National Academies Modeling Workshop

Models to Inform Planning for the Future Electric Power in the US

LA DWP Los Angeles Department of Water & Power

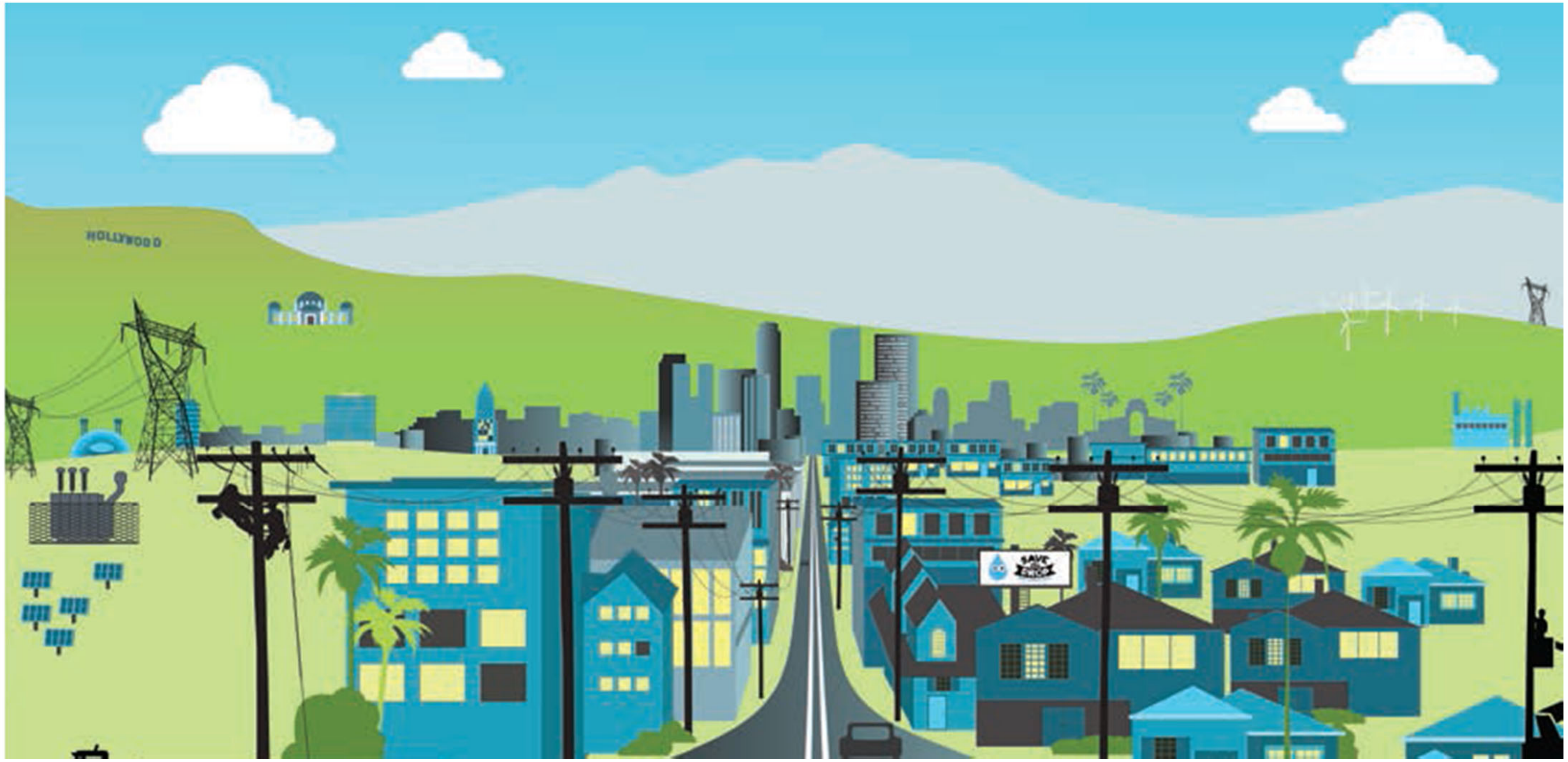
CUSTOMERS FIRST

Case Study – Modeling to Support LADWP's IRP and Stakeholder Engagement

Moderator: Reiko Kerr, Senior Assistant General Manager – Power System, LADWP

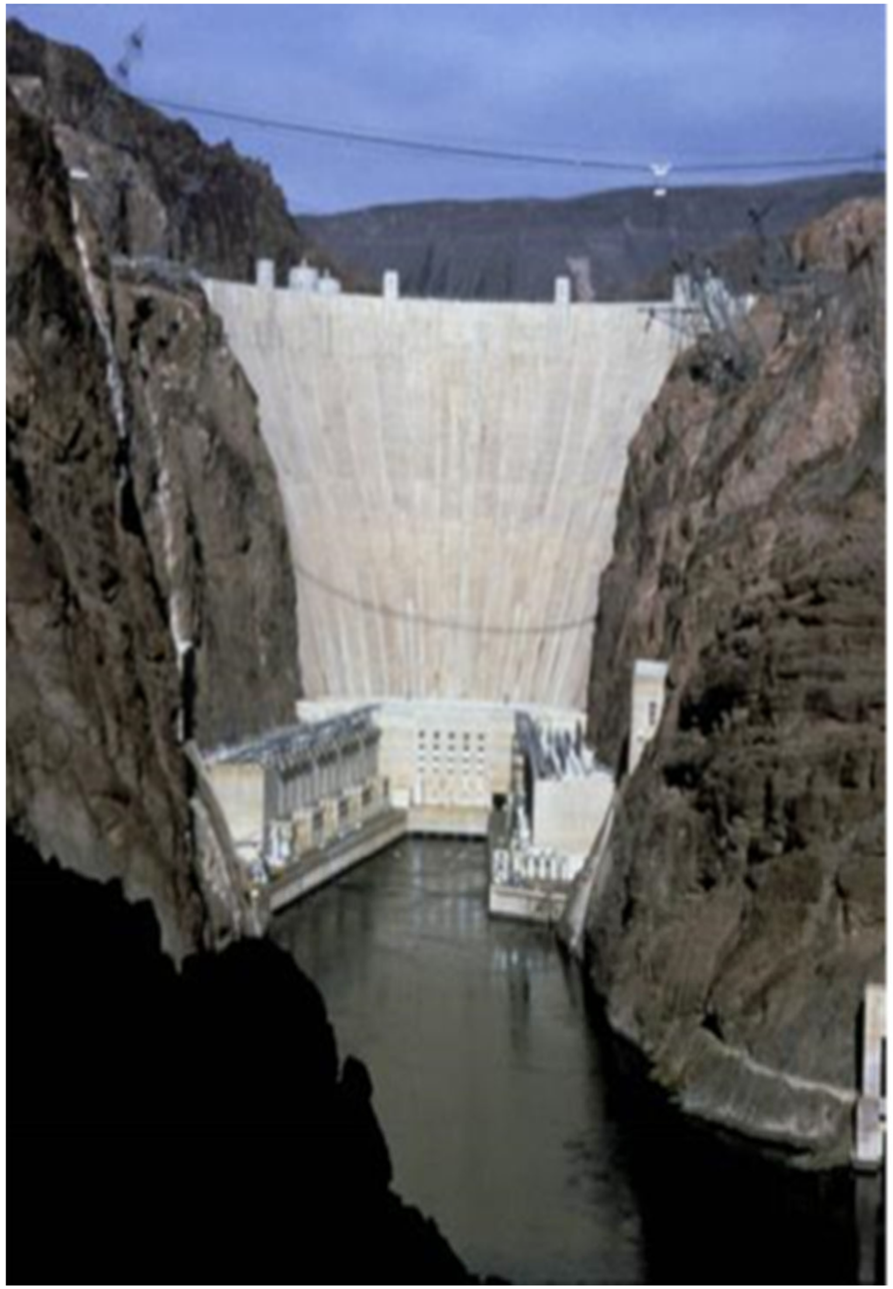
- James Barner, Assistant Director – Clean Grid LA Strategy Division, LADWP
- Jay Lim, Integrated Resource Planning Manager, LADWP
- Jaquelin Cochran, Project Manager, National Renewable Energy Laboratory
- Fred Pickel, Office of Public Accountability, City of Los Angeles

Los Angeles Department of Water and Power Overview



James Barner – 5 minutes

Historical Innovations Bringing Water and Power to LA



Overview of LADWP's Power System

Balancing Authority

Largest Publicly Owned Utility

1.5 Million Customers

$4.2 Billion Annual Budget

Peak Demand of 6,502 MW (8/31/17)

Distribution System

- 10,495 miles of OH lines & UG cables
- 181 stations
- 128,693 transformers

Transmission System

- 3,760 miles of OH & UG circuits
- 15,452 towers

LADWP is a Vertically Integrated Utility

LADWP's Resource Stack (2019)

3,800 MW Nat Gas

2,000 MW Hydro

1,200 MW Coal

380 MW Nuclear

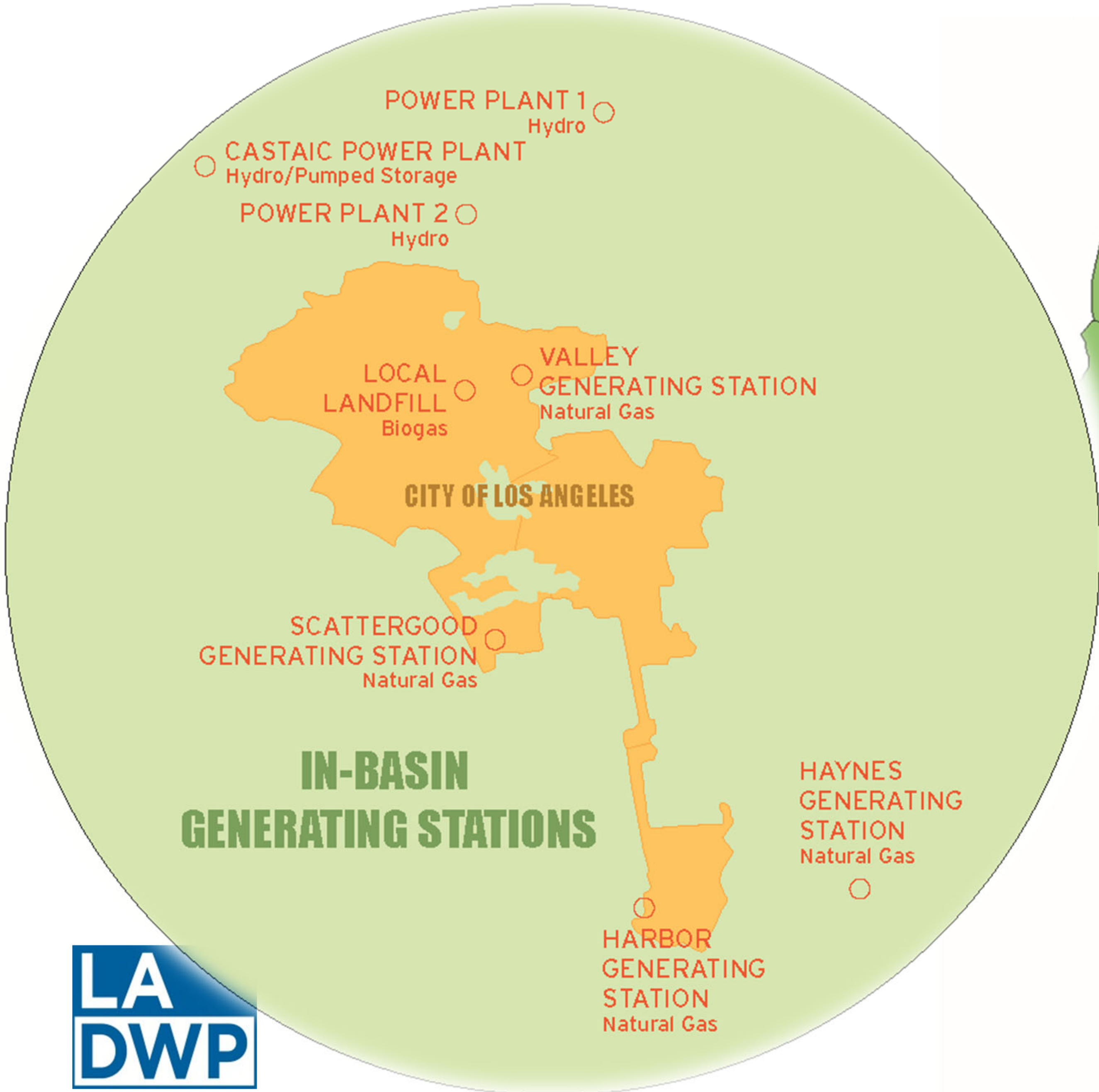
Total Capacity
10,150 MW

1,000 MW Wind

1,530 MW Solar

240 MW Geothermal

How L.A.'s Power Resources Work Together



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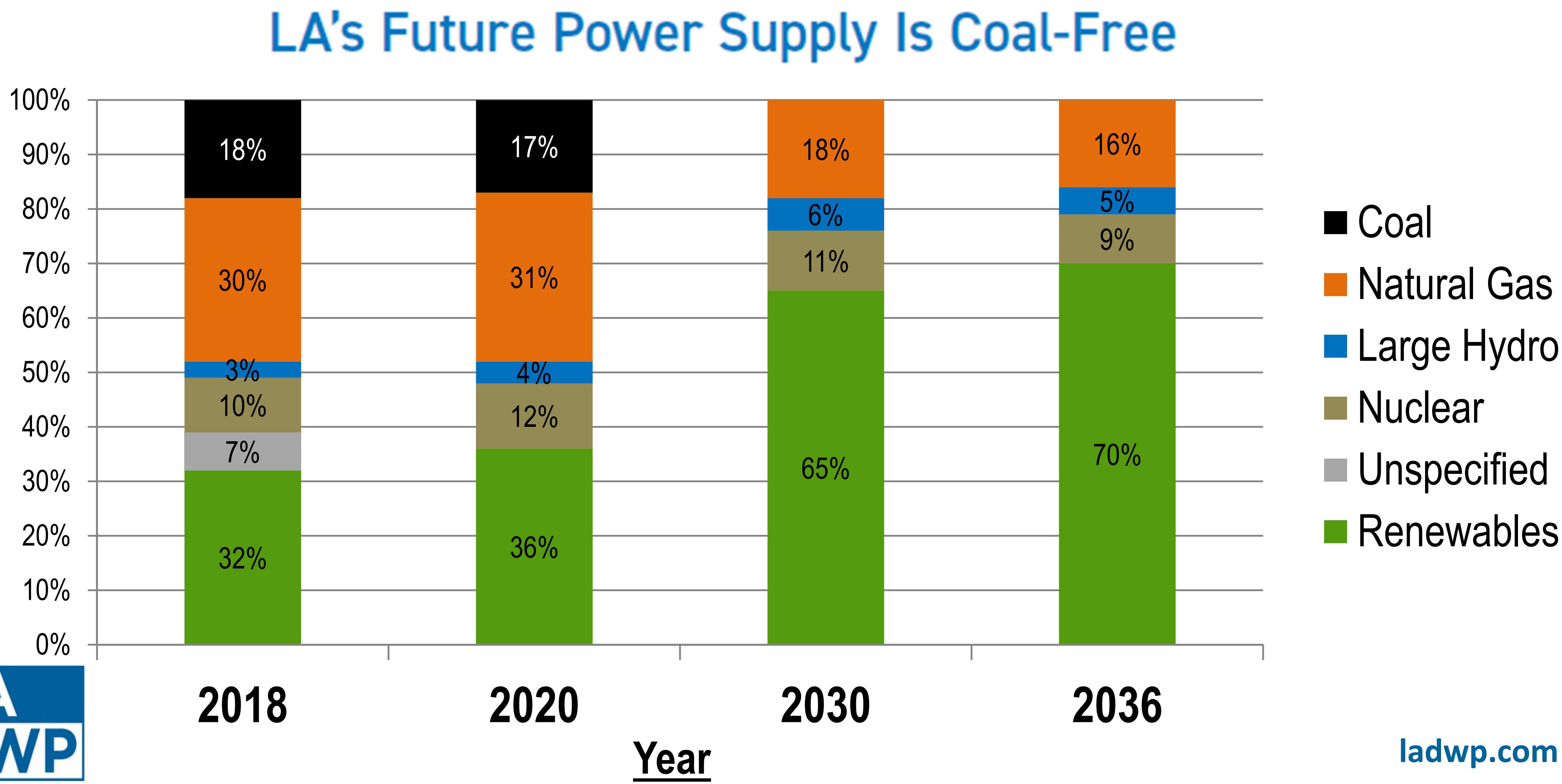
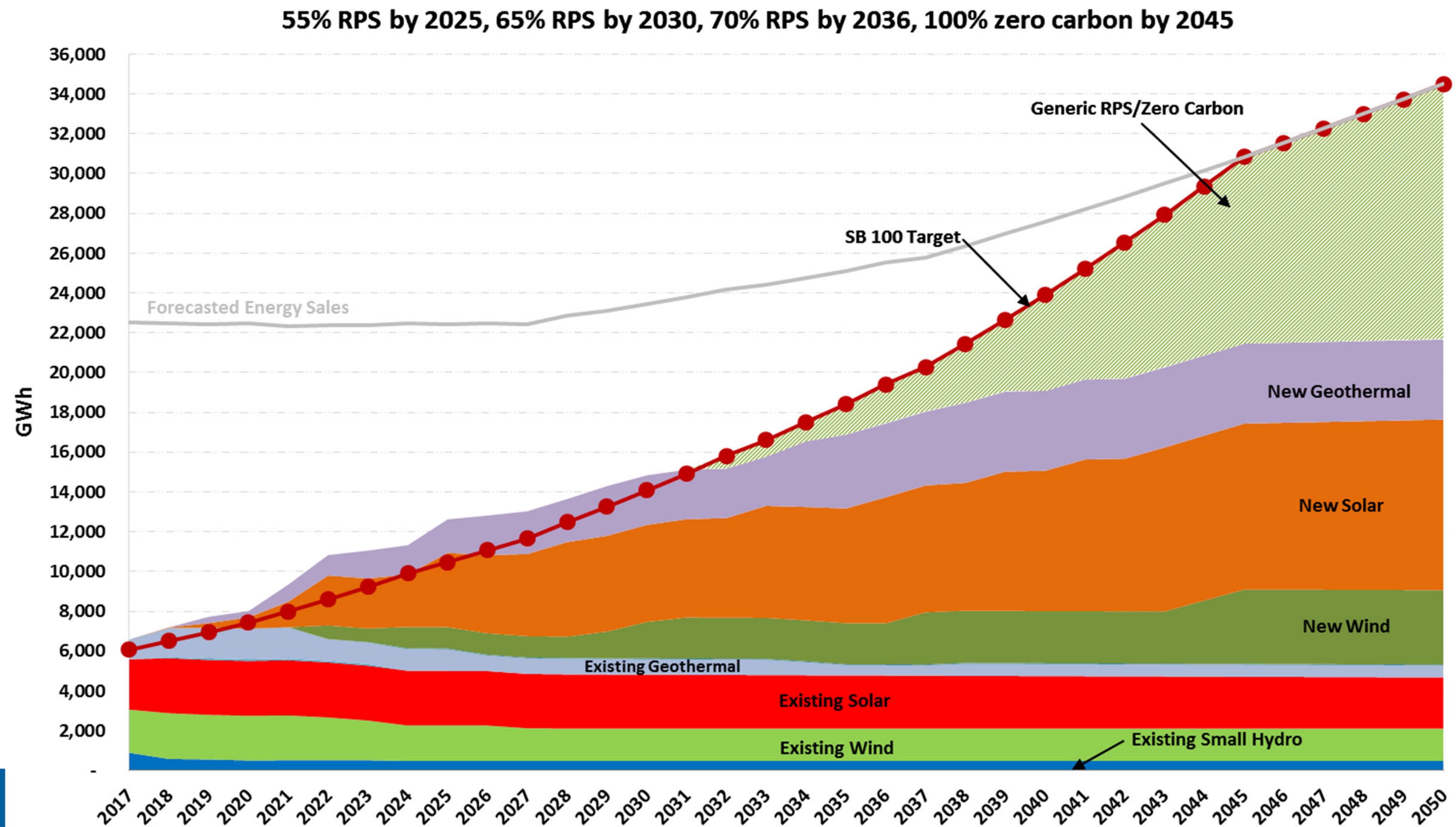
Resource Energy Mix

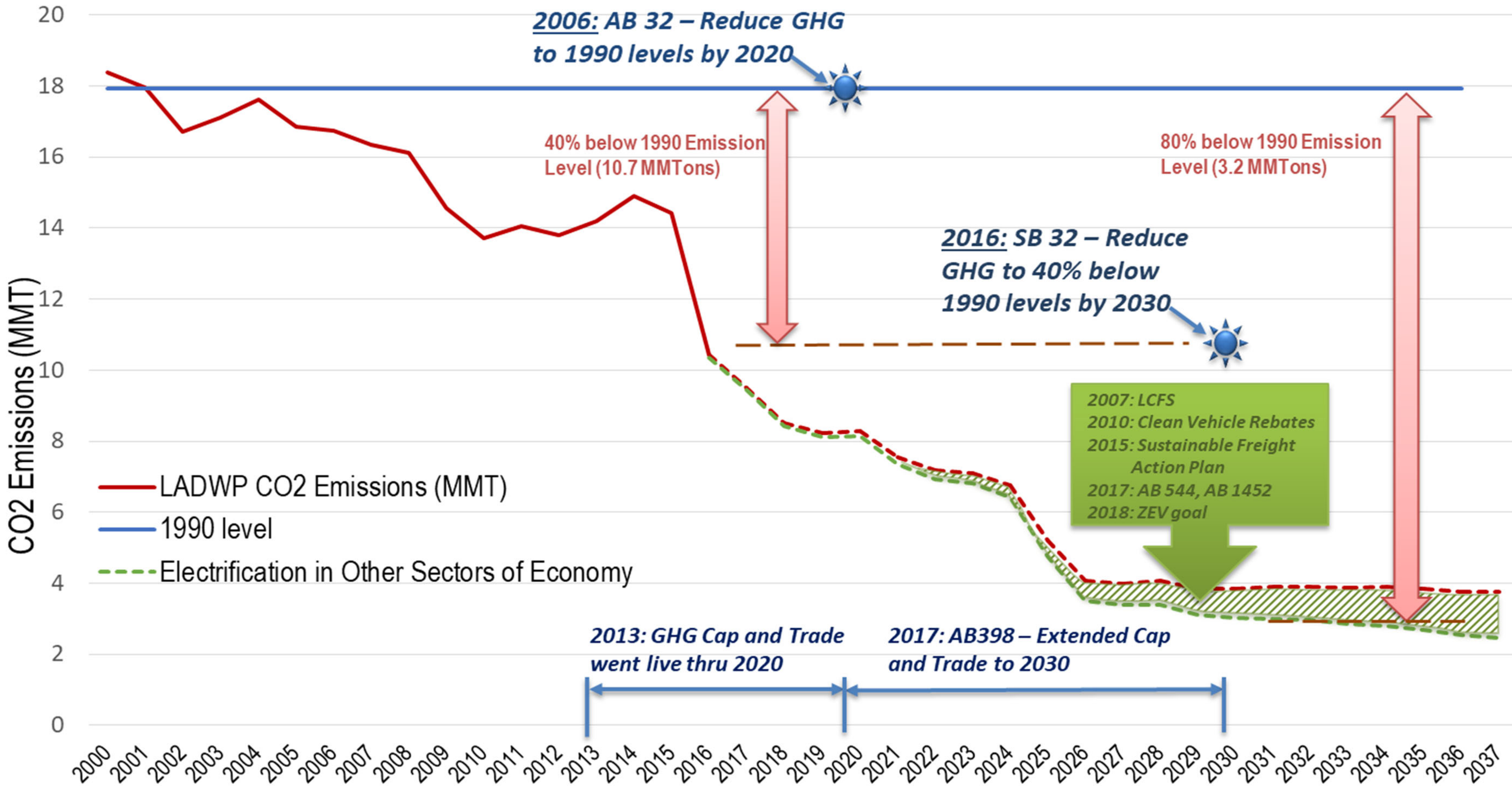
Achieved **32% renewables in 2018**—up from 8% in 2006



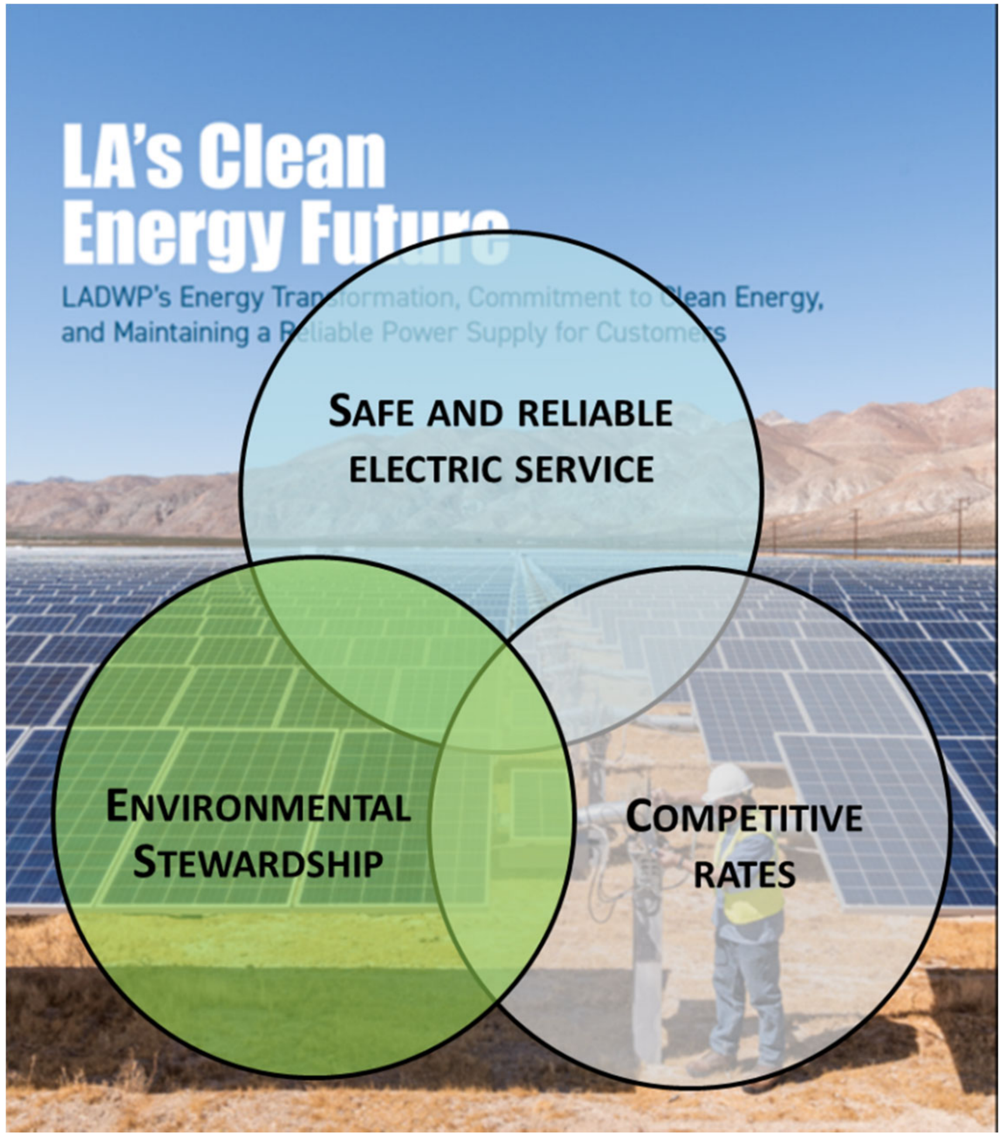
Renewables Forecast (Senate Bill 100)

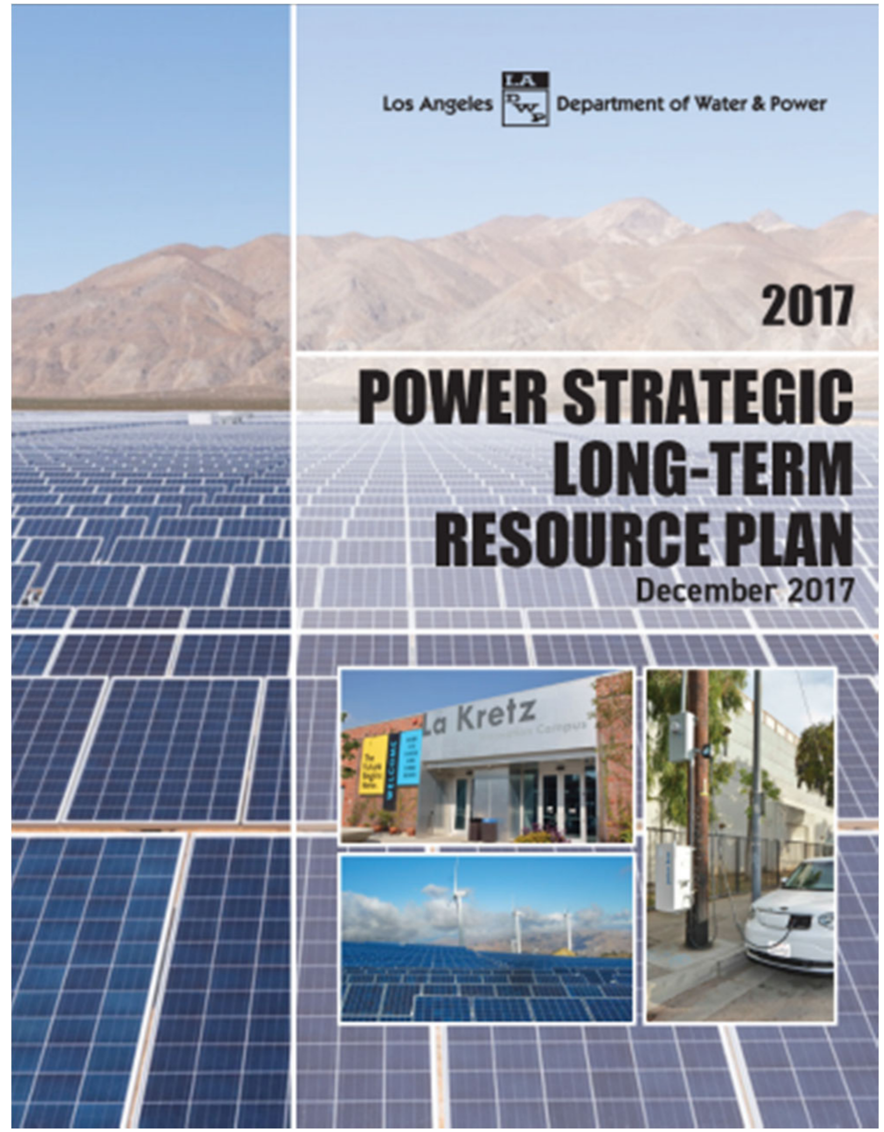


Evolving GHG Emissions Policy



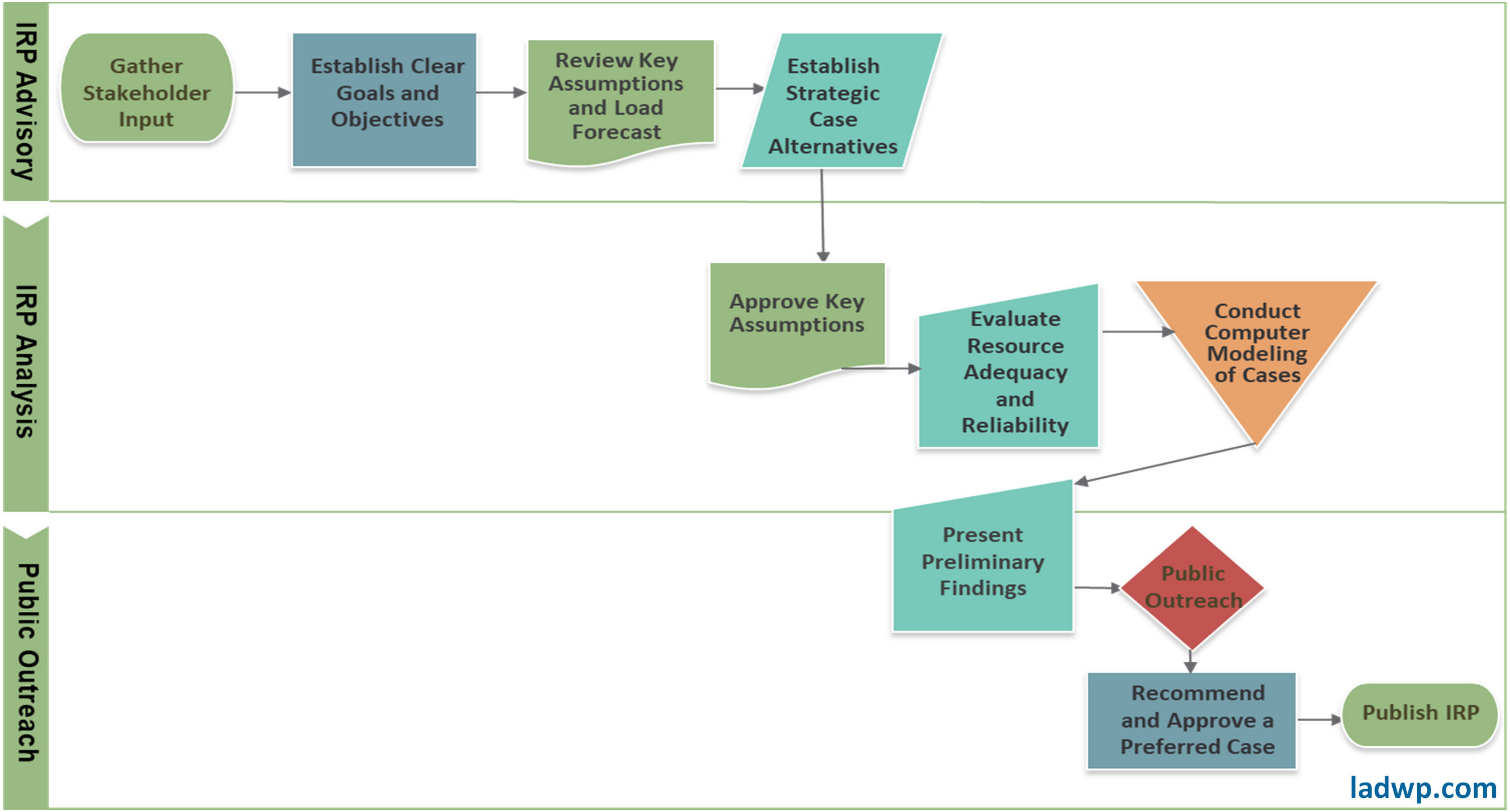
Integrated Resource Planning





James Barner – 10 minutes

IRP Development Process

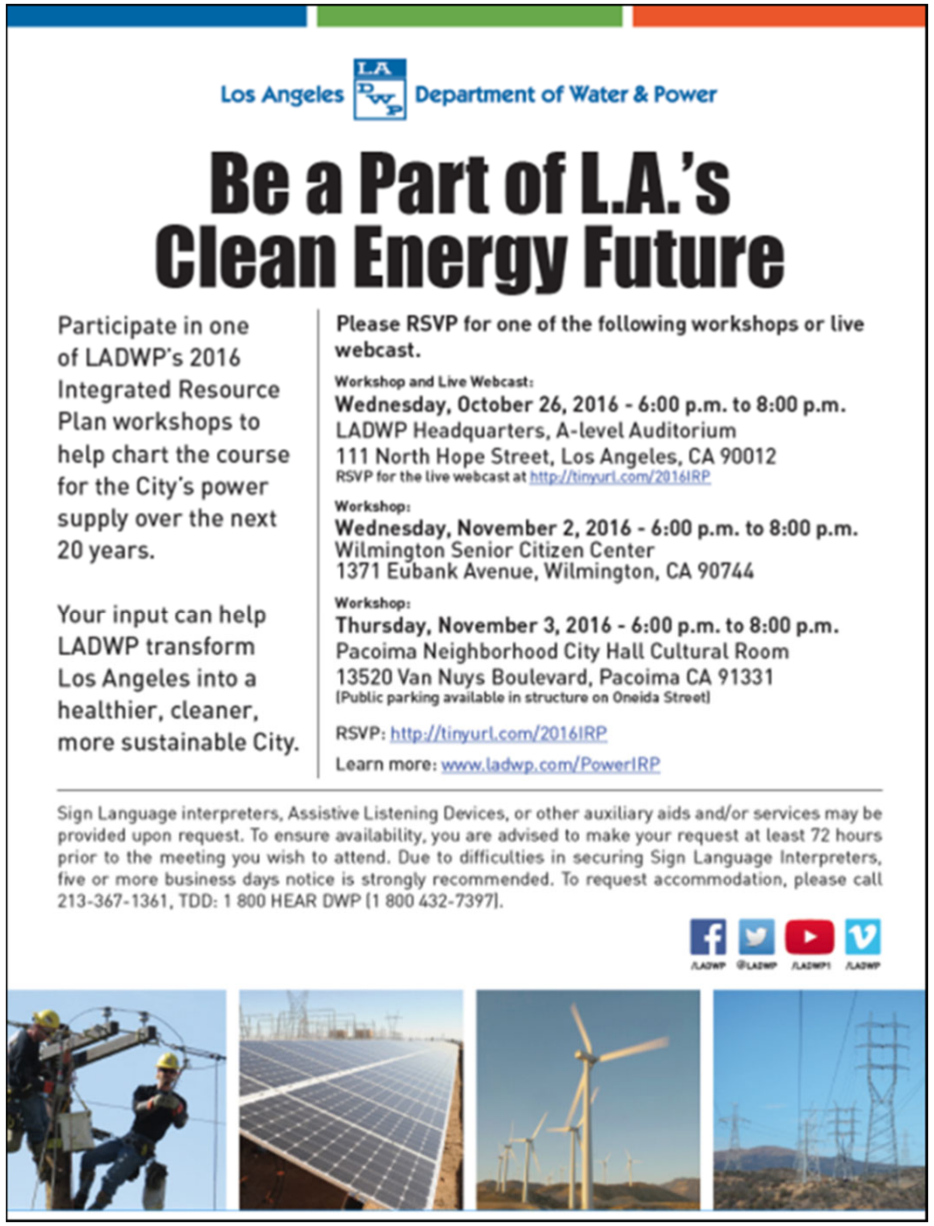


Planning 1.0 – 2016 IRP Advisory Committee

Potential 2016 IRP Major Topics

- Electric Vehicles
- Renewables 50% RPS
- Energy Efficiency (EE)
- Local Solar / Energy Storage
- Natural Gas

Stakeholders
Power System Facilitators
Council Representatives
Mayoral Representatives
Neighborhood Council Representatives
Environmental Community Representatives
Customer Representatives
Business Community Representatives
Academia
Office of Public Accountability
Disadvantaged Community
Labor Union



Planning 1.0 – IRP Case Scenarios 2016/2017

Coal Cases

1. Intermountain Power Plant (IPP) 2027* (base)
2. IPP 2025*

Renewable (RPS), Local Solar, Energy Storage and Electrification (EV) Cases

4. 50% RPS, Low Local Solar, Low Storage, Low EV*
5. 50% RPS, Low Local Solar, Low Storage, High EV
6. 50% RPS, High Local Solar, Low Storage, High EV
7. 50% RPS, High Local Solar, High Storage, High EV
8. 65% RPS, High Local Solar, High Storage, High EV

8LLS. 65% RPS, Low Local Solar, High Storage, High EV
8MLS. 65% RPS, Med Local Solar, High Storage, High EV
8SF. 65% Solar Foc'd RPS, High Local Solar, High Storage, High EV

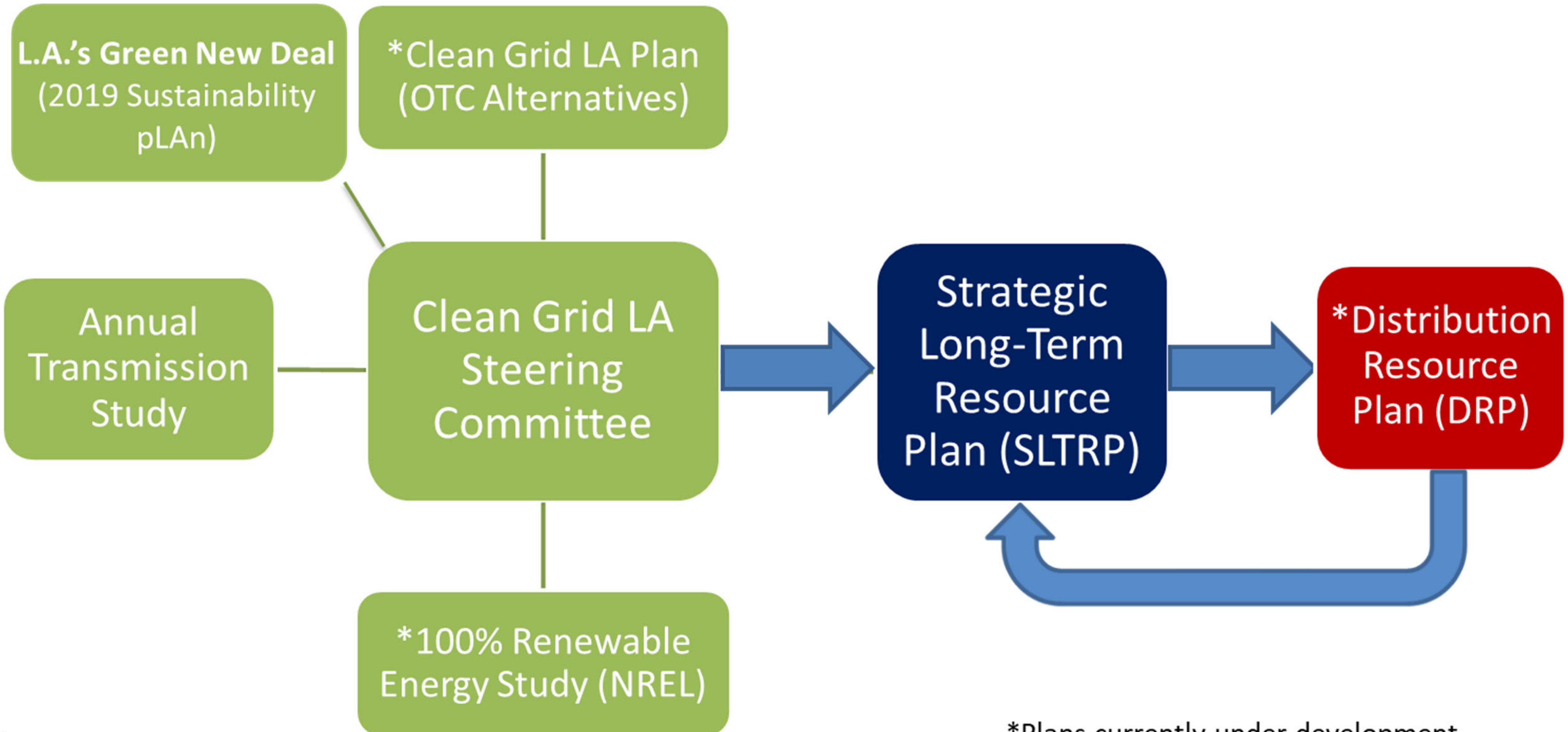
(high local solar and storage in accordance to LA Sustainability pLAn goals)

Recommended Case

LA DWP

**Expected, Low, and High Fuel Cost Sensitivity Analysis was performed*

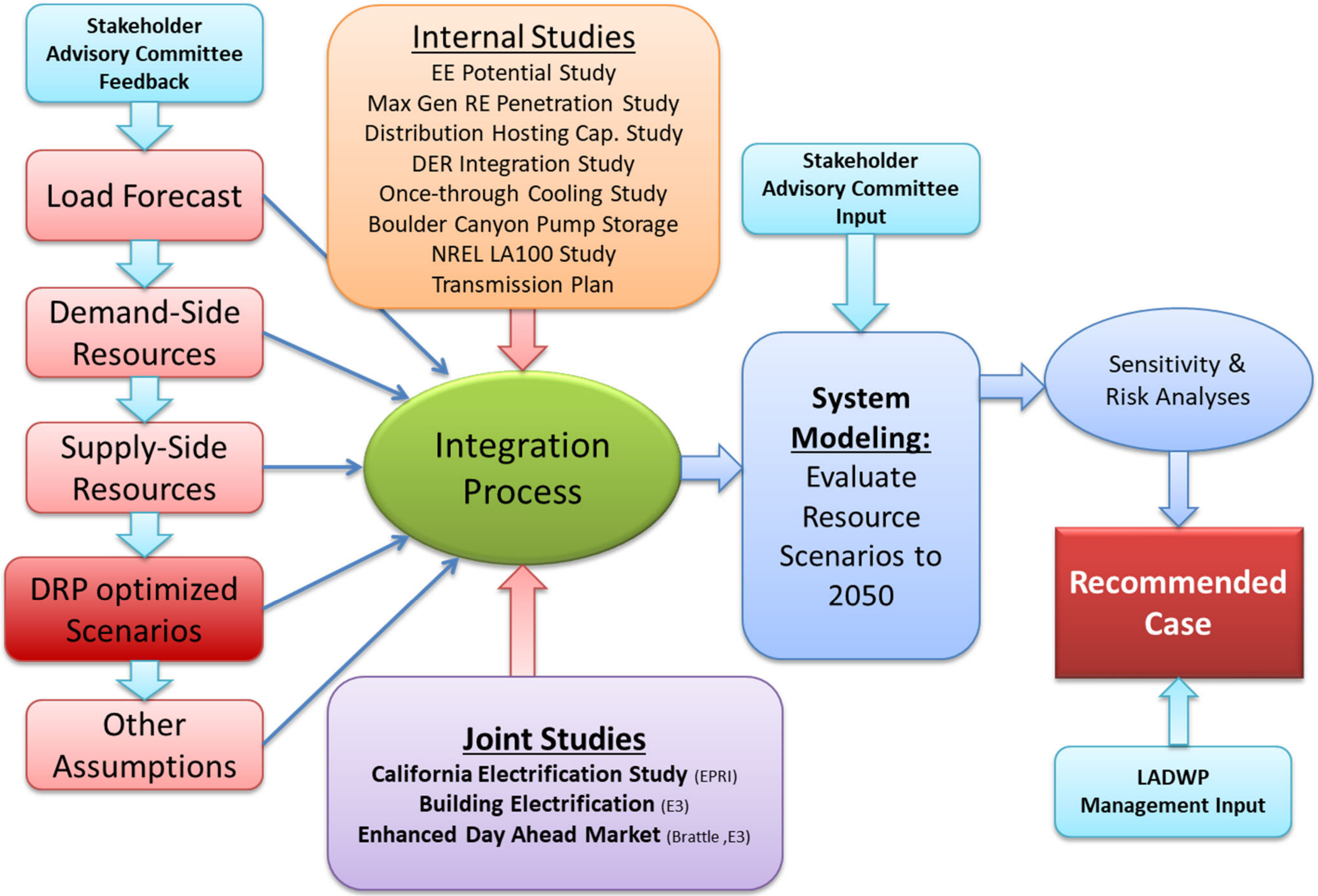
Planning 2.0 – Aligning Resource Planning Efforts for "L.A.'s Clean Energy Future"



*Plans currently under development

Note: LADWP's traditional IRP was renamed the SLTRP beginning 2017, after the California Energy Commission IRP Guidelines were developed as required by SB350.

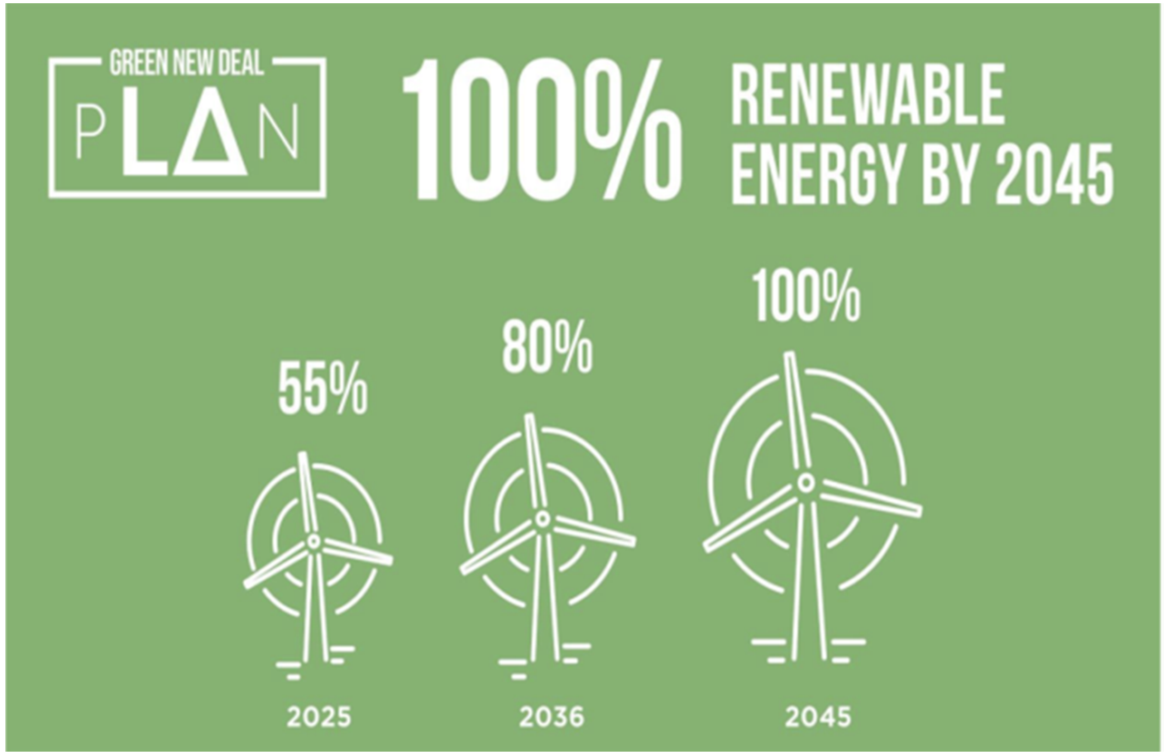
Planning 2.0 – 2021 Strategic Long-Term Resource Plan Scenario Development and Modeling



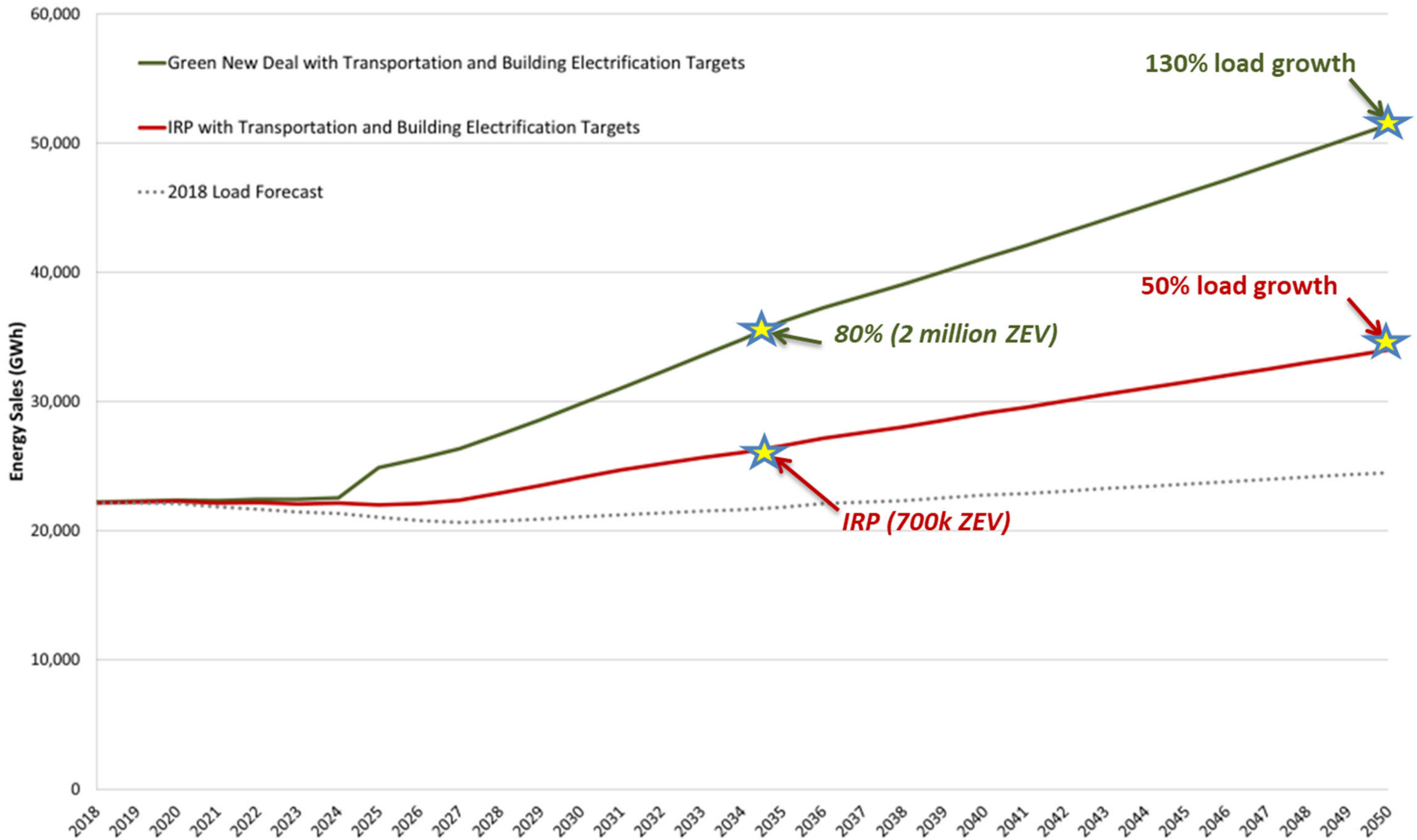
L.A.'s Green New Deal (2019 Sustainability City pLAn)

Integrating Key Sustainability pLAn Initiatives:

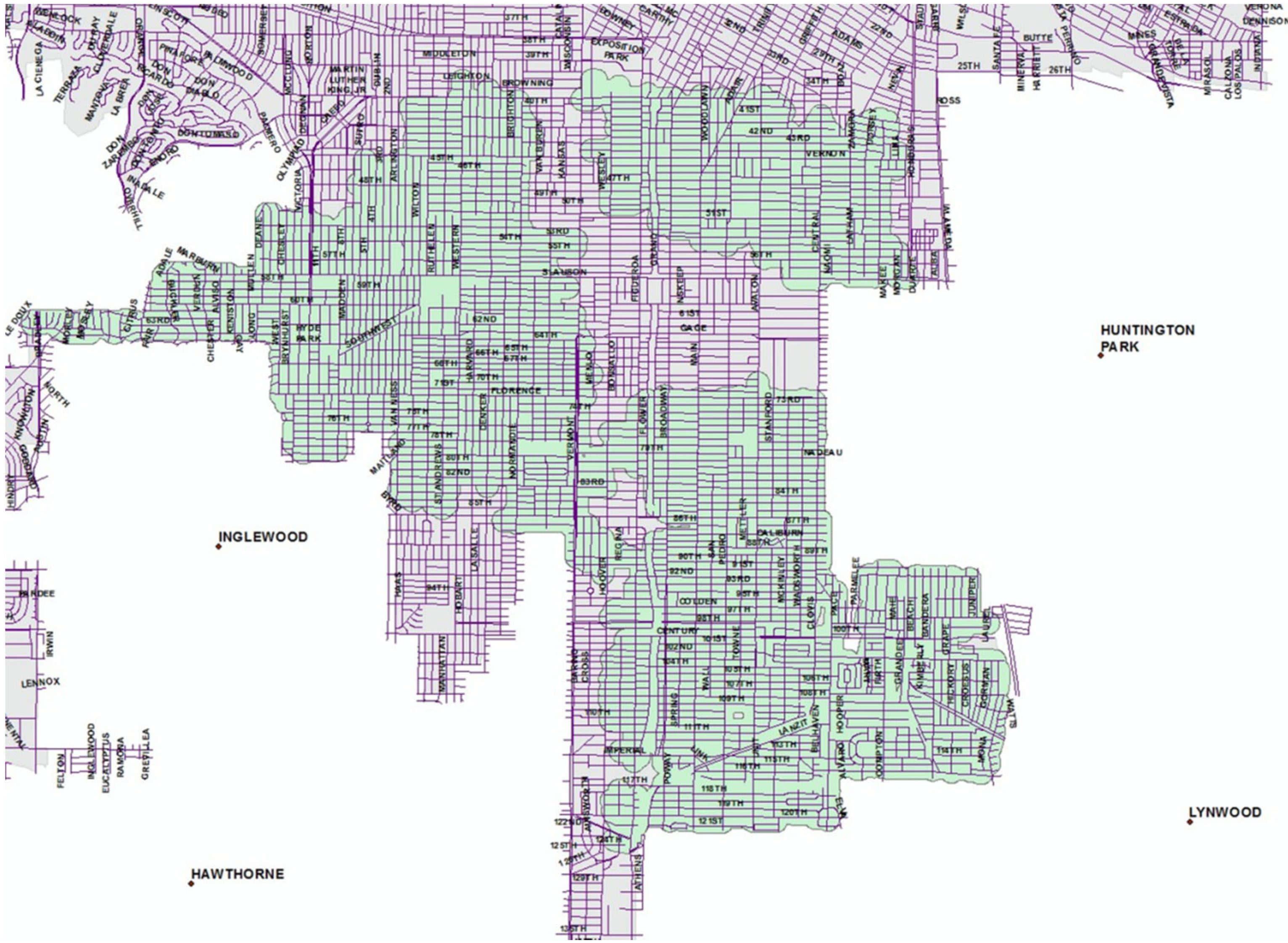
New Goals	2025	2030	2035	2050
Renewables	**55%**	**-**	**80%**	**100%**
Zero Emissions Vehicles (ZEV)	**25%**		**80% (2 million)**	**100% (2.5 million)**
Electrify Metro/LADOT Buses		100%	100%	100%
Zero Emissions City Fleet		100%	100%	100%
Building Electrification (C40)	**100 GWh**	**1,000 GWh**	**2,000 GWh**	**5,400 GWh**
Net Zero Buildings		All New		100%
Energy Efficiency in Buildings	22%		35%	44%
Total Load Growth	**12%**	**33%**	**63%**	**130%**



Cumulative Load Impacts of Green New Deal



Distribution Resource Plan (DRP)



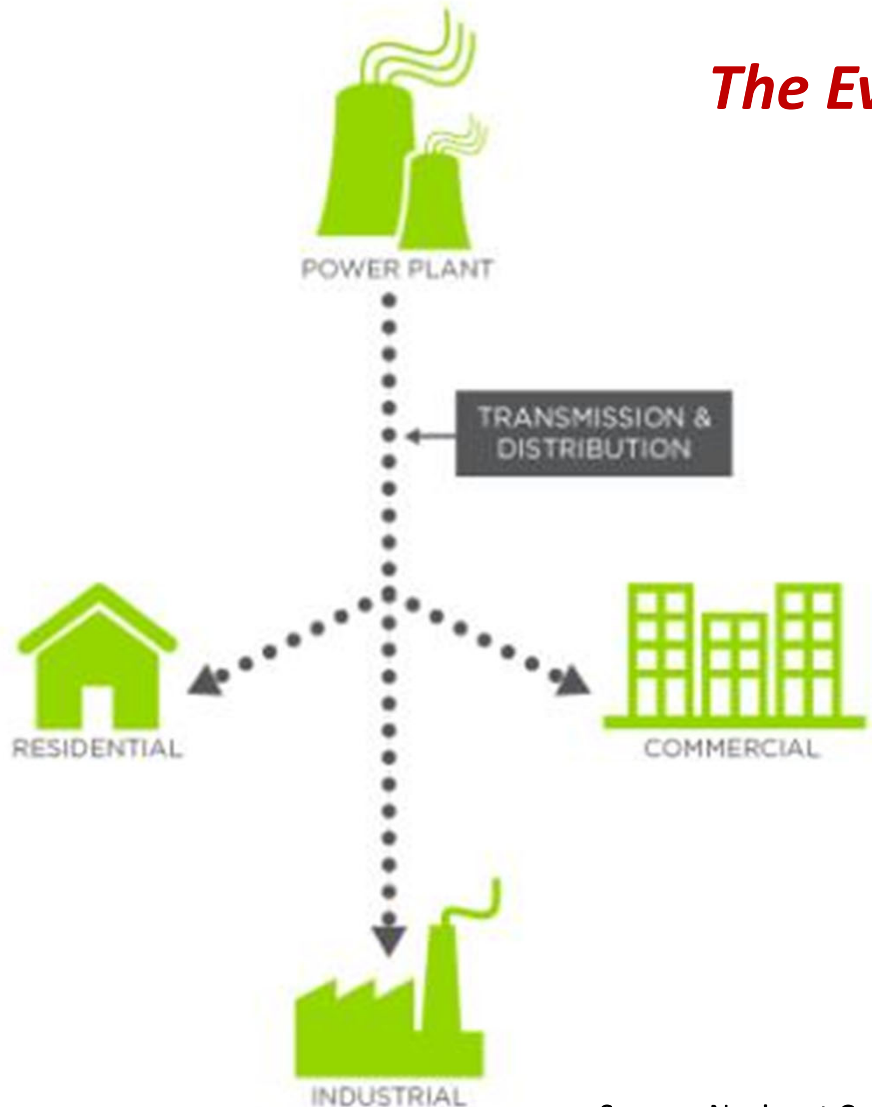
Jay Lim – 5 minutes

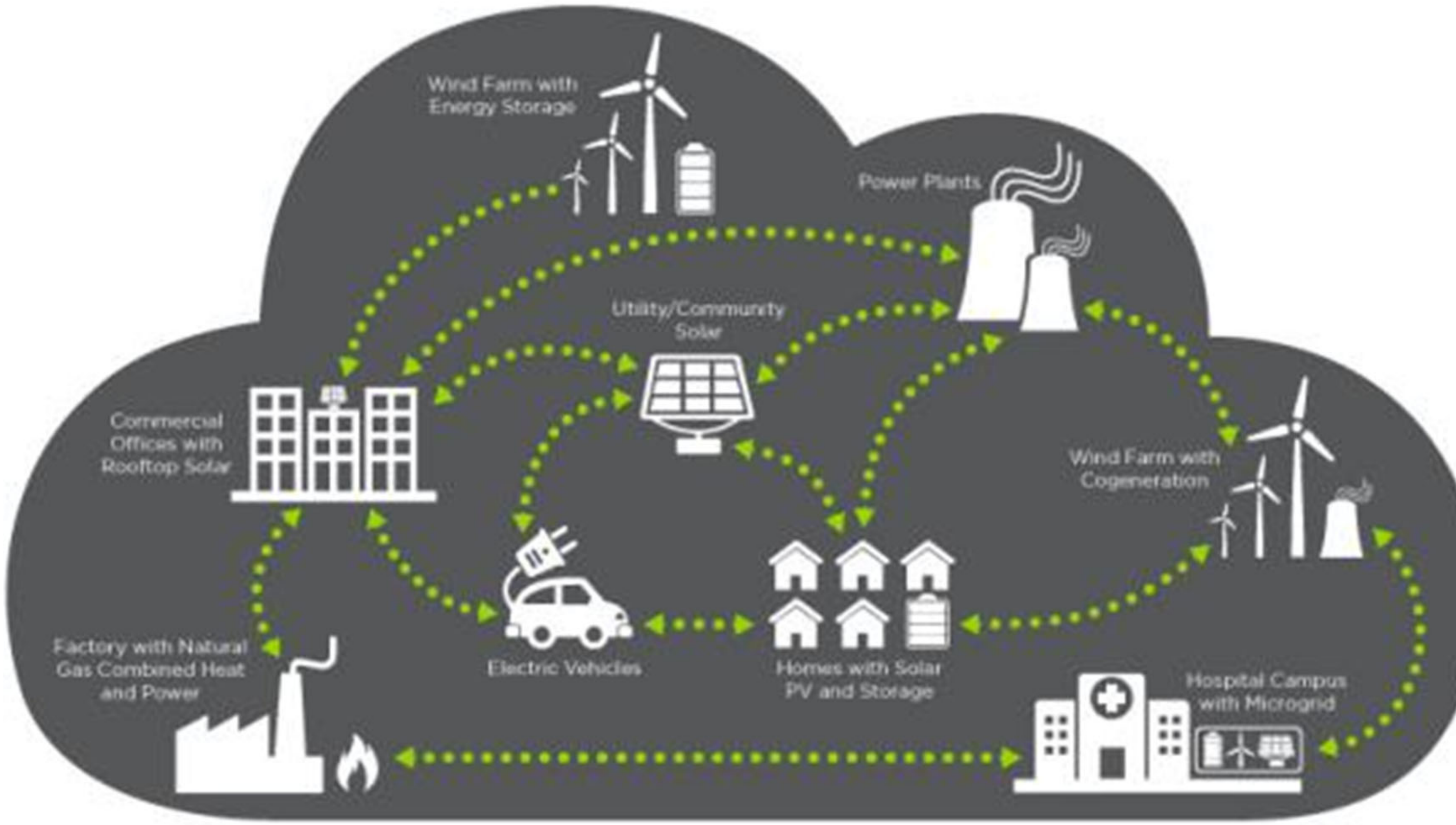
Resource Planning 2.0 – IRP combined with DRP Planning

TODAY: TRADITIONAL POWER GRID
Central, One-Way Power System

EMERGING: THE ENERGY CLOUD
Distributed, Two-Way Power Flows

The Evolving Utility and DERs

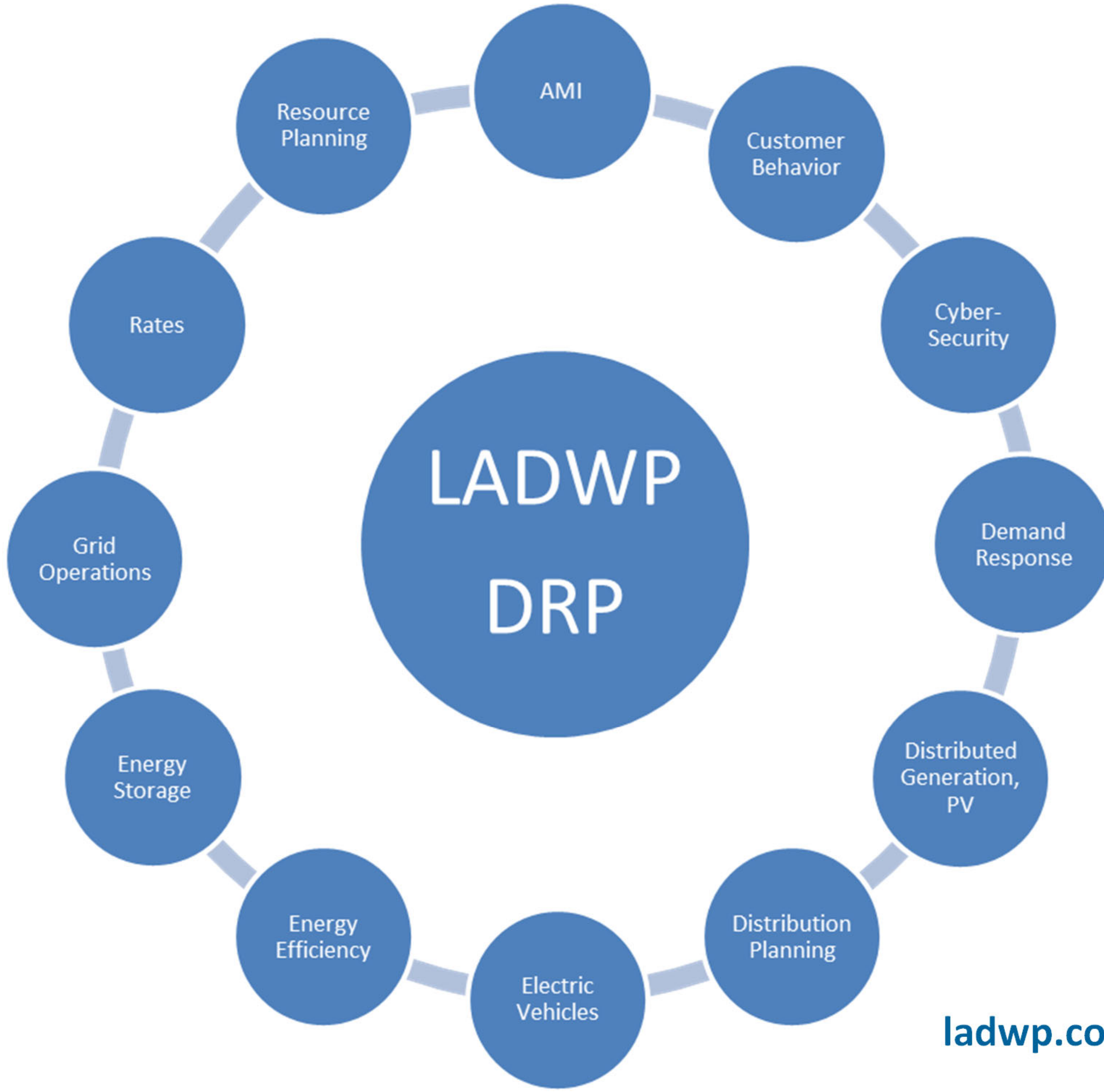




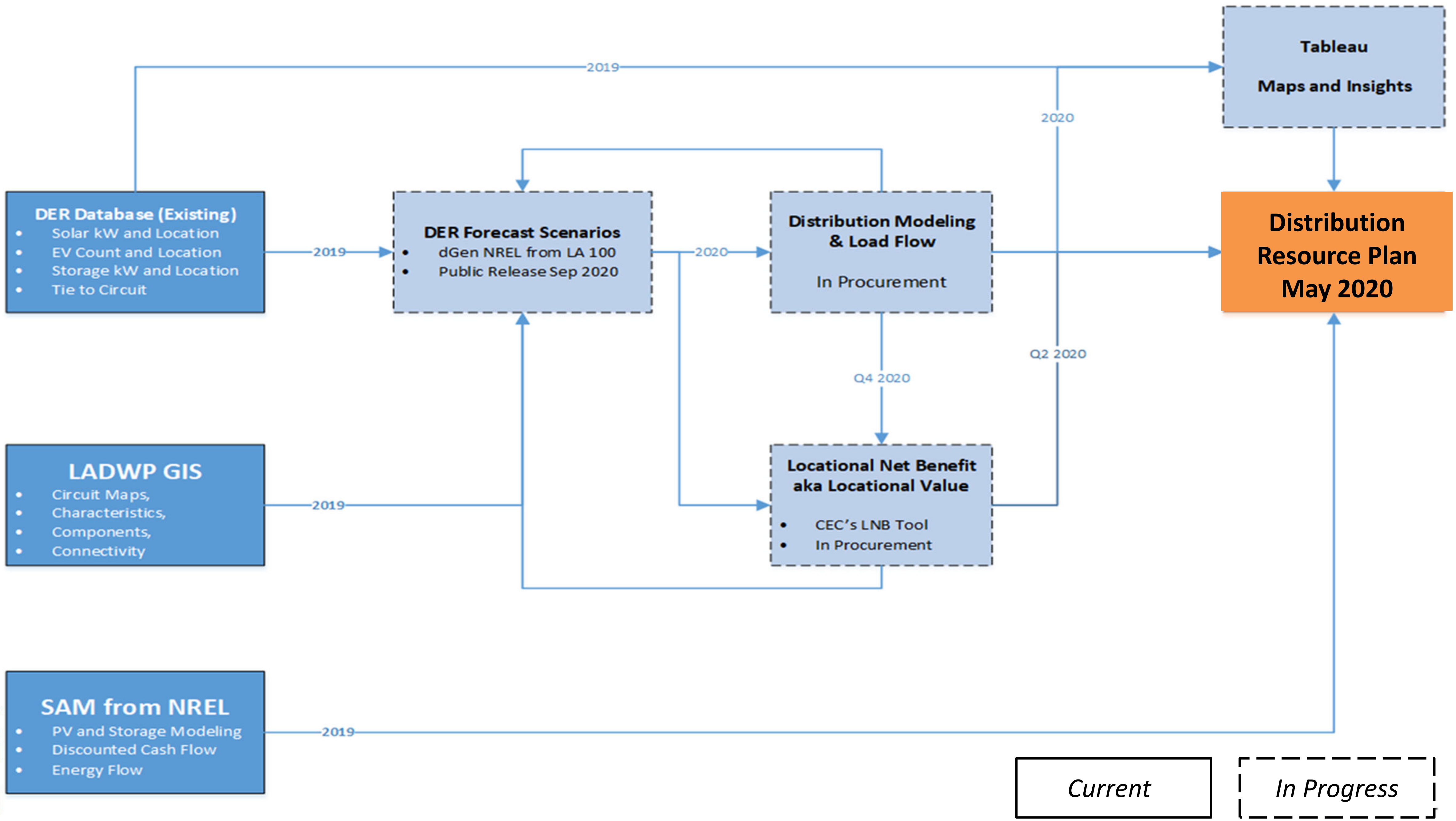
Source: Navigant Consulting

DER Planning Considerations

- Leverage Existing DER program efforts and resources
- Minimize duplications and increase system efficiency
- Achieve optimal DER deployment
- Achieve a common objective
- Improve Grid Resiliency

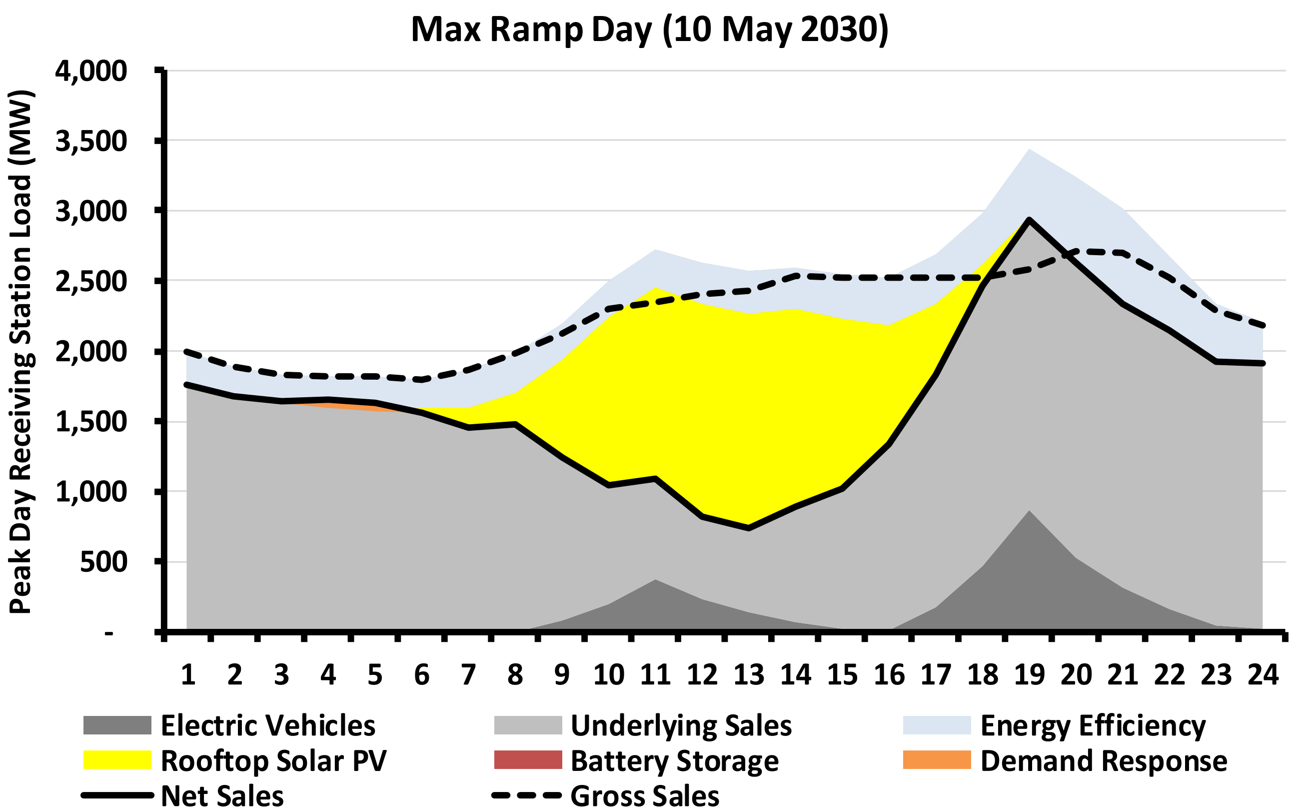


DRP Modeling Framework

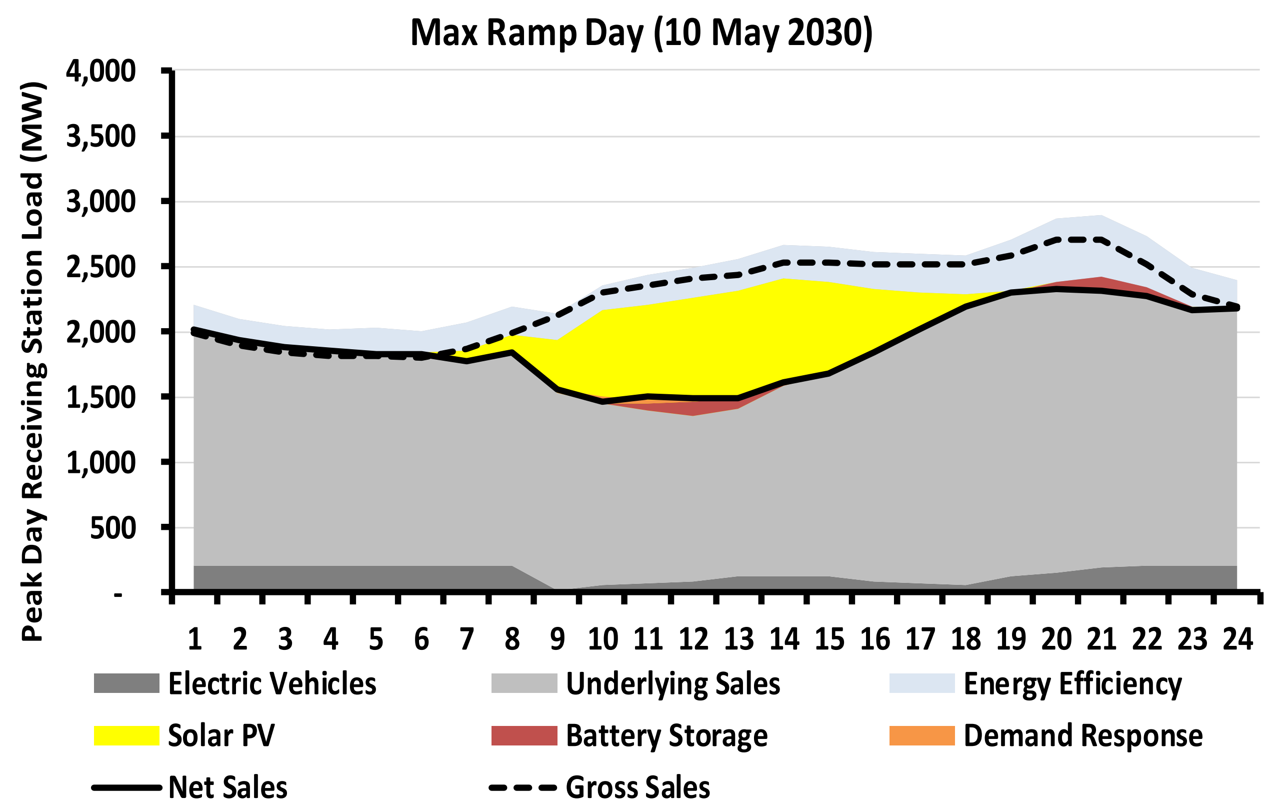


Distributed Energy Resources Integration Study Uncontrolled vs. Managed DER

UNCONTROLLED DER



MANAGED DER



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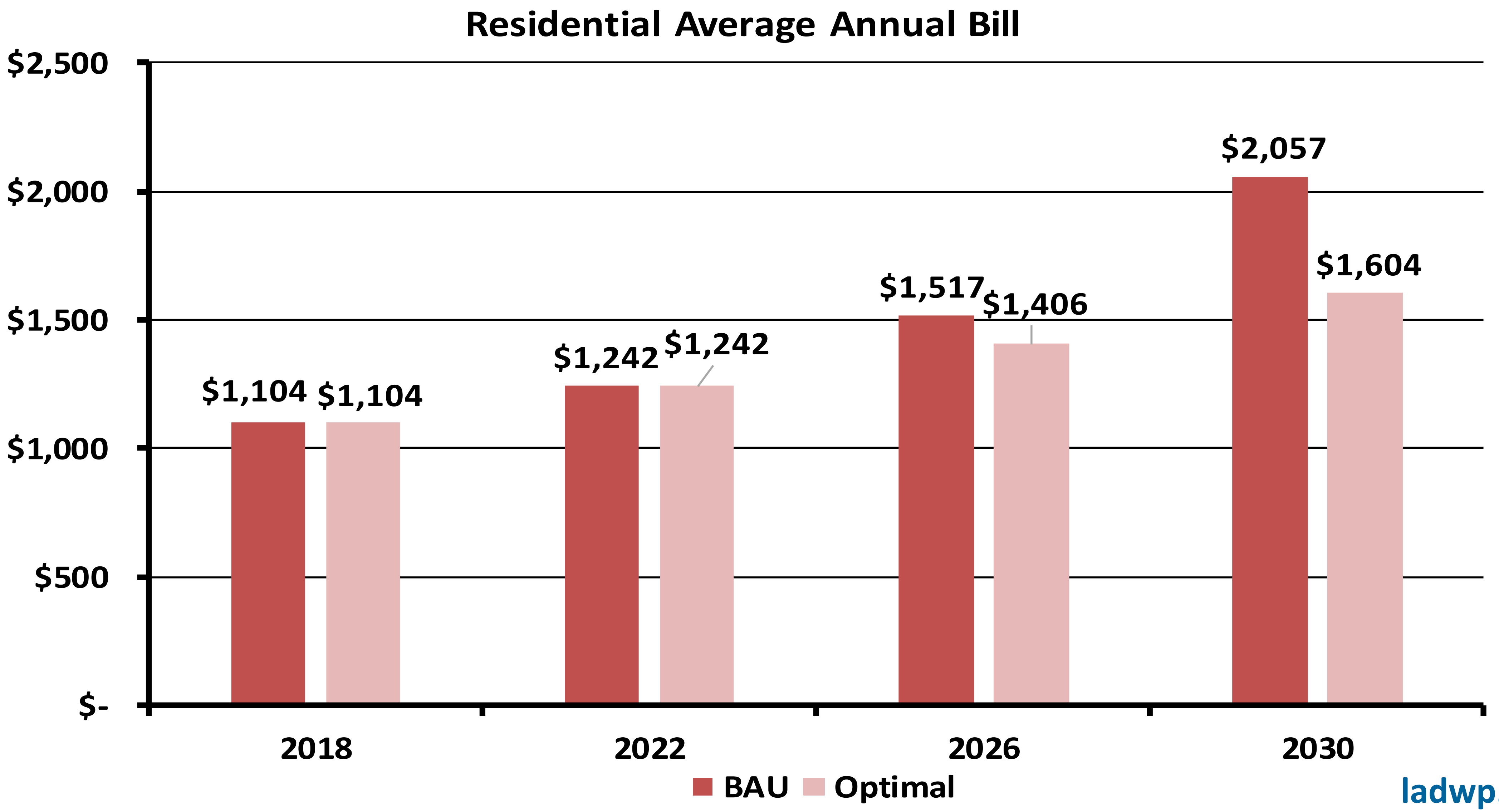
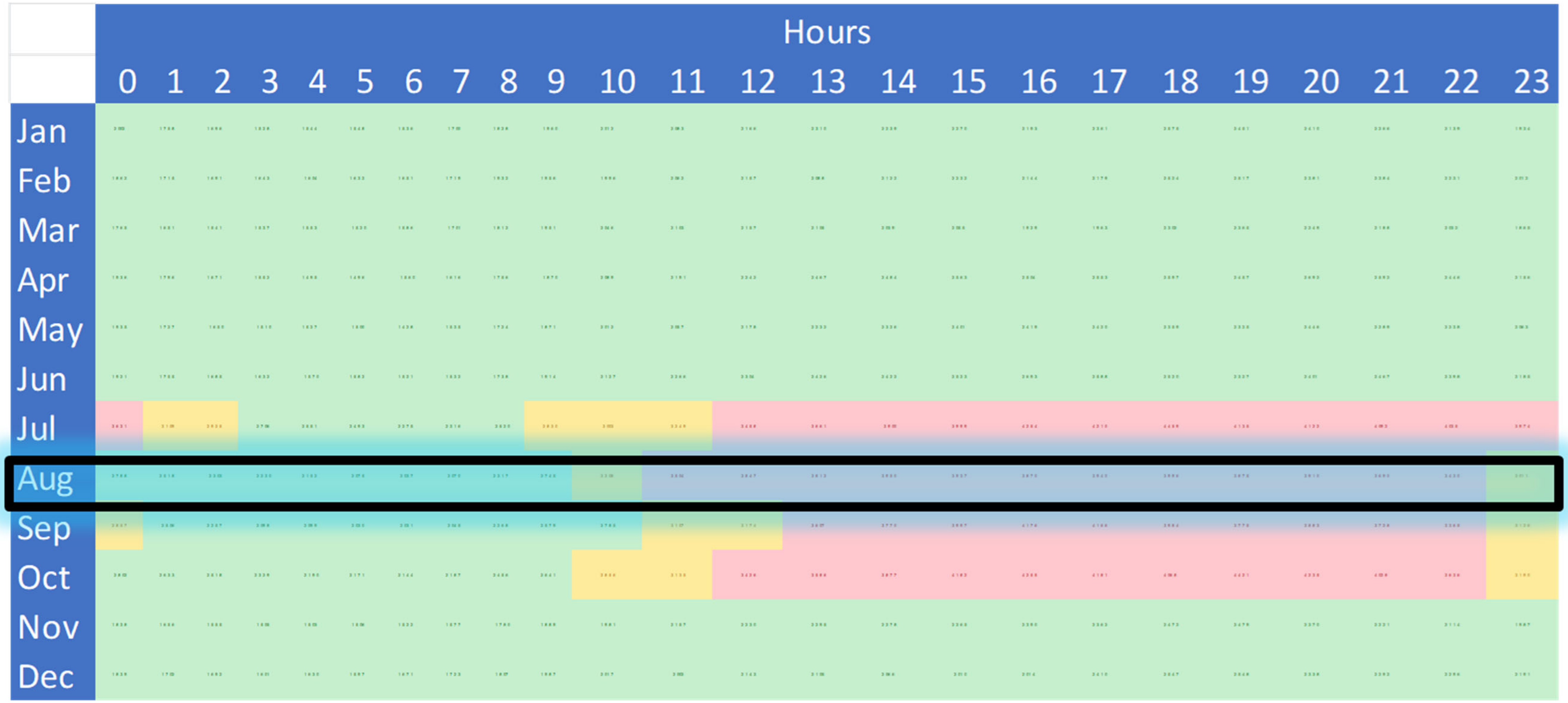
Distributed Energy Resources Integration Study
Benefits of Optimized DER Integration

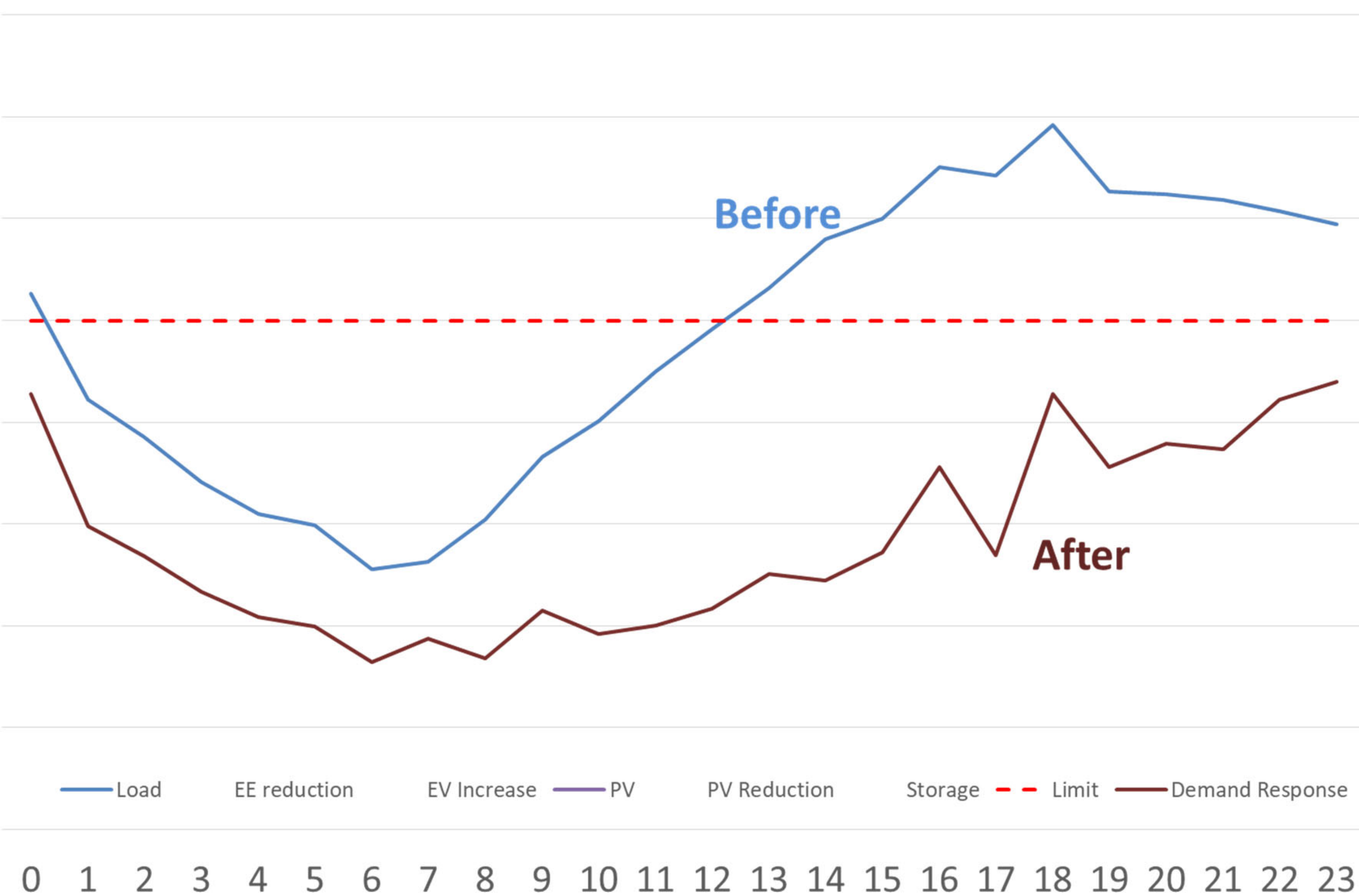


Identifying the Exact Challenge

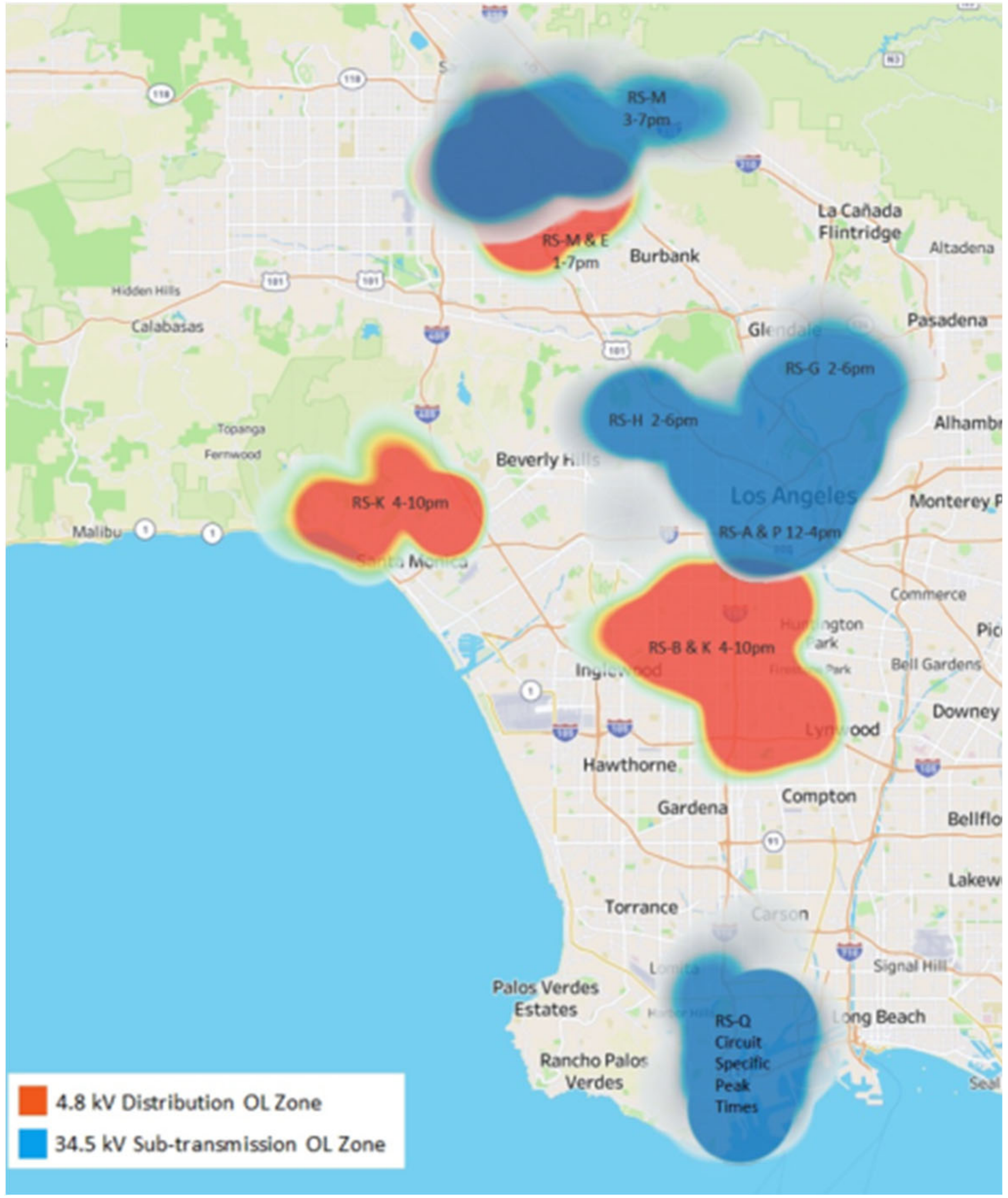


Red = Overload

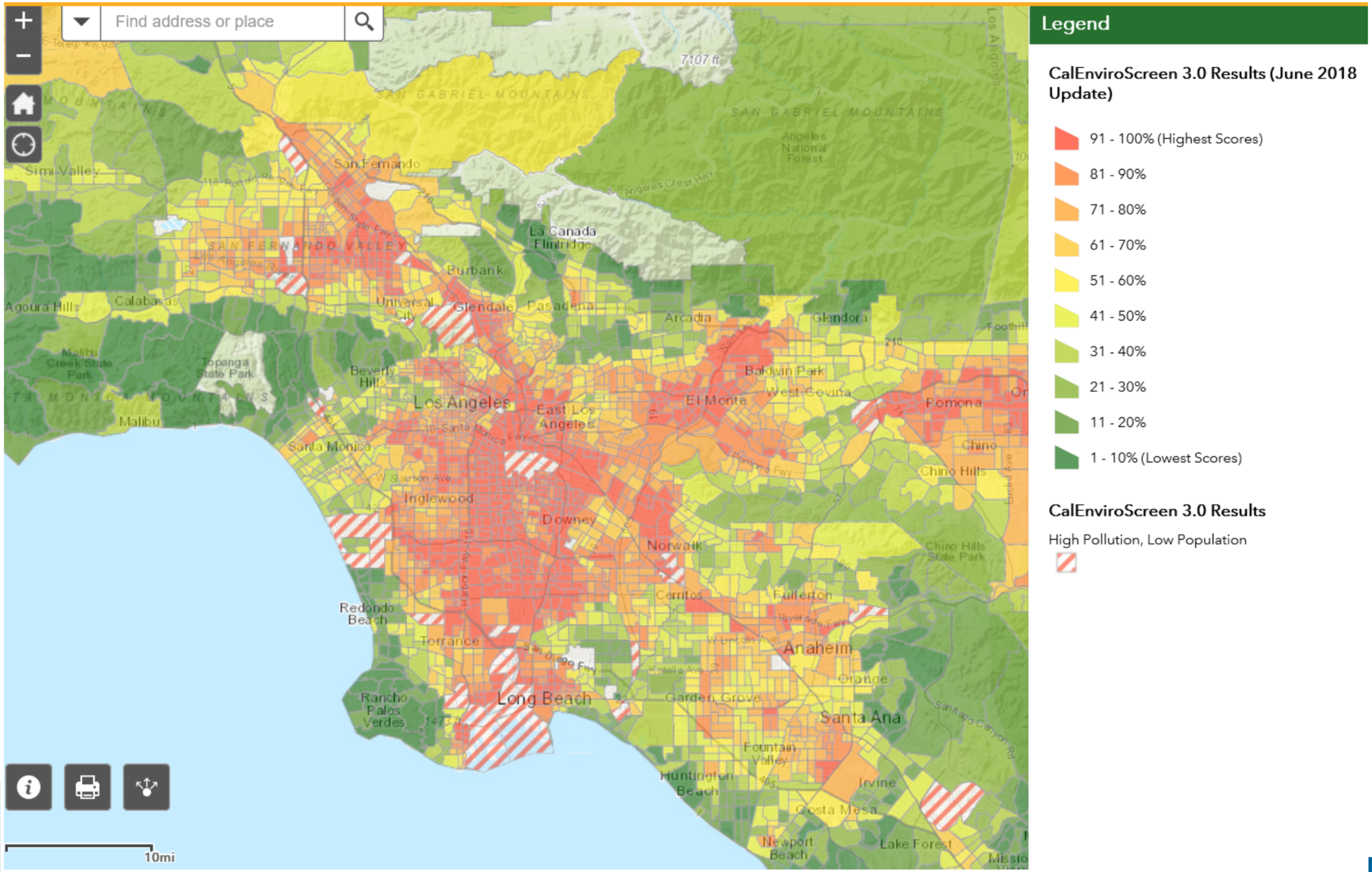
Locational Benefits of DERs



Illustrative



Targeting DERs to address Equity Metrics



Source: Cal Enviro Screen 3.0


ladwp.com/CleanEnergyFuture

LA100

The Los Angeles 100% Renewable Energy Study

The Los Angeles 100% Renewable Energy Study (LA100)

NAS Workshop

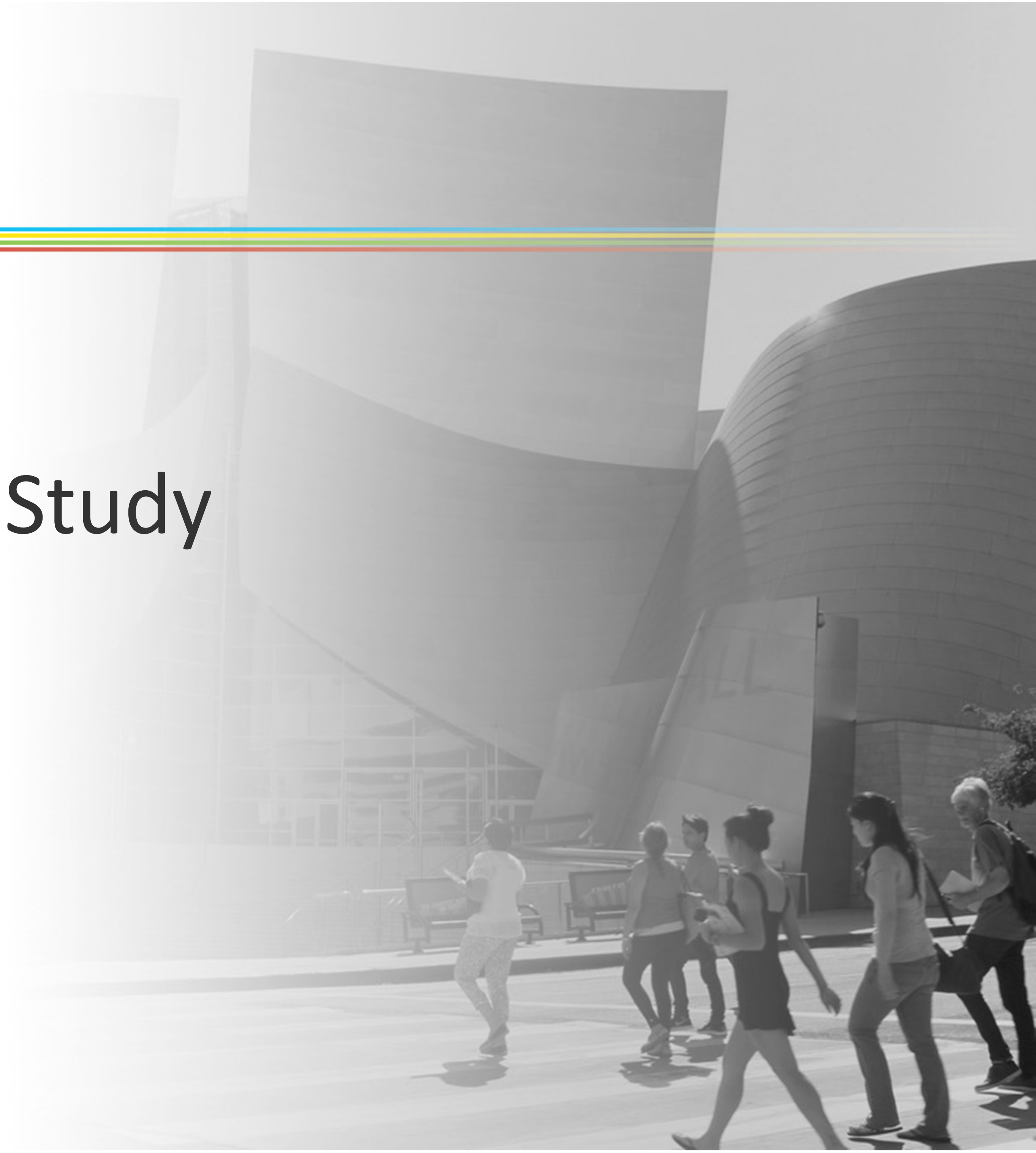
Jaquelin Cochran, Ph.D.

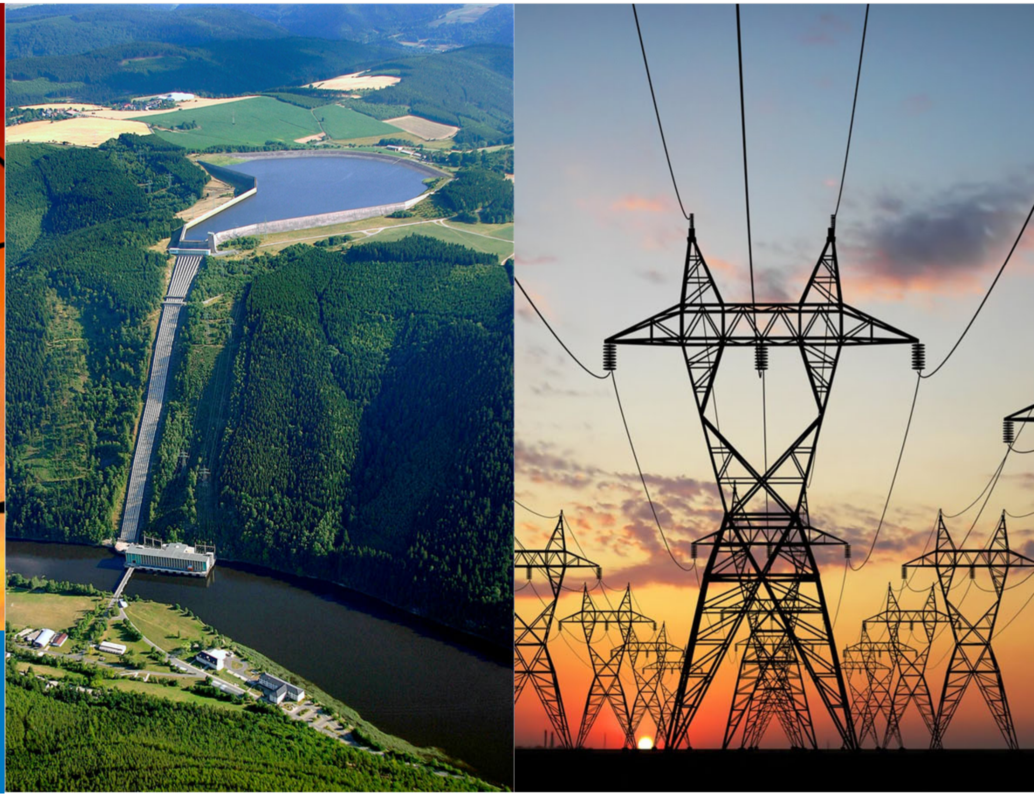
National Renewable Energy Laboratory

February 3, 2020

LA DWP Los Angeles Department of Water & Power

NREL Transforming ENERGY



LA100 Study Objectives

- What are the **pathways** and **costs** to achieve 100% RE while maintaining current reliability?
- What is the impact on the **environment**?
- What are the potential for **high quality careers** and **local economic development**?
- How can **environmental justice** communities be part of the solution?
- In coordination with Ratepayer Advocate: What are impacts to **electricity rates**?

What Is Unique About LA100?

LADWP must balance electricity supply and demand **at all times**

First-of-its-kind modeling

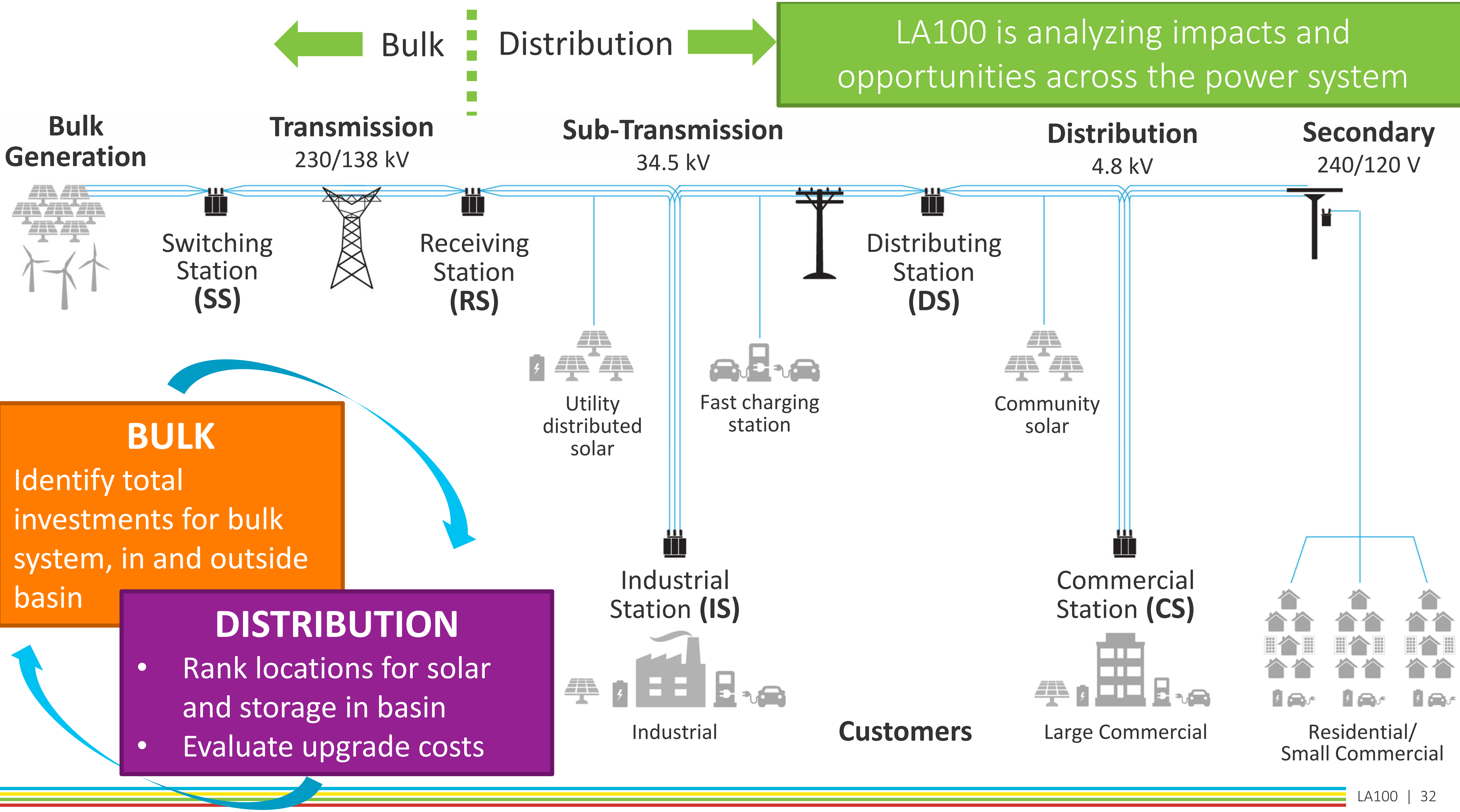
Objective, transparent, stakeholder-based analysis of pathways to 100% RE

LA100 does <u>not</u> present recommendations or suggest policies

Advisory Group Provides Input and Review Throughout the Study

Representatives:

- Environmental groups
- Neighborhood councils
- Academia
- Premier accounts
- City government
- Business and workforce groups
- Utilities


Bulk
Distribution
LA100 is analyzing impacts and opportunities across the power system
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)
Utility distributed solar
Fast charging station
Community solar
Industrial Station (IS)
Commercial Station (CS)
Industrial
Customers
Large Commercial
Residential/ Small Commercial
BULK
Identify total investments for bulk system, in and outside basin
DISTRIBUTION
• Rank locations for solar and storage in basin
• Evaluate upgrade costs

LA100 Methodology

Input models

What is electricity demand and customer-driven supply?

- Electricity demand
- Demand response
- Renewable resource analysis
- Customer-driven solar

Main scenario models

What does LADWP build?

- Generation
- Transmission
- Distribution upgrades

Output and validation models

How do we know it's right?

- Load balancing
- Resource adequacy
- Power flow and stability analysis
- Integrated distribution and transmission analysis

Impact models

What are the impacts?

- Economic and workforce analysis
- Environmental analysis

LA100 Methodology

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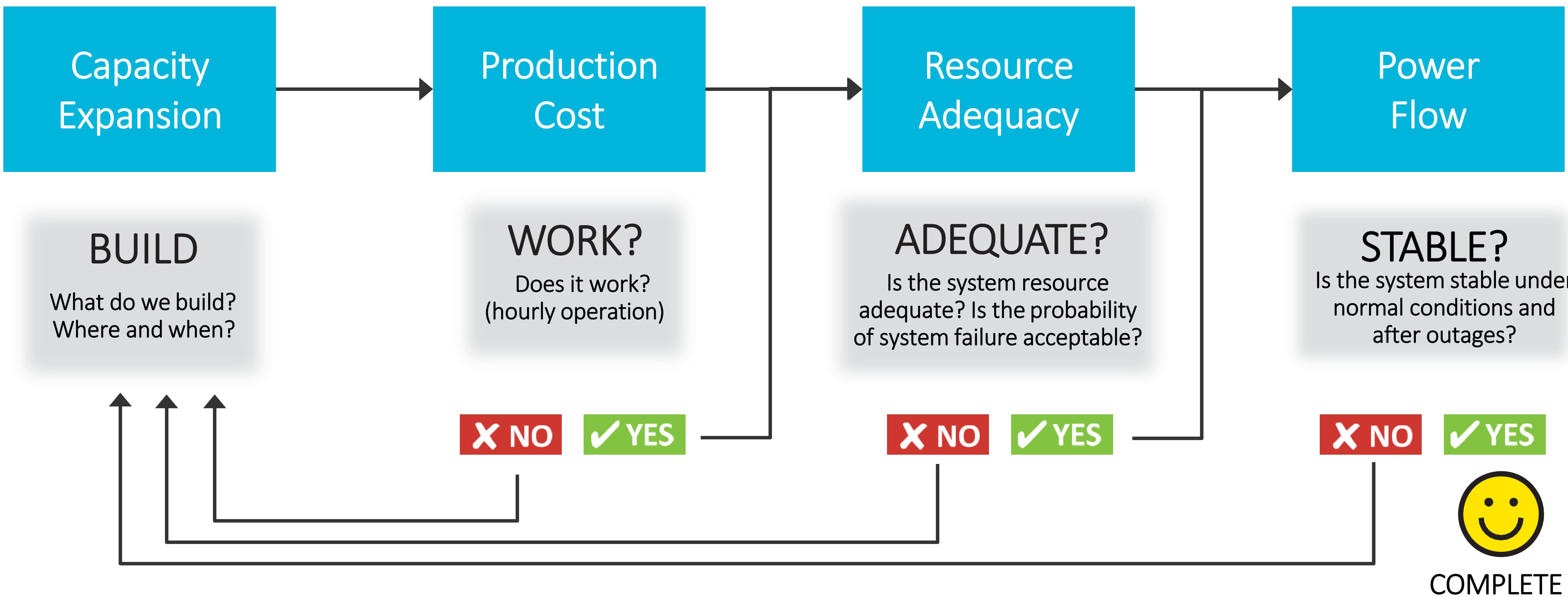
Bulk System Modeling Approach: Estimate, Then Refine



Scenarios Based on Advisory Group Priorities

		LA100 Scenarios								
		Moderate Load Electrification				High Load Electrification (Load Modernization)				High Load
		SB100	LA-Leads, Emissions Free (No Biomass)	Transmission Renaissance	High Distributed Energy Future	SB100	LA-Leads, Emissions Free (No Biomass)	Transmission Renaissance	High Distributed Energy Future	High Load Stress (SB100)
	2030 RE Target	60%	100% Net RE	100% Net RE	100% Net RE	60%	100% Net RE	100% Net RE	100% Net RE	60%
	Compliance Year for 100%	2045	2035/2040	2045	2045	2045	2035/2040	2045	2045	2045
Technologies Eligible in the Compliance Year	Biomass	Y	No	Y	Y	Y	No	Y	Y	Y
	Biogas	Y	No	Y	Y	Y	No	Y	Y	Y
	Electricity to Fuel (e.g. H2)	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Fuel Cells	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Hydro - Existing	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Hydro - New	N	N	N	N	N	N	N	N	N
	Hydro - Upgrades	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Natural Gas	Yes	N	N	N	Yes	N	N	N	Yes
	Nuclear - Existing	Y	Y	No	No	Y	Y	No	No	Y
	Nuclear - New	N	N	N	N	N	N	N	N	N
	Wind, Solar, Geo	Y	Y	Y	Y	Y	Y	Y	Y	Y
	Storage	Y	Y	Y	Y	Y	Y	Y	Y	Y
Repowering OTC	Haynes, Scattergood, Harbor	N	N	N	N	N	N	N	N	N
DG	Distributed Adoption	Moderate	High	Moderate	High	Moderate	High	Moderate	High	Moderate
RECS	Financial Mechanisms (RECS/Allowances)	Yes	N	N	N	Yes	N	N	N	Yes
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

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

Example Goals for Analysis

- Identify what **investments** are **common** across most/all scenarios
- Identify **trade-offs**—including costs, workforce, and air quality—among the scenarios
  - Especially for going from ~90% to 100% RE
- Identify sources of **uncertainty** (especially for technologies not yet at scale)

Going from 90% to 100% RE

Existing, commercially competitive RE technologies can get us most of the way to 100% RE

- Example: pumped hydro and 4-hour battery storage can help meet nighttime electricity demand

The challenge is meeting the last ~10% of time periods, e.g.,

- Summer peak periods when available RE and storage options are exhausted and adding new solar is uneconomical for the rest of the year
- Extended transmission outages (maintenance, fires), during which batteries can't recharge using out of basin resources
- Days with unusually low solar and wind output

The scenarios, with differences among technology eligibility, will indicate costs and tradeoffs of meeting these hard to supply periods

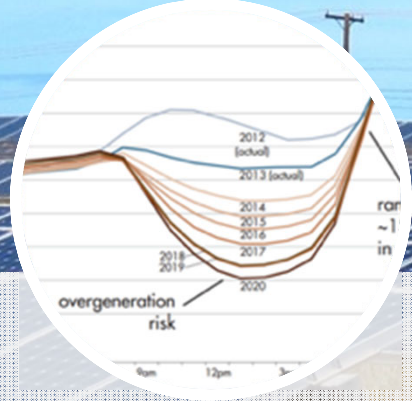
Getting to 100%: Core Strategies

New RE

Required in all scenarios

Storage

Allows shifting of variable generation to evening and morning hours



Curtailment

High rates of curtailment during some hours may be more cost-effective than storage or exports

Flexible Load

Dynamic load and energy efficiency can decrease the need for new resources and help integrate variable RE

Stronger Network

Upgrading transmission and distribution networks allows access to new sources of RE in and outside the basin

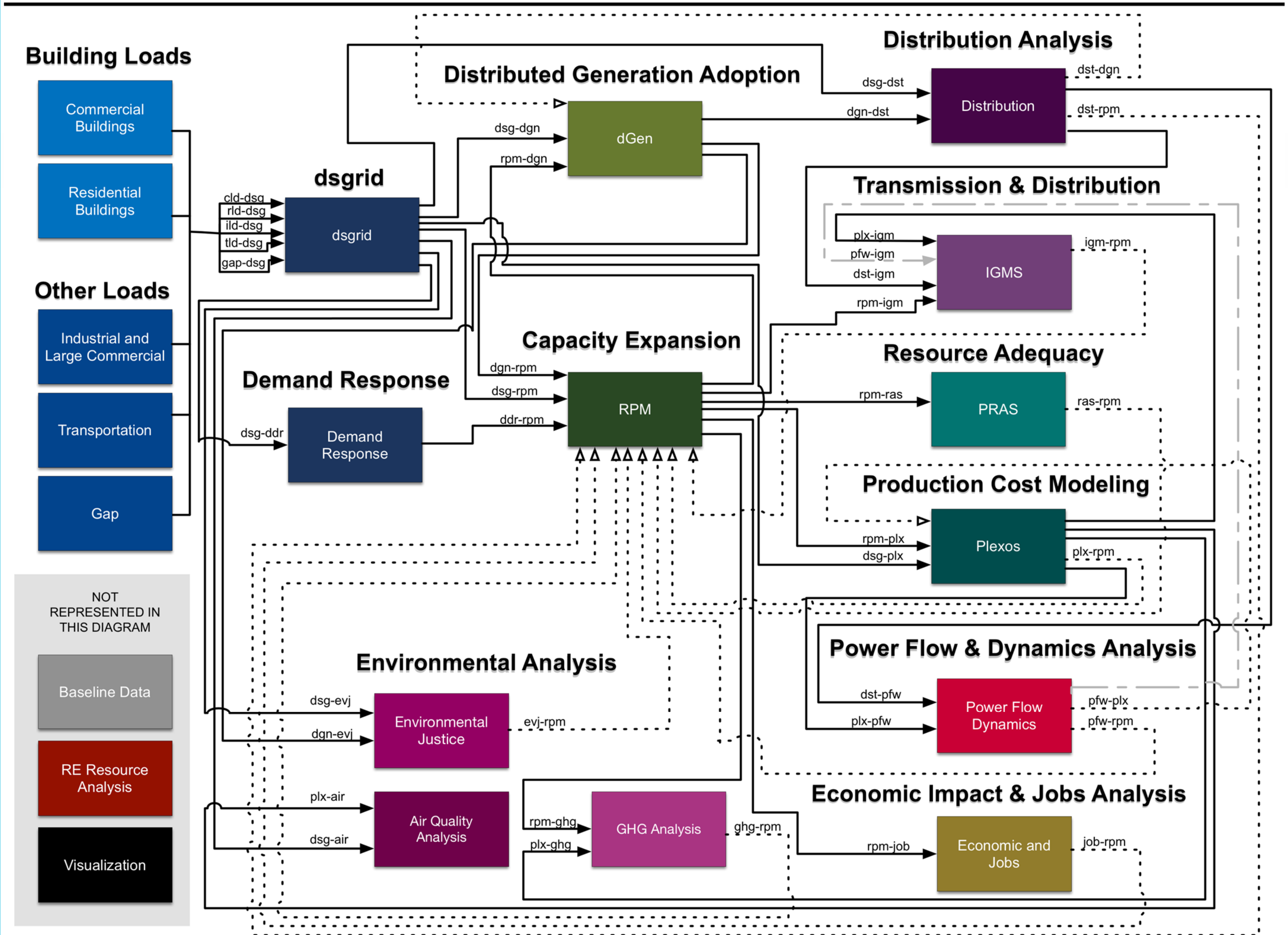
Renewable Peaking Options

Renewable-fueled combustion technologies, fuel cells, seasonal storage, controllable load

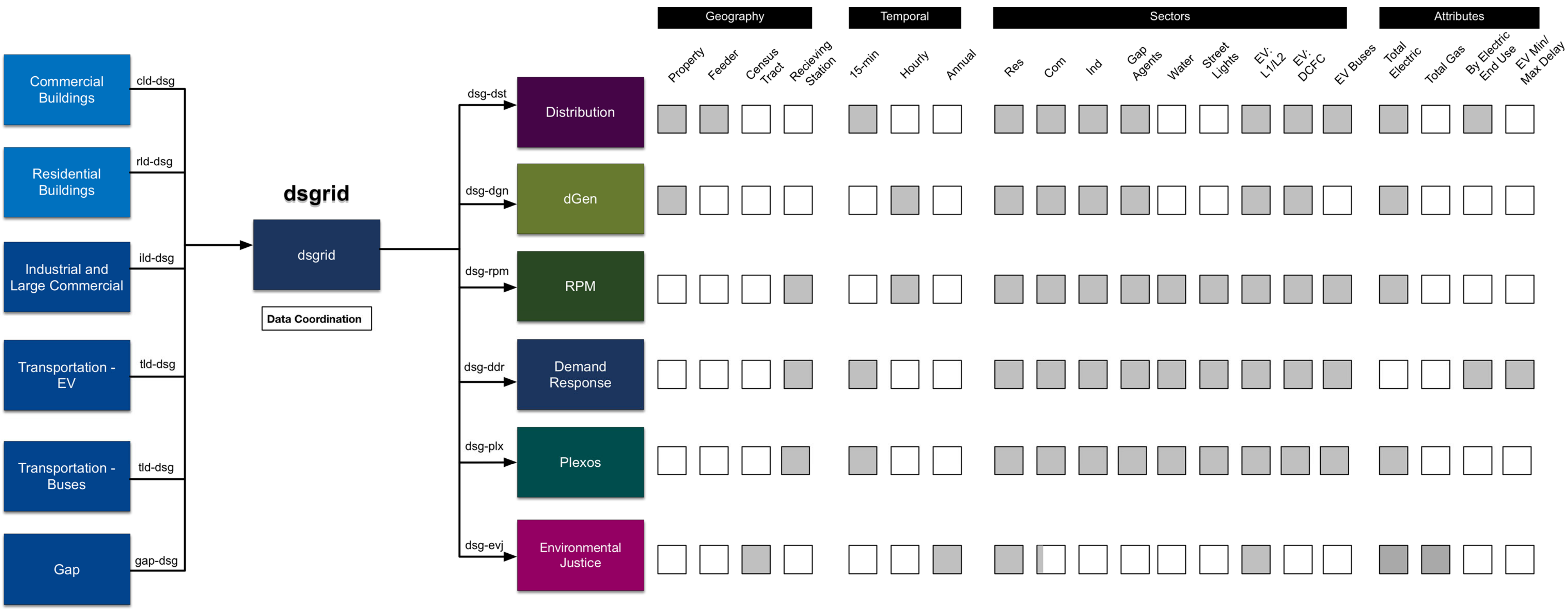
RE Credits (for SB100 scenarios)

Example Modeling Challenges

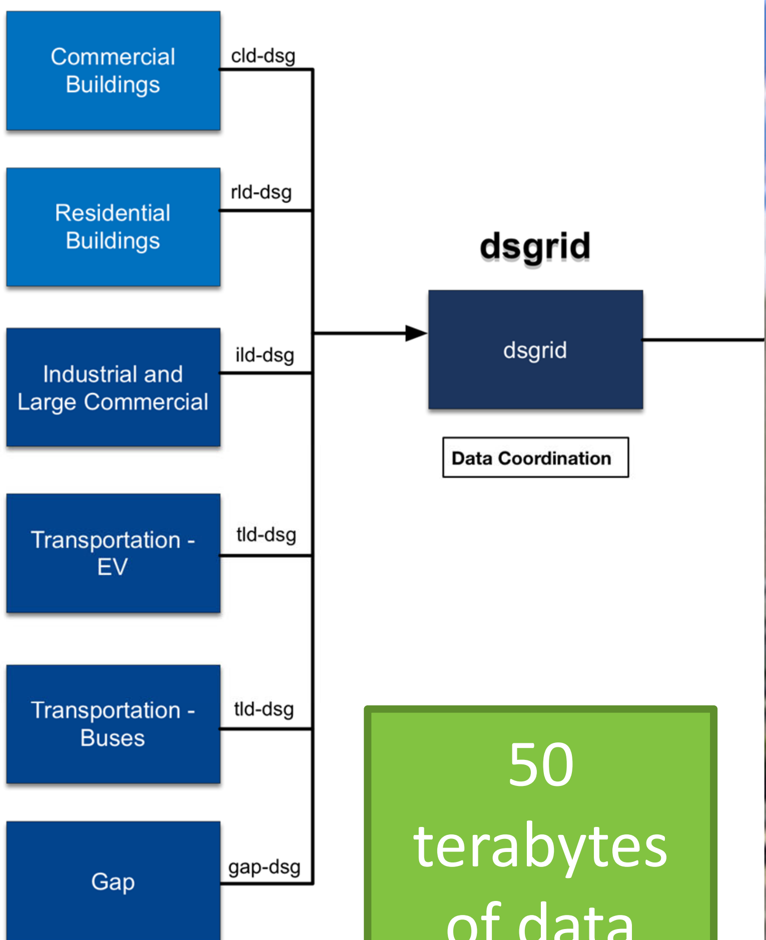
Complexity of Modeling Integration and Data Exchange Among Models



Example: Load Data Allocation to Downstream Models

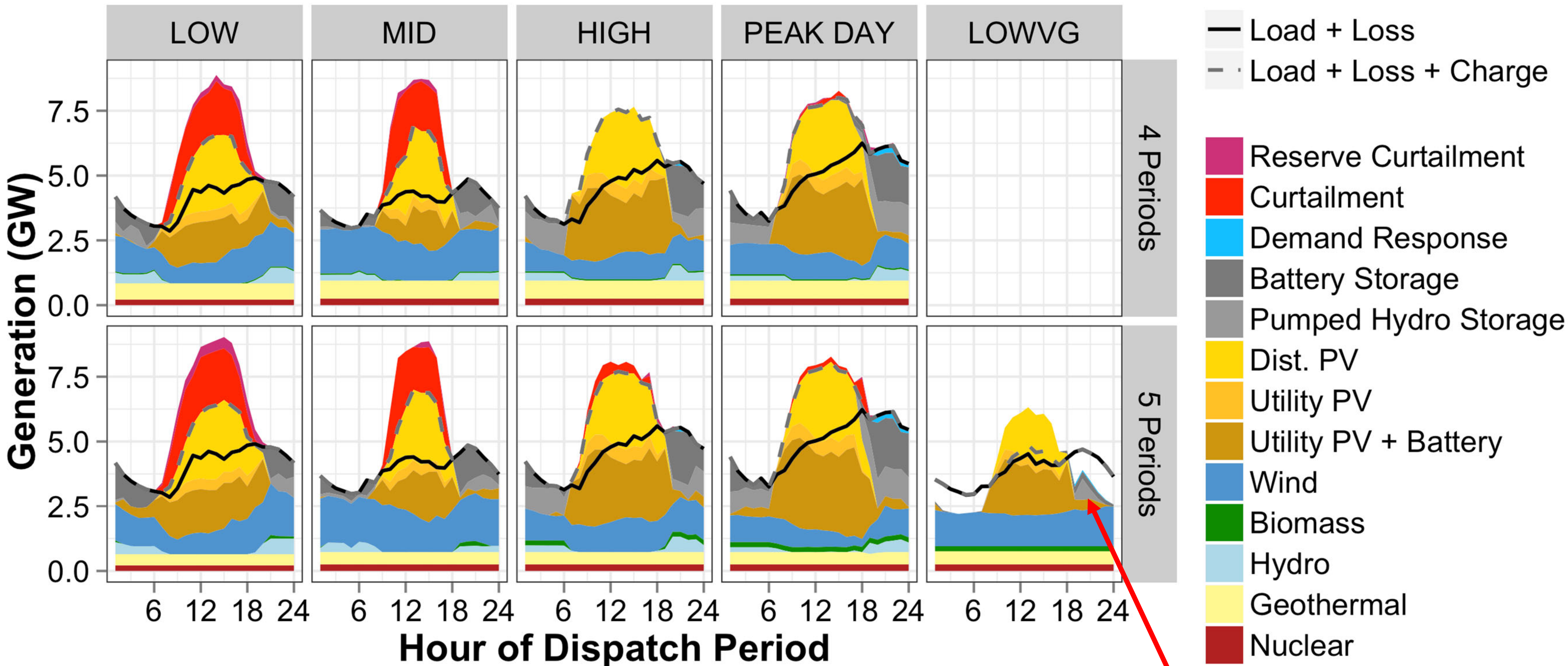


Example: Load Data Allocation to Downstream Models



50 terabytes of data

Capacity Expansion Models: Four Planning Time Periods Were Insufficient at 100% RE to Identify Needed Capacity



Additional time period highlights unserved load…enabling identification of additional capacity needed

But Even Five Time Slices Makes it Challenging to Assess Ability of Storage to Reliably Contribute to Resource Adequacy in 100% RE Systems

- Capacity credit: Fraction of nameplate capacity that can be reliably available during periods of highest system stress
  - CPUC (for IOUs) assumes full credit of storage if at least 4-hours
- Actual capacity credit of storage declines as a function of storage penetration and has strong interactions with solar penetration
- Calculating capacity credit of storage is complicated because in 100% RE systems, we cannot always assume the battery will be fully charged when needed
- Capacity expansion modeling using select time periods is likely to overvalue the ability of the battery to be charged → unserved energy in full-year simulations

LA100 Considers All Facets of Power System Planning

Holistically integrating:

Bottom-up load modeling

Bulk power investments

Distributed energy resources

Resource adequacy

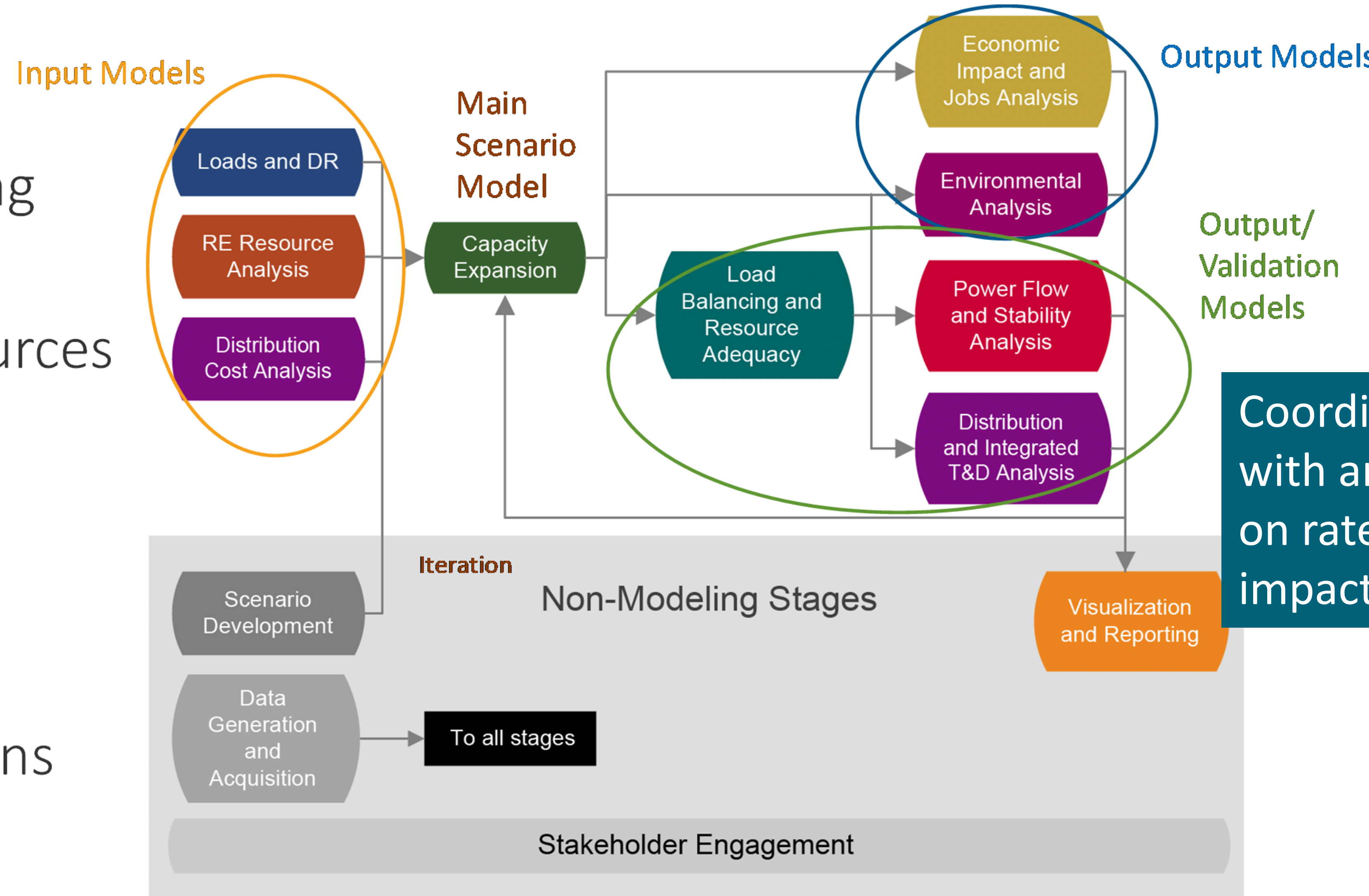
Power flows

Economic impacts

Air quality

Greenhouse gas emissions

Environmental justice



Coordinated with analysis on rate impacts

Questions and Answers

Moderator: Reiko Kerr, Senior Assistant General Manager – Power System, LADWP

- James Barner, Assistant Director – Clean Grid LA Strategy Division, LADWP
- Jay Lim, Integrated Resource Planning Manager, LADWP
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Thank you!

Jaquelin.Cochran@nrel.gov

LA100

The Los Angeles 100% Renewable Energy Study