LA100

The Los Angeles 100% Renewable Energy Study

Distributed Solar & Storage: Methods & Framework

Ben Sigrin

Paritosh Das, Meghan Mooney, Jane Lockshin

September 19th, 2019

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

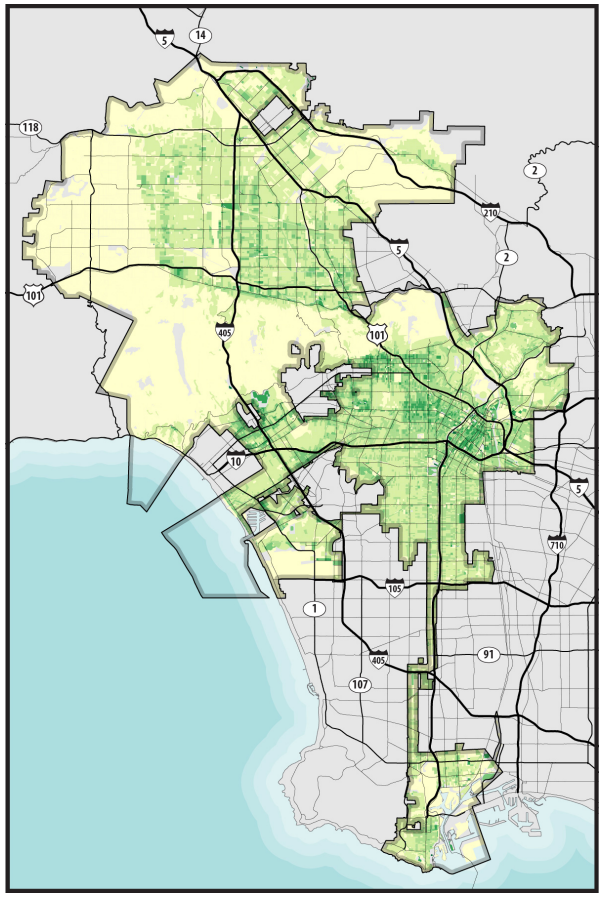
Outline

1. Lightning overview
2. Distributed generation analysis in the project context
3. Modeling assumptions and methodology
4. Discussion

Lightning overview: Analysis questions

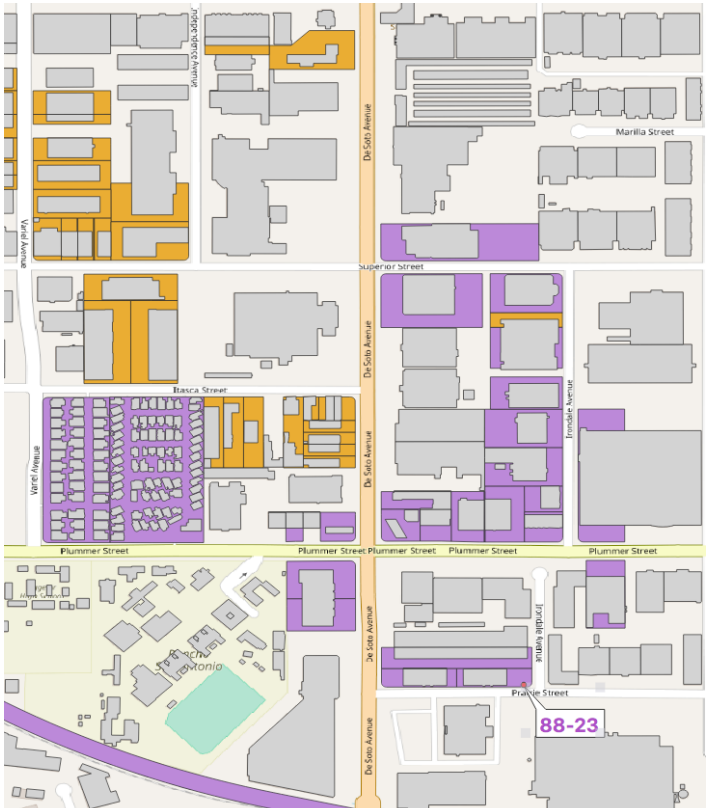
How much distributed solar and storage could be adopted?

Where are **optimal sites** for local solar?



Lightning overview: Model development

- Assess the **technical potential** for rooftop and carport solar
- Identify the **optimal sites** for local solar
- Create a **database of "agents"** for modeling distributed solar

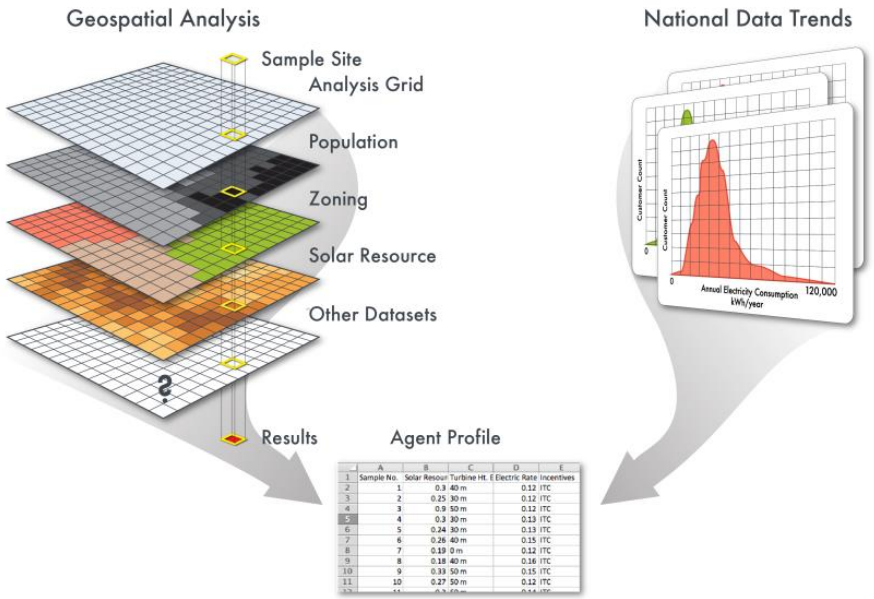


Screenshot of GIS-based agent database

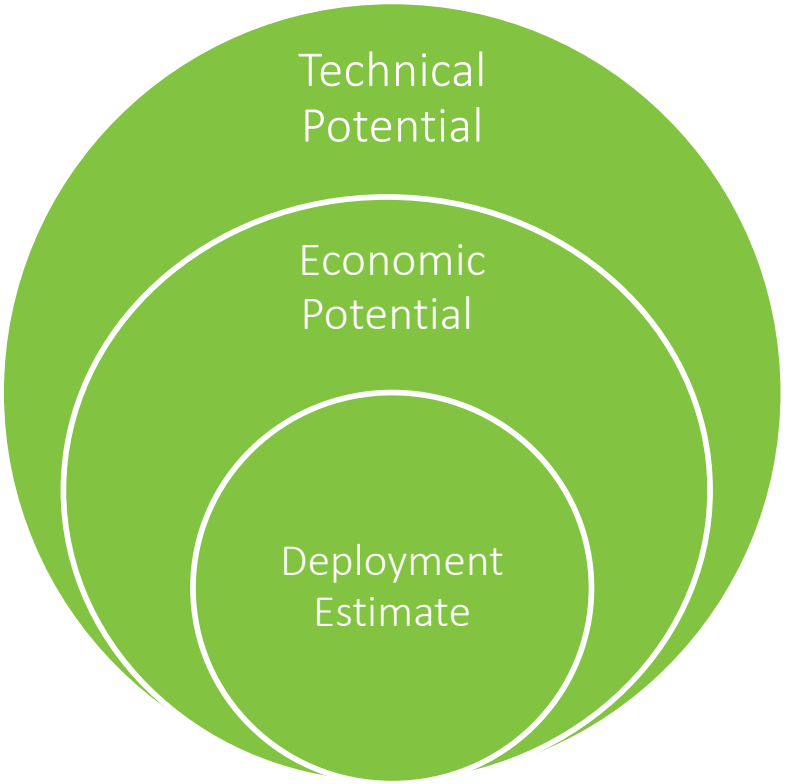
Lightning overview: dGen model

Agent-based model that:

- Simulates **consumer decision-making**
- Forecasts **customer adoption of distributed solar and storage** at the building level
- Incorporates **detailed spatial data** to inform distribution planning questions



Lightning overview: Framework for projecting adoption



- **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
- **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

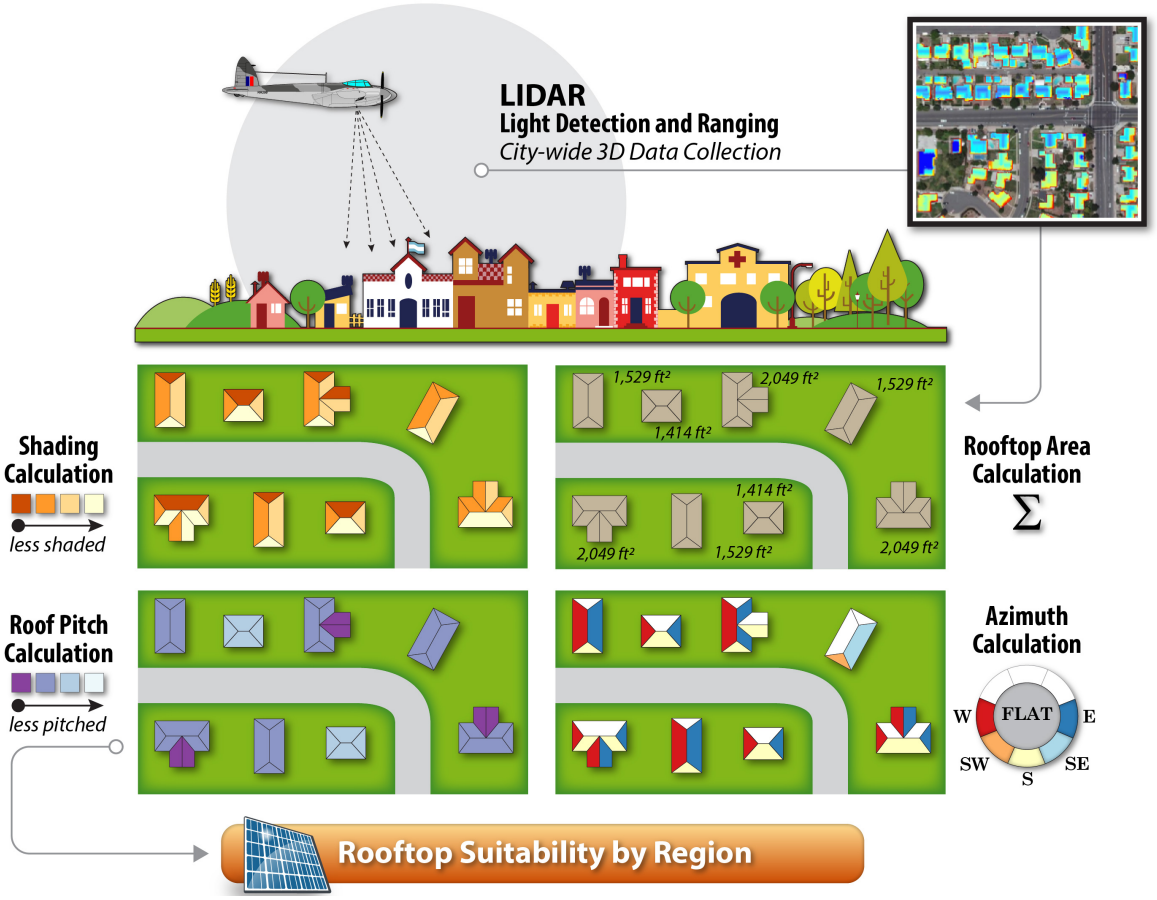

Project Context

dGen in the project context

- dGen **informs the distributed generation element of the capacity expansion modeling**
  - We use the consumer load profiles developed by the NREL Buildings team
  - For "moderate" projections, we use outputs of the capacity expansion model (RPM), e.g., modeled wholesale electricity prices, to analyze how the value of rooftop generation to the power system would influence customer adoption
- dGen outputs are **used in the distribution analysis**, e.g., the projected adoption for each feeder
- dGen outputs are also **used for environmental justice (EJ) analysis**


Methodology

Assess rooftop suitability for solar



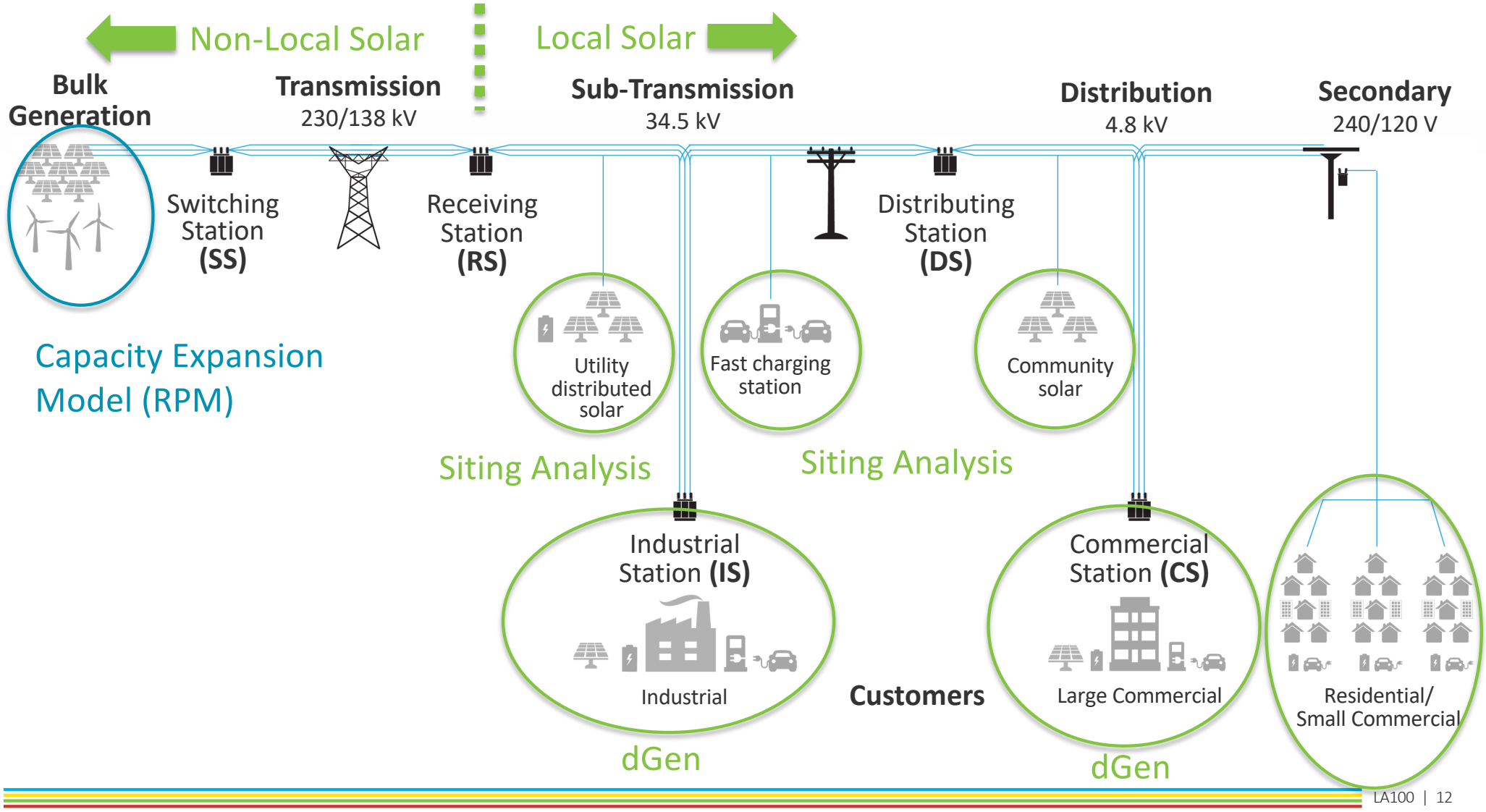
Rooftop and carport technical potential results

- Approximately **10.5 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**

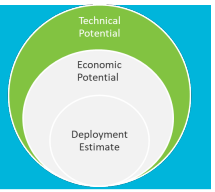
Land Use	Dev. Bldgs (n)	Dev. Area (m^2)	Annual Gen. Potential (TWh)	Capacity Potential (GW)
Airport	477	353,297	0.10	0.06
Commercial	46,844	8,268,321	2.35	1.51
Industrial	1,673	556,524	0.16	0.10
Manufacturing	24,981	9,804,638	2.80	1.79
Open Space	2,743	352,591	0.10	0.06
Other	12,121	2,523,079	0.72	0.46
Residential	738,438	35,439,864	10.18	6.49

Summary of technical potential study results

Note: Actual adoption will be substantially less than the technical potential


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)
Utility distributed solar
Fast charging station
Community solar
Siting Analysis
Siting Analysis
Industrial Station (IS)
Industrial
Commercial Station (CS)
Large Commercial
Residential/ Small Commercial
Customers
dGen
dGen

Siting analysis methods



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

Criteria Used to Exclude Sites

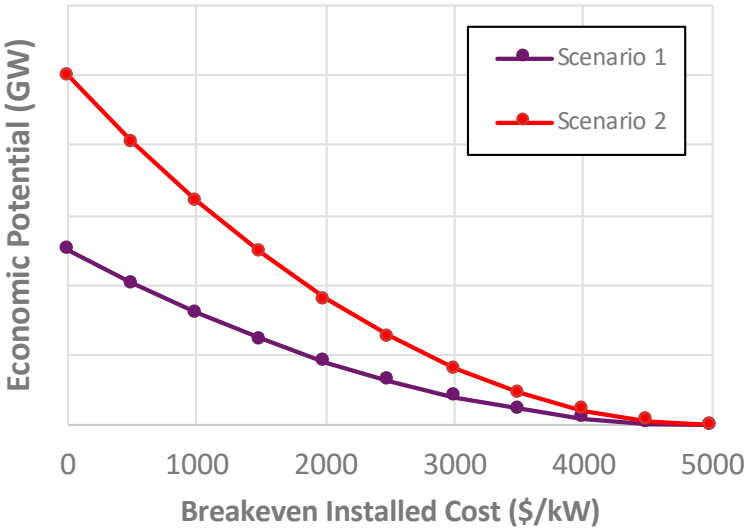
- Already developed
- Landcover (water, wetlands, etc.)
- Parks
- Steep terrain
- Landmarks
- Bike paths
- Technology specific land exclusions

Variables Used to Rank Sites

- **By cost of generation**:
  - Land value and zoning
  - Cost for interconnection to 34.5 kV and 4.8 kV distribution lines
  - Existing ownership, e.g., city-owned, closed coastal generation plants
- **Optional—By location to address EJ:**
  - Environmental Justice tracts
  - Serving low income, renters, and multi-family

Results: A framework for evaluating pathways to local solar deployment

Methodology for economic potential



Example of how dGen outputs can be used to produce supply curves of economic potential and how it varies by scenario, system cost, or degree of compensation for distributed solar

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**

These result in:

- The **system capacity** that maximizes the agents' economic return
- **Net present value** and **payback period** of potential investment

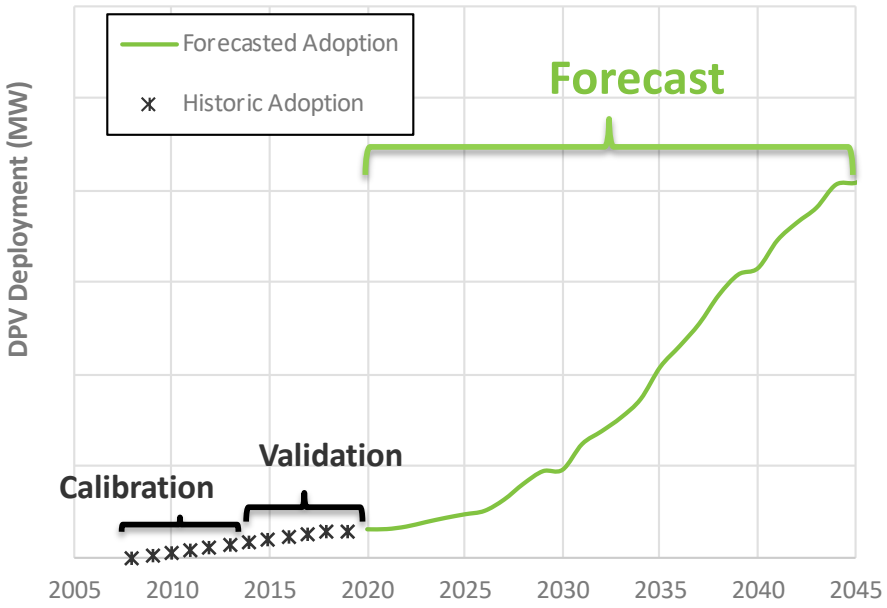
Methodology for economic potential

Distributed generation produces value by **avoiding retail electricity costs**.
We are modeling two projections of future distributed generation compensation:

High Deployment - Net metering: All solar generation is valued at the retail level with no changes to the tariff's structure. However retail prices escalate with future changes to the cost of the power system. ***This is LADWP's current compensation type.***

Moderate Deployment - Net billing: All self-consumed solar generation is valued at the retail level, however any non-consumed generation, i.e. exported to the grid is valued at the real-time wholesale price. ***This represents a hypothetical change in the compensation type.***

Methodology for technology deployment



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

We will train a **predictive model of historic observations of adoption** in LADWP to estimate the agents' probability of adoption in each year.

- Only technically eligible agents can adopt
- Probability of adoption increases with NPV and proximity to other adopters
- Ownership status (e.g., multifamily) and income will affect adoption

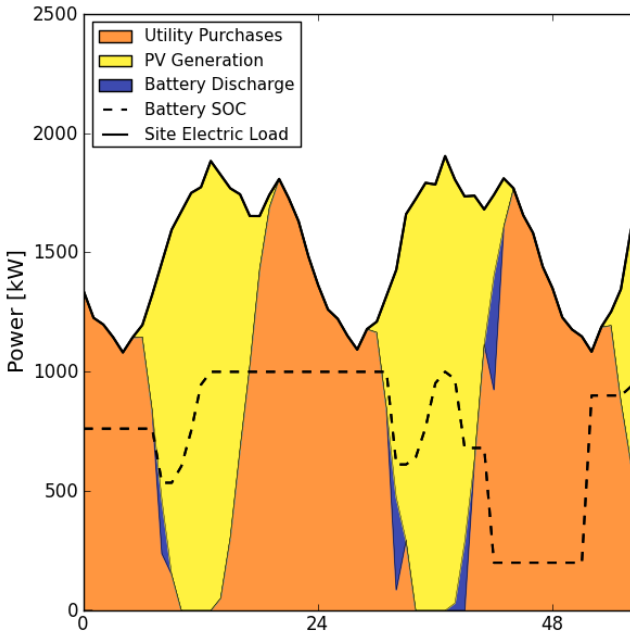
Result: Credible, spatially granular adoption patterns informed by historic trends

Methodology for distributed storage

We will study:

- **Adoption** of distributed storage by end users
- Two projections with **customer control versus LADWP control** of storage dispatch and how these could affect grid operations

Storage adoption will be from the agents' perspective and their respective economic value



Representative diurnal storage, PV, and grid power flows

Methodology for multi-family and low-income solar

We will develop High and Moderate adoption projections for multi-family and low-income buildings.

This includes **the amount of technical and economic potential** for these sectors.

We will also study the extent to which load could be offset by on-site PV.

Questions?

Benjamin.Sigrin@NREL.gov

The Los Angeles 100% Renewable Energy Study