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Practices for Demonstrating Energy Savings from Commercial PACE Projects

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Executive Summary

This issue brief is for state and local governments that want to track the energy impacts and performance of a Commercial Property Assessed Clean Energy (C-PACE) financing program. C-PACE programs provide a mechanism for commercial property owners to finance energy improvements and can provide a variety of both private and public benefits. State and local governments authorize C-PACE programs based on the public benefits they afford, such as economic development opportunities, greater resiliency in the built environment, and, the focus of this brief, energy savings.

Program sponsors and administrators may want to quantify the energy impacts of C-PACE projects and programs to demonstrate the benefits of C-PACE. This can be done through the process of determining and quantifying how an energy efficiency project affects a particular outcome. Such a process is known as an energy impact assessment. This brief examines the value proposition and trade-offs of conducting energy impact assessments for C-PACE programs; methods to quantify energy savings impacts from energy efficiency building improvements; and available resources and tools to support energy impact assessments.

Key findings from this issue brief include:

C-PACE programs may benefit from energy impact assessments for a variety of reasons, including:

- Validating the public benefits of the program.
- Demonstrating that the program can deliver beneficial outcomes for participants.
- Illustrating program impacts on public policy goals.
- Generating data to improve program performance.

Commercial PACE Working Group Issue Briefs

This issue brief is the second in a series of U.S. Department of Energy (DOE) and Lawrence Berkeley National Laboratory (LBNL)-produced issue briefs intended to inform state and local governments about specific barriers to adopting and implementing C-PACE programs. The issue briefs are informed by input from participants in DOE's C-PACE Working Group, which includes state and local governments, third-party program administrators, capital providers, and many other organizations.

This issue brief addresses the topic of assessing and tracking energy savings from C-PACE programs. For readers unfamiliar with C-PACE and the role of state and local governments, consider starting with a foundational C-PACE resource prepared by DOE and LBNL, *Lessons in Commercial PACE Leadership: The Path from Legislation to Launch*. The report aims to fast-track the setup of C-PACE programs by capturing best practices and lessons learned from early adopters. It includes a glossary of terms, summarizes interviews and anecdotes from leading practitioners, and identifies key additional resources.

C-PACE programs are collecting data on project energy savings impacts and there is an opportunity to leverage these data to further support decision making and program implementation.

- All nine C-PACE program administrators who responded to Lawrence Berkeley National Laboratory's questionnaire to inform this issue brief reported collecting some type of data on project energy savings impacts. Four administrators indicated they actively use the data (e.g., to report on progress, to verify savings, for quality control).

Potential drawbacks to energy impact assessments may include added cost and burdens on property owners (e.g., the need to collect building energy consumption data). Where these burdens are considerable, they might slow program uptake.

- State and local governments can balance the benefits of energy impact assessments with the range of costs and accuracy inherent to three available assessment methodologies (see Methods for Assessing Energy Impacts, page 5).

The three most appropriate methods for energy impact assessments for C-PACE programs include:[1]

- Deemed Savings: savings assessment based on predetermined estimates drawn from other settings ("fully deemed"), potentially supplemented with site-specific adjustments ("partially deemed").
- Consumption Data Analysis: comparison of pre- and post-project utility bill consumption data, most often normalized for weather.
- Building Energy Simulation: use of building energy simulation models to forecast energy savings, ideally including an effort to calibrate model results to actual energy consumption.

Depending on the policy context in the state or local government, a C-PACE program may be able to leverage existing efforts to reduce impact assessment costs, align with building owner practices and expectations, and efficiently assess program impact.

- For example, some state and local governments require properties above a certain size (e.g., 100,000 square feet) to annually benchmark and disclose building energy performance data. C-PACE programs in jurisdictions with such building energy disclosure policies can potentially leverage the performance data to assess energy impacts.

Available tools and successful models from leading C-PACE programs are available to support impact assessment processes.

- The U.S. Environmental Protection Agency's (EPA) ENERGY STAR Portfolio Manager[2] is a free online tool that can be used to track, benchmark, and analyze energy use, water consumption, and greenhouse gas emissions using an established methodology.
- Additionally, programs such as the Texas PACE Authority offer a model for a low-cost, partnership-based approach to assessing and sharing project impacts; see page 7 for this case study.

Introduction

This issue brief is for Commercial PACE (C-PACE) program sponsors, state and local policymakers, and other C-PACE stakeholders who are considering conducting (or otherwise seeking to understand) energy impact assessments. C-PACE is a mechanism for financing clean energy and other eligible improvements on commercial buildings via a voluntary tax assessment paid by the property owner. This issue brief reviews methods for energy impact assessments, C-PACE program experience with energy impact assessments, and the benefits and drawbacks of conducting these assessments. Lawrence Berkeley National Laboratory (LBNL) developed the brief through a review of available literature, research on impact assessment methods, interviews with C-PACE stakeholders (e.g., capital providers), and the responses of C-PACE program administrators to a questionnaire about their tracking and impact assessment practices.

C-PACE can provide several benefits, including benefits to building owners and tenants (e.g., energy savings, utility bill savings, higher net operating income, increased property value, increased rent, enhanced public image, healthier building environment) and benefits to the broader community (e.g., increased jobs, investment, energy savings, and economic activity) (Caraghiaur 2016). State and local governments authorize C-PACE because it supports projects that provide public benefits such as energy savings, economic development opportunities, and greater resiliency in the built environment. Program sponsors and administrators may want to quantify these benefits to demonstrate program value.

This issue brief reviews methods to quantify energy impacts of C-PACE projects and programs. The U.S. Department of Energy (DOE) has created this issue brief to help state and local governments can champion and promote their C-PACE programs and projects by demonstrating the energy savings generated. Demonstrating energy savings will enhance program accountability, longevity, and ultimately, beneficial outcomes for state and local governments.

[1] Many benchmarking programs begin with larger thresholds (e.g., 100,000 square feet or greater) and lower the threshold (e.g., 10,000 to 25,000 square feet) over time to include more buildings. Source: https://www.naseo.org/issues/buildings/benchmarking.
[2] Explore ENERGY STAR Portfolio Manager online at: https://www.energystar.gov/buildings/facility-owners-and-managers/ existing-buildings/use-portfolio-manager.

Some readers may be familiar with energy impact assessments of energy efficiency incentive programs funded by utility ratepayers. Such energy impact assessments are routinely conducted for most utility programs. In fact, impact assessments are usually required for these programs and the budget for impact assessments is raised from utility customers' bill payments. By contrast, most C-PACE programs as they are currently implemented, absent a state or local action, have neither a requirement nor a budget for impact assessment.

Value Proposition and Feasibility of Energy Impact Assessments

LBNL communicated with administrators of nine C-PACE programs to capture their experiences with energy impact assessment. Respondents identified several benefits, from a program administrator perspective, to assessing C-PACE energy impacts. These benefits include:

- Validation of the public benefit nature of the C-PACE program (e.g., a demonstration for policymakers that the program provides energy savings).
- Quantification of the impact of C-PACE programs on public policy goals (i.e., confirmation of energy savings realized as progress toward savings targets).
- Realization of a proof of concept (i.e., evidence that C-PACE programs save energy for participants) to encourage increased program participation.
- Internal evaluation of program performance to improve programs (e.g., identifying outliers and patterns of performance with specific measures or participating contractors).

Other C-PACE stakeholders may have other rationales for conducting energy impact assessments. Table 1 summarizes rationales for C-PACE stakeholders, including those for program administrators as described more fully above.

Table 1. Potential Applications of Energy Impact Assessments that Could Benefit C-PACE Stakeholders

Stakeholder	Potential Impact Assessment Use Cases
State and local governments	Validate public benefit Illustrate impact on policy goals
Program administrators	Validate public benefit Provide a proof of concept Illustrate impact on policy goals Internally evaluate program performance
Property owners/mortgage holders	Demonstrate lifetime savings can offset—if not exceed—project costs Where used, validate savings guarantees

Many program administrators with whom LBNL communicated noted that they do not track impacts or have not taken full advantage of tracking. In other words, these program administrators have room to expand their impact assessment practices or better use the data they collect provided that the benefits of doing so outweigh the costs.

While property administrators may choose to conduct impact assessments to reap the benefits mentioned above, these assessments may also be directly or indirectly mandated through three mechanisms: (1) legislation; (2) savings-to-investment ratio rules; and (3) savings guarantees (e.g., through energy savings performance contracts, or ESPCs).[3]

1. C-PACE-enabling legislation can either directly require impact assessments or indirectly motivate such assessments. As an example of a direct legal requirement, Washington D.C.'s Energy Efficiency Financing Act of 2010, codified as DC Law 18-183, states that the C-PACE program administrator shall implement a quality assurance program that "measures actual energy savings" (Council of the District of Columbia, 2010). As an example of legislation indirectly motivating impact assessments, California's SB 350 includes PACE as one mechanism by which savings may be counted toward the state's robust energy savings goals (State of California, 2015), which will presumably require impact assessment to quantify those savings.[4]

[3] ESPC is a contracting and financing method that provides upfront financing for energy efficiency projects that is then repaid over time by the cost savings resulting from the upgrades. This budget-neutral approach saves taxpayers money by cutting energy and water waste and saving those operating funds for other priorities. Learn more with U.S. DOE's ESPC Toolkit: https://betterbuildingssolutioncenter.energy.gov/energy-savings-performance-contracting-espc-toolkit.

[4] SB 350, the Clean Energy and Pollution Reduction Act of 2015, directs the California Public Utilities Commission to establish annual energy efficiency savings and demand reduction targets for investor-owned and publicly owned utilities. The goals aim for a cumulative doubling of statewide energy savings by 2030. See (State of California, 2015).

2. The savings-to-investment ratio ("SIR") is the ratio of energy cost savings from a project to the money spent on (i.e., the investment in) that project. Programs that use SIRs must perform an assessment of projected impacts to comply with the rule.[5] The SIR is estimated before a project is undertaken to understand project economics. An SIR greater than one (i.e., SIR>1) means the project cost savings are estimated to exceed investment costs.[6] C-PACE programs in at least eight states have SIR rules (PACENation, 2018). In some cases, projects must exceed an SIR threshold to qualify for financing; in others, participants must report an SIR even absent a qualifying threshold.

3. Some C-PACE projects may be implemented using agreements with energy service companies that guarantee the project will realize a certain amount of savings. Such agreements often use the contractual instrument known as ESPC (see footnote 3 for a definition). In Wisconsin, for example, projects over $250,000 are required to obtain a performance guarantee stating savings will exceed investment (Wisconsin State Legislature, 2012). An impact assessment is generally conducted to demonstrate that the project has generated the requisite savings. After agreeing on consumption baselines, the customer and the energy service company decide how they will measure and verify project savings (DOE 2019). The plan for how savings will be measured is agreed upon before the project begins, and is part of the contract with the energy service company.

Though energy impact assessments can provide benefits and may in some cases be required, several program administrators surveyed for this issue brief noted drawbacks to energy impact assessments for C-PACE projects. These drawbacks include additional costs (typically borne by the property owner) and the collection of potentially sensitive information. For example, collecting, analyzing, and reporting building energy usage data after a C-PACE-financed project is complete may involve one-time or ongoing labor costs. (Alternatively, there may be no additional cost if a building is subject to a benchmarking policy and energy usage data is regularly disclosed.) Property owners may see these or other requirements of energy impact assessment as a burden, especially for projects where energy savings are not central to the project's business case.[7] Depending on a property owner's sensitivity to these factors, costly or intrusive impact assessments can discourage use of C-PACE financing. These factors should be weighed against the benefits that impact assessments can provide. This issue brief can help state and local government C-PACE sponsors implement energy impact assessments that maximize benefits and minimize costs.

Decision makers should calibrate the depth and expense of energy impact assessment efforts based on program goals to ensure the benefits of energy impact assessments exceed the drawbacks. Property owners may conduct impact assessments for other reasons (e.g., to comply with other policies). C-PACE program sponsors in some jurisdictions could leverage existing policies or practices that require some form of impact assessment and achieve the benefits of impact assessments with lower costs to C-PACE program participants. Examples include the following:

- **Benchmarking and Disclosure:** Benchmarking and disclosure policies require building owners to publicly disclose data on building energy consumption. Three states and Washington, D.C. have legislation requiring energy use disclosure or benchmarking, as do 30 municipalities in an additional 18 states (ENERGY STAR 2020).[8] Where these requirements exist, C-PACE programs may be able to leverage those energy data collection processes to facilitate impact analysis, particularly consumption data analysis (see page 6).

- **Premium Certifications:** Some building owners or managers seek to demonstrate the energy efficiency of their buildings by pursuing recognition through premium certifications such as those offered by the ENERGY STAR or Leadership in Energy and Environmental Design (LEED) programs. To be ENERGY STAR-certified, for example, a building owner must enter energy consumption data into the online energy management and tracking tool known as Portfolio Manager (see *ENERGY STAR Portfolio Manager* text box, page 9), which delivers a score that can earn the building ENERGY STAR certification. The data must be verified by a licensed third party each year (ENERGY STAR n.d.b).[9] C-PACE programs can potentially leverage such energy consumption data collection and reporting efforts.

- **Building Energy Codes:** Building energy codes are minimum efficiency standards that state and local governments implement and local permitting offices enforce. All but eight states require commercial building energy codes.[10] To comply with the codes, DOE offers the *EnergyPlus* open-source building energy modeling software and *COMcheck*, a software tool that determines whether new construction, alterations, or additions will meet building energy codes.[11] Many C-PACE projects likely trigger building energy code requirements. Where they do, code-required estimates of building energy consumption using *EnergyPlus, COMcheck*, or similar simulation tools (see the Building Energy Simulation section, page 7) could double as impact assessment for C-PACE projects if compared with pre-project estimates using the same methods.[12]

[5] Post-project assessments could help improve the accuracy of SIR projections for future projects.
[6] States use different definitions of "savings" and "investment." Some are broad and inclusive, while others include fewer items in the calculations. And the calculations can combine sources of savings (e.g., energy savings and water savings), so they may need to be broken out in order isolate cost savings resulting from energy savings.
[7] A program administrator from a state that requires impact assessments observed that the requirement would be difficult to enforce if a participant refused to comply.
[8] For more, see: https://www.energystar.gov/sites/default/files/tools/Benchmarking-Programs-and-Policies-Factsheet_Q3-2020%20KAB508c.pdf
[9] "ENERGY STAR Certification for Your Building," https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/earn-recognition/energy-star-certification.
[10] See: "Energy Codes 101: What Are They and What is DOE's Role?" DOE, May 31, 2016: https://www.energy.gov/eere/buildings/articles/energy-codes-101-what-are-they-and-what-doe-s-role and "Status of State Energy Code Adoption," DOE, Updated September 30, 2020: https://www.energycodes.gov/status-state-energy-code-adoption.
[11] "To learn more about EnergyPlus and COMcheck, see (EnergyPlus) https://energyplus.net and (Building Energy Codes Program: COMcheck,) https://www.energycodes.gov/comcheck.
[12] Building energy code assessments are done before construction begins on a project.

Methods for Assessing Energy Impacts

Estimating C-PACE energy savings requires comparing energy consumption—once energy-related improvements are implemented—to the baseline usage that would have occurred without the improvements. The International Performance Measurement and Verification Protocol (IPMVP)[13] and the Uniform Methods Project (UMP) frameworks offer methods for determining savings. Since 1997, the Efficiency Valuation Organization (EVO) has maintained and published the IPMVP, while UMP is a DOE-led initiative.[14] Other impact assessment resources – for example, those written for ESPC projects (FEMP 2015) – generally build upon these same fundamental resources.

IPMVP identifies four methods:

- Option A: Retrofit isolation with key parameter measurement.
- Option B: Retrofit isolation with all parameter measurement.
- Option C: Whole facility analysis.
- Option D: Calibrated simulation.

If program sponsors plan to implement impact assessments as policy, they must consider costs and which party will bear those costs. For example, IPMVP Option B methods can be relatively more expensive and intrusive than the other options, so they may be less appropriate for most C-PACE projects. The other three options, which are more appropriate for assessing C-PACE program energy impacts, roughly map onto the IPMVP options as follows:

- **Deemed Savings:** Partially deemed savings methods that may be included in IPMVP Option A: Retrofit isolation with key parameter measurement.
- **Consumption Data Analysis:** Roughly corresponds to IPMVP Option C: Whole facility analysis.
- **Building Energy Simulation:** Corresponds to IPMVP Option D: Calibrated simulation.

Identification of the most-appropriate savings assessment method is driven by program objectives and scale, the impact on property owners' participation, the budget for impact assessments, and specific aspects of the measures and program participants involved (SEE Action, 2012). Generally, the choice of method is a balance of cost on the one hand and accuracy and results on the other (EVO 2018). Table 2 (page 8) summarizes the benefits and drawbacks of each of these methods for C-PACE programs.

Deemed Savings[15]

Deemed savings values are "predetermined estimates of energy or peak demand savings attributable to" a specific efficiency measure (ACEEE, n.d.). They may be specific values or engineering algorithms designed to calculate savings from a particular measure. For example, if light-emitting diode (LED) lamps are included in a project, an impact assessment based on "fully deemed" savings could assign a savings amount[16] per LED lamp installed. The per-lamp savings number can be multiplied by the number of lamps installed at the project site to calculate total energy savings from LEDs in that project. "Partially deemed" savings values (which correspond to IPMVP Option A) augment fully deemed savings values with site-specific adjustments for better accuracy (e.g., incorporating site-specific estimates of the hours of use for each room with new LED lamps and the wattage of the lamps that the LEDs replaced). Deemed savings values may sometimes be used in pre-project audits to determine expected project energy savings.

[13] The IPMVP provides "methods...for determining savings either for the whole facility or for individual energy conservation measures" (EVO, n.d.). It offers an agreed upon, proven methodology for estimating energy savings (e.g., many energy service companies use the IPMVP framework to assess savings for energy savings performance contracts). For more information, see "International Performance Measurement and Verification Protocol (IPMVP)," EVO, https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp.
[14] DOE developed the UMP, which offers a set of protocols to determine the savings of energy efficiency measures. UMP protocols are based on IPMVP but "provide a more detailed approach." The UMP consists of protocols that focus on individual end uses under the commercial sector, residential sector, combined commercial and residential sector, and it has protocols that fit under a "crosscutting" heading. For more information, see "Uniform Methods Project: Determining Energy Efficiency Savings for Specific Measures," DOE, https://www.energy.gov/eere/about-us/ump-protocols.
[15] Deemed savings are also referred to as stipulated savings or unit energy savings.
[16] This value or algorithm can be found in a technical reference manual.

Energy Audits

Energy audits—which may use deemed savings, building energy simulation methods, or other energy engineering calculations—can determine energy use baselines for estimating an efficiency project's potential savings. According to International Standard ISO 50002, an audit is a systematic analysis of energy use and consumption within a defined scope to identify, quantify, and report opportunities for improved energy performance (SIS, 2014). Energy audits may include a preliminary review of energy use, a site assessment, and an energy and cost analysis (Baechler, Stecker, & Shafer, 2011).

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) delineates three levels of energy audits:

- Level I includes an energy bill assessment and limited building inspection.
- Level II employs a more refined energy use survey and more extensive analysis of building characteristics, costs, energy use, and potential energy savings.
- Level III (sometimes called an "investment-grade audit") includes Level I and II activities as well as equipment monitoring, more-extensive data collection, and more-comprehensive engineering analysis (Baechler, Stecker, & Shafer, 2011).

Costs typically start at around $5,000 for a Level I audit. As the audit level increases, costs increase and can vary widely depending on building size (Roush 2020).

Policies such as building energy codes may involve audits to comply with policy requirements. In some jurisdictions, audits are required for C-PACE projects. According to PACENation (2018), C-PACE-enabling legislation in 19 states requires an audit or some form of project benchmarking. If C-PACE programs or other policies or rules already require audits, program sponsors could potentially leverage them to estimate program energy impacts.

Consumption Data Analysis

Consumption data analysis, which corresponds to IPMVP Option C for individual buildings, assesses energy outcomes by comparing a facility's energy consumption before and after an efficiency project. Some C-PACE programs employ this method.[17]

The method compares whole-building energy usage before and after a project to estimate the energy impacts of the project. It does not estimate consumption changes for specific energy systems (e.g., an HVAC system). In most cases, consumption data analyses account for drivers of energy use that are unrelated to an efficiency project (e.g., normalizing for weather conditions or building occupancy). Several software packages implement typical consumption data analysis methods (see next section: Tools and Resources for Assessing Energy Impacts).

A building's energy consumption can also be compared to a group of similar buildings that are not participating in C-PACE. Such a comparison can account for non-project factors that would be expected to affect other similar buildings, such as energy price changes or economic factors.[18] DOE's UMP protocol recommends using a valid comparison group where data are available. However, developing a valid comparison group of commercial buildings is often prohibitively expensive.

Consumption data analysis can be conducted on a program scale or even the multi-program scale. In a consumption data analysis of the energy impacts of residential PACE projects in California, LBNL examined multiple programs across the state (Deason et al., forthcoming).

Case Study

Connecticut Green Bank Uses Consumption Data Analysis to Look for Useful Program Performance Patterns

The Connecticut Green Bank (CGB) has offered a C-PACE program since 2013. Early on, CGB funded all projects and sought to track impacts by requesting permission from each building owner to access their utility billing data. CGB received permission and collected data for some projects. Later, private capital providers began to participate and fund projects, and they have not tracked energy impacts. To facilitate impact analysis, going forward CGB plans to request access to energy usage data at the outset of each project. CGB will employ OpenEEMeter software (see next section: Tools and Resources for Assessing Energy Impacts), which is designed to perform consumption data analysis. CGB believes performing consumption data analysis will allow them to find useful patterns in project performance that can help improve the program. For example, CGB has a rule that each project's SIR must be greater than one (SIR>1) based on auditing and a technical review. Consumption data analysis could reveal how well the SIR is performing and whether there are differences in performance across contractors. CGB notes that impact analysis can also provide a track record that can be used to market the program to potential participants.

[17] In some programs, for example those in Connecticut, Michigan, and Texas, C-PACE program administrators seek pre-project consent from participants to allow administrators to access their energy consumption data for analysis purposes.
[18] It is common for consumption data analyses to control for weather, but it is less common to control for other factors.

Building Energy Simulation

Building energy simulation methods use physics-based building energy models to forecast energy savings from a specific energy efficiency project for either a specific building or typical buildings. Generally, to estimate project impact, one must simulate the building in its pre-project state and in its post-project state and then calculate the difference between the energy usage predicted by the two simulations.

Building energy models are often quite complex and are generally capable of specifying many features of the simulated building in detail. For higher accuracy, a calibrated simulation, which corresponds to IPMVP Option D, would need to be performed. This approach adjusts the simulation to site specifics such as by calibrating to metered performance data. The Efficiency Valuation Organization (EVO) notes that “this option requires considerable skill in calibrated simulation” (EVO 2018).

In some jurisdictions, building owners may have a whole building energy simulation done as part of an energy audit in order to comply with building energy codes, or to earn premium certifications (e.g., LEED or ENERGY STAR certification). However, these simulations will generally not be calibrated to the extent the IPMVP would recommend. If not required by another policy, calibrated simulations may require more effort than programs and property owners want to undertake.

Case Study

Texas PACE Authority Uses Consumption Data Analysis to Promote C-PACE and Program Transparency

The Texas PACE Authority—the nonprofit, state program administrator—partnered with the Houston Advanced Research Center (HARC)[19]—a nonprofit research hub that “provides independent analysis on energy, air and water issues”—to create the TX-PACE Energy and Emissions Tracker.[20] This tracker allows stakeholders and the public to view total and annual C-PACE program aggregate investment, jobs created, average payback, number of projects, energy use reduction, water use reduction, and emissions reduction (including sulfur dioxide, nitrogen dioxide, and carbon dioxide). Potential C-PACE participants—both building owners and local governments—can use the Tracker to see the impact that C-PACE is having in Texas and see which types of outcomes can be measured. The Texas PACE Authority uses the Tracker along with case studies to provide information for interested parties.[21]

The Tracker collects data from individual projects and then aggregates it and reports it at the state and regional levels. C-PACE participants enter their consumption data into ENERGY STAR Portfolio Manager (see ENERGY STAR Portfolio Manager text box, page 9). In some cases, the utility will populate the Portfolio Manager data fields.[22]

HARC uses an application programming interface (API)—a type of operating system interface that allows different computer applications to communicate—to access the data. HARC staff work with building owners to set up their Portfolio Manager accounts and establish energy and water use baselines. HARC also normalizes the data for weather and identifies errors and outliers. HARC then analyzes the data to determine energy and water savings, and it uses EPA’s AVERT[23] model to determine emissions reductions.

To encourage use of the Tracker, staff at HARC conduct ongoing outreach and dialogue, including regular newsletters, information sessions, webinars, leveraging of a team of interns, and one-on-one outreach. A portion of Texas C-PACE program participants (on average less than 50%) provide data for analysis. For those participants that do not provide data, HARC models savings based on available audit information (Dillingham, 2020).

[19] For more on HARC, visit https://harcresearch.org/about/.
[20] See “TX-PACE Energy and Emissions Tracker,” https://pace.harcresearch.org.
[21] To see more, visit “Texas PACE Authority Resources,” https://www.texaspaceauthority.org/resources/.
[22] Many owners and managers of Class A office buildings (i.e., the most desirable buildings in a given market) access their utility data and enter it into Portfolio Manager for ENERGY STAR certification. Some Class B building owners also do so. (Dillingham, 2020)
[23] To learn more about the AVERT model, see “Avoided Emissions and geneRation Tool (AVERT),” U.S. Environmental Protection Agency, https://www.epa.gov/statelocalenergy/avoided-emissions-and-generation-tool-avert.

Summary of Methods

Table 2 summarizes the three energy impact assessment methods most appropriate for C-PACE programs, including benefits and drawbacks of each method.

Table 2. Benefits and Drawbacks for C-PACE Programs Using the Different Impact Assessment Methods

	Benefits	Drawbacks
Deemed Savings	▪ Forecasts energy savings ahead of project implementation. ▪ Delivers estimates of individual measure impacts. ▪ Using fully deemed values can be straightforward and low-cost. ▪ Inexpensive if there is access to reliable and applicable deemed savings values (e.g., via technical reference manuals).	▪ Does not indicate actual savings (e.g., cannot assess quality of installation or commissioning). ▪ May not capture site specifics, especially in the case of fully deemed approaches. ▪ Lower accuracy in some applications, especially in the case of fully deemed approaches, depending on the quality of the deemed savings values.
Consumption Data Analysis	▪ Reflects actual consumption post-project. ▪ Can control for some external factors (most commonly, weather conditions).	▪ Requires access to energy consumption data. ▪ No assessment of individual measures. ▪ May not account for change in energy use due to changes in occupancy, operations, or physical site.
Building Energy Simulation	▪ Forecasts energy savings ahead of project implementation. ▪ Enables assessment of individual measures and whole building (though whole building estimates are the most common output). ▪ Captures site specifics.	▪ Does not indicate actual savings. ▪ Requires access to specific information about building and at least historical energy use. ▪ May require expertise and significant effort (i.e., costs) to develop models and calibrate (i.e., capture site specifics).

Tools and Resources for Assessing Energy Impacts

Many resources are available to guide and enable energy impact assessments. Several widely used tools—some already in use by C-PACE programs—can support C-PACE energy impact assessments. These resources and tools include:

- IPMVP and the UMP offer methods for determining savings, as discussed in the Building Energy Simulation section (page 7).
- The State and Local Energy Efficiency Action Network's (SEE Action) Evaluation, Measurement, and Verification Resource Portal has links to resources on impact evaluation. For more information, see: https://www4.eere.energy.gov/seeaction/evaluation-measurement-and-verification-resource-portal.
- Technical reference manuals (TRMs) can provide the basis for deemed savings values. TRMs offer unit energy savings estimates (i.e., "documented, numerical values for specific energy efficiency measures")(SEE Action, 2012) that can be aggregated to estimate expected project savings. State utility regulatory commissions or utilities often maintain TRMs that provide fully deemed savings values for their states or service territories.[24] Using a TRM ensures savings estimates are consistent with deemed values used for other projects in a state or service territory.
- The *National Standard Practice Manual for Benefit-Cost of Distributed Energy Resources* is available to guide cost-effectiveness tests for distributed energy resources.[25]
- OpenEEMeter is open-source software that combines data from the utility meter, the project, and the site itself with weather data to conduct consumption data analysis (Recurve, n.d.). OpenEEMeter powers the CalTRACK methods, which standardize calculation of weather-normalized, avoided energy use for California pay-for-performance projects.[26] C-PACE programs in Connecticut and Texas use OpenEEMeter.

[24] Schiller et al. (2017) provides a list of U.S. TRMs and links to online TRMs.
[25] Distributed energy resources are resources located on the distribution system that are generally sited close to or at customer's facilities and include energy efficiency, demand response, distributed generation, distributed storage, electric vehicles and more. Available online: https://www.nationalenergyscreeningproject.org/wp-content/uploads/2020/08/NSPM-DERs_08-24-2020.pdf.
[26] For more on CalTRACK see "What is CalTRACK?" https://www.caltrack.org/.

- LBNL's Building Technology and Urban Systems Division website provides links to additional tools and resources on consumption data analysis methods that use automation and interval data.[27]

- The Green Button initiative is an industry-led effort that seeks to provide utility customers with easy and secure access to their energy usage information in a consumer-friendly and computer-friendly format. Green Button policies can be helpful to secure participant permission to access utility consumption data. These policies can also be useful for consumption data analysis and simulation. Thirty-six utilities have implemented Green Button, and others have pledged to do so. The Green Button Alliance[28] and DOE have more information on Green Button policies. Information on Green Button is available here: https://www.energy.gov/data/green-button.

- U.S. Environmental Protection Agency's ENERGY STAR Portfolio Manager software is a free tool that tracks and shares energy savings data (see text box: ENERGY STAR Portfolio Manager). Some C-PACE programs require or ask participants to use Portfolio Manager. See more information online at: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager.

- DOE's Building Technologies Office provides tools and resources on building energy simulation. See more information online at: https://www.energy.gov/eere/buildings/building-energy-modeling.

Some program administrators or other stakeholders have developed their own tools for determining and quantifying energy impact assessments. These tools may be available to other programs.[29]

ENERGY STAR Portfolio Manager

The U.S. Environmental Protection Agency's ENERGY STAR Portfolio Manager is a free online tool that can track, benchmark and analyze energy use, water consumption, and greenhouse gas emissions using an IPMVP-consistent methodology (SEE Action, 2012). Building managers can use it for any type of building, including parts of buildings, whole buildings, groups or portfolios of buildings, and new construction projects (Energy Star, n.d.a.).

Portfolio Manager has nearly 25% of U.S. commercial building space benchmarked—including more than half of Fortune 100 businesses—to help building managers compare their buildings' performance to that of other tracked buildings (Energy Star, n.d.a.). Users enter building characteristics (year built, gross floor area, occupancy, operating hours, number of workers, and primary building function) and energy and water data (number of meters, units of consumption, bill dates, costs, and whether the consumption is estimated or measured) (Energy Star, 2018). Users may have to enter consumption and billing data manually, but may also be able to work with their utility to directly populate the Portfolio Manager data fields (Baptiste, 2019). Examples of C-PACE programs that require participants to use Portfolio Manager include:

- DC PACE requires either benchmarking in Portfolio Manager or two years of impact assessment using IPMVP protocols.

- The Lean & Green Michigan program requires property owners to create and share data through an ENERGY STAR Portfolio Manager account.

Explore ENERGY STAR Portfolio Manager online at: https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager.

[27] These methods are also known as advanced measurement and verification (M&V) or M&V 2.0. See "Advanced Measurement and Verification (M&V) Research," LBNL, https://buildings.lbl.gov/emis/assessment-automated-mv-methods. "Assessment of Advanced Measurement and Verification Methods (M&V 2.0)," DOE, https://www.energy.gov/eere/buildings/downloads/assessment-advanced-measurement-and-verification-methods-mv-20.

[28] More on Green Button Alliance at "About Green Button and the Alliance," Green Button Alliance, https://www.greenbuttonalliance.org/about.

[29] For example, see the SRS EPIC tool at https://srsworx.com/. Note that Berkeley Lab has not reviewed or otherwise vetted this or other program-developed tools.

Conclusion

When passing C-PACE-enabling legislation and ordinances, state and local governments often cite the public benefits of clean energy among their rationales. By demonstrating the energy savings benefits that C-PACE programs generate, governments will be more prepared to promote and advocate for their programs. Energy impact assessments generates benefits such as measuring progress toward policy goals, promoting program growth, helping to qualify eligible measures, and improving the program through feedback on energy performance.

State and local governments making decisions about C-PACE energy impact assessments should ask several questions for guidance:

- What are the goals of conducting energy impact assessments?
- Which data are most useful to have to achieve those goals?
- What is the existing policy context? Do existing policies align with specific energy impact assessment methods?
- Who will the costs of conducting energy impact assessments fall on?
- What are property owners' expectations regarding energy impact assessments? What are they already doing?
- What is the relationship with electric utilities and how difficult is it to get building-level data (e.g., do your utilities use Green Button)?
- What is the most cost-effective way—for all stakeholders—to successfully implement energy impact assessments?

Themes and Trends

There are many benefits of C-PACE program energy impact assessments and both new and existing programs can evolve and improve by using the data generated by energy impact assessments. Most C-PACE program administrators that responded to LBNL's questionnaire recognized multiple benefits of impact assessments. But LBNL also found program administrators are either not implementing impact assessments or they are not taking full advantage of the data generated when they perform impact assessments. Integrating impact assessments into C-PACE programs will be increasingly important as project pipelines grow and programs transition from start-up operations to mature, self-sustaining programs.

The costs of C-PACE program impact assessments are often specific to the methodology used as well as the policy context of a C-PACE program. Energy efficiency stakeholders have derived a range of methods to assess energy impacts, some of which have been codified and standardized in the IPMVP and the UMP. Three methods—deemed savings, consumption data analysis, and building energy simulation—may be appropriate for C-PACE programs to use, as they could strike the right balance between accuracy and cost. These methods roughly map onto a subset of IPMVP options and UMP protocols. In some jurisdictions, building owners may already apply one or more of these methods to comply with other policy requirements like benchmarking and disclosure, or contractual obligations, such as might be required in an ESPC. Where property owners are already performing energy impact assessments or gathering relevant data for other purposes, if the C-PACE program administrator can leverage that data, energy impact assessment cost and effort will be lower.

Available tools and successful models from leading C-PACE programs can facilitate understanding and implementation of energy impact assessment processes. Free tools such as ENERGY STAR Portfolio Manager are available to support C-PACE programs with energy impact assessments. Leading C-PACE programs have demonstrated cost-effective strategies for assessing program impact. In Texas, for example, the Houston Advanced Research Center (HARC) collects data on energy and other impacts from state C-PACE projects, and it publishes independent analysis that stakeholders can use to see evidence of C-PACE benefits. Although stakeholders must consider the trade-offs, the Texas example shows that impact assessment can be done successfully and to the benefit of programs.

References

ACEEE. (n.d.). *Energy Efficiency Resource Standard: In Practice*. American Council for an Energy-Efficient Economy (ACEEE). Retrieved from https://www.aceee.org/sites/default/files/pdf/fact-sheet/EERSInPractice_detailed.pdf

Baechler, M., Stecker, C., & Shafer, J. (2011). *A Guide to Energy Audits*. Retrieved from https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-20956.pdf

Baptiste, R. (2019). *ENERGY STAR Portfolio Manager Reference Guide*. Center for Sustainable Energy for the City of San Diego. Retrieved from https://www.sandiego.gov/sites/default/files/portfolio_manager_reference_guide_may_2019.pdf

Caraghiaur, G. (2016, May). *The Benefits of PACE Financing for Commercial Real Estate Companies*. Retrieved from https://www.pacenation.org/wp-content/uploads/2016/05/The-benefits-of-PACE-for-CRE-FINAL-1.pdf

Deason, J., S. Murphy, and C. Goldman. (Forthcoming). *Tracking the PACE of household energy usage: Energy usage impacts of project financed through Property Assessed Clean Energy programs in California*.

Department of Energy (DOE). (January 2019). "Understanding Your ESPC Savings Guarantee." Office of Energy Efficiency and Renewable Energy. https://www.energy.gov/sites/prod/files/2019/02/f59/understanding-espc-savings-guarantee.pdf

Dilingham, Gavin, interview by LBNL, August 21, 2020.

ENERGY STAR. (July 2020). "Benchmarking Programs and Policies Leveraging Energy Star®." https://www.energystar.gov/sites/default/files/tools/Benchmarking-Programs-and-Policies-Factsheet_Q3-2020%20KAB508c.pdf

ENERGY STAR. (2018, February). Portfolio Manager Quick Start Guide. Retrieved from https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/energy/pdf/QuickStart-EN-Feb2018-ACC.pdf

ENERGY STAR. (n.d.a.). Buildings and Plants—Use Portfolio Manager. Retrieved from https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/use-portfolio-manager

ENERGY STAR. (n.d.b). *ENERGY STAR certification for your building*. https://www.energystar.gov/buildings/facility-owners-and-managers/existing-buildings/earn-recognition/energy-star-certification

Efficiency Valuation Organization (EVO). (n.d.). International Performance Measurement and Verification Protocol (IPMVP).

Efficiency Valuation Organization (EVO). Retrieved from https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp

Efficiency Valuation Organization (EVO). (2018). *IPMVP Generally Accepted Principals*. http://evo-world.org/images/corporate_documents/IPMVP-Generally-Accepted-Principles_Final_26OCT2018.pdf

Federal Energy Management Program (FEMP). (2015). "M&V Guidelines: Measurement and Verification for Performance-Based Contracts Version 4.0." Prepared for the U.S. Department of energy Federal Energy Management Program. https://www.energy.gov/sites/prod/files/2016/01/f28/mv_guide_4_0.pdf

Leventis, G., Schwartz, L., Kramer, C., & Deason, J. (2018). *Lessons in Commercial PACE Leadership: The Path from Legislation to Launch*. Lawrence Berkeley National Laboratory (LBNL). Retrieved from http://eta-publications.lbl.gov/sites/default/files/lessons_in_commercial_pace_leadership_final.pdf

PACENation. (2018, December). Legislative Characteristics By State. Retrieved from https://www.pacenation.org/wp-content/uploads/2018/12/2018.12.5_leg_characteristics.pdf

Recurve. (n.d.). How the Recurve Platform works.

Roush, Ben, conversation with LBNL and DOE, September 2, 2020.

Schiller, Steven R., Greg Leventis, Tom Eckman, and Sean Murphy. 2017. *Guidance on Establishing and Maintaining Technical Reference Manuals for Energy Efficiency Measures*. Prepared by Lawrence Berkeley National Laboratory for the State and Local Energy Efficiency Action Network. DOE/EE-1610. https://www7.eere.energy.gov/seeaction/system/files/documents/TRM%20Guide_Final_6.21.17.pdf.

State and Local Energy Efficiency Action Network (SEE Action). (2012). *Energy Efficiency Program Impact Evaluation Guide*. Prepared by Steven R. Schiller, Schiller Consulting, Inc., www.seeaction.energy.gov. Retrieved from https://www4.eere.energy.gov/seeaction/system/files/documents/emv_ee_program_impact_guide_0.pdf

SIS. (2014, July 1). ISO 50002—Energy audits—Requirements with guidance for use. Svenska Institutet for Standarder (SIS). Retrieved from https://www.sis.se/api/document/preview/917504/

State of California. (2015). Senate Bill No. 350. State of California Legislative Information. Retrieved from http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB350

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