INNOVATION

2020

SMUD®

Table of contents

As the nation's sixth-largest community-owned and not-for-profit electric service, we continue to be a leader in the industry, exploring new concepts and technologies that will help forge a path to a carbon-neutral future.

SMUD was the first large California utility to derive more than 20 percent of its energy from renewable resources, and we now get about 50% of our power from carbon-free resources.

In October 2018, the locally elected SMUD Board of Directors approved the Integrated Resource Plan (IRP), which included a goal to achieve net-zero greenhouse gas emissions by 2040.

The plan, approved in December 2019 by the California Energy Commission, focuses on local renewables and includes a $7 billion investment to achieve some very ambitious goals:

- More than 2,900 megawatts (MW) of new carbon-free resources, including large-scale solar, wind, energy storage and geothermal.
- An aggressive expansion of distributed energy resources (DERs) such as rooftop solar, electric vehicles (EVs), all-electric homes and customer-installed battery storage can help us use more renewable energy and manage demand. DERs are located close to where electricity is consumed and can meet some of a customer's electricity needs, help meet the needs of the grid, or both.

In July 2020, the Board of Directors approved a climate emergency declaration that commits to working toward an even more ambitious goal of delivering carbon-neutral electricity by 2030. The declaration recognizes the immediate risks to our community and demands bold action to achieve results. This resolution commits SMUD to finding carbon reductions in the quickest way possible and investing in our most vulnerable communities.

Led by our Energy Strategy, Research and Development team, we're empowering our customers to be active participants in an innovative, modern electric grid. We're rethinking the systems and resources that we rely on, for everything from building construction, lighting, fuel sources, moment-to-moment operation of the grid and future resource planning.

This report highlights projects that integrate emerging technologies and new business models. We're committed to delivering innovative products, programs and services that provide solutions our customers care about. How can we best optimize the growing number of customer-owned solar generation assets, batteries and large electric loads like EV charging, while continuing to provide reliable and affordable electric service to all of our customers?

It's not just about carbon. It's about clean, accessible community resources that help improve the quality of life for all our customers.

We're leading the way to a carbon-neutral future

To achieve this goal, we need to significantly expand clean electricity delivery to our customers and partner with them to optimize their resources. DERs such as battery storage, EVs and flexible loads can help us absorb renewable energy and reduce demand, minimizing the need for overall system investments.

However, if left unmanaged, DERs may not meet overall customer electricity needs as reliably and affordably as possible. So, as our customers adopt DERs, we're developing technology platforms and programs intended to maximize both the individual and community benefits. This shared approach aligns best with our community-owned, not-for profit structure.

Our research and development efforts are focused on understanding the best approaches to create shared value with our customers' DER; to minimize grid impacts of transportation and buildings; and to help accelerate our transition to a carbon-neutral future. We're thinking broadly about all our touchpoints with greenhouse gas emissions. We're implementing new ideas, such as increasing soil carbon uptake and pollinator habitats at new solar farms, and providing incentives for natural refrigerants as part of our energy efficiency programs. We're exploring new tools and emerging technologies that will help us maximize the value of all DERs on the grid.

To face this monumental challenge of climate change, we're working creatively and cooperatively on solutions that can increase our community's resilience to its threats, while providing benefits for all our customers.

Living Future Project Accelerator

Did you know that there's a certified Living Building in Sacramento? This is something to be proud of, and we wanted to amplify its success to encourage other developers, builders, designers and architects to take on the Living Building and Living Community Challenges—the most rigorous of "green" building standards.

Living Buildings generate and store their own renewable, non-fossil power; capture rainwater; treat their wastewater onsite; grow organic food and use local, non-toxic materials. Plus, these buildings are required to perform as designed for one full year before they're certified, meaning all the planned benefits actually come to life.

Living Buildings are not just "less bad" than conventional buildings—these standards support regenerative development and have a positive impact on human health and on the environment. Living Communities do all this, and more, for multiple buildings on a campus or in a neighborhood.

The Living Building in Sacramento is the local office of architectural firm Arch Nexus, and is also the first certified adaptive reuse project in the world.

To support this effort, SMUD collaborated with staff from the International Living Future Institute and Arch Nexus. Together we offered free training sessions, building tours, technical assistance and, when feasible, focused design meetings to share information about the Living Future frameworks.

Autism Spectrum Disorder Residential Lighting Project

LEDs have transformed the lighting market and can illuminate spaces with an almost unlimited range of colors and color temperatures. They work with smart devices, are dimmable and are very energy-efficient. LEDs are being used to illuminate spaces differently, and more dynamically, than ever before.

Studies have shown that lighting affects our natural, internal process that regulates our sleep-wake cycle—our circadian rhythms—and may directly impact our health and behaviors. We began studying the effects of different ranges of lighting on health in 2015 with dementia patients and have continued to develop lighting solutions that could improve our customers' lives.

The Autism Spectrum Disorder (ASD) Residential Lighting Project installed circadian lighting systems in the homes of 36 families who have children with ASD. Circadian lighting changes the color of light inside to mimic daylight patterns outside. By changing colors throughout the day, not only can light stimulate our bodies and minds and help us stay alert and awake, but it can also help us unwind and relax in the evening as we get ready for bed.

This programmable (or "connected") circadian lighting reinforced daily routines and eased transitions between activities. One of the primary goals was to help children and their parents or guardians sleep better.

All the families reported significant improvements in daily routines, behaviors and activities, including sleep. Best of all, when asked what impact the lighting system had made upon their lives, 77% of the respondents characterized the experience from "high impact" to "life-changing." There are more than 7,600 SMUD customers in Sacramento County with ASD, and we hope to use these results to benefit all our customers with special needs.

of the respondents characterized the experience from **"high impact"** to **"life-changing."**

Virtual Power Plant Pilot Program

To meet our clean energy goals, we'll need a lot of load flexibility and tools to predict or control the way those loads will behave. This program explores the potential of customers sharing their investments in residential battery storage and thermal storage with SMUD in exchange for incentives. Customers with compatible devices, such as SolarEdge StorEdge batteries, GE heat pump water heaters, and Rheem heat pump water heaters that are connectivity-enabled can participate. By coordinating a fleet of these devices, we can create a Virtual Power Plant (VPP) that grid operators can use in lieu of conventional resources in times of need.

We wanted to demonstrate that use of controllable heat pump water heaters and battery energy storage systems, shared between customers and SMUD, can be cost-effective and reliable for both parties. PowerMinder, a water heater program, began in Summer 2019 and Smart Energy Optimizer (SEO) began enrolling customer battery systems in Fall 2019.

The PowerMinder program adds to the value of controllable GE and Rheem Heat Pump Water Heaters by providing additional bill savings without compromising hot water delivery. By using a thermostatic mixing valve, tank temperature can be raised at times of additional grid capacity or energy availability (such as excess solar energy generation) without impacting the delivered hot water temperature. The mixing valve automatically mixes hot tank water with cold water to maintain each customer's desired hot water temperature. Participating customers receive an enrollment incentive of $150 and an ongoing monthly incentive of $2.

The SEO program adds to the value of residential battery systems for customers and for the electrical grid by shifting battery operation in response to signals dispatched by SMUD. On 120 days of the year, SMUD sends a signal to discharge the batteries during the peak hours of grid operation. The remaining 245 days of the year, customers can still save money on their bills by shifting renewable energy from the battery to the peak hours. Customers receive an upfront incentive of $500 and a $10 monthly bill credit for their participation.

These programs offer customers an opportunity to reduce their electricity costs while providing a taskforce of VPP devices that we anticipate will become cost-competitive with traditional power plants.

Time to Charge savings for EV owners

To help the region and state meet its required clean energy and transportation goals, our cutting-edge "Time to Charge" project will synchronize EV charging with low-cost, local and clean energy production. Drivers will be able to choose whether they'll charge their cars during the hours that solar generation is at its highest. If they do charge their EVs during peak solar periods, not only will they earn rebates, they'll also be making a case for more local renewable energy systems to be installed.

We're pioneering the use of a new "blockchain" records-keeping technology that passes local electric grid savings directly on to customers. The charging rebates will add up as blockchain-enabled tokens, each of which are locked into a 'chain' of records. If any of the records are tampered with, that chain is broken and will be immediately rejected by the system. Long story short, it's a cyber-safe way of making, tracking and storing many, many online transactions for automated energy savings.

This is geared to encourage EV drivers to charge their vehicles during mid-day hours when solar power is at its peak, inexpensive and generated locally. And if enough customers choose to use locally produced renewable energy, we won't need as much expensive battery storage and other infrastructure—ensuring that all SMUD customers can benefit from lower costs and a cleaner grid.

EV charging integrated with storage and local solar energy

The most common concern among EV drivers is range—the perception that their travel is limited by their vehicles' charge capacity and by the availability of charging stations. EV manufacturers respond by increasing car battery capacity and therefore drive ranges as much as they can, but as these increase, so does the demand for faster charging speeds. This requires higher-capacity charging stations, which can have a big impact on local energy distribution resources. As you can imagine, the costs to install and support these chargers can be high.

We wanted to find a way to lower the costs of necessary infrastructure upgrades, while also minimizing any environmental impacts. So, we proactively addressed the question of what to do with the old EV batteries when they no longer could hold enough charge to power the vehicles. Could we use them for something else?

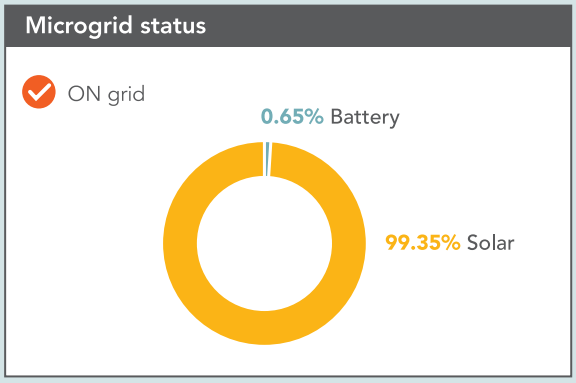
Since there's still considerable life left in used EV batteries, we combined multiple used batteries to create a large stationary battery, to see if it would perform like any other battery you would install on the grid. We installed used Nissan Leaf batteries, a local site controller, a DC Fast Charger, and four controllable level 2 EV chargers at SMUD's Solar Port. This battery is controlled by the site controller, which acts as a universal remote.

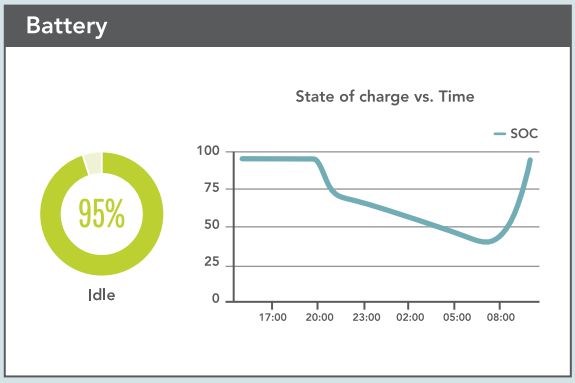
The site controller is the brains of the operation. It automatically measures the output of solar energy and tells the battery when to charge. Currently, the battery system charges during the day, using excess solar energy generation, and provides power to the site during the evening and night. This makes the site almost 100% renewable and carbon-free.

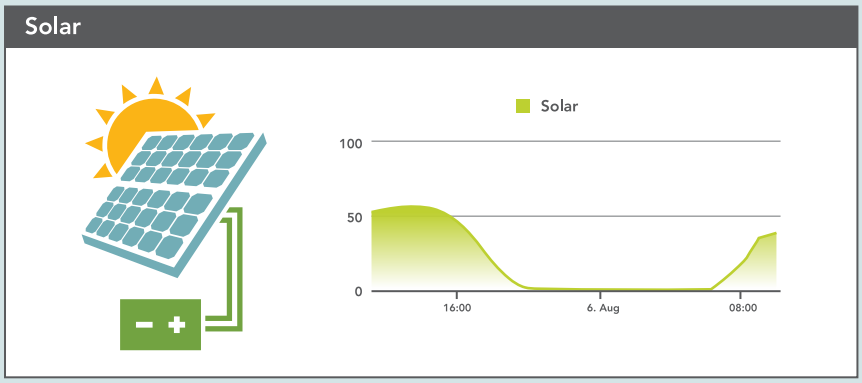
Next, we're working on a way to keep the charging site load at the 150kW transformer limit, by reducing the EV charge output and discharging the battery. By keeping the site load at this limit, we can continue to use the original transformer and save the expense of replacing it with new—and larger—equipment.

Projects like this can replace the need for upgrades to the grid or energy distribution system where upgrades would be too costly, impractical or even physically impossible. With a few site modifications, the excess solar energy stored in batteries can be used to provide backup power to the site in case there's a grid outage. It's a sustainable EV charging model that limits its impact on the grid, which would benefit property owners and third party EV charger installers as well as utilities.

This could be the first step in creating a 100% renewable microgrid in the very near future!







Solar energy generation and storage: SHINES

In partnership with the Electric Power Research Institute (EPRI) and other participating utilities, we're contributing to a Department of Energy project that will develop tools to optimize the integration of DERs, such as solar energy, onto the existing electric grid. The purpose of the project is to build an infrastructure that can manage multiple DERs to help provide safe, reliable, clean and affordable electricity to all.

The Sustainable and Holistic Integration of Energy Storage and Solar Photovoltaic project, or SHINES, is developing a robust electric power delivery network that combines the benefits of clean, efficient solar photovoltaic (PV) energy generation, battery energy storage, electricity load management and advanced solar forecasting techniques. By supporting this project, we're investing in a valuable tool that may help us manage and integrate dynamic energy generation and use. So, we're able to operate more efficiently, as well as more reliably predict load on the grid.

SHINES is part of an overall modernizing of the electric grid through new technologies and management systems. The idea that really sets it apart is the two-level control structure:

- **System controller** that maintains overall reliability of the electric grid, through coordinated control of multiple local controllers and other energy distribution equipment.
- **Local controller** that responds to system controller needs and makes solar PV more manageable by efficiently using energy storage, load management, smart inverters and solar/load forecasting.

SHINES promotes coordination of joint customer and utility energy control, which improves grid operations, reduces grid and load impact, smooths out the delivery of PV energy and ultimately lowers the total cost of energy for all.

Rancho Seco Solar Ecosystem Services Assessment

Isn't it funny how some things can sound so technical, yet be so beautiful? How would you describe a project that nurtures butterflies, grows flowers, feeds farm animals and supports some of the richest agricultural land in California?

In early 2020, we completed an assessment of the options and operational issues involved with the integration of ecosystem services into the Rancho Seco II Solar Project. Elements of the project, as well as research to evaluate its effectiveness, will be implemented beginning in 2021. This is a unique opportunity to evaluate long-term, land-based carbon storage benefits; create vital pollinator habitats; support working lands and agricultural values; and enhance multiple ecosystem services across this solar site. Our proposed project scope includes:

- Seeding California Central Valley prairie plants
- Planting hedgerows of native flowering shrubs around perimeters of solar arrays and access roads
- Implementing prescribed sheep grazing for weed management within solar array fields
- Rehabilitating soil to support successful seed germination
- Testing the impact of solar panels on milkweed, a critical habitat for the monarch butterfly

These native plants trap carbon in their extensive underground root systems, which can actually remove greenhouse gas emissions from the atmosphere!

We conducted this initial technical assessment of project options in partnership with our Power Generation staff and the third-party developer of the site DESRI Renewables. Our inquiries even inspired the developer to plan for grazing at the site, instead of spreading herbicides and mowing.

We also actively participate in EPRI's Power in Pollinators initiative, which promotes and supports pollinator conservation among energy utilities. The partnership shares the latest scientific findings, case studies and tools to assist with the integration of pollinator-friendly practices into utility vegetation, facilities and land management.

If this work is successful, we can potentially expand its scope to help improve agricultural yields and sustain our local food supply.

What we need to do to achieve carbon neutrality

Simply put, we need to stop using fossil fuels. This is even more challenging than it sounds, and we're committed to finding the right solutions for our customers and community. So, we're constantly researching, evaluating and testing innovative and sustainable energy solutions that can bring the benefits of emerging technologies to our customers in the most cost-effective ways.

We're objectively assessing the benefits of these technologies to identify the renewable and carbon-free options that are most efficient and that produce enough electricity, when and where we need it, to ensure a reliable grid. At the same time, we're developing new tools that can absorb and dispatch electricity, store generated electricity for extended periods and control output to align with grid requirements. This enables us to continue supporting proven low-carbon solutions while we determine the most cost-effective and productive ways to reduce carbon emissions.

Navigating the road to carbon neutrality requires a steady hand. Our customers trust us, as their community-owned utility, to put their interests first, and we embrace this once-in-a-generation opportunity to lead the capital region to a brighter, more sustainable future. Yes, our carbon reduction goals are aggressive and ambitious, but we're prepared for the challenge.

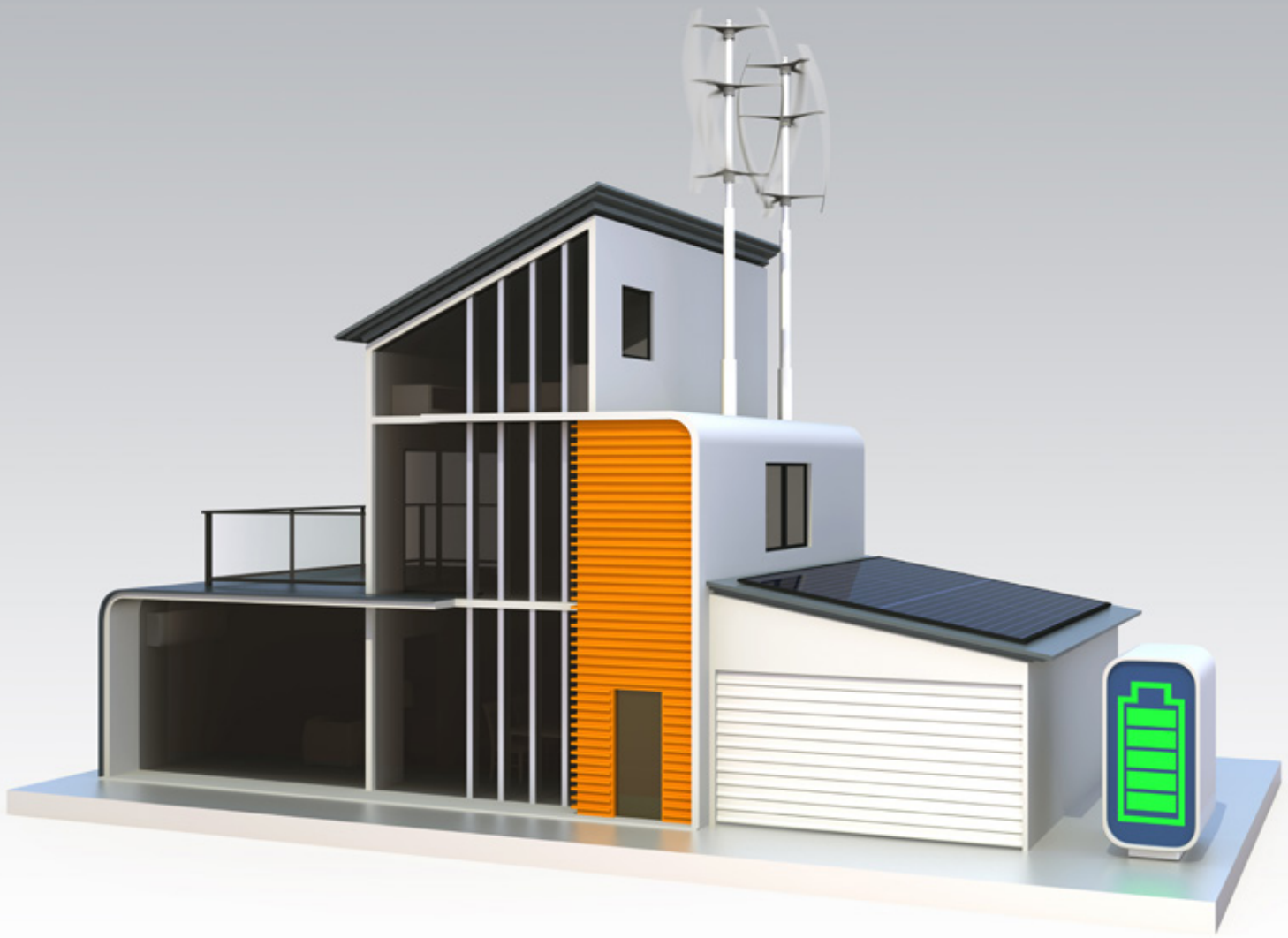
Energy StorageShares

Our award-winning Energy StorageShares program is a first-of-its-kind partnership that maximizes customer benefit from their investment in energy storage while minimizing the cost for SMUD to upgrade or build new infrastructure for the grid. We want to support customer-owned storage while also providing options so businesses can choose the best solution for their needs.

Businesses that are considering installing batteries at their site (but don't have a back-up power need) can choose to make an up-front investment in shared battery energy storage, in exchange for a monthly on-bill credit for 10 years. SMUD combines the investments with its own capital to install the battery in a prime location that provides significant benefits to the grid.

The bill credit reflects the savings the customer would have gained from an onsite battery that would reduce demand charges. Demand charges are imposed to recover the fixed cost of capacity-related facilities. Commercial customers' demand charges vary based on their maximum demand, but the charges can be reduced if the customer chooses to use an onsite battery. With StorageShares, we give them a bill credit that represents the savings they would have had if they had installed a battery—without having to install and maintain a battery onsite. How convenient is that?

The program provides guaranteed savings to the customer without impacting their business operations, creating maintenance obligations, or requiring physical space at their business for a battery system. It drastically lowers the cost of battery energy storage, as it is much less expensive to install a few large battery systems than it is to install multiple smaller batteries. The program benefits all SMUD customers by reducing demand on the grid, and by deferring infrastructure upgrades so that we don't need to install or upgrade a substation.



Commitment to Operate Program

Offered to both Residential and Commercial customers, the Commitment to Operate pilot program was developed to understand how customers use their energy storage batteries. We also wanted to know if an incentive would encourage customers to discharge part of their battery during SMUD's Time-of-Day (TOD) peak hours to help reduce their electricity costs and contribute to a healthier environment.

Battery storage customers receive incentives by "committing to operate" their battery system in a way that uses no more than 51% of their battery capacity during peak hours (which still reserves 49% for back-up power). Customers program their battery to optimize for TOD rates, which can lower their bill and helps reduce strain on the grid during peak times. Plus, it provides customers with a battery back-up in case of a power outage. Residential customers receive a one-time $300 incentive, and commercial customers receive a one-time incentive between $600 and $5,000, depending on the size of the battery.

With the information about load profiles and battery operation gained from this project, we can host more batteries and help customers get more value from them. We can better predict impacts of battery storage on grid operations, and eventually better manage the impacts of these batteries on the grid.

Local battery storage brings us a step closer to integrating more renewable energy onto the grid, by storing generated energy and using it during peak periods.

Smart Grid Billing Energy Storage Solution Project

We added a battery energy storage system to the Hyatt Regency Sacramento's existing energy management system (EMS) that controls thermostats and EV chargers to see how integrated control could lower energy costs, provide grid benefits and manage energy demand during peak times.

Our aim was to independently determine how battery storage and demand management software work together, so we could establish customer cost and grid benefits as well as verify manufacturer claims of battery system performance.

Hotel guests generally want maximum comfort and convenience, but traditional approaches to load management can make that difficult and don't always produce a reliable load reduction. When we added batteries to the EMS, the hotel was able to significantly reduce load with a high degree of reliability—without negatively impacting the customer experience. This is great news for businesses interested in partnering with utilities to use batteries for grid services.

Our results confirmed that as the costs of battery systems continue to drop, combining them with intelligent energy systems can potentially benefit medium- to large-sized businesses with reliable load management and fewer infrastructure upgrade costs. Also, the project helped us to better understand the grid impacts, performance and energy load flexibility of a battery system connected to a business customer's existing energy system.

We'd like to see a future where large businesses can host batteries onsite and participate in utility programs to dispatch them during times when they don't need them onsite. Projects like this help build confidence for both the customer and the utility.

Distribution Resource Integration and Value Estimation: DRIVE

Another joint project with EPRI, the Distribution Resource Integration and Value Estimation project, or DRIVE, provides us with a new software tool that evaluates grid capacity and determines the grid's ability to host DERs on distribution feeders.

Why is this valuable? Distribution feeders are the power lines that transfer power from a substation to the transformer, so they're literally what deliver our power. The challenge is that hosting capacity of these feeders, or the number of DERs that can be handled without affecting quality or reliability, can vary. The capacity can also change over time as resources are added or infrastructure changes.

We needed a way to accurately assess the feeder hosting capacity, system-wide, that accounted for the impact of the resource technology type, size and location as well as the feeder itself. DRIVE enables our planners to efficiently and effectively evaluate these technical impacts on our distribution systems.

Our engineers and planners will use the tool to improve customer experience and hosting capacity for customers who want to interconnect their own DERs on the grid. Having the efficient planning tools provided by DRIVE makes it possible for us to offer more effective and creative customer solutions that will reduce energy delivery time and costs and increase our ability to bring customer-owned DERs onto the grid.

Creating pathways from clean energy to clean cars

This initiative leverages California Air Resources Board (CARB)'s Low Carbon Fuel Standard (LCFS) credit program to assign renewable generation sources to EV charging. It increases the number of LCFS credits that can be reinvested in renewables and electric transportation to accelerate the growth in both markets. Basically, we generate more rewards and pump them right back out to our customer programs and clean energy partners.

Besides sources like solar and wind, we can also use biomass sources like food waste, wastewater, or even the debris removed as part of SMUD wildfire mitigation efforts. We've already made significant headway in using wind, solar and dairy waste by acquiring certifications and creating SMUD programs to support these sources. In fact, we were the first utility to work closely with CARB to certify dairies and move this initiative forward.

The pathway plays an important role delivering renewable energy as clean fuel to EVs. Dairies emit the largest amounts of climate pollutants in California, and dairy digesters reduce those emissions by using the dairy waste to create electricity instead.

This enables commercial customers to fuel their fleets with clean energy, which significantly increases the number of LCFS credits. SMUD can then reinvest those additional credits to support the growth of electric transportation, while the generators can reinvest their credits in new advanced renewable generation.

By implementing digesters, California dairy farms are not only helping further shrink dairy's carbon footprint to unprecedented levels, they're also helping SMUD and the state transition to a carbon-neutral future using clean energy.

Repowering of New Hope Dairy

You've heard of cows contributing to greenhouse gases that endanger the planet? Well, we can proudly say that this project is another one of our contributions toward reversing the damage.

By agreeing to buy power generated by the New Hope Dairy digester, we helped get it back up and running. The digester has been interconnected to the SMUD grid and delivering power since August 2019.

Powered entirely by cow waste, the anaerobic digester will generate clean electricity and keep tons of methane gas (a harmful greenhouse gas that traps 32 times more heat than carbon dioxide) from escaping into the atmosphere. The digester separates the solids from the liquid, the liquid goes into a digester that produces biogas, and the biogas fuels an engine-generator that produces electricity—which interconnects with the SMUD grid.

One cow can produce enough electricity to drive a car across the country. Two cows can produce enough electricity to charge an EV for a year. Five to six cows can power a household for a year. Now that's what we call cow power!

By generating power, the New Hope Dairy digester and systems like it also can create a revenue stream from the value of carbon credits, as described previously, as an LCFS electricity pathway. Projects like this increase the "green" power in our energy mix.

Just when you think it can't get any better, the byproducts of this anaerobic digestion of dairy waste can be used to make compost that can be used to grow more crops or as feed for the cows. It also produces a nitrogen-rich fertilizer that even reduces odor and flies.

So, New Hope Dairy turns waste into fuel, generates clean electricity and reduces greenhouse gases. If only we could all be this efficient!

Renewable Energy Preconfiguring & Controlling Inverter Set-Points: PRECISE

PRECISE is an integrated software tool developed by the National Renewable Energy Laboratory (NREL) with support from SMUD. This tool helps SMUD and other utilities customize PV smart inverter settings for interconnection to the grid. While this may not sound simple, it certainly simplifies energy delivery for solar customers.

PRECISE is a system that allows us to seamlessly interconnect PV energy resources, using the customer's address and a built-in model of that customer's distribution feeder to calculate the advanced inverter modes that will provide grid support and minimize energy limitations. This streamlines the integration of customer solar power by significantly cutting down customer costs and wait times.

We found that PRECISE also can dramatically reduce the time it takes to approve and connect PV systems to the distribution feeder. PRECISE is now helping us integrate more solar energy resources onto our grid in a safe, secure and cost-effective way. In fact, this project's innovation was recently recognized with a prestigious R&D 100 award.

Online transformer monitoring

Power transformers, which are essential to the distribution of electricity, are also among the most expensive elements of the grid. To help reduce maintenance costs of this equipment as well as increase its reliability, we're installing online transformer monitoring systems. These systems enable us to continually assess the condition of the equipment so we can identify issues early, better predict how long a transformer can stay in service and, most importantly, prevent unexpected equipment failure. Online transformer monitoring helps us deliver safe, reliable, uninterrupted power more cost-effectively.

We're reducing emissions on a wider scale

Our goal of reducing emissions isn't limited to our own. We're committed to helping our community upgrade equipment that burns natural gas, gasoline, or diesel fuel; that leaks harmful refrigerants; that degrades our local air quality. We're working to make it easier for our customers to adopt renewable generation and to replace equipment that damages our environment, and these changes have other far-reaching benefits as well. Better air quality, less noise pollution, fewer safety risks and lower energy costs will all be within reach.

Building science projects

While SMUD has strong programs in place that support upgrades for building systems in single-family residential settings, the industrial and multifamily sectors require more complex technological solutions. These projects explore new approaches to old challenges (heating water, cooling food) that are cleaner, lower-cost and more environmentally responsible.

Sanden Heat Pump Water Project

Moving away from natural gas-powered central water heating plays a big part in achieving our carbon-neutral goals. As part of our commitment to clean and efficient energy for our customers, we wanted to test the viability, performance and potential benefits of replacing gas water heaters with electric heat pump water heaters (HPWHs).

This transition is particularly challenging for multifamily applications, where it can be costly. For fourplexes specifically, there were no known, proven heat pump water heater solutions. The Sanden CO_2 HPWHs used in this project successfully replaced the gas water heaters at two local fourplexes with centralized water heating. These are two of the first installations of the kind and open up the possibility of clean, cost-effective HPWH energy solutions for this type of multifamily residence.

Although this study is still underway, preliminary results show that the HPWHs have been able to meet the customers' demand for hot water while saving about $1,000 in energy costs per year for each fourplex.

Natural Refrigerant Incentive Program

Starting local doesn't mean we won't go big. Conventional hydrofluorocarbon refrigerants (HFCs) are the fastest-growing source of greenhouse gas emissions globally, trapping thousands of times more heat per molecule than carbon dioxide. This makes refrigerant management a huge opportunity for global reductions in greenhouse gas emissions. Natural alternatives have zero or near-zero Global Warming Potential (GWP), but they require extensive reconfiguration and are not common locally.

In our effort to stimulate and expand the market for natural refrigerants, we helped install unique refrigeration systems at two popular local grocery stores: Grocery Outlet and Raley's. Our program created a valuable opportunity to study the energy efficiency and performance of these natural refrigerant systems in our climate zone. What we're learning can be implemented at larger grocery stores and large commercial and industrial food processors, and will be shared throughout the refrigeration industry to accelerate adoption of these systems.

Not only do these systems reduce local use of very potent high GWP greenhouse gases, they're also expected to drive down customer operational costs by eliminating regular refrigerant retrofits, regulatory compliance reporting and, potentially, electricity use.

We installed system monitoring tools and will compare the performance of the natural refrigerant installations to conventional systems at other stores for two years to provide a complete picture of seasonal patterns.

Creative solutions to public charging access

The costs savings associated with driving and maintaining EVs are beginning to be broadly accepted, but there still are barriers to the widespread adoption needed to achieve the market transformation that supports our climate goals.

Beyond these goals, we want to help provide all our customers with a genuine opportunity to experience the benefits of EV innovation.

Uber/SMUD EV Champion Initiative

Rideshare services have revolutionized the way we all get around. With this initiative, we leveraged the trend by partnering with Uber to incent rideshare drivers to adopt EVs. This can help increase access to mobility in a way that doesn't also increase emissions.

Uber and SMUD provided a per-trip incentive of $2 per ride ($1.25 from SMUD + $0.75 Uber) to Uber drivers who drove an EV to help increase the number of EV miles driven in our region. SMUD provided unlimited free charging at SMUD-owned charging stations, and Uber provided educational materials about EVs for drivers to give to passengers.

Not only did this education and outreach build public awareness of the benefits of electric transportation, it also increased the number of EVs and EV miles driven in the Sacramento region, helping to reduce local greenhouse gases and pollutant emissions.

Electric Fleets Initiative: eFleets

As making the change from gas to EVs has a huge potential impact on carbon and emissions goals, we developed the eFleets initiative to help our commercial customers convert their service fleets to electric. We worked closely with our commercial customers' fleet operators and facilities staff, as well as our own, to determine and test the best technologies, tools and consultation support for EV fleet adoption.

Areas of focus included charging solutions, site design and cost analysis. We tested a full suite of fleet services that aimed to reduce construction costs and logistics challenges. This initiative includes the EV Charging Strategies for Fleets and Workplaces Project, EV suitability assessments for fleets and ad hoc Fleet Advisory Services.

EV Charging Strategies for Fleets and Workplaces Project

This was a real-world test of charge management systems to determine whether these systems would perform as expected and if they could reduce the installation cost of EV charging stations. Customers who install more than one charging station may have challenges with electrical capacity or concerns about how their bill may be impacted if all vehicles charge at the same time. The key lies in the way the system decides to share power among vehicles that are charging at the same time: autonomously; on a set schedule ("set it and forget it"); or by making a choice to do either or both of these. We found that charge management systems can reduce charging station installation costs, a major barrier for fleet electrification.

EV suitability assessments for fleets

We provided participating customers with an EV suitability assessment for vehicles in their fleet which provided a total cost of ownership analysis, comparing the life cycle cost of a standard internal combustion engine (ICE) vehicle with that of a comparable EV. This involved the fleet operator inserting a data-logging device into the ICE vehicles to assess drive patterns and duty cycles. The information was analyzed to generate a list of potential replacement EVs that would serve the same function at an equivalent or lower total cost of ownership. The assessment also provided vehicle alternatives to customers who were interested in changing the body style or function of their fleet vehicle. The assessment aimed to provide fleet operators with information customized to their fleet and vehicle usage to help inform their buying decisions and electrification strategy.

Ad hoc Fleet Advisory Services

When requested, we provided consultations on charging and site design to our commercial customers. This resulted in schools, delivery services and other fleet customers considering and developing charging station site plans that would accommodate EV expansion over periods of up to five years. The consulting service has been in such demand that we've decided to add resources, formalize the service and offer it as a pilot program to all commercial customers seeking support in converting their fleet to electric vehicles.

The valuable lessons learned from these eFleet projects will help our commercial customers transition to EV fleets and contribute to cleaner air and a cleaner environment.

Fleet and Workplace Advisory Service

What we learned from our eFleet initiative drove our decision to provide direct consultation to support workplace charging and fleet electrification. Our commercial customers wanted help that included planning the change. That's why we're currently planning SMUD's Fleet and Workplace Advisory Service. Our team of experts can help fleet and workplace charging managers gather the information and tools they need to successfully navigate all regulations and requirements for starting a new electric fleet or workplace charging program.

We're on a path to provide a suite of comprehensive consultation services that include determining EV availability, EV and charging station procurement planning, charging infrastructure design, EV charging scenario tools, utility interface support and funding opportunities. The services will be "right-sized" to fit each customer's needs.

Working closely with our customers, we can provide personal and customized support to ensure the successful procurement and implementation of an all-electric fleet and workplace charging programs.

Zeus EV production

As a founding member of the California Mobility Center (CMC), we're spearheading efforts to bring more innovative industries to our region to support economic development, workforce training and transportation innovation. We're negotiating contracts with our first clients, including Zeus Electric Chassis out of Minnesota. Zeus makes medium-duty EVs, such as dump trucks, garbage trucks and flatbeds for industrial fleets.

Zeus will build and customize five medium-duty trucks to incorporate into SMUD's fleet. While that may not sound like much, the medium- and heavy-duty electric truck market is emerging, and the technology has tremendous room for creative design and development. Use of these vehicles directly supports SMUD's corporate emission reduction and fleet electrification goals, and the information learned will help Zeus showcase their trucks' capabilities in various scenarios.

It's an important step toward the CMC being recognized as a center for innovation, and toward companies in the new mobility space choosing to relocate to or expand their business in Sacramento. Zeus plans to bring their manufacturing here, which will provide opportunities for economic development and workforce training as well. This means local jobs and an economic boost for our entire region. SMUD benefits from potentially lower fleet O&M costs, reduced local vehicle emissions and reduction of carbon emissions, and our customers benefit from cleaner air and fewer emissions, too.

Amply Power Charging Service

Another CMC partner helping us advance electric transportation, including medium- and heavy-duty vehicles, is a managed charging company called Amply Power. Amply provides charging as a service to help commercial fleets transition to EVs, an important part of the strategy needed to meet regional EV expansion goals. This application is exciting for utilities because it allows for power sharing and load management to potentially avoid customer capacity upgrades or utility service upgrades that could ultimately save customers money.

We're partnering with Amply in their testing of a "gas station" model, multi-tenant charging depot in Sacramento. The project will mainly serve medium- and heavy-duty EV fleet managers, supporting charging infrastructure and reducing up-front installation costs or ongoing maintenance costs to SMUD customers. Commercial customers such as school districts, delivery services, transportation companies and waste management fleets could potentially benefit from this resource.

eMobility Hubs

We're supporting Sacramento Metropolitan Air Quality Management District and Green Tech (a local nonprofit organization that provides access to training centers, workplaces and medical care in disadvantaged communities) as they establish the first mobility hub in the area to use EVs.

Located in Del Paso Heights, the hub plans to feature electric and fuel cell vehicles, EV chargers and an electric shuttle, along with amenities such as a digital kiosk and free Wi-Fi. Anticipated benefits of the eMobility hub include:

Jobs and economic development

The hub will create jobs and self-employment opportunities for Green Tech students and neighborhood residents. Not only will the hub employ EV drivers, security and maintenance workers, but it'll also provide transportation to job centers for 30 to 50 people. And, it can reduce transportation costs and travel time for family members.

Cleaner environment

By providing transportation to healthcare centers and a medicine delivery service, not only will the hub directly improve overall resident health, it will also reduce air pollution by the equivalent of 1,000 miles driven per day.

Improved access to education and enhanced technology

More than 100 youth will have access to convenient transportation, free Wi-Fi and a digital kiosk. This will help build educational equity and make it easier for them to attend job training, school and other educational programs.

Emergency response center

A solar canopy will make it possible to allocate a portion of the hub as an emergency response center—a helpful resource in case of flooding, fire or other environmental disasters.

EV DC Fast Charging Incentive Program

This project increased the number and visibility of high-speed public EV chargers in SMUD territory to make sure customers are aware EV charging is available to them. Drivers want quick and easy charging options that are conveniently located, especially if they don't have access to EV charging at home, or if they need to charge quickly enroute.

Concerns about driving range, access to public charging and the speed at which vehicles can charge are significant factors in the decision-making process when considering an EV. To support adequate coverage for all drivers, SMUD designed an incentive program to promote the installation of fast EV charging stations within our service territory. Incentives were made available to commercial customers along major corridors, as well as in underserved communities.

After building and refining the program for about a year, the California Energy Commission (CEC) announced the CALeVIP program, with $14 million in funds for DC fast chargers and level 2 charging station installations within Sacramento County. We made the strategic decision to redirect our incentive program funds and partner with CALeVIP to have a larger impact in addressing the need for EV charging infrastructure at the regional level. Prior to being closed to new applicants, though, we secured two more sites—one in Rancho Cordova and one in Elk Grove—for a total of five new DC fast charging stations.

We're happy to report that the original incentive program started at SMUD has evolved into a regional partnership with a substantial impact.

Mobi EV and Gen Charger Loan Pilot Program

We wanted to test and understand the value of using mobile EV chargers and battery-powered generators, so we could support the expansion of electric transportation as well as reduce greenhouse gas emissions and pollutants at local events. This program also evaluates the logistics of using the mobile batteries, such as charging, storing and transporting them.

The Mobi Gen is a clean, quiet mobile battery that can replace conventional gas or diesel power generators to fulfill temporary electricity needs. It provides convenient charging options where no permanent charging stations exist. The ingenious Mobi units are batteries on wheels equipped with a joystick to get them from point A to point B. They're about the size of a small riding lawn mower and are a great way to provide electricity in places that might not otherwise have affordable or physical access to power.

Since Mobis can move easily between locations or be loaded onto a truck or trailer, a single unit can be used for multiple customers in various scenarios. It's a convenient back-up charger for fleets and a great alternative to the noisy, polluting output of diesel generators at events.

We've been loaning both the Mobi EV and the Mobi Gen to interested commercial customers who demonstrate a need for the chargers. The chargers were used at numerous events in 2019, including ECOS's Sacramento Earth Day, Cal Expo and SACOG's Regional Futures Forum, a SMUD-sponsored Ride & Drive and Electrification event in Elk Grove, the Sacramento Auto Show and a Visit Sacramento event at CSUS, and piqued a lot of interest. The Mobi units are just one example of where our exploration of new, agile technology can lead us.

Looking ahead

We see the global picture, and we're planning for it. We recognize the need to continue reinventing the way we do business, both internally and with our customers, as we work toward the ambitious goals set by our Board of Directors. The need for innovative energy solutions took on even greater urgency when our Board adopted a climate emergency declaration. Net-zero carbon by 2040 isn't easy, and to achieve carbon neutrality by 2030 will be significantly more challenging.

We'll continue to accelerate progress toward carbon neutrality, help maintain reliability and bolster community resilience in the face of these challenges. We'll work to significantly expand external collaboration across the community we serve, because we realize that the best energy solutions won't rely solely on individual technologies. The best solutions will arise from understanding how the interplay among technology, customers and the grid can achieve carbon neutrality at the lowest cost while maintaining service, value and reliability for all customers. **Powering forward. Together.**