MODELS FOR UTILITY-MANAGED ROOFTOP SOLAR PROGRAMS

September 13, 2019

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Executive Summary

This report investigates, reviews, and summarizes key findings on four utility-managed solar models and existing programs of each model. These models include: 1) Roof Rental or Lease Programs, 2) On-Bill Rent-to-Own Tariff (i.e., Pay-As-You-Save), 3) Sleeved Power Purchase Agreement Through Utility, and 4) Utility-Participant Shared Distributed Energy Resources. The models, and their associated programs, were evaluated across 16 criteria that aim to describe the potential benefits and drawbacks to their implementation and management.

1) Roof Rental or Lease Programs

In general, the roof rental or lease program model is structured such that solar PV systems are installed on participants' roofs at little or no upfront cost to the participant. The PV systems are owned and installed by the utility or a third-party developer and the participant is often compensated with a monetary credit or incentive on their electricity bill for allowing the utility to use (i.e., rent) their roof. This report describes five programs of this model-type.

Key benefits associated with this model:

- Increases distributed solar energy
- Can be structured to target low to moderate income customers and renters
- Can be designed to offer electricity bill savings to participants
- Can be coupled with the utility's research goals such as implementing smart meter technology and solar PV and storage for smart peak load shaving
- Utility can select roofs that better align with higher local wholesale market prices

Potential drawbacks associated with this model:

- Often requires cross-subsidization by other ratepayers
- Often associated with high maintenance costs and significant program overhead costs
- Some utility structures (including municipal utilities) must partner with third-party developer to capture the ITC savings

Key risks:

- Due to significant maintenance and overhead costs, these programs should be carefully assessed prior to implementing a similar program by AE
- Safety concerns with equipment at participants' homes or elsewhere

2) On-Bill Rent-to-Own Tariff (Pay-As-You-Save)

In the On-Bill Rent-to-Own Tariff model, the utility installs (or directly contracts out installation of) efficiency upgrades and/or solar PV systems at or on participants' homes/buildings and recuperates those costs by adding a charge (via an on-bill tariff) to the participants' monthly bill. The tariff is generally less than the savings captured from the upgrade/PV system thereby giving the participant an overall savings on their monthly utility bill while paying for the

upgrade/PV system. At the point the participant has finished paying off the upgrade/PV system, ownership transfers from the utility to the participant.

Key benefits associated with this model:

- Credit scores are not required so more customers can qualify for program
- Customers with lack of funds to make the investments themselves can participate
- Renters can participate
- The utility is likely to recover most, if not all, of its investment
- Homes that receive energy efficiency upgrades have lower energy demands and, as such, the energy load on the utility is reduced as more upgrades are made

Potential drawbacks associated with this model:

- Federal loans with favorable terms might be hard to obtain
- Key risk: Utility takes on the burden of the loan terms and payback and all risks associated with having the loan

3) Sleeved Power Purchase Agreement (SPPA)

Similar to virtual PPAs, in SPPAs the participant is contracting with an off-site renewable facility but relies on the utility to act as the broker. As the broker, the utility bears the market risk and would be on the hook to pay the difference if/when the market price falls below the PPA price. The utility can charge the participant a pass-through (or "sleeve") fee for the contracted energy to cover the overhead costs and hedge against market risks. Finally, when market price is higher than the SPPA price, the utility has the opportunity to make a profit on the difference.

Key benefits associated with this model:

- Potentially fewer installations to manage and maintain compared to a rooftop lease program
- Structure allows for utilization of ITC savings
- Off-site utility-scale projects can realize economies of scale to reducing energy costs
- AE has experience and competence in negotiating very low-cost PPAs
- AE is a sophisticated electric wholesale market participant and understands market risk and can appropriately hedge against that risk

Potential drawbacks associated with this model:

- Complicated three-party contracts can add additional management overhead
- Key Risk: AE bears the market risk of the PPA contract
- It could be difficult to find smaller customers that are willing to enter into the longer, multi-year contracts that are typical with PPAs
- Utilizing the SPPA construct with renewable energy projects that are smaller than utility-scale might make it difficult to develop products that are low enough cost to be attractive to customers
- Applying the sleeved PPA framework to multifamily buildings (as the energy producers) could make it difficult to offer a competitive PPA rate to program participants

4) Utility-Participant Shared Distributed Energy Resources (DER)

In the Utility-Participant Shared DER model, the utility and the participant both utilize and extract value from the same asset for different reasons. For example, dual use of participant premises-sited energy storage systems. In this case, the utility is able to access the battery to provide power to the grid during peak power demand and the participant can use it in the event of an electric service disruption.

Key benefits associated with this model:

- Potentially decreases costs to the utility and customers through decreased use of high cost peaking plants
- Research opportunities for studying new technologies and devices such as 'battery-as-a-meter' or smart thermostats

Potential drawbacks associated with this model:

- Customer participation dependent on customer desire and/or need for backup power which may be lacking for AE customers
- Structure of program that allows for most benefits to utility (dispatchable storage as DER) not translatable to residential solar
- Data privacy and security concerns with shared resources

Glossary

The following acronyms are used in the report:

- AE: Austin Energy
- AMI: Advanced metering infrastructure
- CAPEX: Capital expenditures
- CPS: CPS Energy, San Antonio's municipal electric utility (previously stood for 'City Public Service')
- DER: Distributed energy resources
- EECLP: Energy Efficiency and Conservation Loan Program
- EPRI: Electric Power Research Institute
- GMP: Green Mountain Power
- HVAC: Heating, ventilation, and air conditioning
- LADWP: Los Angeles Department of Water and Power
- MACRS: Modified accelerated cost recovery system
- NPV: Net present value
- O&M: Operation and maintenance costs
- PPA: Power Purchase Agreement
- PV: Photovoltaic
- RE: Renewable energy
- REC: Renewable Energy Credit
- SPPA: Sleeved Power Purchase Agreement
- TEP: Tucson Electric Power
- VPPA: Virtual Power Purchase Agreement

The following are terms used in the report and their definitions:

- Cross Subsidization: the practice of charging higher prices to one group of consumers in order to lower prices for another group; in the context of these programs, a solar program which decreases bills for program participants and doesn't also reduce utility costs could increase bills for non-participants.
- Customers: all existing rate payers within the utility's service area
- Electricity Rate: The rate a customer pays for energy on a per kWh basis
- Local Solar Value: The utility's avoided cost of local, distributed solar generation, based on Austin Energy's most recent commercial Value of Solar study. Value set at 5.2 cents/kWh.
- Participants: utility customers that are enrolled in the solar/DER program
- Residential: Single-family home
- Tariff: a collection of electric rates and other charges that are applied per the specific definitions of the tariff in order to calculate a final utility bill.

Introduction

The *Austin Energy Resource, Generation and Climate Protection Plan to 2027* calls on Austin Energy (AE) to "study and possibly pilot a utility-managed rooftop solar program that requires no investment from customer participants" [1]. Austin Energy's solar team has identified and completed a preliminary review of utility-managed rooftop solar program models, and presented these to stakeholders as part of discussions around the future of the solar program and opportunities to expand solar access to hard-to-reach markets, including low-income customers. In addition, the city of Austin has a 65% renewable energy goal by 2027. The Webber Energy Group (WEG) at UT Austin was tasked with assisting AE in their efforts to compare potential program models and identifying their relative merits.

Examples of existing utility-managed rooftop solar models and distributed energy resource programs exist around the country in various forms. While the rooftop solar models are organized and funded in different ways, all such programs seek to increase the amount of residential and commercial solar access with little to no upfront cost to the participants. This report evaluates many existing programs and program structures for four potential utility-managed models. Numerous programs across the US informed this report.

Other non-financial and non-renewable energy reasons utilities are exploring and implementing these programs are to 1) study advanced metering infrastructure (AMI) and smart inverter technology, 2) better understand the impacts of integrating solar and other RE technologies on the stability of the electric grid, and 3) assess how utilities and their customers could share distributed energy resources (DERs) to provide added value [2].

Not all models evaluated are rooftop solar-specific. For example, there are utility-participant shared battery programs, such as Green Mountain Power's Resilient Home program. GMP's program is based on residential participants installing Tesla Powerwall batteries in their home with the utility and participant both having access to the stored power under the appropriate circumstances. In addition, the On-Bill Rent-to-Own Tariff model is generally associated with energy efficiency upgrades that aim to reduce home energy consumption, although the model might be extended to solar. Finally, the sleeved PPA model is often associated with off-site utility-scale renewable projects. More details on these models and current programs can be found later in the report.

One issue of concern with the implementation of any of these types of programs is that often their costs are higher than their expected financial benefits. As such, the additional costs might be passed onto all customers, including customers that are not participating in the respective programs. Depending on the values of the utility and overall project goals, some level of cross-subsidization might be acceptable, but that evaluation must be made for every program.

Four models were evaluated including: Roof Rental or Lease Programs, On-Bill Rent-to-Own Tariff, Sleeved Power Purchase Agreement, and Utility-Participant Shared DERs. More details about the model types and examples of existing programs of each type can be found in Table 1.

Table 1. This table lists program models investigated in this report and examples of existing programs for each model.

Program Type/Model	Existing Program Name
Roof Rental or Lease Programs	CPS Solar Host SA APS Solar Partner TEP Residential Solar LADWP Solar Rooftops Program
On-Bill Tariff (i.e. Pay As You Save (PAYS))	How$mart HELP PAYS Upgrade to $ave
Sleeved PPA Through Utility	Enel
Utility-Participant Shared DERs	Green Mountain Power (GMP) Resilient Home

Roof Rental or Lease Programs

These programs generally take the form of either the utility or third party installing and maintaining solar PV systems on participant's property. These programs often do not require participants to provide any upfront funds for the project and the utility usually pays a small fee to the participant (serving as a proxy for renting the participant's roof) for the energy produced by the system. This fee is often less than what the utility might otherwise pay in rebates and/or through net metering for a customer-owned system and the programs often last for 20 or more years. The cost associated with these programs often outweigh the revenue generated from selling the solar electricity produced.

On-Bill Rent-to-Own Tariff

On-Bill Rent-to-Own Tariff programs are similar to the roof rental or lease programs in that the utility often either installs or directly contracts out the installation of efficiency upgrades (and potentially solar PV systems) at or on participants' homes/buildings and then recuperates those costs, potentially with interest, by adding a charge (in the form of an on-bill tariff) to the participant's monthly bill. When the participant finishes paying off the upgrade (via the on-bill payment) the ownership transfers from the utility to the participant. Program lengths depend on the expense of the upgrade and the repayment terms agreed to.

Sleeved Power Purchase Agreement

Sleeved Power Purchase Agreements (SPPAs) are similar to virtual PPAs (VPPA) in that the participant is contracting (usually long-term) with an off-site renewable facility. In a VPPA, the participant takes on wholesale market price risk in that if the wholesale market price at the contractual pricing node or hub is below the contracted VPPA price, the participant must pay the renewable facility (or the party holding the other side of the PPA) the difference. In an SPPA, the utility broker bears the market risk and must pay the energy supplier (typically a wind or solar farm) the difference if the market price is lower than the PPA price. But the utility is able to charge the participant a pass-through fee for the contracted energy. In the case that the market price is higher than the SPPA price (between the utility and renewable facility), the utility (or participant in a VPPA) stand to make a profit on the difference.

Utility-Participant Shared Distributed Energy Resources

Utility-Participant Shared DER programs are unique in that the utility and the participant both utilize the same asset for different reasons. The example program detailed in this report included the dual (utility and participant) use of a participant premises-sited energy storage system. The utility was able to access the battery to provide power to the grid during peak power demand and the participant was able to utilize the battery in the event of an electric service disruption.

Methodology

This report evaluates utility-managed rooftop solar models and distributed energy resource programs based on the following criteria that were included in the Statement of Work for this project. Below, a description is included for each criterion.

Ownership framework: Who owns the capital? Does ownership change hands at some point in the program? If so, when and under what conditions?

Funding/payment structure: How is the program funded? What is the payment structure for participants?

Markets it could serve/target markets: What type of participants (i.e., residential and/or commercial) is the program meant to serve?

Participant accessibility: Who are the target program participants? Within the residential segment, does the program target low-income or multi-family affordable housing as part of program charter/mission?

Cost effectiveness: Can the program viably pay for itself or will it require cross-subsidization from other rate payers?

Payback period: The length of time required to recover the costs of an investment.

Benefits to non-participating utility customers: Are there benefits to other customers that the utility serves, or utility operations at large? For example, do the programs offer additional grid stability or cost savings to non-participating customers?

Scalability: Could the program be scaled to include a significant portion of AE customers or do the terms and requirements to participate limit the size of the program significantly?

Bill savings potential for participants: What monetary savings, if any, do the participants receive by being part of the program?

Opportunity for participants to build equity: This criterion expands on the ownership framework criterion by highlighting which programs have built-in mechanisms to allow participants to eventually own the energy infrastructure.

Who receives the electricity and green attributes?: Generated renewable energy come with a tradable energy commodity known as its Renewable Energy Certificate (REC). In the case of these various programs, who owns these RECs (i.e., is it the participant, the utility, or another party)?

Who is responsible for maintenance?: Maintenance costs on the assets are expected over the lifetime of the various programs. Who is ultimately responsible for these costs (i.e., the participant, the utility, or another party)?

Risks to participants: What risks do participants take on by joining into the program?

Risks and liability to utility: What risks and liabilities do the utility take on when providing these programs? What is the severity of said risks and are there ways to mitigate them?

Smart inverter or storage integration opportunities or other grid benefits?: Are there additional benefits to the grid offered by this program aside from the renewable energy?

Potential legal or regulatory hurdles: What are the potential legal or regulatory hurdles associated with the various programs?

The overarching objective of this report is to gather and summarize information on the above criteria for the various models to assist AE in determining which type(s) of program(s) are best suited for their needs.

Model and Program Evaluations

Roof Rental or Lease Program Model

The roof rental or lease program model is generally structured such that solar PV systems are installed on participants' roofs at little or no upfront cost to the participant. As the name of the model suggests, the participants' roofs are rented/leased while the PV systems are owned and installed by the utility or a third-party developer. As such, the participants sometimes receive a monetary credit or incentive on their electricity bill for allowing the utility to use their roof. Many programs of this model-type were evaluated and help inform this report. Five programs of this model-type are detailed in this report including: CPS SolarHost, APS Solar Partners, APS Solar Communities, LADWP Solar Rooftop Program, and TEP Solar Program. In general, the programs were marketed by some combination of press releases, social media, reaching out to customers, and providing program information on the utilities' websites.

CPS SolarHost

Program Overview

CPS' SolarHost pilot program in San Antonio, Texas is a partnership by which PowerFin—a third-party solar developer—finances, installs, and maintains solar PV systems on private residential and commercial participants' roofs in the CPS service area. The program aims to "address equity issue and broaden access to solar'' since much of the "private solar ownership is concentrated in more affluent areas" [3]. CPS states that this program helps them and the city "meet important renewable energy goals" [4]. The program received approximately 7,000 applications for 600 program slots [3]. The program did not actively target low-income customers but rather was offered "to all parts of the community." CPS planned to have approximately 850 residential and 50-75 commercial participants in the pilot program.

SolarHost participants receive $0.03 per kWh solar energy produced as a bill credit from CPS for the 20-year program life [4]. This corresponds to an average monthly bill savings of 20-30% [4]. The program is set up such that there is no upfront cost to either the participants or the utility, as CPS simply agrees to buy solar energy at a contracted PPA price from PowerFin for the lifetime of the program. While PowerFin owns the PV systems, CPS is able to count the solar electricity towards goals of increasing consumption of renewable energy [5]. At the point the PV systems are to be removed, PowerFin is responsible for removing them and returning the roof to its original condition.

Participants

This program targets both residential and commercial customers. One of its more notable commercial participants is Toyota. Their 260 kW solar array is expected to save the company around $15,000 a year on its electricity bill [6]. Opportunities also exist to serve populations who are largely unable to install solar, such as renters. Property owners must submit the application, but renters see the credit on their bills. Participants are selected based on multiple criteria including rooftop age, orientation, and shading. While low-income customers who

otherwise might not be able to afford solar PV systems are able to join this program, this particular program did not have any income limits (minimum or maximum) to participate.

Risks to Participants
The risks to the participant are considered low because there are no up-front or ongoing costs for participating in the program and PowerFin is responsible for all ongoing maintenance and associated costs. If a participating homeowner wants to sell their home, the new homeowner can be enrolled in the program and eligible for all the associated bill savings.

Program Summary

- *Utility structure:* Municipally-owned utility
- *DER Ownership Structure:* 3rd party provider owns system for 20 years
- *Target Market:* Residential & Commercial
- *Accessibility:* Available to all-income renters and homeowners with eligibility selected based on multiple criteria including rooftop age, orientation, and shading
- *Scalability:* Demand would likely be high given CPS terms, but would depend on cost effectiveness
- *Build Participant Equity:* None
- *Upfront Costs to Participants:* None
- *Ongoing Costs to Participants:* None
- *Bill Savings Potential:* $0.03/kWh credit for 20 years, typically 20-30% savings on monthly electric bill
- *Upfront Costs to Utility:* None if procured through third-party provider via PPA
- *Ongoing Costs to Utility:* Cost of solar energy PPA to third party solar provider, overhead costs and $0.03/kWh credit to participants; in the agreement with PowerFin, the cost of system removal at end of program life is also paid by the Utility
- *Cost Effectiveness:* Likely not as cost effective as utility-scale solar given distributed solar costs
- *Payback Period:* This program is not expected to payback over the program lifetime
- *Recipient of Electricity and Green Attributes:* Electricity goes to the grid and utility can count solar electricity towards renewable energy goals
- *Maintenance Responsibility:* 3rd party entity
- *Program Lifetime:* 20 years
- *Program offering:* approx. 2015 through 2017

APS Solar Partners & Solar Communities

Solar Partners Program Overview
In the Arizona Public Services (APS) Solar Partners pilot program, about 10 MW of rooftop PV solar systems were installed on approximately 1,500 rooftops [7]. The participants' roofs had to

be able to accommodate a minimum of 16 panels and face west or southwest [7]. This program also included a deployment of two battery storage systems, each rated at 2 MW "for use during peak shaving" at the substation and feeder levels [7]. The participants receive a fixed $30 credit on their monthly electricity bill for the 20-year program duration. If their monthly bill is less than $30, the unused credit rolls over for future months. APS is responsible for the installation and maintenance of the systems but contracts the services out to third-party vendors. There is no upfront cost for participants and if the system needs repairs, participants continue to receive the $30/month credit even when the system is down. While there are no credit score requirements to participate in this program, participants must have homeowner's insurance which prevents renters from participating. At the end of the program, the systems are removed with no current option to allow for participants to buy the system [2].

If a participant decides, for any reason, that they no longer want to participate in the program, APS will remove the system at no cost to the participant. In addition, the program allows for the system to be removed one time over the program duration for roof repairs or replacement at no cost to the participant, if needed [2].

Solar Communities Program Overview

APS has a follow-on program to Solar Partners called Solar Communities. Solar Communities functions very similarly to Solar Partners, with no upfront cost to participants and the same $30/month credit on participant's bills. Both programs do not have credit score or lease payment requirements; however, Solar Partners also did not have any income requirements. By contrast, the Solar Communities program does have an income eligibility requirement and targets limited- to moderate-income customers with the majority of current installations occurring on homes of limited income customers. Solar Communities also targets multifamily housing, non-profits, and commercial customers. For commercial customers the rebate is based on the size of the system and set to $2.50/kW/month of installed capacity [8].

Risks to Utility

An incident that occurred involving an explosion at one of APS's battery storage facilities that left four firefighters injured stirred up major concerns around the safety of this program [9].

Risks to Participants

The risks to the participant are considered low since they are allowed to drop out of the program at any time for any reason without any financial penalty or charge. If a participant sells their home, the new owner can have the system removed or keep it and continue to receive the on-bill savings.

Research/Grid Benefits

This program had a strong research component; APS partnered with EPRI to study smart inverter technology and how it can help integrate more RE onto the distribution network [10]. APS has also stated that one of their objectives with this program was to study "late afternoon solar production against peak usage periods" [2].

Program Summary (Solar Partner / Solar Communities)

- *Utility structure:* Investor Owned Utility
- *DER Ownership Structure:* Utility owns system for 20 years
- *Target Market:* Residential / Residential, multi-family housing, non-profit, and commercial
- *Accessibility:* Available to homeowners, no credit score required / Available to homeowners, no credit score required, must be low- or moderate-income level
- *Scalability:* Demand would likely be high given APS terms, but would depend on cost effectiveness
- *Build Participant Equity:* None
- *Upfront Costs to Participants:* None
- *Ongoing Costs to Participants:* None
- *Bill Savings Potential:* $30 per month credit for 20 years / $30 per month credit for 20 years or $2.50 per kW per month for commercial participants for 20 years. Average residential electricity bill in Phoenix, Arizona is approximately $120 per month [11].
- *Upfront Costs to Utility***:** Cost of solar system installation
- *Ongoing Costs to Utility:* O&M costs, overhead costs, credit to the participants, system removal costs at end of program life (or if participant chooses to exit program early)
- *Cost Effectiveness:* Likely not as cost effective as utility-scale solar given distributed solar costs
- *Payback Period:* This program is not expected to payback over the program lifetime
- *Recipient of Electricity and Green Attributes***:** Electricity goes to the grid and the utility can count solar electricity towards renewable energy goals
- *Maintenance Responsibility:* APS is responsible and contracts out to third party companies
- *Program Lifetime:* 20 years
- *Program Offering:* Approx. 2015 -2016 / 2018 - present

LADWP Solar Rooftops Program

Program Overview

The Los Angeles Department of Water and Power's (LADWP) Solar Rooftops Program aimed to install up to 1 MW of distributed solar PV on residential roofs through a rooftop rental program with installations between 2-4 kW planned for an estimated 300 – 450 customers. Participants can also elect to have energy storage systems installed in addition to the rooftop solar [12]. The program is funded by $12.9 million that was built into power rate increases approved by the DWP Board of Commissioners and City Council [13]. The program is part of a larger community solar project that aims to produce 40 MW of solar power by 2020 and is aimed specifically to bring solar power to low-income communities in LA and help LADWP meet California's mandate to produce half of its power by renewable energy sources by 2030 [13].

The term length of the program is 20 years. Participants can drop out any time after the first year, but participants who drop out must pay back a prorated amount of the annual leasing

fees received prior to that point [14]. During the program length, LADWP is responsible for home evaluation, permits, developing, designing and installing the system, and ongoing O&M costs [15].

Participants

This program is limited to owner-occupied single-story houses with solar suitable roofs; renters are not eligible. There are no upfront costs to participants and homeowners are not required to undergo a credit check to participate and are not responsible for O&M of the installed panels. In order to target low-income participants, LADWP prioritized applicants from zip codes that have the lowest amount of solar penetration [15]. Participants receive a lease payment that can range from $20 - $70 per month depending on the size of the system and whether an energy storage system is also installed. A 12-month prepayment check is sent to participants to cover the leasing fees for the first year and then participants receive a monthly on-bill credit for subsequent years [12].

Risks to Utility

Major risks to the utility identified include that the program 1) requires cross-subsidization by other rate payers, 2) has high maintenance costs, and 3) has significant overhead costs.

Risks to Participants

The risks to participants are considered low since they are not required to pay any fees to participate in the program and are not responsible for any ongoing O&M costs. If a participant moves, the new homeowner is automatically enrolled in the program and continues to receive the financial benefits.

Program Summary

- *Utility structure:* Publicly owned utility
- *DER Ownership Structure:* Utility owns for 20 years
- *Target Market:* Residential
- *Accessibility:* Available to homeowners in specified neighborhoods with low solar penetration, no credit check required; not available to renters
- *Scalability:* Demand would likely be high given program terms, but would depend on cost effectiveness and approved program funding levels from the Commission
- *Build Participant Equity:* None
- *Upfront Costs to Participants:* None
- *Ongoing Costs to Participants:* None
- *Bill Savings Potential:* $20 - $70/month depending on system size and inclusion of energy storage systems. Average electricity bill in southern California ranges from $88 in the winter to $113 in the summer [16]
- *Upfront Costs to Utility:* capital and installation costs of solar panels; $12.9 million allocated by DWP Board of Commissioners and City Council

- *Ongoing Costs to Utility:* O&M of installed systems, overhead costs, and monthly bill credit to participants
- *Cost Effectiveness:* Budget for program part of power rate increase, likely not cost effective and requiring cross subsidization
- *Payback Period:* This program is not expected to payback over the program lifetime
- *Recipient of Electricity and Green Attributes:* Electricity goes to the grid and the utility can count solar electricity towards renewable energy goals
- *Maintenance Responsibility:* Utility
- *Program Lifetime:* 20 years
- *Program offering:* Began accepting applications in 2017

TEP Solar Program

Program Overview

In the Tucson Electric Power (TEP) Solar Program, solar PV systems were installed on 477 residential roofs between 2015 and 2017. To participate, customers had to own their home, fill out an application, and be in good standing with the utility (i.e., the utility verified applicant's payment history). No credit checks were required to participate. In addition, the customer's roof had to be able to accommodate a minimum system size [17]. Once a customer was approved for the program, they were required to pay a one-time $250 processing fee to join but the remaining costs were financed by TEP. In exchange for the use of their roofs and a $250 enrollment fee, participants received a fixed electricity bill for 25 years. The fixed bill is determined by the average rate for the 12 months leading up to participation in the program [17]. If the participant's energy consumption falls outside of 15% of the initial average consumption, the fixed rate is recalculated using this new average consumption [17].

Participants

Participants can choose to purchase the solar system after the sixth year allowing likely to allow TEP the opportunity to benefit from the MACRS depreciation benefits of the ITC tax credit [18]. if a participant purchases the system, they leave the program and take service under a standard electric rate. If they do not purchase the system, TEP removes the system at the end of the program (25 years) [17].

The participants are guaranteed a predictable and consistent utility bill in this program regardless of future energy prices. Participants save money in the event that energy prices rise over the program period but are not guaranteed any bill savings as are present in the other programs. Furthermore, the participants will pay more for electricity in the event that energy prices drop.

Risks to Participants
Unlike the other roof rental programs, the on-bill savings are not as pronounced for the participants of this program. Participants are also at risk of paying more than they would outside the program if electricity prices decrease.

Program Summary

- *Utility structure:* Investor owned utility
- *DER Ownership Structure:* TEP owns the systems for program duration unless participants choose to purchase them after year six
- *Target Market:* Residential
- *Accessibility:* Available to homeowners that are in good standing with TEP and have enough roof space for a minimum system size; this program did not target particular income groups
- *Scalability:* Program is full indicating significant customer interest
- *Build Participant Equity:* Participants can purchase the system after year six
- *Upfront Costs to Participants:* $250 enrollment fee
- *Ongoing Costs to Participants:* None
- *Bill Savings Potential:* While there aren't direct bill savings, participants receive a fixed monthly bill (based on their average costs for the 12 months leading up to program participation) for the 25-year program life; if electricity prices go up in the 25-year period, they will see bill savings
- *Upfront Costs to Utility:* Cost of solar system installation
- *Ongoing Costs to Utility:* O&M costs and overhead costs
- *Cost Effectiveness:* Likely cost effective because participants are paying a similar amount to their bills before joining the program
- *Payback Period:* This program likely pays for itself during the program life
- *Recipient of Electricity and Green Attributes:* Electricity goes to the grid and the utility can count solar electricity to renewable energy goals
- *Maintenance Responsibility:* Utility
- *Program Lifetime:* 25 years
- *Program Offering:* Approx. 2015 through 2017

Risks to Utility
After reviewing many programs of the Roof Rental or Lease Program model type, common themes and risks include:

- Often complex and time-consuming financial structure
- High overhead and maintenance costs for the utility that are not always covered by the revenues of the program
- Often not as straightforward and more expensive and logistically complicated to implement than utility scale solar

Due to the inherent nature of these types of programs requiring the utility to own and/or manage assets that are installed on the property of hundreds to thousands of individual residential customers, the overhead time and cost to the utility will be significant, especially compared to a utility scale solar project. As a result, these programs have complex financial structures to provide bill credit or other incentives to attract participants. In addition to incentivizing customers to apply to the program, the utility will expend significant effort to qualify participants based on program requirements (e.g., confirm income eligibility, roof quality, reliability to pay, etc.). It is up to the utility to decide if these challenges specific to roof rental programs can be managed in a way to make the benefits of the program, such as enabling low income customers to have solar, outweigh the costs.

On-Bill Rent-to-Own Tariff Model

Program Overview

On-bill rent-to-own tariff programs, also known as Pay as You Save (PAYS), involve electric utilities paying for, and potentially installing, new energy efficiency infrastructure such as HVAC upgrades or home insulation for residential and commercial customers. This same program structure could be applied to installing solar PV systems; however, we did not find an existing implementation of this program for solar PV systems. That said, the Energy Efficiency Institute—the original developer of PAYS—is investigating the feasibility of residential solar PV as a PAYS upgrade and expect to have a report out on their findings by early 2020 [19].

A major goal of PAYS—aside from reducing energy demands through energy efficiency upgrades—is to make home energy improvements accessible to customers who generally face financial barriers to increasing their homes' efficiency level. This type of program typically has no credit score requirement, no property value requirement, and no requirement for participants to take out loans. As such, the PAYS program makes it possible for low-to-median income customers to participate, including renters.

With PAYS, typically a fixed monthly tariff is applied to the residential participant's electricity bill that is guaranteed to be less than the money saved from the upgrade (for example, some programs set the tariff to a maximum of 80 percent of the savings). Participants pay this monthly tariff until the energy upgrades are paid off. This means that while the energy company pays the upfront cost of the energy upgrades, and thus "own" the asset, participants will eventually end up paying for the upgrades and own them. That said, the participants are not taking on debt via a traditional bank loan and, as such, are not subject to the usual terms for repayment. For example, if a participant moves homes, their obligation on the repayment of the energy efficiency upgrade ends and it transfers to the new occupant [20].

In general, PAYS does not have eligibility requirements beyond being a customer of the utility. That said, "some utilities define eligibility requirements by referring to bill payment history"

[20]. Doing so would likely reduce the risk of taking on customers that have a history of defaulting on payments.

There are at least 17 programs based on PAYS that have been implemented in several states, including Kansas, California, Hawaii, Arkansas, New Hampshire, Kentucky, and North Carolina [20]. While investor owned utilities, municipal utilities, and co-ops have implemented PAYS programs across commercial buildings, single-family homes, and multi-family homes, "the majority of programs have been implemented by cooperatives and municipal utilities" [20]. Midwest Energy, a customer-owned electric and natural gas co-op serving customers in Central and Western Kansas, implemented their version of PAYS called "How $mart" in July 2007 and, as such, it is the longest running PAYS program [21]. This program currently allows for upgrades in HVAC, insulation, geothermal, and lighting [22]. According to Clean Energy Works, a non-profit organization that seeks "to leverage philanthropic funding to accelerate private capital utility investments in inclusive clean energy solutions at the grid edge", Midwest Energy customer satisfaction is higher with customers enrolled in the How $mart program compared to general customers not in the program by a measure of 97% versus 85%, respectively [21, 23]. By 2017, the program had invested $10 million in energy efficiency improvements and completed 1,710 projects. On average, participants save $53 per month on their energy bills due to these improvements which translates to approximately 3.96 million kWh of electricity avoided annually [24]. Pat Parke, Midwest Energy's Vice President for Customer Service, states that they are able to provide the program "thanks to a series of grants and loans through the USDA" [24].

Decision Tool for Utility Managers

This type of program could potentially be used to deploy solar PV systems as well. A decision tool was designed for utility managers to help them think through "key considerations before investing in resource efficiency and rooftop solar through a tariffed on-bill program" [25]. According to the decision tool, "the utility needs to fulfill three basic program functions: 1) program oversight; 2) outreach including initial customer and community contacts; and 3) financial management including securing capital, making program payments to the capital provider, and billing and collection of the tariffed charge" [25]. Risk mitigation is important for financial management and utilities that have implemented such on-bill tariff programs report cost recovery rate above 99.9% [25].

Treasury rate loans are available to non-profit utilities that serve rural areas for funding energy efficiency on-bill tariff programs through the Energy Efficiency and Conservation Loan Program (EECLP) [25]. Roanoke Electric's program received a loan through this program at 3% interest [20].

Takeaway

PAYS programs have been successful across the country in a variety of utilities mostly for energy efficiency improvement projects. While various websites discussing PAYS do mention its application in rooftop solar, we did not find an actual PAYS for PV solar system program.

Risks to Utility

The major risk to the utility identified is if the participant fails to pay the on-bill tariff. While a potentially significant risk, most implemented programs tout high repayment rates. This risk can be minimized by limiting participants to customers in good standing with the utility. While we do not have any information specific to implementing this program with PV solar systems, we suspect that the risk to utility would look similar to those for roof rental programs in that the utility would have 1) significant overhead costs and 2) potentially high maintenance costs until ownership changed to the participant.

Risks to Participants

The risk to participant is deemed very low with this program since the investment in the upgrade is not tied to the participant but rather the meter. That is, if the participant moves, they do not carry the burden of repayment with them. Instead, the on-bill tariff transfers to the new tenant. Since the tariff provides a savings to the participant, the likelihood is low that the new tenant will want the upgrade (or PV solar system) removed.

Program Summary (Pay As You Save)

- *Utility structure:* Investor owned utility, municipal utilities, and co-ops
- *DER Ownership Structure:* Utility owns system until participant pays off the cost through an on-bill tariff
- *Target Market:* Residential
- *Accessibility:* Available to renters and homeowners; no credit score required; burden of loan repayment not on participant
- *Scalability:* Demand would likely be high
- *Build Participant Equity:* Once the cost of the upgrade is paid off via the on-bill tariff, the participant owns the system
- *Upfront Costs to Participants:* None
- *Ongoing Costs to Participants:* The on-bill tariff that is less than the cost of the energy savings due to upgrade/PV solar system
- *Bill Savings Potential:* Since the tariff is usually capped at a maximum of 80% of the energy efficiency savings, the customer saves on their electricity bill
- *Upfront Costs to Utility:* Cost of upgrade/PV solar system
- *Ongoing Costs to Utility:* O&M costs, overhead costs, and loan repayment
- *Cost Effectiveness:* Since the upgrade is eventually paid off by the customer, these programs are considered to be highly cost effective
- *Payback Period:* The investment the utility makes is eventually paid off at which point ownership of the upgrade switches and the program ends for that customer

- *Recipient of Electricity and Green Attributes:* For PV solar system approach, we speculate that the RECs would be owned by utility until system is paid off through the on-bill tariff. We also speculate that the electricity would go to the participant.
- *Maintenance Responsibility:* Utility would be responsible for maintenance until the upgrade is paid off and ownership shifts to customer
- *Program Lifetime:* Variable

Sleeved Power Purchase Agreement Model

Sleeved PPAs (SPPA) take on different forms depending on the market type and how the contracts are written. In regulated markets, SPPAs usually take on the form of Green Energy Tariffs and most deployed programs are typically limited to larger commercial and industrial (C&I) customers. As of June 2017, corporations and utilities in the US have signed agreements for almost 1,000 MW of renewable capacity via Green Energy Tariff programs [26]. The most common type of Green Energy Tariff on the utility-scale renewables level is where the utility passes through the terms and structure of the PPA to the large C&I participant. However, most of the time, the market risk is not passed through. Thus, the participant gets the benefit of a long-term fixed price of electricity, but is not exposed to the potential downside risk of the PPA, such as if the market price is lower than the contracted PPA price. In a typical SPPA, the utility bears the market risk and, if the market price is lower than the contracted PPA price, must pay the difference to the renewable energy provider. This risk, and the overhead required to manage the project, is usually hedged by charging the participant a sleeving fee for the delivered energy. Benefits to the utility include the ability to get long-term contracts in place for projects that can count towards renewable energy goals. Because the utility-renewable energy asset side of the SPPA is a contract with a third-party owner of the renewable energy asset, no upfront investment is required by the utility. RECs are typically owned and retired by the customer. A summary of existing Green Energy Tariff programs is given in Table 2.

Table 2. This table summarizes various Green Energy Tariff programs from several utilities *[26]*

Utility	Eligible Participants	Potential Cost Savings	Length of Contract	REC Treatment	Enrollment Period and Program Limits	Early Exit Fees
Duke Energy (NC)	Certain classes of large customers with new load	Credit capped at renewable energy cost, so no cost savings potential	5-10 years	RECs owned by/retired for customer	Tariff currently expired after 3-year pilot period; legislation passed to modify and extend the program	Equal to the net present value of remaining PPA cost
Dominion Energy Virginia (VA)[a]	Certain classes of large customers with peak demand > 5 MW and > 85% load factor	Depends on market rates	At least 3 years	No RECs involved; renewable contract is a separate agreement between customer and developer	Before November 1, 2019, capped at 200 MW	Not specified, determined by contract with developer
NV Energy (NV)	Certain classes of large customers	Determined by final agreement with supplier	At least 2 years	Retired against customers' share of renewable portfolio standard obligation; then, RECs are retired on customer's behalf	No specific enrollment period; annual subscription limit: 250,000 MWh for northern Nevada, 250,000 MWh for southern Nevada	Not specified, determined by contract with developer
Omaha Public Power District (NE)	Certain large-power and high-voltage customers	Depends on market rates and the separate renewable contract cost	Minimum of 12 consecutive months or the length of the utility's signed contract	REC management arranged with developer	No specific enrollment period or program limit	Not specified, determined by contract with developer
Puget Sound Energy (WA)	Commercial customers using over 10,000 MWh/year; and government facilities	Premium currently; future net cost will depend on credit escalation	10-, 15-, and 20-year options	RECs owned by/retired for customer	Annual open season May 1–July 31	Penalty for early exit
Public Service Company of New Mexico (NM)	Certain classes of new, large customers (≥ 10 MW) and ≥ 75% load factor	Determined by final agreement with supplier	Contract must have the same length as contract with supplier	RECs owned by/retired for customer	No specific enrollment period or program limits	Early termination fee included
Rocky Mountain Power (UT)[b]	Certain classes of large customers able to purchase ≥2 MW	Determined by final agreement with supplier	Contract specific; must be same length of utility contract with supplier	RECs owned by/retired for customer	No specific enrollment period; capped at 300 MW	Not specified, determined by contract with developer
Xcel Energy (MN)	Any customer that pays fuel clause charge	Determined by length of contract and fluctuation in fuel clause charge	Month-to-month, 5 years, and 10 years	RECs owned by/retired for customer	No specific enrollment period; capped at 50 MW of wind and 25 MW of solar; available for 10 years	$10/MWh penalty multiplied by last 12 months of usage
Xcel Energy (CO)	Certain classes of large customers	Depends on market rates	Month-to-month, 5 years, and 10 years	RECs owned by/retired for customer	No specific enrollment period; capped at 50 MW	Fixed fees for customers on a 5- or 10-year contract

Given Austin Energy's unique status in a mostly-deregulated Texas, any SPPA program would likely be similar to other regulated utility SPPA programs and might require Public Utility Commission approval [26].

In deregulated markets, SPPAs are typically dual power purchase agreements with one PPA signed between a utility and renewable energy provider and a matching PPA signed between the utility and (typically) a large commercial or industrial customer -- although the customer could also be a housing cooperative or apartment complex. More control of the PPA terms remain with the customer, but the utility generally takes on the market risk and management overhead in exchange for charging the sleeving fee. SPPAs in deregulated markets are typically entered into by customers that want large-scale renewable energy, but are not sophisticated enough to operate in wholesale electricity markets.

Most of these projects appear to have been initiated by large corporate customers wanting to reduce their carbon footprint, but because of the local utility structure, were not able to enter into their own PPAs. Streamlining the implementation of this type of program might allow for reduced overhead and management costs for AE and allow them to offer these types of long-term renewable energy contracts to smaller, or groups of smaller, customers for a lower price than for one-off cases. Potentially offering dual request for proposals (RFP) in the future, one for renewable energy and one for off-takers (customers) of that renewable energy might be one way of matching projects and customers through a SPPA structure.

Locally-sourced SPPA programs

If the renewable energy project were to be located more locally on a large industrial or multi-family building, but still owned by a third-party (not AE or their customer) company, the terms of the agreement might be similar, but PPA prices might be higher (given the relatively higher costs of rooftop and commercial solar vs. utility scale), and thus less attractive to customers. AE would also want to consider what network upgrades might be required for large solar systems deployed on the distribution system. This type of program might be attractive to residential customers that generally pay higher rates than larger C&I customers, but residential customers might be less willing to enter into the typically longer, multi-year, agreements. AE could offer a backstop purchase of the energy if they felt confident that they could always recruit new residential off-takers, which would likely be the case if the price were lower than the regular rate.

Large multi-family buildings could benefit from owning the solar PV systems by receiving a guaranteed (possibly escalating) income stream from AE as part of the SPPA, but it might take some education of the building owners as it would be a secondary priority. Initiating this type of program (non-utility-scale renewable SPPAs) could be harder as the difference in what AE would have to pay for the solar and what they could sell it for would be smaller than traditional SPPA structures.

Program Summary (Sleeved Power Purchase Agreement)

- *Utility structure:* Multiple types
- *DER Ownership Structure:* 3rd party provider owns system (usually utility-scale) for 20+ years

- *Target Market:* Commercial & industrial, might work for blocks of residential
- *Accessibility:* Typically limited to customers with large, potentially fragmented loads (2 MW+)
- *Scalability:* Can scale large if AE can identify and aggregate demand
- *Build Participant Equity:* None
- *Upfront Costs to Participants:* Potential research/legal fees to set up contract
- *Ongoing Costs to Participants:* None
- *Bill Savings Potential:* Depends on sleeved PPA rate relative to participants retail rate, can lock in a lower rate for longer, multi-year periods
- *Upfront Costs to Utility:* None beyond program setup and management
- *Ongoing Costs to Utility:* None if wholesale market costs below contract PPA price plus ongoing management fees
- *Cost Effectiveness:* Likely cost-effective for large, highly-motivated customers
- *Payback Period:* Should be short to none if market favorable
- *Recipient of Electricity and Green Attributes:* Electricity goes to the grid and the RECS go to participant unless otherwise specified in PPA contract
- *Maintenance Responsibility:* 3rd party entity
- *Program Lifetime:* decades

Utility-Participant Shared DERs Model

In the utility-participant shared distributed energy resources model, both the utility and the participant have access to the resource, such as a battery in the case of Green Mountain Power, but this type of program also has similarities to AE's Power Partner Thermostat program where both the participant and AE are able to utilize the thermostat to control air-conditioning demand. However, most other programs are less interactive.

Green Mountain Power Resilient Home Program

Program Overview

In this program, Green Mountain Power (GMP) facilitates shared access to Tesla Powerwall battery systems in a home. The residential participant pays $30/month for 10 years or a one-time fee of $3,000 to have two Tesla Powerwalls installed in their home [27]. This cost is currently less than half of the retail price of the energy storage systems [28]. At the end of the program, the participant is allowed to keep the Powerwalls or can choose to have them removed at the expense of GMP. The Powerwalls used in this program can also be paired with residential solar; however, the solar must be installed at the expense of the homeowner and is not considered part of the Resilient Home program.

Customers can also choose to purchase their own Powerwalls or other energy storage devices and participate through GMP's Bring-Your-Own-Device program [29].

Shared access of the Powerwalls allows GMP to deploy the stored energy during peak demand times [27]. Thus, the advantage of this program to the utility is the ability to leverage the energy stored in the fleet of Powerwalls to displace expensive peaking power plants. Due to high electricity prices during peak demand times, the cost savings of this program for the utility have the potential to be significant. Also, reducing peak demand might result in cost savings for all GMP customers. Participants have access to the Powerwalls during power outages as backup generation, in place of more traditional fossil-fuel based generators used under such circumstances.

While GMP is responsible for maintenance and installation of the Powerwalls, participants must pay a $450 fee if they want the Powerwalls removed. Additionally, only homeowners with reliable internet access are allowed to participate in this program. For rental properties, landlords must be the ones to sign up for the program [27].

At the end of the program, participants own the Powerwall batteries and do so at a significant cost savings over their current retail price. In addition, the participants have the added benefit that their home will continue to have power during outages and blackouts. In return, the utility benefits from the additional 2.5 MW (program-wide) of capacity during peak periods [27].

Battery-as-a-Meter Benefit

As a potential advantage to both utilities and customers, the batteries are being studied as a "patent pending all-in-one innovative battery-as-a-meter" technology. The electronics within the battery allow for it to be used in place of a meter to monitor and account for power being used, generated, and stored within the home [27]. Both the utility and the customer can monitor the battery storage levels. This potentially has the advantage for utilities to save money on traditional metering infrastructure.

Program Structure with Solar PV

This program does not seem directly translatable to use with residential solar as the dynamics of energy storage are quite different. While not without its own benefits, a stand-alone solar system would not be able to provide firm power with the same characteristics that the batteries do in the GMP framework. The main economic advantage of this program for utilities is the ability to dispatch stored power during peak times when prices are highest. Additionally, a stand-alone solar system would also not provide the same benefits to customers that are realized with the battery system because a grid-tied solar system must go offline during a power outage.

This program does seem to couple well with residential solar systems as the two can often share the same inverter and the battery can be used to island the home so that the PV plus battery system can be used to provide power during an outage. The coupled solar can also decrease the overall emissions of the system. There is also the potential for the full Investment Tax Credit to extend to energy storage systems that are charged by an on-site solar system, but standalone storage currently does not qualify [30].

Scalability
Many of the customers in Vermont already have backup power and see the value in it because they experience outages several times a year due to winter weather conditions. Customers in this region understand the value of backup generation and are willing to pay the monthly fee to have the energy storage systems installed at their homes. For this program to have the same appeal in Austin, customers would need to either desire a backup power system, or have an electric rate structure that was conducive to a battery system, such as a time-of-use rate.

Program Summary (GMP Resilient Home)

- *Utility structure:* Investor Owned Utility
- *DER Ownership Structure:* Utility owns energy storage for 10 years
- *Target Market:* Residential
- *Accessibility:* Available to home-owners with reliable internet access
- *Scalability:* High demand for program and desire to own storage will likely increase with decreasing battery costs and increased deployment of EVs
- *Build Participant Equity:* Yes - participant owns DER after 10 years
- *Upfront Costs to Participants:* $0 or $3,000
- *Ongoing Costs to Participants:* $30/month if $3,000 not paid up front
- *Bill Savings Potential:* None
- *Upfront Costs to Utility:* Cost of Powerwall and installation
- *Ongoing Costs to Utility:* None
- *Cost Effectiveness:* Yes
- *Payback Period:* Likely to pay back during program lifetime, depends on cost savings to utility based on displacing expensive peak-time power
- *Recipient of Electricity and Green Attributes:* Electricity goes to the utility during peak and to customers during outages; no RECs involved
- *Maintenance Responsibility:* GMP
- *Program Lifetime:* 10 years
- *Program offering:* 2019

Model Risks

As with any type of program, there are risks to both the utility and the program participants. To try to help AE determine which model(s) might have more acceptable risk profiles for both the utility and the participants, we briefly discuss the different risks of each.

Risks to Utility

In some of these programs, the utility either owns physical assets or is contractually obligated to purchase energy from third-party owners of assets that are sited on land or structures that are not owned by the utility. Because of this type of arrangement, there are risks associated with the land or building owners defaulting on payments or dropping out of the program all together, which could result in the utility having to take down or repossess assets, both

incurring costs. For these model types (e.g., Roof Rental or Lease) the risks include, but are not limited to:

Failure to pay
Given that the purpose (at least partly) of some of these types of programs is to expand solar options to lower-income and/or lower-(or no) credit score groups, there could be an increased risk of participants failing to pay their bill. One way to potentially mitigate against this risk without conducting a credit check is to require, as a condition of participation in the program, a proven track record of payment to the utility over some length of time (e.g., one year). For example, TEP Residential Solar, requires that participants be customers "of the Company in good standing at the premises for no less than 12 months" [17].

Participant turnover due to moving
Another concern and possible risk the utility will want to mitigate against is how to handle the inevitable issue of property ownership turnover. The average homeowner in Austin owns their home for just over ten years [31], which is less than half the length of most program terms. Thus, if the initial participant moves and/or sells the property, the utility would need to assess the risk that the new tenant or owner will either fail to pay or otherwise choose to drop out of the program. If the program were structured to either include incentives for the new homeowner, or still provide savings and/or value to the home, this type of risk could be mitigated. For example, one utility saw a very small number of participants drop out of their program due to new homeowners who were not interested in being part of the program.

Participant drop out
Participants often have the right to drop out of the program at any time, sometimes subject to early termination fees. That said, with financial incentives (such as those provided by programs like CPS SolarHost and APS Solar Partners) that provide continuous value to the participant, likely reduce the risk of participant drop out. The TEP Solar Program might have a higher risk of participant drop out if electricity prices drop (which is possible) and participants have a fixed electricity bill for the program life. In that event, it could be possible to mitigate against participant defection by reassessing the fixed electricity bill amount if electricity rates drop enough to make a substantial difference to participants. While financial penalties for dropping out could reduce the number of participants who drop out, it could also hinder customers from joining the program.

Participant dissatisfaction
Many factors can contribute to participant dissatisfaction including things like slow response time and/or inadequately resolving questions/concerns/issues. In general, customers are satisfied when they "consistently receive 1) a perfect product, 2) delivered by a caring, friendly person, 3) in a timely fashion with 4) the support of an effective problem resolution process" [32]. Participant surveys conducted at different points in the program life can provide essential information and feedback to ensure their overall satisfaction in the program and areas for

improvement. Keeping the product offering simple and easy to understand could help reduce misunderstandings during all phases of the program(s).

The utility should consider the potential customer dissatisfaction (and possible negative impacts) that applicants who were not selected or otherwise not eligible to join the program might feel. For example, one utility's program had a less than 10% acceptance rate which means that the vast majority of applicants spent the time to apply to the program and ultimately did not become program participants.

Participant non-materialization
Based on the enrollment into the programs described in this report, the risk of participant non-materialization for beneficial programs is likely fairly low. The financial incentives to participants and—in some cases—high accessibility that include renters and low-income participants means that it is unlikely that there will be a lack of customers interested in the program. Finding customers that also meet all the program requirements could be more challenging, depending on the level of acceptable risk that the utility is willing to take on.

Third party backing out or folding during project lifetime
In cases where the utility contracts with third party entities for installation, maintenance, and/or ownership of the PV systems, there is a risk that those companies back out of the deal or fold during the project life. AE should do their due diligence on any such company and know their track record of success and customer service before entering into long-term contracts with them. The transferability of services given unsatisfactory performance could provide the utility with some control over how the program interfaces with the participants.

Damage to equipment or participant property
There is always the risk of unexpected costs due to situations such as accidental damage to equipment installed on participant's roofs or property. Having proper insurance coverage should be considered as one possible mitigation strategy. In addition, working with third parties with proven track records could help minimize these types of issues.

Regulatory Risks

Regulatory risks involve any sort of changes to laws or regulations that would jeopardize the progress or legality of the utility-managed programs. Deregulation of Austin Energy is an example of a regulatory risk, although continued management of these programs would likely be of small concern given such action. The larger concern would be an extremely botched or poorly executed program that required large amounts of cross-subsidization by other ratepayers. Such action could lead to higher rates, increasing customer dissatisfaction, and increasing the possibility of complaints to the City Council and/or the state legislature, which could ultimately lead to increased calls for the deregulation of the utility.

There are also regulatory actions that could benefit such programs such as an increased Renewable Portfolio Standard (RPS), federal low-income solar programs, or potential climate

legislation such as a carbon tax. However, experience with these types of programs could give AE a head start in expanding the programs given such favorable conditions.

Financial Risks

Beyond the potential for large amounts of cross-subsidization to decrease general customer satisfaction, there is potential for programs, such as the Sleeved PPA, to become economically unfavorable for the utility. Continued low ERCOT wholesale market prices, largely driven by low natural gas prices, make negotiating PPAs challenging, and some PPAs signed in the early part of this decade are likely no-longer economically advantageous for the energy customers. It is also possible that continued cost declines in utility-scale renewable energy projects make it very challenging for these types of higher overhead projects to compete [33].

Risks to Participants

Risks to participants include potential property damage, although in most cases the utility or third party is responsible for maintenance and other damage so this would not be a financial risk to participants but rather just the inconvenience of having to deal with repairs.

Some programs have no drop-out fees or upfront costs to participants so risks to participants are very low. In many cases, if a new homeowner chooses to have the system removed, there is no cost to the new homeowner. By contrast, some programs have fees if participants want to exit the program.

Overall, it appears that risks to participants for these programs are intentionally very minimal, so as to not deter participation. In most cases, participants pay little to no money upfront to participate, are not responsible for any operation, maintenance, or other costs associated with the system throughout its lifetime, and have easy and free means by which to exit the program if they so choose.

Conclusion

This report evaluated four different program models (roof rental or lease programs, on-bill rent-to-own tariff, sleeved power purchase agreement, and utility-participant shared DERs) for consideration as options for AE to implement to expand residential solar. Several of the considered program models have existing programs employed at utilities around the country.

As expected, the variety of models and programs have different trade-offs that need to be carefully examined when deciding the best option for a utility to implement. Based on our research the main takeaways, in general, were as follows:

Roof Rental or Lease Program

Benefits

- Increases distributed solar energy
- Can often target low to moderate income customers and renters

- Program is often designed to lower participants' electricity bills
- Can be coupled with the utility's research goals such as implementing smart meter technology and solar PV and storage for smart peak load shaving
- The utility can select roofs that better align with higher local wholesale market prices (in ERCOT, more west-facing)

Drawbacks

- Often requires cross-subsidization by other ratepayers
- Potential high maintenance costs
- Significant program overhead costs
- Could have higher rates of participant drop-out, especially among residential participants (primarily as a result of home sales and new home owners not wanting to have the systems)
- Some utility structures (including municipal utilities) must partner with third-party developer to capture the ITC savings

Major Risks and Impact

- High probability & high impact: Maintenance and overhead costs were deemed significant challenges with these programs and should be carefully assessed prior to implementing a similar program in AE
- Low probability & low impact: Participant drop-out and dissatisfaction are deemed low probability and low impact
- Low probability & medium impact: Participant non-materialization is deemed low probability and medium impact
- Low probability & high impact: Safety concerns with equipment at participants' homes or elsewhere
- Low/medium probability & medium/high impact: Unexpected costs due to unforeseen maintenance issues or property damage

PAYS

Benefits

- Credit scores are not required so more customers can qualify for program
- Customers with lack of funds to make the investments themselves can participate
- Renters can participate
- The utility is likely to recover most, if not all, of its investment
- For efficiency upgrades: Homes that receive energy efficiency upgrades have lower energy demands and, as such, the energy load on the utility is reduced as more upgrades are made

Drawbacks

- Federal loans with favorable terms might be hard to obtain (EECLP is available but targets rural municipalities).

- Utility takes on the burden of the loan terms and payback and all risks associated with having the loan

Major Risks and Impact

- Low probability & high impact: Since the utility takes out the loan, they are responsible for repayment even if participants fail to pay their on-bill tariff. Having a requirement that a customer be in good standing to participate in the program can help mitigate this risk. Based on current programs, repayment is not generally an issue.
- For PV solar systems, costs could be higher and payback periods longer than typically seen with PAYS programs.

Utility-Participant Shared DERs

Benefits

- Potentially decreases costs to the utility and all customers through decreased use of high cost peaking plants
- Research opportunities for studying new technologies and devices such as 'battery-as-a-meter' or smart thermostats
- Utility is not responsible for paying a credit to the customers and in some cases the customers pays the utility for use of the DER

Drawbacks

- Customer participation dependent on customer desire and/or need for backup power which may be lacking for AE customers
- Structure of program that allows for most benefits to utility (dispatchable storage as DER) not translatable to residential solar

Major Risks and Impact

- High probability & high impact: customer participation minimal due to a customer required monthly payment to the utility and no monthly bill credit or lack of customer interest in having energy storage for backup power
- Low probability & medium impact: data privacy and security concerns with shared resources

Sleeved PPA

Benefits

- Potentially fewer installations to manage and maintain compared to a rooftop lease program
- Structure allows for utilization of ITC savings
- Utilizing off-site utility-scale projects can realize economies of scale to reducing energy costs
- AE has experience and competence in negotiating very low-cost PPAs already

- AE is a sophisticated electric wholesale market participant and understands market risk and can appropriately hedge against that risk
- These renewable energy projects could count towards AE's renewable energy goals

Drawbacks

- Complicated three-party contracts can add additional management overhead
- AE bears the market and shape risk of the PPA contract
- It could be difficult to find smaller customers that are willing to enter into the longer, multi-year contracts that are typical with PPAs
- Utilizing the SPPA construct with renewable energy projects that are smaller than utility-scale might make it difficult to develop products that are low enough cost to be attractive to customers

Major Risks and Impacts

- Low risk and high impact: wholesale market prices stay below PPA rate and AE has to make payments to renewable developer
- High risk and high impact: applying the sleeved PPA framework to multifamily buildings (as the energy producers) could make it difficult to offer a competitive PPA rate to program participants

In general, it is difficult for some of these types of programs to compete financially with other forms of renewable energy procurement, such as utility-scale PPAs or direct development. Expanding access without incurring some level of cross-subsidization can be difficult. The only programs evaluated (that included customer-sited assets) that did not do so were the on-bill rent-to-own tariff and (potentially) the utility-participant shared DERs models. It appears that the roof lease/rental programs were harder to deploy without cross-subsidization.

Prices for DERs continue to decline, but non-labor soft costs (permitting, inspection, interconnection, sales tax, overhead, net profit, etc.) now make up more than half of the cost for residential and commercial solar PV systems [34]. If AE were able to develop an efficient program that was able to reduce, or even eliminate, some of these costs, it could significantly close the gap between these and utility-scale renewable project costs. Doing so could change the economic outlook for programs that seek to expand solar access.

Works Cited

[1] Austin Energy, "Austin Energy Resource, Generation, and Climate Protection Plan to 2027," 2 Oct 2017. [Online]. Available: https://austinenergy.com/wcm/connect/6dd1c1c7-77e4-43e4-8789-838eb9f0790d/2027+Austin+Energy+Resource+Plan+20171002.pdf. [Accessed 25 June 2019].

[2] APS, "APS Solar Partner Program," 2019. [Online]. Available: https://www.aps.com/en/ourcompany/aboutus/investmentinrenewableenergy/Pages/solar-partner.aspx?src=solarpartner. [Accessed 26 June 2019].

[3] CPS, "Case Study: CPS Energy's Solar Programs," 9 June 2017. [Online]. Available: http://www.ncsl.org/Portals/1/Documents/energy/solar_workshop_R_Luna_present_6_2017_31424.pdf. [Accessed 25 June 2019].

[4] CPS, "SolarHost SA FAQs," 2019. [Online]. Available: https://www.solarhostsa.com/#faq. [Accessed 25 June 2019].

[5] I. Dimmick, "Happy Southsider is first 'Solar Host' in San Antonio," 10 12 2015. [Online]. Available: https://www.solarhostsa.com/happy-southsider-first-solar-host-san-antonio/.

[6] S. Chapa, "Toyota debuts solar panels at San Antonio Plant," *San Antonio Business Journal,* 7 Apr 2017.

[7] S. Adhikari, "APS Solar Partner Program," 22 October 2015. [Online]. Available: https://www.nrel.gov/esif/assets/pdfs/highpenworkshop_adhikari.pdf. [Accessed 9 July 2019].

[8] APS, "APS Solar Communities," 2018. [Online]. Available: https://www.aps.com/en/ourcompany/aboutus/investmentinrenewableenergy/Pages/aps-solar-communities.aspx?src=solarcommunities.

[9] H. Mai, "'Not all batteries are made equal' - APS battery fire highlights safety risks, lack of knowledge," 5 June 2019. [Online]. Available: https://www.utilitydive.com/news/not-all-batteries-are-made-equal-aps-battery-fire-highlights-safety-ris/555185/.

[10] J. Pyper, "Smart Inverters in Action: Initial Results From APS' Utility-Owned Solar Program," 19 Aug 2016. [Online]. Available: https://www.greentechmedia.com/articles/read/Smart-Inverters-in-Action-Initial-Findings-From-APS-Utility-Owned#gs.zgm854.

[11] Electricity Local, "Phoenix, Arizona Electricity Statistics," 2019. [Online]. Available: https://www.electricitylocal.com/states/arizona/phoenix/.

[12] Los Angeles Department of Water and Power, "Solar Rooftops Program Guidelines," Los Angeles, 2017.

[13] S. McNary, "LADWP approves program to put solar on low-income homes," *89.3KPCC,* 15 November 2016.

[14] Los Angeles Department of Water and Power, "Solar Rooftops Community Solar Program," LADWP, Los Angeles, 2017.

[15] Los Angeles Department of Water and Power, "Solar Rooftops," 2013. [Online]. Available: https://www.ladwp.com/ladwp/faces/ladwp/residential/r-gogreen/r-gg-ressolar/r-gg-rs-solarrooftops.

[16] R. Rockzsfforde and M. Zafar, "Comparative Analysis of Utility Services & Rates in California," California Public Utilities Commission, San Francisco, 2015.

[17] Tucson Electric Power, "TEP Residential Solar Program," [Online]. Available: https://www.tep.com/residential-solar/.

[18] Sunbridge Solar, "MACRS Solar Accelerated Depreciation," 2019. [Online]. Available: https://sunbridgesolar.com/solar-macrs-commercial-details/.

[19] P. Cillo, "EEI investigating feasibility of on-site PV as PAYS upgrade," 28 May 2019. [Online]. Available: https://www.eeivt.com/eei-investigating-feasibility-of-on-site-pv-as-pays-upgrade/. [Accessed 10 July 2019].

[20] H. Hummel and H. Lachman, "What is inclusive financing for energy efficiency, and why are some of the largest states in the country calling for it now?," Clean Energy Works, 2018.

[21] Clean Energy Works, "PAYS for Energy Efficiency - Q&A," 2019. [Online]. Available: http://www.cleanenergyworks.org/qa-pays-for-ee/. [Accessed 9 July 2019].

[22] Midwest Energy Inc., "How$mart Q&A Sheet," July 2015. [Online]. Available: https://www.mwenergy.com/assets/documents/Howsmart_FAQs.pdf. [Accessed 9 July 2019].

[23] Clean Energy Works, "About Us," 2019. [Online]. Available: http://www.cleanenergyworks.org/about/. [Accessed 9 July 2019].

[24] Midwest Energy Inc., "How$mart Program Invests $10 Million in Customer Homes," 1 March 2017. [Online]. Available: https://www.mwenergy.com/news/view/howmart-invests-10-million-in-customer-homes. [Accessed 9 July 2019].

[25] The Energy Efficiency Institute, Inc., "Decision Tool for Utility Managers," Colchester, VT, 2016.

[26] J. Heeter, J. J. Cook and L. Bird, "Charting the Emergence of Corporate Procurement of Utility-Scale PV," National Renewable Energy Laboratory, Golden, CO, 2017.

[27] Green Mountain Power, "Resilient Home," 2019. [Online]. Available: https://greenmountainpower.com/product/powerwall/. [Accessed 8 July 2019].

[28] Tesla, "Powerwall," 2019. [Online]. Available: https://www.tesla.com/powerwall. [Accessed 7 July 2019].

[29] Green Mountain Power, "Bring Your Own Device," 2019. [Online]. Available: https://greenmountainpower.com/bring-your-own-device/.

[30] energy sage, "Using the solar investment tax credit for energy storage," 2 1 2019. [Online]. Available: https://www.energysage.com/solar/solar-energy-storage/energy-storage-tax-credits-incentives/.

[31] C. Moon and M. Miller, "How Long Do Homeowners Stay in Their Homes?," 4 June 2018. [Online]. Available: https://www.valuepenguin.com/how-long-homeowners-stay-in-their-homes.

[32] M. Solomon, "The Four Secrets of Achieving Customer Satisfaction," *Forbes,* 10 June 2018.

[33] E. F. Merchant, "Texas Municipal Utility Signs New Super-Low Solar PPA," *Green Tech Media,* 14 December 2018.

[34] R. Fu, D. Chung, T. Lowder, D. Feldman, K. Ardani and R. Margolis, "U.S. Solar Photovoltaic System Cost Benchmark: Q1 2016," National Renewable Energy Laboratory, Golden, CO, 2016.