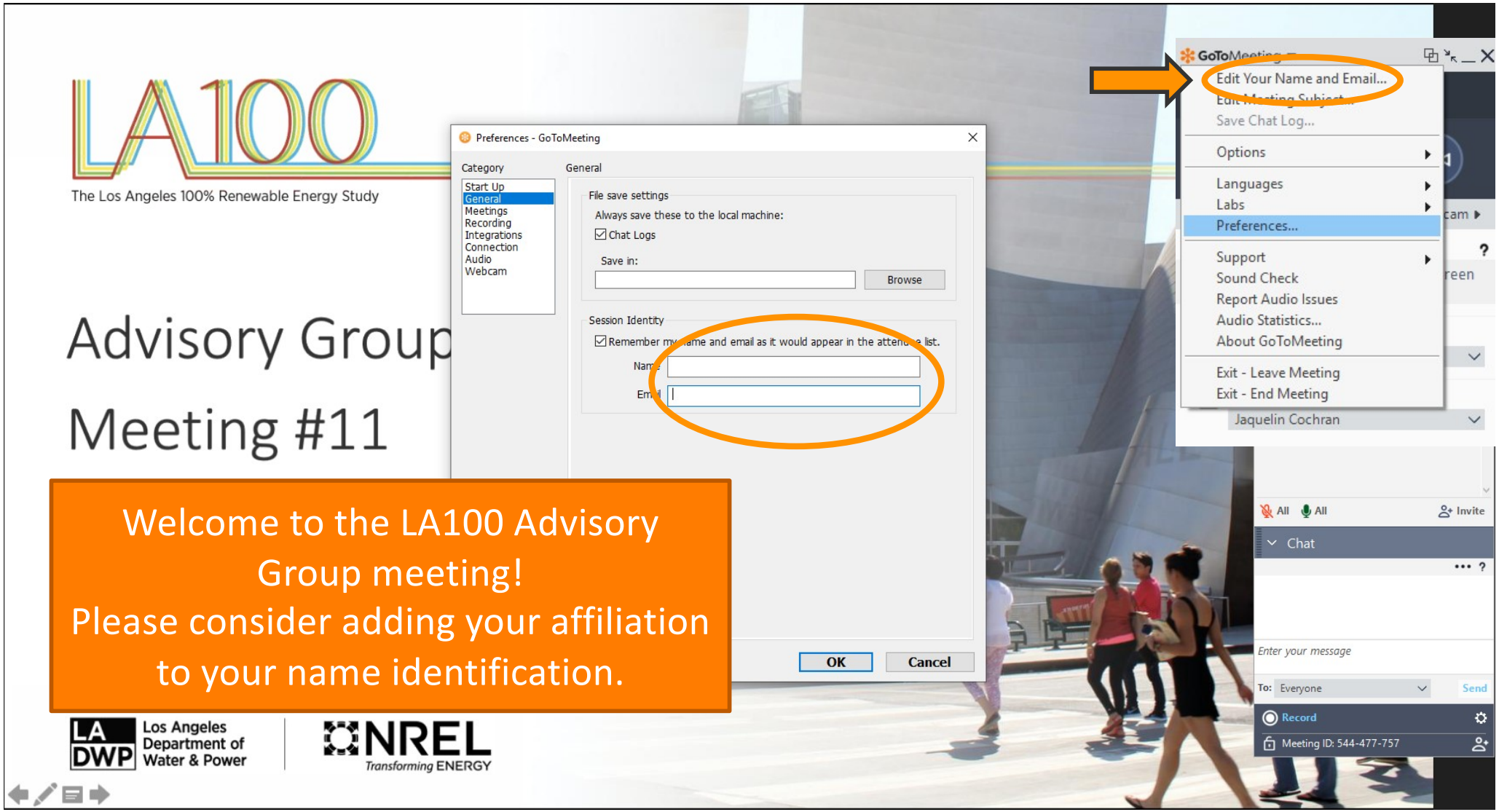
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# Advisory Group Meeting #11

## Virtual Meeting #3

LA DWP Los Angeles Department of Water & Power | NREL Transforming ENERGY

# Agenda

May 14
- Welcome
- Electricity Demand Projections and Demand Response
- Discussion/Q&A

May 21
- Welcome
- Renewable Options and Trade-offs to Go from 90% to 100% RE
- Discussion/Q&A

Today (May 28)
- Welcome
- Local Solar and Storage
- Discussion/Q&A

June 4
- Follow-up Q&A

We will continue last week's discussion on technology eligibility

Plus…any other topics raised by the Advisory Group

# Tips for Productive Discussions

Let one person speak at a time

Keep phone/computer on mute until ready to speak

Help ensure everyone gets equal time to give input

Type “Hand” in Chat Function to raise hand

Keep input concise so others have time to participate

Also make use of CHAT function

Actively listen to others, seek to understand perspectives

Offer ideas to address questions and concerns raised by others

Hold questions until after presentations

# * How to Mute and Share your Webcam

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# * Chat Functions

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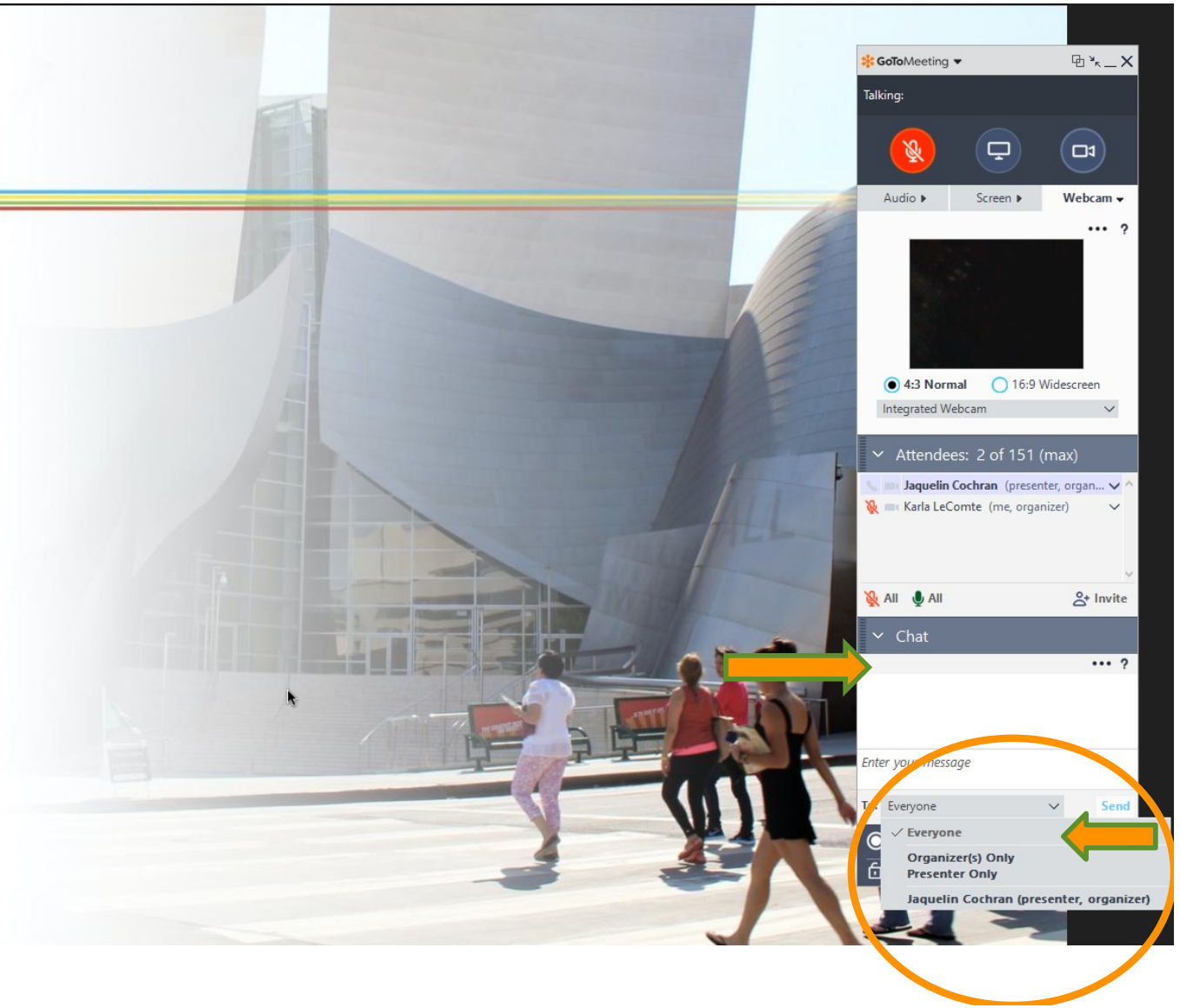


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# Local Solar and Storage

Ben Sigrin, Paritosh Das, Jane Lockshin,
Meghan Mooney, Ashreeta Prasanna

May 28, 2020

LA100 Advisory Group Meeting #11

Virtual Meeting #3

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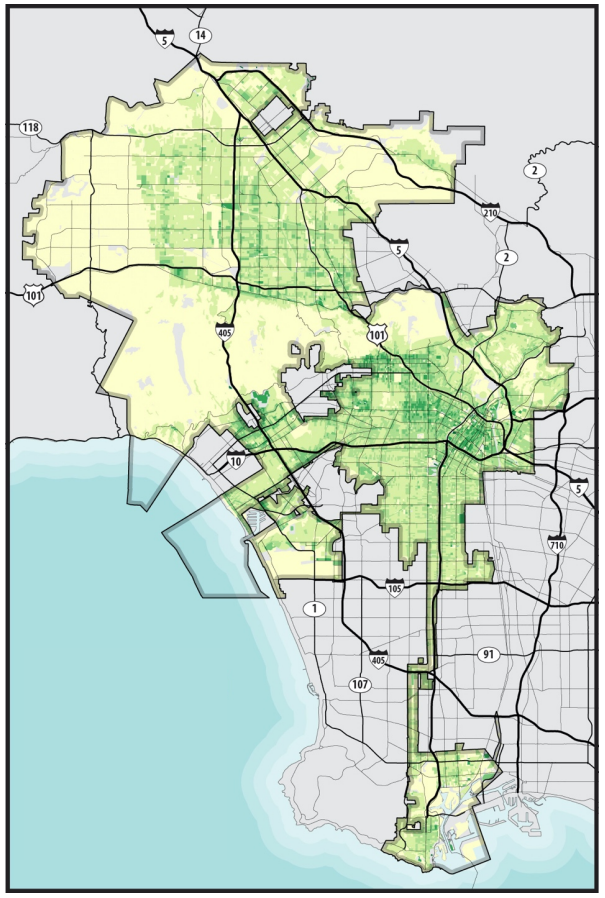
# Outline

1. Context within LA100
2. Customer-owned rooftop solar projections
3. Customer-owned storage
4. LADWP-procured local solar
   Identifying and ranking potential sites
5. Discussion/Q&A

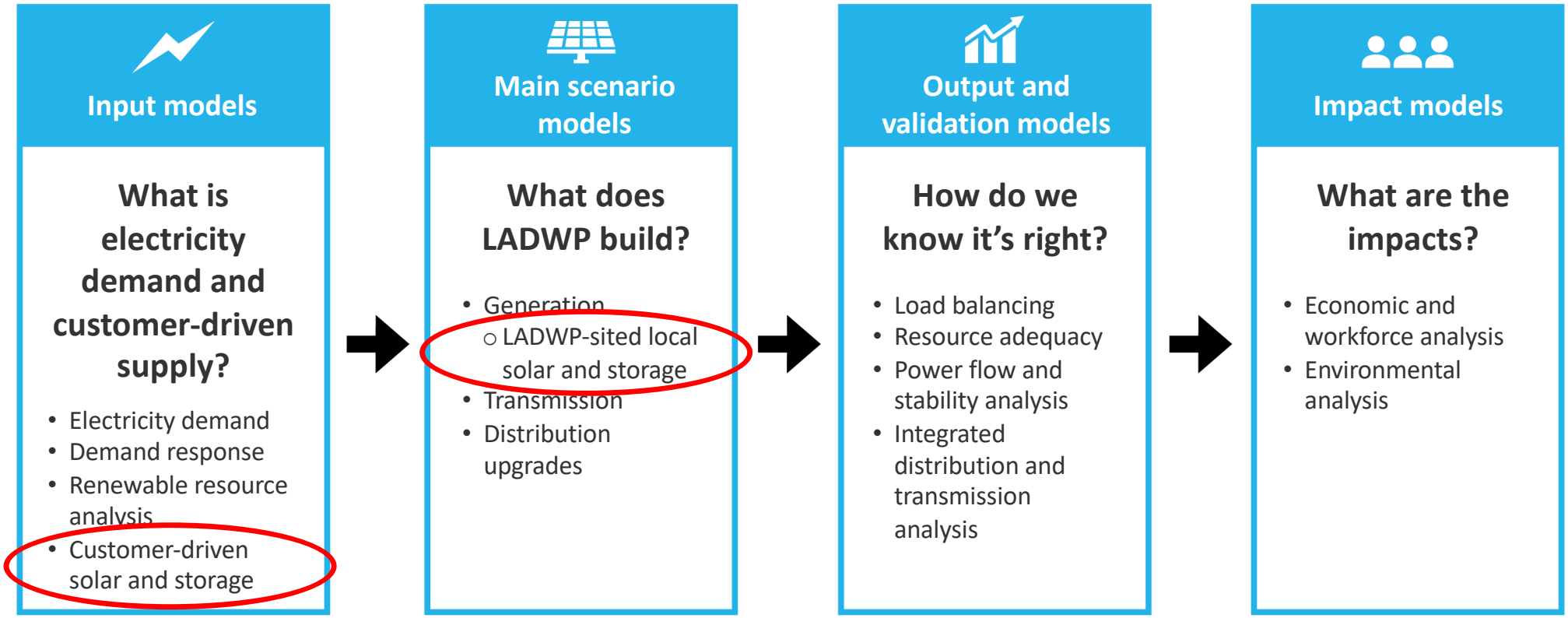
# Analysis Questions

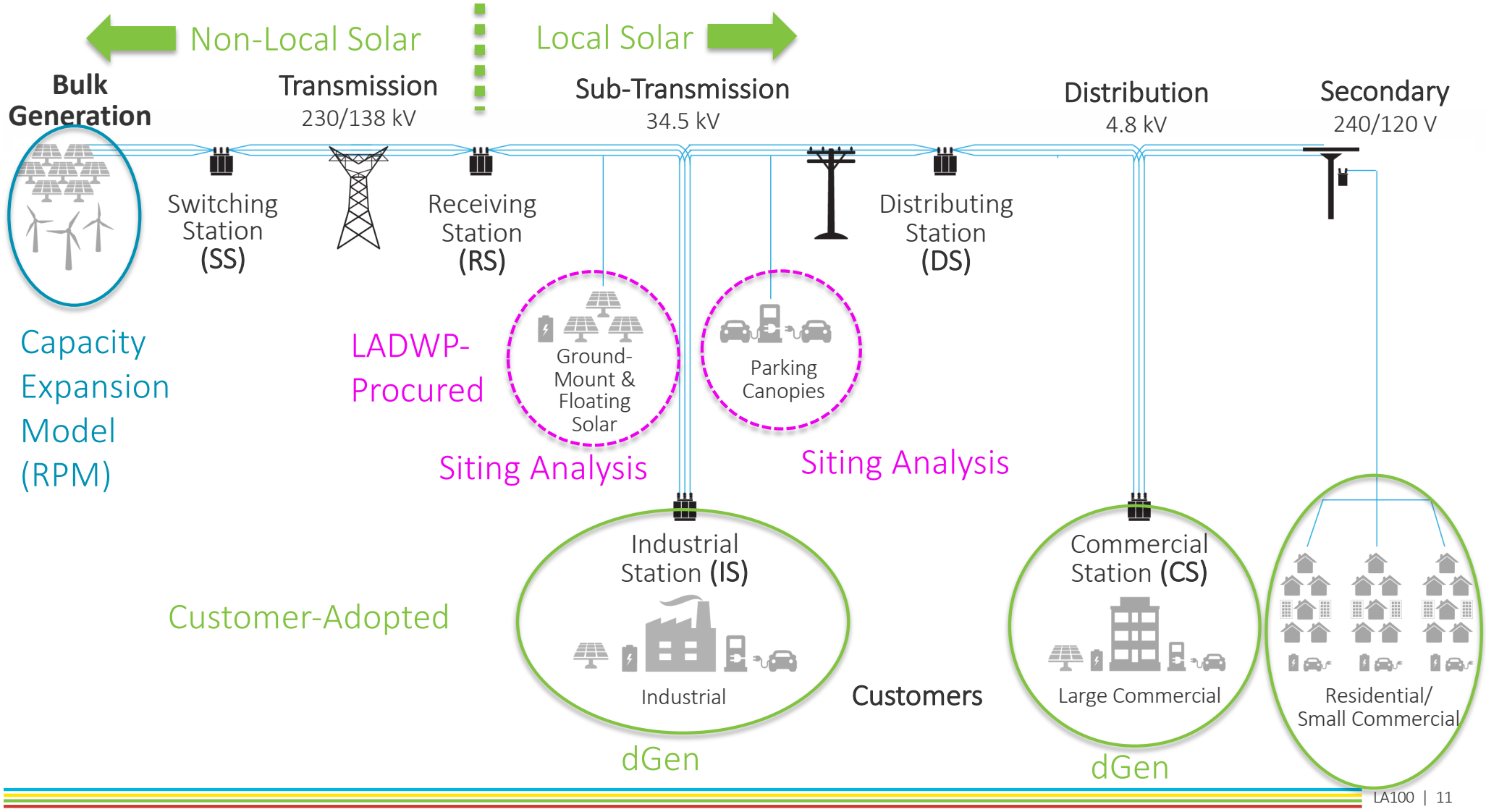
**How much** customer-owned distributed solar and storage could be adopted? Where?

Where are **optimal sites** for LADWP-procured solar?



# LA100 Methodology—Where This Fits




Non-Local Solar
Local Solar
Bulk Generation
Transmission
230/138 kV
Sub-Transmission
34.5 kV
Distribution
4.8 kV
Secondary
240/120 V
Switching Station (SS)
Receiving Station (RS)
Distributing Station (DS)
Capacity Expansion Model (RPM)
LADWP-Procured
Ground-Mount & Floating Solar
Parking Canopies
Siting Analysis
Siting Analysis
Customer-Adopted
Industrial Station (IS)
Industrial
Commercial Station (CS)
Large Commercial
Residential/ Small Commercial
Customers
dGen
dGen

# Where We Are Now

- ✓ Lidar-based rooftop assessment
- ✓ Building-level “agent” database
- ✓ First model runs
- ✓ Local solar site ranking
- ✓ Second model runs
- ✓ Final model updates
- ✓ Final model runs
- ○ Write report

# Your Feedback

- What do you see as the most significant findings of this research?

- What information and analysis can we provide to help inform post-LA100 deliberations on policy (e.g., on rate structures, environmental justice)?

# Customer-Owned Rooftop Solar Adoption

# LA100 Scenarios

DG = Distributed Generation
In scenario matrix, this refers to customer-owned solar.

| | | LA100 Scenarios | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Moderate Load Electrification | | | | High Load Electrification (Load Modernization) | | | | High Load Stress |
| | | SB100 | LA-Leads, Emissions Free (No Biofuels) | Transmission Renaissance | High Distributed Energy Future | SB100 | LA-Leads, Emissions Free (No Biofuels) | Transmission Renaissance | High Distributed Energy Future | SB100 |
| | RE Target in 2030 with RECs | 60% | 100% | 100% | 100% | 60% | 100% | 100% | 100% | 60% |
| | Compliance Year for 100% RE | 2045 | 2035 | 2045 | 2045 | 2045 | 2035 | 2045 | 2045 | 2045 |
| Technologies that do not vary in eligibility across scenarios | Solid Biomass | N | N | N | N | | | | | N |
| | Fuel Cells | Y | Y | Y | Y | | | | | Y |
| | Hydro - Existing | Y | Y | Y | Y | | | | | Y |
| | Hydro - New | N | N | N | N | | | | | N |
| | Hydro - Upgrades | Y | Y | Y | Y | | | | | Y |
| | Nuclear - New | N | N | N | N | | | | | N |
| | Wind, Solar, Geothermal | Y | Y | Y | Y | | | | | Y |
| | Storage | Y | Y | Y | Y | | | | | Y |
| Technologies that do vary | Biofuel Combustion | Y | No | Y | Y | | | | | Y |
| | RE-derived Fuel Combustion (e.g., hydrogen) | Y | No | Y | Y | | | | | Y |
| | Natural Gas | Y | No | No | No | | | | | Y |
| | Nuclear - Existing | Y | Y | No | No | | | | | Y |
| Repowering OTC | Haynes, Scattergood, Harbor | N | N | N | N | | | | | N |
| RECS | Financial Mechanisms (RECS/Allowances) | Yes | N | N | N | Yes | N | N | N | Yes |
| DG | Distributed Adoption | Moderate | High | Moderate | High | Moderate | High | Moderate | High | Moderate |
| Load | Energy Efficiency | Moderate | Moderate | Moderate | Moderate | High | High | High | High | Reference |
| | Demand Response | Moderate | Moderate | Moderate | Moderate | High | High | High | High | Reference |
| | Electrification | Moderate | Moderate | Moderate | Moderate | High | High | High | High | High |
| Transmission | New or Upgraded Transmission Allowed? | Only Along Existing or Planned Corridors | Only Along Existing or Planned Corridors | New Corridors Allowed | No New Transmission | Only Along Existing or Planned Corridors | Only Along Existing or Planned Corridors | New Corridors Allowed | No New Transmission | Only Along Existing or Planned Corridors |
| WECC | WECC VRE Penetration | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate | Moderate |

**Five DG Projections in Total:**
Moderate Load – Moderate DG
Moderate Load – High DG
High Load – Moderate DG
High Load – High DG
Stress Load – Moderate DG

Note, the study also includes a reference case (2017 IRP with minor updates). This case extends through 2036.

# Overview of Existing Rooftop Solar in LA

| Sector | Premises (n) | Adopters (n) | Avg. Size (kW) | Adoption Rate (%) |
|---|---|---|---|---|
| Residential | 572,125 | 31,085 | 7.9 kW | 5.4% |
| Commercial | 45,150 | 545 | 182 kW | 1.2% |
| Industrial | 2,595 | 37 | 558 kW | 1.4% |

Through 2018, approximately 365 MW adopted. Adoption in Los Angeles has historically been correlated with:

- Amount of existing adoption (peer effects)
- Income
- Home size
- Low-density residential areas

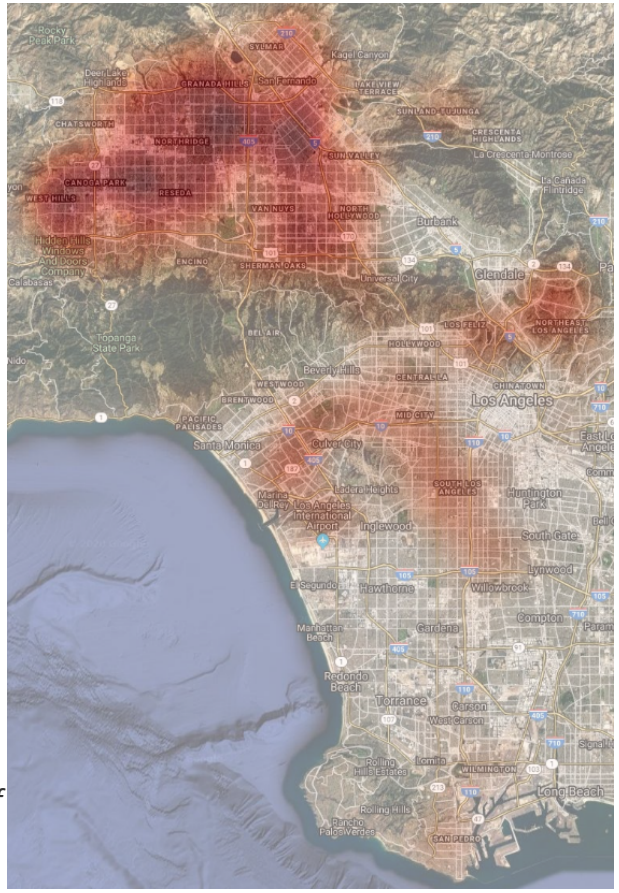
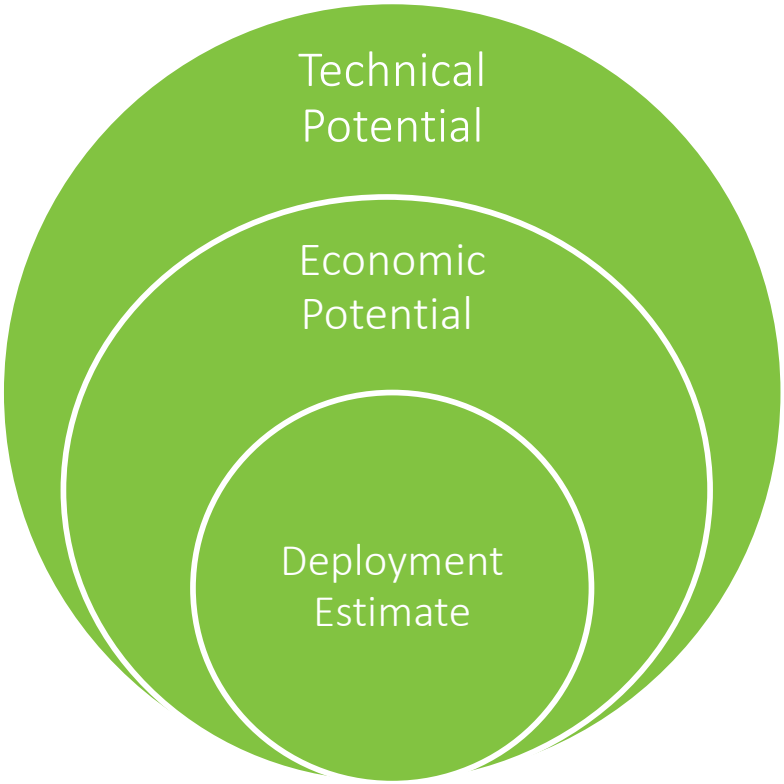



*Figure: Heat map of solar deployment through 2018*

# Framework for Projecting Adoption

Customer-built

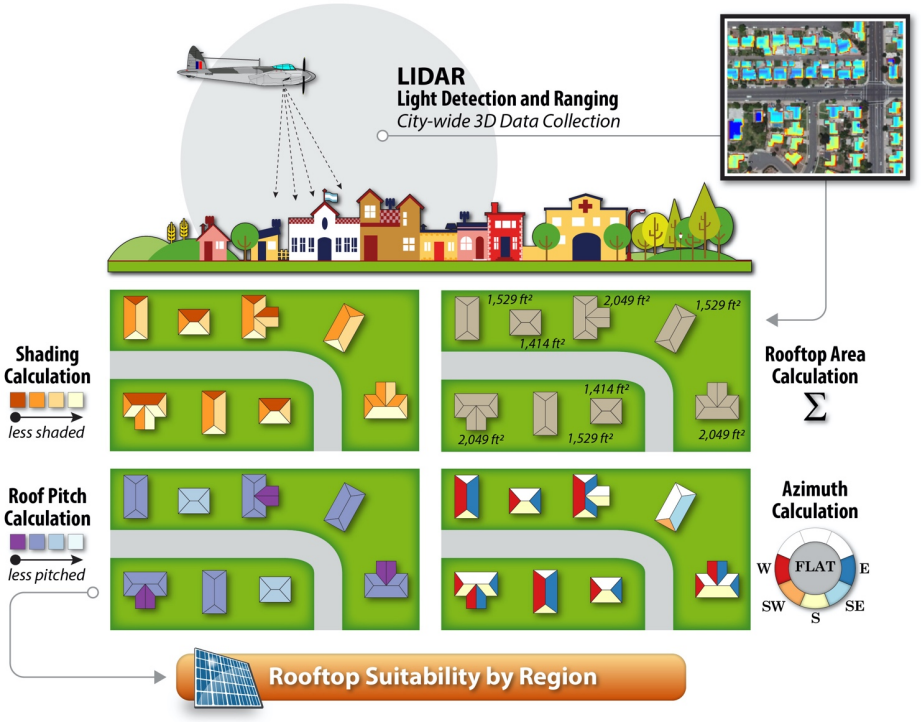



- **Technical potential** is the maximum feasible amount of capacity that could be deployed
- **Economic potential** is the amount of capacity that meets or exceeds a rate of return threshold, i.e., would be economic for the consumer to adopt
  - Moderate adoption based on net billing
  - High adoption based on net metering
- **Deployment** is the decision for the agent to adopt in a given year and, if so, the amount of system capacity. The agent can only adopt if the system is technically and economically feasible

# Rooftop Solar Technical Potential

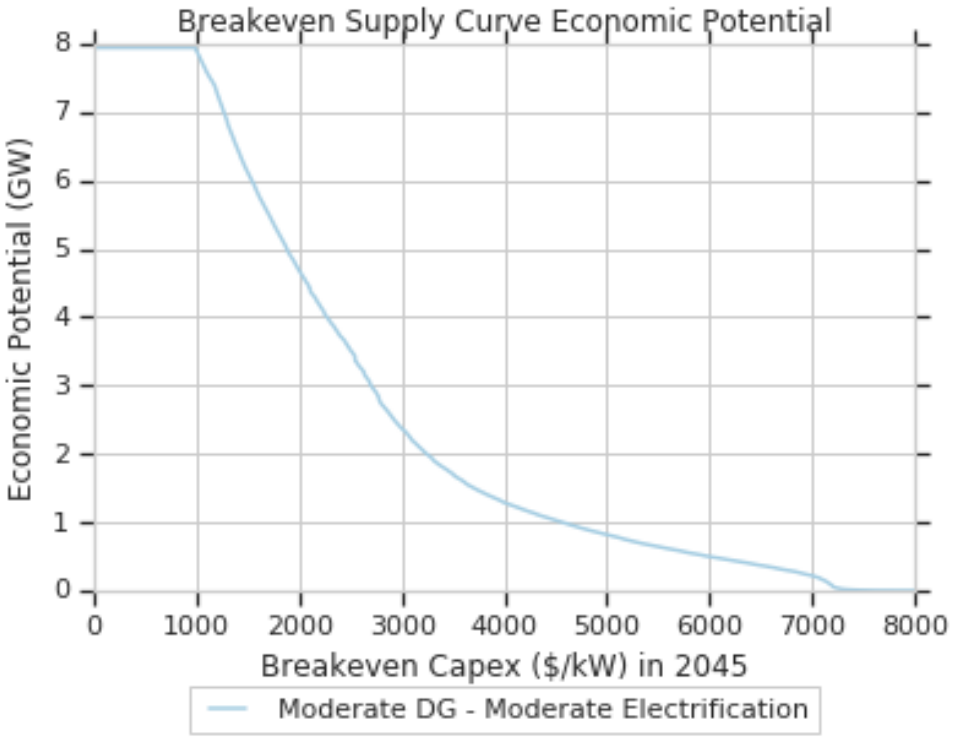
Customer-built


- Approximately **13.4 $GW_{DC}$ of technical potential for rooftops** and **3.3 $GW_{DC}$ for parking lot canopies** in LADWP
  - Roof age not considered as a suitability criteria
- Most is in the **residential sector**, followed by manufacturing and commercial
- Nearly half is in census tracts designated as **disadvantaged communities**



# Final Economic Potential Results—All Customers

Customer-built

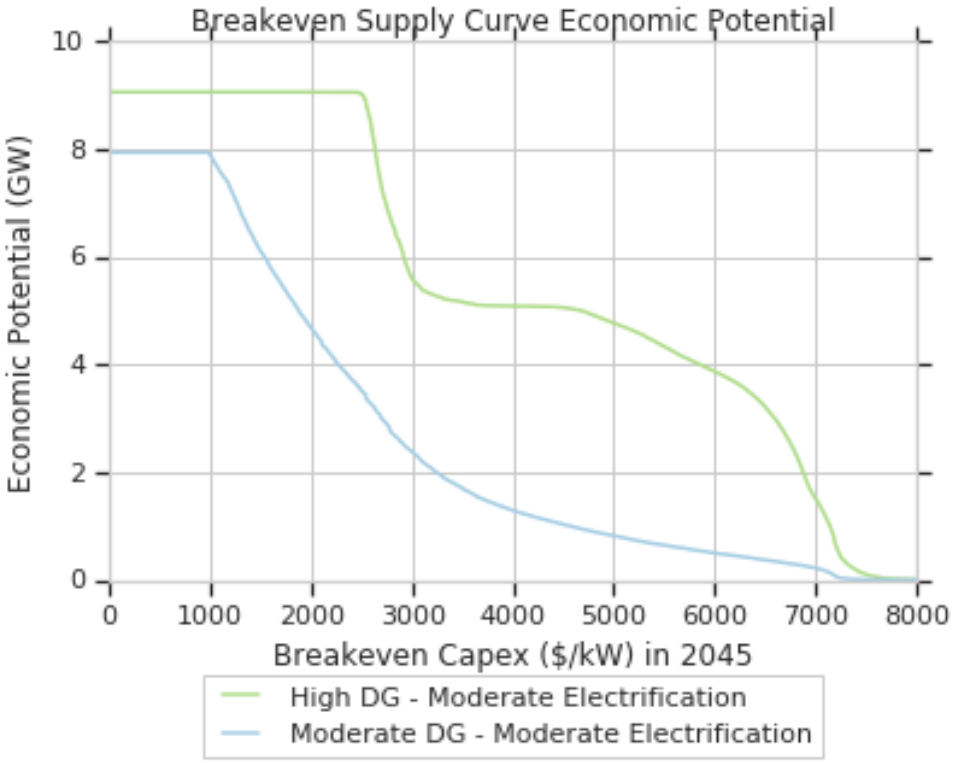




Agents complete a discounted cash flow analysis that includes:

- System **cost and expected maintenance**
- **Retail bill savings** from avoided electricity consumption
- Whether the system is **eligible for incentives, rebates, or avoided tax**

# Final Economic Potential Results—All Customers

Customer-built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# Final Economic Potential Results—All Customers

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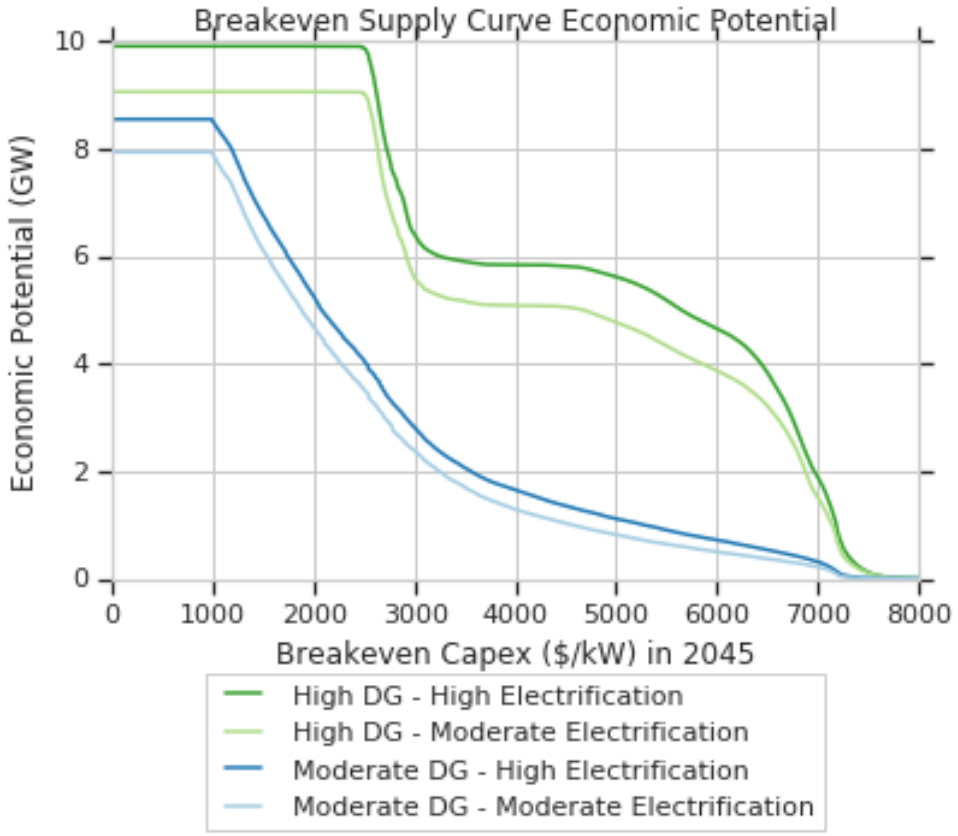
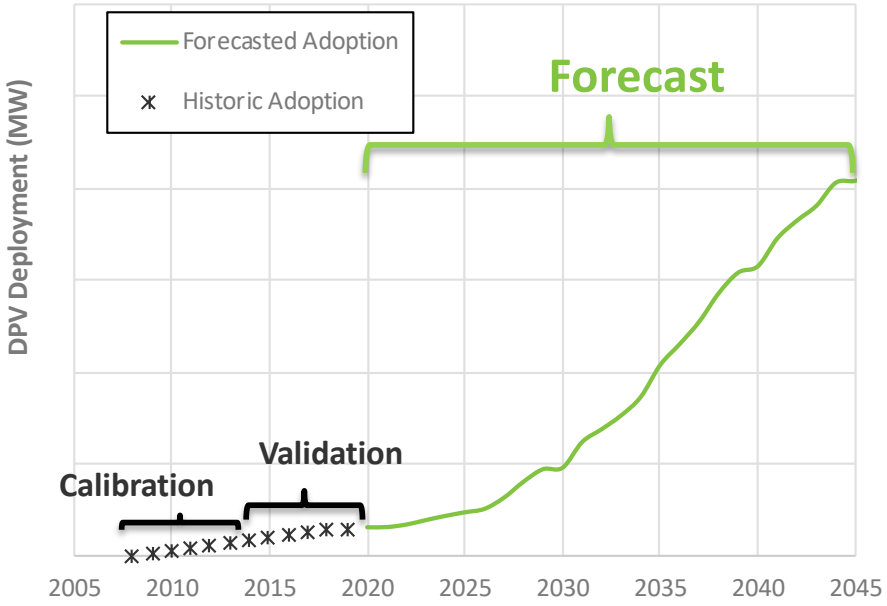



| Econ. Potential in GW | 2030 | 2045 |
|---|---|---|
| High DG High Elec. | 7.7 | 9.9 |
| High DG Mod Elec. | 7.4 | 9.1 |
| Mod DG High Elec. | 6.6 | 8.5 |
| Mod DG Mod Elec. | 6.4 | 7.9 |

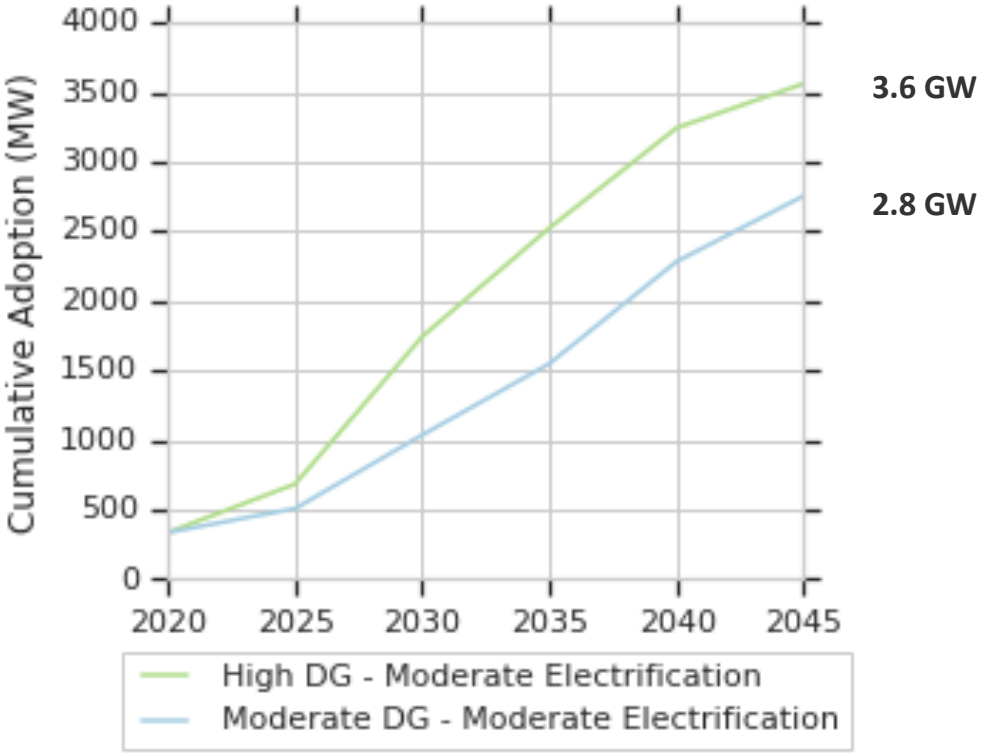
**Electrification level has a modest impact**

# Final Deployment Projections—All Customers

Customer-built

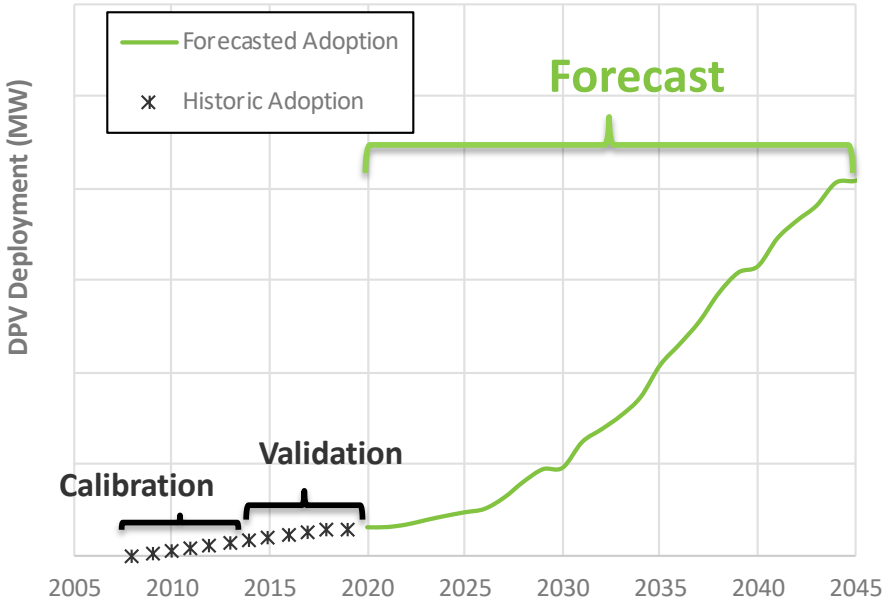




Example of model calibration, validation, and application for forecasting. Actual model forecasts are resolved at the building level but can be aggregated at different geographic levels



# Final Deployment Projections—All Customers

Customer-built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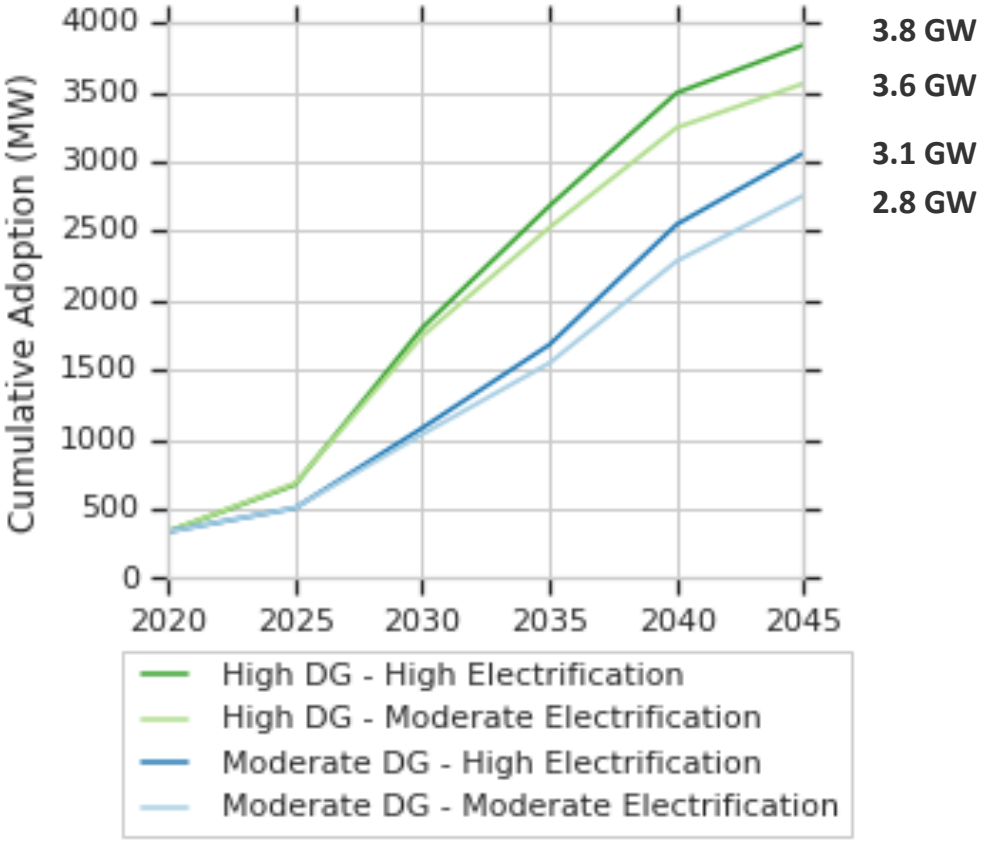
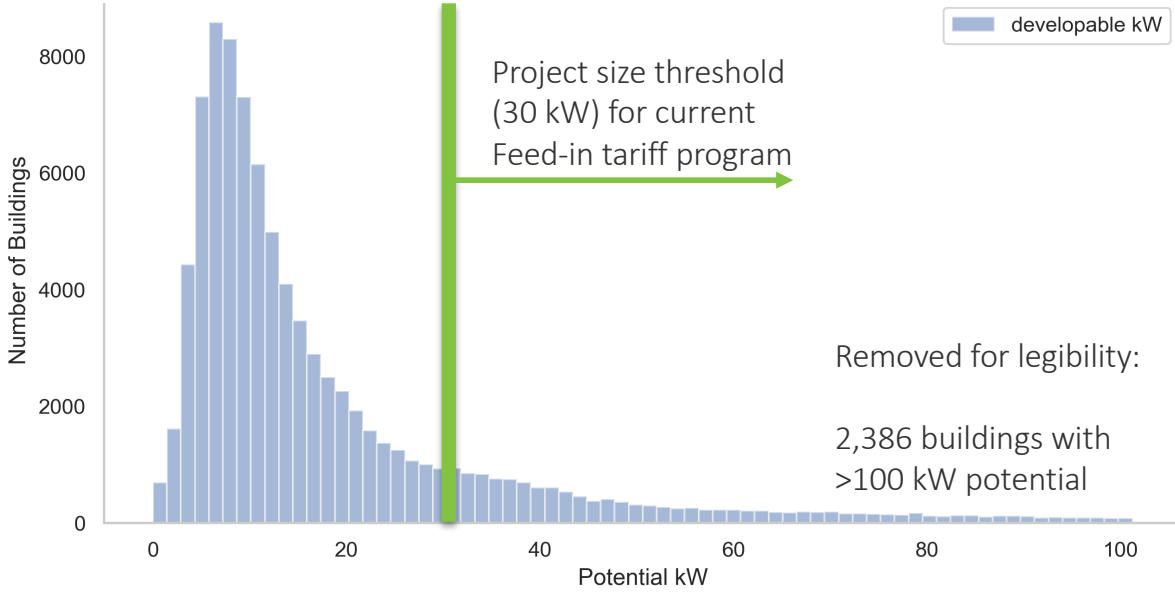


# Multi-Family Building Subset: Technical Potential

Customer-built


Substantial technical potential exists for multi-family buildings

- 2.06 GW (rooftop)
- 0.34 GW (on-site ground)



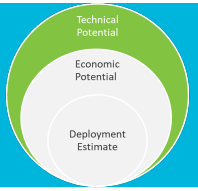

Distribution of rooftop technical potential for multi-family buildings in LADWP

Feed-in tariff misses most technical potential and one-third of customers

76% of potential ⟷ 24% of potential

36% of tenants ⟷ 64% of tenants

# Multi-Family Subset: High Economic Potential for Small Buildings; But Most Tenants are in Large Buildings with Less Potential




Customer-built

How much annual consumption could technical potential on multi-family buildings offset?

| | Number of premises | Total electricity consumption MWh/yr | Total solar potential generation MWh/yr | Avg developable project (kW) | Mean percentage production to metered load |
|---|---|---|---|---|---|
| **50+ Units** | 1,807 | 796 | 487 | 248.8 | 61% |
| **20 to 49 Units** | 5,956 | 624 | 717 | 98.6 | 114% |
| **10 to 19 Units** | 8,985 | 392 | 559 | 58.6 | 142% |
| **5 to 9 Units** | 15,979 | 326 | 524 | 31.8 | 161% |
| **3 or 4 Units** | 14,550 | 139 | 271 | 17.2 | 196% |
| **2 Units** | 43,087 | 246 | 591 | 14.4 | 240% |

On an annual basis most **small** multi-family buildings could offset **> 100%** of consumption. This is independent of cost or incentives for building owners to adopt.

# Multi-Family Subset: Deployment

Customer-built


Methodology used to estimate deployment

- **Economic potential**: Same methodology as single-family buildings
- **Deployment estimate**:
  - Use same deployment methodology as single-family buildings to get an initial estimate
  - Then, based on literature review to incorporate landlord-tenant market barriers, assume only 30% of that initial estimate is deployed

# Questions?

**Up Next:**

Customer-Owned Storage

Identifying and Ranking Local (LADWP-Procured) Solar Sites

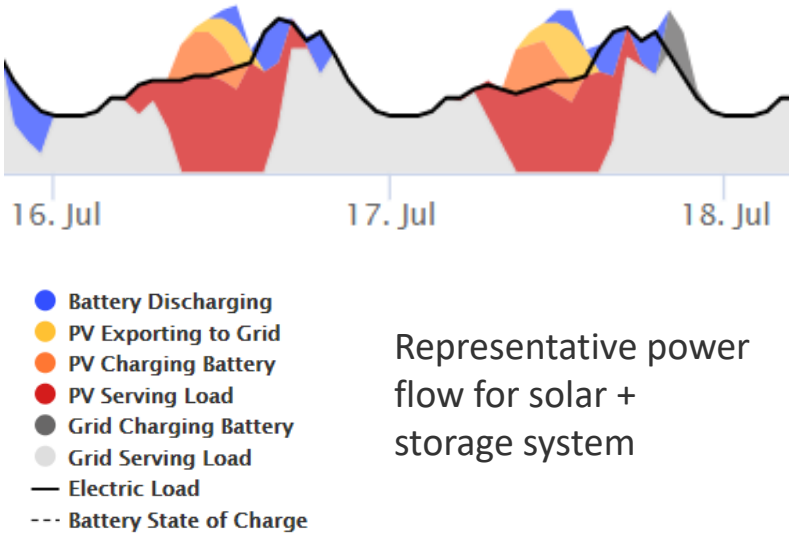

# Customer-Owned Storage

# Customer-owned Storage

Distributed storage **adoption remains limited** in LADWP, with 10.8 MW adopted to date

BTM storage could be a valuable resource, **if operated to minimize overall system costs** and provide local system benefits

**How consumers with storage will operate their system** and respond to price signals remains a significant research question



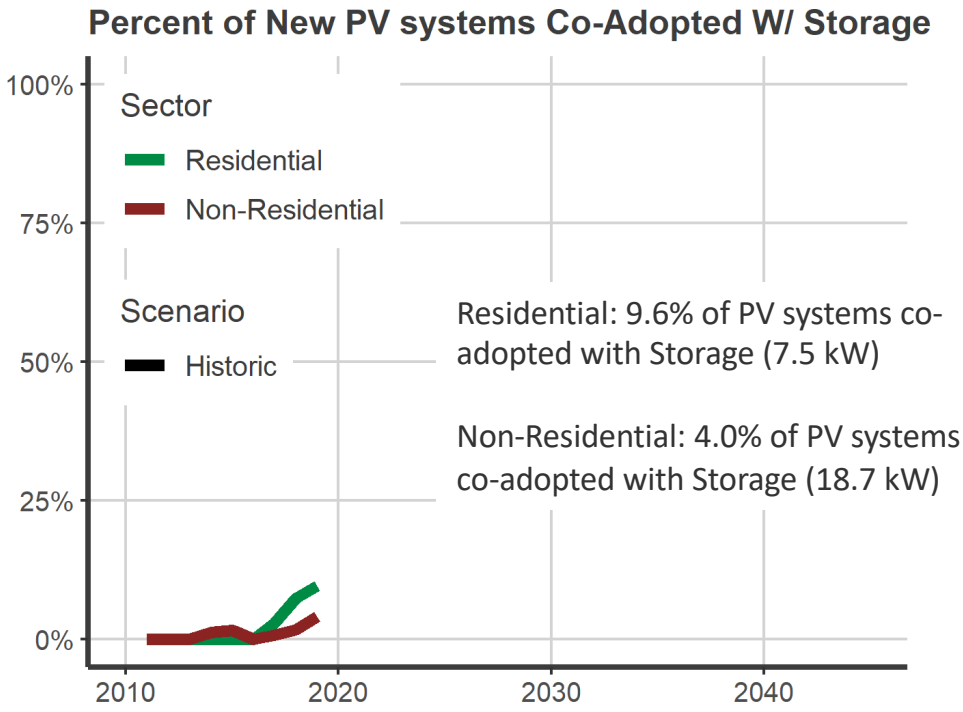

Representative power flow for solar + storage system

# Distributed Storage Modeling Approach

Due to its complexity, NREL did not model distributed storage within the dGen model.

We establish an adoption forecast based on historic trends in LADWP and California

Distributed storage is operated in the Capacity Expansion and Production Cost Models



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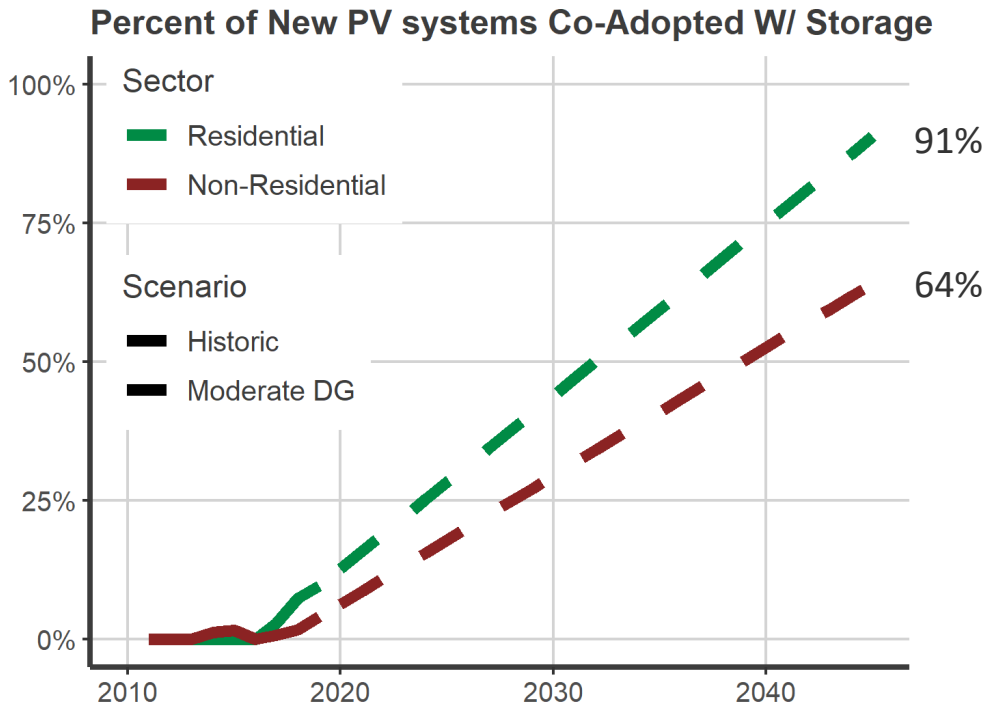

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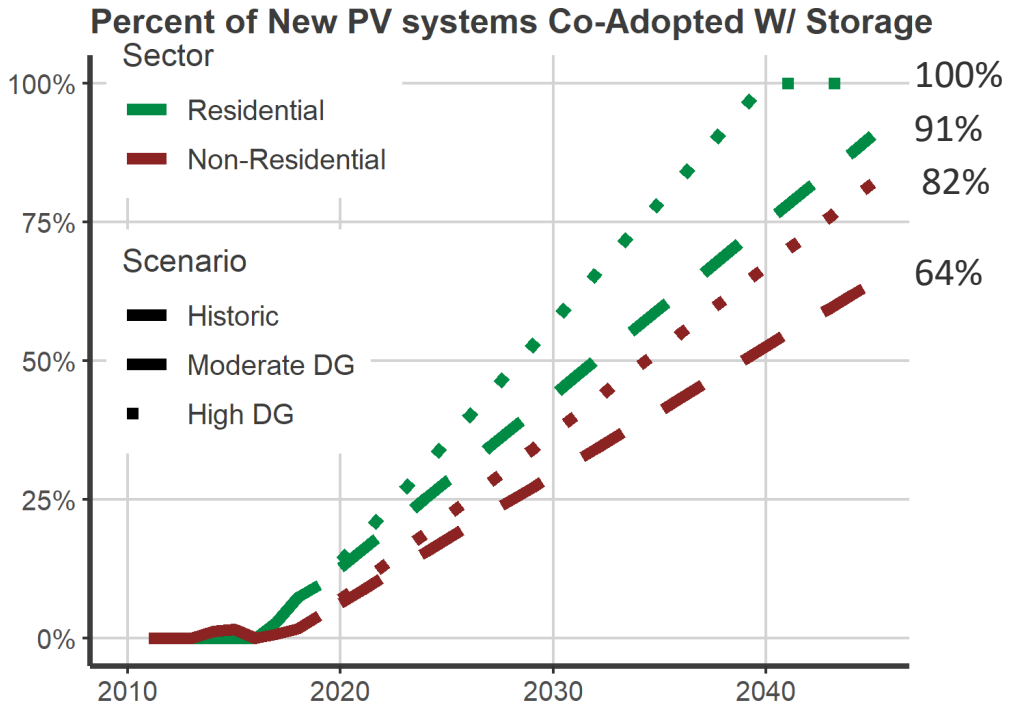


# Questions?

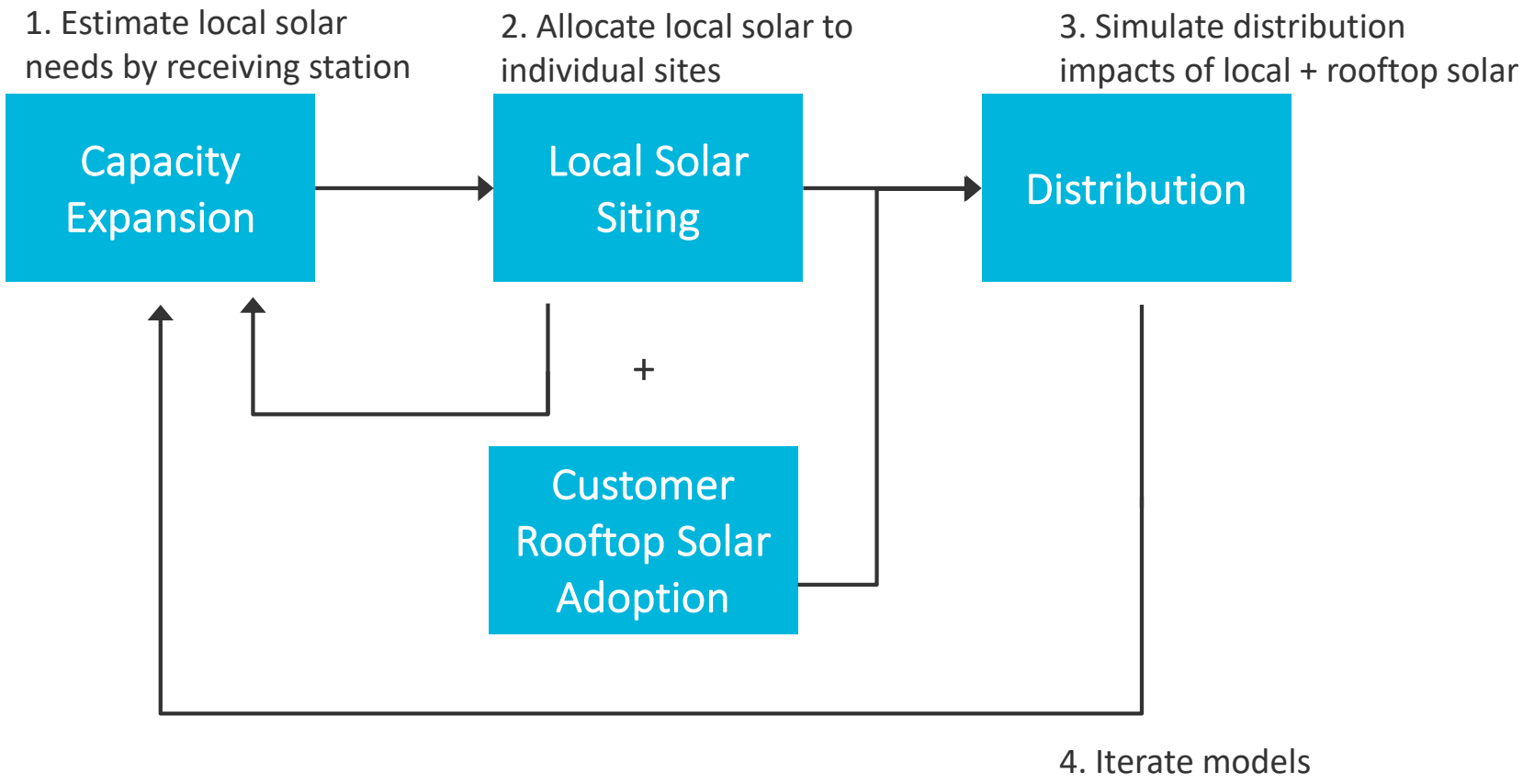
**Up Next:**

Identifying and Ranking Local (LADWP-Procured) Solar Sites

# Identifying and Ranking Local Solar Sites

LADWP-built

# Finding the "Optimal" Amount of LADWP-Procured Local Solar



LADWP-built

# Siting Analysis Methodology

We conduct a GIS analysis for each LA parcel to screen and rank sites for local solar

## Criteria Used to Exclude Sites

- Existing development
- Landcover (water, forests, etc.)
- Parks and Recreational Sites
- Steep terrain
- Landmarks
- Shaded area

## Cost-Based Variables Used to Rank Sites

- Project size
- Distance to interconnect
- Cost of land
- Differentiation for sites on private or public land

➢ Costs do not reflect distribution system upgrades (addressed separately in LA100)

➢ Rooftop projects not included in ranking

**Result:** A ranked list of the optimal sites to meet local solar targets

LADWP-built

# High-Level Results

- Non-rooftop local solar **technical** potential: **4.8 GW** (ground-mount, parking canopy, floating solar)

- **1,897 MW** of capacity for projects > 1 MW
- **707 MW** of capacity for projects > 10 MW

- **2.9 GW** (61%) occurs in disadvantaged communities

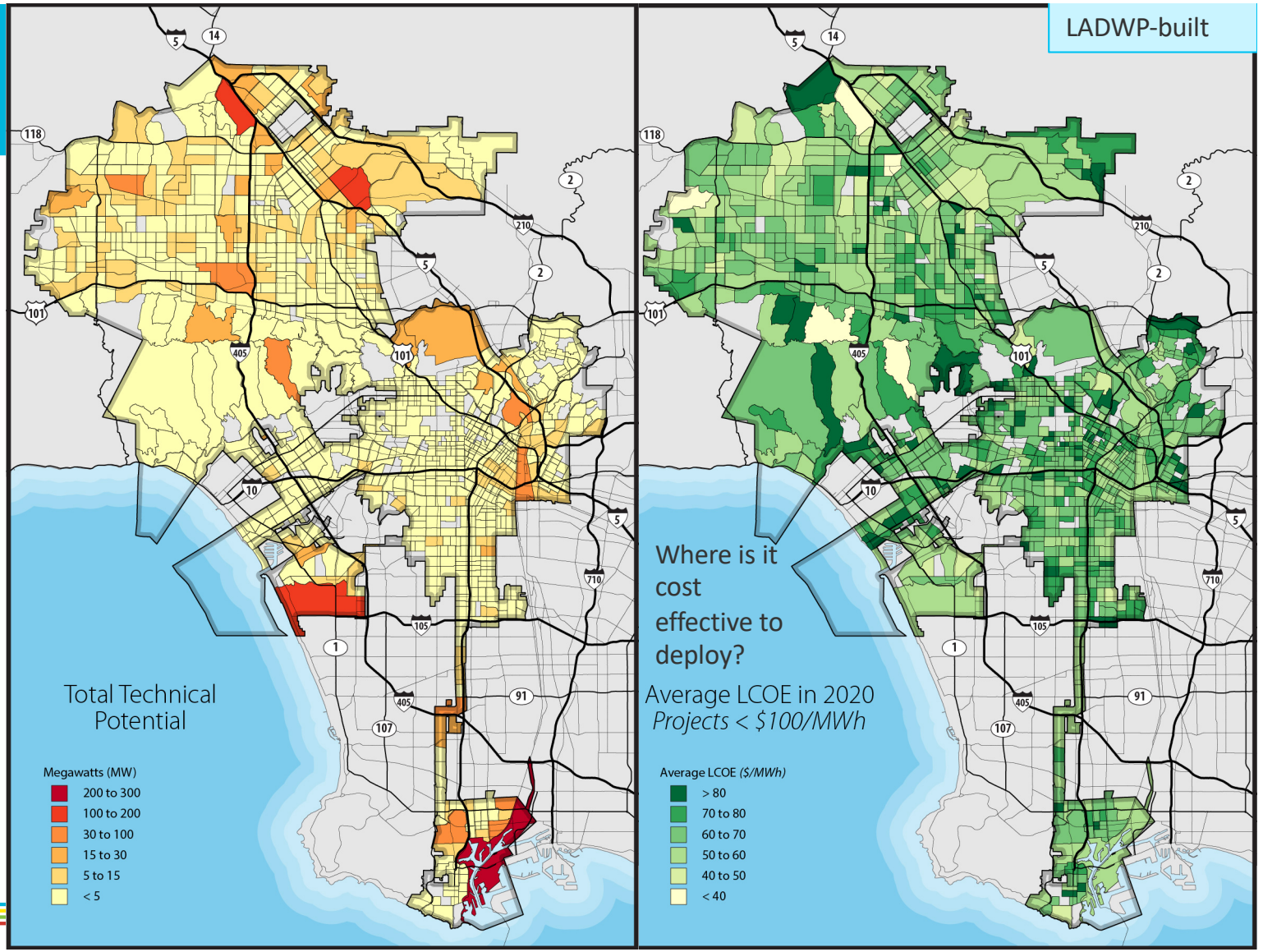
- **3,851 MW** could be deployed at a levelized cost of energy (LCOE) of < $100/MWh based on 2020 costs

# Local Solar Spatial Trends

**Left:** Technical potential for local solar by tract

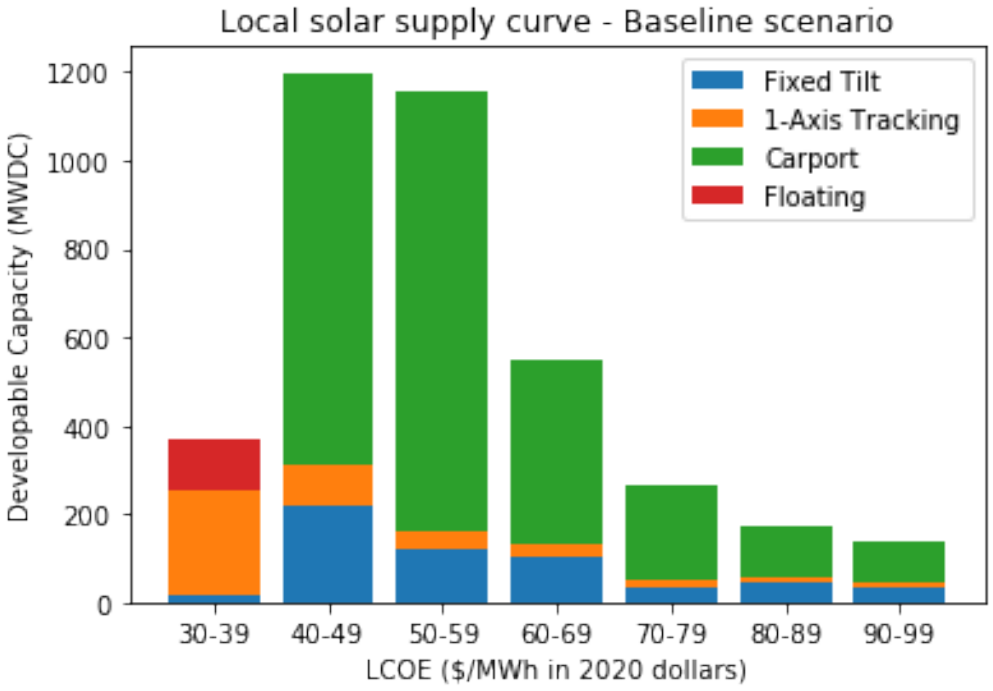
**Right:** Average LCOE of local solar projects in the tract

Both filtered for sites with LCOE < $100/MWh



LADWP-built

# Local Solar Supply Curve




Supply curve of local solar sites

In current scenarios, our capacity expansion model builds between 170 – 1748 MW of local solar. This is in addition to customer-adopted solar.

Within our supply curve, of the 1,748 MW:

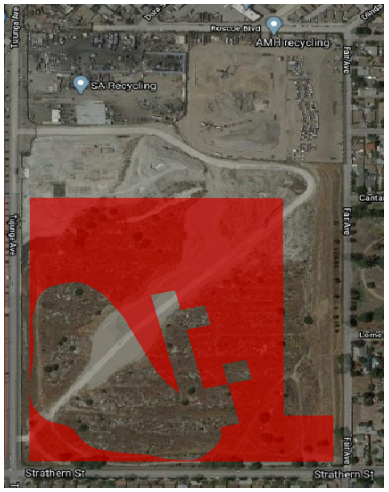
- Fixed tilt: 357 MW
- 1-Axis Tracking: 362 MW
- Carport: 911 MW
- Floating: 118 MW

Carport and floating projects are ranked higher because of assumed zero land cost. Actual project LCOE may differ based on project capital costs

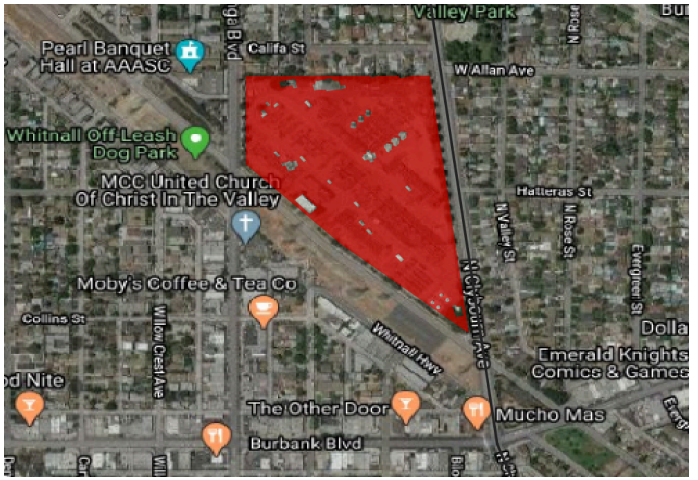
LADWP-built

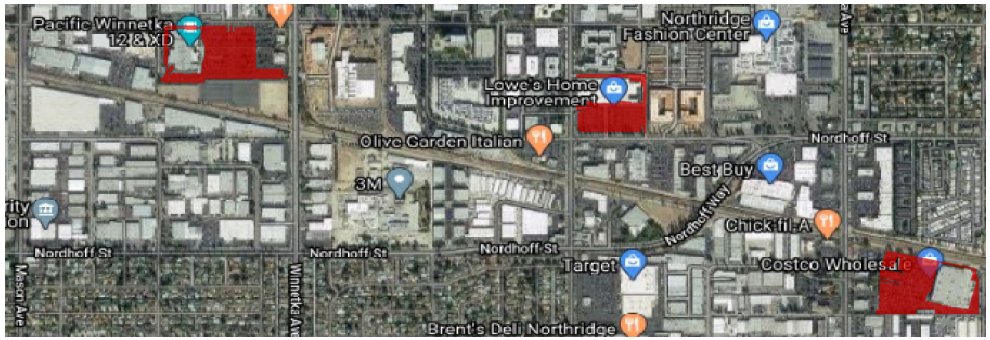
# Three Examples of High-Ranked Sites

Industrial-zoned




LADWP-owned in North Hollywood




Parking lots for carports

# Initial Conclusions

- All current capacity expansion scenarios indicate that an optimal resource portfolio for LA100 includes **some mixture of in-basin and out-of-basin resources**
  - This mixture will vary by scenario
- Independent of economics, roughly **16 GW of rooftop and non-rooftop solar is technically feasible, but costs widely vary** (e.g., due to project size and land costs)
  - Substantial potential exists for multi-family buildings
- Projections for **rooftop solar adoption range from 2.7 – 3.8 GW** by 2045
- Effects from **electrification on PV adoption may be modest** because most adopters already maximize roof space
- Distributed storage is **co-adopted with solar at 4 – 10% currently**, and we use time series forecasting to project co-adoption trends through 2045

# Thank you!

Benjamin.Sigrin@NREL.gov

**Discussion**

What do you see as the most significant findings of this research?

What information and analysis can we provide to help inform post-LA100 deliberations on policy (e.g., on rate structures, environmental justice)?


The Los Angeles 100% Renewable Energy Study