sunrun

2019-2030

Repowering Clean

Gigawatt-Scale Potential for Residential Solar & Battery Storage in Los Angeles

Executive Summary

The City of Los Angeles and the Los Angeles Department of Water and Power (LADWP) have taken a leadership position by pursuing a path to 100% clean energy, including retiring aging fossil fuel powered plants in the coming years. **This report shows how LADWP can raise its targets for local clean energy with residential solar to create a city-wide clean energy 'virtual power plant': rooftop solar and battery storage on as few as 75,000 Los Angeles homes can replace peak capacity of one of LADWP's retiring gas plants.**

Home solar has grown rapidly across California and nationwide. By 2030, LADWP can build a fleet of roughly 150,000 homes and 5,000 apartment buildings with home solar. This goal is achievable: as of 2018, nearly this much rooftop solar has already been deployed in San Diego Gas & Electric's territory, along with a rapidly increasing amount of battery storage. Through programs focused on areas with low solar penetration, LADWP can also bring savings and clean energy to 25,000 homes and 2,500 apartment buildings in traditionally underserved and low income communities.

The cost of advanced batteries has declined rapidly, supporting the rapid growth of energy storage. This means that LADWP could achieve a clean energy virtual power plant for less than the cost of building new gas plants. Sunrun estimates that doing so could save almost $60 million as compared to equivalent new gas plant capacity.

Solar and batteries deliver a broad range of benefits to the city of Los Angeles in the form of quality jobs, cleaner air, lower energy costs and more reliable power for communities and businesses. Building clean energy locally eliminates the need for expensive transmission lines to move power into the city and can help strengthen an aging distribution grid - preventing blackouts and providing emergency backup power if outages do occur.

Across the country, a growing number of utilities and wholesale markets are already incorporating distributed energy resources. By engaging customers to be part of the solution, partnering with clean energy innovators and streamlining permitting and interconnection for local clean energy LADWP can create a more modern, reliable power grid for residents and businesses across the city. LADWP can show the world that a vibrant, growing city can be powered by residential solar generating clean energy, jobs, cost savings, and grid innovation.

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Setting the Stage for Solar and Batteries in Los Angeles

Residential Solar in Los Angeles Today

Despite the significant expansion of solar as a resource in recent years, the penetration of local rooftop solar in LA is low compared to other areas in Southern California. Today, Los Angeles is home to approximately 182 megawatts of residential rooftop solar installed on 36,000 homes.[1] This represents only 2.5% of LADWP's 1.34 million total residential customers.[2]

To put this into perspective, 139,000 homeowners, or fully 11% of San Diego Gas & Electric's (SDG&E) 1.25 million residential customers, have adopted solar—a total of 740 megawatts of installed capacity. SDG&E customers are also rapidly adopting batteries with home solar. Customers in California's other utility territories are adopting solar and batteries at nearly the same rates.

In comparison to utility rates that keep rising, solar can lower electricity costs. As a result, many people are investing in solar to save money. LADWP's electricity rates are lower than those of other utilities across California, which has dampened demand for home solar. However, the trends are clear: solar costs continue to decline while LADWP's rates continue to increase.[3] In the coming years, the improving economics of home solar and battery systems will increase demand and market potential in Los Angeles. Residential electricity use accounts for 40% of LADWP's total. If LADWP acts to encourage the adoption of batteries with residential solar and then bundles and coordinates these resources as a virtual power plant, the utility will gain access to a new and innovative energy resource.

Growth of Residential Solar & Batteries Nationwide

The adoption of residential batteries is growing nationwide, predominantly in tandem with home solar. In response to utility programs, incentives and "Time of Use" rates, customers are embracing storage to manage their electricity bills and store energy to have backup power in outages. For instance, through Q3 2018, residential battery deployment increased 526% year-over-year. Residential batteries constituted 35% of all energy storage deployed in these first three quarters of 2018.[4]

Even as utilities across the United States invest in energy storage, including as replacements for gas peaker plants, the amount of residential storage installed surpassed the amount deployed by utility companies for the first three quarters of 2018.[5] The rapid growth of residential storage nationwide illustrates its potential to play a key role in LADWP's overall approach to energy storage.

Wood Mackenzie projects residential storage to grow dramatically in coming years across the United States. Specifically, as shown in the graph below, they forecast more than 1,000 megawatt-hours of residential storage will be deployed by 2020 and more than 3,000 megawatt-hours will be deployed by 2023. Sunrun's analysis projects that LADWP should be able to realize at minimum ~170 megawatt-hours of residential storage by 2024, out of 8,800 megawatt-hours that Wood Mackenzie projects to be deployed nationwide by 2024.

What are the challenges for LA?

- Los Angeles has charted a path to 100% renewable energy.[6] LADWP needs new, clean and reliable resources, including local energy resources in key locations on the grid to maintain grid reliability and power quality.
- Los Angeles is a sustainability leader with the largest amount of solar installed of any US city in 2018.[7] Despite this, residential rooftop solar remains a largely untapped clean energy resource - especially for Angelenos in the parts of the city that historically have had less access to solar.

How can home solar & batteries help?

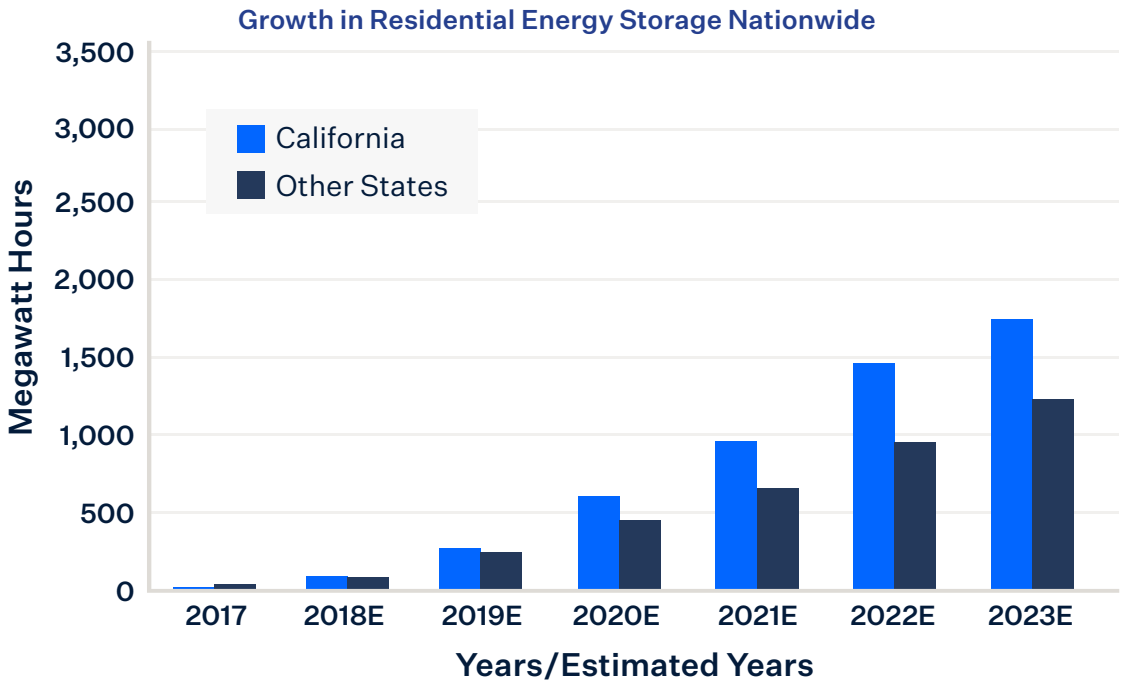
- Home solar and batteries can provide LADWP with a clean, scalable and flexible source of electricity to meet the evolving needs of Los Angeles' electricity grid when and where it's needed, without expensive transmission lines.
- Locally-sited batteries enable customers across Los Angeles to access backup power in the event of a blackout or a power outage.
- By partnering with clean energy developers and software platforms to manage a network of solar and batteries, LADWP can create a virtual power plant.

What scale can be achieved?

- LADWP has enormous residential solar potential. This report shows how simply by continuing recent growth trends through 2024, Los Angeles could have ~400 megawatts of residential rooftop solar. By 2030, this could be ~860 megawatts. **To help meet the critical need for in-basin clean energy, LADWP should raise its local solar goals to include this ~860 megawatts from residential solar.**
- LADWP can build on existing programs, like the Self-Generation Incentive Program (SGIP) to encourage customers to adopt storage with solar. **By 2024 there could be ~170 megawatt-hours of residential storage and by 2030 this can reach ~1,200 megawatt-hours.**
- When bundled and coordinated as a virtual power plant, this resource would be equivalent in scale to one of LADWP's existing gas-fired power plants. **LADWP should focus on growing battery deployment to reach this ~1,200 megawatt-hour level or beyond.**
- LADWP can specifically target areas of the city with low solar penetration currently, which overlaps with areas where local energy resources can benefit the grid. **Sunrun recommends that LADWP could achieve at least 180 megawatts of solar and 260 megawatt-hours of storage through 2030 in these areas.**

How can the potential be realized?

- Engage customers to be a part of the solution.
- Include residential storage in planning.
- Create a next-gen "Residential Solar & Smart Battery Program."
- Enable residential solar and storage to compete.
- Focus where the grid and communities benefit most.
- Consider the value to the local grid.
- Partner with innovators.



Residential storage is projected to grow rapidly, with California leading the way. Wood Mackenzie Energy Storage Monitor Q4 2018 shows the rapid growth of residential energy storage and projected growth through 2023.

Today, the all-in cost of a typical battery installed with a solar system for a single family home typically ranges between $8,000-$10,000. Incentives, like the Investment Tax Credit (ITC) and California's Self Generation Incentive Program (SGIP), together reduce home battery costs by as much as 50%. Battery prices are dropping quickly—falling by 55% between 2014 and 2018.[8] This trend is expected to continue, making a battery an increasingly small cost relative to the solar system to which it can be attached.

Just as high-quality cameras on mobile phones have evolved from being an expensive addition to a standard feature, batteries will also become a standard feature for solar installations. This promises to provide customers with greater capabilities from their solar systems for their own homes as well as for the grid.

Home batteries are installed with a solar system and located in garages or on outdoor walls. They are certified safe for installation in homes. In the event of an outage, Sunrun's Brightbox solar and battery switches into islanding mode to provide backup power to the home, while posing no risk to utility workers repairing the grid.

Home Solar and Batteries in a Virtual Power Plant

A home solar and battery system features software to manage how it delivers electricity to an individual building or household. Any home solar and battery system can be networked through wi-fi or a cellular network to respond to signals from a utility when the grid needs power. By bundling, coordinating and delivering clean energy from home solar and batteries, these systems can supply power at a scale rivaling that of a centralized power plant. This is called a "virtual power plant."

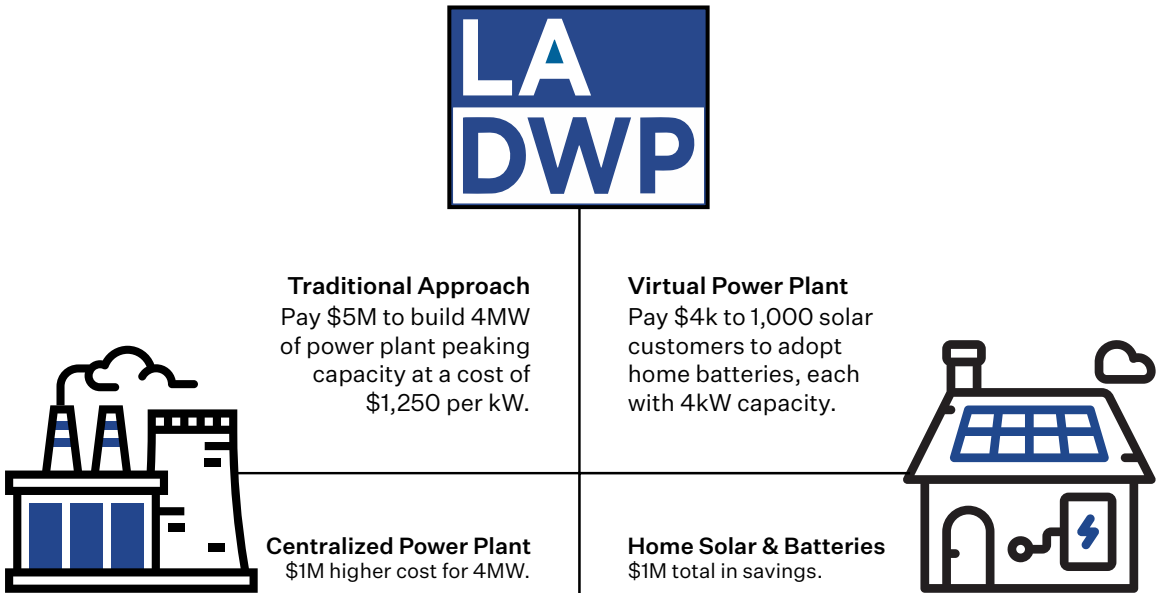
This approach is spreading nationwide. Southern California Edison has contracted to use 250 megawatts of distributed storage to address grid reliability across the Los Angeles basin after the closure of the San Onofre nuclear plant.[9] The grid operator for New England included 20 megawatts of Sunrun home solar and batteries as a virtual power plant in the ISO-NE forward capacity market, replacing that amount of need for traditional generating capacity.[10]

How do Solar and Batteries Replace the Need for Peaker Plants and Transmission Lines?

Solar generates energy during the day, but electricity is needed most in the afternoon and early evening when Los Angeles experiences its peak demand.[11] To accommodate this need, peaker power plants can be kept online to ramp up their output for a short period of time in the afternoon or evening. As LADWP's grid transitions to clean energy resources, LADWP needs to ensure that there is always enough generating capacity to serve peak electricity demand. With batteries charged by solar and ready to be discharged in the evening to bring down this peak demand as well as provide related services to balance the grid, home solar and batteries can support this need.

To illustrate this, consider how a hypothetical cohort of 1,000 customers could help LADWP reduce the need for power plant capacity. An illustrative cost of a new power plant in an urban area with strong environmental regulations like Los Angeles could be $1,250 per kilowatt of generating capacity.[12] On this basis, four megawatts of capacity could be added for $5 million. However, the utility could instead work with third parties to encourage the deployment of 1,000 batteries, each with four kilowatts of capacity to cover peak demand periods and networked to respond to utility dispatches.

"Across California, distributed energy has already avoided $2.6 billion in new transmission costs.[26] It is time to bring this approach to Los Angeles."



If LADWP provides $1,000 per kilowatt of capacity to customers for adopting batteries and allowing their use as a peak resource, most of the net cost of a battery would be covered. By the time that existing power plants must be replaced, battery cost projections suggest that this $1,000 per kilowatt would cover the entire cost of a battery installed with solar.

If this can be achieved, LADWP will save $1 million and 1,000 customers will enjoy the benefits of batteries to manage their solar energy and deliver backup power. Multiplied over ~295 megawatts[13] of power plant capacity that we estimate residential solar and storage could deliver, the potential savings would be almost $60 million.

LADWP would not be the first to utilize batteries in this way. Utilities in New England, led by Green Mountain Power,[14] have begun investing up to thousands of dollars for each battery that customers adopt due to the reduced peak generation costs.[15]

Residential batteries can replace power plant capacity, reduce the need to send power over transmission and distribution lines at peak hours, and upgrade substations to handle peak load, ultimately adding to savings for all customers. LADWP can source cost-effective improvements to its grid directly from its customers.

"In Los Angeles, a home battery paired with solar can cost less than the equivalent power plant and transmission line capacity."

Benefits to LA:

Virtual power plants would deliver more than just clean energy. They would deliver a range of benefits to Los Angeles:

- Providing energy generation at the scale of a natural gas peaker power plant without the associated costs and health impacts.
- Creating jobs in a growing industry in the Los Angeles market.
- Benefiting LADWP customers in all parts of Los Angeles.
- Avoiding the need for new and expensive transmission infrastructure.
- Strengthening the local electricity distribution grid.
- Creating an emergency backup power network across the city.

Delivering the Capabilities Equivalent to a Natural Gas Peaker Power Plant

Leading clean energy developers and software platforms make it possible for grid operators to engage networks of solar and batteries just as they would an LADWP natural gas peaker power plant. LADWP's grid operators can partner with networks of home solar and batteries across the city to send signals and get an immediate response, as with a centralized power plant. Customers can earn credits on their bills for allowing batteries to serve as a resource for the utility.

When LADWP calls on the virtual power plant, an individual home battery will feed electricity to the home where it is connected. This offsets the need to power the home from the grid and reduces overall peak demand. If a battery has extra capacity, it can inject energy onto the grid to power adjacent homes, thus reducing the need for LADWP to deliver energy across the transmission grid. Working with the clean energy platforms that manage this battery network, LADWP can compensate customers for allowing their batteries to be used to avoid the cost of power plant and transmission infrastructure. This puts more money into the pockets of customers for being part of a smarter, cleaner grid.[16]

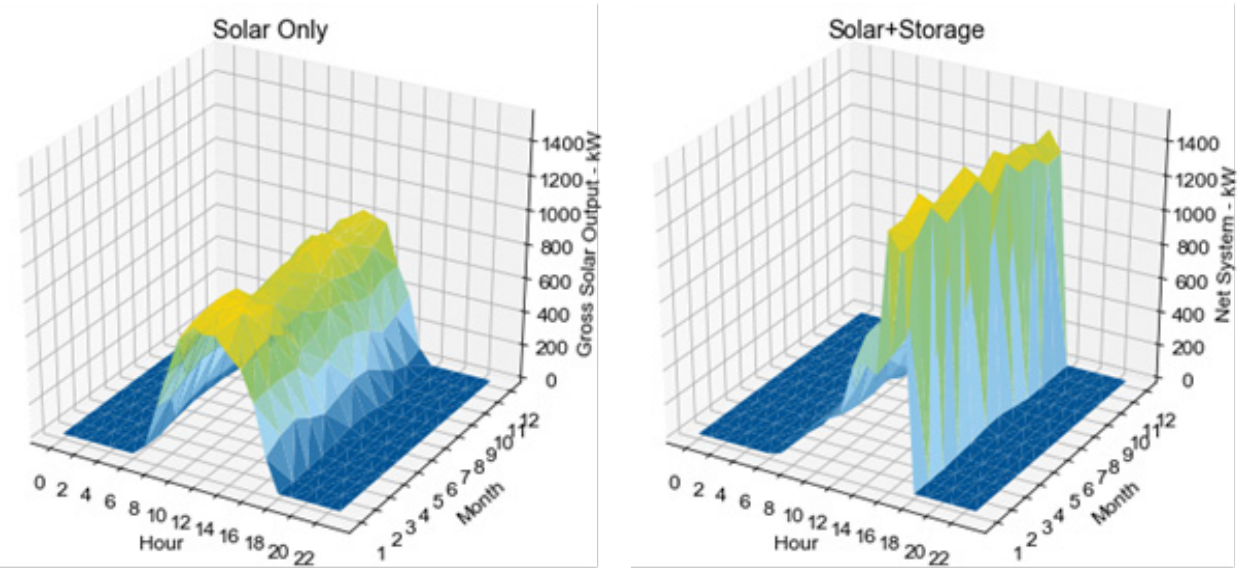
Creating New Jobs in a Growing Industry

In 2018, over 242,000 Americans worked in the solar industry, a 159% increase since 2010.[17] According to the U.S. Department of Labor's Bureau of Labor Statistics (BLS), solar installation will be the fastest growing job in America over the next decade.[18] Domestic solar companies are providing what our country needs most: well-paying jobs that can't be outsourced or automated. Solar industry wages remain competitive with similar industries and above the national average. Most solar jobs don't require a bachelor's degree.[19] Los Angeles can drive job creation and worker training through growth in solar and storage.

Reach and Benefit LADWP Customers Across Los Angeles

To create a virtual power plant with the greatest scale and lowest costs, LADWP can expand its existing programs and partner with clean energy developers like Sunrun. For example, Sunrun is participating in the state's Solar on Multifamily Affordable Housing (SOMAH) program because multifamily housing provides a valuable opportunity for deploying residential solar and storage. LADWP has existing multi-family programs, but with modification, these programs can grow to have a much greater impact. For instance, LADWP's Solar Rooftop Program and Feed-In Tariff Program could both support scaling solar for multifamily housing. By linking these programs with a virtual power plant approach, energy storage can be added to these sites.

Growth in Residential Energy Storage Nationwide



The above illustration is from the planned operation of a virtual power plant to store solar power in a battery midday and discharge later in the day when power is needed most on the grid. Batteries can use this stored power on a schedule or respond in real-time to a signal from the utility.

Lower the Need for New Transmission Infrastructure

By installing home solar and battery systems in the parts of Los Angeles where electricity demand is highest, a virtual power plant can reduce the need for LADWP to build new transmission lines to service these same "load pocket" areas. This aids in reducing costs, ultimately saving money for both LADWP and its customers. When the added cost and complexity of a new transmission line is considered, virtual power plants become even more cost-effective. Across California, distributed energy has already avoided $2.6 billion in new transmission costs.[20] It is time to bring this approach to Los Angeles.

Reduce the Risk of Blackouts in the Local Electricity Distribution Grid

New growth and development combined with aging infrastructure on the LADWP grid presents a growing challenge for the utility to safely and reliably supply electricity to Los Angeles. Already, on hot days when electricity demand is high, there is the risk that local electricity circuits could overload and fail. Blackouts are more likely to occur, leaving Angelenos without power. Stored battery power can be used to respond to overloading events on local circuits and prevent blackouts. If blackouts do occur, the electricity stored in individual batteries can be used by the customers as backup power.

Provide Emergency Backup Power Across the City

Wildfires and other natural disasters put today's electricity grid at risk. They illustrate the importance of securing local access to an emergency source of backup power. A virtual power plant can serve as an emergency power resource for the homes, neighborhoods and communities that are supported by the network. This can be extended to critical facilities, such as hospitals, first responders, schools and other key community sites.

In the event of a grid outage, solar and battery systems island themselves from the grid to power an individual building. The connected battery provides power overnight and is recharged by the solar in the morning. If a natural disaster were to disrupt the grid for an extended period of time, the individual batteries that constitute the virtual power plant would become a sustained source of backup power for residents. Especially for multifamily housing, this helps support those who are most vulnerable, such as the elderly and families with children.

LADWP's Home Solar and Battery Potential

Analyzing the Market

Sunrun has examined LADWP's residential market for home solar and batteries, including past trends and future potential. With this market potential as a starting point and given LADWP's need for innovative solutions for in-basin clean energy, we recommend the minimum scale of residential solar and storage that LADWP should target for development. By looking at the total addressable potential, we show that this is not only possible, but that it is also demonstrably achievable.

To consider what level of residential solar and batteries LADWP should target, Sunrun studied the solar penetration rates in similar utility territories, the rate of potential growth in solar deployment and the rate at which new solar installations with storage are built. Sunrun has analyzed the building stock across LADWP's territory to identify the addressable potential for residential solar and battery storage in order to model what development on this building stock could look like over the coming decade.

Current Addressable Potential for Residential Solar & Batteries

Sunrun has built on its knowledge of the residential solar market to work from public data to illustrate a transparent methodology for estimating the high-level solar and storage potential for LADWP.[21] We conservatively estimate that out of approximately 660,000 single family homes that there are at least 308,000 single family homes served by LADWP that are prime candidates for solar - nearly ten times the number that have adopted solar so far.

To arrive at this estimate, Sunrun has considered the number of single family homes in Los Angeles, as well as the percentage of homes fitting criteria like roof size and sufficient solar insolation. For the residential sector, broadly identifiable characteristics like square footage help in identifying ideal candidates for solar because it is closely linked to energy usage. In sunny Los Angeles, if roof size and orientation requirements and minimum square footage/energy usage thresholds are met, most homes are viable for solar at today's solar economics. As solar economics improve, the number of homes that are prime candidates for solar will increase. We also consider owner-occupancy as a criteria because this describes the vast majority of homes adopting solar to date. Through programs that address solar for rental properties in LADWP, the number of homes that are ideal for solar could increase dramatically.

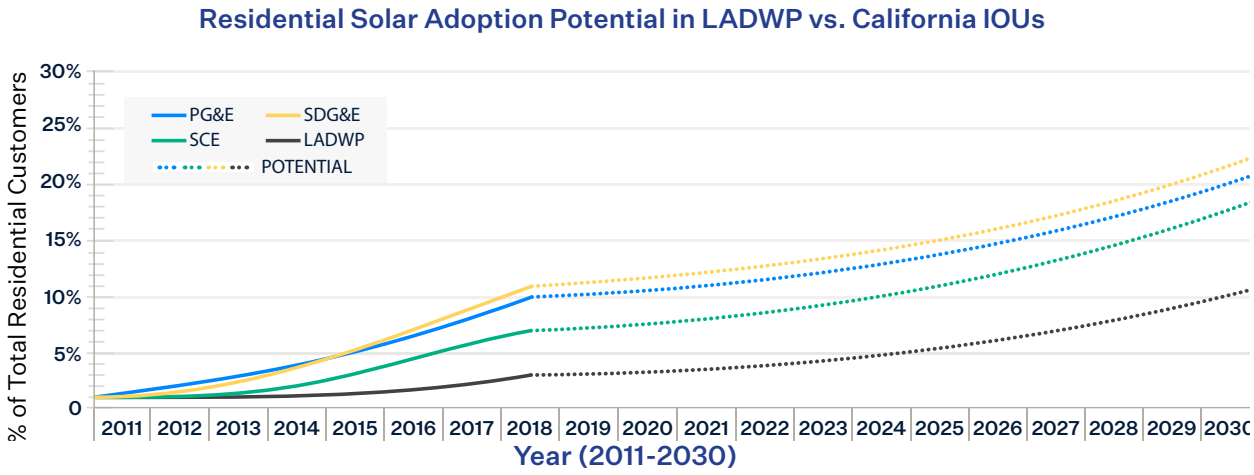
By achieving LADWP's residential solar and battery growth in line with other markets in California, a virtual power plant of 862 megawatts of home solar paired with 1,180 megawatts of storage is achievable by 2030.

For instance, Sunrun uses a similar methodology to estimate that there are approximately 60,000 multifamily buildings in Los Angeles. Rental multifamily properties form a potentially addressable market, as property owners could be encouraged to join a LADWP program to adopt solar. As multifamily property energy usage and roof characteristics vary more than a single family home would, it is more difficult to apply broad assumptions. Instead, we identify a path for multifamily solar development that shows high potential that requires only a modest number of these properties to adopt solar. (More detail on methodology can be found in the appendix of this paper.)

We estimate that installing solar for all of this prime solar potential would result in a total of 3,042 megawatts of solar from residential rooftops. This is based on a typical solar installation size. Of this, 1,542 megawatts, or 50% of the potential, is from single family homes, while the remaining 1,500 megawatts is from multifamily buildings. This can be compared to LADWP's existing goal of developing 900 megawatts of total local solar, including commercial, industrial and/or public rooftops by 2,025 and 1,500 megawatts by 2,035. We highlight this comparison to suggest that while LADWP has not focused on residential solar to this degree, the utility recognizes that rooftop solar potential is already at this general magnitude.[22] Residential solar can push the potential scale much higher.

Continuing Residential Solar Development Through 2030

LADWP has lagged behind other utility territories in California in the percent of residential customers who have adopted solar. But as the data above shows, this is not for a lack of solar potential. Despite increasing electricity rates, solar costs continue to decrease. The potential and benefit of local clean energy to Los Angeles residents is enormous. Given LADWP's need for in-basin clean energy, the utility should at minimum maintain historic growth rates that have allowed 36,000 homes to go solar to date.



This graph shows how continued growth in residential solar through 2030 would put LADWP at a rate of solar penetration similar to what has been achieved in other large California utility territories as of 2018. Source: For 2011-2018, CAISO NEM Interconnection Data, EIA Form 861M. For 2019-2030, solar adoption is illustrated to increase on a linear basis that translates to a 5-8% CAGR depending on IOU, in line with current solar growth.

Potential for Solar in Single Family Homes

Sustaining this steady growth in solar is fully achievable. For example, during 2011-2018, annual residential solar deployments in LADWP grew at an average rate of 18%. As growth continues, it can be expected to level off, so Sunrun has considered the outcome if annual installations of residential solar grow at a lower average rate of 12% per year through 2030.

The end result would be 147,000 single family homes with solar or 11% of 1.34 million total residential customers in 2030. This is less than the level achieved in nearby San Diego Gas & Electric as of 2018. This would translate into approximately 737 megawatts of solar on single family homes.

As solar economics improve, the number of homes that are good candidates for solar will increase. Despite that fact, the 147,000 homes quoted above would represent less than half of the estimated 308,000 homes that are prime candidates for solar in Los Angeles today, excluding rental properties.

Given the number of rental properties and the need to increase access to solar for LADWP customers, LADWP should work with clean energy developers to identify scalable ways to address rental single family homes. Doing so will open up new avenues for residential solar and make continued solar growth that much more achievable.

Potential for Solar in Multifamily Homes

For multifamily properties today, solar deployment is low but the potential is almost as large as the more mature single family market. For California as a whole, the SOMAH program will deploy 300 megawatts of solar to affordable housing across the investor-owned utility territories by 2030. By 2030, Sunrun recommends that LADWP jumpstart multifamily solar development by targeting 125 megawatts of solar with an emphasis on affordable multifamily properties. This would imply installing solar on only 8% of an estimated 60,000 multifamily rooftops, assuming an average installation size of just 25 kilowatts.

If this achievable path is pursued, it would mean that the residential segment alone would support **862 megawatts** of solar capacity in Los Angeles. At this scale, LADWP would begin to catch up with the expected solar deployment in other markets in California. If Los Angeles seeks to replace gas-fired power plants with 100% clean energy, residential rooftop solar is a path LADWP should include.

See section *Focus on Equity and Solar Benefits for All* for detailed estimates for solar potential in parts of Los Angeles with low existing penetration of solar and recommendations for achieving solar growth across all regions of the city.

Storage and Aggregation Potential

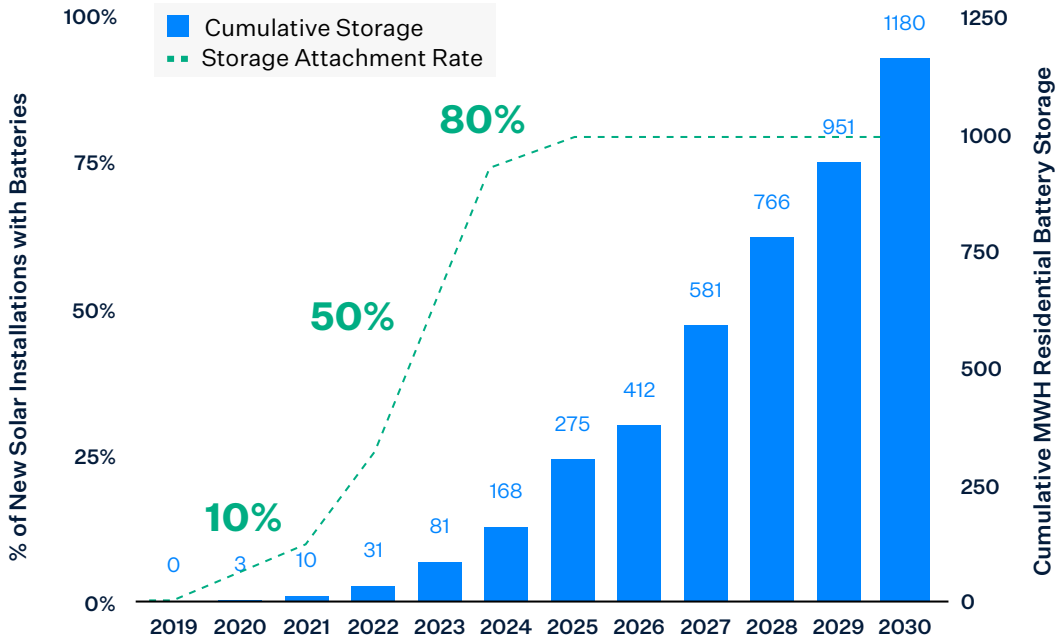
As more solar is installed across Los Angeles, the percentage of solar installed with battery storage (storage attachment rate) will help to determine the amount of local clean energy that can be available as a firm, dispatchable resource to support the electricity grid through a virtual power plant. **This will also determine how broadly Angelenos will gain access to backup power in the event of grid outages.**

Across California, the rate of storage attachment to new solar installations is rapidly increasing. For instance, in Q3 2018, 25% of Sunrun's new customers in its direct-to-consumer business in California adopted storage,[23] increased from less than 10% in 2017. This upward trend is expected to continue in line with industry analyst expectations for residential storage growth. With the right program structures in place, as described below, LADWP can support a similar growth of residential battery storage in Los Angeles. When LADWP customers see greater value by adopting a battery with solar, the rate of battery adoption should increase, as demonstrated in other parts of California.

To provide a sense of scale, based on expected battery sizing for residential solar, if all of the 147,000 solar homes and 5,000 multifamily properties modeled above installed storage, this would result in 1,620 megawatt-hours of storage. This is based on 50 kilowatt-hours of storage per multifamily property and 15 kilowatt-hours per single family home. To achieve this goal would require installing batteries with solar starting immediately. To identify what LADWP can achieve through programs to encourage battery adoption, Sunrun has modeled a growth rate in the proportion of customers adopting storage along with solar by following the trend observed in other markets in California.

Sunrun recommends that LADWP's target increases the storage attachment rate during 2019-2025 to reach no less than 80% by 2025. It is possible for the rate to increase and be achieved sooner. But even if it takes six years to reach this level and the rate of attachment never goes above this, cumulative battery installations will continue to increase each year.

Rate of Batteries Installed with New Solar Installations + Cumulative Residential Battery Potential



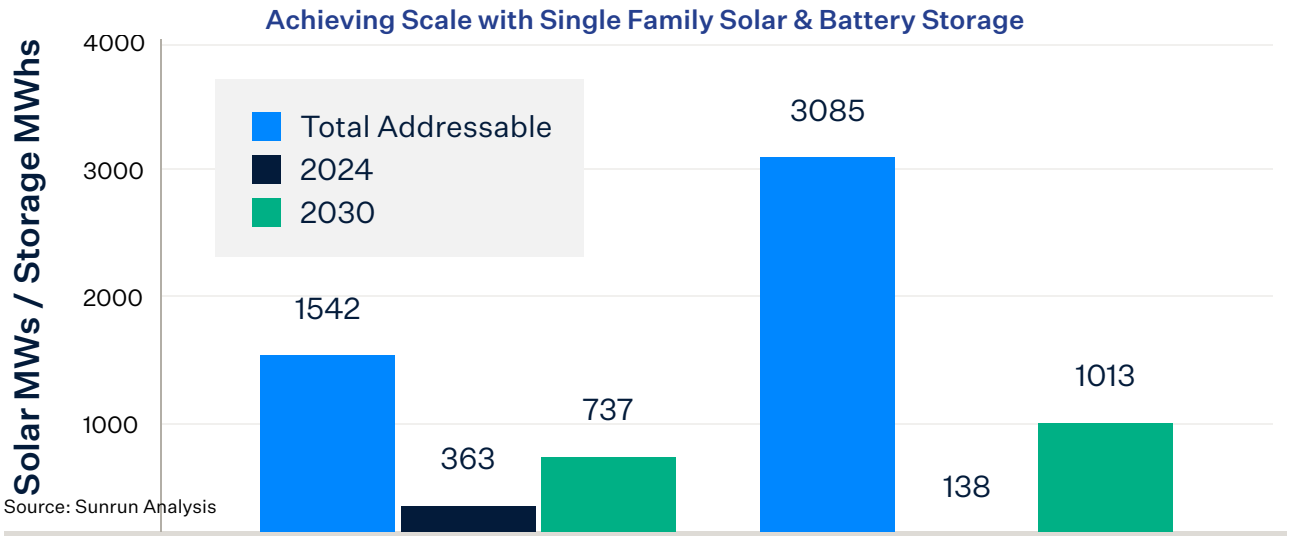
Source: Sunrun Analysis

If the percent of new single and multifamily solar installations that include a battery increases to 80% by 2025, the cumulative amount of solar-charged residential battery storage available to LADWP as a dispatchable resource could grow to over 1 GWh by 2030. Encouraging the attachment of battery storage to a growing base of residential solar is LADWP's highest-leverage opportunity to maximize the value of residential solar.

Cumulative Residential Storage Potential

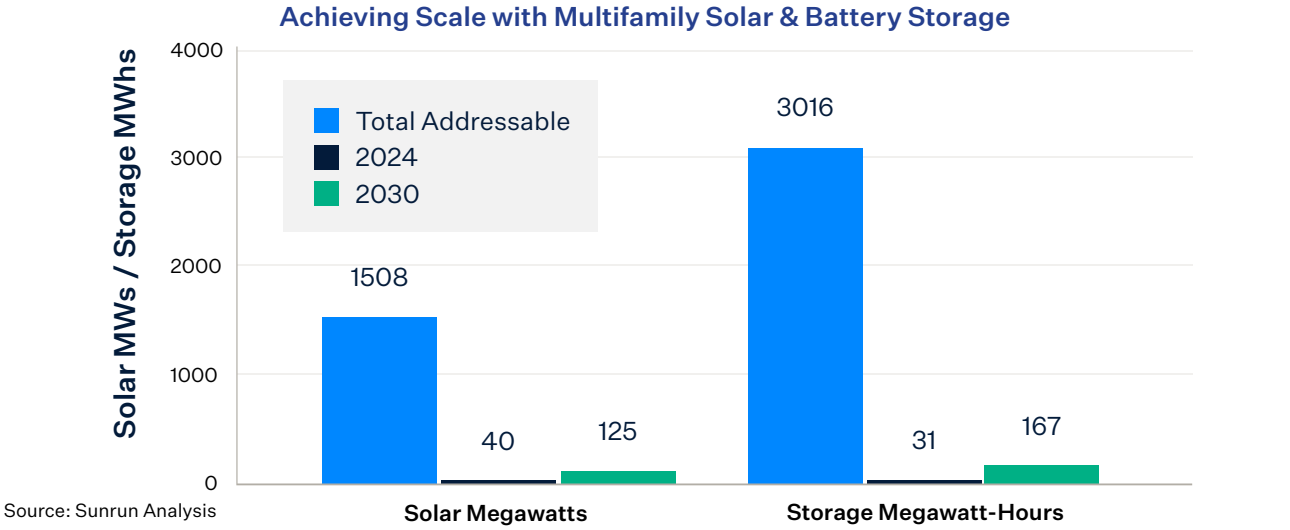
If LADWP targets continued solar growth in line with the assumptions above, by 2024 Sunrun estimates that **403 megawatts** of residential solar would be achieved. By this time, of the 73,000 solar single family homes in Los Angeles, 12,000 would have batteries, leading to approximately 138 megawatt-hours of storage. Of the 1,600 multifamily properties (or a smaller number of properties with solar systems larger than the 25 kilowatt average we assume) with solar, 613 multifamily properties with storage would add an estimated 31 megawatt-hours, for a total of approximately **168 megawatt-hours** of battery capacity.

Continuing this trend, by 2030 **737 megawatts** of solar on 147,000 homes and **125 megawatts** of solar on 5,000 multifamily buildings would result in 72,000 homes and 3,300 multifamily properties with batteries, for a total of **1,180 megawatt-hours** of residential storage. If batteries are used to provide electricity to homes and neighborhoods over a peak period lasting four hours, this is roughly equivalent to a **295 megawatt** gas-fired power plant. **This is the same order of magnitude of the peak capacity provided by either LADWP's Scattergood or Harbor generating plants.**



Source: Sunrun Analysis

LADWP can achieve the levels of single family solar and battery storage adoption modeled by reaching only a portion of today's addressable potential.

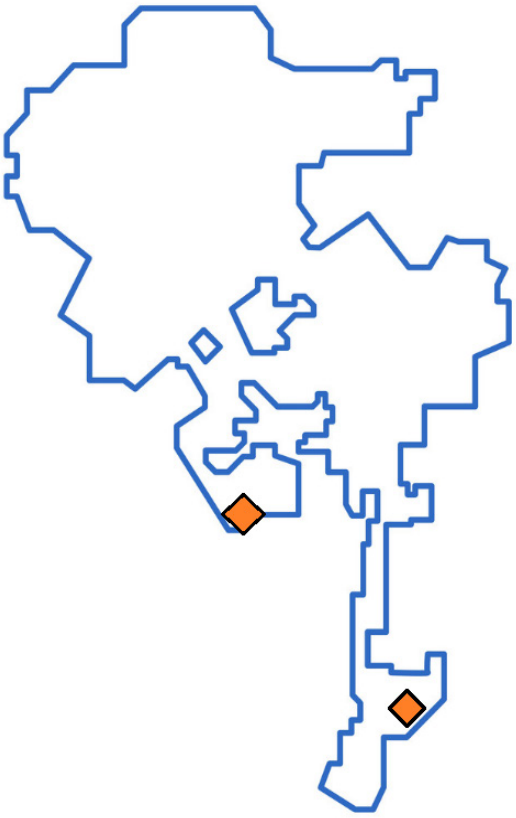


Source: Sunrun Analysis

The multifamily solar sector in LADWP is more nascent. Jumpstarting this market by following the policy recommendations in this report would begin to address the potential. This graph illustrates how much greater the potential is, beyond a recommended initial 125 megawatt solar target. For comparison, the SOMAH program targets 300 megawatts over ten years in the investor-owned utility territories across California.

Through steady growth in solar, focus on jumpstarting the multifamily solar market, enabling rental homes to go solar and a target for increasing battery deployment, LADWP can achieve gigawatt-scale results from residential solar and storage. These results can be achieved with conservative assumptions for the rate of growth of solar and the speed with which batteries become the norm for new solar installations. We believe that LADWP could be even more ambitious than this. In particular, the results modeled show that even after a large increase from today, enormous potential would remain for further growth in the multifamily sector in particular. With the right programs, identified below, LADWP could drive further expansion of solar serving residents of multifamily housing through 2030 and beyond.

"By 2030, roughly 75,000 homes with solar and batteries can generate approximately 295 megawatts, equivalent to the amount of power from one of LADWP's gas plants."



The planned retirement of the Scattergood, Haynes and Harbor plants will create the need for energy resources in specific places on the LADWP grid. LADWP's distribution grid is aging and so placing dispatchable energy resources on the local grid, as with residential solar and battery storage, can also support local reliability at reduced infrastructure costs. In many cases, the places where the grid can benefit from residential solar and battery storage overlaps with communities that currently have lower penetrations of solar.

Focus on Equity and Solar+Storage Benefits for All

A priority in scaling solar and storage in Los Angeles must be that citizens in **all** parts of the city benefit, including areas that currently see little solar deployment. Too often, this coincides with lower income communities. Simultaneously, the topography of the Los Angeles grid requires that as gas-fired power plants are retired, energy resources are sited in "load pockets" to ensure local reliability. In South L.A. and around the Harbor / Port of L.A., these geographies may coincide.[24]

To address this, Sunrun has examined the scale of solar potential that exists in areas of Los Angeles with the lowest current solar deployment starting with regions of the city where penetration is estimated to be the lowest. Based on building stock data defined by zip code, Sunrun identified approximately **145,000 single family homes and 17,000 multifamily properties.**

Despite currently low penetration rates of solar, Sunrun recommends LADWP target 115 megawatts of solar and 200 megawatt-hours of storage to be deployed to single family homes in these areas by 2030, benefitting nearly **25,000 households.** To achieve this, LADWP needs to spur solar deployment growth from 2020 forward in these areas in line with overall solar growth across the city.

With an identified 17,000 multifamily properties in these zip codes, Sunrun recommends that out of a total target of solar for 5,000 multifamily properties by 2030 across Los Angeles, a minimum of 50% of these properties should be targeted in these zip codes. This would result in 63 megawatts of solar and 67 megawatt-hours of storage on 2,500 properties, benefiting an estimated additional **~20,000 households.**

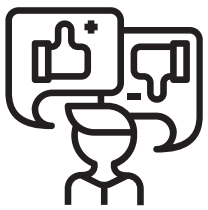
What Will it Take to Realize This Potential?

Realizing Los Angeles' potential requires LADWP's leadership, collaboration with interested stakeholders and partnership with clean energy innovators. Achieving this scale of local clean energy starts with recognizing the added value that home solar and batteries can deliver to Los Angeles as a virtual power plant. LADWP will need the right programs and partners. The utility cannot deliver these results on its own - it must engage with the leading clean energy developers and implement the latest software platforms.

The time to act is now. LADWP's approach in the next 3-5 years will set the trajectory for the scale that home solar and battery storage achieves by 2030. Waiting too long to pursue this will mean playing catch-up when the need for new clean energy is at its greatest.

Furthermore, Sunrun believes that equity must be a driver of efforts to ensure that the benefits of clean energy reach Angelenos in all parts of the city. We include specific analysis of the solar potential for areas with low current solar penetration, recommended solar equity targets, and four additional key recommendations to achieve this, in the following section titled "Targeting Solar Deployment for Grid and Community Benefit."

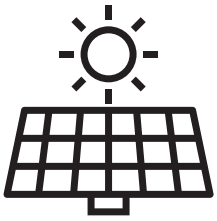
Steps in Supporting Local Clean Energy

1. 

Engage Customers to Be Part of the Solution

2. 

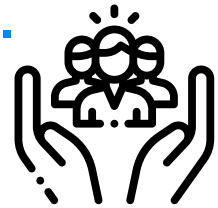
Include Residential Storage in Planning

3. 

Next Gen "Solar & Smart Battery Program"

4. 

Enable Residential Solar & Storage to Compete

5. 

Target for Grid & Community Benefit

6. 

Consider the Value to the Local Grid

7. 

Partner with Innovators

1. Engage Customers to Be a Part of the Solution

The greatest champions for achieving 100% clean energy in Los Angeles are Angelenos themselves. LADWP should embrace customer participation in achieving its clean energy goals. This begins with making sure it is easy for customers to adopt home solar and battery storage. Plus, compensating them for the added value their battery provides is an excellent method. Rate structures should remain friendly to solar adoption and encourage batteries and related smart home energy technology adoption. Interconnection and permitting processes should be streamlined and adopt best practices found across the U.S. and internationally. Customers should have the opportunity to be compensated by LADWP based on the enhanced value that a battery can provide in a virtual power plant.

2. Include Residential Storage in Planning

LADWP is now committed to a path to 100% renewable energy, including the replacement of large in-basin gas-fired power plants. Ongoing analysis considers a wide range of technologies, but currently **does not include** the full potential for home solar and battery to be deployed at a growing scale. Sunrun has written this report to illuminate the residential potential that may otherwise be overlooked. Current planning does not take into account the potential of using distributed solar and batteries as a virtual power plant resource. Los Angeles must recognize the added value of home solar and batteries for Los Angeles as a virtual power plant. If this potential is considered, new options may open up to help achieve LADWP's goals for a clean, reliable system. For instance, rooftop solar and batteries can provide firm capacity **without siting challenges** and **without building new transmission lines throughout the city.**

3. Create a Next Generation "Residential Solar & Smart Battery Program"

LADWP can build on the growing landscape of innovation in residential storage, including utilities in New York and New England that have begun creating customer programs for residential storage. This will lay the groundwork for large-scale virtual power plants. LADWP recently sunset its solar rebate program, but could relaunch this as a **Residential Solar & Smart Battery program.** To do this LADWP would identify the value that a battery with a ten-year equipment lifetime can offer to the system if it is networked to respond to LADWP Demand Response programs and more.

LADWP can then partner with solar and storage installers to encourage batteries to be added to new solar installations and delivering that value to customers in the form of a rebate and/or an ongoing payment for their battery's performance. This will dramatically lower the effective cost of a battery and rapidly increase battery uptake—setting LADWP on track to reach the storage adoption rates modeled above.

4. Enable Solar and Storage to Compete

When LADWP solicits information and proposals for alternative approaches to its existing generating capacity, those requests should be open to residential solar and storage as a virtual power plant resource, even if this looks different than traditional resources. By enabling developers to provide the latest cost estimates for newer technology and ideas for innovative business models, LADWP will benefit from the broadest set of solutions. For those who assume customer-sited resources are more expensive than individual large-scale solutions, this will provide clarity on cost effectiveness.

5. Focus Where the Grid and Communities Benefit Most

When LADWP retires gas generation in specific parts of the city, ensuring local grid stability will require siting resources in specific geographies or load pockets. As modular resources that can be sited on existing buildings and homes, solar and storage are ideal resources for this. Batteries, including potentially aggregations of small batteries, are able to provide the ancillary services like frequency regulation that maintain the stability on the grid, which have traditionally been provided by generators. At the same time, certain parts of Los Angeles currently have much lower than average solar penetration. This is despite having strong intrinsic potential for local solar as quantified above. These communities can see the greatest benefit from increasing solar deployment.

LADWP can focus programs on the critical need to target geographically for the benefit of communities and the grid. In some parts of Los Angeles, these may overlap for even greater impact. **See next section—*Targeting Solar Deployment for Grid and Community Benefit* for four detailed programmatic recommendations to help solar flourish in key parts of Los Angeles.**

6. Consider the Value to the Local Grid

LADWP has an aging grid that requires increased investment to handle higher electricity demand in growing parts of the city. Residential solar and batteries provide an alternative to this expensive new infrastructure. Batteries can discharge to counteract spikes in demand in local areas, preventing blackouts. This helps circumvent the need to expand the local distribution grid's capacity. Next door in Southern California Edison's territory and across the country (in places as far-flung as Oregon, New York, and Maine), utilities are showing that deferring such investments in "poles and wires" can save millions of dollars.[25] These benefits should be recognized for their value in the implementation of residential solar and batteries.

7. Partner with Innovators

To achieve 100% renewable energy, LADWP must incorporate many new solutions. Some of these solutions will take the form of technologies that complement LADWP's expertise in managing the grid. By enabling third parties to develop and manage fleets of resources like residential solar and storage (as well as other distributed energy resources), LADWP can leverage these resources even if they do not own and directly control them. By starting now, as with a Residential Solar & Smart Battery Program that enables LADWP's grid operators experiment, test and learn. They will gain expertise with a new energy asset type. Partnering with third parties will further enable LADWP to test how they can engage with assets that they do not own but with which they can communicate to achieve the results they need on the grid.

Targeting Solar Deployment for Grid and Community Benefit

To address the elevated need for clean energy resources in specific parts of Los Angeles for both grid and community benefit, the recommendations found throughout this report can be focused on addressing the challenges of deploying solar including lower income, more pollution-burdened communities. Based on evaluation of building stock in areas with lower solar penetration, Sunrun recommends a minimum target of 25,000 single family homes and 2,500 multifamily buildings in these areas. If, through LADWP programs, batteries are added to these solar systems at the same rate of uptake as modeled for the city as a whole, this would result in a total of approximately 255 megawatt-hours of battery storage, offsetting the need to build 64 MW of peak power plant capacity. This can be expanded and refined based on more specific knowledge of the areas where the grid can benefit most from local energy resources.

Jump start multifamily solar growth with an expanded Shared Solar Program

Multifamily solar in LADWP is limited compared to elsewhere in California, where the Multifamily Affordable Solar Homes (MASH) and SOMAH programs have delivered energy savings to residents in affordable housing. LADWP has launched the **Shared Solar Program** for renters that utilizes city property for solar installations, but this leaves actual multifamily roofs unaddressed.

This does not enable the addition of energy storage to provide backup power to the residents of multifamily buildings or support the grid in locations where the grid can benefit most. LADWP can expand the impact of these programs by establishing a Virtual Net Metering program for multifamily homes and by carving out capacity from an expanded Feed-In Tariff program specifically for affordable multifamily properties, including in local areas where solar and batteries can benefit communities and the grid.

Partner to engage customers in key areas

The need to target specific parts of the city for clean energy is an example of where LADWP can partner with clean energy developers for the greatest impact. LADWP has customer relationships with properties in these areas as well as historical data on energy usage.

In the places where local solar and storage is needed most, LADWP can create frameworks to enable property owners to engage clean energy developers qualified to provide solar and storage for an LADWP Virtual Power Plant. This would allow developers to rapidly advance projects with more prospective property owners and drive increased deployment. The property types targeted by LADWP could reflect goals for community impact.

Enable solar for rental properties

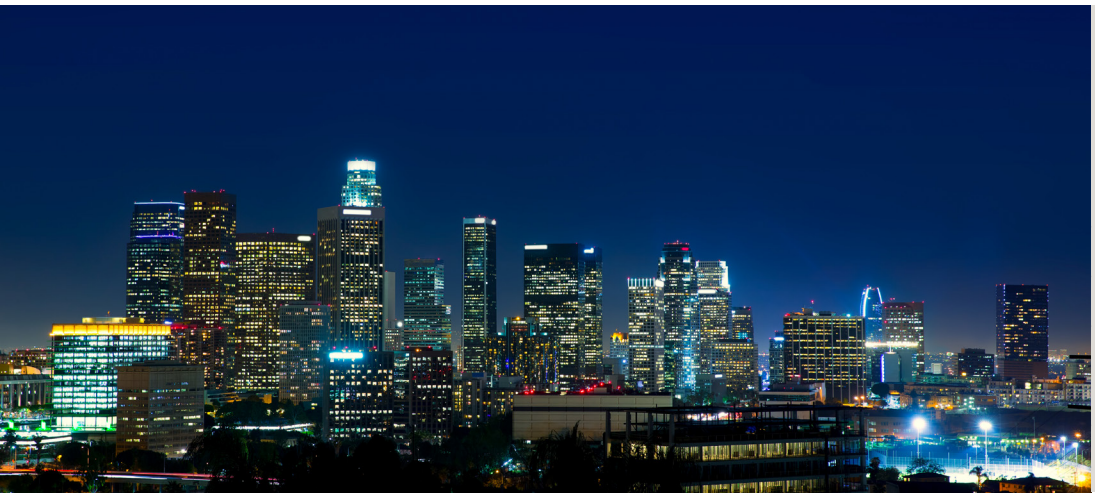
Rental homes more rarely have solar because there is a split incentive between the property owner, who would invest in solar and, if the tenant pays the utility bill, the party that would benefit from reduced electricity costs. LADWP's Solar Rooftops Program enables any homeowner to "rent" their roof to LADWP to install solar at no cost to the homeowner in exchange for a $30 per month credit on their electricity bill.

While limited in scale today, this model has promise to address rental properties if benefit flows to both tenant and property owner. Adding a battery adds more value to the grid and also value to the home by providing new backup power, incentivizing property owners to adopt it. By marketing this program to property owners and partnering with clean energy developers to scale up the program cost efficiently, LADWP could unlock solar for renters across targeted local areas.

Add economic value for solar and storage in targeted locations

Particularly where gas plant retirement creates future need for local energy capacity, including energy storage, there is added economic value for energy from local solar and storage. By creating a price signal through Net Metering rates and its Feed-in Tariff, LADWP can drive increased development in these locations. Pricing signals can reward solar development as well as delivery of energy via batteries at specific high-value times of today.

There are many procurement mechanisms that can be utilized to drive deployment in these areas, but this approach enables the entire market to respond to locational need. LADWP can then directly contract with developers to deploy clean energy where needed, above and beyond these price signals.



Appendix

About Sunrun

Sunrun is the nation's largest residential solar, battery storage and energy services company. With a mission to create a planet run by the sun, Sunrun has led the industry since 2007. With its solar-as-a-service model, Sunrun provides clean energy to households with little to no upfront cost - supporting customer savings when compared to traditional electricity. The company designs, installs, finances, insures, monitors, and maintains the systems, while families receive predictable pricing for 20 years or more.

Sunrun offers a home solar battery service, Sunrun Brightbox, that manages household solar energy, storage and utility power with smart inverter technology. Sunrun has deployed approximately 1,500 megawatts of solar to over 220,000 families in 23 states, the District of Columbia and Puerto Rico. As of late 2018, Sunrun has installed Brightbox solar and storage for approximately 5,000 of its customers. In 2019, Sunrun successfully bid into the New England-ISO market to provide capacity resources. Over the next three years, Sunrun will install and aggregate approximately 5,000 Brightbox systems across New England to provide a valuable capacity resource throughout that area.

For the past seven years, Sunrun has partnered with GRID Alternatives, a national leader in making solar power and jobs accessible to underserved communities. Sunrun serves as the third-party owner (TPO) on GRID projects through its solar lease and solar power purchase agreement (PPA) products. The partnership also includes a philanthropic donation to support job training and solar installations for low-income families, as well as employee volunteerism on projects across the United States. As of 2018, Sunrun and GRID Alternatives have contributed some of their installs through the Solar Equity Initiative spearheaded by the National Association for the Advancement of Colored People (NAACP).

In September 2018, Sunrun announced plans to develop a minimum of 100 megawatts of solar on affordable multi-family housing, where 80% of tenants fall below 60% of the area median income, over the next decade in California.[26] Sunrun's commitment, when fully deployed, will directly benefit at least 50,000 moderate and low-income households. The installations will be done through the CPUC's Solar on Multifamily Affordable Housing (SOMAH) program, creating significant economic benefits and reducing cost for renters. This initiative will also improve local air quality, decrease reliance on fossil fuels and offer freedom from climbing electric utility bills.

For more information, please visit: www.sunrun.com.

Glossary

ADDRESSABLE POTENTIAL Sunrun's calculation of potential number of households that are viable for solar today considering housing stock characteristics and viability for installation. This has been converted to solar megawatts and battery megawatt-hours using hardware assumptions detailed in the appendix above.

BATTERY an energy storage product that is attached to residential property—in this case—linked with solar photovoltaic panels (PV).

CPUC the California Public Utilities Commission is a regulatory agency that regulates privately owned public utilities in the state of California.

FORWARD CAPACITY MARKET the Forward Capacity Market (FCM) ensures that the New England power system will have sufficient resources to meet the future demand for electricity. Forward Capacity Auctions (FCAs) are held annually, three years in advance of the operating period. Resources compete in the auctions to obtain a commitment to supply capacity in exchange for a market-priced capacity payment. These payments help support the development of new resources. Capacity payments also help retain existing resources.

GAS PEAKER power plants that generally run only when there is a high demand, known as peak demand, for electricity. Peak load power plants are dispatched in combination with base load power plants, which supply a dependable and consistent amount of electricity, to meet the minimum demand.

GREEN MOUNTAIN POWER Vermont based utility with approximately 265,000 residential and business customers.

RESIDENTIAL HOME SOLAR photovoltaic (PV) panels generally attached to home rooftops to generate electricity for use in the household and exported back to the electricity grid when there are greater levels of generation than are used in the home.

INSOLATION amount of solar radiation reaching a given area. Used to determine how much electricity can be generated from PV panels.

INVESTMENT TAX CREDIT the investment tax credit (ITC), also known as the federal solar tax credit, allows a 30% deduction of the cost of installing a solar energy system from federal taxes. The ITC applies to both residential and commercial systems.

ISO-NE Independent System Operator for New England.

LADWP the Los Angeles Department of Water and Power is the largest municipal utility in the United States, serving over four million residents.

MEGAWATT a unit of power equal to one million watts, especially as a measure of the output of a power station.

MEGAWATT- HOUR a megawatt hour is one million watts of electrical power used for 1 hour.

MULTIFAMILY HOUSING buildings that encompass homes for multiple occupants such as apartment blocks.

SDG&E San Diego Gas & Electric is an investor owned utility that provides natural gas and electricity to San Diego County and southern Orange County.

SGIP the CPUC's Self-Generation Incentive Program (SGIP) provides incentives to support distributed energy resources

installed on the customer's side of the utility meter.

SOMAH PROGRAM the Solar on Multifamily Affordable Housing (SOMAH) program provides financial incentives for installing photovoltaic (PV) energy systems on multifamily affordable housing.

SCE Southern California Edison, the largest subsidiary of Edison International, is the primary electricity supply company for much of Southern California. It provides 14 million people with electricity.

SUNRUN Sunrun inc. is the largest provider of residential solar, storage and energy services in the US.

TRANSMISSION GRID the section of the electricity grid that transports electricity from centralized generation to the distribution system at high voltage.

VIRTUAL POWER PLANT a network of solar and storage assets that are managed and dispatched to deliver coordinated benefit to the grid.

Methodology for Market Sizing

For the residential market, a separate assessment has been conducted for addressable market and deployment potential, from today to 2030.

Total Addressable Market Potential

Sunrun estimated the residential addressable market potential as follows:

- U.S. Census data, current as of 2017, for LA for housing units, sorted by the type of housing units.
- Assumed 75% of roofs in Los Angeles are viable for solar based on roof size and orientation and building energy usage. This is more conservative than data from Google Project Sunroof, which showed that 82% of Los Angeles roofs are viable for solar based on satellite imagery and analysis.
- For single family homes, assumed that 63% of single family homes are owner-occupied, according to the U.S. Census data for Los Angeles. Although non-owner occupied homes can be served by solar, the current market development is typically with owner-occupied homes.
- Assumed 5 kilowatts solar per home for single family homes. This is in line with the observed installations in LADWP today. Sunrun has developed an estimation of increased usable battery size over time, starting with a 6 kilowatt-hour battery in 2019 increasing to a 15 kilowatt-hour battery by 2026. This estimate is based on the expected decrease in battery cost and the scale of battery that can effectively be paired with a 5 kilowatt solar system for charging and discharging of daily solar production on a year-round basis. Also, the value of being able to back up greater energy use, including whole-home backup, with larger batteries.
- Assumed 25 kilowatts of solar and 50 kilowatt-hours of for each multifamily building. This is based on an estimated weighted average number of units of ~10 per multifamily property and an average of 2.5 kilowatts of solar per unit, in line with observed trends for multifamily solar. We assumed that the same proportion of multifamily units adopt storage as single family units.

Market potential through 2030

We have calculated development potential in 2024 and 2030 for single family and multifamily solar and storage according to the to the following schedule.

Single Family Homes

Year	Storage Attachment Rate	Units Added In-Year	Cumulative Solar Homes	Solar per Unit (kW)	Battery Size per Unit (kWh)	Solar Added in Year (MW)	Cumulative Solar (MW)	Storage Added In-Year (MWh)	Cumulative Storage (MWh)
2018	0%	3602*	35855	5	6	N/A	182*	0	0
2019	0.3%	4453	40308	5	6	22	202	0.1	0
2020	5%	5374	45682	5	10	27	228	3	3
2021	10%	5374	51057	5	10	27	255	5	8
2022	25%	6718	57774	5	10	34	289	17	25
2023	50%	6718	64492	5	12	34	322	40	65
2024	75%	8062	72554	5	12	40	363	73	138
2025	80%	9405	81959	5	12	47	410	90	228
2026	80%	9405	91364	5	15	47	457	113	341
2027	80%	12092	103457	5	15	60	517	145	486
2028	80%	13436	116893	5	15	67	584	161	647
2029	80%	13436	130329	5	15	67	652	161	809
2030	80%	17037	147365	5	15	85	737	204	1013

As of the date of publication, EIA Form 861, source for current LADWP net metering connections, provides data through October 2018. This slightly understates 2018 solar deployment, which can be expected to total ~4,300 units in 2018.

Multifamily Homes

Year	Storage Attachment Rate	Units Added In-Year	Cumulative Multifamily Solar	Solar Size (kW)	Battery Size (kWh)	Solar Added in Year (MWO	Cumulative Solar (MW)	Storage Added In-Year (MWh)	Cumulative Storage (MWh)
2018	0%	N/A	N/A	25	50	N/A	N/A	N/A	N/A
2019	0.3%	50	50	25	50	1	1	0	0
2020	5%	150	200	25	50	4	5	0	0
2021	10%	300	500	25	50	8	13	2	2
2022	25%	300	800	25	50	8	20	4	6
2023	50%	400	1200	25	50	10	30	10	16
2024	75%	400	1600	25	50	10	40	15	31
2025	80%	400	2000	25	50	10	50	16	47
2026	80%	600	2600	25	50	15	65	24	71
2027	80%	600	3200	25	50	15	80	24	95
2028	80%	600	3800	25	50	15	95	24	119
2029	80%	600	4400	25	50	15	110	24	143
2030	80%	600	5000	25	50	15	125	24	167

While existing multifamily solar is greater than zero as of the end of 2018, for the purpose of this analysis new multifamily solar development under revamped LADWP multifamily solar programs is considered on a standalone basis.

Endnotes

1. EIA Form 861(M), 2018 net metering data.

2. EIA Form 861(M), 2018 Sales and revenue data.

3. LADWP Final Incremental Electric Rates Ordinance (effective April 15, 2016).

4. Wood Mackenzie Energy Storage Monitor Q4 2018.

5. "Residential overtakes quarterly utility deployment in US for the first time." Energy Storage News, September 4, 2018.

1. "Los Angeles ditches plan to invest billions in fossil fuels, Mayor Eric Garcetti says." Los Angeles Times, February 11, 2019.

2. Shining Cities 2018: How Smart Local Policies Are Expanding Solar Power in America, Environment America.

8. Q3 2018 US Energy Storage Monitor. Wood Mackenzie Power & Renewables.

9. "SCE Announces Winners of Energy Storage Contracts Worth 250MW." Greentech Media, November 4, 2015.

10. "Marking a first, solar and battery bid clears ISO-NE auction." American Public Power Association. February 12, 2019.

11. Based on LADWP Time-of-Use Residential Rate, Peak and Low-peak periods, www.ladwp.com/ladwp/faces/ladwp/residential/r-customerservices/r-cs-understandingyourrates.

12. "Capital Cost Estimates for Utility Scale Electricity Generating Plants," EIA, November 2016. Overnight construction costs for a 702 MW Natural Gas Combined Cycle plant is estimated at $988 per kilowatt, excluding financing costs, fixed O&M and variable O&M. EIA's estimates for regional cost adjustments are that a plant in Los Angeles would carry a 28% cost adder, resulting in an estimated overnight cost of $1,248 per kilowatt.

13. 1,180 MWh of residential storage by 2030 divided by 4 hour delivery = 295MW.

14. Vermont based utility with approximately 265,000 residential and business customers.

15. "Tesla batteries save $500K for Green Mountain Power through hot-weather peak shaving." Utility Dive, July 23, 2018. "New Hampshire Utility to Fight System Peaks With Home Batteries Under New Settlement," Greentech Media, November 30, 2018.

16. The use of flexible, customer cited resources is growing in sophistication as well as prevalence, serving multiple roles traditionally played by centralized power plants. For example, the California ISO has adopted in recent years structures through which customer-sited solar and batteries can provide reduced system demand at peak periods that serves as an equivalent to generating capacity for the purpose of Resource Adequacy requirements for California utilities under CPUC jurisdiction. This capacity is traditionally provided by large-scale power plants. Customer-sited solar and batteries are also eligible to provide Flexible Resource Adequacy, reducing the "ramp rate" on the CAISO grid during morning and evening hours when solar output changes and other power resources must come online or go offline. Similarly,

customer-sited solar and batteries can provide Local Resource Adequacy provides capacity within a specific load zone where a transmission constraint or potential constraint creates the need for localized resources. In 2018, CAISO added new ways for customer-sited solar and batteries to provide "load shift," charging batteries with solar output midday when it is most prevalent and shifting its usage to other times of day. These varied use cases illustrate how rooftop solar and batteries can serve the varied needs of the grid in California and Los Angeles as they transition to higher penetration of solar and other renewable energy. For more information, see CAISO's Energy Storage and Distributed Energy Resources page.(http://www.caiso.com/informed/Pages/StakeholderProcesses/EnergyStorage_DistributedEnergyResources.aspx)

17. "National Solar Jobs Census." The Solar Foundation. https://www.thesolarfoundation.org/national/

18. "Occupational Outlook Handbook." Bureau of Labor Statistics. 1/30/18. https://www.bls.gov/ooh/fastest-growing.htm.

19. "National Solar Jobs Census." The Solar Foundation.

20. CAISO 2017/18 Transmission Plan, March 22, 2018, p.3

21. U.S. Census, CAISO NEM Interconnection data, Energy Information Administration Form 861M, and Google Sunroof.

22. LADWP 2017 Power Strategic Resource Plan. p.ES-10

23. Sunrun quarterly earnings conference call, Q3 2018.

24. "The need for local capacity to replace the Scattergood and Harbor power plants coincides in many cases with the need to increase solar deployment in communities that have lower than average solar penetration."

25. "A Snapshot of the US Gigawatt-Scale Non-Wires Alternatives Market." Greentech Media Research, August 22, 2017.

26. Sunrun Press Release: http://investors.sunrun.com/news-releases/news-release-details/sunrun-expands-solar-access-affordable-housing-communities#

sunrun