BONNEVILLE POWER ADMINISTRATION

POWER IN EFFICIENCY

Energy Storage Pilot

Collaborating in the Pacific Northwest

Presented by:

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BPA Energy Efficiency

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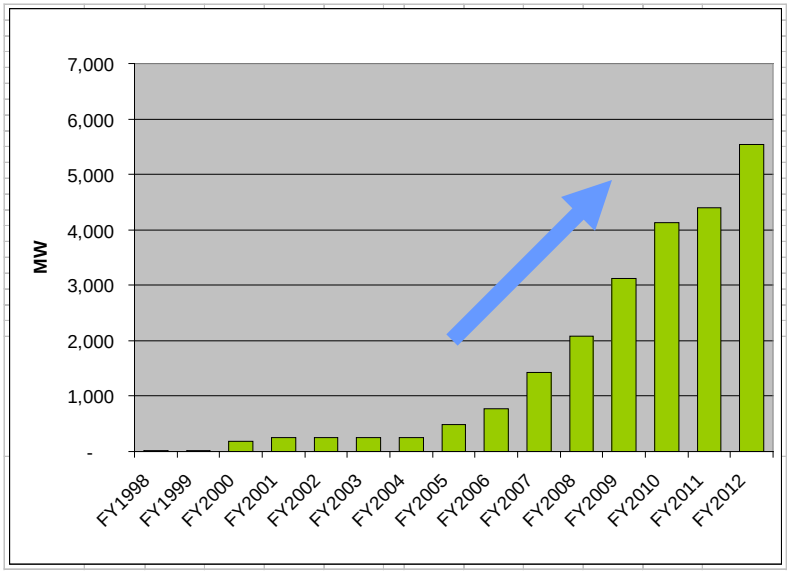
Lower Valley Energy

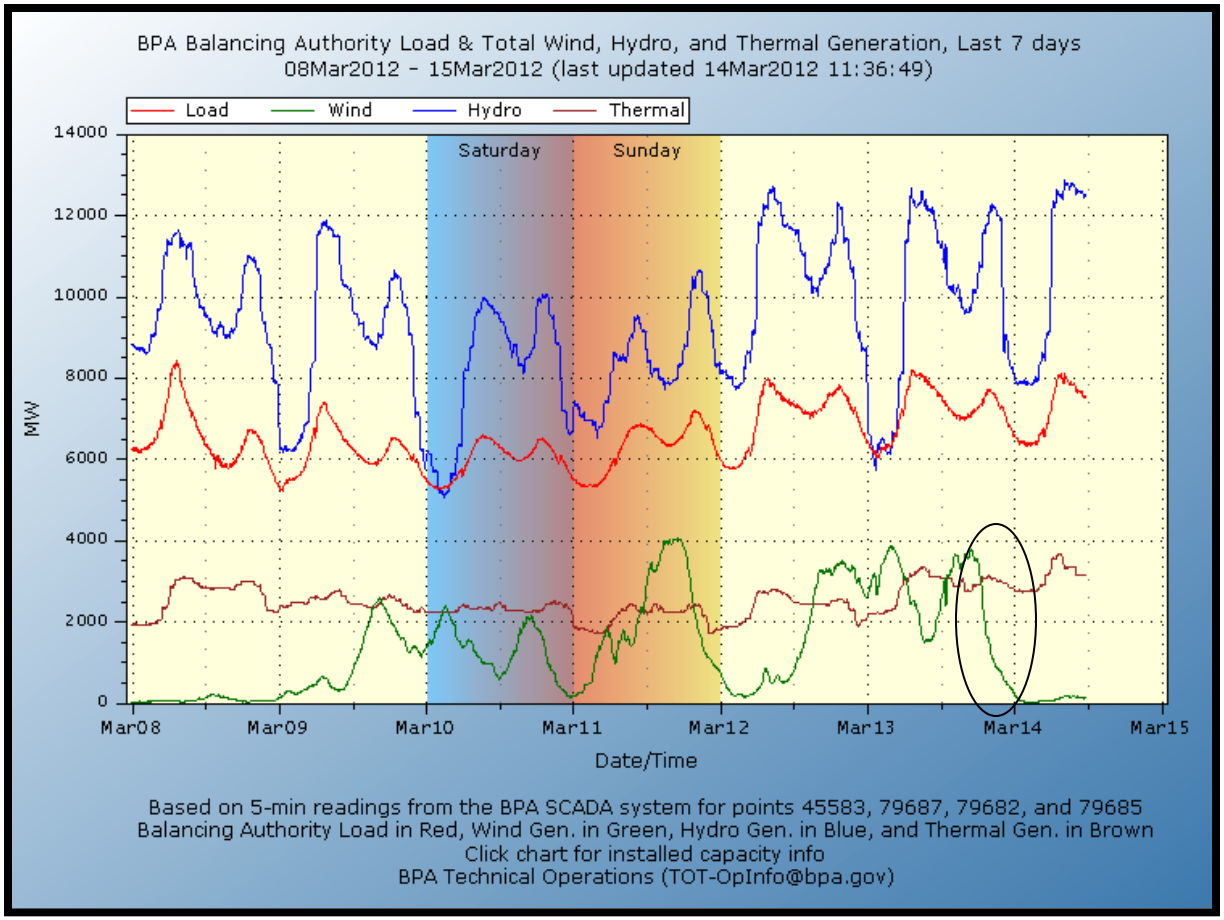
Unique Challenge - Optimizing Wind

Wind generation on BPA's system surpassed the 4,000 megawatt milestone March 11 at 3:22 p.m. BPA expects to have 5,000 megawatts connected to its system by 2013.



Wind connected to
BPA's Transmission System

Significant Wind Ramps – Demand Response as Potential Balancing Reserve



The limits of the federal hydro system are being pushed to support balancing, particularly with the wind buildout

Additional strategies needed for balancing, including Demand Response

BPA and Utility Needs – Multiple Potential Demand Response Uses

Joint benefits to BPA and utilities to use demand response

- ***load shifting***
- ***peak avoidance***
- ***balancing***
- ***reliability***
- ***congestion management***

Potential DR Use	Constraint Example	Notification Period	Duration	Dispatch	Frequency
Load shifting (HLH to LLH)	Heavy spring run-off Dry April I or August II	Pre-planned, day-ahead or longer	Up to 3 months	BPA	Seasonal, not deployed every year
Utility peak load avoidance	Tier 1 demand charge avoidance by utility	Pre-planned, based on utility algorithm	Up to ~4 hours	Utility	Monthly (e.g., up to 4x per month)
DEC (load up)	Wind integration	< 10 minutes	< 90 minutes	BPA	Up to multiple times per day, multiple frequencies possible
INC (load down)	Wind integration	< 10 minutes	< 90 minutes	BPA	Up to multiple times per day, multiple frequencies possible
Capacity	Winter cold spell, summer heat wave	Day-ahead	Up to ~4 hours	BPA or Utility	As needed, locational, multiple frequencies possible
Reliability / emergency	Large generation unit outage or unit fails to start	< 10 minutes	< 90 minutes	BPA	As needed, BA-wide multiple frequencies possible
Congestion management - transmission	Defer or avoid transmission construction	< 10 minutes	Multi-hour	BPA	As needed, location-specific
Congestion management - distribution	Defer or avoid distribution construction	< 10 minutes	Multi-hour	Utility	As needed, feeder/substation-specific

Numerous Utility DR Pilots Over the Past Three Years Supported by BPA

Current DR Pilots	Residential	Commercial	Irrigation	Industrial	Building management	Storage-battery	HVAC thermostat	In-home display	Process adjustment	Refrigeration/ cold storage	Thermal storage space heating	Thermal storage water hearting	Water heater controller	Water pumping
Central Electric	0.2												403	
City of Forest Grove				0.1						1				
City of Port Angeles	0.4						90	90			30	20	500	
		1.8			1	1	2		4				4	2
				18.0-40.0					2					
City of Richland	0.1			0.2						1		30		
Clark Public Utilities		0.1			1									
Columbia REA			3.0-5.0						1					2
Consumers Power				0.3						2				
Cowlitz County PUD	0.1 - 0.2											70		
Emerald PUD	0.3						200				10	10	200	
EWEB	0.1			0.2						1		50		
Kootenai Electric	0.1-0.2						78						95	
Lower Valley	0.1-0.2										6			
		0.1-0.2									3			
Mason County PUD #3	0.1-0.2					2							100	
Orcas Power & Light	0.4												410	
United Electric Co-op			1.8											4

- ✓ ***Testing in Residential and Commercial / Industrial sectors***
- ✓ ***Testing Technical Feasibility***
- ✓ ***Testing Approaches to Signal Events***

What We Are Learning About Demand Response

- **Demand Response prevalent across the US – 58,000 MW – much of it for peak management**
- **Drivers for DR in the PNW, e.g. new rates, hydro system limits/wind balancing…**
- **Loads with storage capability (for increasing or decreasing) offer opportunity to use Demand Response without impacting customer service**

Energy Storage/DR (Ecofys) Pilot

Objectives:

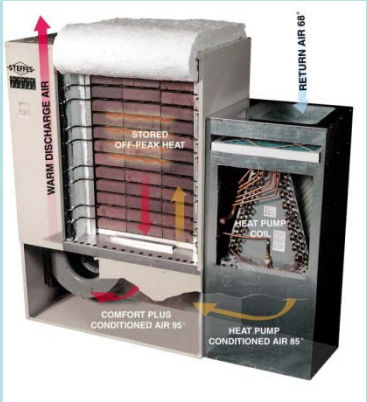
- Use controllable loads to help integrate variable renewables - testing control and dispatch
- Demonstrate that these loads can provide balancing services and benefit end-use customers and host utilities
- Scope: 1 to 3 megawatts of DR storage
- Develop a demand response business case and marketing materials to support utilities
- Two year project; active since Sept. 2010

Commercial and Industrial

Commercial HVAC Controls

Cold storage

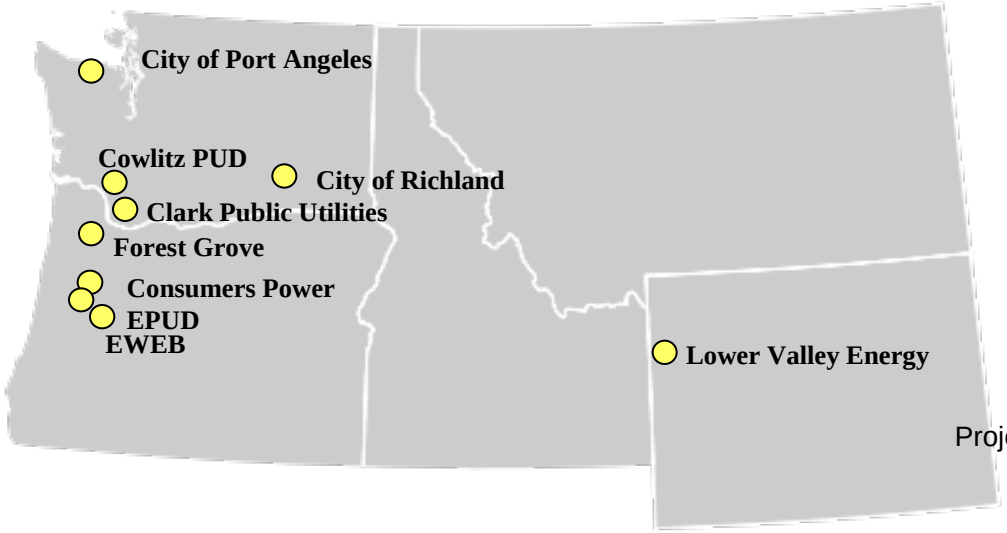
Residential

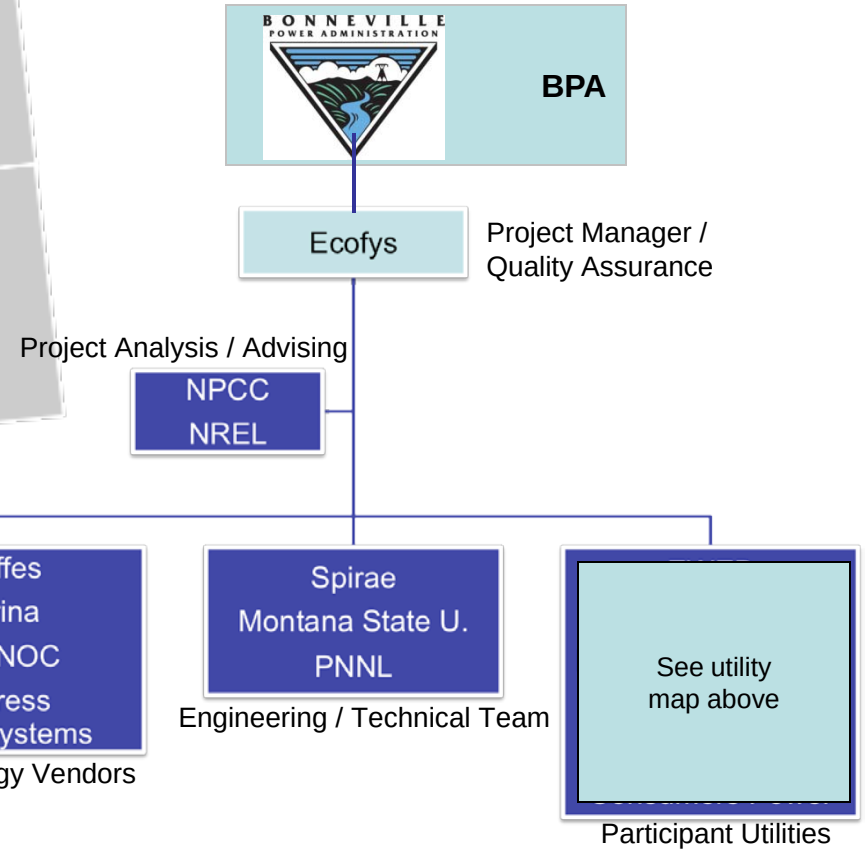


Thermal Brick Furnaces

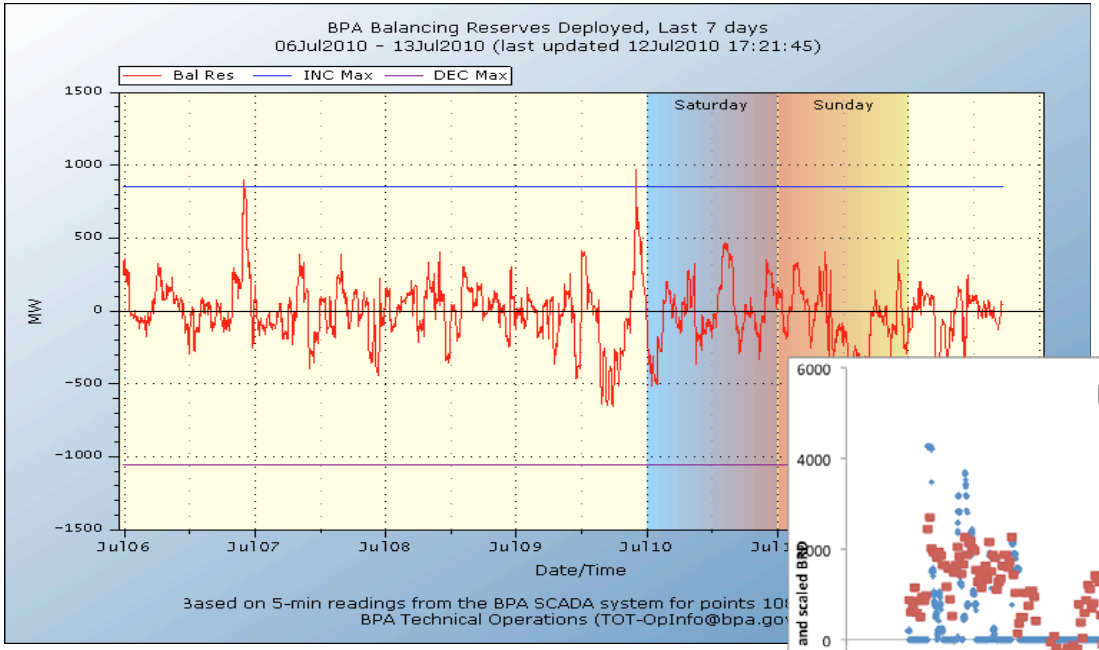
Residential Water Heaters

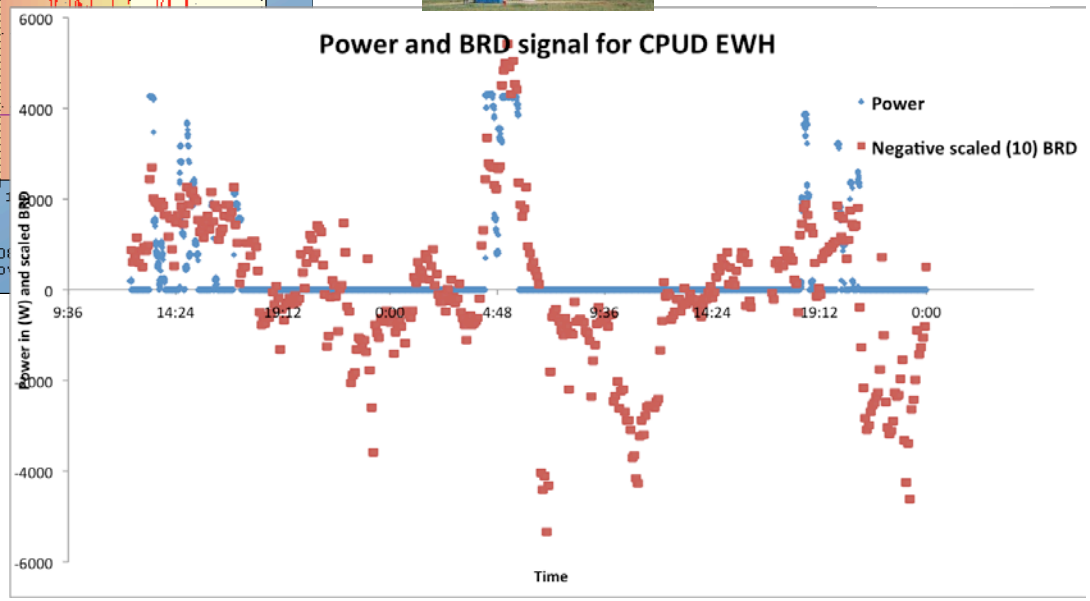
Numerous Entities Participating in this Pilot





Pilot is testing utility end loads connected to a BPA Wind Signal to Support Balancing





Balancing reserves deployed

Signal sent to electric water heaters

Pilot includes creating Utility Specific Demand Response Business Cases

EWEB

LOWER VALLEY ENERGY

Clark Public Utilities

COWLITZ COUNTY PUD

The People's Power

Richland Washington

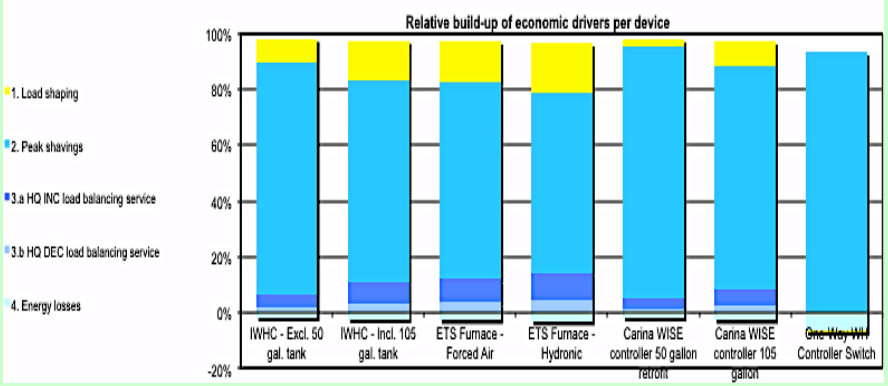
FOREST GROVE OREGON

CPI CONSUMERS POWER INC.

Each Business Case Looks at the Cost / Benefit of Implementing DR Technologies

Potential Utility Revenue Streams

- **Load shaping**
- **Peak shaving**
- **INC load balancing**
- **DEC load balancing**
- **Energy losses**



Utility Costs by Tested Technology

(water heaters, thermal storage furnaces, cold storage, thermostats)

Hardware / systems [Price per piece]			2012
Steffes IWHC with 50 gallon tank	☑ Include in Buildout		$75
Steffes IWHC with 105 gallon tank	☑ Include in Buildout		$1,7
Steffes ETS furnace (Forced air)	☑ Include in Buildout		$5,3
Steffes ETS furnace (Hydronic)	☑ Include in Buildout		$7,6
Air Source heat pump (to operate with ETS furnace)	☑ Include in Buildout		$3,0
Steffes Communications and data for ETS (pilot stage)	☑ Include in Buildout		$
Carina WISE controller 50 gallon retrofit	☑ Include in Buildout		$4
One-Way WH Controller Switch	☑ Include in Buildout		$15
Installation costs			
Installation costs IWHC		[1]	$3
Installation costs IWHC + tank			$5
Installation cost per ETS furnace - all			$3,0
Installation costs WISE controller			$15
One-Way WH Controller Switch			$15

Example – Revenue from Peak Shaving using Water Heaters

5. Typical peak shaving yield per device [kW]

Device/system	Average [kW]	Jan	Feb
Steffes IWHC with 50 gallon tank	1.7	2.07	2.07
Steffes IWHC with 105 gallon tank	1.7	2.07	2.07
Steffes ETS furnace (Forced air)	4.4	10.0	8.0
Steffes ETS furnace (Hydronic)	4.4	10.0	8.0
Carina WISE controller 50 gallon tank	1.7	2.07	2.07
Carina WISE controller 105 gallon tank	1.7	2.07	2.07
One-Way WH Controller Switch	0.8	1.04	1.04

Load Opportunity / Device (kW)

x

Installed base	2012	2013	2014	2015
IWHC - Excl. 50 gal. tank	4	12	22	34
IWHC - Incl. 105 gal. tank	0	0	0	0
ETS Furnace - Forced Air	2	4	4	6
ETS Furnace - Hydronic	0	0	0	0
Carina WISE controller 50 gallon retrofit	25	25	25	25
Carina WISE controller 105 gallon	2	6	8	8
One-Way WH Controller Switch	100	200	300	400

Device Rollout Plan

x

Assumes a coincidence level (% time heater on during peak)

1. Utility System Inputs

Price Option
- Open Marke
- Forecast
- Priority Firm
- Alternative
- New Resour

*Rare situation, do not select the New Resource option exept in special circumstances

Inc / Dec Balancing
- Low Cas
- Moderat
- High Case

Lo

Price overview - inputs in yellow	Price Option		Avg. price	Jan
Heavy Load Price	2	$/kWh	$0.040	$0.040
Light Load Price		$/kWh	$0.031	$0.032
Spread		$/kWh	$0.009	$0.008
Demand Rate (*Ref: Rates Sheet*)		$/kW	$9.568	$9.740
INC Balancing Fee (*Ref: Rates Sheet*)	2	$/kW-Month		$5.000
DEC Balancing Fee (*Ref: Rates Sheet*)		$/kW-Month		$2.000
Average Electricity Price		$/kWh	$0.035	$0.036

Demand Charge (LF) Calculation

= Potential Peak Shaving Revenue

Example – Costs of all Aspects Are Input into the Model

4. Hardware related costs - Input & Assumptions

Hardware / systems [Price per piece]		2012	2013	2014	2015
Steffes IWHC with 50 gallon tank		$758	$438		$394
Steffes IWHC with 105 gallon tank		$1,705	$1,385		$1,247
Steffes ETS furnace (Forced air)		$5,382	$4,844		$4,359
Steffes ETS furnace (Hydronic)		$7,671	$6,904		$6,214
Air Source heat pump (to operate with ETS furnace)		$3,000	$2,700		$2,430
Steffes Communications and data for ETS (pilot stage)		$0	$0		$0
Carina WISE controller 50 gallon retrofit		$480	$250		$250
One-Way WH Controller Switch		$150	$150		$150
Installation costs					
Installation costs IWHC	[1]	$300	$262		$262
Installation costs IWHC + tank		$500	$400		$400
Installation cost per ETS furnace - all		$3,000	$3,000		$3,000
Installation costs WISE controller		$150	$150		$150
One-Way WH Controller Switch		$150	$150		$150
Costs Reference					
50 gallon tank		$500			
105 gallon tank		$1,000			
Average conventional heating system		$4,000			

Assumes that costs of new technology decreases over time

Control Hardware and Systems Costs

Installation Costs

Base Tank Cost

5. Project costs - Input & Assumptions

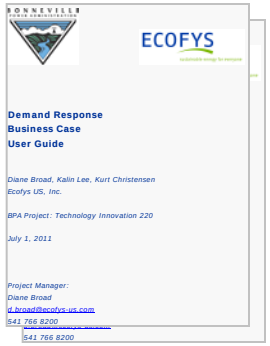
	2012	2013	2014	2015
Participant acquisition costs (marketing effort & materials)	$100	$75		$50
Additional staff support time	$100	$75		$50
Annual maintenance costs	1%	1%		1%

Staff and Marketing Costs

Example – The Model produces Multiple Return on Investment Views

Revenues per load mgt. strategy (x 1,000)	2013	2014	2015
1. Load shaping	$ 0.92	$ 1.14	$ 1.57
2. Peak shavings	$ 29.63	$ 41.59	$ 54.57
3.a HQ INC load balancing service	$ 0.45	$ 0.55	$ 0.72
3.b HQ DEC load balancing service	$ 0.18	$ 0.22	$ 0.29
4. Energy losses	$ -0.81	$ -1.18	$ -1.56
Total cash in (x 1,000)	$ 30	$ 42	$ 56

Revenue by Utility Strategy Employed


ECOFYS

Demand Response
Business Case
User Guide

Diane Broad, Kalin Lee, Kurt Christensen
Ecofys US, Inc.

BPA Project: Technology Innovation 220

July 1, 2011

Project Manager:
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Payback Period

1.2 Devices procured & installed in 2013				
Financial results per device (incl. costs for comm. & data kit)	**Additional investment**	**Add. annual maintenance**	**Annual revenues**	**Payback time** [years]
Steffes IWHC with 50 gallon tank	$ 738	$ 7	$ 221	3.5
Steffes IWHC with 105 gallon tank	$ 1,385	$ 14	$ 250	5.9
Steffes ETS furnace (Forced air) (Incl. Air source Heat Pump)	$ 3,844	$ 65	$ 667	6.4
Steffes ETS furnace (Hydronic) (Incl. Air source Heat Pump)	$ 5,904	$ 86	$ 716	9.4
Carina WISE controller 50 gallon retrofit	$ 400	$ 4	$ 204	2.0
One-Way WH Controller Switch	$ 300	$ 3	$ 93	3.3

Contact

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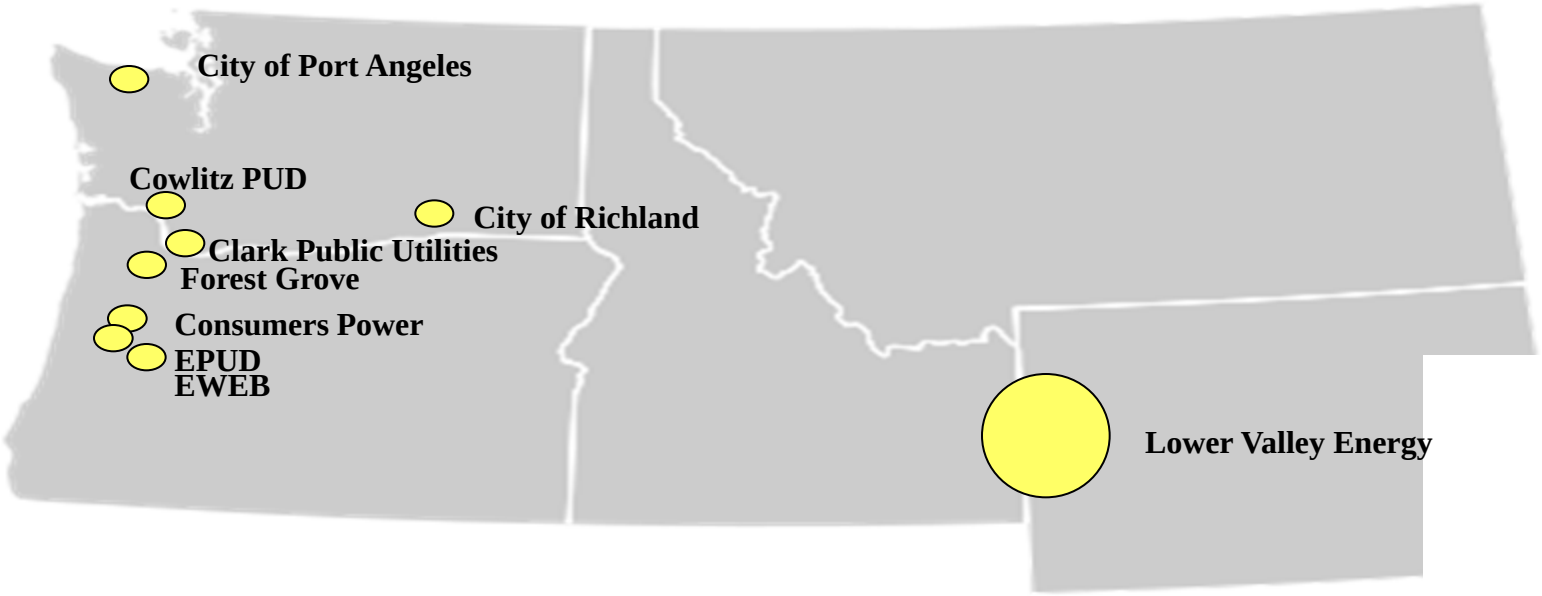
For more Smart Grid Information:

PNNL: www.pnl.gov

DOE OE: www.oe.energy.gov

Smart Grid: www.smartgrid.gov
Pacific Northwest Smart Grid Demonstration Project:
www.pnwsmartgrid.org
BPA wind site: http://www.bpa.gov/corporate/WindPower/
Smart Grid Consumer Collaborative: http://smartgridcc.org/

LOWER VALLEY ENERGY



~25,000 electric and 4,000 gas customers in western Wyoming and southeast Idaho

Winter-peaking load highly correlated with space heating

LOWER VALLEY ENERGY

LOWER VALLEY ENERGY

Status: 7 projects operating - 5 residential, 2 commercial
4 forced-air, 3 hydronic
~ 300 KW of DR potential
Being controlled & monitored by
Steffes (furnace manufacturer)

Yet to learn: DR value for LVE?
Proper incentive for furnace owners?
$$ value for wind-power offset
Best ways to market similar projects for new construction