The Role of Clean Energy Banks in Increasing Private Investment in Electric Vehicle Charging Infrastructure

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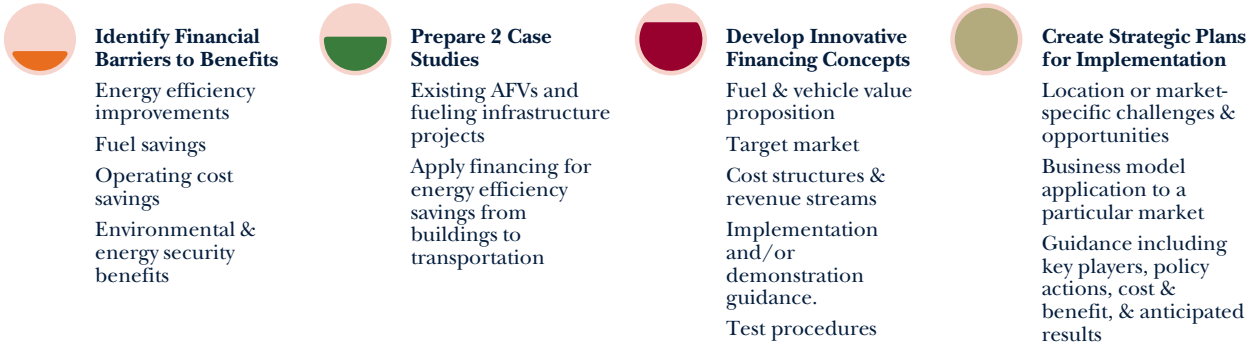
Unlocking Private Sector Financing for Alternative Fuel Vehicles and Fueling Infrastructure

NASEO and C2ES, with funding from the U.S. Department of Energy's Clean Cities Program, began a two-year project in early 2013 to develop innovative finance mechanisms aimed at accelerating the deployment of AFVs and fueling infrastructure. C2ES has assembled an advisory group of experts on AFVs, infrastructure, and finance from the public and private sectors to help guide its work. The project aims to:

- Identify barriers that hinder private sector investment;
- Develop and evaluate innovative financing concepts for vehicle purchase and fueling infrastructure in order to make AFVs more accessible to consumers and fleet operators; and
- Stimulate private-sector investment in AFVs and the associated infrastructure deployment, building upon and complementing investments previously made by the public sector.

C2ES is researching financial barriers, preparing case studies, and developing strategies to deploy innovative financing concepts that states can consider piloting at the project's conclusion:



The project specifically emphasizes two fuels that offer significant opportunities for growth—electricity and natural gas. Biofuels are not considered because the deployment of biofuel-powered vehicles is already being facilitated by many government and private sector stakeholders. Vehicles powered by hydrogen are included, but they are not a major focus because hydrogen fuel cell vehicles are not yet widely available.

This project is a part of C2ES's AFV Finance Initiative. More information is available at www.c2es.org/initiatives/alternative-fuel-vehicle-finance.

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EXECUTIVE SUMMARY

The widespread use of electric vehicles (EVs) is currently held back in part by an EV charging station infrastructure gap. This infrastructure gap is defined as the insufficiency of charging infrastructure to support EV market expansion, as consumers assess the adequacy of charging station access before buying EVs. To address the infrastructure gap, charging access must be expanded at multi-unit residential buildings, at workplaces, along major roadways, and at popular driving destinations.

While governments have played a central role in deploying public EV charging infrastructure to date, greater private investment will be needed to ensure adequate access to public charging.

Two primary financial barriers stand in the way of greater private sector investment in EV infrastructure. Currently, the primary barrier is that it is challenging to construct a compelling, profitable business case for EV charging investments that will help address the infrastructure gap. In the long term, insufficient access to flows of capital for EV infrastructure projects may emerge as the critical barrier to scaling up market development.

Clean energy banks (CEBs) could play a role in reducing the barriers to EV charging infrastructure deployment. A CEB is a governmental or quasi-governmental organization that is designed to efficiently use limited public funding to advance deployment of clean energy technologies. Increasingly, governments are exploring and implementing innovative programs that aim to maximize the impact of public funds on the development of clean energy markets by striking a strategic balance between public and private sector roles. These public-private financing programs are becoming increasingly sophisticated, with some leading states consolidating and expanding their financing offerings to form CEBs.

While no CEB has established financing offerings for AFVs to date, it is reasonable to consider that some CEBs or similar public financing programs could employ their financial tools to help close the EV infrastructure gap. The lessons learned from decades of government experience facilitating the financing of energy efficiency and renewable energy projects can inform strategies to help address some of the similar barriers currently facing EV charging market development.

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This paper explores how CEBs, or other similar organizations aimed at leveraging public funds to attract private investment in clean energy deployment, could help reduce the barriers to EV charging infrastructure by (1) supporting the development of viable business models for charging services in the near term and (2) helping scale up private capital investments into EV infrastructure in the longer term.

KEY INSIGHTS

In the near term, the primary challenge is to help establish a compelling business case for EV infrastructure investment. The business case for deploying EV charging stations may be challenging due to high upfront equipment, installation, and transaction costs; high operating costs resulting from electricity demand charges; low and uncertain station utilization; low consumer willingness to pay for charging; inefficiency and uncertainty resulting from lack of experience; and a high cost of capital.

CEBs could share upfront costs and risk with project developers to foster early market development. At present, offering EV charging services at some locations and charging levels may be unprofitable or too uncertain for the private sector to deploy without government support. If a CEB determines that offering charging services is valuable for EV market development, despite the challenging business case, the CEB may conclude providing cost and risk subsidies for some charging stations is justified in order to facilitate EV market

development. A CEB could provide cost and risk subsidies for EV charging projects through grants and rebates or by providing project equity.

CEBs could reduce the cost and risk of offering EV charging services by disseminating needed information and facilitating partnerships. Collecting and sharing data on the financial performance of EV charging loans and projects could reduce uncertainty among developers and private lenders. The transaction costs associated with financing and deploying EV charging could also be reduced by developing standardized contracts or conducting community-based marketing campaigns. New partnerships could empower stakeholders to work together to overcome market barriers, perhaps even co-financing mutually-beneficial deployment projects.

CEBs could help advance market development by expanding EV charging developers' access to attractive financing options. The costs and risk of financing EV charging deployment could be reduced if developers had access to loans with lower interest rates, longer loan terms, and/or flexible repayment schedules. CEBs could provide attractive financing directly using their own funding. Alternatively, and enabling greater leverage, CEBs could develop programs that enable private investors or offer more attractive financing to EV charging developers, such as credit enhancements, interest rate buydowns, and alternative collateralization and repayment mechanisms.

In the long term, as the business case for offering EV charging improves, the challenge will be to scale up flows of financial capital. Investment in EV charging infrastructure may remain at relatively low levels if the availability of low-cost capital for EV charging projects remains limited. Capital flows may be limited due to a weak secondary market for EV infrastructure financial products; the lack of standardized financing structures; and insufficient information among potential investors.

CEBs could increase capital flows by fostering the development of secondary markets for EV charging loans and leases. A robust secondary market for EV charging financial products would enable loan and lease originators to recapitalize and fund more projects. To develop these secondary markets, CEBs could implement programs aimed at standardizing these products, increasing their liquidity, reducing uncertainty about their financial performance, and facilitating their incorporation into new securitized products.

RECOMMENDATIONS FOR POLICYMAKERS

CEBs could help EV markets overcome the limitation currently posed by insufficient access to EV charging infrastructure. CEBs could help increase deployment of clean energy technologies through a wide array of financial programs such as direct lending, credit enhancements, and outreach. To date, CEBs have focused on energy efficiency and renewable energy technology deployment and have little experience with transportation projects. However, AFVs and infrastructure face many of the same financial, information, and coordination barriers faced by other clean energy technologies. CEBs could apply their expertise and experience in other clean energy sectors to help advance clean transportation technologies.

States could gain experience applying financial tools to increase private investment in EV charging infrastructure by using existing funding sources and authorities to launch pilot programs. To help establish a compelling business case for EV infrastructure investment and ensure adequate access to capital, states could use existing financial programs and authority to apply some the tools discussed in this report through pilot programs of limited scale and financial commitment. Based on the results and the experiences under such a pilot program, a state could refine and expand the program or discontinue it.

It is valuable for CEBs and other clean energy financial programs to be empowered with a range of tools and to retain flexibility. The barriers standing in the way of expanded EV charging deployment depend on the state of the EV charging market, which will evolve over time and will depend in part on the geographic location as well as the location and type of charging station. There are many tools that CEBs could employ to help address these barriers. CEBs that are able to adapt to these changes by developing programs that apply the tools best suited to addressing the evolving needs of the EV charging markets will be most successful at efficiently promoting market development.

INTRODUCTION

Alternative fuel vehicles (AFVs) are a small but increasingly important part of the U.S. transportation system. Powered by rechargeable batteries, natural gas, hydrogen, or other non-petroleum-based fuels, AFVs hold the potential to provide public benefits by reducing greenhouse gas emissions, enhancing energy security, and improving air quality. In many applications, AFVs can also offer fuel cost savings to their operators.

Decades of public and private research, technology and market development, and pilot programs have advanced AFV technologies to a point where their use is economically viable in many transportation applications, including light-, medium-, and heavy-duty vehicles. The U.S. Department of Energy's Clean Cities program—in partnership with public and private stakeholders across the nation—has been actively promoting AFVs and fueling infrastructure for over 20 years, supporting deployment that has displaced over five billion gallons of petroleum to date.[2]

Despite this progress, challenges continue to limit wide-scale deployment of AFVs and fueling infrastructure, including high upfront costs, risk aversion, and information barriers.

This paper explores how clean energy banks (CEBs) could help reduce the barriers to expanding the private sector role in financing one type of AFV investment: electric vehicle (EV) charging infrastructure. The paper considers how CEBs could support the development of viable business models for charging services in the near term and how they could help scale up private capital investments into EV infrastructure in the longer term.

The expanded use of EVs offers many benefits including reduced emissions, improved public health, economic development, and bolstered energy security benefits.[3] EVs can also reduce fuel costs for drivers, as it costs 2 to 3 times less to drive an electric vehicle on electricity than on gasoline.[4]

However, the widespread use of EVs is hindered in part by the insufficiency of available EV charging infrastructure. Consumers look for available public charging before buying EVs, as it gives them peace of mind that they will have access to charging when they need it.[5] The insufficiency of charging infrastructure at multi-unit residential buildings, at workplaces, at public sites along major roadways, and at popular driving destinations is referred to as the "EV infrastructure gap."

While governments have played a central role in deploying public EV charging infrastructure to date, greater private investment will be needed to ensure adequate access to public charging. Yet, private sector financing of EV infrastructure faces significant barriers. Project developers and private investors are deterred by the difficulty of establishing a profitable business case for EV charging deployment due to significant upfront and operating costs, potentially high financing costs, low and uncertain revenues, and limited information and expertise. In the long term, even if a viable business case for charging can be constructed, the scale of investment may not be sufficient to support a growing EV market.

To expand the private sector's role in clean energy deployment, governments are exploring and implementing innovative programs that aim to maximize the impact of public funds on the development of clean energy markets by striking a strategic balance between public and private sector roles. State energy offices and their partners already manage over $4 billion in financing programs, which to date have primarily focused on building energy efficiency and renewable energy investments.[6] Some of these programs have achieved private-to-public capital leverage ratios of up to 15:1.[7]

These public-private financing programs are becoming increasingly sophisticated, with some leading states consolidating and expanding their financing offerings to form a CEB, also known as a "green bank."[8] A CEB is a governmental or quasi-governmental organization that is designed to efficiently use limited public funding to advance deployment of clean energy technologies. While the structure, authority, and mission of new and emerging CEBs may vary, these organizations are widely considered to share the goal of developing programs that:

- Increase deployment of clean energy technologies;
- Leverage small amounts of public funding to attract larger amounts of private capital for investment in clean energy;

- Lead to the repayment of public investments when possible, often with interest, to enable reinvestment in subsequent programs with limited recurring public funding.

CEBs can be structured to employ a wide array of financial tools, such as direct lending, credit enhancements, and outreach, to achieve their goals, depending on states' needs and market maturity.

While no CEB has established financing offerings to advance AFVs to date, it is reasonable to consider that some CEBs or similar public financing programs could employ their financial tools to help close the EV infrastructure gap. When combined with other policies and incentives, financing programs could significantly accelerate deployment of EV charging infrastructure and facilitate EV market development. The lessons learned from decades of government experience facilitating the financing of energy efficiency and renewable energy projects can inform strategies to help address some of the similar barriers facing EV charging market development.

Although the CEB is not the only public financing program structure that can advance EV infrastructure deployment, this paper focuses on its potential role in increasing private sector investment in charging stations because:

1. CEBs can employ a wide array of tools to help address the various barriers facing EV infrastructure;
2. CEBs can flexibly address these barriers as the EV market evolves and the barriers to expanded private sector investment change over time; and
3. CEBs are of growing interest to state and federal governments seeking to advance clean energy deployment.

Many of the tools a CEB could use to advance EV infrastructure development could also be used by other public financing programs with similar authorities and missions. In addition, CEB tools could also help to advance AFV types other than electric vehicles (see Box 1).

This paper first details the range of financial tools available to CEBs then examines the potential of these tools to reduce barriers to EV infrastructure investment and explores how lessons learned from the early activities of CEBs and other relevant organizations could be applied to the EV charging market. This paper was prepared as part of the AFV Finance Initiative, a two-year project to develop innovative finance mechanisms aimed at accelerating the deployment of AFVs and fueling infrastructure funded by the U.S. Department of Energy's Clean Cities program. The project is led by the National Association of State Energy Officials (NASEO) and the Center for Climate and Energy Solutions (C2ES), with guidance from the AFV Finance Advisory Group, an assembly of experts on AFVs, infrastructure, and finance from the public and private sectors. The project's first white paper, *Alternative Fuel Vehicle and Fueling Infrastructure Deployment Barriers and The Potential Role of Private Sector Financial Solutions* (hereafter *AFV Barriers*),[9] provides a general overview of the barriers to widespread private sector investment in AFV projects. An additional 2014 white paper, *Applying the Energy Service Company Model to Advance Deployment of Fleet Natural Gas Vehicles and Fueling Infrastructure*, explores how innovative service contracts could help reduce the barriers to vehicle fleet investment in natural gas vehicles and fueling infrastructure.

Box 1. Opportunities for Applying CEBs to Other Alternative Fuel Vehicle Types

While this paper focuses on the potential for CEBs to help advance EV infrastructure development, many of the tools explored could also be applied to help advance other types of AFV infrastructure such as natural gas or hydrogen refueling infrastructure.

Natural gas and hydrogen refueling markets do face somewhat different barriers than those faced by EV charging markets, especially in the near term. For instance, retail sales of natural gas for vehicles currently can be highly profitable as long as demand is sufficient, while charging service business models remain challenging. The profitability of selling hydrogen for vehicles is not well known, as hydrogen refueling markets are still in an early stage of development.

However, CEBs could help overcome information and risk barriers faced by each of these AFV refueling markets. CEB programs could help natural gas refueling infrastructure projects access low-cost private capital. Since hydrogen vehicles are not yet commercially available, CEBs could help to reduce the information barriers facing hydrogen refueling investments, which are even greater than those facing EV infrastructure.

BACKGROUND

This section explains the EV infrastructure gap, the need for expanded private investment, and the short-term and long-term barriers to addressing the infrastructure gap. A glossary provided at the end of this report provides definitions for financial terms.

THE EV INFRASTRUCTURE GAP AND BARRIERS TO NEEDED PRIVATE SECTOR INVESTMENT

Widespread adoption of EVs is limited to some extent by an infrastructure gap that leaves drivers with insufficient access to EV charging at three key location types: multi-unit residential buildings, workplaces, and public sites near major roadways and popular driving destinations. While most EV charging occurs at home,[10] where access to electricity is often convenient and inexpensive, prospective consumers consider availability of workplace and public charging before buying EVs.[11] Additionally, many residents of multi-unit dwellings are unable to install their own charging stations at home, and may instead have to rely on the availability of charging stations at public parking facilities.

Addressing the EV infrastructure gap will require substantial investment in charging stations. The amount of charging infrastructure needed to both support EV market development and meet the needs of a growing number of EV drivers will depend on:

- Travel needs of drivers, including trip characteristics and how drivers use EV charging stations both locally and on long trips;
- How effective additional charging stations are at reducing EV driver range anxiety;
- Technological progress, in particular innovations that increase the energy density of batteries; and
- Government deployment goals for EVs and public policy support for market development, including EV purchase incentives.

Because these factors are uncertain and will vary over time and geographically, the amount of charging infrastructure needed in a given region, state, locality, or travel corridor is difficult to specify precisely. One metric often used to evaluate the adequacy of EV charging is the ratio of charging locations to EVs on the road. A 2013 National Research Council report estimated that one public Level 2 charging location would be needed for every 2.5 EVs.[12] For context, Washington, a leading state in EV charging deployment, currently has one public Level 2 charging location for every 9 EVs on the road in the state.[13]

Despite the fact that charging infrastructure needs are challenging to quantify, it is clear that public investment alone will not be sufficient to ensure adequate access to charging. To illustrate this point, consider that in 2013, eight states committed to deploying 3.3 million zero emission vehicles on their roads by 2025.[14] If 3 million of these vehicles are EVs, the cost of installing an adequate public charging infrastructure could easily cost billions of dollars.[15]

While the government has provided sizeable grants to install public charging stations in the past, greater investment will be needed to continue to advance EV adoption. Sizeable public investments in charging infrastructure expansion are unlikely to be repeated in the near future, and the federal tax incentive for EV charging infrastructure expired at the end of 2013.16,17 Although state infrastructure incentives, such as New York's EV charging station tax credit of 50% of the cost up to $5,000, 18 support EV infrastructure development, private investors may still decide not to invest in EV charging even with these incentives. Critically, even if states do manage to pick up where the federal government left off, much higher levels of private investment are likely to be needed to support EV market development and meet the needs of a growing number of EV drivers.

Two primary financial barriers stand in the way of greater private sector investment in EV infrastructure:

- Currently, the primary barrier is the challenge of constructing a compelling, profitable business case for EV charging investments that will help address infrastructure gaps.
- In the long term, insufficient access to flows of capital for EV infrastructure projects may emerge as the critical barrier to scaling up market development.

In the sections below, these challenges are explored in

detail. While the installation and use of EV charging stations face a wide spectrum of barriers, this paper focuses on the challenges directly related to establishing a compelling business case for EV infrastructure and ensuring adequate access to capital among potential EV infrastructure investors. For more general information about the physical, technical, and policy barriers to charging station installation and use, as well as solutions to these barriers, see the Department of Energy / C2ES report: *A Guide to the Lessons Learned from the Clean Cities Community Electric Vehicle Readiness Projects.*[19]

NEAR-TERM: BARRIERS TO ESTABLISHING A COMPELLING BUSINESS CASE FOR EV INFRASTRUCTURE INVESTMENT

For the private sector to expand its role in deployment and operation of EV charging infrastructure, investors must expect that upfront costs and operating costs will be paid back by direct revenue from charging service fees and/or by indirect increases in other revenue streams that are attributable to charging stations.

Box 3: Commercially Available Charging[20]

AC (Alternating Current) Level 1 charging is the cheapest option because it consists simply of plugging an electric car into a socket at the standard household voltage. AC Level 1 is also the slowest charging level. At this level, most plug-in hybrid electric vehicles charge overnight or over the course of a workday, but fully charging an empty all-electric vehicle at Level 1 can take a day or more.

AC Level 2, which runs at a higher voltage and draws more current than AC Level 1, charges more rapidly, but requires the purchase of dedicated charging equipment and usually requires installation by a licensed electrician. AC Level 2 generally can fully charge an all-electric vehicle overnight from empty, so it is often recommended for installation at residences of all-electric vehicle owners. For daytime charging, AC Level 2 is commonly installed where vehicles park for a relatively short duration (for instance, a coffee shop). For workplace charging, the relative desirability of AC Level 1 versus Level 2 stations, or the most desirable mix of these levels, is still being debated.

DC (Direct Current) chargers, often referred to as "DC fast chargers," are the fastest charging methods but also the most expensive to purchase, install, and maintain. A DC fast charger can charge typical all-electric vehicles to 80% capacity in as little as 30 minutes. DC fast chargers are recommended for stations offering rapid charging to many vehicles, such as those along major roadways, highway rest stops, or at shopping centers.

TABLE 1: PEV Charging Level Comparison

CHARGE LEVEL	VOLTAGE	CURRENT	MAXIMUM POWER†	POWER SIMILAR TO…	TIME TO FULLY CHARGE AN ALL-ELECTRIC VEHICLE ‡
AC Level 1	120 V	12/16 amps	1.4/1.9 kW	Toaster	8–24 hours
AC Level 2	240 V	up to 80 amps	19.2 kW	Clothes dryer	4–8 hours
DC Fast-Charger	200–450 V	up to 200 amps	90 kW	5–10 Central air conditioners	30 minutes to 80 percent state of charge

† Power, measured in kilowatts (kW), is the rate at which energy is used. Energy, measured in kilowatt-hours (kWh), is the capacity to do work. In the case of an electric vehicle, energy is stored in a battery.
‡ Refers to a vehicle with a usable battery capacity of approximately 24 kWh.

There are two primary ways for EV charging infrastructure to directly generate revenue: the pay-per-use model and the subscription model. Under a pay-per-use model, owners collect payment from charging station users based on usage. A pay-per-use rate can be established as a flat fee per charging session, a fee based on the time spent parked or connected to the charging station, or a fee based on the amount of energy used. Alternatively, under a subscription model, owners collect monthly or annual fees from charging station users who seek free or discounted per-use access to a charging station or network of charging stations. Charging station owners may collect payment through both pay-per-use fees and subscription fees.

EV charging infrastructure may also generate indirect revenue for various stakeholders, although these indirect revenues may be difficult to forecast and verify. Offering EV charging at retail locations may increase sales revenue by drawing EV drivers to the destination and by increasing customer time spent parked at these locations. Similarly, offering access to charging at residential multifamily buildings or commercial offices as an amenity may enable building owners to charge higher rents to their tenants. Second, EV charging infrastructure deployment may increase sales of EVs, potentially increasing expected automaker revenues as they work to drive down costs for these advanced technology vehicles. Third, over a longer time frame, technology and infrastructure development may enable EVs to provide valuable energy storage and ancillary grid services due to their potentially flexible electricity demand, sizable batteries, and ability to provide power back to the grid, generating additional revenues or cost savings.[21]

The challenge of establishing a compelling business case for providing EV charging services is the primary financial barrier currently limiting private investment in EV infrastructure. Establishing a financially viable business model for EV charging is challenging for several reasons:

- **Deploying charging stations requires significant upfront investment in charging station equipment and installation.** The installed cost for each charging station depends on local physical and regulatory conditions, as well as charging power levels (explained in Box 3). The total installed cost of a typical Level 2 charging station can range from $500 to $5,000, with the actual value dependent on the amount of electrical work needed. The total installed cost of a DC fast-charging station can range from $50,000 to $150,000.[22]
- **Near-term demand for public charging may be relatively low and future demand is uncertain.** As of June 2014, only about 200,000 EVs were on the road in the United States, with fewer than 8,500 public charging stations. Forecasts of future EV sales vary widely and great uncertainty remains about whether, and when, EVs will be a major segment of the auto market.[23] As a result, public charging stations may experience low utilization (the time charging a vehicle as a proportion of the total time the station is open to users) and generate limited revenue from usage and subscription fees for months or years. Indirect revenues from charging station deployment, such as increased retail sales at charging station host sites, may also be limited and uncertain.
- **Low consumer awareness of, information about, and experience with public EV charging may deflate demand for charging services.** Many drivers are unaware of the locations of publically-accessible charging stations and how long it will take to charge once they arrive. Charging stations may be challenging for EV drivers to use due to unfamiliar and unstandardized charging technologies and payment mechanisms. Lengthy charge times can be inconvenient, especially where public charging stations are congested, requiring drivers to wait for others to finish, and driver etiquette and rules around charging station use are nascent. As a result of these factors, demand for public EV charging services may be stifled even in locations where there are significant numbers of EV drivers.
- **Consumer demand for public charging services and willingness to pay for those services may be limited due to competition with relatively inexpensive residential electricity.** Since most consumers can charge their EVs at home relatively inexpensively, they may be unlikely to pay a price premium for frequent charging outside the home.[24] The average price of electricity in the United States was $0.12 per kilowatt-hour in 2013.[25] Since an EV can travel approximately 3.5 miles on each kilowatt-hour of energy and Americans travel 30 miles per day on average, an EV driver's daily travel cost is roughly $1.00.[26] EV drivers may be willing to pay higher

prices to increase their range for occasional road trips or for convenience, but these purchases are likely to be relatively infrequent. As a result of competition with inexpensive residential electricity, revenues to charging service providers are limited by both low demand for services and low willingness to pay.

- **Charging station hosts or service providers may bear substantial electricity costs associated with powering DC fast chargers or sites with multiple Level 2 chargers.** In addition to electricity rates per unit of energy consumed, many electric utilities assess a "demand charge" on electricity consumers based on a customer's highest rate of power use during a given billing period. While these additional fees are inconsequential for individual Level 1 or Level 2 chargers, they can be substantial for service providers who deliver fast charging or manage sites with several Level 2 chargers. Operators may pass through these demand charges to their customers, increasing the cost premium that they must charge.
- **Charging service providers are uncertain about how to most efficiently deploy and operate EV charging stations and must make decisions as EV technology and standards continue to evolve.** Technologies and standards for DC fast charging and payment processing are still evolving. As a result, investors are hesitant to invest heavily in infrastructure that could become outdated. In addition, good practices for siting and pricing are still developing because experience offering charging services is limited. Inefficient deployment or operation decisions may reduce the profitability of EV infrastructure investments and possibly result in stranded assets.
- **Lack of standardized contracts increases transaction costs.** Currently, deployment and operation of EV charging stations requires developing customized contracts that drive up transaction costs. For example, EV charging infrastructure maintenance service contracts may be needed to establish which parties are responsible for repairs and for the lost revenue during periods when a charging station is inoperable. Developing individualized contracts for each project adds costs.
- **Stakeholders may not be aware of, or organized to capture, indirect revenue streams that could be generated by charging station deployment.** Retail sites or landlords considering offering charging infrastructure are uncertain about the potential impacts on sales or rental revenues. Automakers may be hesitant about directly investing in charging infrastructure despite the fact that adequate public charging may boost EV sales because: (1) the effects of EV infrastructure on EV sales is uncertain, (2) sales of EVs may not be profitable in the short term, and (3) automakers have little experience deploying refueling infrastructure. Without recognizing, quantifying, and internalizing the indirect revenue benefits of charging station deployment, opportunities for increasing private investment in charging infrastructure could be left on the table.
- **Capital for EV charging projects may be expensive due to a lender's assessment of business risk, adding to the challenge of constructing a profitable business model.** Little is known about the financial performance of EV charging infrastructure, and past projections about EV sales have proven unreliable. Lenders may charge a relatively high interest rate and/or limit loan length terms if they perceive an EV charging business model to be risky. High interest rates and short loan terms can compound the challenge of establishing a profitable business case for charging services.

As a result of these factors, it is challenging to construct a profitable business case for investing in EV charging based solely on selling electricity at a price that is competitive with residential electricity rates. Although the financial performance of a charging station investment depends on many factors, under a range of reasonable assumptions, it could take between 5 and 10 years for a charging provider to recoup its costs for the installation of a Level 2 charging station if the station serviced four vehicles per day at a cost of $0.15 per kilowatt-hour to customers. To achieve a similar payback period, a DC fast charging station would have to service eight vehicles per day at a price of $0.50 per kilowatt-hour. Importantly, $0.50 per kilowatt-hour is the price equivalent of fueling an average gasoline vehicle, so EV drivers will not be able to realize fuel cost savings on trips fueled by DC fast chargers if charging providers must price the fuel at $0.50 per kilowatt-hour or higher.[27]

The barriers to constructing a profitable business case for EV charging depend on the EV charging market conditions, which vary depending on geographic location

as well as the location and type of charger. For instance, the barriers facing EV adoption and EV charging deployment in different markets will likely vary depending on state and local policies, EV ownership rates, driving patterns, socioeconomic factors such as levels of education and income, electricity rate structures, and prices of competing transportation fuels such as gasoline. An understanding of a local economy and market will be essential in order to analyze which tools can most effectively and efficiently reduce these barriers.

LONG-TERM: CHALLENGE OF SCALING UP FLOWS OF CAPITAL

As the EV market grows and as the business case for offering charging services is established, the long-term financial challenge will be to ensure adequate access to capital needed to ramp up investment in EV infrastructure. Even if charging can be provided profitably, investment in EV charging infrastructure may remain at relatively low levels because investors face barriers that limit the availability of low-cost capital for EV charging projects. The barriers standing in the way of expanded investment include:

- Lack of standardized financing structures increases the cost of capital and limits both loan origination and the development of secondary financial markets. EV infrastructure markets are still in the early stages of development, so individual financial transactions are often handled on a case-by-case basis. The transaction costs of these individualized loans are quite high relative to the loan value because non-standardized transactions require a significant amount of dedicated financial modeling, risk analysis, and organizational and legal work. As standardized, repeatable financial mechanisms are established, the transaction costs per unit of financing are reduced and banks can more easily assess risk and perform due diligence as they originate loans. Standardization also would allow loans with similar terms and risk profiles to be pooled and sold in a secondary market, further increasing liquidity and decreasing the cost of capital.
- Absence of a robust secondary financial market for EV infrastructure financial products limits the scale of investment. The existence of secondary markets with numerous buyers and sellers for EV charging infrastructure loans and leases would encourage more primary market loan originations and increase liquidity. A secondary market allows banks and other investors to recapitalize by selling the loans they originate, providing fresh waves of capital that can be used to make more loans. In addition, developing new financial instruments to be traded in secondary markets, such as securities that consist of a pool of EV charging infrastructure loans or leases, could also increase capital flows to EV infrastructure projects. Securitization and asset-backed securities are discussed in Box 4.
- **Investors have insufficient information about the financial performance of EV charging investments.** The lack of sufficient information about EV

Box 4. Securitization and Asset-Backed Securities

Asset-backed securities are financial instruments whose income payments, and hence value, are derived from and collateralized (or "backed") by a pool of loans or leases that have a similar or homogeneous profile of borrower default risk. To securitize assets, a financial institution (such as an investment bank) buys a number of assets, places them in a pool, and then sells securities that represent ownership of part of the pool to investors. The pool is typically composed of a group of small, illiquid assets that are difficult to sell or unprofitable when sold individually due to low margins and transaction costs.

Securitization addresses investors' preferences for diversification and liquidity and can also help to scale up investment by providing standardized financial products. Securitization has been widely used in several sectors where consumer lending is prominent, including the housing and automobile markets. More recently, securitization has helped to lower the cost of capital for solar power projects.[28]

Developing markets for new financial instruments, such as asset-backed securities backed by a pool of EV charging infrastructure loans or leases, could increase financial inflows to the sector and help scale up capital flows and lower the cost of capital for EV infrastructure projects. Securitization can reduce the cost of financing for EV infrastructure by giving investors a way to invest in charging station projects while maintaining a diverse, liquid portfolio.

charging companies and the financial performance of EV charging investments can be a significant barrier to the availability of low-cost capital for EV infrastructure projects. If investors face significant uncertainty about costs, prices, rewards, the market, competition, and other factors, they will be hesitant to invest and will require a higher rate of return to tolerate the perceived higher risk.[29]

- **The low liquidity of EV charging investments reduces their desirability to investors.** Until the EV charging market achieves scale and related financial assets can be traded in a secondary market, investors run the risk that EV infrastructure investments cannot be sold without a significant concession in price because it can be hard to find a buyer for unfamiliar investments. Owning illiquid assets may legally obligate investors to increase their holdings of safer assets— resulting in a high opportunity cost—or expose investors to potentially large losses in the process of rebalancing their portfolios.[30] In addition, highly regulated investors, such as banks, pension funds, and insurance companies, may face liquidity requirements that increase the cost of capital for early, illiquid EV infrastructure investments.

Together, these factors limit the flow of capital into EV infrastructure projects—even projects that are expected to be profitable. Reducing these barriers could induce a virtuous cycle that accelerates investment and, thus, the development of the EV charging services market.

POTENTIAL FOR CEBS TO INCREASE PRIVATE INVESTMENT IN EV INFRASTRUCTURE

CEBs could employ an array of tools to help close the EV infrastructure gap by reducing the barriers to increased private investment in EV charging infrastructure, discussed above. CEB managers and state government officials can analyze the barriers hindering private investment in their local markets, and select the tools best suited to address those barriers.

Addressing the above barriers could initiate a virtuous cycle (depicted in Figure 1) wherein greater numbers of investors contribute low-cost financing, thus expanding the EV charging services market and in turn further reducing barriers to investment. While some barriers, such as access to low-cost capital and insufficient information, can be directly addressed by CEBs, others barriers, such as limited consumer willingness to pay for charging services, cannot be directly addressed by CEB tools. However, CEBs can still indirectly help EV charging business models overcome the limitations that these barriers pose by directly reducing other barriers.

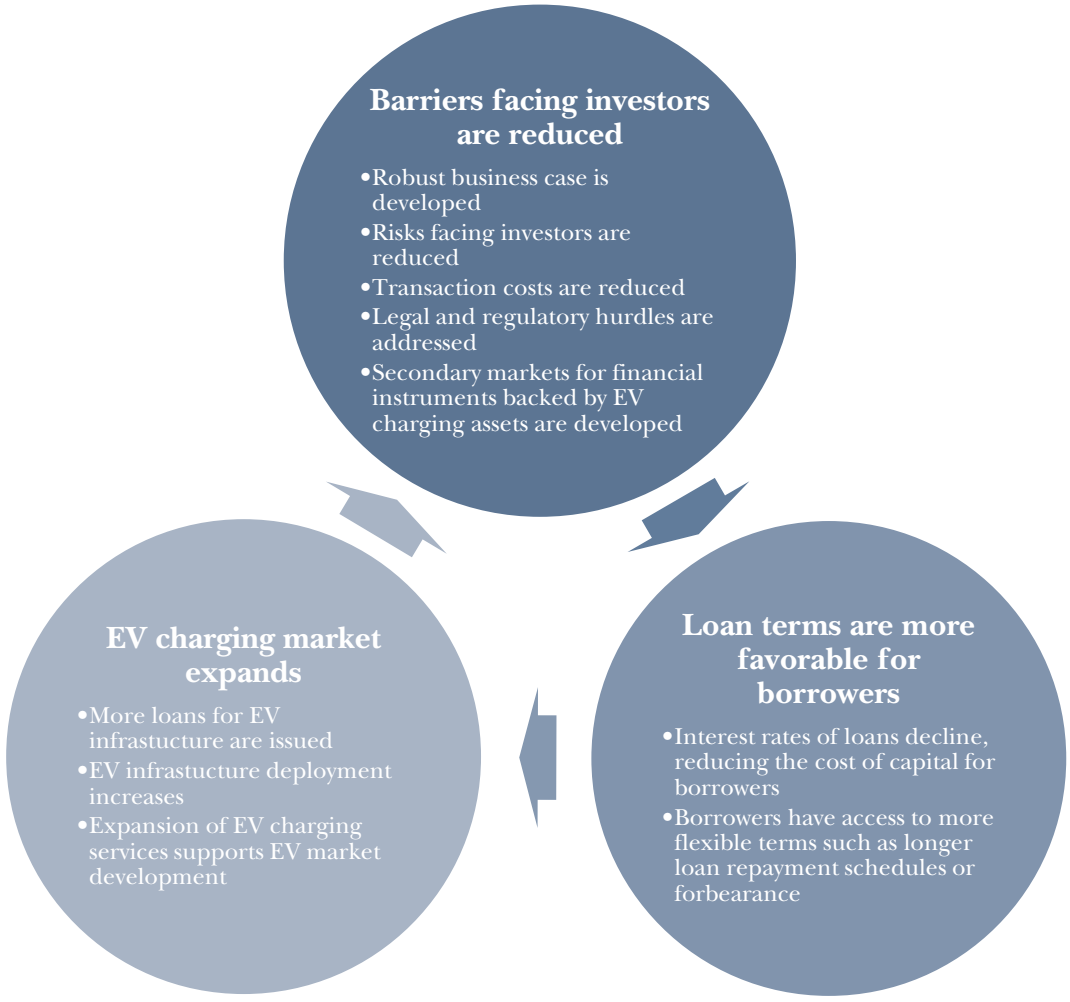
This section first describes the tools typically available to CEBs and then explores opportunities for applying these tools to reduce barriers to (1) developing a viable business model for EV charging and (2) scaling up flows of capital to EV investments.

TOOLS USED BY CEBS

Although a CEB can provide direct lending like a traditional commercial bank, CEBs have many other tools at their disposal that are designed to unlock private lending and remove other barriers to clean energy deployment. CEBs can use these tools to develop programs that help support clean energy deployment in different ways depending on the stage of market development. In general, the mission of CEBs is to facilitate financing for commercially viable technologies that would have far greater market penetration but for the lack of capital. As markets develop, CEBs can scale down their role and achieve greater leverage of their funds as net benefits of clean energy investments become more certain, as the private sector becomes more engaged in deployment and financing, and as barriers to deployment are reduced. And, to manage the risk devoting resources to new types of programs in new clean energy sectors, CEBs can gain experience with some CEB tools through pilot programs of limited scale and financial commitment. Based on the results and the experiences under a pilot program, CEBs can refine and expand the program or discontinue it.

To address the barriers faced by a particular clean energy market, a CEB may develop programs that:

FIGURE 1: Virtuous Cycle of Increased Investment in EV Charging Projects



- Share upfront cost or risk of deployment with project developers during early market development by using CEB funds to provide grants, rebates, or project equity;
- Directly issue low-cost loans using CEB funds for projects that show potential to yield cost savings or other benefits, but are unable to attract sufficient low-cost private capital;
- Enable private investors to offer reasonable-cost financing for potentially profitable projects by using CEB funds to provide interest rate buydowns or credit enhancements (see Box 5);
- Collect and disseminate data and information to reduce investor uncertainty in early markets and decrease costs and risk of technology deployment;
- Facilitate stakeholder partnerships that lower costs or reduce risk by promoting standardized and streamlined contracts, establishing alternative collateralization and repayment mechanisms, directing community-based marketing efforts, or organizing deployment partnerships; and/or
- Support the scaling-up of capital flows into maturing clean energy markets by facilitating the development of secondary markets through warehousing, information dissemination, and securitization.

Depending on how a particular CEB is structured and

what authority it is are granted, it may not have all of these tools available or may have other tools available. The tools described in this section are intended to be representative of the scope of the tools that a CEB could employ to increase private investment in EV infrastructure.

Grants and rebates

Public programs typically use grants and rebates to support technology deployment in early markets that face many barriers, particularly cost barriers.

Grant and rebate programs do not align well with the central goal of CEBs to design and implement programs that leverage a small amount of public funding to attract larger amounts of private investment in commercially viable technologies. Grant and rebate programs require sustained public funding and expend CEB funds more quickly than other public finance programs because there is no repayment.

However, CEBs still may offer grants and rebates as part of their mission to advance clean energy technology development for two reasons. First, CEBs may choose to offer grants and rebates as a component of a broad program aimed at attracting private investment to early-market clean energy technologies. A CEB may determine that it is beneficial to offer grants or rebates as a temporary bridge from the early adopter market to mainstream market viability. Second, CEBs that are established as a consolidation of existing state clean energy programs may be charged with administering grant and rebate programs.

As a result, in some cases, CEBs may provide capital for clean energy projects directly, without expectation of repayment, in the form of grants or rebates. Grants and rebates reduce the need for developers to raise capital for energy projects and can improve project economics by subsidizing costs.

To the extent that grants and rebates improve the economics of clean energy projects, they may also make it easier for developers to attract private investment. In this way, grants and rebates may achieve some benefits similar to credit enhancements, although they are not specifically designed to protect investors from risk of borrower default.[32]

Direct lending, co-lending, and subordinated debt

CEBs can provide low-cost capital to clean energy projects by directly providing loans, either alone or co-lending with private investors by contributing capital into a loan pool along with other investors.

CEBs can offer loans with lower interest rates and longer loan terms than are available to borrowers on the market. In addition, CEBs can also offer other attractive features, such as forbearance, which allows the borrower to defer repayment without defaulting. Forbearance can be particularly helpful to clean energy project deployments with low or uncertain early revenue. CEBs can also expand access to a broader set of borrowers by

Box 5. Credit Enhancements

Credit enhancements are tools that help private investors to offer more attractive financial products by protecting them from exposure to the risk of borrower late payments or loan defaults in immature markets.

The U.S. Department of Energy's and the U.S. Environmental Protection Agency's State and Local Energy Efficiency Action Network has published a helpful brief on credit enhancements, entitled *Credit Enhancement Overview Guide*, which explores the trade-offs among various credit enhancement tools and provides real-world examples.[31]

By lowering the exposure to risk of late payment or default faced by private investors, credit enhancements can encourage increase private investments in clean energy projects in two ways:

1. Expanding access to private capital in relatively immature markets by enabling private investors to relax underwriting criteria; and/or
2. Making financing products more attractive to borrowers by enabling private investors to offer lower interest rates, longer terms, or otherwise more favorable terms.

The following types of credit enhancements are commonly used by public financing programs and are described in the section below:

- Contribution of project equity or willingness to subordinate lending in case of default
- Loan loss reserves and loan guarantees
- Debt service reserve funds

relaxing underwriting criteria, such as minimum credit score and collateral requirements.

Each of these features can enhance the economics of clean energy projects, but also may increase the risk of borrower default faced by the CEB. However, taking on some risk may be within a CEB's mission to promote clean energy deployment. Furthermore, since financial sustainability is often a central goal of CEBs, as opposed to profit, loan programs can be designed with the goal of interest earnings being sufficient to cover any losses from borrower defaults.

Unlike grants, direct lending programs, such as revolving loan funds, are often designed to be financially self-sustaining. Once loan repayments are collected, these funds can be used to issue subsequent rounds of direct loans and leverage the initial public funds. Some energy efficiency and renewable energy loan funds (for instance, the Nebraska Energy Office's Dollar and Energy Savings Loan Program and the Oregon Department of Energy's State Energy Loan Program) have revolved 7-8 times since their establishment.[33]

CEBs can also contribute capital into debt financing pools alongside private investment, which can act as a credit enhancement if the CEB's contribution is subordinated. Under such an arrangement, a CEB would lose their capital first in the event of borrower default, providing a level of protection for the other lenders. In addition to loan pools, CEBs can also contribute capital into pools alongside private capital used to issue attractive clean energy leases.

Direct lending is commonly used to advance clean energy markets that face high barriers to private investment. Direct lending can be particularly useful if there is an overall shortage of bank lending and loan originations, as was the case during and soon after the 2008 financial crisis.[34]

Project equity

By becoming an equity partner in clean energy projects, CEBs can expand access to low-cost capital and improve the economics of clean energy investments.

Equity investment is a less common public finance program than grants or direct loans (discussed above), but could strike a useful balance between these two tools. Unlike grants or rebates, equity investments hold the prospect of repayment, including a return on investment. On the other hand, equity investors take on greater project risk than lenders, as equity bears investment losses before debt. If a clean energy market no longer requires direct cost subsidies, but is still too risky to attract adequate equity investment in the private market, a CEB could provide equity.

The balance of risk between the CEB and the project developer can be adjusted by negotiating:

- The length of time until or conditions under which the CEB expects to cash out;
- The return on investment the CEB expects to realize; and/or
- The subordination of the CEB's equity to other equity investments.

A CEB could reduce the cost of capital for clean energy developers by agreeing to accept a buyout of their equity, with a return on investment that is lower than what the private market would expect. This equity buyout could occur after a predefined period or once specified conditions, such as project profitability, are met. The CEB could also shoulder more risk by agreeing to subordinate their equity investment to other equity investments. This subordinated, low-cost equity capital within the overall portfolio of a project could reduce project risk and could attract greater overall private investment. Such a program would expose CEB investments to significant risk. However, equity investments that experience losses due to project underperformance would, in the worst case, be similar to a project grant on a CEB's balance sheet.

Interest rate buydowns

CEBs can reduce the cost of capital for borrowers by providing interest rate buydowns, which are agreements to subsidize the high interest rates that private investors may require as compensation for lending in uncertain clean energy markets.[35] A typical way to provide an interest rate buydown is to provide either the borrower or the lender with an upfront sum that is equal to the present value of the subsidized component of interest payments over the lifetime of the loan.[36]

While interest rate buydowns are similar to grants and rebates in that they entail a transfer of funds with no expectation of repayment, they differ in that their express purpose is to expend a relatively small amount of public money in order to make private loans more attractive to borrowers. As such, interest rate buydown programs are

able to support a greater amount of clean energy investment per public dollar than grants and rebates. However, while interest rate buydowns reduce the cost of capital for clean energy projects, they do not provide as much financial support to early market projects as grants and rebates.

Interest rate buydowns also reduce the risk of borrower default to a limited extent, by reducing the cost of capital, which increases the likelihood that repayment will occur on time and in full. For this reason, despite the fact that they do not provide explicit protection against non-payment, some professionals consider interest rate buydowns to be a form of credit enhancement.[37]

Loan-loss reserves and loan guarantees

CEBs can use loan-loss reserves or loan guarantees, both of which are types of credit enhancements, to increase private investment in clean energy projects by protecting private lenders from the risk of borrower default.

A loan-loss reserve is a pool of capital from which a CEB pledges to compensate private investors in the event of borrower defaults so the lender and the CEB share the risk of defaults.[38] Under a loan-loss reserve program, a CEB agrees to compensate private lenders for a specified percentage of loan amounts in the event of default. To further ensure that private lenders are motivated to lend responsibly, a CEB also limits each lender's total compensation for defaults under the loan-loss reserve program.

A loan guarantee works similarly to loan-loss reserve, except that a CEB may or may not be required to set aside dedicated capital to cover loan guarantees, depending on its authority. If dedicated funds are not set aside, then a CEB's loan guarantees are backed by the full faith and credit of the CEB and its government sponsor.

CEBs can adjust the level of support provided to clean energy projects, as well as the balance of risk between the CEB and private lenders, by altering the percentage of private loans and loan pools covered against risk.

Loan-loss reserves and loan guarantees that cover a high percentage of private risk may require an amount of funds to be set aside that may be similar in size to the amount that would be required for the CEB to directly issue loans. However, the effects of such loan guarantees and loan-loss reserves are distinct from direct lending in that they engage private lenders to a much greater degree. As a result, the private sector stands to gain more experience in new clean energy markets, which may reduce information barriers and lead to sustained investment as a CEB phases out credit enhancements.

Debt service reserve funds

CEBs can use debt service reserve funds, a type of credit enhancement, to increase private investment in clean energy by reducing the risk of overdue payments from borrowers.

A debt service reserve fund is a pool of capital that a CEB reserves to compensate private investors in a timely fashion in the event of overdue payments from borrowers. If a borrower makes an overdue payment after a CEB has compensated the private investor, the private investor must return the compensation to the debt service reserve.

Debt service reserve funds are particularly effective at protecting private investors' cash flows from risk of late payments. Debt service reserve funds do not protect private investors from borrower default risk, unlike loan guarantees or loan loss reserves, although private lenders may be entitled to keep compensation previously issued from debt service reserve funds in the event of borrower defaults.

Relative to other credit enhancements, debt service reserve funds may require less CEB capital, although funds may be drawn down quickly in the event of borrower default if the program allows lenders to keep the funds in case of default.

Alternative collateralization and repayment programs

CEBs can facilitate the development of clean energy financing programs that provide alternatives to typical collateral types and repayment mechanisms, expanding credit access to a broader set of borrowers and providing some protection against the risk of non-payment.

A secured loan is a loan in which a borrower pledges an asset as collateral to reduce risk for the lender. Loans are often secured against the assets that are financed using the loan, such as a car or a real estate property. The collateral pledged in secured loans allows lenders to offer lower interest rates to borrowers with a wider range of creditworthiness. Unsecured loans are loans in which the borrower does not pledge an asset as collateral. All other factors being equal, unsecured loans generally have higher interest rates than secured loans because lenders

must be compensated for the additional risk of losses due to default.[39]

Using clean energy technology investments themselves as collateral is impractical because it is too difficult for banks to repossess and resell these technologies, both because they are physically installed in a property and because secondary markets may be weak.[40]

Providing an alternative collateralization mechanism can help reduce interest rates and lengthen loan terms by avoiding unsecured loans typically that are issued for clean energy projects. If other more practical collateral sources can be identified, investor risk can be lowered enough to offer more attractive loan terms.

Commercial Property Assessed Clean Energy (Commercial PACE) programs are an example of alternative collateralization and repayment.[41] Under a Commercial PACE program, a local government provides a commercial property owner with low-cost financing for building energy efficiency or renewable energy upgrades. The property owner repays the local government through their property tax bills. To provide collateral, the building owner legally encumbers the property until the debt is repaid, by placing a tax lien on the property in the senior position like other public benefit assessments, which stays with the property even if ownership of the property is transferred. In order for a project to be eligible for financing, that project must be deemed cost-effective by Commercial PACE program administrators and/or third-party evaluators. Commercial PACE financing typically also requires the consent of the existing property mortgage owner.

On-bill financing programs present another opportunity to take advantage of alternative repayment mechanisms.[42] Under an on-bill financing program, loans for qualifying clean energy projects could be repaid through utility bills. On-bill financing decreases overhead costs of loan servicing[43] and may lower the risk of non-payment because the loan is repaid through an existing, familiar channel with a long repayment history.[44] Under an on-bill financing program, customers would select from available private financing options or, if available, dedicated public financing programs. Projects participating in an on-bill financing program would not be financed by utility ratepayers. Similar to Commercial PACE, projects would be required to generate net monthly savings in order to qualify for loans through an on-bill financing program.[45]

Warehousing

CEBs can use warehousing to facilitate the development of a secondary market for loans or other financial products, including securities backed by clean energy financial products. Warehousing is the process of a third party buying, holding, and eventually reselling a financial product to support the development of a secondary market for that financial product. Warehoused financial products may be sold either directly or together with other loans in an asset-backed security.

Warehousing can foster the development of secondary markets in two ways. First, when banks and other primary lenders invest in immature markets, they become liquidity constrained because they cannot sell off the loans they originate. Warehousing allows these lenders to recapitalize and issue more loans, helping primary markets to grow which in turn supports the development of secondary markets. Second, while loans are being warehoused, their history of repayment can build, a process known as seasoning. Seasoning debt instruments gives the loans time to reveal the credit quality of the borrowers, which reduces uncertainty for both primary lenders and secondary market buyers.[46]

Warehousing can also help foster the pooling of financial assets into securities. For a security to be created and sold, a relatively large pool of loans or leases is needed. However, in an immature market, the number of loans may be limited. A CEB can buy and warehouse loans, enabling banks to recapitalize and originate more loans, until such time as there are sufficient loans for incorporation into a security.

When warehousing loans, CEBs take on the risk of borrower default as well as the risk that they may be forced to sell the loans at a loss if, once loans are seasoned, repayment history reveals lower than expected credit quality or if the loans lose value for other reasons.

Information collection and dissemination

As a trusted source of impartial information on overall financial performance for the sector, CEBs can help to diminish risk for primary and secondary market investors in several ways. First, they can be a centralized source for information about clean energy technologies, the financial performance of investments in clean energy technologies, and available programs aimed at accelerating clean energy investment. Because CEBs are

involved in many types of clean energy projects, they can also provide a consolidated central repository of financial information about available clean energy programs in a state or region. Next, through their project funding and credit enhancement programs, they can collect data about the financial viability of projects and repayment history as well as help to develop standardized underwriting criteria. Finally, they can play an important role in promoting the use of standardized contracts and practices by requiring their use in all of their transactions with financiers and project developers.

Standardized contracts, agreements, and procedures can streamline the technology deployment process for all stakeholders and reduce transaction costs. Developing consistent terms, conditions, reporting requirements, financial calculations, and contracts can save time, money, and improve investor confidence. Related to this, standardized contracts and underwriting criteria are also important for investors trying to assess the risk and value of associated loans or leases. For all of these reasons, standardization is often recommended by programs that aim to facilitate investment in clean energy technology.[47]

Standardization facilitates the bundling of related types of investments into new types of investment vehicles or securities, which can, in turn, help generate more investment. Standardization also enables investors and analysts to more easily assess the quality of the bundled assets against an industry standard.[48]

Collecting and disseminating data and information about the technical and financial performance of clean energy loans and leases can help develop primary and secondary markets for associated financial products. Once a new clean energy financial product exists, CEBs can use the data and history it generates to further reduce uncertainty for private lenders and investors.

Coordination, outreach, and facilitating partnerships

Finally, CEBs can play a valuable coordination role, organizing stakeholders and facilitating partnerships that advance clean energy deployment by lowering project costs, reducing risk, and enabling diverse partners to collaborate on new projects and programs.

Through dedicated outreach efforts and as a component of other clean energy programs, CEBs can work with stakeholders to improve clean energy project financial performance by streamlining processes and agreements required for clean energy deployment, which can reduce transaction costs. CEBs can work with banks, suppliers, installers, insurers, and service companies to develop standardized and streamlined contracts for services related to clean energy technology deployments.[49, 50] CEBs can also work with local governments and state agencies to help prudently streamline deployment permitting processes by providing information, including model codes and best practices.[51,52]

CEBs can also develop and coordinate community-based marketing programs for clean energy technology deployment. A community-based marketing program is designed to focus outreach efforts and lower the price of clean energy technologies to customers by reducing the cost of customer acquisition to sellers and installers. Under such a program, volunteers engage with local residents to offer below-market pricing of a clean energy technology, such as a solar power system, with tiered pricing based on the number of residents who sign up. Installers are able to offer discounts because the program's education and outreach campaign, arranged financing options, and the volume of local customers reduces the installer's marketing and transaction costs.[53]

CEBs can also organize public-private partnerships aimed at advancing deployment by pooling the efforts, financial resources, and expertise of diverse stakeholders for whom clean energy deployment generates different kinds of value. Public-private partnerships with broad participation can empower stakeholders to work together to overcome market barriers, perhaps even co-financing mutually-beneficial deployment projects.

The success of many other CEB tools also depends on the coordination of diverse private sector partners. To develop and execute programs that provide credit enhancements or pool public and private dollars, CEBs may work with technology experts, commercial lenders and investors, lending servicers, installers, insurers, and financial services companies. To facilitate the development of alternative collateralization and repayment mechanisms, CEBs may also work with local governments, state legislators and regulators, and utilities to enable and implement these programs.

Finally, the consolidation of existing financial programs into a centralized entity, such as a CEB, may enhance outreach efforts and program design and may lead to greater efficiency. Consolidating new and existing

clean energy finance programs under a single structure provides stakeholders with a one-stop source of information, which can raise the profile of clean energy opportunities and supporting public policies and programs. In addition, consolidation of clean energy program offerings under a single structure can facilitate their coordination and harmonization by empowering administrators to identify and address program synergies, overlaps, and gaps.

NEAR TERM: ESTABLISHING A COMPELLING BUSINESS CASE FOR EV CHARGING SERVICES

This section explores how the CEB tools discussed above could help overcome the barriers to a compelling business case for providing EV charging services.

The most effective set of tools to apply depends on the goals of the CEB, the maturity of the EV infrastructure market, and the specific barriers standing in the way of a profitable business case for offering charging services in a given region. Broadly speaking, CEBs can reduce EV charging business risk by:

- Sharing risk and upfront costs with project developers;
- Reducing project costs and risk through information dissemination and stakeholder coordination; and
- Expanding access to low-cost capital.

The tools that CEBs can apply to reach these goals are discussed below, and are summarized in Table 2.

TABLE 2: CEB tools that could help overcome near-term barriers to a viable business case for EV charging services

GOAL	TOOL	OUTCOMES
Sharing upfront costs and risk with project developers during early market development	Grants and rebates	• Directly provides project capital • Subsidizes project costs
	Project equity	• Directly provides project capital • Capped rate of return on public investment reduces cost of capital • Reduce risks faced by project developers and may subsidize project costs if equity investments are subordinated
Reducing project costs and risk through outreach and coordination	Information collection and dissemination	• Reduces uncertainty for charging station developers and investors • Reduces transaction costs by promoting standardized contracts
	Coordination, outreach, and facilitating partnerships	• Reduces charging station utilization risk through community-based marketing for EVs • Provides needed cost-sharing or low-cost capital from private stakeholders that benefit from EV infrastructure deployment through deployment partnerships
Expanding access to low-cost capital	Interest rate buydowns	• Reduces the cost of capital for EV charging project developers • Increases private investment

GOAL	TOOL	OUTCOMES
	Direct lending	• Directly provides needed project capital • May offer lower interest rates, longer loan terms, and relaxed underwriting criteria
	Co-lending and project equity	• Increases private investment through co-lending • Enables private investors to offer attractive loan terms to an expanded set of borrowers, as subordinated loans and project equity act as credit enhancements
	Loan loss reserves and loan guarantees	• Act as a credit enhancement, enabling private investors offer attractive loan terms to an expanded set of borrowers
	Debt service reserve funds	• Act as a credit enhancement, enabling private investors offer attractive loan terms to an expanded set of borrowers
	Alternative collateralization and repayment programs	• Avoids unsecured loans through alternative collateralization, enabling private investors to offer reduced interest rates and lengthen loan terms • May decrease overhead costs and lower the risk of non-payment through alternative repayment modes, enabling private investors to offer reduced interest rates and lengthen loan terms
	Information collection and outreach	• Educates private investors about EV charging business opportunities and provides financial performance history data • Provides a centralized source of information about available financial programs that can increase investor and developer participation in these programs

Sharing upfront costs and risk with project developers during early market development

In the early market, the business case for offering EV charging services at some locations and charging levels may be unprofitable or too uncertain for the private sector to deploy without government support, even if charging station project developers can access low-cost financing. The business case for a particular early market charging station project could be unfavorable due to combination of factors, such as:

- High upfront equipment, installation, and transaction costs;
- High operating costs because of electricity demand charges;
- Low and uncertain station utilization;
- Low consumer willingness to pay for charging; and
- Inefficiency and uncertainty resulting from lack of experience in an immature market.

If a CEB determines that offering charging services is valuable for EV market development, despite the challenging business case, the CEB may conclude that providing cost and risk subsidies for some charging stations is justified in order to facilitate EV market development.

A CEB could provide cost and risk subsidies for EV charging projects through grants and rebates, or by providing equity investment. Subsidies could be provided at the project's initiation to offset upfront equipment and installation costs and/or over time to offset operating costs while cash flows are uncertain during periods of low utilization. Many states and municipalities already offer grant or rebate incentives for charging station deployment,[54] while no states have made equity investments in EV charging deployment projects to date.

As the EV market develops, a CEB could readjust its grant, rebate, and equity offerings to provide a minimal level of support. To use resources efficiently and avoid crowding out private investment, if the financial performance of EV charging investments improves, a CEB could offer smaller grants and rebates, provide equity investments that hold the prospect of repayment, and/or shift resources to other EV charging programs that provide less direct support.

Reducing costs and risk through outreach and coordination

CEBs could reduce some of the costs and risks of EV charging service business models by collecting and disseminating information, by coordinating targeted outreach programs, and by facilitating partnerships.

By working with private sector partners to collect data about the financial performance of EV charging loans and projects, and by publically releasing data and information products based on these data, CEBs could reduce uncertainty among project developers and investors. By overcoming this information barrier, the risk of debt and equity investments in charging station projects could be reduced, resulting in a lower cost of capital for developers and greater private investment. As a means of collecting data, CEBs could require some data sharing as a condition of participation in other programs, such as grant or credit enhancement programs.

CEBs could work with partners in the EV charging industry to develop standardized contracts for services related to EV charging business models, such as repair and maintenance, which could lower transaction costs for project developers by reducing the cost of establishing these agreements. For example, a standardized EV charging infrastructure maintenance service contract could indicate which parties are responsible for repairs and for the lost revenue while the charging station is inoperable. This standardization could reduce the costs of developing individualized contracts. A CEB could also work with state and local governments to help prudently streamline EV charger installation permitting processes by providing information, including model building and construction codes and best practices.

CEBs could work with stakeholders to promote opportunities for including EV charging plans in larger projects, including offering incentives to bundle projects in its other programs. Linking investments in EV infrastructure with investments in other projects that have more immediate cash flows, shorter paybacks, and/or more established repayment histories could also reduce EV charging project costs and risks. Bundling projects with different payback periods has been successful in the energy efficiency market, where items with a short payback time, such as lighting, are bundled with more expensive items having longer payback times such as heating, ventilation, and air conditioning (HVAC) systems. These bundled projects, often taking the form of comprehensive retrofits, can be designed to yield an overall project cost and payback period that is acceptable to building owners/operators as well as investors. For EV charging projects, bundling together with solar deployments could provide tax credits, depreciation allowance, and tradable solar credits that could boost the business case for investors.

CEBs could directly support EV market development and reduce the risk of charging station underutilization by coordinating community-based marketing programs for EV sales. Focusing outreach and EV sales efforts on communities or workplaces where EV adoption is likely to occur could reduce the cost of educating customers about EVs and selling the vehicles. Volunteers from the community who are knowledgeable about EVs could engage with residents or employees. Local automobile dealerships, potentially in collaboration with automakers, could offer vehicle discounts or other incentives based on the number of buyers. EV charging station deployment could be informed by the local, concentrated adoption of

EVs, potentially reducing the risk that stations are underutilized.[55]

CEBs could also facilitate a partnership among stakeholders to advance EV charging deployment by pooling the efforts, financial resources, and expertise of diverse stakeholders for whom clean energy deployment generates different kinds of value. For example, wider deployment of AFV refueling infrastructure benefits refueling equipment suppliers and installers, fuel suppliers, automakers, retail site owners, and the general public. Public-private partnerships with broad participation can empower stakeholders to work together to overcome market barriers, perhaps even co-financing mutually beneficial deployment projects.

Expanding access to low-cost capital

In situations where the business case for offering charging services is financially viable or close to viable, CEBs could help develop the market by expanding EV charging developers' access to attractive financial products, including loans with lower interest rates, longer loan terms, and/or flexible repayment schedules.

Expanding access to loans with lower interest rates and longer loan terms can have a significant impact on EV charging project costs and cash flows, as demonstrated in Table 3. For a ten-year $1 million loan to deploy ten DC fast-chargers, reducing the interest rate from 15% to 5% reduces the borrower's monthly payments by over $5,500—a 34% reduction. For a similar loan at an interest rate of 15%, increasing the loan term from 5 years to 10 years reduces monthly payment by over $7,500—a 32% reduction. For projects on the edge of profitability, reducing financing costs can tip the scales toward financial viability. Additionally, reducing monthly payments can improve EV charging project cash flows during critical early years when, as the EV market develops, revenues may be low as a result of station underutilization.

TABLE 3: Monthly loan payments for a traditional $1,000,000 amortizing loan to finance ten DC fast-charging stations

		INTEREST RATE					
		1%	5%	10%	15%	20%	25%
LENGTH OF LOAN TERM	3 years	$28,208	$29,971	$32,267	$34,665	$37,164	$39,760
	5 years	$17,094	$18,871	$21,247	$23,790	$26,494	$29,351
	10 years	$8,760	$10,607	$13,215	$16,133	$19,326	$22,749
	20 years	$4,599	$6,600	$9,650	$13,168	$16,988	$20,982

$100k in upfront costs per station. Interest rate refers to annual interest rate, with interest compounded on a monthly basis. Payments include both principal and interest and have been rounded to the nearest dollar.

The option for borrowers to delay repayment through forbearance could also help EV project developers withstand low and uncertain early EV charging project revenues. Forbearance periods could be designed to correspond to the estimated time lag between public EV charging station deployment and sufficient local EV adoption for station profitability. Forbearance could allow EV infrastructure owners to withstand very lean initial

months or years by requiring no payments in the near term.

CEBs may have several different tools at their disposal that can expand access to attractive financing products, including:

- Directly providing attractive financing products;
- Enabling private investors to offer attractive financing products by:
- providing subordinated debt or equity to pool with and de-risk private capital;
- providing interest rate buydowns;
- providing other credit enhancements such as loan guarantees, loan-loss reserves, or debt-service reserve funds;
- offering programs that enable advantageous collateralization and repayment mechanisms; and
- reducing investor uncertainty by collecting and disseminating information.

CEB programs designed to expand access to low-cost capital for EV charging projects should aim to strike an efficient balance of risk among project developers, private investors, and the public sector based on the state of the EV charging market, the government's EV market development goals, and the resources available to CEBs. The opportunities for applying these tools to support EV charging market development are discussed below.

One way for CEBs to expand access to low-cost capital for EV charging project developers would be to directly provide loans. By providing direct loans, a CEB can offer attractive low-cost, flexible loans and relax borrower credit requirements, within the bounds of their underwriting practices and risk tolerance, to help finance EV charging projects.

Alternatively, CEBs can develop programs that engage private investors and enable them to offer low-cost private finance, longer repayment terms, and options for delayed repayment. Such programs are advantageous because (1) public funds can be leveraged to directly enable greater immediate impact on EV charging deployment by attracting private investment; (2) engaging the private sector familiarizes private investors with EV charging investment opportunities; and (3) expanding the private sector role in financing EV charging projects will help the markets to scale up more effectively than would result from public financing alone.

For instance, CEBs could develop and coordinate financial programs that pool public and private dollars and enable the CEB to contribute subordinated debt or equity capital as a credit enhancement. By directly providing project equity or subordinated loans for EV charging projects, a CEB could provide needed capital as well as a credit enhancement that could expand access to more attractive private loans.

Furthermore, as part of an equity investment, a CEB could offer additional conditions to incentivize investment and improve the business case for EV charging, such as a cap on the CEB's return on investment or the subordination of the CEB's equity to private investors' equity. Such programs could also be designed to enable tax equity investors to participate by contributing low-cost capital in exchange for tax benefits, including tax credit incentives for EV infrastructure deployment and accelerated depreciation tax benefits of physical EV charging assets.

CEBs could also increase private investment in EV charging stations by providing interest rate buydowns for loans offered by commercial banks or by offering credit enhancements, such as loan guarantees, loan-loss reserves, or debt-service reserve funds. Such programs could be designed to enable or require private investors to offer lower-cost, longer term financing to borrowers seeking to deploy EV infrastructure, reducing financing costs and improving cash flows for EV charging projects.

Working together with local and state governments, utilities, and/or private investors, CEBs could explore opportunities to develop and coordinate programs that enable advantageous collateralization and repayment mechanisms for loans that fund EV infrastructure. For instance, EV charging investments could be included in Commercial PACE or utility on-bill financing programs. Under such programs, CEBs and/or commercial banks could provide more attractive lending for EV charging projects because their risk would be reduced. Providing alternative forms of collateral, such as property tax liens through a program like Commercial PACE, could enable public or private lenders to offer lower-cost loans for EV charging projects. This is because, like many clean energy investments, EV charging assets are ineffective as collateral, as they are too difficult for banks to repossess and resell. Providing alternative forms of repayment, on property tax bills through programs like Commercial PACE or on electric utility bills through an on-bill

financing program, could make repayment more convenient and reduce the risk of borrower non-payment. While these opportunities present potential benefits, establishing eligibility of some EV charging assets under these programs may be challenging, because transportation investments have not been included in such programs before and these programs typically require clean energy investments to be demonstrably profitable to qualify.

Lastly, CEBs could collect information and reach out to potential EV charging developers and investors to lower the cost of capital for EV projects by reducing uncertainty among private sector stakeholders. CEBs could help educate private investors on the opportunities and risks of investment in the evolving EV infrastructure market. CEBs could also collect data on the financial performance of EV charging projects and investments and these data to reduce uncertainty for developers and investors. CEBs could also act as a one-stop source of information about available financial programs aimed at facilitating EV charging development. Together, these tools could unlock low-cost private investment in EV charging by raising the profile of investment opportunities and reducing developer and investor uncertainty about these opportunities.

LONG-TERM: SCALING UP FLOWS OF CAPITAL TO EV CHARGING PROJECTS

This section explores how, in markets where a compelling business case for EV charging services is established, CEBs could increase EV infrastructure deployment by helping to ensure adequate access to capital needed to ramp up investment.

CEBs could help to scale up available capital by:

- Fostering the development of secondary markets for EV charging loans and leases; and
- Exploring and facilitating securitization of EV charging loans and leases to enhance their value on secondary markets and to reduce the cost of capital for EV projects.

The tools that CEBs can apply in support of these goals are discussed below, and are summarized in Table 4.

Developing secondary markets for EV charging loans and leases

CEBs could help scale up investment in EV infrastructure by facilitating the development of secondary markets for EV charging loans and leases, which would enable loan and lease originators to recapitalize and fund more projects. To develop these secondary markets, CEBs could implement programs aimed at standardizing these products, increasing their liquidity, and reducing uncertainty about their financial performance.

The first step toward developing secondary markets for EV loans and leases is to develop well-functioning primary markets for EV charging loan and lease origination, which is the topic of the previous section. High-quality primary financial markets are needed to generate loans and leases that can be sold in secondary markets. In addition, some CEB actions undertaken to advance primary markets also facilitate secondary market development beyond simply providing more loans and leases to be sold. In particular, efforts to standardize loan and lease terms not only reduce transaction costs in the primary market, but also increase the liquidity of those products in the secondary market. Similarly, gathering and disseminating information about the history of repayment of EV loans and leases is particularly important for secondary market buyers who are likely to be less familiar with EV charging technology and investments than primary investors.

By developing programs to warehouse EV charging loans and leases, CEBs could enable lenders to recapitalize and issue more loans in the immediate term and, over the longer term, allow warehoused loans and leases to generate a history of repayment that can reduce uncertainty and risk for both primary and secondary markets investors. In addition, by agreeing to purchase some EV charging loans and leases and not others, CEBs can send signals to primary market investors, encouraging them to originate more standardized, high quality loans and leases and/or invest in desired EV charging markets. CEBs could also facilitate secondary market development through information collection and dissemination. Gathering and disseminating information about the payment history of EV loans and leases can reduce information barriers and may foster greater secondary market activity.

TABLE 4: CEB tools that could help overcome long-term barriers to scaling up flows of capital to EV charging projects

GOAL	TOOL	OUTCOMES
Developing secondary markets for EV charging loans and leases	Primary market lending and credit enhancement programs	• Increases the supply of financial products that can be sold in secondary markets • Can promote standardization of financial product contracts, increasing their liquidity
	Warehousing of loans and leases	• Increases liquidity of EV financial products • Reduces uncertainty and risk of investment by providing more information about the history of repayment of EV financial products
	Information collection and dissemination	• Reduces information barriers and may foster greater secondary market activity by disseminating information about the history of repayment of EV financial products
Facilitating securitization of EV charging loans and leases	Warehousing of loans and leases	• Provides a sufficient number of EV charging loans or leases to be incorporated into early securities • Can streamline the process of securitization by requiring standardized contracts and credit terms as a condition of purchasing loans or leases • Informs securitization by providing data on the repayment performance of EV charging loans and leases
	Information collection and dissemination	• Can attract greater private investment through secondary markets by collaborating with stakeholders to develop new securities backed by EV charging assets • Reduces information barriers to private investment by disseminating data on and analysis of the risk and financial performance of new securities • Supports the pooling of EV charging assets alongside other assets in securities, which may increase attractiveness of those securities to investors
	Warehousing of securities	• Increases liquidity of new securities • Reduces uncertainty and risk of investment by providing more information about the financial performance of securities

Securitization of EV charging loans and leases

Developing markets for new securitized financial instruments, such as asset-backed securities backed by a pool of EV charging infrastructure loans or leases, could play a role in scaling up the capital flow to EV infrastructure projects. CEBs could help address investors' needs for diversification by facilitating the development of new securities that allow investors to easily own either a small part of a large EV charging project or a part of a pool of diverse projects that include EV charging projects. Furthermore, pooling EV loans or leases into a security with safer, more familiar clean energy investments that have a shorter payback and/or a higher return on investment could also help attract investment in early EV securities.

Warehousing of EV charging loans and leases by a CEB could facilitate their incorporation into new securities in several ways. First, in the early stages of EV charging market development, the number of loans and leases available to be securitized may be limited. By warehousing a pool of these assets, a CEB could help amass a sufficient number of EV charging loans or leases to be incorporated into early securities. Second, as part of a CEB's agreement to buy loans or other debt instruments from loan originators, that CEB could require standardized contracts and credit terms, which can streamline the process of securitizing these assets at a later date. Lastly, data collected on the repayment performance of EV charging loans and leases while they are warehoused could inform which types of these assets can be securitized and in what manner. Warehousing could also facilitate primary market development, as it allows lenders to recapitalize and reinvest in new EV charging projects.

By collaborating with investors and other stakeholders to develop and promote a new security backed by an asset pool that includes EV charging loans or leases, CEBs could help initiate new markets for similar financial instruments. The data collection made possible by the creation of the first security, and the dissemination of these data, can make the next round of securitization less risky for private investors. Supporting the pooling of EV assets alongside other project types in securities also may increase the attractiveness of those securities to investors. Experience and data on early securities can also inform the development of standards for securitization of asset pools that include EV charging loans or leases, which can make these securities more liquid.

Once a new type of security is established that is backed by an asset pool that includes EV charging loans or leases, a CEB could facilitate development of markets for these securities by warehousing them. Investors may not want to purchase a new, unfamiliar security backed by a pool of EV charging infrastructure until the first movers have provided more data on its volatility and returns. Before the EV charging market achieves scale, investors run the risk that an EV asset-backed security cannot be sold without a significant concession in price. Warehousing new securities can allow for collection of financial data that reduces uncertainty and risk for investors. This reduced risk can also help a new type of security obtain favorable ratings from ratings agencies, which can broaden the potential set of investors.

THE IMPORTANCE OF CEBS RETAINING FLEXIBILITY

It is important for CEBs to retain flexibility because, as the EV charging market develops, the barriers standing in the way of addressing the EV infrastructure gap will change. There are many tools that CEBs may have available to them that can help address the barriers impeding the business case for EV charging, limiting access to low cost financing for EV charging deployment, and constricting capital flows into these projects. CEBs that are able to adapt to these changes by developing programs that apply the tools best suited to addressing the evolving needs of the EV charging markets will be most successful at efficiently promoting market development. CEB planners should work with local businesses, investors, and other stakeholders to develop an understanding of what barriers are most important in their area and develop programs that can efficiently help to reduce those barriers. The barriers to greater EV charging deployment will depend on the changing state of the EV charging market in each geographic location, as well as the specific location and type of charger. An understanding of a local economy and market are essential to analyzing which tools can most effectively and efficiently reduce these barriers.

CLEAN ENERGY BANKS AND OTHER FINANCIAL PROGRAMS: EARLY LESSONS AND OPPORTUNITIES TO ADVANCE EV INFRASTRUCTURE

This section gives a brief overview of existing and proposed CEBs as well as a few other government programs that offer similar financial tools that could be applicable to AFVs. While there are many such programs, the focus here is on insights that could be useful for financing transportation-related projects with uncertain revenue streams.[56]

The structure of a CEB affects the CEB's rules of operation and therefore the way it uses the different tools at its disposal. Generally, a CEB can be housed directly within a government or can act as a separate, quasi-governmental entity. The creation of a new quasi-governmental organization may ultimately allow greater flexibility, but could be more challenging to set up and require new legislation. Creating a new group within a state government may only require a program reorganization and redefinition of mission and objectives.[57] Once a CEB is established, however, organizational structure can affect its operating rules and its focus. For example, state procurement rules may require agencies to issue a public call for proposals, rather than seeking out or reacting to submitted project proposals outside of an official call for proposals.

Currently, two states refer to their public-private finance programs as CEBs: Connecticut and New York. Other states have similar programs to a CEB and additional states are considering establishing CEBs. Connecticut created its CEB through legislation and structured it as a quasi-governmental organization in 2011. New York's CEB, created through a reorganization of existing government agencies, was initially announced in January 2013. Hawaii began its public-private finance program, known as the GreenSun program, in June 2013 and like New York, it too is housed within the government.[58] Other states giving serious consideration to a CEB include California and Maryland. Funding for California's program was not included in the 2014 budget, but significant progress in underway for its creation. The Maryland General Assembly passed Senate Bill 985 in April, directing a study of the opportunity and role of a Maryland Green Bank.

No CEBs or other public-private finance programs have yet focused on the deployment of EV infrastructure, but many of their tools and lessons would be applicable. Connecticut and New York, however, have noted the eligibility of EV charging projects for their CEB programs.

CONNECTICUT'S CLEAN ENERGY FINANCE AND INVESTMENT AUTHORITY

In 2011, Connecticut's Clean Energy Finance and Investment Authority, later renamed the Connecticut Green Bank (CGB), became the first clean energy bank in the United States. As the successor organization to the Connecticut's Clean Energy Fund, it was created to leverage private capital and promote the deployment of clean energy.[59,60] CGB is a quasi-governmental organization overseen and guided by a Governor-appointed Board of Directors. Funding for the organization comes from three sources: a one-time contribution from funds provided to the state by the American Recovery and Reinvestment Act of 2009 (ARRA), as well as continued capitalizations from a state electricity system benefit charge and revenues from the Regional Greenhouse Gas Initiative.[61] At the end of 2013, CGB had almost $100 million in assets.[62] The CGB's main goal is to bring clean energy deployment to scale by leveraging its limited public funding to attract private funding. The organization focuses around real estate sectors: Residential, Commercial & Industrial; Municipalities, Universities, Schools & Hospitals; and Grid & Infrastructure..

While no transportation projects have been funded thus far, alternative fuels are identified as eligible for support in the list of clean energy technologies identified in CGB's establishing legislation.[63] The list of technologies eligible for CGB specifically lists hydrogen conversion technologies, fuel cells, EVs, hybrid-electric vehicles, and AFV fueling infrastructure projects as eligible for assistance, and CGB staff have begun researching what types of assistance would best facilitate EV charging deployment.[64,65] Like it has done for energy efficiency and solar energy, CGB could establish financial programs or wholesale support to private sector programs to reduce market uncertainty and attract private capital to EV charging projects. In addition, CGB could also advance EV infrastructure by lowering transaction costs;

operating as a trusted clearinghouse of information for consumers, installers, and investors and generally acting as a market coordinator are all services that would benefit the AFV infrastructure deployment. The three initiatives highlighted below illustrate a few of the financial tools that CGB and, more generally, a CEB could provide to support EV charging market development.

C-PACE. CGB offers property assessed clean energy financing to non-profit and commercial property owners throughout Connecticut through a program named C-PACE. C-PACE allows building owners to finance qualifying energy efficiency and clean energy improvements by taking on a voluntary assessment on their property tax bill. In this way, property owners can pay for the improvements over time and the repayment obligation transfers with the property should it be sold. Because repayment is attached to the tax bill and the investment is secured with a lien on the property, there is less risk for the investor and capital can be secured at a lower interest rate. If a C-PACE participant does not make its payments, the investors can recoup their investment through the lien on the property and be second in line for repayment, subordinate only to local municipal property taxes. A benefit for building owners is that the repayment obligation remains with the building, not the owner, so if they sell the building, the repayment requirement stays with the building where the energy benefit is realized.[66,67] In May 2014, CGB announced its first sale of a securitized portfolio, under which $30 million of C-PACE liens were sold to private finance provider Clean Fund.[68]

By providing subordinated loans, alternative collateralization, and acting as a trusted source for general information and technical assistance, a program like C-PACE could be helpful for EV infrastructure where high upfront costs and uncertain repayment history make deployment challenging.

CT Solar Lease II. Using credit enhancements to leverage funds for solar projects, CGB's CT Solar Lease II supports deployment of residential solar photovoltaic and solar thermal (hot water) systems as well as commercial solar systems for over two years.[69] The program uses three types of credit enhancements—loan loss reserves, subordinated debt, and sponsor equity—to help lower the risk for private investors and attract private capital to finance solar installations. The program used $3.5 million of ARRA and U.S. Department of Energy State Energy Program funding for a loan loss reserve and $9.5 million for subordinated debt and sponsor equity as credit enhancements. The program is expected to support the deployment of nearly 2,000 solar systems.[70]

Private capital came from two primary sources. A syndicate of banks, led by First Niagara, provided $26.7 million of senior debt for the program. US Bank provided $23.6 million in funding in return for the ability to aggregate and monetize the tax benefits, including a federal investment tax credit and accelerated depreciation.[71,72] All totaled, Solar Lease II will provide $60 million for solar leases. With $9.5 million of ratepayer funds attracting $50 million of private capital, the ratio of private to public funds is expected to be nearly five to one.[73]

CGB expects to recoup its original capital investment, along with a nominal return.[74] Through credit enhancements and tax credit monetization, CGB shares the investment risk with private investors. If the program is successful, with a low default rate and CEB's equity, the subordinated debt and the loan loss reserve funds will all be repaid as the leases mature.[75]

Solarize Connecticut. CGB is a partner in and coordinator of the Solarize Connecticut community-based marketing initiative for solar power deployment, along with the John Merck Fund, Putnam Foundation, and SmartPower.[76] Under this program, communities and project partners engage with local residents to offer residential solar deployments. Working with CGB, each community selects an installer who agrees to offer significant discounts depending on the number of residents who agree to participate. The installer is able to offer these discounts because the education and outreach campaign, arranged financing offers, and volume of local customers reduces the installer's marketing, acquisition, and transaction costs. CGB acts as a program coordinator, a trusted source of information, as well as financial partner for the program.

HAWAII'S GREENSUN AND GEMS PROGRAMS

In October 2011, Hawaii launched a green bank-type public-private entity called the GreenSun Program with initial capitalization of $2.7 million from ARRA. Administered by the Hawaii Community Reinvestment Corporation (HCRC), a community based 501(c)(3)

nonprofit, HCRC is also a Community Development Financial Institution and a Community Development Entity as designated by the U.S. Department of Treasury. Open to residential and commercial entities, the GreenSun program works with a list of lenders to offer more attractive financing options for renewable energy generation and building energy efficiency upgrades. GreenSun provides a credit enhancement program by offering a loan loss reserve to lenders with two options:

1. The GreenSun Legacy Program, which allows participating lenders to offer eligible property owners loans better loan terms and interest rates than might be offered without the program.
2. The GreenSun CAP Program, which expands financing options for underserved property owners. By absorbing some of the risk, the GreenSun Capital Access Program's credit enhancement encourages participating lenders to consider loans that may otherwise fall outside of conventional underwriting standards.

Depending on the type of loan (GreenSun Legacy or GreenSun CAP), contributions to the lender's loan-loss reserve account may range from 4% to 14% and first losses covered on defaulted loans may range from 10% to 100%. The program asserts that it has the ability to leverage $2.7 million of federal funds into $53 million in energy saving loans statewide.[77]

In addition, Hawaii is in the process of establishing a "Green Infrastructure Authority,"[78] known as Green Energy Market Securitization (GEMS), to be housed within the state government.[79] Hawaii Senate Bill 1087 authorized $100 million in bonds to finance a renewable energy loan fund under the program.[80] Under this program, loans for renewable energy deployment can be paid back through on-bill financing, whereby customers repay the loans through line-item charges on their regular utility bill. The program enables many individuals and businesses to invest in solar power systems for their homes and businesses that were without access to traditional financing sources due to low income levels or a poor credit history.[81]

While loan-loss reserves, like those used for energy efficiency and renewable energy, and on-bill repayment could potentially be similarly applied for AFV infrastructure, AFV infrastructure is not currently included as an eligible project type in the GreenSun or GEMS programs.

NEW YORK GREEN BANK

Announced in January 2013 by Governor Cuomo, the New York Green Bank (NYGB) is part of the New York State Energy Research & Development Authority (NYSERDA). New York officials anticipate that NYGB could eventually be the largest CEB in the country.[82] NYGB was established with approval from the New York Public Service Commission at the end of 2013. Because NYSERDA had existing authority to provide market support, legislation was not needed to establish NYGB. The governor pledged to capitalize the NYGB with $1 billion. The bank's initial funds of $218 million are a combination of $165 million from regulated electric and natural gas utility ratepayer funds, which required the Public Service Commission's approval, and $53 million from the Regional Greenhouse Gas Initiative funds already under NYSERDA's authority.[83,84]

NYGB officially opened for business in February 2014, and issued an open market solicitation to private sector lenders, investors, and other industry participants. NYGB officials elected to solicit project requests from businesses and investors rather than directly creating products, in hopes of ensuring that bank programs are responsive to the needs of the market.[85] The solicitation is very broad, open to both investors and clean energy project developers. The solicitation is also ongoing, allowing for submissions at any time, including resubmission by previous applicants. NYGB requires applicants to cite the market barrier that its support would help to overcome and describe how the proposed plan could support clean energy reaching market scale.[86]

All projects that have the potential to reduce state greenhouse gas emissions are eligible, including AFV-related projects.[87] New York's CEB includes electric vehicle infrastructure in its list of eligible investments.[88,89]

CONSIDERATION OF CLEAN ENERGY BANKS IN MARYLAND AND CALIFORNIA

During the 2014 legislative session, Maryland adopted legislation directing the state's energy office to produce a study of the feasibility of forming a CEB.[90] The study will consider issues including whether the financing needs of clean energy sectors are being met, how a CEB could help address financing gaps, and how a CEB might be

established and structured. The next steps may be to expand an existing direct-loan program to offer credit enhancements and the potential of repurposing additional funds for new projects, including possible EV charging infrastructure support.[91] In the future, Maryland may consider creating a more comprehensive CEB that would enable it to participate in projects beyond the existing financing authority in both scope and scale of the MEA and other state agencies. The state would need to enact new legislation for this CEB to be created. Notably, Maryland appears poised to include transportation options to help deploy alternative transportation technologies, including EV charging infrastructure.[92]

In February of 2014, California Senator De Leon introduced Senate Bill 1121: The California Climate Technology and Infrastructure Financing Act, which proposed to establish a CEB charged with maximizing greenhouse gas emissions reductions per public dollar spent, helping clean energy technologies achieve scale, and prioritizing projects that help to improve water and air quality throughout the state.[93] As currently amended, the bill would place the CEB within California's Infrastructure and Economic Development Bank. The bill would provide the CEB with funding from the state's Greenhouse Gas Reduction Fund cap-and-trade proceeds.[94] S.B. 1121 must pass through the state legislature by August 31, 2014 in order to proceed.

U.S. TRANSPORTATION FUNDING UNDER THE TRANSPORTATION INFRASTRUCTURE FINANCE AND INNOVATION PROGRAM

Federal financing for transportation infrastructure has been available through various programs, including through the Infrastructure Finance and Innovation Act of 1998 (TIFIA), which established the U.S. Department of Transportation's TIFIA program. In order to improve the U.S. transportation system, TIFIA provides three types of credit assistance—direct lending, loan guarantees, and standby lines of credit—designed specifically to offer loans and leverage private investment in areas where market gaps exist and/or repayment history is uncertain.[95] TIFIA financing is primarily for very large projects (typically over $50 million) and generally directed at state departments of transportation, transit operators, special authorities, local governments, and private entities.

By providing credit enhancements like loan guarantees and favorable loan terms, TIFIA has been able to reduce investor risk and help 22 projects leverage $7.9 billion in federal credit to deliver $29.4 billion in infrastructure investment since 1999.[96] TIFIA also limits its exposure by covering only up to one-third of the total eligible costs of the amount of the senior debt. By requiring project developers to find other funding sources, TIFIA is able to leverage its funds more effectively and ensure that private market investors have a vested interest in vetting the projects. The latter issue is important for harnessing the power of the private market to select the best projects with the highest chance of success. In addition, only projects with dedicated revenue sources to pledge as repayment are eligible for funding.[97] Repayment pledges include tax receipts (including sales tax, tax increment finance, and fuel taxes) and other revenue pledge agreements.[98]

Although AFV infrastructure projects may be ineligible for TIFIA funding,[99] the TIFIA program is relevant to the discussion of increasing investment in EV charging stations for two reasons. First, understanding how other government financial programs are structured can be valuable as CEBs are developed and applied to technology deployment objectives. Second, in the future there may be opportunities to expand the scope of eligible TIFIA projects to include AFV infrastructure. Notably, some of the projects that TIFIA has supported share characteristics with AFV infrastructure in that they are new technologies, have little repayment history, and generally lack an investment grade rating.

STATE INFRASTRUCTURE FUNDING MODELS

States have a long history of funding clean energy and transportation infrastructure. To do so, states have established several financing structures, such as infrastructure banks and revolving loan funds, which can leverage public funds, engage reduce lenders, and reduce lending risks.[100] While transportation infrastructure banks have been thoroughly examined elsewhere,[101] this section highlights a few examples of existing state public-private finance programs, from which lessons for advancing EV charging infrastructure can be drawn.

Vermont's State Infrastructure Bank (VTSIB)[102] provides both standard, low-interest direct lending for traditional transportation projects—such as roads and bridges—and lending for EV charging stations. When traditional financing routes are limited because of

insufficient repayment history or uncertainty about usage, direct lending may be needed and state infrastructure banks—which generally focus on direct lending—can offer useful examples. The VTSIB can lend money for building highways, roads, bridges, and certain facilities related to rail transit, as well as for installing public EV charging infrastructure. Its direct lending includes longer loan terms (up to 30 years), forbearance of up to five years, and low interest rates. The current interest rates are 3% for private-sector borrowers, 1% for municipal governments, and 1% for EV charging stations (including for private sector borrowers). Specifically for EV charging infrastructure, the program is set up to remain flexible for lending terms. There are no standard business plans or loan terms for EV charging stations, unlike for traditional transportation projects such as building new roads, which have a long history. As such, the VTSIB specifically states that the loan terms will vary depending on the business model and the projected cash flows the station would provide.

Financing programs are in use across the country for clean energy, transportation, and many other technologies. A few examples from other states include:

- Utah's Clean Fuel Vehicle Grant and Loan Program, which provides low-interest loans to fund alternative fuel infrastructure deployment, including EV charging stations.[103]
- Oklahoma's Alternative Fuel Vehicle Loan Program, which provides low interest loans for the purchase of AFVs. Although the program is aimed primarily at compressed natural gas and liquid petroleum gas vehicles, other alternative fuels such as EVs are eligible.[104]
- Oregon's State Energy Loan Program, which operates a revolving loan fund that issues low-interest loans for fleet procurement of AFVs.[105]
- Alabama's Local Government Energy Loan Program, which provides low-interest loans to local governments, K-12 schools, and public colleges and universities to fund cost-saving energy efficiency projects.[106]

New CEBs may want to consult with infrastructure banks in their own state to gain from their experience with transportation projects and loans. CEBs can use the state infrastructure banks' loan structures and terms to examine repayment histories and see which flexible terms most effectively accommodate the different cash flow expectations of investors and project developers, thereby reducing investor uncertainty about the credit quality of the loans. CEBs may also partner with state infrastructure banks to provide loans for projects where private investors are especially hesitant to invest at a low cost of capital, such as for loans with longer terms or forbearance.

CONCLUSIONS

Widespread adoption of EVs, currently limited to some extent by an EV infrastructure gap, could be facilitated if the public and private sectors collaborate to develop and implement programs that address the barriers to investment in EV charging stations.

CEBs, or other similar organizations aimed at leveraging public funds to attract private investment in clean energy deployment, could play a key role in addressing the barriers to EV charging deployment by establishing such programs. Public-private financing programs offered by such organizations have so far focused on energy efficiency and renewable energy deployment projects, and experience applying these tools to advance clean transportation deployment has been limited. CEBs can learn from the experiences of other clean technology financing programs to deploy more AFVs and infrastructure through finance.

This section (1) summarizes the opportunities for CEBs and similar organizations to foster EV infrastructure development, (2) presents recommendations for policymakers to enable these opportunities, and (3) lays out the next steps for this project.

KEY INSIGHTS

In the near term, the primary challenge is to help establish a compelling business case for EV infrastructure investment. The business case for deploying EV charging stations may be challenging due to high upfront equipment, installation, and transaction costs; high operating costs resulting from electricity demand charges;

low and uncertain station utilization; low consumer willingness to pay for charging; inefficiency and uncertainty resulting from lack of experience; and a high cost of capital.

CEBs could share upfront costs and risk with project developers to foster early market development. At present, offering EV charging services at some locations and charging levels may be unprofitable or too uncertain for the private sector to deploy without government support. If a CEB determines that offering charging services is valuable for EV market development, despite the challenging business case, the CEB may conclude that providing cost and risk subsidies for some charging stations is justified in order to facilitate EV market development. A CEB could provide cost and risk subsidies for EV charging projects through grants and rebates or by providing project equity.

CEBs could reduce the cost and risk of offering EV charging services by disseminating needed information and facilitating partnerships. Collecting and sharing data on the financial performance of EV charging loans and projects could reduce uncertainty among developers and private lenders. The transaction costs associated with financing and deploying EV charging could also be reduced by developing standardized contracts or conducting community-based marketing campaigns. New partnerships could empower stakeholders to work together to overcome market barriers, perhaps even co-financing mutually beneficial deployment projects.

CEBs could help advance market development by expanding EV charging developers' access to attractive financing options. The costs and risk of financing EV charging deployment could be reduced if developers had access to loans with lower interest rates, longer loan terms, and/or flexible repayment schedules. CEBs could provide attractive financing directly using their own funding. Alternatively, and enabling greater leverage, CEBs could develop programs that enable private investors or offer more attractive financing to EV charging developers, such as credit enhancements, interest rate buydowns, and alternative collateralization and repayment mechanisms.

In the long term, as the business case for offering EV charging improves, the challenge will be to scale up flows of financial capital. Investment in EV charging infrastructure may remain at relatively low levels if the availability of low-cost capital for EV charging projects remains limited. Capital flows may be limited due to a weak secondary market for EV infrastructure financial products, the lack of standardized financing structures, and insufficient information among potential investors.

CEBs could increase capital flows by fostering the development of secondary markets for EV charging loans and leases. A robust secondary market for EV charging financial products would enable loan and lease originators to recapitalize and fund more projects. To develop these secondary markets, CEBs could implement programs aimed at standardizing these products, increasing their liquidity, reducing uncertainty about their financial performance, and facilitating their incorporation into new securitized products.

RECOMMENDATIONS FOR POLICYMAKERS

CEBs could help EV markets overcome the limitation currently posed by insufficient access to EV charging infrastructure. CEBs could help increase deployment of clean energy technologies through a wide array of financial programs such as direct lending, credit enhancements, and outreach. To date, CEBs have focused on energy efficiency and renewable energy technology deployment and have little experience with transportation projects. However, AFVs and infrastructure face many of the same financial, information, and coordination barriers faced by other clean energy technologies. CEBs could apply their expertise and experience in other clean energy sectors to help advance clean transportation technologies.

States could gain experience applying financial tools to increase private investment in EV charging infrastructure by using existing funding sources and authorities to launch pilot programs. To help establish a compelling business case for EV infrastructure investment and ensure adequate access to capital, states could use existing financial programs and authority to apply some the tools discussed in this report through pilot programs of limited scale and financial commitment. Based on the results and the experiences under such pilot programs, a state could refine and expand the programs or discontinue them.

It is valuable for CEBs and other clean energy financial programs to be empowered with a range of tools and to retain flexibility. The barriers standing in the way of expanded EV charging deployment depend on the state of the EV charging market, which will evolve over time

and will depend in part on the geographic location as well as the location and type of charger. There are many tools that CEBs could employ to help address these barriers. CEBs that are able to adapt to these changes by developing programs that apply the tools best suited to addressing the evolving needs of the EV charging markets will be most successful at efficiently promoting market development.

NEXT STEPS

The next phase of the AFV Finance Initiative is to identify and articulate promising business model concepts that can unlock private investment in AFVs and infrastructure. This paper explores the tools that CEBs and other public financial programs have employed with success in the solar, energy efficiency, and transportation sectors and the potential of these solutions to help overcome current challenges for the deployment of EV charging infrastructure. This groundwork will serve as the foundation on which to build and evaluate novel business models that could reduce EV infrastructure investment barriers. More information on this initiative is available at www.c2es.org/initiatives/alternative-fuel-vehicle-finance.

GLOSSARY

Asset-backed security. A financial instrument whose income payments, and hence value, is derived from and collateralized (or "backed") by a specified pool of underlying assets that have a relatively similar or homogeneous risk profile. The pool of assets is typically a group of small and illiquid assets that are unprofitable when sold, or unable to be sold, individually.

Credit enhancement. A tool that reduces the credit risk of a debt instrument by offering collateral or insurance, or by making other agreements to provide a lender with protection and assurance that it will be compensated if the borrower defaults. Credit enhancements fall into two categories: internal and external. Internal credit enhancements are inside of the deal, including subordination (see **subordinated debt)** and posting extra collateral to cover losses. External credit enhancements are provided by a third party, such as a third party bank providing a letter of credit to cover losses, if they occur.

Credit rating. A grade by an organization known as credit rating agency indicating the potential risk of nonpayment, or default risk, associated with a debt instrument such as an asset-backed security or company issuing the debt instrument. High quality debt instruments with high grades are known as investment grade instruments. Low grade instruments are known as non-investment grade or "junk."

Debt instrument. A written promise to repay a debt. Examples include loans, bonds, certificates, leases, or other financing agreements between a lender and a borrower.

Liquidity risk. The hazard that a financial instrument, such as a new asset-backed security that includes loans for EV infrastructure, cannot be sold without a significant concession in price due to the small size of the market.

Loan loss reserve. Cash or cash equivalents holdings set aside to cover estimated potential losses due to defaults and nonpayment for debt instruments.

Over-collateralization. Posting more collateral than is required to obtain financing. Over-collateralization is often used as a method of credit enhancement by lowering an investor's exposure to default risk. In the case of a security, the underlying pool of assets is greater than the amount of the issued security**.**

Pooled assets. The grouping of assets that are to be repackaged into interest-bearing securities. The interest and principal payments from the assets are passed through to the purchasers of the securities.

Primary market. The market in which buyers and sellers, or lenders and borrowers, negotiate and transact business directly. Examples include banks originating loans with borrowers or markets for newly issued securities.

Secondary market. The market where securities, including those based on pooled loans or asset-backed security, are traded among investors.

Securitization. The process of pooling types of debt such as loans and leases of a similar risk profile or type to create securities that are backed by assets.

Sponsor equity: Cash investment by the owners of a project. The initial losses would come from the equity, before moving down to the least senior debt.

Subordinated debt: A loan or security that ranks below other forms of debt with regard to claims on assets or earnings.

Tax appetite: The ability and interest for a company or individual to use tax credits and other tax equity. It requires a tax liability, and thus profits or income, which can be offset by the tax equity.

ENDNOTES

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