CADMUS

Methodology for Estimating Transmission and Distribution Energy Efficiency Potential in Minnesota

Data Collection

Initial Data Request

Conducting an energy efficiency potential study for Electric Utility Infrastructure is a relatively new concept. The plan for this study is to model the EUI study on a typical demand-side potential study using EUI measures from the Minnesota TRM. Therefore, the initial data targeted for collection will be the inputs required for those EUI measures. The TRM savings algorithm inputs include variables like conductor resistance, transformer capacity, and load profiles.

Most of the data required for the study will come from utilities. Preliminary discussions with stakeholders indicate that these data are available in the form of transmission and distribution planning documents as well as system design standards and historical product inventory. However, we will need to carefully construct our data request to best target individuals at utilities with access to the required data. We will also need to be mindful of participants' time, so we will work to streamline our data request to limit the effort required to respond to it.

A preliminary data request was designed and submitted to a small number of utilities to solicit the required data and to ensure the request was properly formatted.

Revised Data Request

Based on responses to the preliminary data request, we updated our understanding of what data is available and how to best request it from utilities. We revised the data request to target the desired data more concisely. Specifically, we suggested that a significant portion of the data we're requesting is likely found in a utility's GIS system, so a data dump from that system may be the simplest format to respond with. Once the revised data request was completed, we reached out to a large number of utilities for a response.

Sampling

Also based on responses to the preliminary data request, we realized that a complete characterization of all substations and feeders throughout the state is not going to be possible to construct. Not all utilities are likely to respond to our data requests and not all respondents will be able to provide a complete model of their entire distribution system. Therefore, we devised a sampling strategy to make

use of the data we are likely to be able to collect rather than attempt unreasonable requests of stakeholders.

Project partner Demand Side Analytics developed a Neyman Allocation to determine the number of utilities that must be included in the model to ensure a statistically representative sample of the whole state. The number and size of utilities to include depends on annual sales, utility type (IOU, Co-op, or municipal), and geographic meter density.

From each responding utility, we will collect overall system information from their GIS system and product inventories. We will then create a sample of substations and feeders to fully characterize with detailed load profiles (energy, demand, power factor, and any other available data). In the ideal case, this data would be available for all feeders on all distribution systems across the state, but the data collection process has limited us to creating a statistically representative model instead.

Surveys and Interviews

After compiling responses from the data requests, we will conduct surveys and interviews with stakeholders to inform our understanding of the data. We will also build an understanding of transmission and distribution planning processes to better understand the viability of implementing measures and construct reasonable ramp rate estimates.

Avoided Costs and Load Forecasts

The savings estimates will depend on forecasted loads, which we will share with the parallel demand-side potential study. The data will come from utilities' own load forecasts included in rate cases or integrated resource plans. Avoided cost information will also be shared across the two potential studies and will be used to inform cost-effectiveness evaluations.

Measure Characterization

Establish Baseline Conditions

From the data collected, including surveys and interviews, we establish a baseline description of the existing utility infrastructure in Minnesota. That is, for all measures under consideration, we will characterize the existing technology in terms of the baseline variables required for estimating the electric utility infrastructure (EUI) potential.

Develop T&D Measure Impacts and Costs

The Minnesota EUI technical resource manual (TRM) serves as the primary measure design reference. In addition to the TRM we use well-defined measures from the "Utility Infrastructure Improvements for Energy Efficiency" report, which was commissioned by the Minnesota Department of Commerce as a preliminary foray into EUI potential in 2010[1]. Between the two references, approximately 5-7 major measures will likely have enough data to support completion of the potential estimate. Measures will

[1] Utility Infrastructure Improvements for Energy Efficiency. Prepared by Franklin Energy for Minnesota Office of Energy Security, Minnesota Department of Commerce. November, 2010.

include efficient transmission and distribution transformers, voltage optimization, low-loss conductors, and conservation voltage reduction.

Potential Modeling

Develop T&D Baseline Forecast

We employ a bottom-up approach, which entails developing forecasts of energy and demand consumption for the transmission and distribution system by component – transformers, feeders, substations, and transmission lines – statewide. The bottom-up forecast provides the basis for estimating technical potential for each component based upon the following elements: (1) base-year conditions, (2) natural equipment turnover rates, and (3) distribution transformers, miles of feeder conductors, substation transformers, substation peripheral equipment, and miles of transmission, by size category.

Estimate T&D Efficiency Technical Potential

Technical potential is estimated by introducing all technically feasible measures into the baseline forecast and calculating the resulting impacts. For modeling purposes, this requires separating measures into several distinct classes:

- **Equipment retrofit measures** save energy by retrofitting existing transmission and distribution equipment prior to the end of useful life. The technical potential assumes all utilities will install the most efficient, technically feasible option.
- **Equipment replacement upon burnout measures** save energy by upgrading the efficiency of T&D equipment at the end of life or for new projects. The technical potential assumes the most efficient technically feasible option will be chosen at the time of upgrade.
- **System efficiency measures** save energy by reducing consumption or line losses without affecting equipment efficiency. Examples include conservation voltage reduction or reducing the energy consumption of substation lighting and motors.

Technical potential estimates account for interactive effects associated with installations of multiple measures, between and within the measure categories listed above.

Estimate T&D Efficiency Economic Potential

Economic potential is estimated by applying cost-effectiveness criteria screening to each individual measure's technical potential. Working with the stakeholders and advisory group, we will determine if the primary cost-effectiveness tests will be based upon either the total resource cost or utility cost test. Underlying data informing the inputs to cost-effectiveness tests will come from interviews with stakeholders, from manufacturer information, and from avoided cost estimates shared with the parallel demand-side potential study. Exactly how the cost-effectiveness tests will be applied will be discussed with stakeholders and Advisory Committee members.

Estimate T&D Achievable Potential

Achievable potential estimates are developed by applying a two-step approach to account for market barriers that would normally prevent the adoption of electric utility infrastructure improvements. These two steps include:

- Estimating the long-term market penetration for varying levels of incremental infrastructure efficiency spending, and
- Applying ramp rates to each measure to align acquisition of savings with events likely to occur, considering the barriers faced by utilities.

Interviews with advisory committee members will help guide the development of ramp rates. In particular, it will be important to clearly understand the near-term plans for projects that would be completed in the course of business-as-usual and it will be necessary to understand plant and equipment retirement plans.

Estimate T&D Energy, Capacity, and Carbon-savings Potential

The estimated, potential energy and capacity savings for each EUI measure will be summed by individual investor-owned utility and COU grouping. The marginal emissions rate for each year of the analysis is multiplied by the potential energy efficiency savings to calculate the total carbon-saving potential that may be avoided though the EUI efficiency measures in Minnesota.

System Loss Addendum

In addition to estimating the potential for Electric Utility Infrastructure efficiency of the Transmission and Distribution system according to the measure-based approach outlined above, the Potential Study team will also collect system loss data to corroborate findings and improve understanding of the study results. Looking at the system losses (top-down view) will help to put findings in context and verify understanding of the measure-based approach (bottom-up view). For clarification, we do not intend to conduct an entire second potential study. The systems loss approach will be a high-level snapshot to compare to for corroboration of our main methodology.

System Loss Approach

As part of the potential study, we intend to capture some data about existing system losses. System losses are a high-level measurement of energy entering the distribution system (at either the substation or feeder level) subtract the energy billed to end-users. The objective of collecting system losses was not originally included in the project plan, but has been identified as a valuable addition to the study. The primary methodology uses a measure-based approach to estimate potential by looking at conservation opportunities by upgrading individual components of the distribution system. We will use system loss data to construct a parallel model of efficiency, as viewed from the system perspective.

The top-down system view will be used corroborate our main, bottom-up methodology by ensuring the study results are comparable from both perspectives. The systems approach will also allow for comparisons among dissimilar systems (differing load profiles or specific equipment) both within the state and nationally.

Over the course of stakeholder discussions about EUI efficiency, the issue of defining metrics to measure improvement has been raised. Tracking system loss data may prove to be a useful metric to measure system efficiency and improvement over time because the data is easier to collect and more generalizable across all distribution systems. Though the system loss-based approach wasn't the original plan for this project, discussions with stakeholders have convinced the team that at least collecting the data right now is worth the additional effort and will likely result in more nuanced policy recommendations for adopting reasonable measurement metrics and goals for EUI improvement. Further, system loss data may be useful for utilities to better compare their efficiency opportunities

System Loss Data Sources

Rate Cases - Investor-Owned Utilities file estimates of system losses as part of their rate cases for regulatory approval. This data can provide a high-level understanding of system losses for utilities that file rate cases.

Loss Studies - Many utilities conduct loss studies, either to inform the loss data reported in rate cases (IOUs) or for system planning. It is not known how many such studies may have been recently conducted in Minnesota, but it will be a focus of data collection to find this data if possible. Loss studies may be able to provide a high-resolution understanding of efficiency of systems that have produces such studies

FERC Filings - It may be possible to construct a high-level systems loss model by conducting our own, scaled-down loss study on data found in publicly available records, such as FERC filings. The availability and condition of this data is not yet known, but the team will investigate the possibility of using this data.