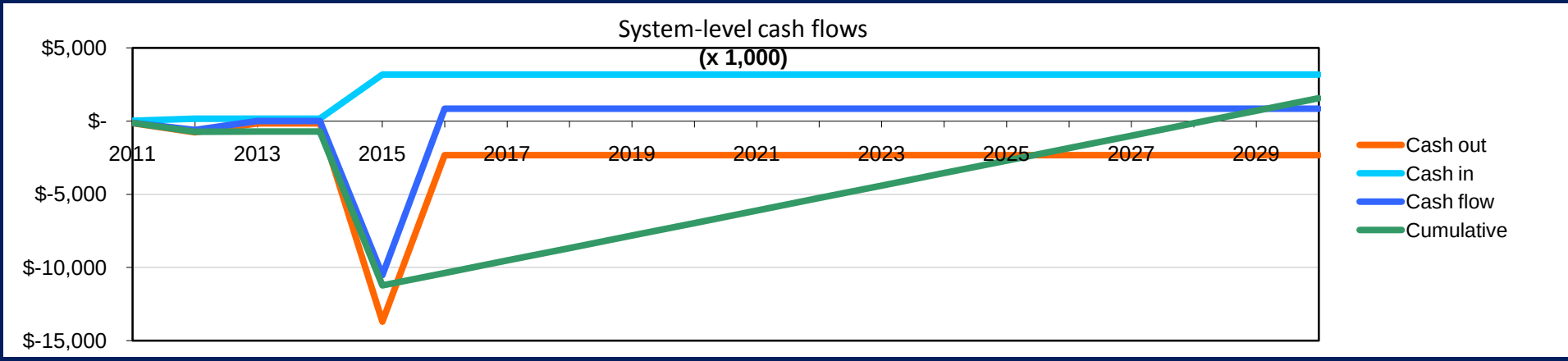


Output of Business Case – Overall investments





Output of Business Case – Cash Flow (illustrative example only)



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Steffes Layered Control Strategy

- Layer 1: Define Peak/Off Peak

  Includes off-peak, soft peak and hard peak (results in charging desired/allowed/disallowed)

- Layer 2: Determine Customer Need

  Intelligent controller “learns” the customer's usage pattern by logging a 30-day rolling average

- Layer 3: Set a Nominal Charge Rate

  Based on output of Layers 1 and 2, sets # of kW per hour (e.g., 16 kWh of energy needed during an 8-hour off-peak period = 2kW/hr)

- Layer 4: Follow the Control Signal

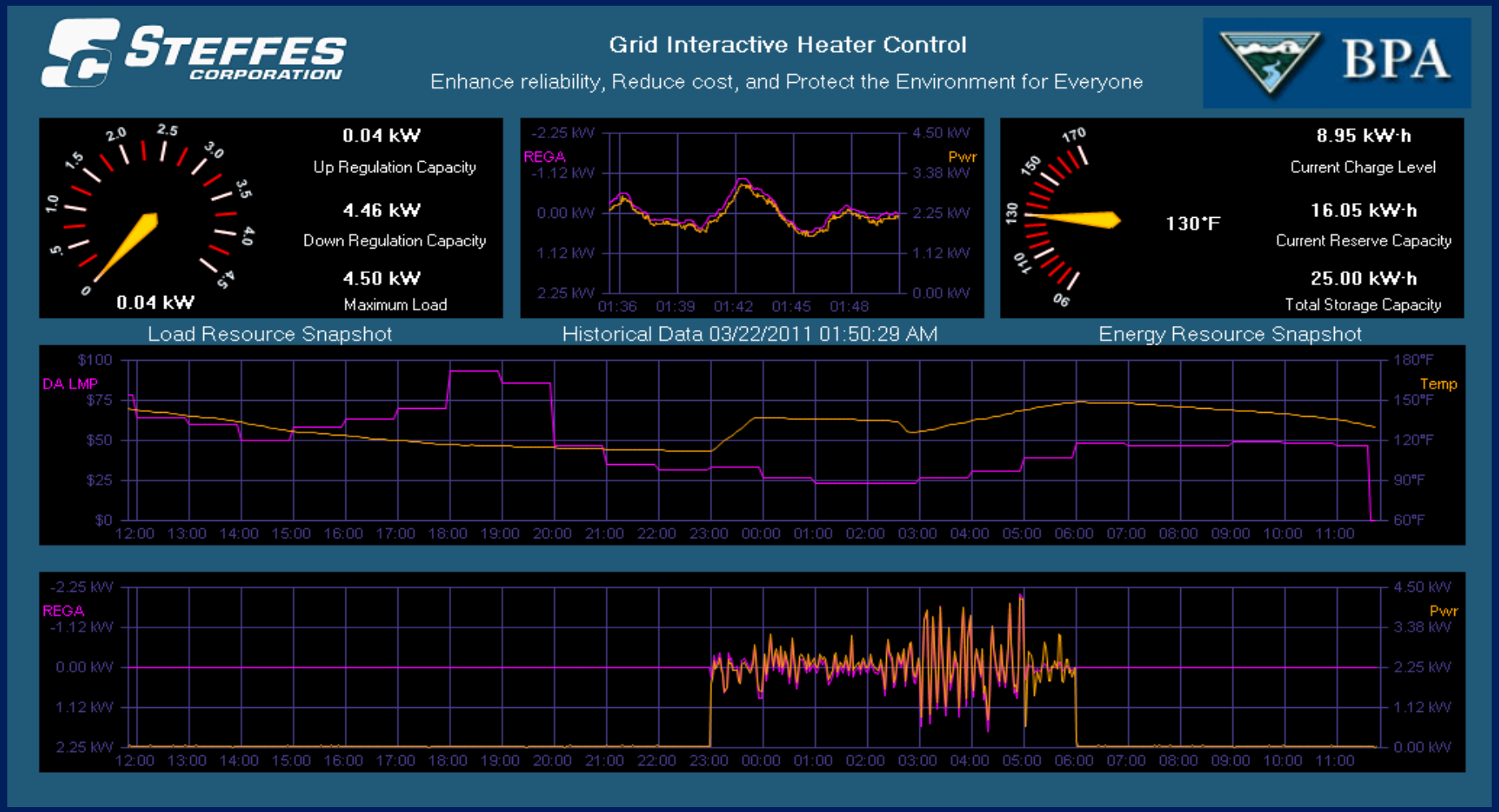
  BPA Balancing Reserve Deployment signal will be used, with units responding symmetrically to calls for INCs and DECs

- Layer 5: Handle Exceptions

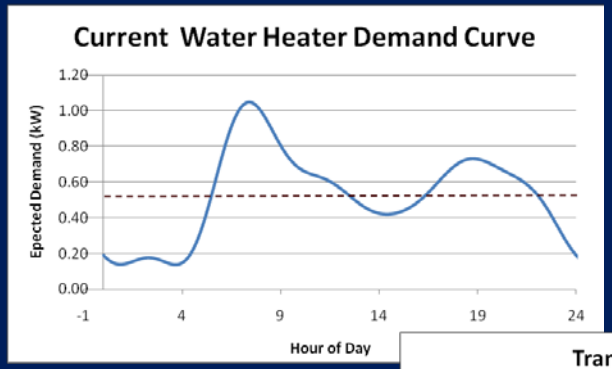
  Ensures customer comfort with automatic override if temp in ETS unit is too low; also responds to local out-of-normal conditions (outages, etc.)

NOTE: ETS Furnaces also employ an exterior temperature measurement

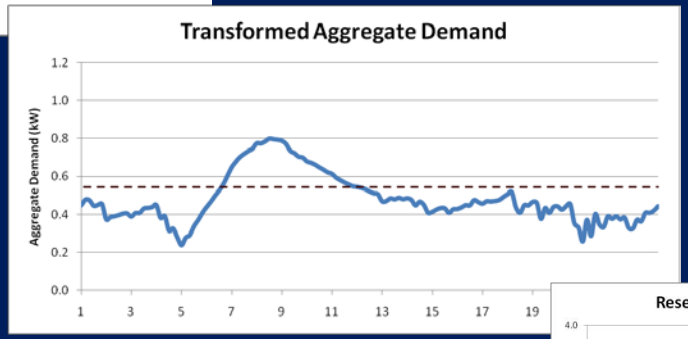
Steffes Dashboard for each iWHC unit



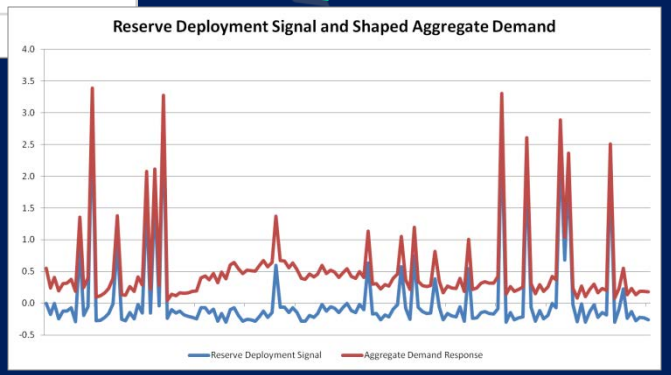
Various Dispatch Options



Use storage to reshape demand (e.g., reduce on-peak demand



Use storage to provide balancing services.



Optimized Control Strategies in Development

Asymmetrical response to BA need for INCs/DECs

- ETS water heaters have more capacity to provide DECs than INCs
- Control strategy needs to evaluate energy balance over time, so not to “over-charge” the tanks

Spirae is modeling water heaters in power system simulation software (PowerFactory), and creating a representative distribution system model to assess effects of control

Ecofys is analyzing the Balancing Reserve Deployment signal: daily, monthly and seasonal shape; time & energy in the “high deployment” periods; correlation with wind ramps

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Optimized Control Strategies in Development

- Evaluating various value streams

The aggregate water heater load shape was split into its component value streams:

- Peak shaving
- Load shaping (taking advantage of TOU rates, if any)
- Incremental reserves
- Decremental reserves

Peak Shaving was about ½ the value received

Balancing Reserves were about ¼ to ½ the value, with more contributed by providing DEC reserves

This tool needs further development, including sensitivity analysis to price ranges for providing INCs and DECs