Review

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Green Finance in Property Assessed Clean Energy Programs

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Abstract: Property Assessed Clean Energy (PACE) programs finance energy efficiency and renewable energy improvements in residential and commercial properties with a special tax assessment added to property taxes. The paper surveys the literature and documents the quantitative estimates of environmental and economic benefits. The paper extends to discuss the securitization of PACE loans. The issuance of PACE green bonds frees up capacity for more PACE improvements. In addition, we summarize the concerns raised after the programs have been implemented. Those concerns include consumer protection, audit after program implementation, and lien-related risks for lenders. We highlight the challenges and discuss measures to continue to grow PACE financing. The success of PACE programs will contribute to mitigating climate change and to achieving the United Nations Sustainable Development Goals (SDGs).

Keywords: property assessed clean energy; sustainable development goals; green finance; energy efficient mortgages; environmental benefits; energy efficiency; securitization; green bonds

1. Introduction

Property Assessed Clean Energy (PACE) programs provide financing for energy efficiency and renewable energy improvements. Property owners make repayments via an assessment on the property tax bill. The financing arrangement remains with the property and can be transferred to the new owner upon sale. PACE loans are an alternative to traditional financing such as a personal bank loan or an energy efficient mortgage (a mortgage to finance or refinance an energy efficient home or to pay for energy efficient improvements). PACE programs are public-private partnerships. Public partners are the state that enacts legislation enabling the program and the municipality that places and collects special assessments. Private partners are the fund providers that provide money to pay for the improvements and receive repayments from the assessed taxes. The PACE loans are often securitized and sold to the capital markets. The securitization frees up lending capacity for new loans.

PACE financing is available for commercial properties, referred to as Commercial PACE (CPACE), as well as residential properties, referred to as Residential PACE (RPACE) (For commercial PACE, both abbreviations C-PACE and CPACE have been used in the literature. For residential PACE, both R-PACE and RPACE have been used in the literature). A unique feature of PACE financing is that it is tied to the property rather than the owner and is repaid through a special assessment added to the property tax bill. The municipality collects the assessed tax payments and passes on to the lender. Such structure is different from an energy efficient mortgage (EEM). Under an EEM, the loan depends on the borrower's credit and ability to repay. Furthermore, the PACE loan may transfer with property ownership. Thus, the property owner may transfer the remaining balance to the buyer upon sale. This differs from a mortgage in which the loan must be paid off when the title is transferred to the new owner.

The direct benefits of PACE programs are reductions in energy and water use, greenhouse gas emissions, and hazard vulnerability (Rose and Wei (2019 and 2020); Oliphant et al (2020); and Deason et al (2021)). The PACE financed improvements contribute to mitigating climate change that directly supports the 2050 net-zero target (The. net zero target is to reduce greenhouse gas emissions

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to as close to zero as possible, with any remaining emissions re-absorbed from the atmosphere. This was called for by the Paris Agreement to cut emissions 45 percent by 2030 and to reach net zero by 2050.) and the Sustainable Development Goals (SDGs) (United Nations established seventeen Sustainable Development Goals in 2015 to provide a shared blueprint for peace and prosperity for people and the planet). The financing also generates economic benefits (Pozdena and Josephson (2011); Rose and Wei (2019 and 2020); and Oliphant et al (2020)). PACE programs help stimulate job growth in clean energy sector. The installation of energy-efficient and renewable energy systems creates employment opportunities in the local community. Those upgrades reduce energy consumption and save on utility bills, leading to increased disposable income for property owners. Energy-efficient upgrades improve quality of dwelling (healthier homes) and, together with savings on energy bills, can enhance the value of the property as well (Goodman and Zhu (2016)).

In the United States, PACE programs are active in 31 states and Washington, D.C. Most of the programs are for commercial customers. Residential programs are currently offered in California, Florida, and Missouri. PACE programs in remaining states are still under development. Data from PACENation (www.pacenation.org) show that cumulative investments in CPACE are $7.2 billion (2009 – 2023) and in RPACE are $8.4 billion (2015 – 2022). The investments in CPACE included 3,340 projects and in RPACE upgraded 344,000 homes.

PACE programs are public-private partnerships. The collaboration offers an alternative source for property owners to access financing for energy improvements. The market is still in early stages of development. The literature on the empirical studies of PACE is limited. The paper surveys the literature, documents empirical evidence of PACE benefits, addresses concerns especially for low-income participants, and discusses measures to support the continued growth of PACE programs. Energy-efficient and healthy homes contribute to meeting six of the seventeen SDGs established by the United Nations (https://sdgs.un.org/goals). Table 1 lists the seventeen SDGs and the six goals that PACE financing is aligned with. The six PACE-aligned goals are directly related to energy and the environment. The seventeen SDGs are the United Nations 2030 Agenda for sustainable development.

Table 1. Sustainable Development Goals and Property Assessed Clean Energy Financing.

Sustainable Development Goals	**Aligning PACE with SDGs**
1 No Poverty	
2 Zero Hunger	
3 Good Health and Well-Being	V
4 Quality Education	
5 Gender Equality	
6 Clean Water and Sanitation	
7 Affordable and Clean Energy	V
8 Decent Work and Economic Growth	
9 Industry, Innovation and Infrastructure	
10 Reduced Inequalities	V
11 Sustainable Cities and Communities	V
12 Responsible Consumption and Production	V
13 Climate Action	
14 Life Below Water	
15 Life on Land	V
16 Peace, Justice and Strong Institutions	
17 Partnerships for the Goals	

Note: "V" in second column indicates PACE aligned with the SDG. Source: https://sdgs.un.org/goals.

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1.1. Literature Review

We group the literature into three categories and provide a brief review of each below. First, two articles address some of the key considerations in promoting PACE. Additional reports show PACE financing increases solar installations and discuss concerns for low-income participants. Second, several studies use data from California and Florida to provide empirical estimates of the environmental and economic benefits. Finally, two publications focus on the resale value and price appreciation of the home related to PACE financing.

National Association of State Energy Officials (NASEO, 2016) discusses the growth and the challenges of CPACE. The report cites the Clinton Climate Initiative (The Clinton Climate Initiative of the Clinton Foundation focuses on solutions related to climate change. It aims at a holistic approach to address the main sources of greenhouse gas emissions.) estimates that the market potential for CPACE to be between $88 and $133 billion in large commercial buildings. The initial success of CPACE has been led by local governments. But, municipalities face steep learning curves and high costs associated with launching CPACE. The report explains how State Energy Offices and other state-level partners can establish an environment to increase local CPACE participation. The report offers insights and strategies for state-level entities to provide strong statewide coordination and support to PACE programs. Another report from NASEO (2018) focuses on RPACE. This report reviews the history and status of RPACE, with an emphasis of RPACE in California (the largest market) and federal involvement in the program. The report discusses the concerns raised by the mortgage lenders and consumer advocates. Mortgage lenders are concerned about the senior lien of PACE over mortgages. Consumer advocates raised concerns about potential financial risks RPACE poses to borrowers, as RPACE tax assessments operate at the discretion of government and are not subject to the same requirements as those imposed on a traditional consumer credit or a mortgage. The report supports the inclusion of ability to pay, strengthened disclosure practices, contractor oversight, and other provisions included in PACE laws in California. For the impact of PACE financing, Kirkpatrick and Bennear (2014) show that, from 2008 to 2010, PACE programs increase solar energy installations in three California programs (Palm Desert, Yucaipa, and Sonoma County). Winecoff and Graff (2021) estimate the effect of PACE bonds issued between 2009 and 2017 on energy purchases and self-generation. They find more residential energy self-generation in California counties with PACE programs. But the results for electricity and natural gas purchases are inconclusive. With a different focus, McAlister and Sandler (2023) study the effect of PACE loans on consumer financial outcome from over 200,000 consumers who applied PACE loans. They compare mortgage delinquency between those who have taken a PACE loan and those who were approved but opted not to go forward with the loan. They find that PACE loans cause an increase in negative credit outcome, particularly in mortgage delinquency. Furthermore, their data also indicate PACE borrowers are relatively more likely to live in Black or Hispanic neighbors compared to state average. Polsky, et al (2021) criticize PACE for lacking adequate consumer protections and environmental performance checks. Central to those concerns is that PACE does not assess the borrower's financial status to determine whether the borrower can repay. PACE loans create economic risk for low-income California homeowners facing steep property tax debt and potential foreclosure. The second flaw in PACE program design is it does not require pre-project energy audit or post-construction inspection. Thus, they recommend requirements to ensure environmental benefits before payment flows to PACE contractors. Note that the matter related to consumer protections will be resolved with Consumer Financial Protection Bureau's proposal to prescribe ability-to-repay rules for PACE financing and to apply the civil liability provisions of the Truth in Lending Act for violations.

The second set of publications provides estimates of environmental and economic benefits. Pozdena and Josephson (2011) study the economic effect of hypothetical PACE program implementation in four cities. They hypothesize $1 million PACE spending in each city and estimate benefits in economic output, tax revenues, and job creation. Rose and Wei (2019) estimate the net economic impact of projects with PACE financing by Ygrene Energy Fund, Inc. (Ygrene) on the economies of California and Florida. They use Economic Consequence Analysis to focus on several

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macroeconomic indicators such as sales revenues, personal income, and employment. In another study, Rose and Wei (2020) investigate the economic impacts of PACE in California. The results show that PACE financing generates direct environmental benefits as well as additional benefits in enhanced economic output and employment. Olophant et al. (2020) use investments in Florida by Ygrene and show significant impacts in reductions in energy use and greenhouse gas emissions. They also show significant economic benefits in job creation and state economy. Deason et al. (2021) estimate typical California RPACE household electricity and gas savings. Their analysis includes aggregate savings for all RPACE projects in the state through 2018. They show how the impacts vary by investor-owned utility, measure category, and climate zone. The empirical estimates of those impacts will be documented in more detail in a later section.

The third area in the literature is on value of the home. Goodman and Zhu (2016) focus on the resale values of homes with PACE-financed improvements compared to those without. They utilize three different methodologies and find that all three demonstrate a net positive impact of PACE on the resale value of the home in California. On the other hand, Millar and White (2024) employ a two-way fixed effects regression to estimate the effect of the RPACE program rollouts on local housing returns in Florida. They find RPACE rollouts lead to fewer home sales and weaker house price appreciation in the year of PACE introduction and the year after.

1.2. Organization of Paper

The rest of the paper is organized as follows. Section 2 first discusses energy efficient mortgages and then offers a more detailed description of PACE programs. Section 3 provides a more detailed review of articles on the benefits of PACE and documents the estimated benefits. Those benefits include environment, economic output, and employment. The next section covers the securitization of PACE loans to replenish capital for PACE financing. Such green securitization is an additional mechanism to unlock finance for small-scale low carbon projects in residential and commercial properties. Finally, the last section concludes the paper, outlines several significant challenges, and discusses recommended measures for continued growth of the market.

2. Energy Efficient Mortgages and PACE Programs

Energy efficient mortgages (EEM) and PACE programs are both designed to finance energy efficiency and renewable energy. However, the mechanics are different. An EEM is a mortgage, tied to the borrower, and is repaid via the monthly mortgage payments. In case of a sale of the property, the owner must pay off the mortgage. On the other hand, a PACE loan is tied to the property and the property owner repays annually or semi-annually through a special tax assessment added to the property tax bill. If the property is sold, the PACE financing can be transferred to the buyer.

2.1. Energy Efficient Mortgage

An EEM, also called a green mortgage, offers the mortgage borrower favorable terms to finance a new energy efficient home or energy efficient improvements. The loan can be used for two purposes. One is to purchase or build an energy efficient home in which the lender takes into consideration energy savings when determining the amount of the loan. Second, there is also energy improvement mortgage to pay for improvements on the existing home. The lender can increase the loan amount to an existing mortgage to pay for the upgrade. Those green mortgages have been securitized to issue green mortgage-backed securities. In the United States, Fannie Mae leads the market in green mortgage-backed securities, with issuance over $100 billion by 2021 (Fannie Mae, 2021). Another federal agency, Freddie Mac, is also active in supporting the EEMs.

An energy efficient home lowers utility bills and so there is more income available for mortgage payment. The literature shows evidence that savings from the energy improvements lead to lower mortgage default in the United States and other countries. For example, Kaza et al. (2013) and Argento et al. (2019) provide evidence for United States, Richardson and Drinkwater (2017) for the European Union, and Guin and Korhonen (2020) for the United Kingdom. In addition, studies have

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also shown that energy efficient homes have higher sale prices. For example, Walls, et al. (2017) and Kahn and Kok (2014) show the positive estimates in Unites States, Shimizu (2013) in Tokyo, and Zhang et al. (2016) in China.

In summary, EEMs contribute to low-carbon economy, healthier and more comfortable homes, and lower mortgage defaults. Those improvements also have a positive effect on the property sale prices. Therefore, an EEMs help finance greener homes that benefit the environment, borrower, and lender.

2.2. Property Assessed Clean Energy Financing

Under PACE, state must pass legislation to authorize PACE programs at the local level. PACE financing, unlike EEM or other alternatives, is tied to the property and is structured as an assessment to the property and not to the property owner. PACE funds full cost of qualified structural improvements. The property owner repays semiannually or annually through a special assessment added to the property tax bill. The repayment obligation may transfer with property ownership if the buyer agrees to assume the PACE loan and the new mortgage holder allows the PACE obligation to remain on the property.

One unique characteristic of PACE financing is that the special assessment filed with the local municipality as a lien on the property. PACE loan assessments have lien priority like real estate taxes and therefore have priority over existing mortgages and subsequent mortgage financings (Note that measures have been adopted in California to protect the interests of the mortgage lenders). PACE loans cannot be accelerated, even in the event of a missed assessment payment. In the event of a PACE loan foreclosure, only the amount of the past due assessments is due at the time of foreclosure. The future assessments are payable as scheduled initially.

There are two types of PACE programs. Commercial PACE is for commercial properties and Residential PACE for residential properties. CPACE is authorized by state legislation, requires further authorization from local governments, and is a voluntary tool for financing energy efficiency, renewable energy, and resilience upgrades in commercial buildings. CPACE programs are active in 30 states plus Washington, D.C. As of 2023, total investments in CPACE are $7.2 billion in 3,340 commercial projects. CPACE investments include projects in energy efficiency, renewable energy, and resilience.

For residential properties, RPACE allows homeowners to finance the eligible improvements on their homes using private sources of capital. RPACE is currently offered only in California, Florida, and Missouri. As of 2022, the cumulative investments in RPACE are $8.4 billion in 344,000 home upgrades. RPACE investments include improvements in energy efficiency, renewable energy, residence, and water efficiency. Table 2 lists PACE by project type for residential and commercial properties. Improving energy efficiency accounts for most of the investments for both CPACE and RPACE. For residential properties, there is a five percent in water efficiency. Other smaller items are not listed in the table.

Table 2. PACE Investments in Project Type.

PACE Programs	Project Type	Percentage of Total
CPACE	Energy efficiency	55%
	Renewable energy	17%
	Mixed	15%
	Resilience	3%
RPACE	Energy efficiency	32%
	Renewable energy	29%
	Resilience	28%
	Water efficiency	5%

Source: https://www.pacenation.org/pace-market-data/. Note: The table lists main project types. Other types are not listed.

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3. Benefits of PACE Financing

PACE financing pays for full costs of qualified improvements. A PACE loan is repaid on the property tax bill over a period of up to 30 years. The savings can be more than the additions to the tax bill, making the improvements cash flow positive from the start. As listed previously, PACE-funded projects include energy efficiency, renewable energy, resilience, and water efficiency. Thus, PACE helps communities reduce carbon emissions and increase resilience to natural disasters. As such, PACE financing contributes to mitigating climate change and to support the SDGs. PACE is more complicated than traditional financing alternatives. There is limited literature on PACE. Most studies on environmental and economic impacts of PACE are for programs in California and Florida, as RPACE programs have achieved significant scale in those two states. This section extends the brief review in Section 1 and documents the main findings on the benefits of PACE.

In an early attempt to analyze the economic impact of PACE financing, Pozdena and Josephson (2011) assume a PACE budget of $4 million and allocate $1 million to each of the four cities: Columbus, OH; Long Island, NY; Santa Barbara, CA; and San Antonio, TX. They calculate the direct, indirect, and induced impacts of purchases associated with the hypothetical PACE financing. The findings are that the $4 million PACE financing generates $10 million in gross economic output, $1 million in tax revenues, and 60 jobs.

After PACE programs have implemented, Rose and Wei (2019) perform economic impact analysis of PACE funded projects in Florida and California. Their study focuses on PACE financing by Ygrene. During the covered period of 2013 to July 2018, Ygrene provided $1.16 billion to finance 54,500 improvement projects. The results show that in California the improvements lead to reduction in water consumption of 2.36 billion gallons, in electricity consumption of 3.63 million megawatt hours (MWh), in natural gas consumption of 2.86 billion cubic feet (bcf), in greenhouse gas emissions of 1.15 million metric tons of carbon dioxide equivalent (CO_2e), and avoidance of property damage from earthquake of $2.36 million. In addition, those projects generate a net present value of economic output of $661.4 million, a net present value of tax impacts of $120.9 million, and create person-year jobs of 9,774 in California. In Florida, the PACE financed improvements lead to reduction in electricity consumption of 0.46 million MWh, in natural gas consumption of 0.28 bcf, in greenhouse gas emissions of 0.26 million metric tCO_2e, and avoidance of property damage of $507.76 million from hurricanes. In addition, those projects produce a net present value of $608.2 millions of economic output, a net present value of tax impacts of $136.6 million, and create person-year jobs of 11,716 in Florida. Rose and Wei (2020) focus the economic impact analysis of Ygrene funded PACE projects in California during the same period. The results are included in Rose and Wei (2019) listed above.

Oliphant et al. (2020) extend the research by Rose and Wei (2019) for PACE in Florida to November 2019 (from July 2018). They find a large portion of the impacts are in southern counties. Based on data for Ygrene funded PACE programs, the estimated benefits are as follows. The environmental impacts include reduction in electricity consumption of 960 kilowatt-hour (kWh), in gas consumption of 580 Mcf (one thousand cubic feet), in greenhouse gas emission of 0.54 million metric tCO_2e, and in property damage avoidance from hurricanes of $970 million. In addition, the economic benefits include 21,820 person-year jobs created and gross state product growth of $1.14 billion.

Deason et al. (2021) investigate the energy use impacts of solar photovoltaic (PV) projects financed by RPACE in California. The data sample covers RPACE projects submitted to The California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) through June 2017. CAEATFA administers a loss reserve supporting RPACE assessments in the state. The results show that installed energy efficiency technologies reduce electricity consumption by about 3 percent and gas consumption by about 3.5 percent on average. Solar PV projects produce electricity for about 69 percent of average household electricity consumption. They estimate that California RPACE projects installed through 2019 reduce annual consumption of grid-tied electricity of 506 Gigawatt hours (equivalent to the electricity consumption of 74,000 households) and gas consumption of 2 million therms (equivalent to gas consumption of 4,700 households).

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Goodman and Zhu (2016) estimate the change in home values relative to the PACE financing. Their data cover 773 loans with PACE improvements; each with the purchase price, sale price, and PACE loan. All loans are in California. The average purchase price is $236,324 and average sales price $342,577. The average PACE financing is $19,091. The study uses three different methodologies. Methodology 1 compares PACE sales price with three home price indexes. The results show a positive PACE premium of $199 -- $8,882. The second methodology compares PACE homes with non-PACE homes. The PACE homes gain $5,010 more than non-PACE counterparts. The third approach is multivariate regression. The regression results show PACE improvements increase home resale value by $4,042.

In summary, those publications show PACE financing produces environmental or hazard risk reduction benefits. Furthermore, there are additional economic benefits such as job creation and increases in local economic outputs. Table 3 lists the summary of findings of the publications mentioned above.

Table 3. Summary of Select Publications on PACE, Environmental Benefits, and Economic Benefits.

Publication	**Estimates of Environmental Benefits**	**Estimates of Economic Benefits**
Pozdena and Josephson (2011)	N/A	Increasing economic output in the four cities with hypothetical PACE programs Increasing tax revenues in the four cities with hypothetical PACE programs Creating jobs in the four cities with hypothetical PACE programs
Rose and Wei (2019 and 2020)	Reducing consumption of water, electricity, and natural gas Reducing greenhouse gas emissions Avoidance of property damage from earthquake in California and that from hurricanes in Florida	Increasing output in California and Florida Creating jobs in California and Florida Increasing tax revenues in California and Florida
Oliphant, Culhane, and Haldar (2020)	Reducing consumption of electricity and natural gas Reducing greenhouse gas emissions Avoidance of property damage from hurricanes in Florida	Increasing output in Florida Creating jobs in Florida
Deason, Murphy, and Goldman (2021)	Reducing consumption of electricity and gas Solar PV projects produce electricity for about 69 percent of average household electricity consumption	N/A
Goodman and Zhu (2016)	N/A	PACE improvements increase home resale value

Note: N/A denotes not applicable (not included in publication).

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4. Securitization of PACE Loans

PACE loans fund the upfront cost of improvements in energy efficiency, renewable energy, water efficiency, and resiliency projects. Sponsoring states implement legislation to collect repayments through property tax bills and redistribute them to lending agencies. The payments and associated credit risk are passed on to investors through securitization of PACE loans. Such securitization enables lenders to sell off PACE loans to free up capacity for more business. It is the process through which a lender creates PACE loans backed securities. The PACE bonds are sold to investors who receive a return from the special tax assessments of the underlying PACE loans.

4.1. Green Securitization of PACE Loans

PACE loans finance improvements to support greener environment. Similar to energy efficient mortgages, PACE loans can be aggregated together to issue PACE green bonds (FitchRatings, 2021). By pooling PACE loans into a common structure, the green securitization provides an avenue for institutional investors to fund improvements on the residential and commercial properties. PACE green bonds follow guidelines of The Green Bond Principles (International Capital Market Association, 2021). The principles include criteria for the use of proceeds, the issuer's process for project evaluation, the management of proceeds, and reporting both at the time of issuance and on a periodic basis thereafter.

PACE green bonds typically have one of the strongest forms of credit quality, as the tax assessments in most states have a lien priority on par with tax liens and above the liens on mortgages. PACE financing providers have issued those green bonds and have found that many investors are interested in purchasing high-quality green bonds that make a positive impact on the environment. As an example, Nuveen Green Capital has issued over $1 billion securitizations of PACE assets. Ygrene has several issues of PACE green bonds totaling more than $2.5 billion. PACE financing providers have provided more than $13.6 billion for qualified improvements on residential and commercial properties.

4.2. Investing in PACE Green Bonds

PACE securitization allows investors to gain exposure to the risks and rewards of the green bond market. PACE green bonds are a recent addition to the growing green bond market. The green bond market started in 2007. By 2021, the annual issuance reached $587 billion. The volume decreased slightly to $487 billion in 2022. The green bond market is still small and has potentials to become a significant segment in the global fixed-income market.

One important contributing factor to the development and growth of the green bond market is the increasing requirements to finance climate and environmental solutions. The Paris Climate Agreement provides an additional motivation for investors to direct some of their investments towards climate solutions. The United Nations SDGs also call for investments to support the environment. Green bonds are tailored to unlock private capital to meet the funding requirement to promote climate or other environmental sustainability purposes. The need to finance climate or environmental solutions in combination with growing investor demand will continue to lift green bond issuance.

In summary, many institutional investors allocate a portion of their investments to support the low-carbon climate. The demand is driven largely by investors with a green mandate but also by regular investors interested in green bonds to gain exposure to the green theme. The strong demand for green investments leads to some observations that green bonds are priced at a lower yield than the similar conventional bonds by the same issuer (also known as green premium). For example, Kapraun and Scheins (2019), Baker et al. (2018), Hyun et al. (2019) and Gianfrare and Peri (2019) are among the many publications that show the existence of the green premium.

5. Conclusions

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PACE loans finance the cost of energy and other eligible improvements on the property. The owner pays back the costs overtime through a special tax assessment. The unique characteristic of PACE financing is that the assessment is attached to the property rather than the owner. PACE-financed improvements generate environmental and economic benefits. In addition, PACE can provide financing to those that might otherwise have difficulties obtaining other forms of credit. Another direct benefit to residential and commercial borrowers is that there is no down payment or upfront cost. Together with other initiatives and incentives, PACE programs can be an important part of the government's efforts to mitigate climate change. PACE is also aligned with six of the United Nations SDGs. PACE financing is an effective tool for financing upgrades in residential and commercial buildings. As of 2023, the cumulative investments in both CPACE and RPACE improvements are more than $15 billion. However, PACE market growth has faced challenges. Those challenges are in part due to its complexity, the lack of program standardization across jurisdictions, and the administrative and legal lifts required for successful completion. NASEO (2016 and 2018) discuss the multiple roles State Energy Offices can play in supporting and advancing PACE. McAlister and Sandler (2023) address concerns for consumer protection. Polsky et al. (2021) discuss concerns over consumer protection and lack of pre-project audit or post-project inspection. Those reports have identified the huddles and offered recommendations to overcome the challenges. Below we highlight several important areas that are crucial to the continued success of PACE financing.

First, PACE programs are established and operated at the state and local government levels. Some states have fully operational PACE. Other states have authorized PACE programs but have not implemented or only have limited utilizations. In addition, some states have introduced legislation but have not enacted them to authorize PACE. There is no uniformity in application process, financing structures, or program procedures. It is helpful to promote the programs nationwide, create consistent streamline process for borrowers and bankers, and offer supportive federal and state policies to promote PACE programs.

Second, PACE loans are secured by the property itself, are collected in the same manner as taxes, and take precedence over other debts on the property. In a foreclosure, this senior lien status means that the delinquent portion of the PACE obligation is paid by the foreclosure sale proceeds before the mortgage is paid. Because of its potential impacts on federally backed mortgage products, RPACE has drawn attention from multiple federal agencies. In addition, some mortgage lenders have raised concerns with subordinating their mortgage to a PACE assessment. To mitigate the perceived risks of senior-lien PACE, some have suggested to implement junior-lien PACE programs that make PACE assessments subordinate to the mortgage, thus providing the mortgage holder with priority status to be repaid in the event of default or foreclosure. Furthermore, California has established a PACE Loss Reserve Program to enable residential PACE financing by making first mortgage lenders whole for direct losses because of a PACE lien in a foreclosure or forced sale.

Another important issue in RPACE relates to consumer protection. As McAlister and Sandler (2023) show, consumer protection laws of 2018 in California for PACE lead to smaller increases in mortgage delinquency. Furthermore, PACE financing that includes income in the application process also leads to better outcomes in mortgage delinquency. Polsky et al. (2021) emphasize the negative impacts on low-income Californians as one of the two serious flaws in PACE program design. Along this direction, the Consumer Financial Protection Bureau has proposed to prescribe ability-to-repay rules for PACE financing and to apply the civil liability provisions of the Truth in Lending Act for violations.

The 2022 Inflation Reduction Act (IRA), the landmark federal climate law, includes $369 billion to mitigate climate change (Glavinskas, 2022). Those climate goals support United Nations SDGs as well. The IRA will increase the pace of emission reductions. But, to reach the 2030 climate goal of cutting pollution 45 percent from 2005 levels and to get on the path to net zero by 2050, additional efforts are required. PACE financing, a public-private partnership solution, has provided more than $15 billion for energy related improvements in many states in the United States. PACE programs

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have encountered challenges. With regulatory reforms and enhanced consumer protections, PACE will contribute to meeting the climate goals and to supporting United Nations SDGs as well.

Conflicts of Interest: All authors declare no conflicts of interest in this paper.

Abbreviations

PACE (Property Assessed Clean Energy), RPACE (Residential Property Assessed Clean Energy), CPACE (Commercial Property Assessed Clean Energy), SDGs (Sustainable Development Goals), EEM (Energy Efficient Mortgage).

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