End-Use Load Data Update Project Final Report

Phase 1: Cataloguing Available End-Use and Efficiency Measure Load Data

Prepared for Northwest Power and Conservation Council and Northeast Energy Efficiency Partnerships

September 2009

1. Executive Summary

In recent decades, efforts to gather end-use load data appear to be scattered and minimal across the Pacific Northwest and East regions (the Regions). Although a significant amount of data was gathered through Bonneville Power Administration's End-Use Load and Consumer Assessment Program (ELCAP) in the mid-1980's through the early 1990's, confidence in the data has waned as technologies change and consumer behavior evolves. The overall objective of this project is to assess and catalog the more recently completed existing end-use and load shape data studies that may be useful to the Regions.

This phase of the load data update will identify gaps in and problems with the existing load shape data and establish priorities and study scopes for load shape improvements to support energy efficiency program planning, electricity markets and environmental policy. Elements of the work include:

- Research and inventory the existing load shape data available
- Determine what load shape data is necessary to meet utility energy efficiency program, ISO-New England and PJM Capacity Markets (CMs), and air quality regulatory needs
- Identify weaknesses in the existing data for use in efficiency programs, capacity markets, and air quality regulations
- Evaluate the transferability and applicability of existing load shape data to the Regions
- Provide a road map for meeting future short term and long term end-use metering needs.

Findings and recommendations are provided at a high level from a region-wide perspective. There were limitations that were not possible to capture in this study, including diverse data needs among program administrators. Therefore, we recognize that specific program administrators may have different priorities for data collection than what was identified.

This study is sponsored by the Northwest Power and Conservation Council's Regional Technical Forum (RTF) and the Northeast Energy Efficiency Partnerships (NEEP) Evaluation Measurement and Verification (EMV) Forum.

1.1 Methodology for Data Collection

One of the key challenges in the data collection effort was to cast the net wide enough to capture all potentially useful datasets, while collecting enough specific dataset characteristic information to ultimately assess its usability. Towards this end, KEMA utilized multiple channels and an iterative process for identifying potentially usable data sources, including:

- A web survey of 102 industry contacts to ask them to submit information on relevant studies from various regions of the country, but primarily focusing on the Northeast, Pacific Northwest and Mid-Atlantic regions
- Studies compiled for the 2006 California Load Shape Update Initiative, which also catalogued the usefulness of a list of load data studies from within the state
- Extensive follow up with industry contacts to further identify and collect dataset characteristics of studies that appeared "potentially useful."

For the purposes of this phase of the project, a list of end-uses and associated "Analysis Groups" were defined separately for the residential and non-residential sectors, as shown below in Table 1 and Table 2. These analysis groups form the framework for cataloguing useful datasets, performing the gap analysis and prioritizing efforts to develop and compile end use and measure specific load data. The end use analysis groups are intended to capture both measure savings shapes and end use consumption shapes.

Tables 1 and 2: End-Use Analysis Groups[1]

End Use	Residential Analysis Groups
Appliances	Appliances - Kitchen
Appliances	Appliances - Laundry
Appliances	Appliances -Refrigerators
Water Heating	Domestic Hot Water
HVAC	HVAC – Cooling
HVAC	HVAC – Fan Energy
HVAC	HVAC - Heating
HVAC	HVAC - Ventilation
HVAC	HVAC - Other
Lighting	Lighting - Exterior
Lighting	Lighting - Interior
Other	Plug Load (Electronics)
Other	Pool Pump

End Use	Non-Residential Analysis Groups
Agricultural	Agricultural - Process
Agricultural	Agricultural - Pumping
Appliances	Appliances - Laundry
Other	Clean Room
Other	Compressed Air
Other	Data Center Equipment
Other	Data Center Cooling
Other	Food Service Equipment
HVAC	HVAC - Cooling
HVAC	HVAC - Fan Energy
HVAC	HVAC - Heating
HVAC	HVAC - Other
HVAC	HVAC - Reheat
HVAC	HVAC - Ventilation Only
Process	Industrial - Process
Lighting	Lighting - Exterior
Lighting	Lighting - Interior
Process	Motors - Drives
Other	Plug Load (Electronics)
Process	Pump
Refrigeration	Refrigeration
Other	Water Heating

[1] "HVAC – Other" category includes measures such as controls, envelope (including insulation, window film, etc) and quality installation measures

In total, over 110 studies were identified as part of this effort, with the majority conducted in the New England or California regions. Through this data collection effort, it was found that most studies fell into one of three categories, based upon the general purpose of the study and the type of data collected:

- **Compilation Studies** – were studies that compiled primary interval data from other studies and used either DOE2 modeling or statistical modeling techniques to produce average end-use load shapes.

- **Load Research Studies** – were studies that utilized long term end-use power metering to develop average end-use load shapes. The samples were typically selected to define end-uses at the tariff class level with little or no customer specific data collected other than the interval power data.

- **Evaluation Studies** – were studies that primarily focused on evaluating savings impacts for energy efficiency measures or demand response programs. These studies were typically characterized by shorter term monitoring of program participants that only collected data about the specific program measures being evaluated.

1.2 Interviews with Users of Load Shape Data

To better understand the needs of the Pacific Northwest and East, KEMA conducted a number of interviews and convened two focus groups with three groups of users: energy efficiency program planners, capacity market representatives, and air quality regulators. These groups of users all utilize end-use and measure load shape data to better forecast the potential impacts related to energy efficiency programs, whether to estimate energy savings, demand reductions or reduced air emissions.

The interviews focused on what data users were currently using, including the sources of data they have available to them now and whether the load shapes are 8,760 annual hourly profiles or some other time period. Users were also asked about their confidence in existing load shapes and where they see the need for new metering studies.

In summary, it appears that the data collection related to end-use and measure load shapes is occurring on an ad-hoc basis within and between each region. Most energy efficiency planners and air quality analysts are utilizing whatever the best available data appears to be. The principal driver for hourly 8,760 is not for avoided cost calculations for energy efficiency program planners, but rather to support the forward-capacity market bid programs in both the ISO NE and PJM regions. Furthermore, New York is ramping up significant program activity, with a need to better understand the distribution of savings. There is an urgency related to the lack of

consistency across programs and utilities in both regions and uneven information across the different states (including small versus large utilities).

The capacity markets have the most stringent requirements and urgent need for hourly 8,760 energy savings data. Some energy efficiency programs across the country are funding M&V of program impacts that could potentially support the development of end-use and measure load shapes that would be broadly useful. Although there are some protocols, such as the International Performance Measurement and Verification Protocol (IPVMP), the metering related to the evaluation of efficiency programs is not coordinated or conducted in a consistent manner between (or even within) regions. A first and significant hurdle to overcome this problem is the need for an M&V protocol designed specifically to support the collection of end-use data that can be usable and transferable across different regions.

The conclusion from interviews with users of the load-shape data is that capacity market requirements are the "gold standard" for end-use and measure load profiles. It appears that any data that is good enough for ISO-NE and PJM should certainly be adequate for energy efficiency program planners and air quality regulators.

1.3 Usability and Transferability of Datasets

Following the interviews with the users of the load shapes, KEMA assessed the usability of the identified datasets for load shapes. We first explored metrics for determining the general usability of studies, and then secondly examined the issues and requirements inherent in making a potentially useful study transferable to another region or customer population.

Studies were evaluated for usability based on the following criteria:

- **Accessibility** – The first and foremost indicator of usability is simply whether the underlying data is accessible, meaning that the study contact person has the ability to retrieve the relevant data. For this project, the accessibility rating is self-reported, with 1 being readily accessible and 5 being completely inaccessible. Studies that were completely inaccessible were not considered usable.

- **Statistical significance/Sample size** – In order to properly represent a specific customer population, the initial data must be collected with an appropriate sampling approach. The level of statistical significance is an important metric for assessing the usability of load shapes for the ISO-NE Forward Capacity Market (FCM). Over the years, program implementation and evaluation staffs have grown quite adept at estimating aggregate efficiency impacts from samples with ±10% relative precision at the 90%

confidence level. Load research was traditionally focused on 90/+/-10% as recommended in the Public Utilities Regulatory Policies Act (PURPA) of 1978.[2] This has been deemed the "PURPA Standard" or the "90/10 Rule" and has manifested itself through endless discussions among interval load data collectors primarily in the load research community and more recently among evaluators of energy efficiency and demand response. While annual kWh savings are relatively easy to quantify with reasonable accuracy, pursuit of accurate coincident peak demand impacts poses some challenges.

- **Vintage of Data** – KEMA considered more recently conducted studies to be more usable than older data collected. This is due to the fact that as data get older, users feel less and less comfortable with them, unsure that they represent today's loads. For the most part, these changes are not well understood, and some end-uses and measures have changed more significantly than others in recent years. For instance, we fundamentally rely on some of the same end-uses, such as heating and cooling our buildings, refrigerating our food and using lighting. In some cases, the load shape may still be the same, but the scale or magnitude of energy use may have changed.

- **Time Resolution/Granularity of Data** – The ISO-NE FCM requires at least a 15-minute sampling rate, and this concurs with the load research standard. It is worth noting that if users are interested in absolute peak values, then shorter time resolution may more accurately capture short term peak. Fifteen-minute peak values are almost always higher than hourly peak values due to load diversity factors. As data storage technology and communication speeds continue to improve, we will be able to easily handle data with one minute or even shorter integration periods. For the time being, we consider data collected at 15-minute intervals or less to be most usable. We also acknowledge that 1 hour data may be usable for energy efficiency and air quality regulators in many instances.

- **Geographic Location of Data** – Studies with data collection occurring within the Pacific Northwest and East are generally deemed to be more useful to those regions than studies based in other geographic locations. Some measures by their nature, however, might be expected to have relatively little variation by geographic region or customer type. Even within a specific region, however, studies that focus only on energy efficiency program participants may not represent the general population. This is related

[2] The accuracy level for collected information is addressed in the Code of Federal Requirements CFR 290.403 (b) which stated that "for loads during peak hours, sampling procedures must be designed with a statistically expected accuracy of ±10% at the 90% confidence level. A utility is not required to show that the resulting load curves have this same accuracy but is required to point out any significant deviations from expected accuracy.

to the issue of applying load shapes from one region to another region, and is explored further in the section below.

The question of whether a dataset from one region is usable in another hinges on the transferability of the data. In order to be transferred, the data must first be normalized properly so that it is portable. This requires that usage patterns be defined independent of efficiency and technology.

1.3.1 Transferability of Load Shapes between Regions

In general terms, the transferability of interval load data from a particular end-use analysis group is dictated primarily by the degree to which the power consumption of the equipment is impacted by the ambient weather conditions. The transferability rating looks at the general schedule variability of the analysis group as well as the variability of the end-use due to weather.

Table 3 and Table 4 summarize the general transferability ratings for each of the residential and non-residential end-use analysis groups utilized in the cataloguing effort. It is important to note that these tables assume that the C&I sector will be properly segmented and that data would be transferred across regions, but not within segments. For example the transferability of lighting data for the large office segment from one region would be rated for its transferability to the large office segment of another region and not the small office or retail segments.

Table 3: Residential Analysis Groups Transferability Ratings

Analysis Group	Schedule Variability	Weather Variability	Transferability Rating
Appliances - Kitchen	Medium	Low	High
Appliances - Laundry	Medium	Low	High
Appliances -Refrigerators	Low	Medium	High
Domestic Hot Water	Low	Medium	Medium
HVAC – Cooling	Medium	High	Low
HVAC – Fan Energy	Medium	High	Low
HVAC - Heating	Medium	High	Low
HVAC - Ventilation	Medium	Medium	Low
HVAC - Other	Medium	High	Low
Lighting - Exterior	Medium	Low	High
Lighting - Interior	Low	Low	High
Plug Load	Low	Low	High
Pool Pump	Low	Medium	Medium

Table 4: Non-Residential Analysis Groups Transferability Ratings

Analysis Group	Schedule Variability	Weather Variability	Transferability Rating
Agricultural - Process	Medium	Medium	Medium
Agricultural - Pumping	Medium	Medium	Medium
Appliances - Laundry	Low	Low	High
Clean Room	Low	High	Low
Compressed Air	Low	Low	High
Data Center Equipment	Low	Low	High
Data Center Cooling	Medium	High	Low
Food Service Equipment	Low	Low	High
HVAC - Cooling	Low	High	Low
HVAC - Fan Energy	Low	High	Low
HVAC - Heating	Low	High	Low
HVAC - Other	Low	High	Low
HVAC - Reheat	Medium	High	Low
HVAC - Ventilation Only	Low	High	Low
Industrial - Process	Medium	Medium	Medium
Lighting - Exterior	Low	Low	High
Lighting - Interior	Low	Low	High
Motors - Drives	Medium	Medium	Medium
Plug Load (Electronics)	Low	Medium	Medium
Pump	Low	Medium	Medium
Refrigeration	Low	High	Low
Water Heating	Low	Medium	Medium

Region-wide or even national protocols are needed to establish consistent methods and procedures for monitoring, such that the information can be transferable and useful to other regions and populations. Data from performance monitoring studies can then be used to satisfy diverse needs of energy suppliers and planners, energy end users, designers, researchers, equipment manufacturers, and regulators. The broad priority for the data protocol is transferability, and to enable several small studies from within a region (e.g. conducted for individual program evaluations) to be compiled into a larger dataset.

A wide number of data collection protocols have been established for energy efficiency monitoring and are outlined in the full report. These documents should be utilized as a starting point for a region-wide or national protocol.

1.4 Identification of Potentially Useful Studies and Gap Analysis

Of the 110 studies identified, KEMA focused on a subset of “potentially useful” studies for further analysis and data collection follow up. The selection criteria used for the initial screening of the “potentially useful” studies list was based on a high level review of each dataset.

The studies were reviewed using a variety of different evaluation criteria to determine which could be the most useful. Since there were not a lot of details about the work that was done, the studies were screened based upon the data that were provided consistently such as sample size and the date when the study was completed. The following criteria were used to establish usability criteria:

- Sample size
- Vintage of studies 2000 or more recent
- Studies that developed load profiles

After the initial screening effort, a phone survey was implemented to identify more details about the studies including:

- Types of ancillary data available
- Type of interval data collected (i.e., true power, current only, on/off transition data)[3]
- Whether the data was normalized and identification of normalization variables
- Inclusion of interval weather data or identification of interval weather data source
- Cost and/or level of effort to acquire the data

1.4.1 Summary of Potentially Useful Studies

As previously mentioned, the initial standard for determining potentially useful studies was set fairly low because of the urgent need to utilize end-use load shape data for the ISO/RTO capacity markets. As a result, 37 studies were deemed potentially useful enough to be evaluated for usability using a subjective ranking system as follows:

A – Meets capacity market standards (for defined region, measure(s)), and is usable as a stand alone study within a region

[3] True power refers to the measure of current, voltage and power factor to determine the integrated power usage and is the most accurate measurement. Current only measurement refers to a method that only measures the current in amps and then the voltage and power factor are assumed in order to calculate the demand. Finally on/off transition data typically measures a change of state either using a photocell in the case of lighting loggers or sensing electrical current in the case of CT loggers. These data typically carry a time stamp with each transition and can be converted to time series data, which provides a percent on value per fixed time interval (for example 15 – minutes). The time series data is then converted into interval load data by multiplying the electrical load of the device being monitored by the percent on. This type of metering is particularly efficient for devices that have fixed electrical load and variable operating schedules like lighting.

B – Meets efficiency planning standards (for defined region, measure(s)), and is usable as part of a compilation study

C – Has some issues (e.g. low sample size or data is a little old), but could be used as a last resort or to guide modeling efforts

D – Study should not be used (or data not available to be used)

IP – Study is currently in progress

The following series of tables (Table 5, Table 6, Table 7, and Table 8) present a summary of the useful studies organized by region along with the sponsoring entity, study name, study-end data, analysis groups evaluated, and usability rating. Studies which were rated a C or D were not included for follow up research.

Table 5: Potentially Useful Studies in the Pacific Northwest Region

Sponsoring Entity	Study Name	Study End Date	Analysis Groups Evaluated	Usability Rating
Puget Sound Energy	Commercial & Industrial Lighting Savings Verification Study	2007	Lighting	B
BC Hydro	Load Monitoring Project (LMP)	1994 -2009	Appliance-Kitchen, Appliance Laundry Appliance Refrigerator, Water Heating	B
Seattle Cty Light	Space Heat Thermostat Metering Study	2006	HVAC - Heating	B
BPA	End-Use Load and Consumer Assessment Program (ELCAP)	mid 1980s - early 1990s	Water heating, HVAC - Cooling, HVAC - Heating, Lighting interior, Lighting exterior, Plug Load, HVAC - Fan Energy,	B
BC Hydro	Power Smart Residential End Use Study	Planning Stages	Appliance-Kitchen, Appliance Laundry Appliance Refrigerator, Water Heating	IP
NEEA	Ductless Heat Pump Pilot Evaluation	Not Completed	HVAC-Cooling, HVAC- Fan, HVAC-Heat HVAC-Other, Water Heating	IP
NEEA	Northwest Energy Star Homes Impact Evaluation	Not Completed	Lighting	IP

Table 6: Useful Studies in the Northeast Region

Sponsoring Entity	Study Name	Study End Date	Analysis Groups Evaluated	Usability Rating
SPWG	SPWG Lighting Coincidence Factor Study	2007	Non-Residential Lighting Residential Lighting	A
NSTAR, N-Grid UI, CL&P	Residential Central AC Regional Evaluation	2009	HVAC - Cooling	B
UI	UI Water Heater Controller Study	2008	Water Heating	B
NSTAR, N-Grid NU,UI, VEIC	CFL Lighting Markdown Evaluation	2008	Lighting	B
NSTAR, N-Grid NU, UI	MA & CT Ductless Heat Pump Study	2008	HVAC- Cooling HVAC-Heating	B
NSTAR	BSCS lighting and Non-lighting Studies	2007 & 2008	HVAC-Cooling,HVAC-Other, Compressed Air, Lighting Motor - Drives, Refrigeration, Indsutrial-Process	B
MA Utilities	Mass SAVE Impact Study	2007	Lighting	B
Efficiency Maine	Maine Low Income Light and Appliance Study	2007	Lighting Appliances-Refrigeration	B
SPWG	Residential Room AC Impact Study	2007	HVAC- Cooling	B
UI, CL&P & WMECo	School Lighting Baseline Study	2006	Lighting	B
UI & CL&P for ECMB	CT Coincidence Factor Study	2005	HVAC-Cooling,Motors-Drives	B
NU	Custom Services	2005	HVAC-Cooling, Compressed Air, Lighting Motor - Drives, Refrigeration, Indsutrial-Process	B
NH Electric Coop	New Hampshire Small Business Lighting	2005	Lighting	B
NU	NU Municipal Program	2004	Lighting	B
NSTAR N-Grid	Small Business Solutions (SBS)	2003,2005, 2006	HVAC-Other, Lighting Motor - Drives, Refrigeration	B
N-Grid	Small C&I Unitary HVAC Pilot Impact Study	2003	HVAC-Cooling	B
NU & UI	NU & UI Energy Star Homes Evaluation	2002	Lighting	B
NSTAR	C&I New Construction and Retrofit	2001	HVAC-Other, Compressed Air, Lighting Motor - Drives, Refrigeration, Indsutrial-Process	B
NSTAR	C&I Retrofit	2003	HVAC-Cooling,HVAC-Other, Compressed Air, Motor - Drives, Refrigeration, Lighting	B

Table 7: Useful Studies in the Mid Atlantic Region

Sponsoring Entity	Study Name	Study End Date	Analysis Groups Evaluated	Usability Rating
BGE	Demand Response Infrastructure Pilot Program	2007	HVAC - Cooling	B
BGE	Res. Water Heater, Residential and Commercial AC Control Evaluation	on going	Res. Water - Heating and HVAC-Cooling Non-Res HVAC-Cooling	B
BGE	Residential Water Heater Control (2001 - 2005)	2005	Res. Water - Heating	B
BGE	Residential AC Control (2001 - 2005)	2005	Res. HVAC - Cooling	B
BGE	Commercial AC Control Evaluation (2001 - 2006)	2006	C&I HVAC - Cooling	B

Table 8: Useful Studies in the California Region

Sponsoring Entity	Study Name	Study End Date	Analysis Groups Evaluated	Usability Rating
PG&E and Others	Compressed Air Management Program	2006 - ongoing	Compressed Air	B
CPUC	Database of Energy Efficiency Resources (DEER) (Residential)	2001 - ongoing	All Residential Analysis Groups except HVAC - Ventilation Only & Other	A
CPUC	Database of Energy Efficiency Resources (DEER) (Non Res)	2001 - ongoing	All Non-Res Analysis Groups covered by catalogued studies except Water Heating	A
SDG&E	Express Efficiency Hours of Operation	2006	Lighting	B
CPUC	Industrial End Use Survey (IEUS)	In Progress	Industrial - Process	IP
SCE	Refrigerator Recyclling Study	2005	Appliances-Refrigeration	A
SDG&E	Residential CFL Load Shapes by Room Type	2004	Lighting	A
SCE PG&E	Residential End Use Load Research Study	1996, 2001	Appliance-Kitchen,Laundry & Refrigerator, Water Heating HVAC - Cooling & Heating, Plug Load, Pool Pump	A
LBNL Ecos	Residential Plug Load Study	2006	Plug Load	B
SCE, PG&E CPUC	Savings By Design	2006, 2007 Ongoing	Industrial - Process, Refrigeration, Compressed Air, HVAC - Cooling, Heating&Ventilation Only, Lighting	B

1.4.2 Assessment of Data Availability

The severity of the end-use data gap issue is driven by the extent to which smaller studies of similar measures can be combined within one region, and data from other regions can be transferred and or combined to provide reasonably good load shapes.

Table 9: Summary of Gap Analysis by Region and Sector

Region	Sector	Summary of Gap Analysis
Pacific Northwest region	Residential	The residential customer sector has good coverage in this region as long as the BC Hydro Power Smart Residential End-use metering study is implemented with the large sample sizes that were indicated in the customer survey. If this study is not implemented or the sample sizes are significantly reduced then the coverage for these analysis groups gets thin rather quickly.
	Non-Residential	There was only one non-residential study identified in this region, and it was the Puget Sound Energy lighting study with 65 sample points. Therefore based on the available information **all non-residential analysis groups have a high need for end-use data.**
East region	Residential	Compared to the Pacific Northwest, the residential end-use analysis groups have significantly less coverage in the East. More than half (7 of the 13) analysis groups have no coverage by studies conducted in this region. Additionally only one (lighting interior) of the remaining six analysis groups has a low need for additional data.
	Non-Residential	Ten of the twenty-two analysis groups have no sample data at all. This was the same result as the overall non-residential gap analysis and the same analysis groups are involved and are rated as having a high need for additional data. Once again, the lighting - interior is the only analysis group that appears to have adequate coverage and a low need for additional data.

1.5 Prioritization of Near-term Activities

The gap analysis from the previous section was conducted to identify the promising studies for the various end-use analysis groups where data may be available. This step was necessary to identify where the option of compiling end-use data from groups of other studies may be a viable option. In order to allocate limited near term resources, a ranking of the relative importance of different end-use analysis groups was developed. The relative importance levels are based on a high-level assessment of the perceived and actual contribution of measures within the end-use analysis groups to overall savings within the two regions. The relative prioritization of end-use analysis groups for improvement is categorized as follows:

- **Tier 1** – Most Important. Highest contribution to savings and high need, per web survey
- **Tier 2** – Moderately Important. Moderate contribution to savings and/or need, per web survey
- **Tier 3** – Lower Importance. Lower contribution to savings.

The results from the web survey along with market potential study data from California and Connecticut were used to determine the prioritization rankings for end-use analysis groups.

Generally, there are five options that could be pursued to develop the end-use data sets as follows:

- **Option 1** – Combine existing end-use studies of common measure types into meta studies using data collected within a region (Regional Meta Study). This option is theoretically the most attractive and easiest to implement because there is no primary data collection effort (end-use metering) and there are no transferability issues since data from within one defined region is used. Of course there still are challenges when attempting to combine datasets that involve the format and content of the data. Typically the data were collected to support one evaluation effort and a combined dataset is reduced in detail to the lowest common denominator. One particularly challenging aspect is assigning weights to the observations within the combined dataset. These challenges could be mitigated by developing common data collection and storage procedures that are designed to support the combination of multiple datasets as they are developed.
- **Option 2** – Utilize all data from within the region as well as data from other regions to fill gaps in the regional data (Trans-Regional Meta Study). This option is also theoretically attractive because there is no primary data collection effort (end-use metering) involved. However, because data from multiple regions are to be combined, the issue of data transferability must be addressed. Analysis groups that have a high transferability rating should be the easiest to combine, however it is advisable to perform a statistical comparison of the datasets from each region to make sure that no significant bias is being introduced into the results. If there are no data from within the region than there really is no way to perform this bias analysis and justifying the transferability of the data becomes more problematic particular with respect to capacity market M&V requirements. This option also still has all of the data combination challenges discussed above for Option 1 along with the transferability issue. If a load shape is needed for a relatively unimportant measure that is not weather dependent, then the DEER database could be used directly to extract a load shape.

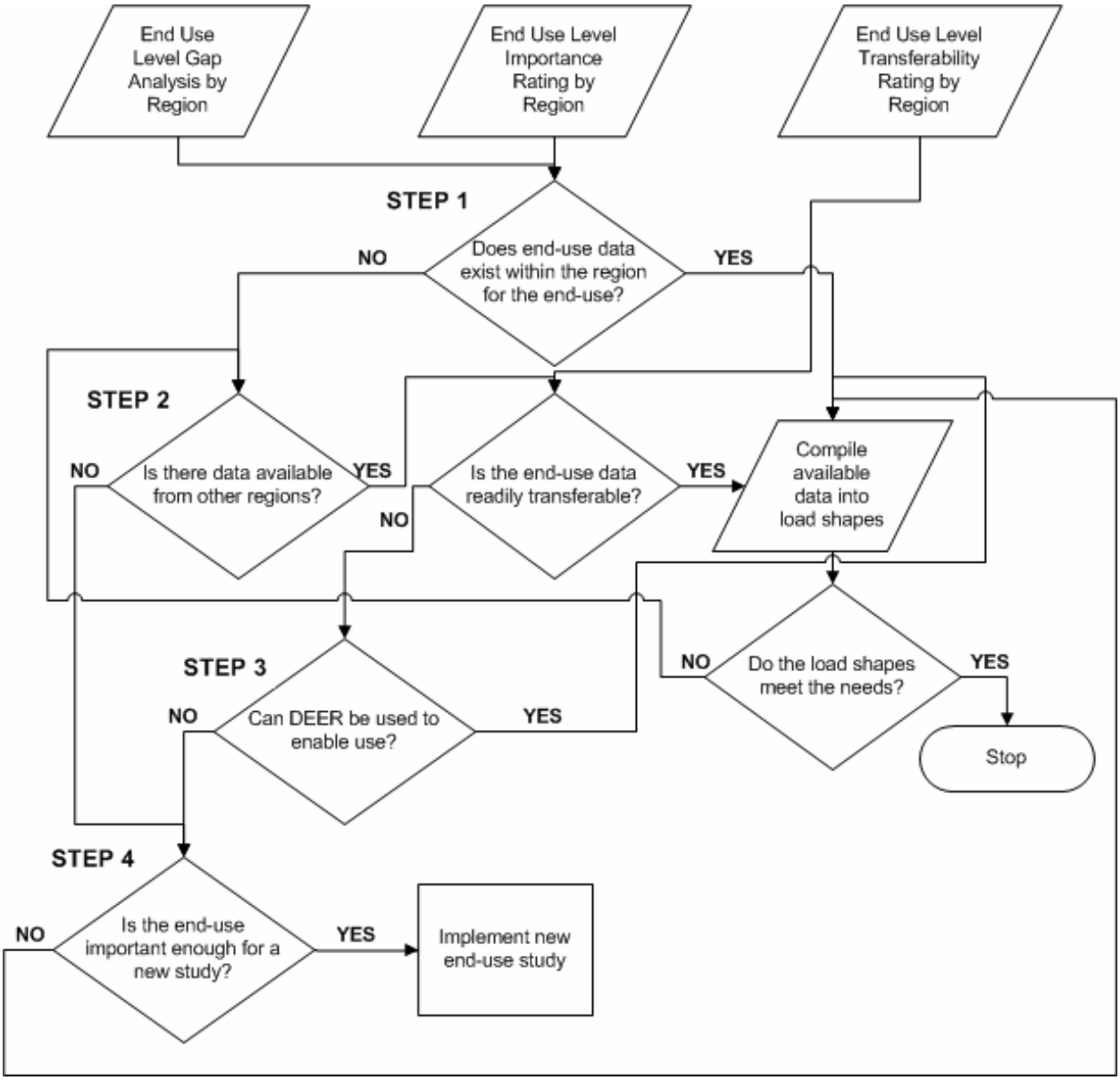
- **Option 3** – Develop database for regionally customized DOE2 models using California Database for Energy Efficient Resources (DEER) as a starting point. Once again this option is theoretically attractive because there is no primary data collection effort. However, customizing the DOE2 models used by DEER to reflect the conditions within a particular region will require a significant data collection effort to identify saturation data of energy efficiency equipment within both Residential and Non-residential customer sectors. DEER models consist of 29 C&I prototypes and 4 Residential prototypes and each provide about 10 different end-uses, excluding whole premise load. Additionally calibration of these models to system load is another process that should be undertaken and can be tremendously onerous depending on the level of rigor attempted.

- **Option 4** – Field new end-use data collection effort to evaluate the measure(s) within a particular region or across multiple regions. This option is attractive because it provides the flexibility to design and conduct the study to meet specific data needs for energy efficiency, air standards or capacity markets. Depending on the level of complexity involved in combining datasets (either from within a region or from multiple regions) or attempting to customize DEER DOE2 prototype models, this may be the easiest and cleanest option.

- **Option 5** – Do nothing because the end-use or measure is not important at this time.

Figure 16 provides a flowchart for the near-term action plan that details the general decision-making process for determining what the best course of action would be for the end-use analysis groups. The decision-making process utilizes the end-use analysis group level gap analysis, importance rating, and transferability rating to inform the decision-making process.

Figure 1: End-use Analysis Group Near-term Action Plan Flowchart



1.5.1 Pacific Northwest Region

Table 10 provides a summary of the near-term actions recommended for the residential sector analysis groups in the Pacific Northwest (PNW) region.

Table 10: End-Use and Measure Shape Improvement Strategies (PNW Residential)

(*Option 1*: Regional Meta-study, *Option 2*: Trans-Regional Meta-study, *Option 3*: DOE2/Modeling, *Option 4*: New Metering, *Option 5*: Do Nothing)

Residential Analysis Groups	Near Term Action	Description
Tier 1 Importance		
Lighting - Interior	Option 1/2	Compile results from BC Hydro Power Smart Residential End-Use Study (IP) and NEEA Energy Star Homes Evaluation (IP). Potentially utilize these studies to assess the transferability of lighting use profile data from other regions (e.g. DEER). Also utilize these studies to assess whether ELCAP data can still be used.
HVAC - Cooling	Option 1/4	Although some limited regional data appears to be in progress, BC Hydro Power Smart (IP) and NEEA Ductless Heat Pump Study (IP), new metering is probably recommended here due to low transferability. These studies can also be utilized to assess whether ELCAP load shapes are still valid.
HVAC - Heating	Option 1	Compile results from BC Hydro Power Smart (IP) and NEEA Ductless Heat Pump (IP) and Seattle City Light Space Heat Thermostat Study.
Plug Load (Electronics)	Option 1/2	Compile results from BC Hydro Power Smart Residential End-Use Study (IP) and consider leveraging LBNL/Ecos CA Residential Plug Load Study and SCE/PG&E Residential End Use Load Research study.
Tier 2 Importance		
Domestic Hot Water	Option 1	Compile results: BC Hydro LMP, BC Hydro Power Smart Residential End-Use Study (IP), and NEEA Ductless Heat Pump Pilot (IP).
Lighting - Exterior	Option 1/2	Compile results from BC Hydro Power Smart Residential End-Use Study (IP) and NEEA Energy Star Homes Evaluation (IP). Potentially utilize these studies to assess the transferability of lighting use profile data from other regions (e.g. DEER). Also utilize these studies to assess whether ELCAP data can still be used.
Appliances - Laundry	Option 1/2	Utilize BC Hydro Power Smart Res End-Use Study (IP) to verify whether data from other regions (e.g. DEER) can be utilized.
Appliances - Refrigerators	Option 1/2	Utilize BC Hydro Power Smart Res End-Use Study (IP) to verify whether data from other regions (e.g. DEER) can be utilized.
Tier 3 Importance		
HVAC - Fan Energy	Option 1/4	Although some limited regional data appears to be in progress, BC Hydro Power Smart (IP) and NEEA Ductless Heat Pump Study (IP), new metering is probably recommended here due to low transferability. These studies can also be utilized to assess whether ELCAP load shapes are still valid.
Pool Pump	Option 1	Leverage BC Hydro Power Smart Res End-Use Study (IP)
HVAC - Other	Option 1/4	Although some limited regional data appears to be in progress, BC Hydro Power Smart (IP) and NEEA Ductless Heat Pump Study (IP), new metering is probably recommended here due to low transferability. These studies can also be utilized to assess whether ELCAP load shapes are still valid.
HVAC-Ventilation Only	Option 5	The only data identified here is from ELCAP. We recommend that this data continue to be utilized.
Appliances - Kitchen	Option 1/2	Utilize BC Hydro Power Smart Res End-Use Study (IP) to verify whether data from other regions (e.g. DEER) can be utilized.

One word of caution should be interjected about the using the existing regional studies as the primary method for developing end-use load shapes, since virtually all of the end-use analysis groups that have Option 1 as their near-term action plan rely almost exclusively on the BC Hydro Power Smart Residential End-use Metering Study for data. This study is still in the planning stages and currently looks to be targeting sample sizes of around 300 for most of the residential sector end-use analysis groups. If this study is not implemented or if sample sizes are significantly reduced, then the available data from within the region becomes very sparse and would probably require that data from other regions be utilized or additional metering efforts within the region. The PNW region should try to leverage (and potentially coordinate with) the BC Hydro study to minimize new metering costs.

The prognosis for the PNW non-residential sector is not good, because there has been no recent end-use interval data collection activity in the region that was identified through this cataloguing effort. The region will have to rely on newer studies that have been conducted in California and the East for borrowed data or launch a significant new metering effort within the region. Some level of new metering effort within the region is unavoidable and the scope of the effort could be managed effectively by looking at specific outside sources of data and considering the ability to leverage these data where practical. It could be that customization of the DEER DOE 2 prototype models is the most cost effective method for developing end-use and impact load shapes however, even this method would benefit from primary data collection from within the region to identify building stock characteristics and develop operating schedules.

Table 11 provides the near-term action plan for the 22 non-residential end-use analysis groups in the Pacific Northwest. There are a total of eight Tier 1 end-use groups identified as a high priority for action.

Table 11: End-Use and Measure Shape Improvement Strategies (PNW Non-Residential)

(*Option 1*: Regional Meta-study, *Option 2*: Trans-Regional Meta-study, *Option 3*: DOE2/Modeling, *Option 4*: New Metering, *Option 5*: Do Nothing)

Non-Residential Analysis Groups	Importance Level	Near Term Action	Description
Lighting - Interior	Tier 1	Option 1/2	Since no studies were found within the region, except for the Puget Sound Energy lighting study, data from outside the region may be utilized, as these end use analysis groups are generally considered transferable (“high”). The Northeast region has good coverage for lighting data and CA DEER provides publicly available data for the other end use groups.
Lighting - Exterior	Tier 1	Option 2	
Compressed Air	Tier 2	Option 2	
Appliances - Laundry	Tier 3	Option 2	
Food Service Equipment	Tier 3	Option 2	
Motors - Drives	Tier 1	Option 4	The remainder of the end use analysis groups are recommended for new metering, due to low or medium transferability. The new metering studies may also be used to assess the extent which the ELCAP load shape data may still be usable.
Plug Load (Electronics)	Tier 1	Option 4	
HVAC - Cooling	Tier 1	Option 4	
HVAC - Fan Energy	Tier 1	Option 4	
HVAC - Heating	Tier 1	Option 4	

Refrigeration	Tier 1	Option 4	The remainder of the end use analysis groups are recommended for new metering, due to low or medium transferability. The new metering studies may also be used to assess the extent which the ELCAP load shape data may still be usable.
Industrial - Process	Tier 2	Option 4	
Water Heating	Tier 2	Option 4	
Pump	Tier 2	Option 4	
Data Center Equipment	Tier 2	Option 4	
Agricultural - Pumping*	Tier 2	Option 4	
Date Center Cooling	Tier 2	Option 4	
HVAC - Other	Tier 2	Option 4	
HVAC-Ventilation (Only)	Tier 2	Option 4	
HVAC-Reheat	Tier 2	Option 4	
Agricultural - Process	Tier 3	Option 4	
Clean Room	Tier 3	Option 4	

1.5.2 Eastern Region

The gap analysis for the East indicated that there were promising studies for both residential and non-residential customer sectors. There were some residential analysis groups that did not have good studies available.

Table 12 provides a listing of the recommended near-term activities for the East residential sector end use groups, which are ranked in order of importance. Of the four Tier 1 end use groups only the lighting – interior has sufficient data from within the region to compile load shapes. The others will require either the use of additional data from other regions, the customization of DEER DOE 2 models and/or the fielding of a new regional metering study. The plug load (electronics) end use will probably require a new metered data collection effort within the region as there is little available data from other regions. The Tier 2 end-use groups will also require the use of additional data from outside of the region, but most of the groups have high transferability ratings, so this does not appear to be a major issue.

Table 12: End-Use and Measure Shape Improvement Strategies (East Residential)

(*Option 1*: Regional Meta-study, *Option 2*: Trans-Regional Meta-study, *Option 3*: DOE2/Modeling, *Option 4*: New Metering, *Option 5*: Do Nothing)

Residential Analysis Groups	Near Term Action	Description
Tier 1 Importance		
Lighting - Interior	Option 1	There have been a number of high quality lighting studies completed in the Eastern Region. In particular, the region is recommended to utilize the SPWG Lighting Coincidence Factor Study.
HVAC - Cooling	Option 1/4	Compile results from the UI and CL&P 2005 Coincidence Factor Study (B), NGrid Residential Room AC Impact Study (B), and NSTAR/NGrid/UI/CL&P CAC Regional Evaluation (B) and conduct new metering.
HVAC - Heating	Option 1/4	Compile results from MACT Ductless heat pump study and conduct new metering.

Plug Load (Electronics)	Option 2/4	Utilize LBNL/Ecos CA Residential Plug Load Study and SCE/PG&E Residential End Use Load Research study. Otherwise, conduct new metering.
Tier 2 Importance		
Domestic Hot Water	Option 1/2	Utilize data from the UI Water Heater Controller Study, NYLE Heat Pump Water Heater Evaluation Study and leverage data from other regions such as the Mid-Atlantic (e.g. BGE Residential Water Heater Evaluation studies).
Lighting - Exterior	Option 1/2	Compile data from the SPWG Lighting Coincidence Factor and NU/CL&P CFL Markdown Impact study, and consider bringing in data from other regions (e.g. DEER) since the end use analysis group has a "high" transferability rating.
Appliances - Laundry	Option 2/4	Consider leveraging public data from other regions, such as DEER, or conduct new metering studies.
Appliances - Refrigerators	Option 1/2	Compile data from the Efficiency Maine Low Income Appliance Impact Study and consider leveraging data from other regions, such as DEER, or BC Hydro Power Smart Res End Use Study (IP).
Tier 3 Importance		
HVAC - Fan Energy	Option 4	Since no data was found, and end use group transferability is low, new metering is recommended.
Pool Pump	Option 5	Leverage BC Hydro Power Smart Res End-Use Study (IP) should it become available.
HVAC - Other	Option 3/4	Since no data was found, DOE modeling or new metering is recommended.
HVAC - Ventilation Only	Option 4/5	Since no studies were found, new metering is recommended, or no action, as the measure is considered low importance.
Appliances - Kitchen	Option 2/4	Due to high transferability, first consider leveraging data from other regions, such as simply utilizing DEER load shapes, or conduct new metering studies.

Table 13 provides a listing of the short-term activities recommended for the East non-residential end use analysis groups ranked in order of importance. Most of the Tier 1 end-use groups can develop load shapes by utilizing data collected within the region in conjunction with data collected from other regions. Once again the plug load (electronics) end-use group would require data provided from a new metering study and the HVAC heating end use may as well although DOE2 models may be used to develop profiles in the short term.

Table 13: End-Use and Measure Shape Improvement Strategies (East Non-Residential)

(*Option 1*: Regional Meta-study, *Option 2*: Trans-Regional Meta-study, *Option 3*: DOE2/Modeling, *Option 4*: New Metering, *Option 5*: Do Nothing)

Non-Residential Analysis Groups	Near Term Action	Description
Tier 1 Importance		
Lighting - Interior	Option 1/2	There have been a number of high quality lighting studies completed in the Eastern Region. In particular, the region is recommended to utilize the SPWG Lighting Coincidence Factor Study.
HVAC - Cooling	Option 1/4	Compile results of UI/CL&P 2005 Coincidence Factor Study, NGrid Small C&I Unitary HVAC Pilot Impact Study, NSTAR BSCS Non-Lighting M&V Impact Study and NSTAR CS Impact Study and conduct new metering.
Lighting - Exterior	Option 1/2/4	Compile results of UI/CL&P 2005 Lighting Coincidence Factor Study, NSTAR BSCS Impact Study and NSTAR CS Custom Impact Study and perhaps conduct some new metering.
HVAC - Fan Energy	Option 1/4	Compile UI/CL&P 2005 Coincidence Factor Study and conduct new metering.
Plug Load (Electronics)	Option 4	No studies were found related to non-residential plug load. New metering is recommended.
HVAC - Heating	Option 1/4	Compile UI/CL&P 2005 Coincidence Factor Study and conduct new metering.

Motors - Drives	Option 1/2/4	Compile data from UI/CL&P 2005 Coincidence Factor Study, CL&P Municipal Impact Study, NSTAR BSCS Non-Lighting M&V Impact Study, NSTAR C&I Retrofit Impact Study and conduct new metering.
Refrigeration	Option 1/4	Compile results from a number of studies that are available, including NSTAR BSCS Impact Studies, NSTAR SBS Impact Study, NSTAR CS Impact Study, NSTAR C&I Impact Study and NGrid SBS Customer Impact.
Tier 2 Importance		
Industrial - Process	Option 1/2/4	Compile data from NSTAR BSCS Non-Lighting Impact Study, NSTAR BSCS Impact Study, NSTAR C&I Retrofit Study and NSTAR C&I New Construction Retrofit Study.
Data Center Cooling	Option 4	No studies were found related to data center cooling. New metering is recommended.
HVAC - Other	Option 1/4	Compile results of NSTAR BSCS Non-Lighting M&V Impact Study, NSTAR C&I Retrofit Impact Study, and NGrid Custom HVAC Impact Study, and conduct new metering.
HVAC - Ventilation (Only)	Option 4	Since no studies were found, DOE modeling or new metering is recommended.
HVAC - Reheat	Option 4	Since no studies were found, DOE modeling or new metering is recommended.
Water Heating	Option 3/4	Since no non-residential water heating studies were found, DOE modeling or new metering is recommended.
Pump	Option 3/4	No studies found. DOE modeling or new metering recommended.
Compressed Air	Option 1/2/4	Compile results of NSTAR studies: BSCS Non-Lighting M&V Impact Study, CS Impact Study, C&I Retrofit Study, C&I New Construction Retrofit Impact Study, and conduct new metering.
Data Center Equipment	Option 4	No studies found. New metering recommended.
Tier 3 Importance		
Agricultural - Pumping	Option 5	Due to minimal contributions to efficiency program savings, no action is recommended at this time.
Appliances - Laundry	Option 5	
Food Service Equipment	Option 5	
Agricultural - Process	Option 5	
Clean Room	Option 5	

1.6 Future Regional End-Use Data Efforts

This study has shown that there is relatively little current end-use data being collected today with the exception of data collected on air conditioners for demand-response program evaluation or for the purpose of energy efficiency evaluation using relatively short data collection periods. Further, the challenges associated with collecting data for this project have made it clear that any future endeavor would greatly benefit from a much more systematic approach.

As we consider the future of end-use metering we must examine various approaches to secure the information. We will review several alternatives including:

- **Traditional approaches** - Traditional end-use metering approaches involved the installation of a load recording device directly on the load of interest. This form of end-

use data collection is very customer intrusive requiring access to the customer's facility/home to install the monitoring devices on the appliance or circuit. Cost of the traditional approach was high, which often limited the sample size; however, data quality and the "signal to noise ratio[4]" was also very high.

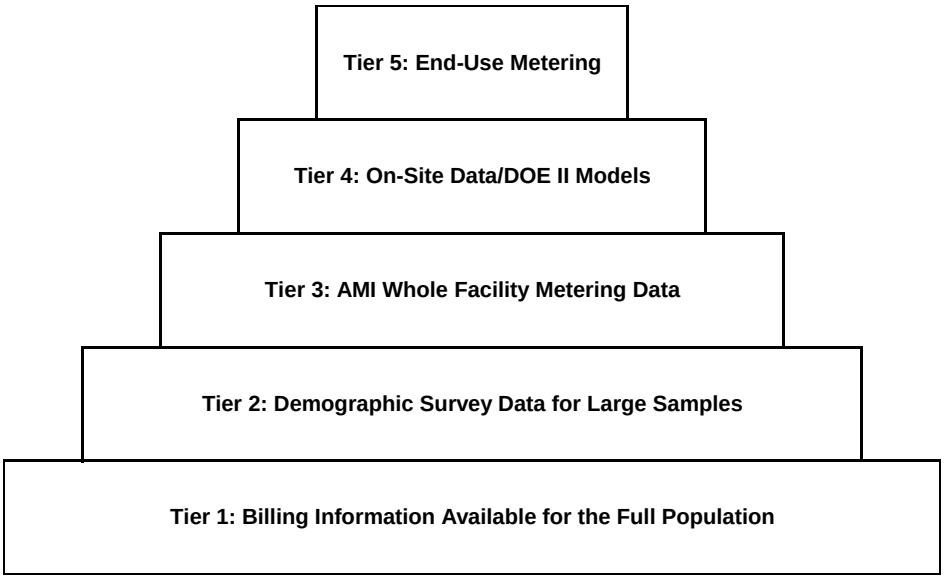
- **Advanced Metering approaches** - Residential end-use data collection may not need to rely on traditional approaches to collect end-use data due to advancements in metering technology. The Single Point End-use Energy Disaggregation (SPEED) and Non-Intrusive Appliance Load Monitoring (NIALMS) devices permit the collection of a multitude of appliance end-use loads without the wiring nightmares of past years. These hardware/software systems purport to allow for the collection of appliance-specific load data without entering customer premises and without installing metering devices on appliances. The analysis software seeks to recognize appliance signatures in the data for example an electric water heater with a 3,500 Watt heating element would look significantly different than a 100 Watt light bulb. However, when appliances have relatively similar electric signatures the ability of the software to distinguish between 3,500 watt water heater element and a 3,500 watt stove burner is somewhat suspect.
- **Statistical approaches** - Statistical approaches, in particular conditional demand analysis, have been used for years to identify the end-use loads within more aggregate data. Typically, responses from a large market saturation survey (i.e., several thousand respondents) are coupled with billing data. Statistical regression techniques are built to estimate the monthly, seasonal, or annual usage of customers with various appliances. Experience to date with the application of conditional demand analysis to short-time integration power-consumption data is limited but has the potential to provide additional end-use detail over traditional monthly billing data approaches.
- **Prototype/DOE2 Engineering Modeling approaches** - When reliable end-use load data are not available, an hourly building energy simulation approach may be used to create the loads. Popular computer tools capable of hourly building load simulations include DOE2 and its user-friendly derivative (eQuest), EnergyPlus, TRNSYS, and BLAST. Currently, the most popular of these, and used throughout the world, is DOE2. One clear advantage of the DOE2 modeling approach is the ability to quickly and easily change weather data by simply utilizing different weather files.
- **Short-term energy efficiency metering approach** - In this study, we found a number of projects that deployed direct metering of energy efficiency measures (e.g., chillers, ductless heat pumps, water heaters). These projects used direct measurements on reasonably sized samples. The one limitation to the energy efficiency evaluation

[4] In this context, the "signal to noise ratio" refers to how well the end-use load is isolated from other household loads.

approach is that the metering usually occurred for relatively short periods of time, i.e., one week to several months, and is focused on the energy efficiency measures in question (these may or may not be end-uses of interest).

- **Hybrid approaches** - Hybrid approaches that link several of the aforementioned strategies together warrant careful consideration in any future end-use metered data collection effort. We tend to think of these as a pyramid with improvements in the "signal-to-noise" ratio as we move up the pyramid coupled with increased cost and complexity. Figure 2 below presents one possible construct. This shows the foundation of the data collection pyramid as being embedded in the billing data that is available at the utility for the full population of customers of interest. All of these strategies can be linked statistically so the highest point of inference is the actual end-use metering data, which has the "best" signal to noise ratio.

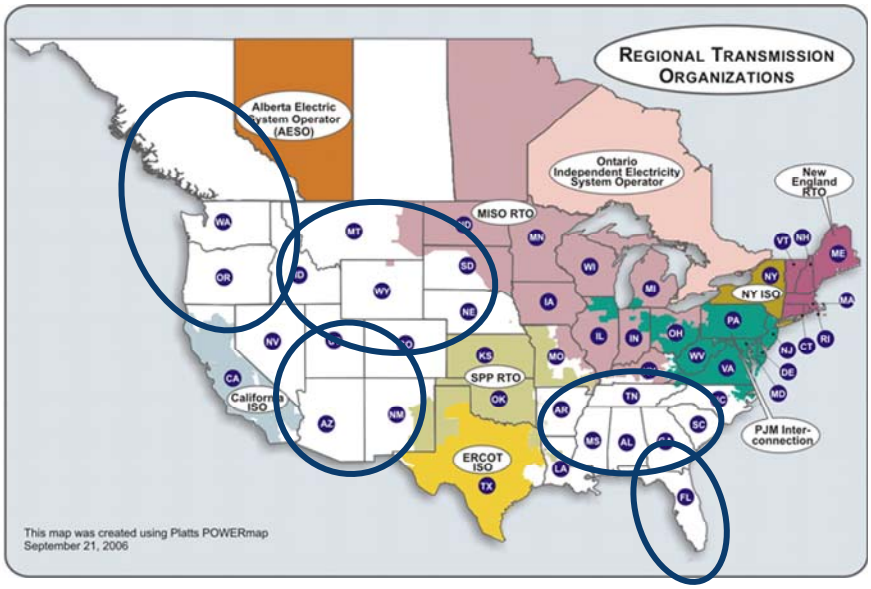
Figure 2: Hybrid Approach



1.6.1 Regional Transmission Areas

Figure 3 presents a U.S. map with the regional transmission organizations highlighted in color and "other" potential regions highlighted using ellipses. As we think about how best to organize future end-use metering data collection efforts, we naturally turn to how transferable the information is from one region to another. Transferability may indeed differ by customer class or customer segment. Clearly, different regions may have very different climates and could even have different usage patterns driven by variations in regional expectations and behavior.

Figure 3 – Regionalizing the effort



1.7 Conclusion and Recommendations

The results of this project have shown that there appear to be some usable end-use datasets available. Since data collection efforts are conducted on an ad-hoc basis within and between the Pacific Northwest and Eastern regions, it makes it difficult to assess how transferable the data is for populations not directly represented by the research efforts. There were significant limitations that were not possible to capture in this study, including limitations on transferability imposed not by inconsistency of methodology and data format, but by heterogeneity of critical determinants of load shape. There was also found to be significant differences in the data priorities among program administrators. Therefore, we recognize that specific program administrators may have different priorities for data collection than what was identified.

The following recommendations are provided to assist the regions with developing a coherent method of warehousing, distributing, and updating end-use and efficiency measure load data for the regions to eventually have a full array of data for all end-uses and efficiency measures.

1.7.1 Near-term Recommendations (Up to 12 Months)

Near-term recommendations are provided to focus on immediate tasks to meet the urgent needs of the capacity markets and the initial steps necessary to support a large coordinated effort by the regions to collect end-use data that would be broadly usable and transferable.

Coordinate with metering studies currently in progress

There is an opportunity to engage the entities conducting the studies to ensure adequate sample size and ancillary data collection and potentially provide additional funding to support data collection that will yield useful results for the Pacific Northwest and/or East regions. This is most important for the Pacific Northwest region, which stands to gather a significant amount of useful end use and measure load shape data from the BC Hydro study. The following studies have been identified as potentially useful, and are in the planning stages:

- The BC Hydro Power Smart Residential End Use Metering Study
- New York City has launched a pilot end-use metering project in governmental facilities.
- Northeast Utilities and United Illuminating in Connecticut are preparing to conduct a new commercial and industrial energy evaluation study over the 2009 summer season.
- Northeast Utilities and United Illuminating in Connecticut are also planning to conduct a residential low income evaluation.

Implement new metering studies targeted at specific end-use analysis groups

For the residential sector, the major data collection efforts recommended at this time are related to plug loads (consumer electronics) and HVAC analysis groups for both regions, due to lack of regional studies and low transferability related to the HVAC analysis groups.

For the non-residential sector, HVAC analysis groups, data center cooling and refrigeration end use analysis groups generally could use new metered data for both regions. The Eastern region has significantly better coverage on the non-residential sector, and some data from completed studies could be combined into a regional meta-study.

The Pacific Northwest should use its new metering studies to examine whether some ELCAP data may still be applicable to today's loads. It is important to note that planning these studies takes significant lead time. In order to have monitoring equipment in the field in time for summer peak monitoring, entities need to start planning no later than December of the previous year. Ideally, in order to pilot test all the protocols, procedures and specifications, the effort should be initiated a full year in advance of when full scale implementation is planned.

Pilot the transfer of end use data from one region to another

To assess the feasibility of transferring data from one region to another, KEMA recommends piloting one specific end use, preferably one with a high transferability rating (e.g. non-residential lighting). Analysis groups that have a high transferability rating should be the easiest to combine, however it is advisable to perform a statistical comparison of the datasets from each region to make sure that no significant bias is being introduced into the results. If there

are no data from within the region than there really is no way to perform this bias analysis and justifying the transferability of the data becomes more problematic, particular with respect to capacity market M&V requirements.

Develop detailed protocols for end-use data collection

If entities between (and within) the regions envision coordinating future efforts to develop load shapes, then region-wide (or even national) protocols are needed to establish consistent methods and procedures for handling the data for end-use and measure savings shapes that are transferable between regions. These protocols would also enable data from smaller studies (e.g. conducted for individual program evaluations) to be combined into larger regional meta-studies.

The protocol effort should be coordinated with other concurrent initiatives and leverage the work of previously developed protocols. The components of a regional data collection protocol should include developing consistent definitions for end-use categorizations and efficiency measure types, precise instrumentation instructions, robust data verification procedures, and specific protocols for collecting the necessary ancillary data, including equipment information, building and occupant characteristics data.

As part of this process, stakeholders should concurrently discuss what a centralized data warehouse for the end-use datasets might look like and ensure that the data collection protocols include guidance for the standardization of data format and storage.

1.8 Mid-Term Recommendations (1-3 years)

Some recommendations are provided, looking ahead to several years from now. These needs are less urgent, but support future coordinated regional end-use data efforts.

Implement multi-region end-use data repository

The end goal of the project is to develop a central warehouse for storing the end-use load datasets and providing consistency in data format and definitions to allow the load shape data to be widely usable. Advances in computational abilities could allow this warehouse to be virtual if robust, yet flexible, data storage specifications are developed. Storage could be dispersed with access over the web. This approach would naturally have additional risk of losing data but could be a viable option to explore if resources to support a central repository are inadequate. A key aspect of whatever data warehouse or repository is eventually implemented is the need for an easy to use interface tool that would allow sorting, adding, and accessing data. This tool would also need key connections to the variables used in the regionalization process and the ability to generate profiles and conduct simple analyses.

Plan for other study types (non-metering studies)

As regions begin collecting data and looking to transfer usable datasets from one area to another, it may become clear that additional region-specific ancillary data is needed to improve the accuracy of the transfer. Examples of customer population-specific data needed may include typical building characteristics, inventory of system types and efficiencies, air and water system temperatures, and saturation of different equipment types, to name a few.

Assess feasibility of disaggregating end use information from AMI whole premise data

Consider launching regional initiatives (one in the Pacific Northwest and one in the Northeast or Mid-Atlantic) to test the ability to leverage end-use information from whole premise interval load data coupled with demographic data using statistical techniques. To support the vision for a hybrid approach to developing end-use load shape datasets in the future, this would be the first step to test the ability to leverage end-use information from whole premise interval load data coupled with demographic data using statistical techniques.

Concurrent to this, the Regions may consider surveying their utility stakeholders to identify opportunities to collect large amounts of whole facility load information through AMI. While utilities have been metering hourly load data for many years for other purposes, these new approaches to developing end-use load and savings data could be substantially less expensive than previous end use data efforts, such as ELCAP. The survey should be divided by customer class and should identify the frequency and potential cost of data capture. In addition, this initial feasibility assessment, should measure the willingness of the regional utilities to engage in such as an exploratory study to leverage their AMI data.

Consider seeking funding for use in launching a regional initiative in the Pacific Northwest and Northeast sponsored by the Council and NEEP. The projects would be proof of concept with the capacity to expand to a full national initiative.

1.9 Long-Term Recommendations (>3 years)

Continue to maintain and update the catalog of end use data

The catalog of end-use and measure load data studies has the potential to be extremely useful to continued efforts to develop regionally applicable load shapes for the range of uses encompassing energy efficiency planning, capacity markets, and air quality. As energy efficiency becomes an increasingly important part of utility portfolios to meet load growth, more and more entities are seeking the data to validate cost, demand and air emissions savings. Maintaining the central repository and catalog is an important long term goal for this project.