Energy Design Assistance Project Tracker (EDAPT): A Web-Based Tool for Utility Design Assistance Program Management

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ABSTRACT

Utility design assistance programs provide financial incentives for prospective new building owners to identify and implement recommendations from building energy efficiency designers and modelers. These incentive programs can be highly effective, because influencing the design process of new construction in its early and conceptual phases is the most effective to achieve the most efficient design at the least cost. Such programs can also be expensive to implement, given the cost/time intensity of energy modeling and the quality control necessary to ensure adherence to program regulatory requirements. This paper describes a new web-based tool created to help Xcel Energy, a regulated utility in Colorado, deal with the cost-effectiveness challenges of its new construction design assistance program amid an evolving and expanding program structure, as well as changing building codes. The design of the tool and its initial six-months of use are discussed below. Of particular note are the tool's features for helping all system users (building owners, consultants, and utility staff) track and manage project workflow as well as its automated quality-control functionality. The reduction in transaction costs alone—versus an old e-mail and phone-based system—enabled the utility to reduce the minimum eligible building size from 50,000 ft^2 to 20,000 ft^2.

Background

Xcel Energy offers a comprehensive approach to energy efficiency and savings for new commercial construction projects through its Energy Design Assistance (EDA) program—a component of its New Construction demand-side management (DSM) product. The tailored services offered by EDA include:

- Energy design consulting and predictive energy modeling (an average value of $30,000).
- Assistance toward green building certification.
- Early analysis in areas such as massing, daylighting, lighting and HVAC.
- Construction rebates for various whole-building energy savings opportunities from envelope, lighting, controls and cooling, to heat recovery and solar water heating.
- Measurement and verification including construction document review, onsite walk-through and data logging.
- Design team reimbursement for participating in the EDA program.

This robust EDA program has been effectively influencing building owners, architects, and engineers to include energy efficiency systems and equipment in their new construction and/or major renovation projects since its inception in 2006. EDA has achieved approximately 85 GWh in savings—just in Xcel Energy's Colorado service territory alone. The energy

modeling and project administration functions of the program have traditionally been supported by one or two energy modeling companies, contracted via a request-for-proposal process, to ensure quality and keep administrative costs in check.

Enter the challenges. As the energy modeling industry and popularity of EDA began to grow in the late 1990's, many new energy modeling companies were requesting to be providers too. In the past, Xcel Energy had made an attempt to allow several companies to provide EDA modeling services, using a variety of differing modeling platforms, however the quality of the support often did not meet the program requirements and the administrative costs for quality control became unsustainable. Adding to the complexity recently is the increased adoption of the more stringent 2012 International Energy Conservation Code (IECC 2012) across much of Xcel Energy's Colorado service territory, making it more difficult for energy consultants to find beyond-code energy savings, and for the EDA program to maintain cost-effectiveness. Why? EDA, like many utility-funded, new construction energy efficiency programs, generally references the local energy code as the baseline above which energy savings are incentivized. As the IECC tightens the baseline requirements for new buildings, the energy savings margin attributable to utility incentives becomes smaller. ASHRAE Standard 90.1-2010, which is referenced by IECC 2012, reduces energy consumption by an average of 18% relative to the previous version published in 2007 (Halverson 2011). Projects in Xcel Energy's EDA program achieve, on average, 30% electricity demand savings (kW), 28% electric energy savings (kWh), and 30% natural gas savings[1] beyond ASHRAE 90.1-2007. With the adoption of the new code, EDA faced (and still faces) savings reductions of nearly two thirds. These challenges gave rise to finding a solution—in order to maintain cost-effectiveness and value to rate-payers, the EDA program needed to evolve.

Re-Designing Program Concepts

In 2011, Xcel Energy began reviewing methods for revamping the EDA new construction program to meet the challenges of more stringent energy codes and to re-open the program to additional energy modeling companies. Keeping the program viable would require a reduction in administrative costs and more cost-effective energy modeling—all while maintaining a high level of quality. After much research, a three-part solution was chosen:

1. A web-based program management tool.
2. A convergence to a single energy modeling platform.
3. A pay-for-performance path to incentivize consultants to create higher performance designs.

These tools are described in detail below.

[1] While Xcel Energy's EDA program requirements and goals are stated in terms of electricity demand, energy, and natural gas savings, compliance with ASHRAE 90.1 is measured in terms of energy cost. DOE uses site and source energy in kBtu to assess improvement in energy standards. In evaluating the influence of the higher energy standards on utility new construction programs, it is important for stakeholders to distinguish between these metrics.

Web-Based Program Management Tool – EDAPT

Program management, coordination and communication between all parties, review of energy modeling results, and the documentation and aggregation of results represent a significant cost to the EDA program. With the expansion of the program to include more modeling consultants and more buildings, these burdens were projected to increase. Seeing this, Xcel Energy teamed up with the National Renewable Energy Laboratory (NREL) in Golden, Colorado and a local energy application developer, concept3D Inc., to create a web-based program management tool, called EDA Project Tracker or EDAPT, to address these issues (see Figure 1 below).

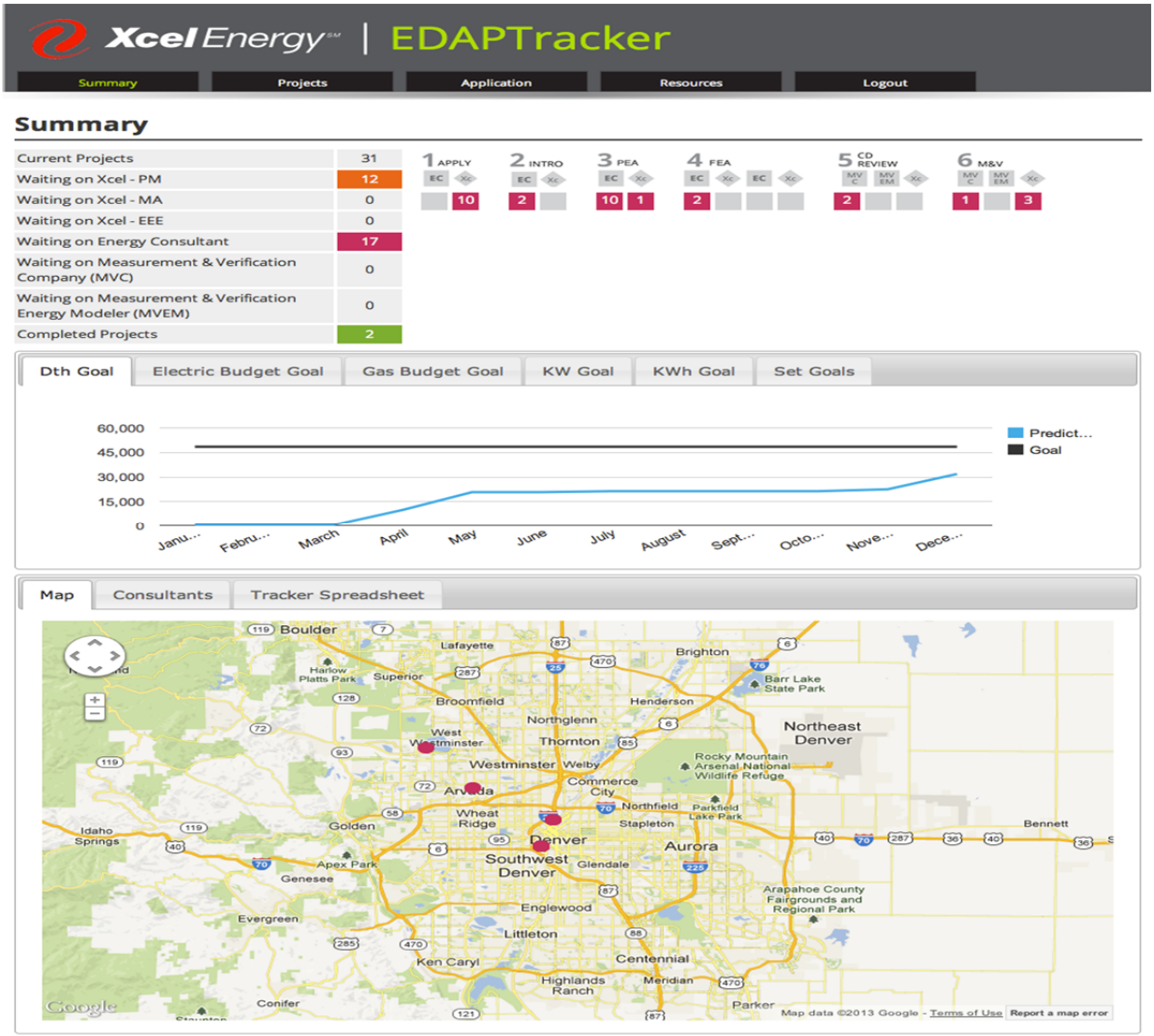

Figure 1. EDAPT pre-production dashboard.

This EDAPTracker tool puts the majority of the project management workflow online with automation built in. It enables Xcel Energy, and its consultants and customers, to track progress of individual projects from the application stage, assessment and selection of energy

efficiency measures, and review of construction drawings through final measurement and verification and incentive payments (Figure 2). At each stage, Xcel Energy can review progress and results, communicate with consultants, and approve or reject projects to move to the next stage. In addition to tracking individual projects, EDAPT allows Xcel Energy to quickly assess and track the performance of its entire EDA portfolio, including progress toward annual savings goals.

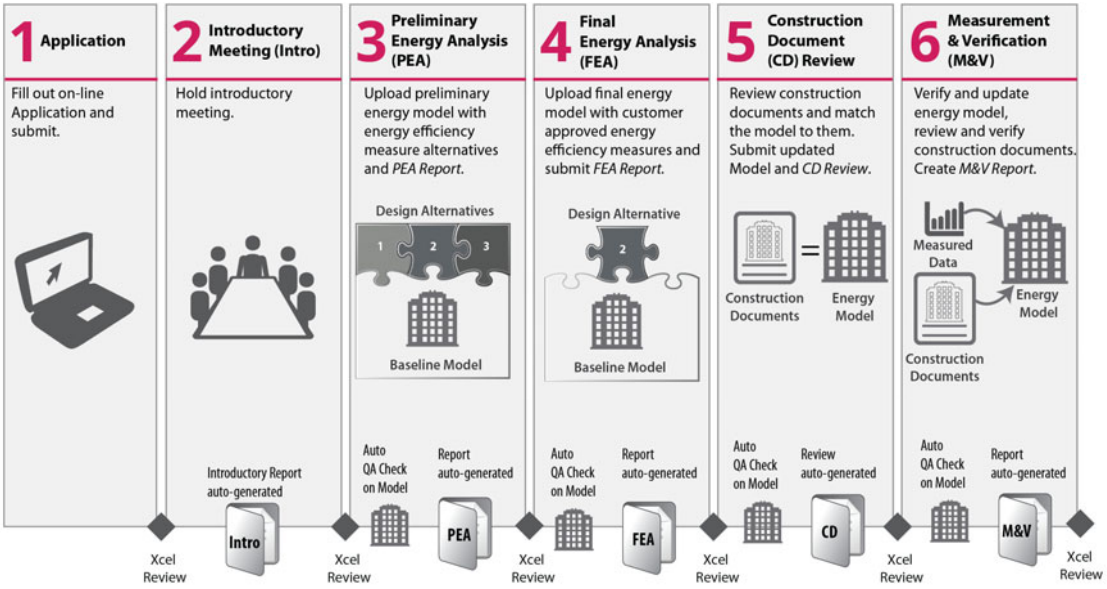

Figure 1. EDAPT workflow including uploads, downloads and approvals.

Documenting energy modeling results for the utility as well as the customers and their design teams represents additional expense for consultants. Transcription of numerical data from energy simulation tools into tables and charts in Microsoft Word or Excel can be a tedious and error-prone process. One feature of EDAPT that was built to address this specific burden was the upload of a simple, open-input file format for energy modeling results. When a consultant uploads these input file results, EDAPT automatically calculates incentives and creates a draft Microsoft Word report document. These documents, designed collaboratively with the consultants, are pre-populated with energy modeling results and EDA program information in a format designed for communication with the customers and their design team. This feature saves the consultants significant transcription and documentation effort, while still allowing them to provide high-quality energy modeling services. In addition, users of a variety of energy modeling software programs can use the simple, open input file format for upload to EDAPT at requisite stages of the process.

Building Energy Simulation Modeling Platform – OpenStudio/EnergyPlus

The automated report generation functionality provided by EDAPT is one instrument for reducing consultant effort, but by itself is insufficient to maintain cost-effectiveness. Recalling that Xcel Energy intended to open the EDA program to more consultants further underscores the fundamental challenge—how could the program reduce analysis costs, maintain quality, and enable assessment of the most cost-effective energy efficiency technologies available, all while simultaneously integrating new consultants into the program? Historically, supporting multiple

building simulation modeling platforms used by various consultants had proven to be cost prohibitive, leading Xcel Energy to determine that just one platform was needed.

Recently the California Energy Commission looked at reputable building energy simulation modeling approaches being undertaken in the public sector (Brook, 2012). Xcel Energy selected the U.S. Department of Energy's (DOE's) EnergyPlus simulation engine due to a combination of open source licensing, continued investment and development by DOE and the private sector, and its ability to correctly model a number of advanced systems required to achieve higher efficiencies. In addition, the California Energy Commission also chose EnergyPlus and is allowing Xcel Energy to leverage the energy modeling advancements made by California. While these points all favored selection of EnergyPlus as a building simulation modeling engine, it is arguably difficult to use, and market adoption had been slow for lack of user interfaces on par with eQUEST paired with the DOE-2 simulation engine.

Fortunately, DOE has identified this barrier to adoption and has invested in the OpenStudio platform to enable rapid and cost-effective development of market-facing applications for modeling and energy analysis. While OpenStudio is foremost a software development kit (SDK), or, in simpler terms, software for making software (Weaver, 2012), it is frequently used for its set of example applications that demonstrate the SDK. These include a Plug-In for the popular SketchUp Computer Aided Design program; the companion OpenStudio Application used to specify HVAC systems, schedules, etc.; and the Parametric Analysis Tool (PAT) used to evaluate the performance of multiple design alternatives relative to a baseline model. OpenStudio is a publicly available, open-source platform whose collaborative development now spans all of DOE's Building Technology Office Laboratories, the Energy Efficient Buildings Hub in Philadelphia, National Resources Canada, and multiple private sector companies that are contributing source code, as well as building their own applications with the SDK (Long, 2013).

While the OpenStudio/EnergyPlus pedigree seemed impressive, the real question for Xcel Energy remained, "could the dog hunt?" In other words, could the example applications and associated modeling ecosystem support the kind of cost-effective, high quality modeling and analysis demanded by the EDA program? In order to support consultant needs in the EDA program, the OpenStudio development team spent significant time understanding their workflows, and added specific functionality to support them. The new OpenStudio workflow was modeled on best practices utilized by a number of Xcel Energy consultants, along with the addition of some new software innovations designed to save time and improve consistency. Recent additions to OpenStudio in direct support of EDA analysis workflows include:

- The Building Component Library (BCL), which provides an online source for standardized model inputs that can be searched, version controlled, and distributed to stakeholders nearly instantaneously.
- Formalized measures, which are small OpenStudio scripts (think of them as Excel Macros[2] for energy modeling) that are also disseminated via the BCL, for modeling energy conservation measures (ECMs).
- The aforementioned PAT application that enables "drag and drop" application of these measures onto a baseline model for comparative energy performance and life cycle analysis.

[2] An Excel Macro is a small, simple, well known software feature used to automate tasks inside Microsoft Excel.

These new capabilities, along with improvements to the existing applications, have produced an extensible workflow (Figure 3) that enables very rapid assessment of design alternatives (Hale, 2012).

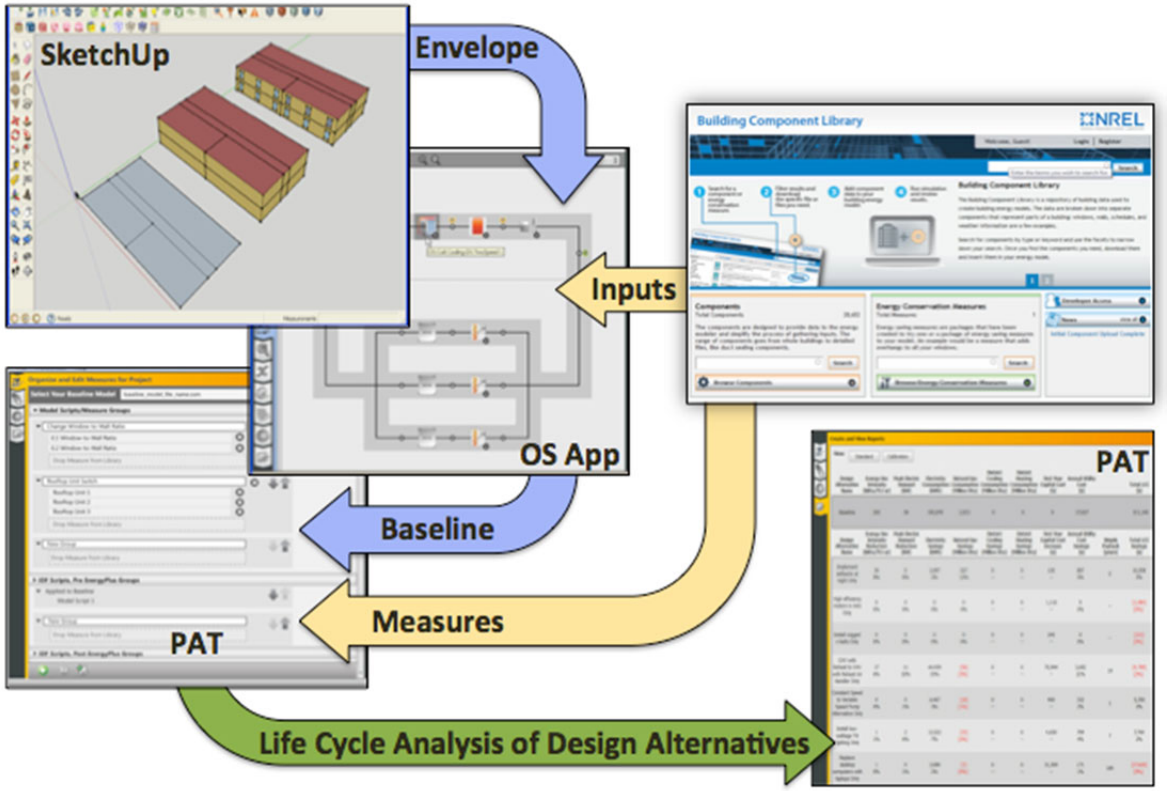

Figure 3. OpenStudio workflow for baseline modeling and design alternative assessment.

While EnergyPlus runtimes remain slower than other engines, due to its more precise bookkeeping of energy flows and dynamics, OpenStudio has ameliorated the issue by enabling cloud-based parametric analysis. The upshot is that OpenStudio allows more design alternatives to be modeled quickly and correctly, rather than being simulated in parallel, to reduce the overall time to perform analysis (Parker, 2014).

Making standardized inputs and modeling approaches (measures) available via the BCL is an important step towards improving the quality of modeling outcomes. Measures in particular enable the encapsulation of "best practice" for ECMs, and immediately useful dissemination of knowledge from experienced to junior modelers within and across organizations. The notion of a "measure" in OpenStudio is more general, however, and can represent not only transformation of models, but also the data associated with them. This means that measures may be applied within an analysis workflow to repeatedly produce performance summaries, plots, or pre-packaged reports.

Xcel Energy has leveraged this capability to package a set of standard quality assurance/quality control (QAQC) checks that are performed on each design alternative. The QAQC measure automates a number of standard checks for model validity, including unmet hours, suspicious energy use intensity, and many more that were recommended as best practice

by engineers at Xcel Energy and NREL. In addition, EDA protocol is automated including, for example, a check for fuel switching. These extensible QAQC checks are of great value to consultants, particularly junior modelers, who can vet their analysis results prior to uploading them from PAT to EDAPT. QAQC outcomes are also available to Xcel Energy engineers within the EDAPT website, and are a valuable input when considering approval of a process step. Automating QAQC was a key part of the strategy to minimize the risk Xcel Energy faced in opening the program to many new energy consultants.

Pay for Performance

As EDAPT and OpenStudio/Energy Plus offered multiple solutions including a reduction in administrative costs and enhanced quality control, Xcel Energy felt able to open the program to more qualified energy consultants—with a final change to shift from the pay-per-project model to a pay-for-performance model. As previously mentioned, EDA was administered by pre-qualifying a small number of energy modeling consultants and paying through a fee-for-service basis that was based on the size of the building under construction. In this new model, the consultant's pay is proportional to the amount of energy the final building saves beyond code. Since the savings are based on what is actually included in the completed building, tying the consultants' pay to actual savings gives them a strong incentive to find all available savings opportunities and work closely with the customer and the design team to ensure the most efficient final design and construction of the building. Additionally, the pay-for-performance path pays the consultants essentially in a few stages – after energy design and again after M&V, subsequent to the building being completed. The second and final payment is revised to include the savings from those measures installed in the actual building. This limits Xcel Energy's risk of paying for non-realized savings. The final change was to increase the number of projects eligible for the program by reducing the minimum eligible building size from 50,000 ft^2 to 20,000 ft^2. A noteworthy additional benefit of opening up the market brings healthy competition between consultants to secure projects.

Results of Program Redesign: National Implications

Xcel Energy launched EDAPT in June 2013 (www.eda-pt.org/). The launch included qualification of numerous additional energy consultants to participate as EDA providers, based on demonstrated capabilities with EnergyPlus and OpenStudio. Many of the consultants were more at home with eQUEST, and for many the prospect of moving to a new modeling platform was daunting. Xcel Energy and NREL supported this transition through multiple training workshops leading up to the EDAPT launch. Comprehension of the new modeling workflow and EDAPT integration was part of the qualification process.

All of the EDA vendors now using OpenStudio have successfully gone through the various modeling/program stages and show optimal design energy/cost savings. Response to the new workflow has been largely positive. Both OpenStudio and the EDAPT report templates have been updated based on valuable consultant feedback. Additional OpenStudio functionality supporting specific EDA projects has been a priority for the development team. The vendors appear to appreciate the convenience of pre-packaged measures when available, and some modelers have demonstrated interest and aptitude in creating new measures using the existing examples. Other modelers have expressed frustration at the available selection of measures. A concerted effort spanning multiple national laboratories to create additional measure content for

the BCL is underway, and Xcel Energy is also planning to provide focused training on measure authoring to encourage self-sufficiency and innovation.

The EDAPT tool is currently saving Xcel Energy roughly 15% in program administration costs, improving the program's cost-effectiveness. Given the ease of administration, efforts can now be spent to create additional opportunities to bring in more projects, including the addition of an "express" workflow for additional savings, and a review of emerging technologies.

DOE has taken an interest in Xcel Energy's successful application of OpenStudio and EnergyPlus to improve the cost-effectiveness of its EDA program, enhance the productivity of consultants, and influence new building owners to achieve energy performance beyond code. As such, DOE is in the process of enhancing and opening EDAPT for use by additional utilities. Current activities include:

- Expanding EDAPT for retrofits of existing buildings.
- Adding additional groups, roles, and permissions that will enable:
  - Multiple utilities to use the service to securely manage and track their own new construction and/or retrofit projects.
  - Vendors to work within new construction and/or retrofit programs for multiple utilities.
  - DOE to assess the aggregate performance of programs in a manner that will inform future investments in energy efficiency technology development and demonstration.
- Adding the ability to manage utility-specific documents, data, and calculations such as:
  - Custom applications.
  - Program-specific incentive calculations.
  - Document templates.
- Adding greater workflow modularity to enable, for example, omitting specific steps called out in Figure 2.

While EDAPT and the supporting tool chain and workflow are helping Xcel Energy maintain the viability of its EDA program, building codes are a continually moving target. There will remain constant pressure to further reduce costs to justify the continued existence of such programs. To meet this challenge, DOE is supporting Xcel Energy in the development of additional measures to further reduce the time and cost of modeling and analysis. In late March, sets of measures corresponding to ECMs recommended by the popular ASHRAE 50% Advanced Energy Design Guides (AEDGs) for K-12 and Office will be added to the BCL. Xcel Energy intends to use these measures in a "quasi-prescriptive" fashion for school and office EDA projects which will go through a significantly shortened process. In this program track, consultants will create their baseline model, apply the prescribed set of measures to their model, and move directly to the Final Energy Analysis (FEA) step in the process. Xcel Energy anticipates that significantly reducing the level of effort of the Preliminary Energy Analysis (PEA) step, or reducing it all together could reduce the cost of projects by as much as 50%. If successful, AEDG measure bundles may be added to the BCL for additional building types, and we may see OpenStudio measure creation become standard practice in the course of developing any new AEDGs.

Conclusion

Improving program cost-effectiveness, enhancing consultants' capabilities, and efficiently influencing building owners to achieve energy performance beyond code are some of the key benefits gained thus far in the creation of EDAPT and use of OpenStudio/Energy Plus. Xcel Energy is seeing roughly a 15% reduction in administrative costs, more projects given the increase in energy consultants, and quality modeling results. And, these benefits are easily achievable for other utilities or entities administering energy efficiency building programs. DOE is keen to distribute and expand on these benefits and is presently seeking utilities with an interest in adopting the web service. DOE will also be working with tool vendors to adopt EDAPT's open-upload format for utilities or consultants who do not wish to use OpenStudio and EnergyPlus. EDAPT generalization work will be completed in late Summer of FY14.

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