Northwest Power and Conservation Council

November 27, 2012

MEMORANDUM

TO: Council Members

FROM: Tom Eckman

SUBJECT: Business Case for Update End Use Load Shape Data

Since 2009, the Pacific Northwest region has invested over two billion[1] dollars in energy efficiency and grid improvements. On a going forward basis, the region must address capacity and intermittent resource integration issues. The engineering and economic analysis needed to support future investments in energy efficiency and load forecasting for capacity planning is, in part, based on historical end-use estimates of hourly customer loads. Most of the end-use data used in the region is based on the End-Use Load Consumer Assessment Program ("ELCAP") between 1986 and 1989. In the ELCAP project, which was funded by Bonneville, over 450 homes and approximately 80 commercial buildings had metering equipments installed that measured the hourly and sub-hourly electricity demand of most of their appliances and equipment. ELCAP has served the region, and the nation, well and is still widely used today. However, the ELCAP data is now nearly three decades old. Current load profiles may differ from the historical load shapes as there have been significant changes in the last thirty years that may have altered the end-use performance landscape. In addition, the load profiles of new appliances, such as game consoles, home office equipment and emerging end-uses of electricity such as electric vehicles are unknown.

Over the past several years the Regional Technical Forum (RTF) has attempted to develop regional support for updating the region's end-use load profile data. This past year the RTF

[1] 2009-2010 energy efficiency expenditures of $672 million as reported by the American Council for an Energy Efficient Economy, 2011 energy efficiency expenditures of $508 million reported by the Northwest Power Planning Council, $818 million in 2009-2011 transmission infrastructure expenditures reported in the BPA Annual Report and the five year $178 million invested in the Pacific Northwest Smart Grid Demonstration project.

851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204-1348
www.nwcouncil.org

Steve Crow
Executive Director

503-222-5161
800-452-5161
Fax: 503-820-2370

contracted with KEMA to develop a business case and strategy for conducting this research. Staff will provide the Power Committee with a summary of the costs and benefits for updating the region's end-use load data and discuss a proposed strategy moving this research forward. A copy of the presentation is attached to this memo. The Executive Summary of the KEMA report can be found on the RTF's website: http://www.nwcouncil.org/energy/rtf/subcommittees/enduseload/RTF%20Executive%20Summary%2030%20SEP%202012%20v04-1.docx

q:\te\6th plan\issue and council papers\p4_121112_endusebusinesscase.docx

851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204-1348
www.nwcouncil.org

Steve Crow
Executive Director

503-222-5161
800-452-5161
Fax: 503-820-2370

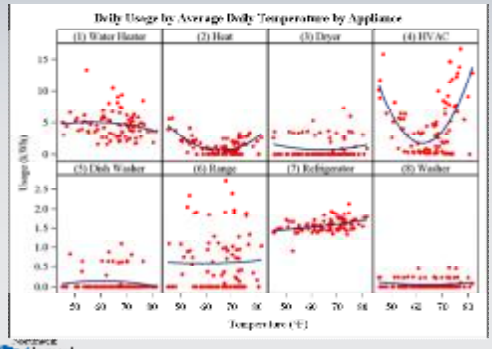
The Business Case for Updating the PNW Region's End-use Load Data

December 11, 2012

What is End-Use Load Data?

Background and context:

- What is it?
- Who uses it?
- How is it used?
- How is it collected or developed?
- Why do we need to update existing data sources?



NEEA RBSA metering data provided by Ecotope

2

Updated End-use Data is Needed

- **Energy Efficiency Planning** – provides the basis for determining the benefits and costs associated with measures and programs helping to direct energy efficiency investment decisions;
- **Energy Efficiency Evaluation** – assigns time differentiated impacts to energy efficiency measures and portfolios helping to improve program designs to become more cost effective at obtaining energy resources;
- **Capacity Planning and Demand Response –** the region is facing a capacity challenge where an understanding of end-use load patterns is necessary for designing effective demand response programs to help manage peaks;
- **Integrated Resource Planning** – provides necessary detail on the hourly impacts helping to establish the value proposition for the energy efficiency portfolio, or the measures that make up a cost effective portfolio;
- **Wind Integration** – understanding of end-use load patterns is a critical element needed to help integrate intermittent renewable resources into the resource mix;
- **Grid Operations and Reliability** – used to update critical components of regional transmission operating models with current customer load information helping to operate the grid reliably and economically;

3

Updated End-use Data is Needed (continued)

- **Load Forecasting** – while many of the regional planners effectively use econometric models, a better understanding of end-use loads would provide the opportunity to isolate and differentiate trends associated with specific technologies, determine impacts of forthcoming codes and standards and assess the effects of changes in energy efficiency policy, not captured by econometric trend forecasting;
- **Rates and Pricing** – provides information for use in designing customized rates/riders targeted at specific end-uses and provides insight into the likely impacts of time differentiated rates. An example would be the development of an off-peak charging rate for the promotion of electric vehicles;
- **Smart Grid Investments** – potentially outdated and inaccurate load shapes are still being used to assess the costs and benefits of demand response including the application of smart appliances from a utility and grid perspective; and
- **Customer Service** – facilitates partnership between electric service providers and customers through enhanced knowledge and understanding of end-use contribution to typical customer usage patterns fostering consumer education, utility response to high bill complaints, rate impact estimation, energy efficiency target marketing and other customer service touch points.

4

Common Concerns About Existing Data Sources

- Vintage
  - Bulk of existing data was collected in late 1980s
  - Equipment and appliance characteristics have changed (e.g., higher efficiency and different feature sets (e.g., refrigerators now have auto-defrost and ice-makers, dishwashers have time-delay start)
- Scope
  - No Data on New and Emerging End uses (Some end uses did not exist in 1980s (e.g., game consoles, DVRs, electric vehicles, variable speed drives);
  - Current widely used energy efficiency control technologies did not exist in the 1980s (e.g., demand controlled ventilation, occupancy sensor lighting controls, etc.);
  - End uses that were small in 1980 and were not captured have grown significantly (e.g., computers/servers, printers, home networking equipment, set-top boxes,)
  - Limited data on energy efficiency measure load profiles if they differ from end-use load profile (e.g., lighting controls change hours of operation, while higher efficiency lamps simply reduce wattage)
- Usability/Applicability
  - Existing load shape data represent conditions that no longer exist (e.g. Grocery store load profiles based on 16 hour/day operation without deli section, not 24 hour/day operation with deli section)
  - Details of data collection methods or sample periods represented by existing data may be unknown so applicability to current situation is uncertain

5

Recent End-Use Research Activities (Since 2009)

- NEEA's Residential Building Stock Assessment (RBSA)
  - Approximately 100 single family homes with detailed end use monitoring equipment installed
  - Last meters installed 12/2011, first "annual" data due mid-2013
- NEEA's Commercial Building Stock Assessment (CBSA)
  - No end use metering component currently scoped or funded
- BC Hydro's Residential End-Use Metering Project (REUMP)
  - Pilot phase underway
  - Full scale deployment time-frame still uncertain
- NorthWestern Energy's End-Use and Load Profile Study
  - Did not involve in-field metering at end-use level

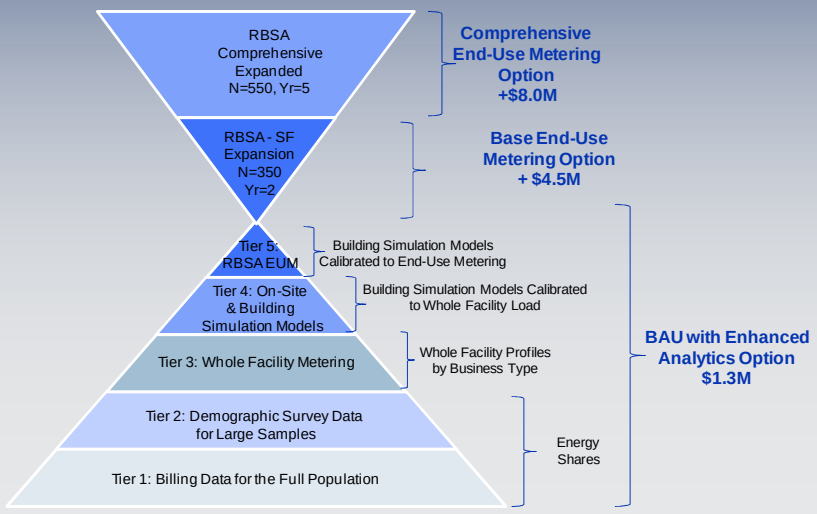
6

Business Case – Three Possible Levels of Effort

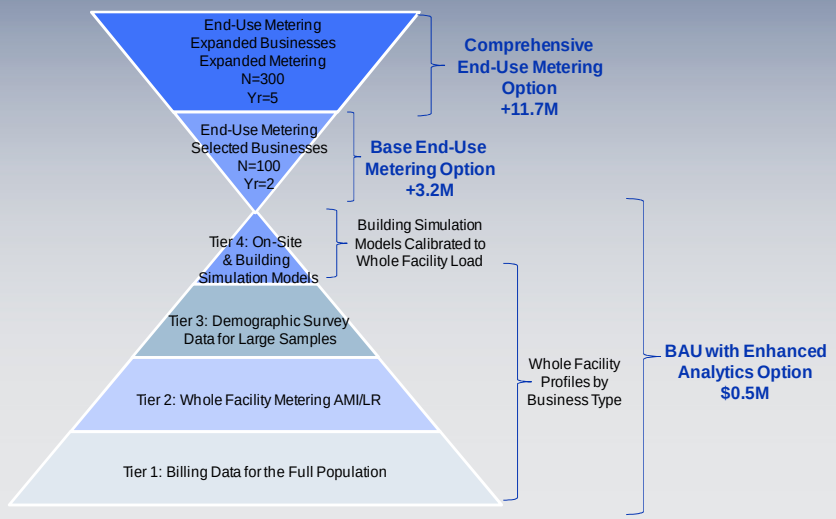
- *Business As Usual with Enhanced Analytics Case*
  - addresses the highest priority areas but does so with limited, if any, actual End Use Metering data
  - requires some primary data collection but is restricted to demographics or secondary data
  - lowest estimated cost and level of effort
- *Base End-Use Metering Case*
  - includes updated, actual end-use data
  - meets a greater range of stakeholder needs
  - attentive to project costs, time and resource (i.e., staff) requirements
- *Comprehensive End-Use Metering Case*
  - relaxes concerns about data acquisition costs and resource requirements
  - focuses on what stakeholders could obtain through a multi-year end-use data collection effort, unconstrained by costs, time and/or resource limitations
  - includes additional data collection elements, e.g., water flow

7

Levels of Effort: Residential



Levels of Effort: Non-Residential



9

Costs for Each Level of Effort

- An investment of just 1% of the planned energy efficiency expenditures over the next five years would provide $25 million dollars

STUDY OPTION	Total Study Cost	Study Cost as % of Five Years of EE Costs*
BAU with Enhanced Analytics	$ 1,857,750	0.07%
Base End-Use Metering	$ 8,740,750	0.35%
Comprehensive End-Use	$ 28,472,750	1.14%

*Assume $500M per year for five years for a total of $2.5B in regional EE expenditures.

10

Benefits for Each Level of Effort

	BAU Enhanced Analytics		Base EUM Option		Comprehensive EUM Option	
	Res	Non-Res	Res	Non-Res	Res	Non-Res
Energy Efficiency	◑	◔	◕	◕	●	●
Grid Reliability	◔	◔	◔	◔	●	●
Wind Integration/DSM	◔	◔	◑	◑	●	●
Load Forecasting	◑	◑	◕	◑	●	●
Smart Grid	◔	◔	◔	◔	●	●
Customized Rates	◔	◔	◑	◕	●	●
Customer Satisfaction	◑	◑	●	●	●	●
Air Quality	◔	◔	●	●	●	●

11

Cost-Benefit Summary

	Total Cost/ Expenditure ($M)	Regional or Utility Level	Description	Study Option Range of Value ($M)								
				BAU with Enhanced Analytics			Base End-Use Metering			Comprehensive End-Use Metering		
				Coverage	Credit to EU		Coverage	Credit to EU		Coverage	Credit to EU	
ANNUAL COSTS/VALUE					1%	5%		1%	5%		1%	5%
Energy Efficiency	$ 508	Regional	PNW EE expenditures (2011)	25%	$ 1.3	$ 6	75%	$ 3.8	$ 19	90%	$ 4.6	$ 25
Grid Reliability	$ 880	Regional	50% of annual societal cost of outages to region	25%	$ 2.2	$ 11	25%	$ 2.2	$ 11	90%	$ 7.9	$ 44
TOTAL ANNUAL	$ 1,388				$ 3.5	$ 17		$ 6.0	$ 30		$ 12.5	$ 69
Length of Study Period			Years		1	1		2	2		5	5
Length of EUM Value					5	5		5	5		10	10
Total Value					$ 17	$ 87		$ 30	$ 150		$ 125	$ 694
NON-ANNUAL COSTS					1%	5%		1%	5%		1%	5%
Capacity Planning/DR	$ 200	Utility	Transmission expansion (Benefit: $200M investment, deferred 5 years @3%)	25%	$ 0.05	$ 0.2	50%	$ 0.09	$ 0.46	90%	$ 0.17	$ 0.83
Load Forecasting/ Resource Planning	$ 200	Utility	Generation Asset (Benefit: $200M investment, deferred 5 years @3%)	25%	$ 0.05	$ 0.2	50%	$ 0.09	$ 0.46	90%	$ 0.17	$ 0.83
Total Estimated Benefits					$ 17	$ 87		$ 30	$ 151	$ 2	$ 125	$ 696
Total Estimated Costs					$ 1.9	$ 1.9		$ 8.7	$ 8.7		$ 28.5	$ 28.5
Benefit Cost Ratio					9:1	47:1		4:1	17:1		4:1	24:1

12

Next Steps

- Council staff will use KEMA reports Executive Summary to prepare end use load profile update "project prospectus"
- Present prospectus to Council
- Identify interested parties and convene discussions
  - RTF PAC
  - NEEA/NEEP
  - PNUCC
  - BC Hydro
  - US DOE
  - National Labs
- Identify the champion(s)
  - Whose best suited as host
- Identify decision points and timeline

Backup

RTF Project Background: Assessment of Regional Interest and Need

- Objective: Lay the foundation for the business case by *assessing the current interests and needs of the region's stakeholders.*
- Process: Webinars and Interviews, discussing:
  - How do the groups currently use end use information,
  - How do the they envision using the data in the future,
  - What are the risks associated with continuing to use the current data,
  - What business decisions are being made based on their analyses, and
  - What are their current data requirements and priorities?

15

RTF Project Objectives and Method

- RTF contracted with KEMA to develop the business case for a comprehensive PNW electric end-use data collection study
  - Assessment of Regional Interest and Need
  - Assessment of Updates since 2009 KEMA Study
  - Assessment of National and Out-of-Region Resources
  - Assessment of the No Action Option
  - Analysis of Options for Proceeding with Study
  - Develop the Business Case for a Range of Viable Options
- Work Commenced February 2012
- Data Collection, interviews and webinars conducted through May
- Seven Subcommittee Meetings

16

National Perspectives & Resources

- KEMA Conducted survey (same as PNW interviews)
- Load Profiles
  - Northeast Energy Efficiency Partnership (NEEP) Commercial Lighting Load Shape Study
  - NEEP Commercial Unitary HVAC
  - Glasgow Electric Plant Board
  - EPRI Load Shape Library and Customer Load Insights Interest Group
  - Residential End-Use Metering Program (Australia)
- Protocols for collecting end use load profiles
  - NEEP Draft Protocols
  - International Performance Measurement and Verification Protocol
  - ASHRAE Guideline 14
  - California Evaluation Protocols
  - Federal Energy Management Program Guidelines
  - ELCAP

Three Study Options – Comparison of Attributes

Analytical Elements	Business As Usual with Enhanced Analytics		Base End-Use Metering		Comprehensive End-Use Metering	
Study Attributes	Residential	Non-Residential	Residential	Non-Residential	Residential	Non-Residential
Temporal Resolution	Hourly	Hourly	15 Minute	15 Minute	5 Minute	5 Minute
Sample Size: WH Only	200	None				
Sample Size: HVAC Only	200	None				
Sample Size: Comprehensive	100	None	350	100	550	300
Statistical Significance	±20%	N/A	±10%	±25%	±10%	±15%
Longitudinal Coverage	1-3 years	N/A	2-5 years	2-5 years	5-10 years	5-10 years
Market Coverage	SF Only	N/A	SF Only	Top Ten	SF, MF, MH	Top 15
Geographical Coverage	Poor	N/A	Good	Poor	Good	Good
Primary Data Development Method	Metered	Modeled	Metered	Metered	Metered	Metered
Whole Facility by Market Segment	Yes	Yes	Yes	Yes	Yes	Yes
End-Use Coverage	HVAC/WH	HVAC/Lighting	Most	Most	All	All
End-Use Interaction	Modeled	Modeled	Observed	Observed	Observed	Observed
Anciliary Supporting Measurements, e.g., water flow, load composition, etc.	No	No	No	No	Yes	Yes
Peak Contribution	Modeled	Modeled	Observed	Observed	Observed	Observed
Confidence in Estimates	Low	Low	Medium	Medium	High	High

Webinar Series

Webinar	Date	No. of Attendees	Organizations Represented	
Webinar 1	April 25, 2012	33	American Electric Power Avista BC Hydro Bonneville Power Administration Dominion Virginia Power Electric Power Research Institute Northeast Energy Efficiency Partnerships	Northwest Power Council/RTF Pacific Gas & Electric Pacific Northwest National Lab Puget Sound Energy Snohomish PUD Vermont Dept. Public Service
Webinar 1 (Repeat)	May 4, 2012	7	Bonneville Power Administration Idaho Power Northwest Power Council/RTF	Pacific Northwest National Lab Puget Sound Energy
Webinar 2	May 10, 2012	19	Avista Bonneville Power Administration Dominion Virginia Power Northwest Energy Efficiency Alliance	Northwest Power Council/RTF PacifiCorp Pacific Northwest National Lab Snohomish PUD Southern Company

Stakeholder Interviews

- Based on feedback from the webinars, interview questions were developed:
  - Current State;
    - Current or potential use(s)
    - Source(s) of data
    - Recent updates or developments of new end-use data
    - Concerns/issues with current sources
  - Future State;
  - Investment(s) based on analyses using end-use information;
  - Specific data requirements and supporting information;
  - Sampling and study preferences; and
  - Load shape library user preferences.
- 17 interviews of Pacific Northwest stakeholders:
  - 15 organizations were represented
  - 38 individuals participated
    - 18 were from EE
    - 10 were from a load forecasting/load research
    - 10 were from resource acquisition, smart grid, DR, transmission, regulatory