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Designing and Executing Measurement and Verification Standards for C-PACE Programs:  
Lessons Learned from Leading C-PACE Programs

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# Designing and Executing Measurement and Verification Standards for C-PACE Programs

## Lessons Learned from Leading C-PACE Programs

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### Executive Summary

This brief seeks to inform Commercial Property Assessed Clean Energy (C-PACE) program administrators about design and execution of measurement and verification (M&V) standards by leveraging the experience of existing C-PACE programs. It also serves as a resource for state and local jurisdictions interested in establishing new C-PACE programs that incorporate M&V standards. It defines M&V standards in broad terms as technical standards to verify and demonstrate performance of C-PACE projects and programs, regardless of whether the programs require performance guarantees or ongoing post-project M&V.

M&V standards may be motivated by any of several considerations, such as ensuring project performance and reducing risk for property owners, enabling more accurate reporting of program impacts by program administrators, and validating the public benefit of the program. M&V standards may evolve over time as a program matures to streamline processes and address feedback from property owners and other stakeholders.

Relatively few C-PACE programs require robust M&V as compared to traditional Energy Savings Performance Contracts (ESPCs) or utility programs. There are no established national M&V standards for C-PACE programs, and uniform standards are unlikely to be appropriate because of variability in markets, programs, and projects. There are, however, some M&V best practices all programs can employ. An earlier Berkeley Lab publication (Leventis and Deason 2021) outlines some of these best practices. This brief expands upon them with reference to C-PACE program experience.

Three case studies in this brief profile the M&V-related technical standards of existing C-PACE programs: Texas-PACE Authority's program, TX-PACE, Lean & Green Michigan, and PACE Wisconsin. Program administrators interviewed for this brief described the motivation for adopting their current M&V standards or technical standards related to M&V, and discussed reasons why the standards will likely continue to evolve. Their collective experience with designing and executing programs with M&V-related standards forms the basis for several key findings, which include the following:

- Look to other states and jurisdictions for lessons learned on designing and executing M&V standards for C-PACE programs. The case studies presented here illustrate some of these lessons.
- Consider what each standard will require in terms of compliance for the property owner and enforcement for the program administrators. Successful standards strike a balance between ensuring project performance and avoiding burden on participants.
- Put a mechanism in place to enforce each standard, or at least to effectively encourage property owners to comply. Enforcement of ongoing reporting requirements is especially difficult once the C-PACE loan has been fully funded.
- Consider methods to simplify annual performance reporting processes. For example, after initial approval from the property owners to release the data, program administrators can work with utilities and/or property owners to automate the process of transferring building consumption data from utility feeds or building management systems for ongoing annual reporting.

In the context of this brief, M&V standards are any technical standards related to verifying and demonstrating the performance of C-PACE projects and programs, regardless of whether the programs require performance guarantees or ongoing post-project M&V.

- Standardize M&V practices across programs to the extent possible to ease participation by building owners, contractors, capital providers, and third-party program administrators.
- Communicate the value proposition of M&V to property owners by framing M&V as a mechanism that ensures projects deliver the intended outcomes and benefits, rather than as a technical obligation.

The brief also maps a list of benefits and drawbacks of M&V to the various stakeholders involved in C-PACE programs. While many of the benefits and drawbacks are difficult to value monetarily, it may be possible to quantify some of them to assess the cost-effectiveness of including M&V standards in C-PACE programs. However, based on discussions with program administrators, very limited quantitative data is currently available to value M&V for C-PACE.

## Introduction

This brief reviews how C-PACE programs have designed and executed M&V standards to increase confidence that programs achieve their intended public purpose of energy savings, water savings, and/or renewable energy impacts. It builds upon two other publications: *Lessons in C-PACE Leadership: The Path from Legislation to Launch* (Leventis et al. 2018), which provides a broad overview of M&V in C-PACE programs, and *Practices for Demonstrating Energy Savings from Commercial PACE Projects* (Leventis and Deason 2021), which explains different C-PACE practices for demonstrating savings. The case studies in this brief will help other programs interested in M&V replicate successful programs, apply lessons learned, and mitigate challenges related to M&V standards.

Based on stakeholder requests and discussion with C-PACE experts, C-PACE programs could benefit from greater focus on M&V to achieve the following objectives:

- **Support the public policy objectives of programs** as they mature and transition from program design and implementation to program evaluation and demonstration of results. C-PACE programs have now been financing projects for over 10 years; M&V or other demonstration of energy impacts will help establish a performance track record for programs and the industry.
- **Establish the value of M&V and consistent practices.** Some C-PACE programs mandate M&V in certain cases, but most programs perform little M&V and may undervalue its benefits. Conducting M&V, even on a project- or time-limited basis, may help stakeholders to establish the value of M&V.
- **Limit the risk of poorly performing projects** that can jeopardize programs and damage consumer confidence.
- **Demonstrate the benefits of C-PACE projects.** Specifically, M&V standards help programs quantify energy and water impacts more accurately.

This brief defines M&V standards in broad terms as technical standards to verify and demonstrate performance<sup>1</sup> of C-PACE projects and programs, regardless of whether the programs require performance guarantees or ongoing post-project M&V. To that end, the brief reviews the following types of technical standards related to M&V:

- **Energy and/or water analysis:** Analysis of impacts from potential projects at the system, building, and site level provide data relevant to M&V, especially in terms of accurate characterization of baseline conditions, development of savings estimation approaches, and, when desired or required, establishment of M&V plans. Programs require or encourage different kinds of analysis depending on the type of project and program requirements. Some programs (e.g., PACE Wisconsin) refer to the analysis phase as an energy assessment. Energy audits are a common type of energy analysis for C-PACE energy efficiency projects. Technical standards that call for more rigorous analysis (e.g., American Society of Heating, Refrigerating and Air

*“As [C-]PACE becomes mainstream, the secondary market for [C-]PACE loans will continue to develop. We believe that sophisticated purchasers of securitized [C-]PACE loans are going to pay more attention to the quality of the programs approving the loans and the diversity of loans themselves. We believe good technical and underwriting standards are necessary for a strong market and will lead to both quality/secure investments and fulfilled ESG [environmental, social, and governance] requirements.”*

*Charlene Heydinger  
President of Texas PACE Authority*

<sup>1</sup> The focus is energy impacts, including energy savings and peak demand reductions arising from energy efficiency measures and renewable energy improvements; however, there may be other performance metrics of interest as well, such as water savings, reduced operation and maintenance, etc.

Conditioning Engineers [ASHRAE] Level 2 or 3 audit)<sup>2</sup> produce more detailed data to inform M&V. However, less complex analysis may be sufficient for renewable energy projects since it is easier to measure their impacts directly.

- **Savings-to-Investment Ratio (SIR):** The SIR is a ratio of the ongoing (usually annual) cost savings from the project to the ongoing annual cost of the project (in this case, the cost of C-PACE assessment payments plus any other costs). If the SIR is greater than 1, then the C-PACE project is expected to generate a net positive cash flow on average. Some programs (e.g., TX-PACE) require an SIR greater than 1 for projects to qualify. The SIR is calculated during the analysis phase by monetizing the project's energy (and possibly non-energy) benefits as compared to costs.<sup>3</sup> An accurate SIR requires an accurate estimate of the project's savings impacts from the analysis phase.
- **Performance guarantee:** A performance guarantee (also referred to as a savings guarantee) benefits from a well-documented M&V plan to confirm that the project achieves the guaranteed performance (e.g., energy savings, water savings, renewable energy output, etc.). Traditional ESPCs use performance guarantees, and some C-PACE programs (e.g., Lean & Green Michigan) require performance guarantees, especially for large projects. The property owner and contractor agree upon the approach for conducting M&V when developing the contract and typically document the approach in an M&V plan. The type and frequency of M&V used with performance guarantees vary across contracts and project types.
- **Independent third-party review:** Some programs (e.g., TX-PACE) require third-party review of analysis results and pre- and post-implementation on-site inspections by a licensed professional engineer. Third-party review helps verify that the savings estimation approach is sound and that contractors implemented the project as intended.
- **Post-implementation verification site visit:** Even in the absence of independent third party review, some programs (e.g., PACE Wisconsin) may require or encourage post-project review and a verification site visit by a program agent, representative, or contractor.<sup>4</sup> Review and verification of the project during the post-implementation stage ensures that the project has been completed and is operating as expected.
- **Project completion report/statement:** Regardless of whether the program requires a post implementation verification site visit, C-PACE programs often require a project completion report or statement from the property owner or a third party to attest that the project was completed and is operating as expected. TX-PACE, Lean & Green Michigan, and PACE Wisconsin all require post-completion reports.
- **Annual performance reporting:** Annual reporting tracks the property's performance over time using energy and (if applicable) water consumption measurements. Some C-PACE programs (e.g., Lean & Green Michigan) require property owners to share pre- and post-project utility bill data with the program through the U.S. Environmental Protection Agency's ENERGY STAR Portfolio Manager®.<sup>5</sup>

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<sup>2</sup> For information on different levels of audits, refer to ASHRAE Standard 211-2018, available here: <https://www.ashrae.org/technical-resources/standards-and-guidelines>.

<sup>3</sup> Texas PACE Authority counts water bill savings toward the SIR. (Refer to the TX-PACE case study in Section 3.)

<sup>4</sup> The contractor may or may not be an energy service company engaged in an ESPC with the property owner. An ESPC is a contractual agreement between a property owner and an energy services company. The ESPC model allows property owners to pay for energy upgrade projects with future energy savings. Based on the negotiated contract, the energy service company guarantees a certain level of energy savings. M&V methods quantify and document the performance of the energy upgrades to ensure the guaranteed savings are realized. For more information on this financing mechanism, refer to the U.S. Department of Energy's ESPC Toolkit, <https://betterbuildingsolutioncenter.energy.gov/energy-savings-performance-contracting-esp-toolkit>.

<sup>5</sup> See <https://portfoliomanager.energystar.gov/pm/login.html>.

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## Overview of Programs and Technical Standards Related to M&V

Berkeley Lab interviewed C-PACE program administrators from Texas, Michigan, and Wisconsin during 2022. Table 1 provides a brief overview of the three C-PACE programs covered in this brief. The full case studies for each state appear in the appendix of this document starting on page 13. Refer to the program websites for additional information.<sup>6</sup>

Program name	TX-PACE	Lean & Green Michigan	PACE Wisconsin
Year of Program Launch	2015	2012 (The first project closed in 2015)	2016
Sectors Served	Commercial, industrial, and multi-family	Commercial, industrial, multi-family, agricultural, nonprofit, and new construction	Nonresidential, multi-family, brownfield rehabilitation, and new construction
Number of Projects Closed as of the end of 2022	71 Projects	65 Projects	82 Projects
Type of Program Administration	Texas PACE Authority is a nonprofit organization that administers the program on behalf of local governments	Lean & Green Michigan staff administer the program, which is a partnership of local governments and private organizations	Slipstream is a nonprofit organization that administers the statewide PACE Wisconsin program

Table 1. Overview of C-PACE Programs Reviewed in this Brief

Texas passed PACE-enabling legislation in 2013 (Texas PACE Act 2013). The Texas PACE Authority’s TX-PACE financing program launched in 2015. Commercial, industrial, and multi-family properties are eligible for the program. As of the end of 2022, 71 projects had closed. The Texas PACE Authority is a nonprofit organization that administers the TX-PACE program on behalf of local governments. Keeping PACE in Texas is a nonprofit organization that consists of stakeholders representing capital providers, contractors, property owners, trade associations, and local governments. It promotes C-PACE financing in the state and worked with the Texas PACE Authority to create the toolkit referred to as PACE in a Box. The PACE in a Box uniform program model is used across the state where Texas PACE Authority is the administrator. Lone Star PACE is another program administrator in the state of Texas that administers a different program referred to as the Lone Star PACE program.

Michigan’s legislature signed PACE-enabling legislation in 2010 (Michigan Legislature 2010). The first project closed in 2015. Commercial, industrial, multi-family, agricultural, nonprofit, and new construction properties are eligible for the program. As of the end of 2022, 65 projects had closed. Lean & Green Michigan, a public-private partnership, is the program administrator for each jurisdiction that has adopted programs in Michigan. There are different programs in different jurisdictions with slightly differing requirements and practices.

Wisconsin enacted its PACE-enabling statute in 2009 (Wisconsin State Legislature 2009). The PACE Wisconsin program started in 2016. Non-residential, multi-family, brownfield rehabilitation, and new construction properties are eligible for the program. As of the end of 2022, 82 projects had closed. Slipstream, a nonprofit organization, is the statewide program administrator for PACE Wisconsin.

<sup>6</sup> TX-PACE: <https://www.keepingpaceintexas.org>; Lean & Green Michigan: <https://leanandgreenmi.com>; PACE Wisconsin: <https://www.pacewi.org>.

## Comparison of Technical Standards

Table 2 maps several types of technical standards related to M&V to the three C-PACE programs profiled in this brief. These were the standards in place as of June 2022. Common features of the programs include requirements for analysis of baseline conditions and estimates of **pre-implementation** savings; project completion documentation in the form of reports or signed statements confirming contractors have completed the project as intended; and annual performance reporting, including data sharing through ENERGY STAR Portfolio Manager.

Technical Standard Related to M&V	TX-PACE PACE in a Box Model		Lean & Green Michigan		PACE Wisconsin <sup>a</sup>	
	Fast Track	Full Energy and/or Water Assessment	PACE Express	Projects >\$250,000	Projects <\$250,000	Projects ≥\$250,000
Energy and/or water analysis to establish baseline conditions and estimate savings (audit)	✓	✓ (Level 2 or 3) <sup>b</sup>	✓ (Level 1) <sup>b</sup>	✓ (Level 2) <sup>b</sup>	✓	✓
SIR > 1	✓	✓	–	✓	–	✓ <sup>a</sup>
Performance guarantee	–	–	–	✓	–	✓ <sup>ac</sup>
Independent third-party review	✓	✓	–	–	–	–
Post-implementation verification site visit	✓ <sup>d</sup>	✓ <sup>d</sup>	–	– <sup>e</sup>	✓ <sup>f</sup>	✓ <sup>f</sup>
Project completion report/ statement	✓	✓	✓	✓	✓	✓
Annual performance reporting	✓	✓	✓	✓	✓	✓

### Legend:

“✓” = Technical standard applies to the program; “–” = Technical standard does not apply to the program.

### Footnotes:

- The PACE Wisconsin requirements listed in this table were effective through June 2022. As of July 2022, there are no longer SIR or performance guarantee requirements for any size project.
- Levels 1, 2, and 3 refer to ASHRAE energy audit levels or the equivalent (ASHRAE, 2018).
- PACE Wisconsin required a savings guarantee for at least three years.
- For the Texas PACE in a Box program model, the independent third-party reviewer conducts the verification site visits for both fast track and full energy and/or water assessment projects.
- Lean & Green Michigan program administrators leave it to the PACE contractor and property owner to verify project construction and to enforce the performance guarantee.
- A post-implementation verification site visit may be conducted at the discretion and expense of PACE Wisconsin.

Table 2. Mapping of M&V-Related Technical Standards to C-PACE Programs in this Brief

The program similarities are due in part to information sharing among program administrators in different states. For example, the Texas program administrator noted that Texas modeled its enabling legislation after Michigan’s. Each program has separate tracks for small projects and for larger or more complex projects. For Lean & Green Michigan and PACE Wisconsin, a project cost threshold of \$250,000 differentiates the two tracks. For the Texas PACE in a Box program model, the project type determines the track, with like-for-like replacement, single-measure efficiency projects, and distributed generation systems being eligible for the fast track set of standards and more complex projects requiring the full assessment protocol track. In each program, the tracks for larger or more complex projects require a more detailed savings analysis (e.g., an ASHRAE Level 2 rather than Level 1 audit for Lean & Green Michigan). In addition, as of June 2022, all programs required a SIR greater than 1 for larger or more complex projects. However, effective July 1, 2022, there is no longer a SIR requirement for PACE Wisconsin and July 2023 legislation loosens the SIR requirement for Lean & Green Michigan.

M&V standards also differ in several respects across the three programs. TX-PACE is the only reviewed program that requires the property owner to select a qualified, independent third-party reviewer that must be a licensed Texas professional engineer.

The independent third-party reviewer conducts pre- and post-installation site visits, reviews and certifies the energy and/or water assessment report created during the analysis phase, and provides a statement of compliance that the project was properly completed and is operating according to program guidelines. The Texas PACE in a Box program model does not require a performance guarantee between the contractor and the property owner. In contrast, as of June 2022, Lean & Green Michigan and PACE Wisconsin both required performance guarantees for large projects. But the performance guarantee requirements are changing. Effective July 1, 2022, PACE Wisconsin no longer requires a performance guarantee, and July 2023 legislation in Michigan makes the Lean & Green Michigan performance guarantee waivable for property owners in the future. The next section describes these and other potential changes to M&V-related technical standards.

## Evolving Technical Standards

All program administrators interviewed note considering modifying certain aspects of the M&V-related technical standards currently in place for their programs. These modifications shed light on how the three programs feel M&V can evolve to best support their program objectives. The subsections below summarize possible future modifications and the motivations behind them.

### Texas

The Texas PACE Authority's primary motivation for instituting the technical standards currently in place was to provide a level of protection for the property owner and lender. However, while some property owners are interested in M&V-type actions to validate performance, many view M&V as adding cost and complexity. The Texas PACE Authority is considering using deemed savings values<sup>7</sup> for common measures in standard building types to simplify the technical requirements where feasible. Utility energy efficiency programs for prescriptive measures often employ this approach. Streamlining the process might also create new opportunities to pair C-PACE financing with small retrofits, since most property owners with small projects may find it too costly to comply with the current C-PACE technical standards.

### Michigan

Legislation signed by Gov. Whitmer in July 2023 amended the C-PACE statute to make the SIR and savings guarantee waivable by the property owner for retrofit projects and eliminated the SIR and savings guarantee requirement for new construction projects (Michigan Legislature 2023).<sup>8</sup> Though the requirements were initially put in place to protect property owners, feedback from multiple property owners who requested waiving SIR and performance guarantee requirements helped motivate and shape the amendments.

Lean & Green Michigan currently requires property owners to share utility bill data using ENERGY STAR Portfolio Manager so they can monitor performance. Because of challenges to enforcing compliance with this requirement and accessing data to assess performance of new construction projects, program administrators are considering other methods for annual reporting and monitoring.<sup>9</sup> They would like to improve the quality of the performance data they receive without creating a cost burden for property owners.

### Wisconsin

In March 2022, the Wisconsin legislature enacted Act 175, which modified the Wisconsin PACE statute in two important ways that affect M&V standards (Wisconsin State Legislature 2022):

1. It adds a requirement to verify that completed projects are implemented properly.
2. It removes the SIR and performance guarantee requirements for projects with greater than or equal to \$250,000 in financing, meaning that now no projects have SIR or performance guarantee requirements.

New technical standards that went into effect on July 1, 2022 reflect these modifications to the PACE statute.

Input from stakeholders and testimony from the Wisconsin PACE Commission motivated the modifications. According to the program administrators, one of the commission's greatest concerns is ensuring that completed projects are consistent with the projects described in the PACE applications, since significant changes between the initial design and the "as-built" design can reduce the planned energy impacts for a given project. Though the program guidelines in operation under the previous version of the statute

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<sup>7</sup> Deemed savings values are predetermined estimates of energy and other impacts attributable to individual energy efficiency measures. Depending on the measure, the values may vary by building type, climate zone, etc. For more on deemed savings in the C-PACE context, see Leventis and Deason 2021.

<sup>8</sup> For a new construction energy project, the new law adds "a requirement that the building or other structure exceed applicable requirements of the Michigan uniform energy code, parts 10 and 10a of the construction code, R408.31059 to 408.31071a and 408.31087 to 408.31099 of the Michigan Administrative Code" (Michigan Legislature 2023).

<sup>9</sup> One example of an alternative reporting method is a Building Energy Performance Standard. Where enacted, these standards require property owners to report building energy usage, and C-PACE programs might be able to leverage that reporting. See Leventis and Deason 2021 for more.

include completion verification reporting as a technical standard, program administrators hope that having explicit language in the updated statute will give them more leverage to enforce the standard moving forward.

The main motivation for removing the SIR and corresponding savings guarantee requirements in the updated statute was to encourage more innovation in energy improvement projects. Previously, some projects that met the SIR requirement did not improve the property’s efficiency much over code, so the program sought a metric that would advance energy efficiency in a meaningful way over state and federal minimum requirements. The new program guidelines will encourage projects to achieve at least a 10% efficiency improvement over state energy code, instead of using the SIR to qualify projects. The program administrators believe this new approach will better drive energy improvements, reinforcing the intent of the program.

## Key Findings

### M&V Benefits and Drawbacks

Findings from the program administrator interviews for this brief, along with findings from previous C-PACE studies and experience with M&V associated with the ESPC model, reveal several benefits and drawbacks of M&V for C-PACE.<sup>10</sup> Table 3 and Table 4, respectively, map the key benefits and drawbacks to the various stakeholders involved in C-PACE programs.

Benefit	Program Sponsor/ Administrator	Property Owner	Contractor/ Energy Service Company	Capital Provider	Mortgage Holder
Increase project performance; reduce risk and uncertainty	✓	✓	✓	✓	✓
Quantify energy and non-energy impacts	✓	✓	✓		
Identify new energy savings opportunities	✓	✓	✓		
Ensure cost-effectiveness of impacts	✓	✓	✓		✓
Generate data to track/evaluate/improve performance and financial outcomes over time	✓	✓	✓		
Enable better reporting by program administrators to community partners and by capital providers to investors	✓			✓	
Where used, document/validate savings guarantees, correct for savings shortfalls		✓	✓		
Validate public benefit of program; illustrate impacts on policy goals; provide a proof of concept to encourage program participation and attract investors	✓	✓	✓	✓	
Show operating expenses are lower, so there is more disposable income to pay assessments, property taxes, and mortgage payments	✓	✓		✓	✓
Identify which contractors are performing well (or not)	✓	✓	✓		
Demonstrate due diligence (and ideally consistent review standards) by qualified third-party reviewer	✓	✓			

Table 3. Benefits of M&V for C-PACE Stakeholders

<sup>10</sup> Other relevant U.S. Department of Energy resources include *Practices for Demonstrating Energy Savings from Commercial PACE Projects* (Leventis et al. 2021) and *The Business Case for Conducting Measurement and Verification in State and Local Government Energy Savings Performance Contract Projects* (Schiller and Stuart 2019).



Drawback or Potential Issue	Program Sponsor/ Administrator	Property Owner	Contractor/ Energy Service Company	Capital Provider	Mortgage Holder
Potential risk of reduced customer interest in program (e.g., because of cost or complexity)	✓	✓	✓	✓	
Extra cost, which may or may not be included in loan amount, especially for any ongoing M&V requirements		✓			
Possible erosion of cost-effectiveness, which could reduce the SIR below required levels in cases where the SIR includes M&V costs	✓	✓	✓	✓	✓
Added complexity: requires special skill set for property owners to understand M&V and for contractors to perform M&V		✓	✓		
Possible time delays	✓	✓	✓	✓	
Added administrative burden (e.g., post-project reporting), including enforcement challenges once loans are funded	✓	✓			
Data may be difficult to access: intrusive to property owner; need for potentially sensitive data	✓	✓	✓		
Performance guarantee risk (where used)			✓		

Table 4. Drawbacks Associated With M&V for C-PACE Stakeholders

While many of the benefits and drawbacks are difficult to value monetarily, it may be possible to quantify some of them to assess the cost-effectiveness of including M&V standards in C-PACE programs. However, based on inquiries with program administrators in Texas, Michigan, and Wisconsin, there is currently very limited quantitative data available to program administrators to value the incremental costs and, especially, the benefits of M&V standards.

The interviewees were able to provide one cost data point relevant to C-PACE M&V. Slipstream, the program administrator for PACE Wisconsin, tracks the property owner's cost for energy assessments. Energy assessments typically add between 0.3% to 3% to the project costs. The other M&V standards (e.g., project completion reports and annual reporting) would represent additional costs.

Other data points of interest are from experience with the traditional ESPC model. Analysis of 183 ESPC projects in the federal sector revealed that that total annual M&V expense was 2% of the total value of annual reported cost savings for the projects analyzed (Walker 2020). The annual M&V work performed for those 183 federal sector projects verified 9% greater annual savings than were in the original performance contracts (\$384.1 million per year verified compared with \$350.9 million per year in the original performance contracts).

## Design and Execution Principles

The C-PACE program administrator interviews reveal several strategies for designing and executing M&V standards that other C-PACE programs may consider replicating:

- **Think through M&V standards.** Before including M&V standards in program design, programs should consider what each M&V standard will require in terms of compliance for the property owner and enforcement for the program administrators. The costs and resource needs should be reasonably aligned with the scale and complexity of the projects. Overly costly and complex requirements may hurt participation. Other requirements may be hard to enforce (see next bullet).
- **Do not reinvent the wheel.** When considering how to incorporate M&V standards in program guidelines, programs should look to other states and jurisdictions for lessons learned on designing and executing M&V standards. C-PACE program administrators share a lot of information with each other. In addition, for specific technical requirements, programs should leverage industry standards such as ANSI/ASHRAE/ACCA Standard 211-2018 (ASHRAE 2018) for energy audits and the International Performance Measurement and Verification Protocol (Efficiency Valuation Organization 2022) for M&V protocols.
- **Have a process in place to enforce M&V standards.** Specifying a standard in the program documentation, even if it is stated as a program requirement, is not always enough to guarantee compliance. Programs must provide a mechanism to enforce the standard, or at least to effectively encourage property owners to comply. Enforcement is especially difficult once the loan has been fully funded. All program administrators interviewed said that enforcing annual performance reporting requirements has been a significant challenge due to the lack of a financial (or other) lever.
- **Simplify reporting process.** One strategy Lean & Green Michigan has used to ease the burden on property owners and improve reporting compliance is to have program interns help property owners submit data to ENERGY STAR Portfolio Manager. Automatic upload of data from utilities to Portfolio Manager, after initial approval from the property owners to release the data, can also help address the challenges with annual performance reporting.
- **Communicate value proposition of M&V.** Frame M&V standards to property owners as a means to mitigate risks or to estimate environmental impacts, instead of focusing on specific technical requirements from an engineering point of view. For many property owners it may be best to explain that M&V helps the project perform correctly and can be used to identify maintenance issues early, which mitigates risks and can save them money. For large real estate companies with significant assets and commitments with environmental, social, and governance outcomes, M&V is a way to demonstrate progress toward environmental, social, and governance goals. This framing transforms M&V from a technical obligation to a mechanism that ensures that projects deliver the intended outcomes and value streams.
- **Consider the value of an independent third-party reviewer.** The Texas program model requires the property owner to hire a qualified independent third-party engineer to review and certify the energy and/or water assessment report prior to project implementation. The same third-party reviewer ensures the project has been completed as planned after implementation. The program also requires that some of the funding be retained until the reviewer conducts the post-implementation site visit and issues a final statement of compliance. According to the Texas PACE Authority, involving the qualified reviewer throughout project development and implementation tends to improve the accuracy of the savings estimate. Retaining a portion of the funds until the project is complete gives the program administrator leverage to collect the project completion report and compliance statement.
- **Consider having property owners drive some of the M&V requirements.** Lean & Green Michigan leaves the specifics of the M&V requirements that are stated in the savings guarantee to the property owner and contractor's discretion. As a result, the post implementation M&V requirements in the owner-contractor agreements vary widely across projects; some have little to no requirements, while others have fairly rigid requirements to assess project performance over time. Giving the property owner flexibility to determine the level of M&V they desire helps to align the M&V requirements to their individual levels of risk tolerance.

“...a challenge generally with M&V is unless there is a mandate or incentive, owners (public and especially private) don't see its value and will not voluntarily invest time or resources to support ongoing M&V. Automation, and direct [application programming interface] linkages to [building management systems] and utility feeds is key to greater acceptance of M&V value proposition.”

*Dub Taylor, Texas PACE Authority*

- **Revise M&V standards when needed.** Be nimble and work with stakeholders to revise or remove technical standards that are not serving the program well and to add new requirements when needed to achieve program goals or address stakeholder concerns. A good example of this is the 2022 statute change in Wisconsin (see Evolving Technical Standards in Section 2 and the PACE Wisconsin case study in the appendix).
- **Balance standardization and flexibility.** Interviewees favor standardization of core elements across programs to the extent possible. In addition, if a state designs a tiered program with different M&V expectations for each tier (e.g., less than \$250,000 versus greater than or equal to \$250,000 in project cost), the practices should be consistent for all projects in each tier. In some cases, certain programs may have legacy practices they hold on to, which can make complete standardization a challenge.

The detailed case studies for the three programs profiled in this brief are in the appendix. Each case study describes the program's current and evolving M&V standards, the motivation for developing the standards, and program administrator experience designing and executing M&V standards.

## References

- American Society for Testing and Materials. 2022. *Standard Practice for Building Energy Performance Assessment for a Building Involved in a Real Estate Transaction*. American Society for Testing and Materials, E2797-15. <https://www.astm.org/e2797-15.html>.
- ASHRAE. 2018. *Standard for Commercial Building Energy Audits*. ANSI/ASHRAE/ACCA Standard 211-2018. <https://www.ashrae.org/technical-resources/standards-and-guidelines>.
- Efficiency Valuation Organization. 2022. *International Performance Measurement and Verification Protocol*. <https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp>.
- Keeping PACE in Texas. 2021. *PACE in a Box Technical Standards Manual*. Version 3.0. [https://www.keepingpaceintexas.org/wp-content/uploads/2021/12/KPT\\_Technical-Standards-Manual-v3\\_FINAL\\_2021\\_10.pdf](https://www.keepingpaceintexas.org/wp-content/uploads/2021/12/KPT_Technical-Standards-Manual-v3_FINAL_2021_10.pdf).
- Lean & Green Michigan. 2022. *PACE Program Manual*. Version 1.0. <http://leanandgreenmi.com/wp-content/uploads/2022/04/LAGM-Program-Manual-v1.-January-2022.pdf>.
- Leventis, Greg, and Jeff Deason. 2023. *Commercial PACE Project Origination: Leverage Points for Growing the Project Pipeline*. Prepared by Lawrence Berkeley National Laboratory for the U.S. Department of Energy. [https://www.energy.gov/sites/default/files/2023-08/SCEP\\_CPACE\\_Issue\\_Brief\\_3\\_Project\\_origination.pdf](https://www.energy.gov/sites/default/files/2023-08/SCEP_CPACE_Issue_Brief_3_Project_origination.pdf)
- Leventis, Greg, Lisa Schwartz, Chris Kramer, and Jeff Deason. 2018. *Lessons in Commercial PACE Leadership: The Path from Legislation to Launch*. Prepared by Lawrence Berkeley National Laboratory for the U.S. Department of Energy. [https://www.energy.gov/sites/prod/files/2018/05/f51/Lessons\\_in\\_Commercial\\_PACE\\_Leadership\\_Finalv2.pdf](https://www.energy.gov/sites/prod/files/2018/05/f51/Lessons_in_Commercial_PACE_Leadership_Finalv2.pdf).
- Leventis, Greg, and Jeff Deason. 2021. *Practices for Demonstrating Energy Savings from Commercial PACE Projects*. Prepared by Lawrence Berkeley National Laboratory for the U.S. Department of Energy. <https://www.energy.gov/sites/default/files/2021-09/CPACE-Demonstrating-Energy-Savings.pdf>.
- Michigan Legislature. 2010. *Property Assessed Clean Energy Act*. Act 270 of 2010. <http://www.legislature.mi.gov/>.
- Michigan Legislature. 2023. *An Act to Amend 2010 PA 270*. Enrolled Senate Bill No. 303. Public Act 107 of 2023. <https://www.legislature.mi.gov/documents/2023-2024/publicact/pdf/2023-PA-0107.pdf>.
- Schiller, Steve, and Elizabeth Stuart. 2019. *The Business Case for Conducting Measurement and Verification in State and Local Government Energy Savings Performance Contract Projects*. Prepared by Lawrence Berkeley National Laboratory for the U.S. Department of Energy. [https://www.energy.gov/sites/prod/files/2019/02/f59/business-case-mv-espcc\\_0.pdf](https://www.energy.gov/sites/prod/files/2019/02/f59/business-case-mv-espcc_0.pdf).
- Slipstream. 2022a. *PACE Wisconsin Program Manual*. Version 3.3. Madison, WI: Slipstream Group, Inc. [https://www.pacewi.org/uploads/9/1/4/6/91467782/wi\\_pace\\_program\\_guidelines\\_02\\_01\\_2022\\_v3.3.pdf](https://www.pacewi.org/uploads/9/1/4/6/91467782/wi_pace_program_guidelines_02_01_2022_v3.3.pdf).
- Slipstream. 2022b. *PACE Wisconsin Program Manual*. Version 4.1. Madison, WI: Slipstream Group, Inc.
- Texas Constitution and Statutes. 2013. *Property Assessed Clean Energy Act*. Chapter 399 of the Texas Local Government Code. <https://statutes.capitol.texas.gov/Docs/LG/htm/LG.399.htm>.
- Walker, Christine E. 2020. *Reported Energy and Cost Savings from the DOE ESPC Program: FY 2019*. Prepared by Oak Ridge National Laboratory, managed by UT-Battelle, for the U.S. Department of Energy. <https://info.ornl.gov/sites/publications/Files/Pub150841.pdf>.
- Wisconsin State Legislature. 2009. *2009 Wisconsin Act 11*. <https://docs.legis.wisconsin.gov/2009/related/acts/11>.
- Wisconsin State Legislature. 2022. *2021 Wisconsin Act 175*. <https://docs.legis.wisconsin.gov/2021/related/acts/175>.

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## Appendix: Program Case Studies

### Topics

Our program case studies focus on three main topics that can inform consideration, design, and implementation of M&V standards in other C-PACE programs. Table A1 summarizes these topics.

Topic	Description
Technical standards related to M&V	Gain a better understanding of state-specific technical standards, with a focus on any M&V-related standards, including when and to what level of rigor the programs require M&V.
Motivation for technical standards	Describe why the programs initiated technical standards related to M&V and what changes the program administrators anticipate for the future.
Program administrator experience with M&V	Describe what has worked well in terms of successful M&V design and execution strategies—and what pitfalls to avoid.

Table A1. Summary of Case Study Topics

The program case studies in this brief describe input received from program administrators on these topics.

### TX-PACE

<b>Program Name</b>	TX-PACE
<b>Contact for Case Study</b>	Dub Taylor, chief operating officer for Texas PACE Authority
<b>Program Website</b>	<a href="https://www.texaspaceauthority.org/">https://www.texaspaceauthority.org/</a>
<b>Date Established</b>	The PACE Act initially passed in Texas in 2013 (Texas PACE Act 2013). The program launched 2015.
<b>Number of Projects</b>	71 projects had closed as of the end of 2022 <sup>11</sup>

### Technical Standards Related to M&V

The Texas PACE Authority utilizes detailed program guidelines, technical standards, and workbooks developed by Keeping PACE in Texas as part of the PACE in a Box program model.<sup>12</sup> Commercial, multi-family (five or more units), and industrial properties are eligible for the program. Properties classified as residential (four or less units) or government-owned are not eligible. The Texas PACE in a Box program model does not require ESPCs, nor the type of ongoing M&V required for traditional ESPC projects, but it does specify several technical standards related to M&V.

There are two sets of technical requirements, depending on the type of the project: fast track or full energy and/or water assessment. The Technical Standards Manual (Keeping PACE in Texas 2021) explains the requirements and refers to other protocols (American Society for Testing and Materials 2022; ASHRAE 2018; Efficiency Valuation Organization 2022; and more).

<sup>11</sup> For a current accounting of PACE projects in Texas, see <https://www.texaspaceauthority.org/project-list/>.

<sup>12</sup> Keeping PACE in Texas, Document Library, see <https://www.keepingpaceintexas.org/library/document-library/>.

- **Fast track**<sup>13</sup> has less stringent audit and energy and/or water assessment report requirements and allows for faster implementation for three types of eligible projects:
  - a. Like-for-like replacement of equipment
  - b. Single-measure efficiency projects
  - c. Distributed renewable generation projects

Other types of projects must follow the full assessment protocol.

- **Full energy and/or water assessment**<sup>14</sup> has stricter data collection and analysis requirements for projects that are not eligible for fast track. For example, full assessments require an energy or water audit equivalent to an ASHRAE Level 2 or 3 audit, depending on the facility and expected projects. They also require more comprehensive energy and/or water assessment reports that describe and quantify the costs and benefits of the project in detail and include an M&V plan.

**All proposed qualified projects require the following:**

- Independent third-party review, including site visits and review of documentation.
- Establishing a baseline of energy use at the property to use as the reference case from which to estimate project impacts.
- Preparing an energy and/or water assessment report with projected savings for proposed projects.
- Meeting a SIR greater than 1.
- Conducting verification that the qualified project was properly completed and is operating as intended.
- Delivering annual savings reports (including sharing information through the ENERGY STAR Portfolio Manager) throughout the term of the assessment or through a different term negotiated between the PACE Program Administrator and the property owner.

The independent third-party review requirement is one aspect that is unique to the enabling Texas PACE Act. The independent third-party reviewer must meet the program’s professional qualifications.

The review process involves two site visits—one before project implementation and one after. During the first site visit, the reviewer examines the energy and/or water assessment report to verify compliance with program guidelines. When deemed compliant, the reviewer prepares a reviewer’s certification. This must happen before the program considers the PACE financing application complete. During the second site visit, the reviewer confirms the improvements were properly installed per program guidelines and are operating as intended. When deemed compliant, the reviewer prepares a statement of compliance. After that, the program releases the remaining (retainage) funding.

## Motivation for Technical Standards

The Texas program’s primary motivation for instituting technical standards was to provide a level of protection for the property owner, as well as for the lender. Language in the PACE legislation formed the basis for the technical requirements. The technical standards are a means for forecasting project performance so that a property owner can square performance expectations with the project’s cost, for example, as measured by the SIR.

According to Dub Taylor, some property owners are interested in M&V-type actions to validate performance, while others are not. He has observed that budgetary concerns are the primary motivating factor for most participating property owners, and many property owners view M&V as adding cost and complexity.

## Experience With M&V

### Number and Types of Projects

Over 90% of the 71 projects that closed as of the end of 2022 required the full assessment protocol. Three of the fast track projects were solar photovoltaic installations. Solar photovoltaic projects are eligible for fast track because photovoltaic power generation can be directly metered, so there is no need to establish pre-project baseline usage.

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<sup>13</sup> See Section V of the Technical Standards Manual for the fast track requirements (Keeping PACE in Texas, 2021).

<sup>14</sup> See Section IV of the Technical Standards Manual for the full assessment protocol (Keeping PACE in Texas, 2021).

C-PACE projects in Texas have ranged in cost from as low as \$68,000 to as high as \$40 million. Most lenders prefer projects that are \$1 million or higher; below that amount, the costs associated with managing and closing projects tend to outweigh the lender benefits. Generally, higher-cost projects end up requiring the full assessment protocol.

Both energy and water projects are eligible for the program. Every project so far has been predominantly driven by energy savings; there have not been any water-only projects. However, participants often add water-saving measures on to energy projects. At least a quarter of projects with energy savings also include some water savings.

## Design and Execution of M&V Standards: Strategies and Lessons Learned

Texas’s PACE-enabling law was deliberately general. The program sponsors needed to develop support documents that define how to meet the requirements in a consistent manner around the state. Developing the documents was a collective effort. The President of the Texas PACE Authority, Charlene Heydinger, refers to it as a “modern day barn raising.” It was an open, structured process that convened stakeholders with expertise and asked them for input on the standards.

The stakeholders developing the technical standards for the PACE in a Box program model sought to leverage standard practices from other clean energy programs. Examples of standard practices incorporated in PACE in a Box include (a) the requirement that a qualified and licensed engineer review the project, and (b) the adoption of existing industry standards for energy audits (ASHRAE 2018; American Society for Testing and Materials 2022) and M&V (Efficiency Valuation Organization 2022).

Executing the technical requirements related to M&V is a very manual process. The Texas PACE Authority is looking to streamline the process where feasible without compromising quality. For example, they are considering employing deemed savings models for common measures in standard building types, similar to how utility energy efficiency programs assess prescriptive measures. For those measures, the deemed savings models would replace or reduce the requirements for a full energy and/or water assessment and detailed engineering review.

In particular, streamlining the process may open up opportunities to pair C-PACE financing with small (e.g., \$20,000) retrofits. Currently, complying with the technical standards is too expensive for property owners with small projects to consider.

Taylor cautions against “reinventing the wheel” when designing M&V standards. Instead, the program administrator recommends leveraging information that is available from other C-PACE programs and related industry standard practices.

In addition, Taylor notes that people responsible for energy efficiency implementation tend to focus on technical details more than the value proposition for owners. Communicating technical standards as risk mitigation to speak to property owner’s value proposition will be more successful than approaching the conversation purely from a technical perspective. Potential participants may receive information better when it is communicated as a means to help the project perform correctly, to identify maintenance issues early, to be the basis for quantifying environmental impacts, etc.

As noted previously, Taylor has found that cost and complexity of M&V standards are concerns for property owners. When making their purchasing decisions, property owners do not necessarily see the longer-term benefits of monitoring performance to ensure savings persist. Many are willing to take the risk associated with possible performance shortfalls.

Taylor believes large real estate companies with significant assets may be more aware of the benefits of ongoing M&V. Many of these companies have made environmental, social, and governance commitments. M&V can demonstrate the progress they are making toward environmental, social, and governance goals.

**“At the end of day, M&V for PACE is a soft insurance policy with value to risk-averse owners, but we have not met any of those owners in Texas—yet!”**

*Dub Taylor, Texas PACE Authority*

## Compliance and Enforcement

In Texas, property owners have always complied with the technical standards associated with the energy and/or water assessment report, technical review by the independent third-party reviewer, and SIR. This is because these requirements are front-end qualifiers—if the energy and/or water assessment report is not completed, it is not reviewed, and the program does not approve the project for funding.

After project implementation, the program also requires a statement of compliance from the independent third-party reviewer before releasing retainage funding. Withholding a portion of the project funding provides an inherent control for ensuring compliance with the post-implementation verification requirement.



However, many program participants have not fully complied with the annual reporting requirement. There is no penalty for noncompliance, making ongoing reporting challenging to enforce. The Texas PACE Authority tried to simplify its reporting requirement by using ENERGY STAR Portfolio Manager, but property owners seem to consider even that too burdensome. There is a need for better tools to monitor energy use impacts throughout the life of the project. For example, automated collection of utility bill data is more seamless for property owners. However, automated processes can be complex to set up since every utility has its own billing system. Where available, property owners can give the program administrators permission to access their utility data through “Green Button” policies;<sup>15</sup> however, not all utilities in Texas participate in the Green Button initiative.<sup>16</sup>

The independent third-party review process in Texas results in changes to the estimated savings between the initial and the approved energy and/or water assessment reports for each project. The property owner or a contractor can prepare the initial energy and/or water assessment report (it is not a requirement that a licensed professional engineer do the initial analysis and create the report). Oftentimes the savings projections are overly optimistic. In some cases, the property owner or contractor may miss or underestimate savings (e.g., they may not factor in demand savings or water savings). In addition, property owners and contractors may not estimate interactive effects between end uses. They also may not have a detailed understanding of utility tariff nuances, so they may incorrectly calculate the dollar value of the energy savings. An important part of the third-party reviewer’s job is to look closely at the initial estimates and provide adjustments before certifying the project.

Generally, the savings do not change after the second (post-implementation) review step. The independent third-party reviewer is informed and engaged from the beginning of the project and partners with the property owner to prevent surprises at the end. The independent third-party reviewer can also offer support on changes to design specifications during project development to help the project close.

### Value of Standardization of Practices

Taylor would like to see more standardization of M&V-related practices across programs, but notes that different states and programs have legacy practices they hold on to, which make standardization a challenge.

“The average contractor may not know the intricacies of tariffs. Recently, an initial assessment report used the wrong tariff schedule and the calculation showed the project didn’t meet the SIR requirement. But, once the tariff values were corrected, the project met the SIR and qualified.”

*Dub Taylor, Texas PACE Authority*

<sup>15</sup> The Green Button initiative provides property owners with easy access to utility data. See <https://www.greenbuttonalliance.org/>.

<sup>16</sup> Taylor’s sense is that obtaining the owner’s permission to access data is not a barrier. The barrier is more related to aligning data access across different utility systems.

## Lean & Green Michigan

<b>Program Name</b>	Lean & Green Michigan
<b>Contact for Case Study</b>	Todd Williams, president and general counsel for Lean & Green Michigan
<b>Program Website</b>	<a href="https://leanandgreenmi.com/">https://leanandgreenmi.com/</a>
<b>Date Established</b>	PACE legislation was signed in 2010 (Michigan Legislature 2010). The program launched in 2012, and the first project closed in 2015.
<b>Number of Projects</b>	65 projects had closed as of the end of 2022.

### Technical Standards Related to M&V

Commercial, industrial, multi-family, agricultural, and nonprofit properties are eligible for the program, as are retrofit and new construction projects.<sup>17</sup> There are two sets of technical standards, depending on the cost of the project:

- **Projects greater than \$250,000:**

Technical standards are stricter for projects with costs greater than \$250,000 in financing. As of the end of 2022, the key requirements related to M&V were as follows:

- a. Having a C-PACE contractor conduct an ASHRAE Level 2 energy audit or equivalent.
- b. Meeting a SIR greater than 1 on an annual basis for the full term of the PACE financing.
- c. Obtaining a savings guarantee from the contractor to the property owner that cost savings will be greater than payments.
- d. Entering utility data into ENERGY STAR Portfolio Manager for annual performance monitoring through the term of the financing agreement.

July 2023 legislation made the SIR and savings guarantee requirements waivable for retrofit projects and removed the requirements for new construction projects (Michigan Legislature 2023). When there are savings guarantees, the Lean & Green program administrators leave the details of the M&V requirements in the savings guarantees up to the property owner and contractor. The specific requirements that a property owner and contractor build into the project savings guarantee differ greatly from project to project. Some require annual true-ups and ongoing operations and maintenance requirements, while others have more relaxed requirements.

- **Projects less than or equal to \$250,000:**

Technical standards are less stringent for projects under \$250,000. These projects qualify for the “PACE Express” track. The key PACE Express requirements related to M&V are as follows:

- a. Conducting an ASHRAE Level 1 energy audit or equivalent.
- b. Entering utility data into ENERGY STAR Portfolio Manager for annual performance monitoring through the term of the financing agreement.

There is no SIR requirement, nor is there a savings guarantee requirement, for projects with less than \$250,000 in financing.

The Lean & Green program originally established the threshold differentiating the two project tracks based on the statutory requirements for the SIR and savings guarantee, which took effect for projects financed with over \$250,000 in assessments (Michigan Legislature 2010).

For new construction projects, the program has additional guidelines since there is no preexisting consumption data upon which to establish baseline energy use. Projects following the new construction path must demonstrate that the project exceeds the applicable International Energy Conservation Code or ASHRAE 90.1 standard under Michigan code using a model similar to an ASHRAE Level 2 audit. Specifically, each PACE-financed improvement must meet at least one of the requirements below (Lean & Green Michigan 2022):

- The improvement exceeds Michigan code at the system level.
- The improvement results in a building that is more energy- and/or water-efficient than required by Michigan code.
- The improvement produces renewable energy.

The program financed its first new construction project in 2019.

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<sup>17</sup> Lean & Green Michigan’s program website provides C-PACE program information for the state: <https://leanandgreenmi.com/>.

## Motivation for Technical Standards

Prior to July 2023 legislation, the C-PACE statute in Michigan had rigid SIR and performance guarantee requirements (for non-PACE Express projects). The requirements were more stringent than in most other states. The M&V standards were meant to protect property owners but, according to Lean & Green President Todd Williams, some property owners felt the requirements were too stringent.

Williams estimates that about half of property owners who have participated in the program range from marginally interested to very interested in M&V, while the other half range from somewhat disinterested to not interested at all. Property owners who pursue retrofit projects seem to be very interested in the SIR and performance guarantee, while developers and others funding new construction projects are less concerned with these protections. Those not interested in M&V are generally concerned about additional costs and requirements. Developers may want to sell and transfer ownership of the property and therefore may be less interested in the SIR. Some property owners have moved away from C-PACE and on to other mechanisms because of the technical requirements. Program administrators have tried to be supportive of the level of M&V property owners are interested in and to help property owners and contractors come together to find what collectively works for them in terms of M&V.

As noted previously, legislation signed by Gov. Whitmer in July 2023 amends the C-PACE statute to make the SIR and savings guarantee requirements waivable by the property owner for retrofit projects and eliminates the requirements for new construction projects (Michigan Legislature 2023). This change in legislation may necessitate adoption of new M&V program requirements, as it may undercut any property owner motivation found in the current statutory requirements. Input from property owners and program administrators helped motivate and shape the amendments.

The program administrators have also been looking into the effectiveness of ENERGY STAR Portfolio Manager for annual reporting. They are considering ways to achieve successful participation and obtain better data while remaining cognizant of the cost of additional M&V for property owners (see discussion below for some example approaches). Another factor related to current reporting requirements is the lack of pre-project baseline data for new construction projects against which to measure post-project savings. This presents a challenge for monitoring new construction performance using utility bills alone and, therefore, may warrant modifications to reporting requirements for new construction projects.

## Experience With M&V

### Number and Types of Projects

The Lean & Green Michigan program had closed 65 projects as of the end of 2022. About 80% of those were over the \$250,000 threshold. Of the 20% of projects under the \$250,000 threshold, three closed prior to the establishment of the PACE Express model.

One of the three early projects under the \$250,000 threshold was part of the motivation for removing some of the requirements for smaller projects and for implementing the PACE Express model. Attorneys for the building owner and lender reviewed the agreement for that early project 13 times for modifications. The program administrators wanted to make the process easier and reduce costs for smaller projects. For example, to reduce attorney costs and time delays, PACE Express projects use a standardized agreement document that cannot be altered for these types of smaller projects.

### Design and Execution of M&V Standards: Strategies and Lessons Learned

Lean & Green Michigan takes the approach of letting the property owner drive the project development with the contractor. The strategy works well for the program in several areas, including the manner in which M&V standards enter the savings guarantees for projects with costs greater than \$250,000 in financing. Program staff facilitate the C-PACE process and support the property owner at the level the property owner requests, but the property owner and contractor work out the details of the savings guarantee and M&V requirements themselves. When property owners are more interested in M&V to demonstrate savings and want support from the program, the program administrators work to make sure the owner-contractor agreement appropriately addresses the property owner's interests. However, for property owners who care less about M&V, the program administrators take a more neutral approach to the M&V requirements in the owner-contractor agreement. The program administrators do not enforce the M&V requirements that are written into the savings guarantee agreements, but they do provide support to property owners if issues arise.

Williams recommends making sure there is a mechanism in place to support data collection for annual reporting requirements or a way for program administrators to collect the property's utility data themselves. Automatic upload of data from utilities to ENERGY STAR Portfolio Manager after initial approval from the property owners to release the data is a possible approach. One strategy Lean & Green Michigan has used to ease the burden on property owners and improve reporting compliance is to have program interns help property owners submit data to Portfolio Manager.

Under the statute in Michigan, utilities can include measures and energy saved from C-PACE within utility demand-side management savings targets. However, it is unclear how much attention utilities pay to C-PACE projects. Having utilities more involved in, or aware of, the C-PACE projects might enable energy usage data collection.

Williams cautions that if M&V standards are too complex, program participation will suffer. For Lean & Green Michigan, the savings performance agreement between the property owner and the contractor largely drives the complexity of the post-implementation M&V requirements. Property owners have found the M&V requirement language in the owner-contractor agreement so burdensome for some projects that they have elected not to follow through with the contract.

## Compliance and Enforcement

Property owners push back most on projects with complex and costly M&V requirements. The complexity is typically a function of the contractor's requirements for the savings guarantee as opposed to the program's general requirements.

In addition, the program is not getting a lot of data out of its annual reporting requirement. As noted earlier, program administrators would like to see more M&V and performance reporting but are also aware of the costs for property owners.

As of the end of 2022, more than half of Lean & Green Michigan's C-PACE projects had closed in the previous two years and many of those had not yet been completed.<sup>18</sup> Program administrators can only assess compliance with the annual reporting requirement for completed projects. Of the projects that have been completed to date, a little fewer than half comply with the annual reporting requirement. However, when the program requires the other technical standards related to M&V (i.e., the energy audit, SIR, and savings guarantee for projects greater than \$250,000) for project qualification, compliance is implicit.

When property owners do not comply with the reporting requirements, they receive compliance requests in the form of a letter followed by a phone call, strongly encouraging them to upload data. However, without another "stick or carrot" mechanism to use, program administrators cannot easily enforce compliance once the lender has disbursed the loan, particularly for property owners uninterested in M&V of project performance.

Program administrators leave the enforcement of the savings guarantee to the property owner and contractor. Some owner contractor agreements allow the contractors to improve performance in lieu of bearing cost impacts (i.e., instead of paying for a savings shortfall). As far as Williams could recall through 2022, there had not yet been an instance in which the contractor had paid the property owner for a savings shortfall through a savings guarantee in a Lean & Green Michigan C-PACE project. Any settlements from enforcement of the savings guarantee would be handled between the contractor and the property owner, without affecting the ongoing C-PACE assessment payment.

## Value of Standardization of Practices

Williams would like to see M&V practices as standardized as possible. Lean & Green Michigan is the program administrator for each jurisdiction that has adopted programs in Michigan. There are different programs in different jurisdictions with slightly differing requirements and practices. Statewide standardization could make the process easier for all parties involved.

*"The language in one savings guarantee contract would have changed the job description for the facilities personnel, or even required that a new facilities person be hired. That scared the property owner off."*

*Todd Williams,  
Lean & Green Michigan*

*"In one example, a contractor inherited a project with some issues from another contractor. A portion of the chiller had not been performing as intended. The project was still in the commissioning stage, so the property owner had withheld the last payment to the contractor until the contractor could improve performance."*

*Todd Williams,  
Lean & Green Michigan*

<sup>18</sup> Lean & Green Michigan's program website provides C-PACE program information for the state: <https://leanandgreenmi.com/>.

## PACE Wisconsin

<b>Program Name</b>	PACE Wisconsin
<b>Contact for Case Study</b>	Holly Edinger, program manager for Slipstream David Vigliotta, director of partnership development for Slipstream Tim Mathison, general counsel and managing director for Slipstream
<b>Program Website</b>	<a href="https://www.pacewi.org">https://www.pacewi.org</a> <a href="https://aminc.org/tags/pace-program">https://aminc.org/tags/pace-program</a>
<b>Date Established</b>	Wisconsin enacted the PACE statute in 2009 (Wisconsin State Legislature 2009). <sup>19</sup> The PACE Wisconsin program started in 2016.
<b>Number of Projects</b>	82 projects had closed as of the end of 2022

### Technical Standards Related to M&V

Nonresidential, multi-family residential (five or more units), and brownfield rehabilitation properties are eligible for the program, as are retrofit and new construction projects. Slipstream, the contracted program administrator, maintains a document that details program guidelines, including technical standards.<sup>20</sup> The guidelines document in effect as of the case study interview in June 2022 was Version 3.3 (Slipstream 2022a). The technical standards in Version 3.3 vary based on the cost of the project as follows:

- **Projects greater than or equal to \$250,000:**

Technical standards were stricter for projects with costs greater than \$250,000 in financing. The key requirements included the following:

- Having an energy assessment conducted by a qualified energy engineer.
- Meeting a SIR greater than 1.
- Obtaining a savings guarantee for at least 3 years from the contractor to the property owner that cost savings will be greater than payments.
- Providing a completion verification report that certifies and provides evidence that the completed project was implemented as intended and achieves the cost savings forecast in the energy assessment.
- Entering utility data into ENERGY STAR Portfolio Manager for annual energy performance reporting.

- **Projects less than \$250,000:**

Fewer technical standards applied to projects with costs less than \$250,000 in financing. The key requirements related to M&V were as follows:

- Having an energy assessment conducted by a qualified energy engineer.
- Providing a completion verification report that certifies and provides evidence that the completed project was implemented as intended and achieves the cost savings forecast in the energy assessment.
- Entering utility data into ENERGY STAR Portfolio Manager for annual energy performance reporting.

There has been no SIR requirement, nor has there been a savings guarantee requirement, for projects with less than \$250,000 in financing.

Changes to the PACE statute removed the language about the \$250,000 threshold and eliminated the SIR and savings guarantee requirements for all new projects (Wisconsin State Legislature 2022). The changes took effect July 1, 2022. Version 4.1 of the technical guidelines reflects outcomes of the new law (Slipstream 2022b).

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<sup>19</sup> The 2009 Wisconsin Act 11 created the enabling PACE statute in § 66.0627(8).

<sup>20</sup> PACE Wisconsin and the statewide program administrator, Slipstream, provide C-PACE program information on their websites. See: the PACE Wisconsin program website at <https://www.pacewi.org/> and the Slipstream PACE program website at <https://slipstreaminc.org/tags/pace-program>.

In addition to describing the required technical standards listed above, the program guidelines strongly recommend that property owners have full commissioning performed after project completion. Commissioning helps confirm that equipment associated with the project is performing optimally and as expected, which is an important element of M&V. The guidelines also note that PACE Wisconsin may choose to do on-site project review to confirm all measures described in the energy assessment have been installed.

## Motivation for Technical Standards

The original C-PACE statute called for savings guarantee and SIR requirements but did not stipulate project completion verification or ongoing reporting. Nevertheless, post-implementation M&V requirements have always been a part of the PACE Wisconsin program.

In Wisconsin, counties and municipalities formed the Wisconsin PACE Commission using their joint exercise of powers authority.<sup>21</sup> Commissioners representing communities across Wisconsin have inquired about M&V and are in favor of it. They are most concerned with ensuring that project installation is consistent with the design included in the PACE application.

Interest from commissioners in post-implementation M&V and conversations with other stakeholders were part of the motivation for modifications to the PACE statute, which were signed into law in March 2022 (Wisconsin State Legislature 2022). Project completion verification (but not necessarily ongoing reporting) is now a stated requirement under the new C-PACE statute. The program administrators believe the new language in the statute will help them enforce the project completion verification requirement. Other changes to the statute include removing the SIR and savings guarantee requirements for all projects, easing the requirements for energy assessments, and allowing new types of projects, such as electric vehicle charging stations and other types of distributed energy resources. The new requirements took effect for C-PACE projects on July 1, 2022.

The main motivation for removing the SIR requirement in the updated statute was to encourage more innovation in energy improvement projects. Previously, the program saw some measures that readily achieved the SIR requirement but did not improve the building's efficiency much over code. In addition, program requirements had defined the way property owners can demonstrate savings broadly—to include energy and other types of financial savings. For example, some analyses included non-energy operational cost savings related to the upgraded equipment. Non-energy operational savings such as reduced labor costs are often hard to verify and may be subjective based on property owner and management input. This left room for adjusting the monetary savings until the SIR was achieved. As a result, the SIR metric was misused in some cases and sometimes reflected savings other than energy cost savings. In the future, the program will encourage projects to achieve at least a 10% efficiency improvement over state energy code, instead of using the SIR to qualify projects.

The program administrators believe this new approach will tie the requirement more to energy improvements, which is the intent of the program. The program administrators believe most property owners will find removal of the savings guarantee requirement desirable. Eliminating that requirement reduces complexity for property owners that are willing to take the risk of possible savings shortfalls.

As of June 2022, 46 out of 72 counties in Wisconsin have C-PACE programs. Participating counties represent 90% of state population.

Though the viewpoint of some lenders is that developing projects that exceed energy codes is difficult, the Wisconsin program administrators have heard from engineers conducting the energy assessments that they do not find it challenging to exceed code when developing projects. However, one difficulty they currently face is supply chain issues that limit the availability for some types of high-performance equipment that exceed code.

<sup>21</sup> See <https://www.pacewi.org/about-us.html> for more information on the Wisconsin PACE Commission.

## Experience With M&V

### Number and Types of Projects

Of the 82 C-PACE projects that had closed by the end of 2022, 69 were in the greater than or equal to \$250,000 category and 13 were in the less than \$250,000 category. The trend has been toward larger projects; even some of the small projects were close to the \$250,000 threshold. The program administrators have been trying to encourage more small projects. They made several changes to program requirements in February 2022 to make it easier for property owners with small projects to participate.

### Design and Execution of M&V Standards: Strategies and Lessons Learned

For programs interested in establishing M&V standards, the PACE Wisconsin program administrators recommend looking to programs in other states and jurisdictions for examples. They note that there is a lot of information sharing by C-PACE program administrators across the United States. This information sharing has resulted in some common elements that are found in many programs with standards related to M&V. A few examples include the cost thresholds for determining M&V requirements for small versus large projects (i.e., \$250,000), technical standards for conducting energy assessments and audits, and pools of qualified professionals to support the analysis.

The program administrators recommend having a protocol for post-project follow-up. Without a stated requirement and without a process to follow up with the property owners, property owners will not voluntarily submit project completion reports or subsequent annual reports through ENERGY STAR Portfolio Manager.

The program administrators recommend planning for all the needed resources to enforce a requirement before putting it in the program guidelines. Specifically, they recommend that any strict requirement or mandate be met before releasing all funding. Without another fallback or incentive, property owners have little motivation to comply.

### Compliance and Enforcement

As described above, PACE Wisconsin program administrators have had difficulty enforcing compliance with the project completion reports and annual Portfolio Manager reporting requirements. During the 2022 interview with Berkeley Lab, program administrators reported that most property owners had not been complying with the post-implementation reporting requirements. Since all the loan money has already been released by the time the project is completed, the program administrators found they had little leverage and lacked the resources to follow up. The program administrators were concerned that adding a condition where a portion of the funding is withheld until after completion would limit the volume of loans that close. Instead, program administrators updated the program guidelines in July 2022 to include alternative options to encourage compliance.

The July 2022 update to the PACE Wisconsin Program Manual (Slipstream 2022b) states that post project completion verification reports are an eligible cost and can be prepaid with the proceeds of the C-PACE loan. Additionally, the guidelines set a clear timeline for completion verification reporting, provide a template for the report, and outline the possible penalties related to noncompliance with the requirement. The PACE special charge and finance agreement that is executed for each C-PACE loan states that the program administrator can perform the completion verification report and charge the property owner for the cost of that report. PACE project approval letters and annual/semiannual invoicing on existing assessments provide information about post-project completion reporting requirements.

For egregious compliance issues, the program administrators could report the property owner to the county to initiate a foreclosure, but that had not happened as of the time of the interview with Berkeley Lab; there had not been any foreclosures (or nonpayment issues of any type) for PACE projects in Wisconsin.

### Value of Standardization of Practices

The PACE Wisconsin program administrators note that about ten capital providers drive much of the C-PACE market across the country.<sup>22</sup> Standardizing aspects of C-PACE would enable these capital providers to manage projects more easily. Since each state currently has its own version of M&V related technical requirements, standardizing practices for newly added measures could increase compliance.

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<sup>22</sup> This aligns with findings from Leventis and Deason (forthcoming), which show that specialty capital providers furnish most of the capital for C-PACE projects in most programs.

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