LA100

The Los Angeles 100% Renewable Energy Study

The Los Angeles 100% Renewable Energy Study (LA100)

Briefing for City of Los Angeles Council Committee
Energy, Climate Change, Environmental Justice, and River
National Renewable Energy Laboratory
February 18, 2021

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




LA100

The Los Angeles 100% Renewable Energy Study

LA City Council motions directed LADWP to evaluate:

- What are the **pathways and costs to achieve a 100% renewable electricity supply** while electrifying key end uses and maintaining the current high degree of reliability?
- What are the potential benefits to **the environment** and **health**?
- How can **environmental justice communities** benefit from and be part of the solution?
- How might **local jobs** and the **economy** change?

What Makes the LA100 Study Groundbreaking?

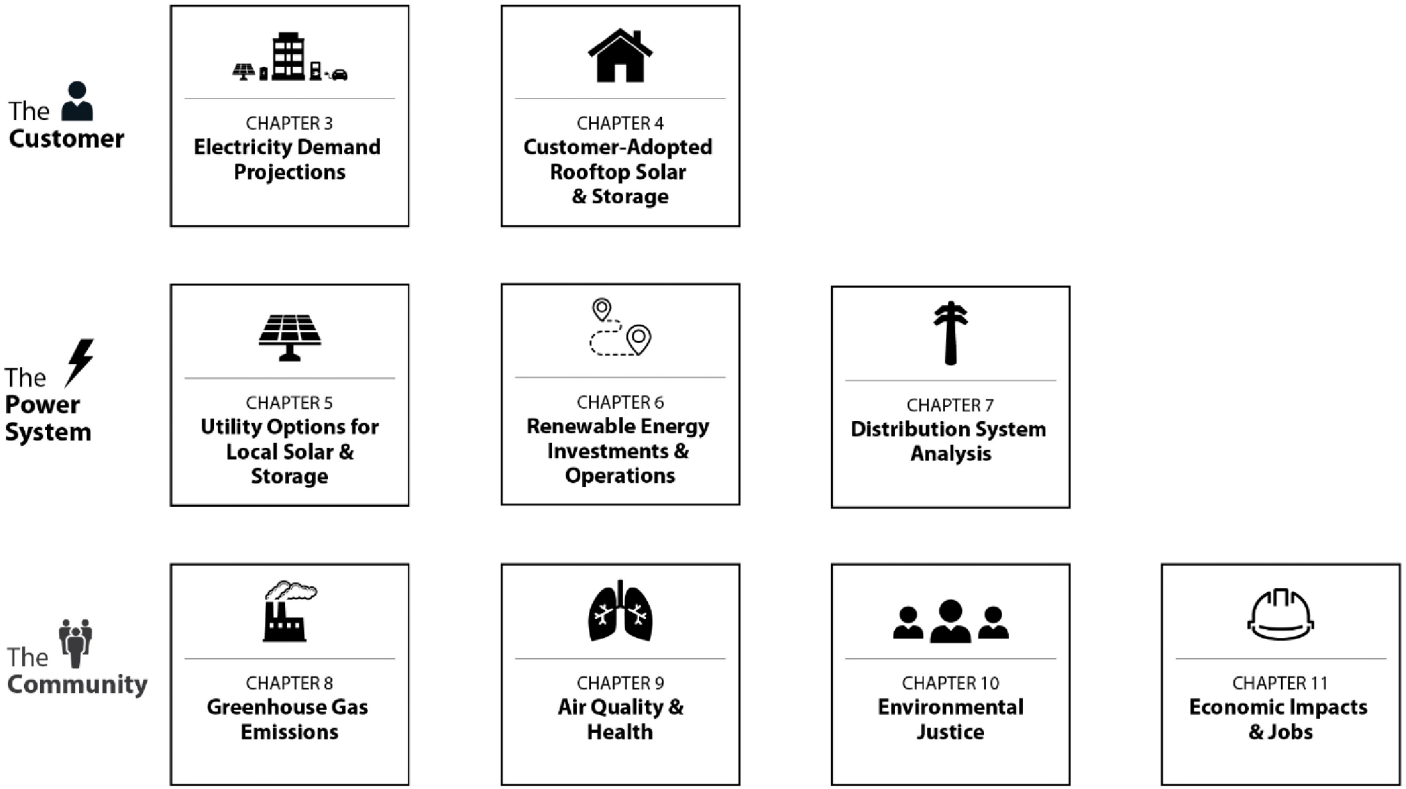
First 100% RE study of a large system that must balance electricity supply and demand **at all times**

Complex analysis reflecting **integration** of models that address multiple aspects of the challenge

Unprecedented **detail** in modeling resolution and simulations

LA100 does **not** present recommendations or suggest policies

Components of LA100

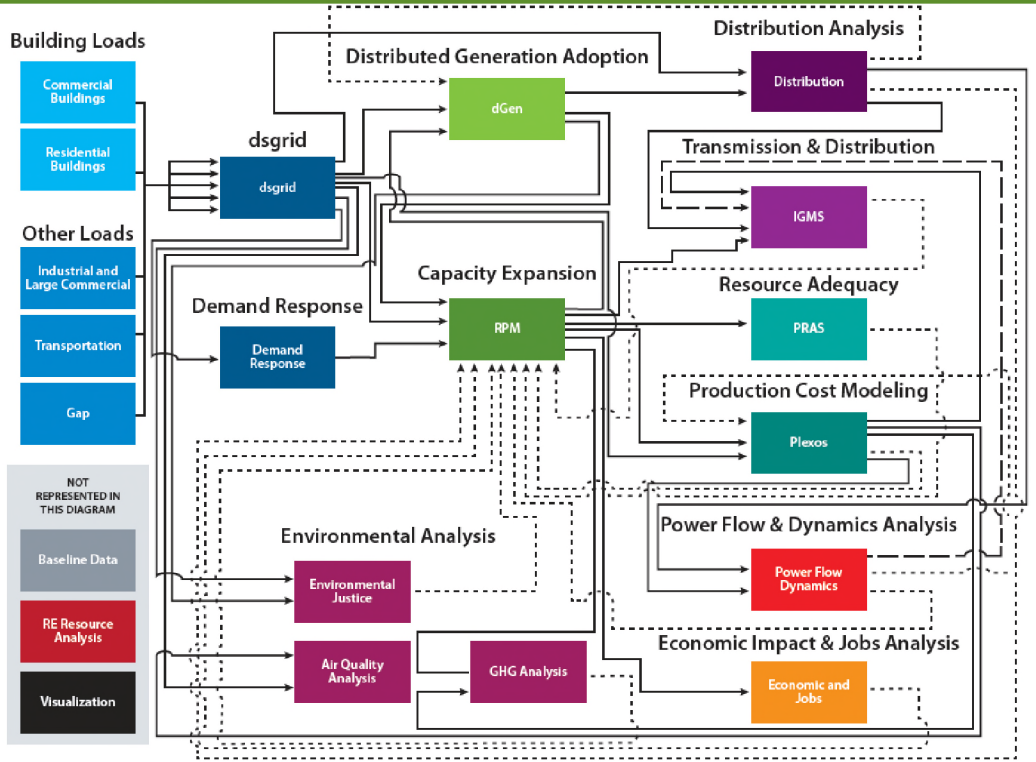


LA100 Employs NREL's High-Performance Computing

dGen
Modeled every property in LA (**625,291** agents), totaling **>65M** simulations

Buildings
Modeled **>7M** buildings using **3.6M** processor hours, which would take **>60 years** to finish on a laptop

dsgrid
Allocated **5** modeling teams' loads to **625,291** geographic locations, generating **>3.5M** combinations and producing **50 TB** of data; if stored in CDs, this would be taller than a **16-story building**



Distribution
Modeled every electric wire in LA (over **1,600** circuits) for thousands of scenarios each—totaling **>25M** detailed engineering simulations

RPM
Simulated **>8,000 years** of dispatch , which would require **2 decades** worth of computing on a laptop

Plexos
Ran **>7.6** node-years on Eagle, which is like conducting a simulation **24/7 for 7.6 years straight** on a laptop

= Over 100 million simulations

Advisory Group Provides Input and Review Throughout the Study

Representatives:

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

Scenarios Based on LA Advisory Group Priorities

SB100

Evaluated under Moderate, High, and Stress Load Electrification

- 100% clean energy by **2045**
- Only scenario with a target based on retail sales, not generation
- Only scenario that allows up to 10% natural gas, offset by renewable electricity credits
- Allows existing nuclear and upgrades to transmission

Early & No Biofuels

Evaluated under Moderate and High Load Electrification

- 100% clean energy by **2035**, 10 years sooner than other scenarios
- No natural gas generation or biofuels
- Allows existing nuclear and upgrades to transmission

Limited New Transmission

Evaluated under Moderate and High Load Electrification

- 100% clean energy by **2045**
- Only scenario that does not allow upgrades to transmission beyond currently planned projects
- No natural gas or nuclear generation

Transmission Focus

Evaluated under Moderate and High Load Electrification

- 100% clean energy by **2045**
- Only scenario that builds new transmission corridors
- No natural gas or nuclear generation

Each Scenario Evaluated Under Different Customer Demand Projections
(different levels of energy efficiency, electrification, and demand response)

Moderate

High

Stress

Major Updates

- 2019-2020 changes to reflect:
  - Mayor Eric Garcetti announcement of no Once-Through Cooling Repowering
  - Electrification targets under L.A.'s Green New Deal: Sustainable City pLAn 2019
  - Consideration of hotter temperatures due to climate change
  - Qualitative assessment of impact of electrifying medium- and heavy-duty vehicles
  - Monetization of morbidity and mortality due to changes in ozone and PM2.5
- COVID-19 Pandemic
  - Advisory Group meetings and community outreach now virtual

Progress to Date

- 14 of 15 Advisory Group meetings held
- All modeling completed
- Website of results shared with Advisory Group
- LA100 final report is drafted

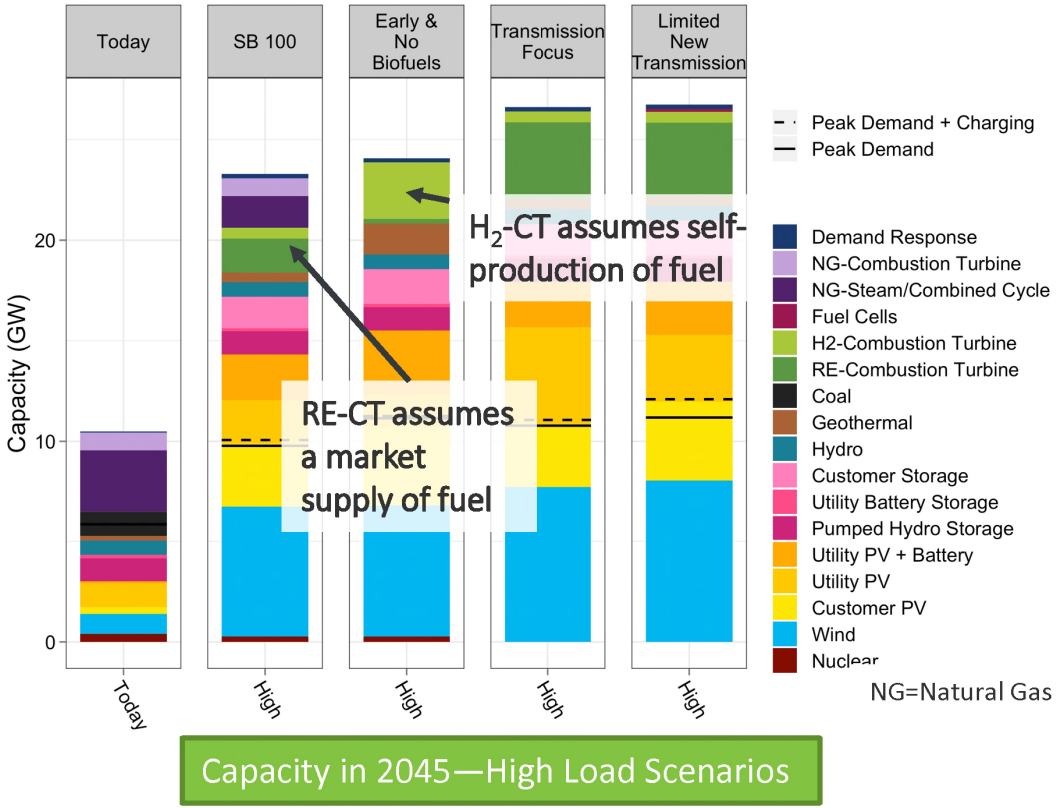
Example Results:
One day's EV charging
August 10, 2045
(Moderate Load)

1 kWh → ~4 miles driving

Place holder for a video

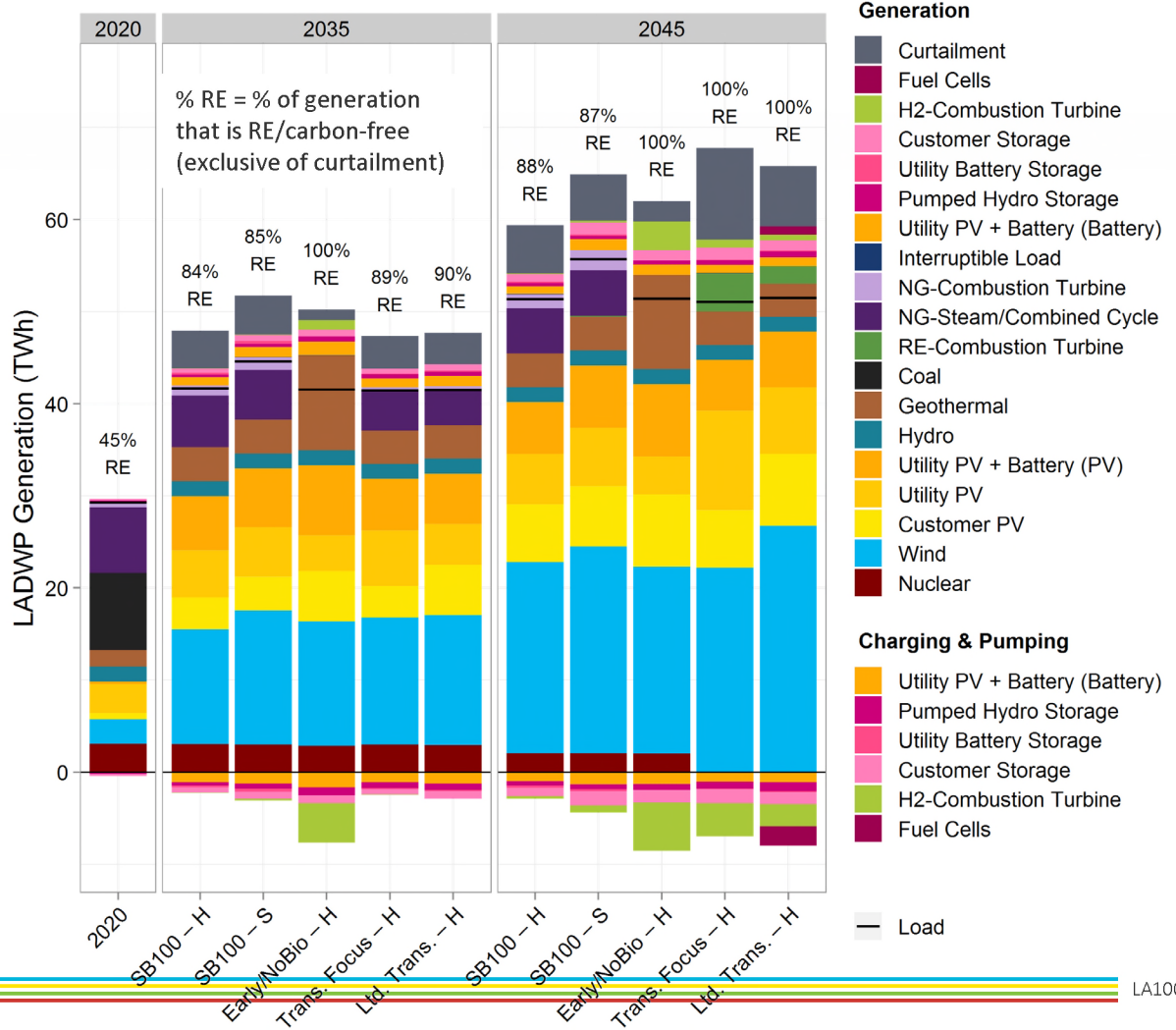
100% RE Is Achievable; the Broader the Eligible Solutions, the Lower the Costs

- Wind and solar resources meet the majority of energy needs (70%–90%)
- Storage resources with 4–12 hours of storage are key to enabling increased use of wind and solar
- New in-basin RE-fueled (e.g., hydrogen) power plants that can come online within minutes and run for hours to days comprise the least-cost options to maintain reliability
- Breadth in eligibility of how to meet 100% target can help manage uncertainty of new fuel options (costs, market readiness)



Annual Generation

High & Stress Load Scenarios



Across All Scenarios

Transmission

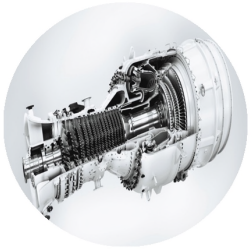
More

Renewable Energy

Customer Rooftop Solar

Storage

Flexible Load



Renewable-Fuel Combustion Turbine

Much more

Very different

New

Coal, natural gas

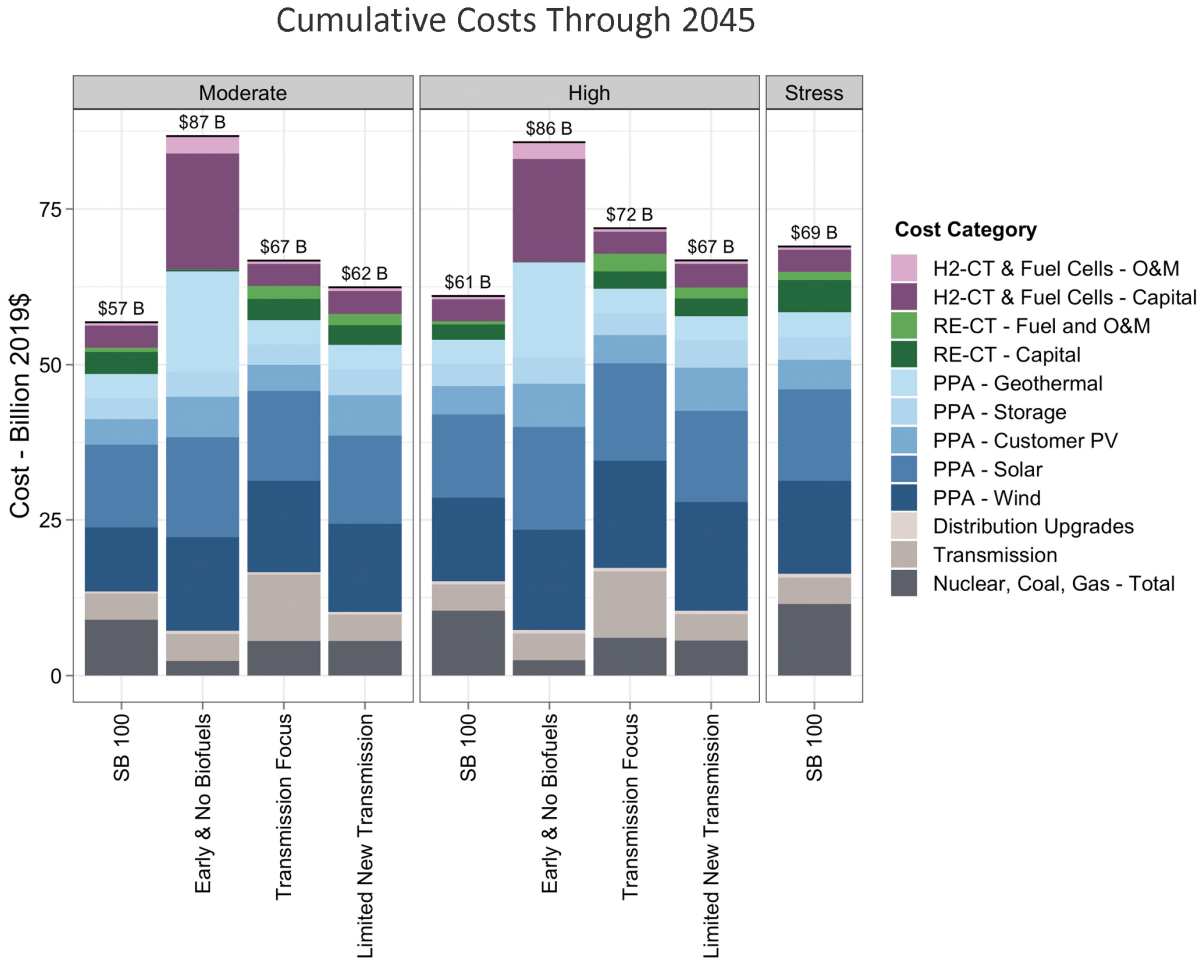
Daily

Biofuel/ hydrogen

Infrequently

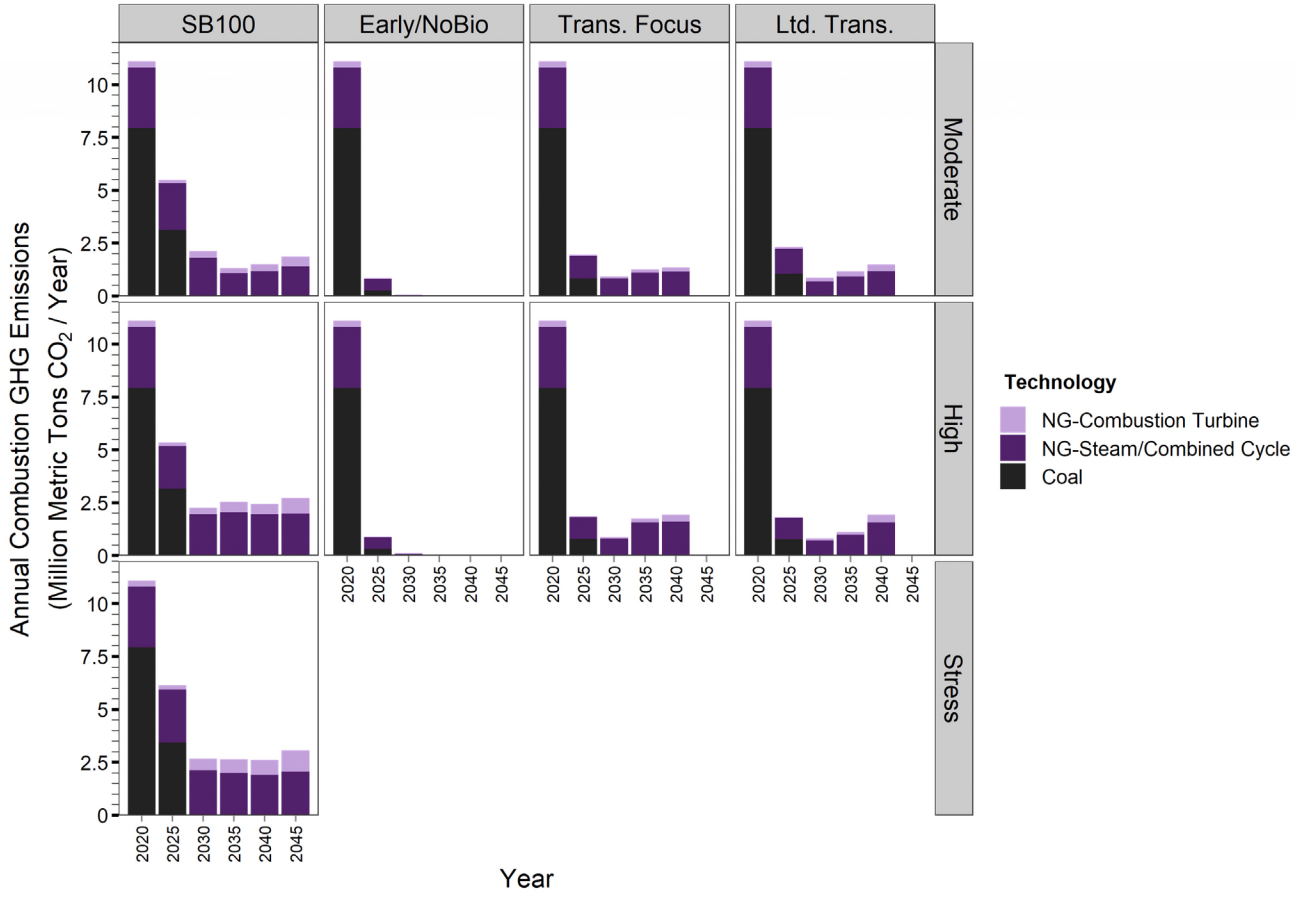
Total bulk system costs are dominated by investment in new solar, wind, and storage.

Pathways that do not allow biofuel plants to be built (i.e., Early & No Biofuel scenarios) result in substantially higher cost.



Greenhouse Gas Emissions

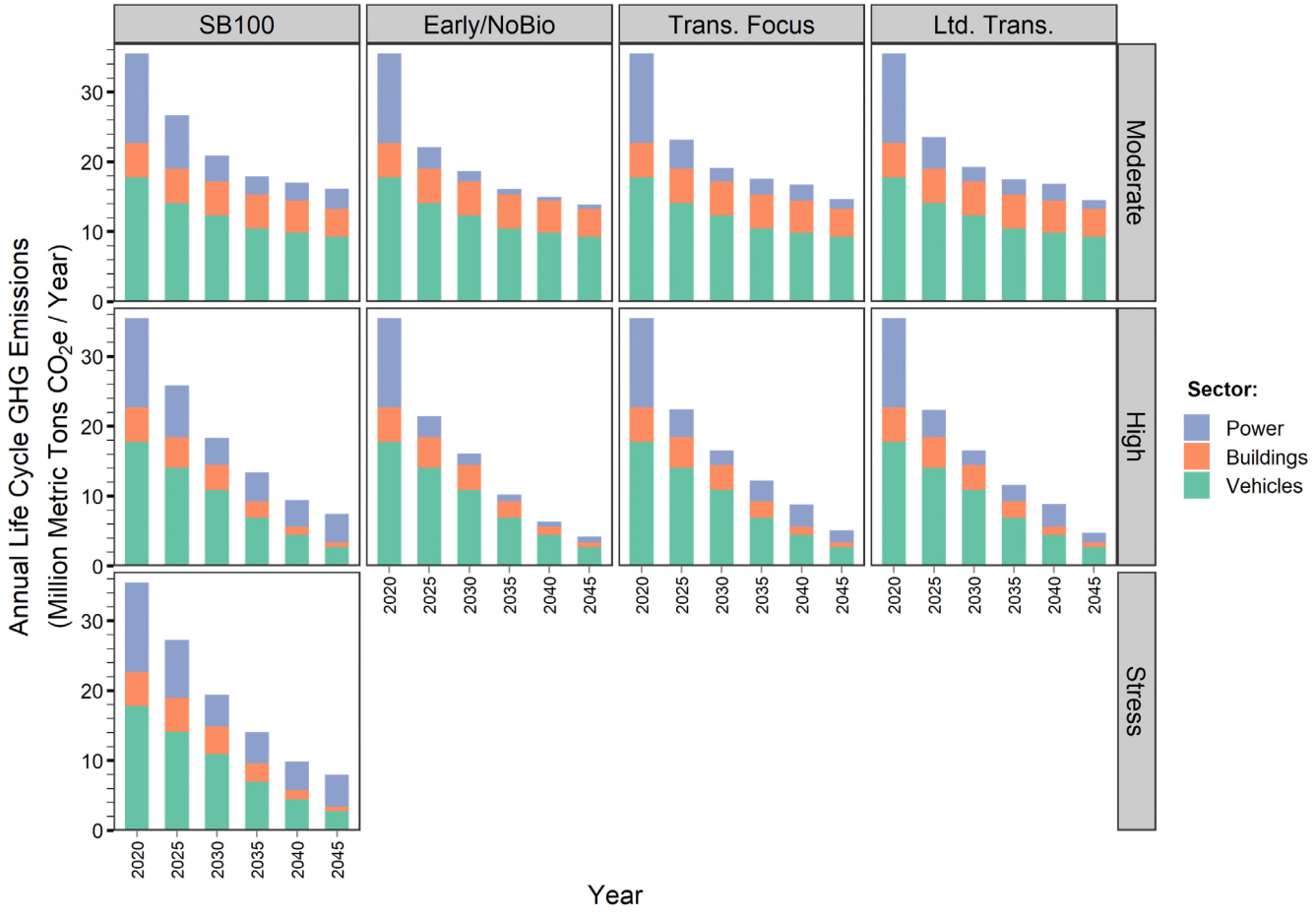
Significant drops in power-sector emissions by 2030 across all scenarios due to elimination of coal at Intermountain Power Plant



Life-Cycle Greenhouse Gas Emissions

All Sectors

Electrifying buildings and cars (middle “High” row) results in least overall emissions, especially by 2045



Examples of Other Components of LA100

Other Components of LA100

- **Air quality** changes to ozone and $PM_{2.5}$ concentrations
- **Health impacts** (select morbidity and mortality) from changes in exposure to ozone and $PM_{2.5}$
- **Monetization** of benefits (health and greenhouse gases)
- **Environmental justice analysis** using CalEnviroScreen
- **Net economic impacts** within the City of LA
- **Workforce needs** within and outside of the LA basin
- Projections of **customer solar and storage**
- Locations for **LADWP-procured solar and storage**
- **Upgrades** and associated costs on the **distribution grid**

Emissions inventory: Contribution of LA100-related sectors to annual average emissions in the City of Los Angeles in 2045

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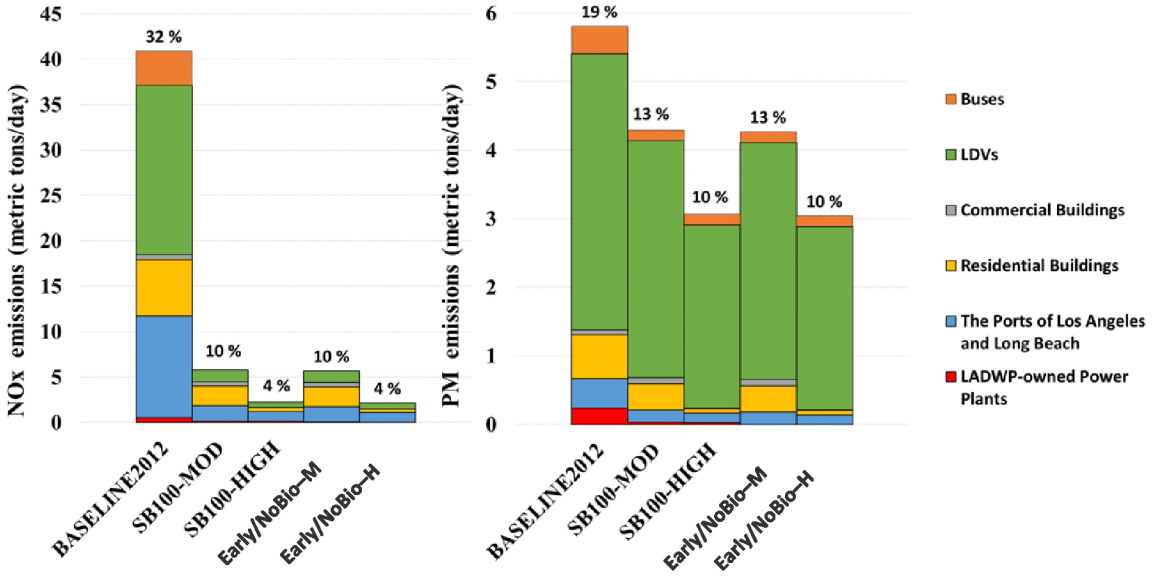

% represents the fraction of emissions that are from the six LA100-related sectors in the total city of LA inventory

Health impact analysis builds from air quality analysis

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Premature Mortality (Ozone & $PM_{2.5}$)

- We quantify premature deaths from exposure to pollutants:
  - Avoided premature deaths from change in the concentration of $PM_{2.5}$ and ozone

Morbidity (Ozone & $PM_{2.5}$)

- We quantify morbidity health effects that are the same **health indicators used in the CalEnviro Screen**, specifically:
  - Emergency department visits for asthma (resulting from O_3 and $PM_{2.5}$) and
  - Emergency department visits for cardiovascular causes ($PM_{2.5}$)

Monetization of health and greenhouse gas benefits

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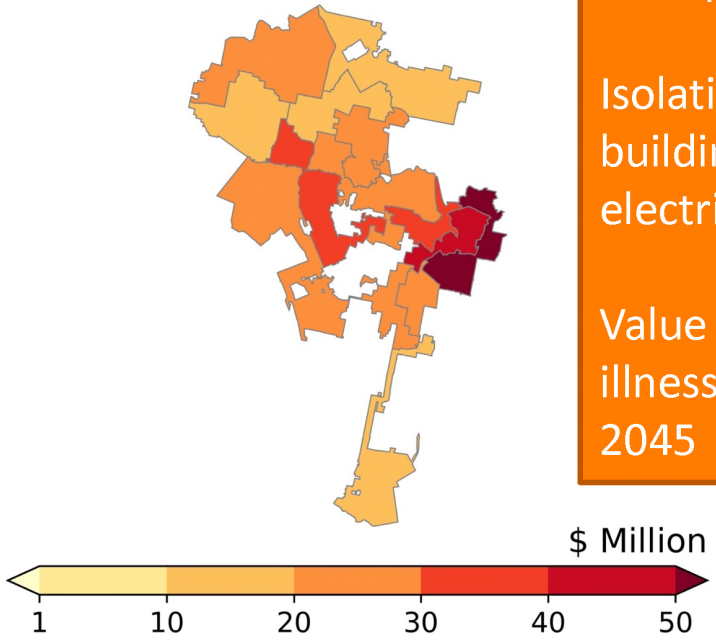

Example:

Isolating the impacts of building & vehicle electrification

Value of avoided cost of illness and early mortality in 2045

Environmental Justice

- **Air quality** changes to ozone and PM concentrations
- **Health impacts** (select morbidity and mortality) from changes in exposure ozone and $PM_{2.5}$
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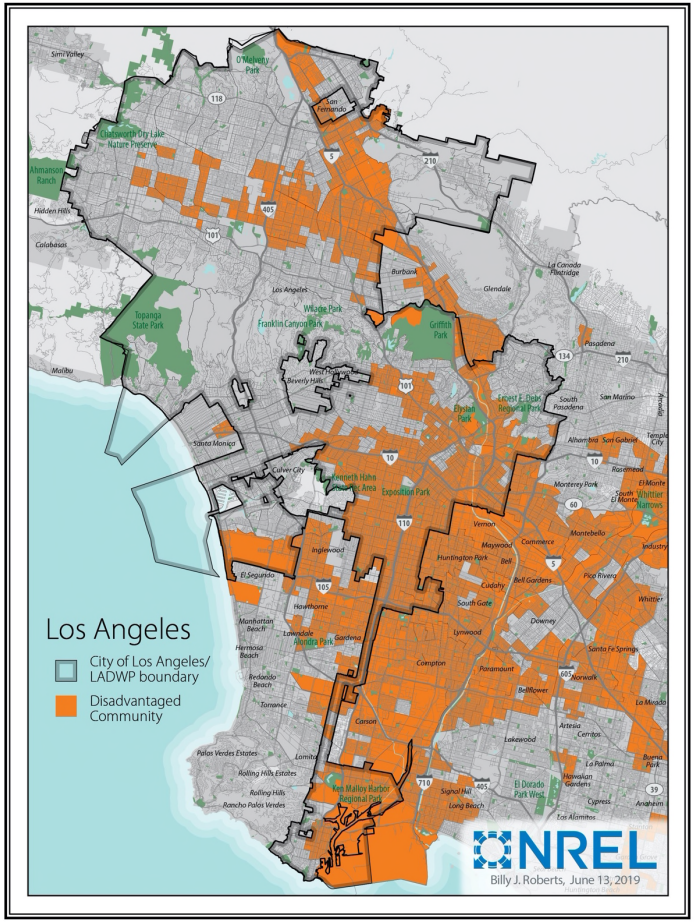
Environmental justice efforts include:

- Facilitating participation in discussions about study scope and results
- Analysis of health benefits using CalEnviroScreen
- Analysis of locational distribution of energy infrastructure



Economic analysis: Positive and negative impacts of LA100 scenarios

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Assess **potential net employment and income impacts** within the City of LA for different LA100 scenarios

Estimate **both positive and negative impacts** to the economy, along with **who** is most affected

Workforce analysis estimates onsite, supply chain, and induced jobs within and outside of LA

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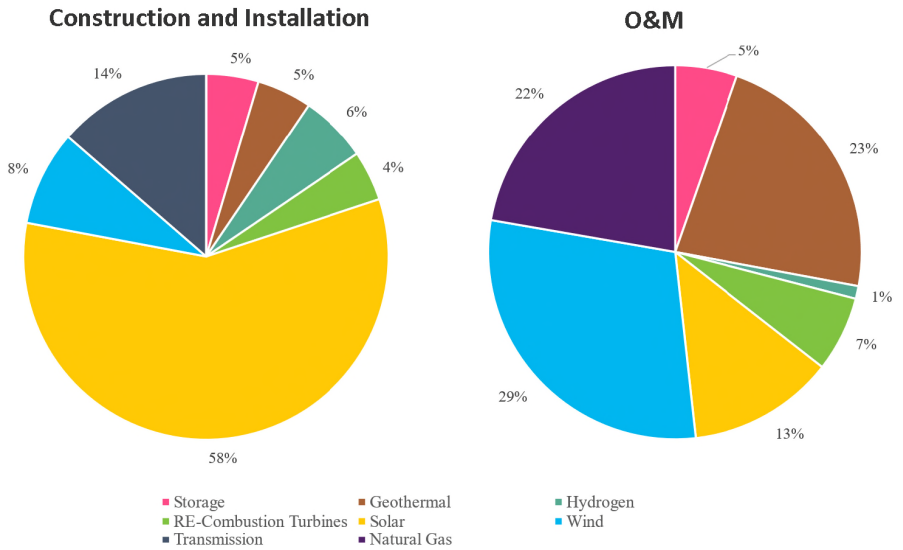
Types of information to be provided:

- Annual construction, O&M jobs
- Average earnings per worker



Example: Distribution of employment (average over 2026-2045 and all scenarios)

Strong projections in customer solar, even if compensation for midday generation is reduced

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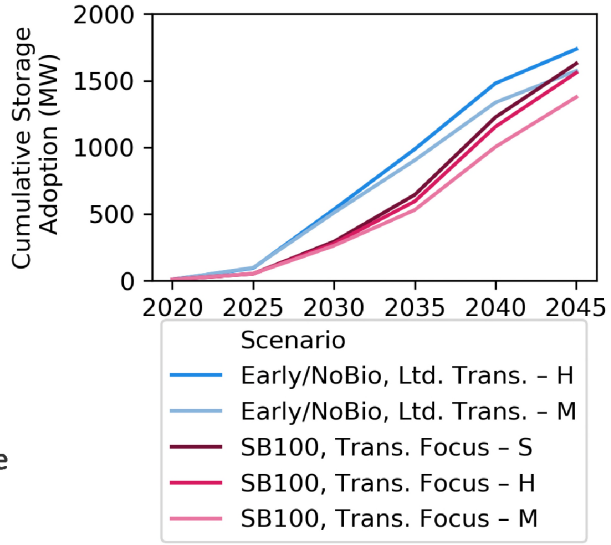
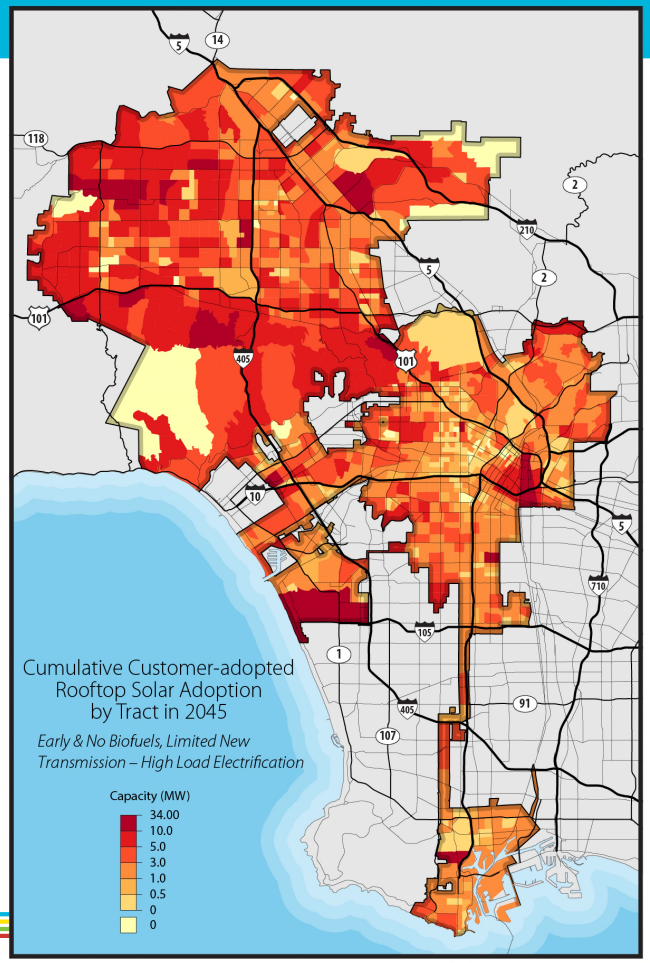


Customer Adoption of Rooftop Solar (MW)



Significant potential for ground-mount solar, but out-of-basin solar is less expensive

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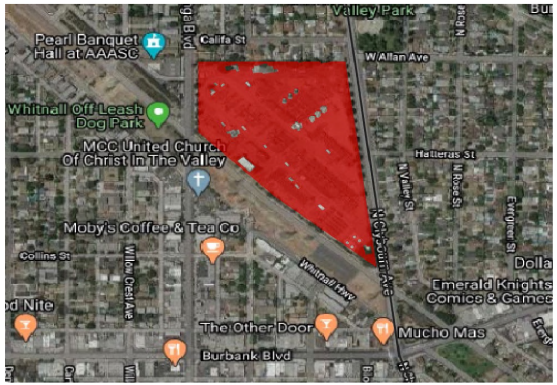
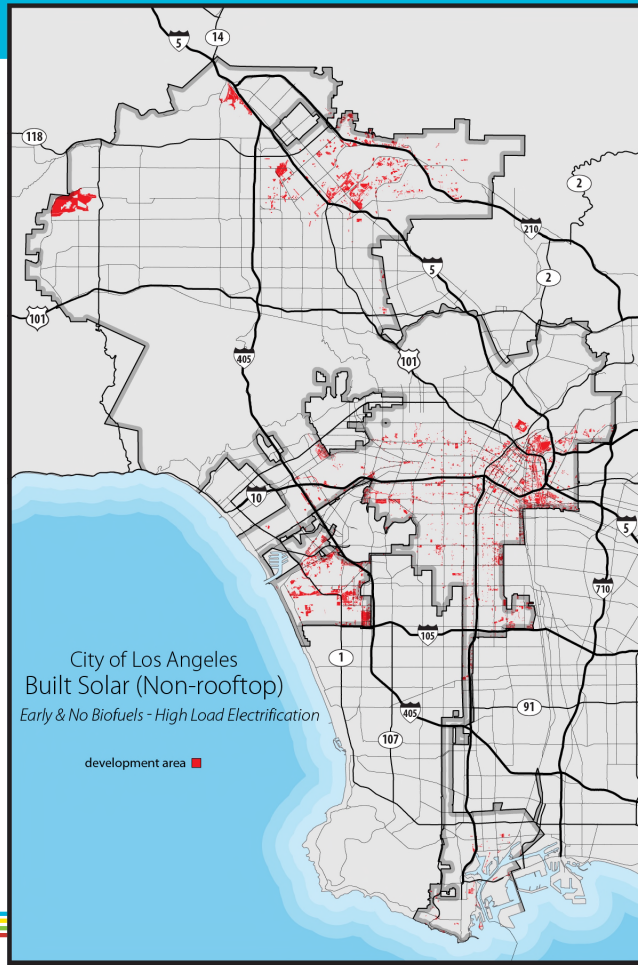
GIS analysis used to rank potential solar and storage sites.

Example of potential: LADWP-owned land in North Hollywood





Distribution grid upgrade costs driven by significant changes in load on 4.8 kV system; small fraction of total LA100 costs

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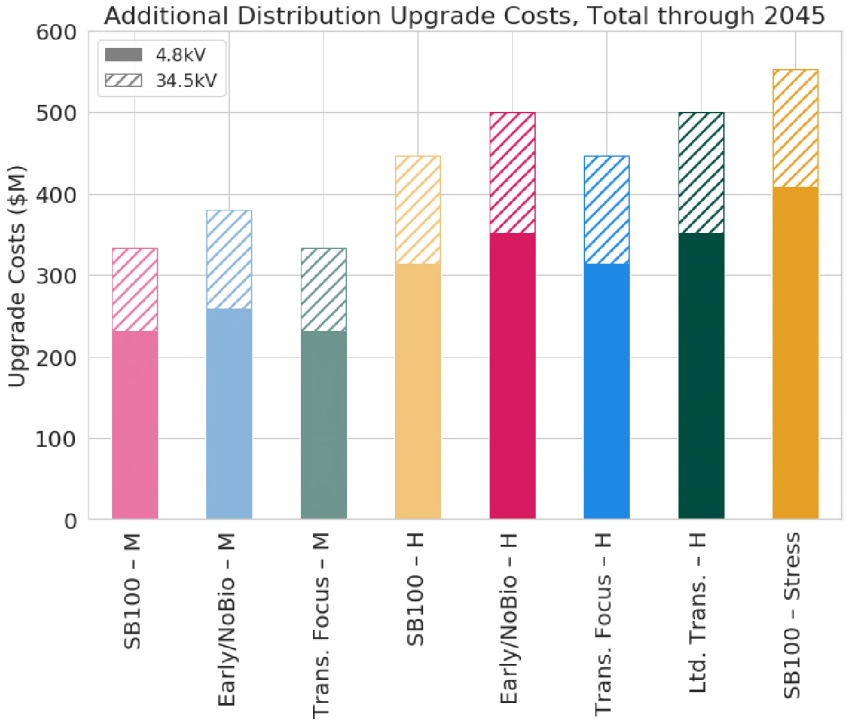
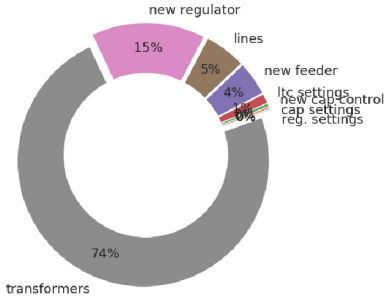


Results from >1400 circuits modeled

Costs by upgrade type



4.8kV
All Scenarios

Outreach Timeline

January – March: Community outreach by LADWP and NREL

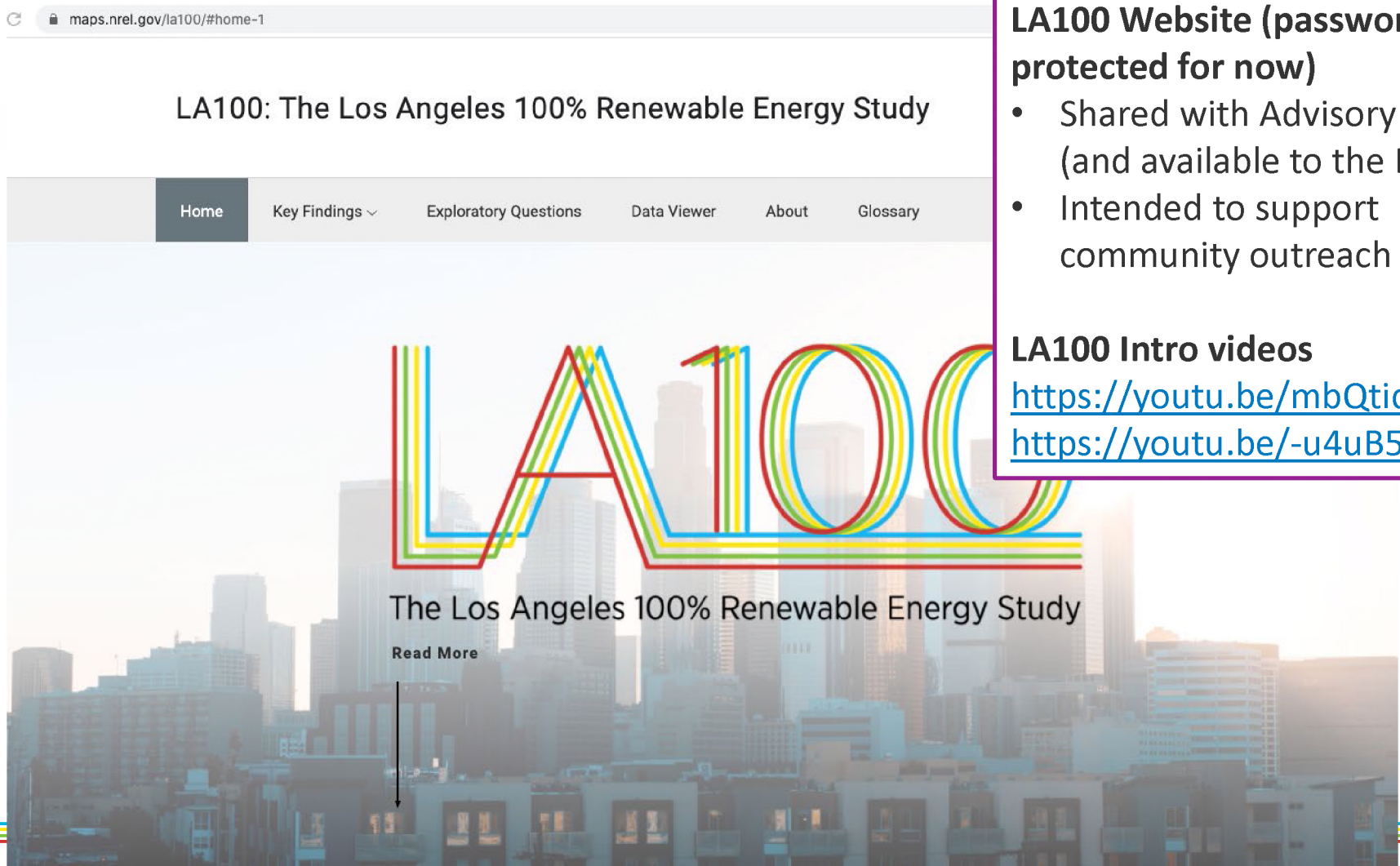
- Meetings spanning morning, afternoon, evening, and weekend
- Additional presentations to NC Alliances

March 2021—Delivery of final report and interactive website

Round 1 Dates

1. Thursday afternoon, Jan 21, 1:00-2:30 pm
2. Thursday evening, Jan 21, 6:30-8:00 pm
3. Friday afternoon, Jan 22, 1:00-2:30 pm
4. Saturday morning, Jan 23, 10:00-11:30 am
5. Saturday morning, February 6, 8:30-10:00 am

Round 2 dates in March TBD



LA100 Website (password protected for now)

- Shared with Advisory Group (and available to the Board)
- Intended to support community outreach

LA100 Intro videos

https://youtu.be/mbQtidp1HCQ
https://youtu.be/-u4uB5H2u5g

Thank you!

The Los Angeles 100% Renewable Energy Study

Additional Slides

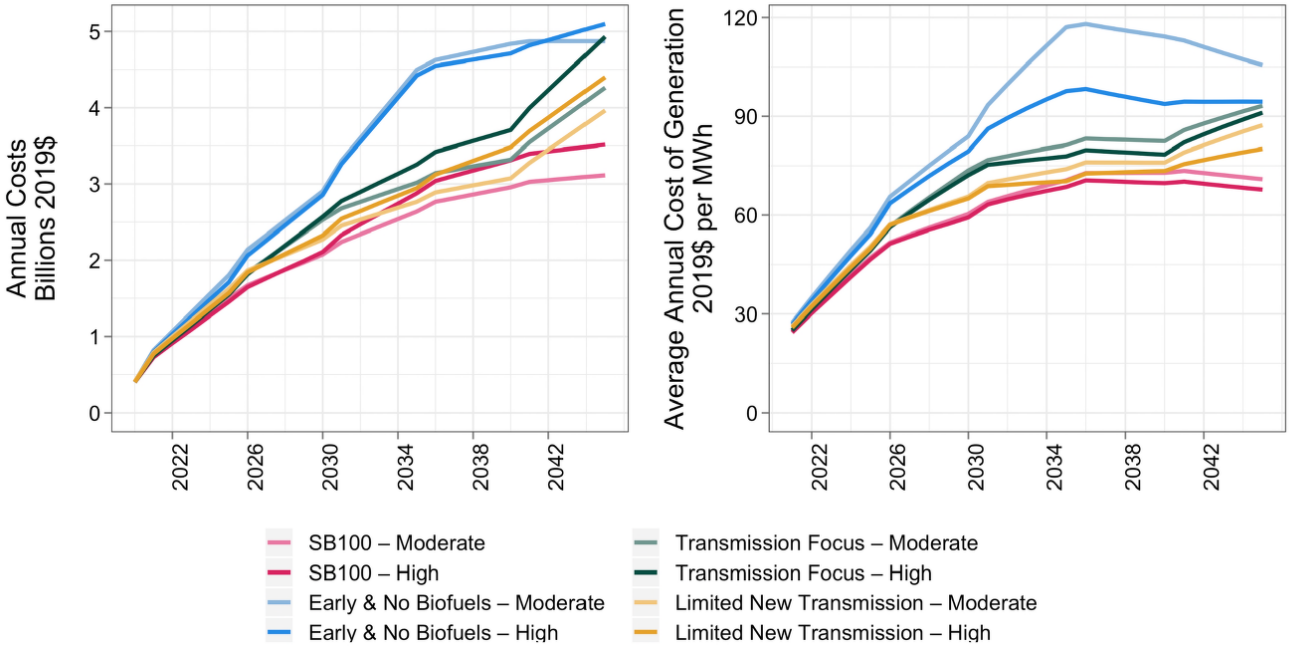
Scenarios Based on LA Advisory Group Priorities

	LA100 Scenarios								
	Moderate Load Electrification				High Load Electrification				Stress
	SB100	Early & No Biofuels	Transmission Focus	Limited New Transmission	SB100	Early & No Biofuels	Transmission Focus	Limited New Transmission	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
Solid Biomass	N	N	N	N	N	N	N	N	N
Fuel Cells	Y	Y	Y	Y	Y	Y	Y	Y	Y
RE-derived Hydrogen Combustion	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
Nuclear - New	N	N	N	N	N	N	N	N	N
Wind, Solar, Geothermal	Y	Y	Y	Y	Y	Y	Y	Y	Y
Storage	Y	Y	Y	Y	Y	Y	Y	Y	Y
Biofuel Combustion	Y	**No**	Y	Y	Y	**No**	Y	Y	Y
Natural Gas	Y	**No**	**No**	**No**	Y	**No**	**No**	**No**	Y
Nuclear - Existing	Y	Y	**No**	**No**	Y	Y	**No**	**No**	Y
Financial Mechanisms (RECS/Allowances)	**Yes**	N	N	N	**Yes**	N	N	N	**Yes**
Distributed Adoption	Moderate	**High**	Moderate	**High**	Moderate	**High**	Moderate	**High**	Moderate
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**
New or Upgraded Transmission Allowed?	Only Along Existing or Planned Corridors	Only Along Existing or Planned Corridors	**New Corridors Allowed**	**Limited to Current Plans**	Only Along Existing or Planned Corridors	Only Along Existing or Planned Corridors	**New Corridors Allowed**	**Limited to Current Plans**	Only Along Existing or Planned Corridors
WECC VRE Penetration	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

The reference case is the 2017 IRP "Recommended Case," which allows comparison of cost and reliability to business as usual.

Total bulk system costs are dominated by investment in new solar, wind, and storage.

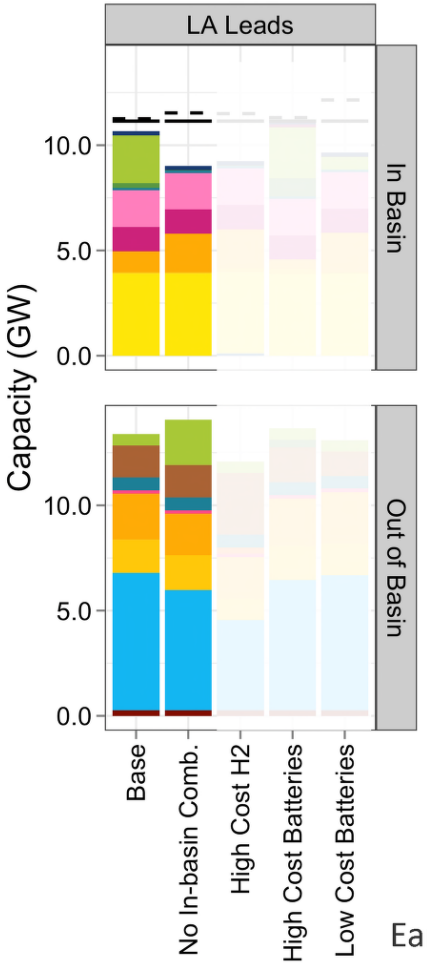
Pathways that do not allow biofuel plants to be built result in substantially higher cost.

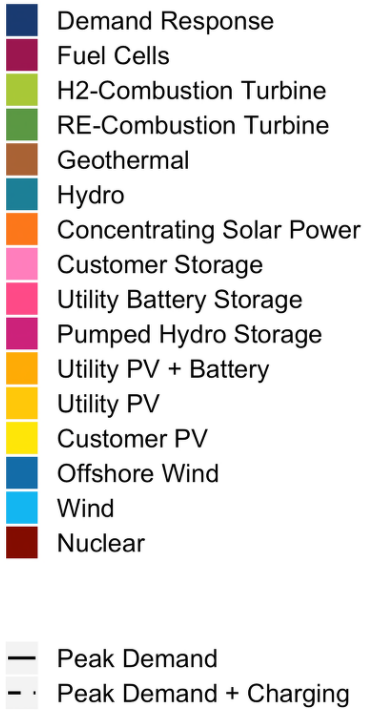


Note that these costs do not include costs of existing (prior to 2021) debt payments or PPAs, or costs associated with future distribution O&M, energy efficiency or demand response program costs

Managing Uncertainty

What happens if in-basin hydrogen combustion and fuel cells are not an option?





In-basin:
More utility PV+battery

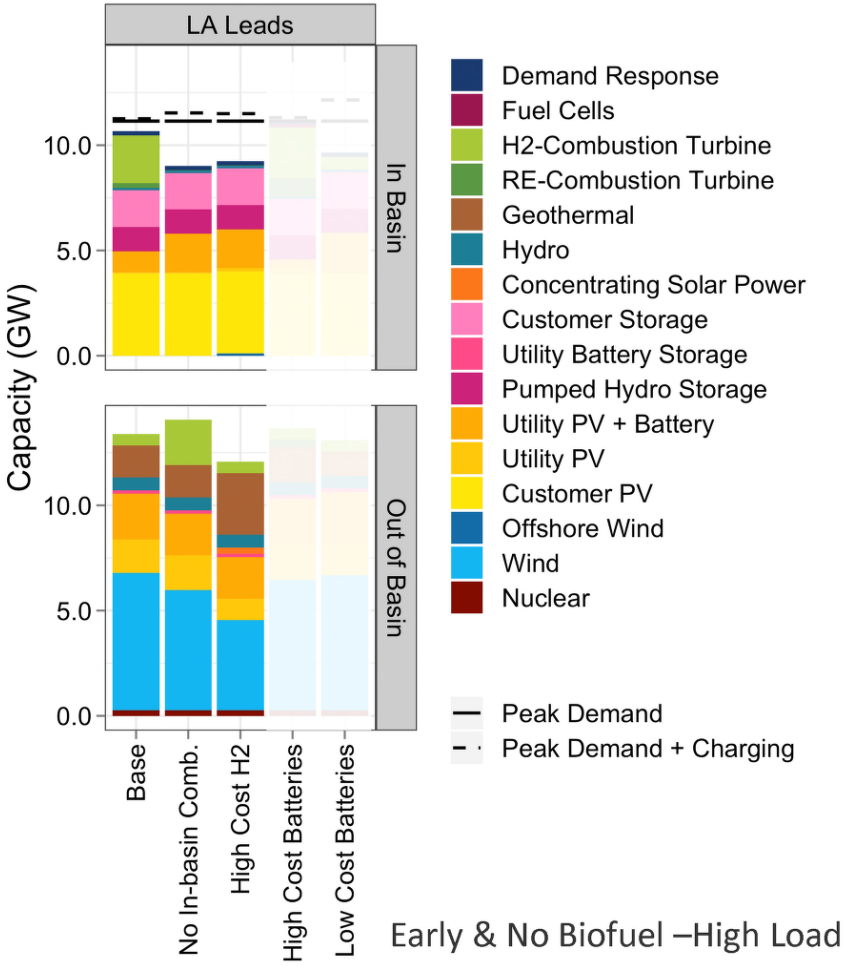
Out-of-basin:
More hydrogen, more transmission upgrades

Early & No Biofuel –High Load

Note, resiliency to contingency events are not evaluated in this sensitivity

Managing Uncertainty

What happens if hydrogen costs are higher?



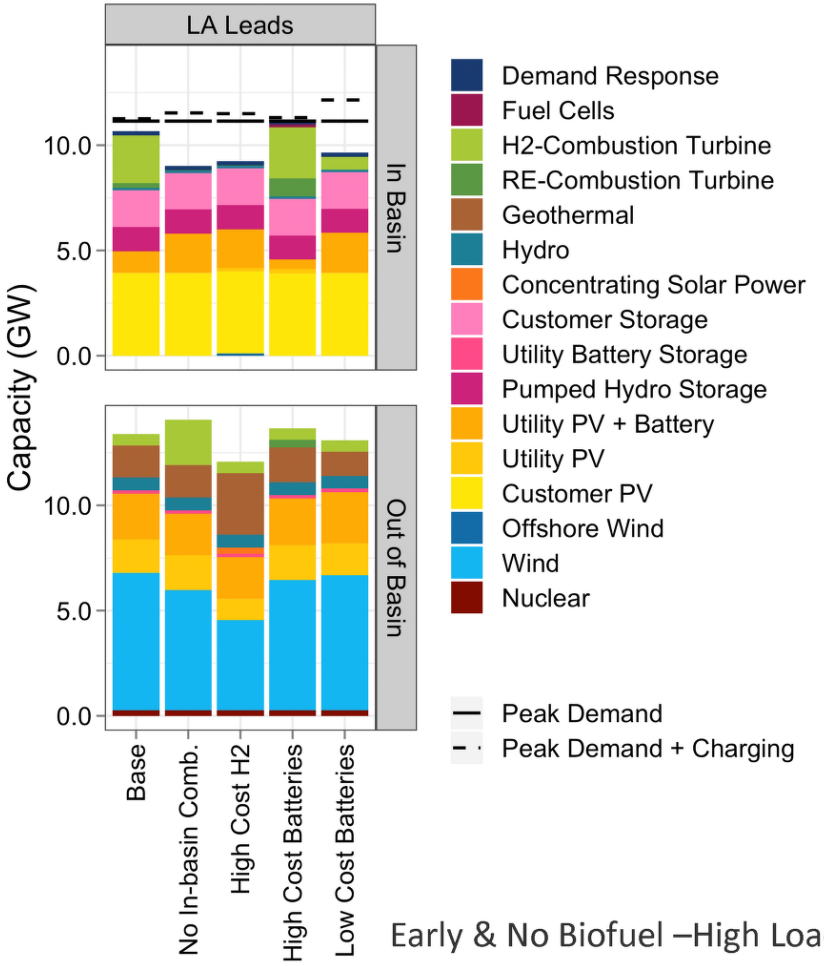
In-basin:
More utility PV+battery, less hydrogen

Out-of-basin:
More geothermal, less wind

Note, resiliency to contingency events are not evaluated in this sensitivity

Managing Uncertainty

What happens if battery costs are higher or lower?



Higher battery costs → more seasonal storage (RE and H_2 CTs, fuel cells)

Lower battery costs→ more PV+ battery, less hydrogen and geothermal

Note, resiliency to contingency events are not evaluated in this sensitivity