Equitable Transportation Electrification: Lessons from the Los Angeles 100% Studies and Path Forward

Vikram Ravi, Yun Li, Garvin Heath
National Renewable Energy Laboratory

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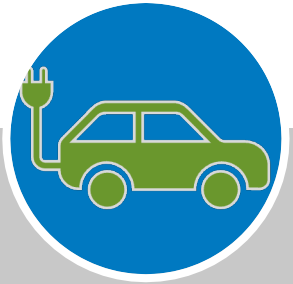
Outline

LA 100 Study



LA100 Outcomes

LA 100 Equity Strategies

Heavy-Duty Trucks Electrification

Summary and Strategies

LA100 Study Overview

Detailed, large-scale analysis evaluating a range of future scenarios to equip city of Los Angeles (LA) decisionmakers to understand:

- 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 is the **impact on the environment**?
- How might the **economy** respond to such a change?
- How can **environmental justice communities** be part of the solution?

LA100

The Los Angeles 100% Renewable Energy Study

In 2021, NREL's LA100 study found that reliable, 100% renewable energy is achievable,

and, if coupled with electrification of other sectors—primarily transportation—can provide significant environmental and health benefits.

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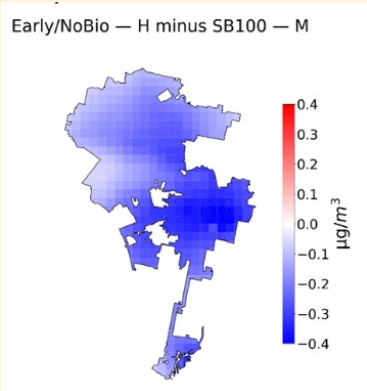
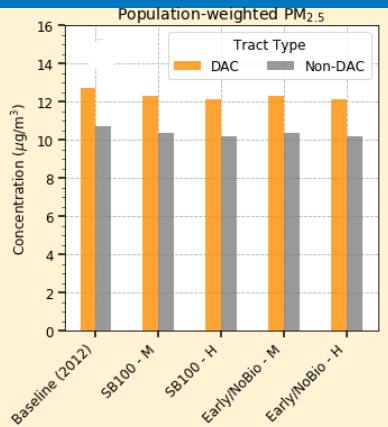
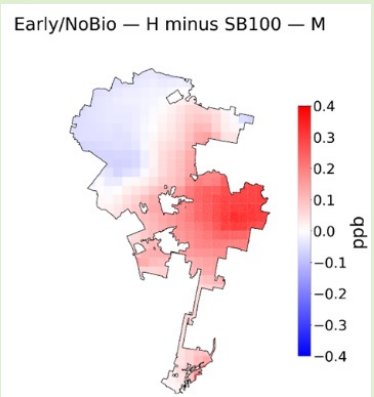
LA100 Air Quality –Related Outcomes

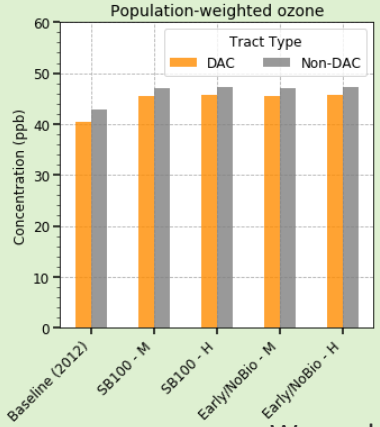
$PM_{2.5}$





Ozone





Li et al. *Env Res Lett* (2023), Cochran et al. *Cell Rep Sust* (2024)

Benefits are almost **equally distributed** among DAC and non-DACs (~50% each)

Key: M - Moderate Electrification, **H** - High Electrification, **DAC** – Disadvantaged Community

We analyzed multiple scenarios, only select shown

But improving energy equity requires intentionally designed strategies.

LA100 Equity Strategies set out to identify ways to improve energy equity in LA's transition to clean energy.

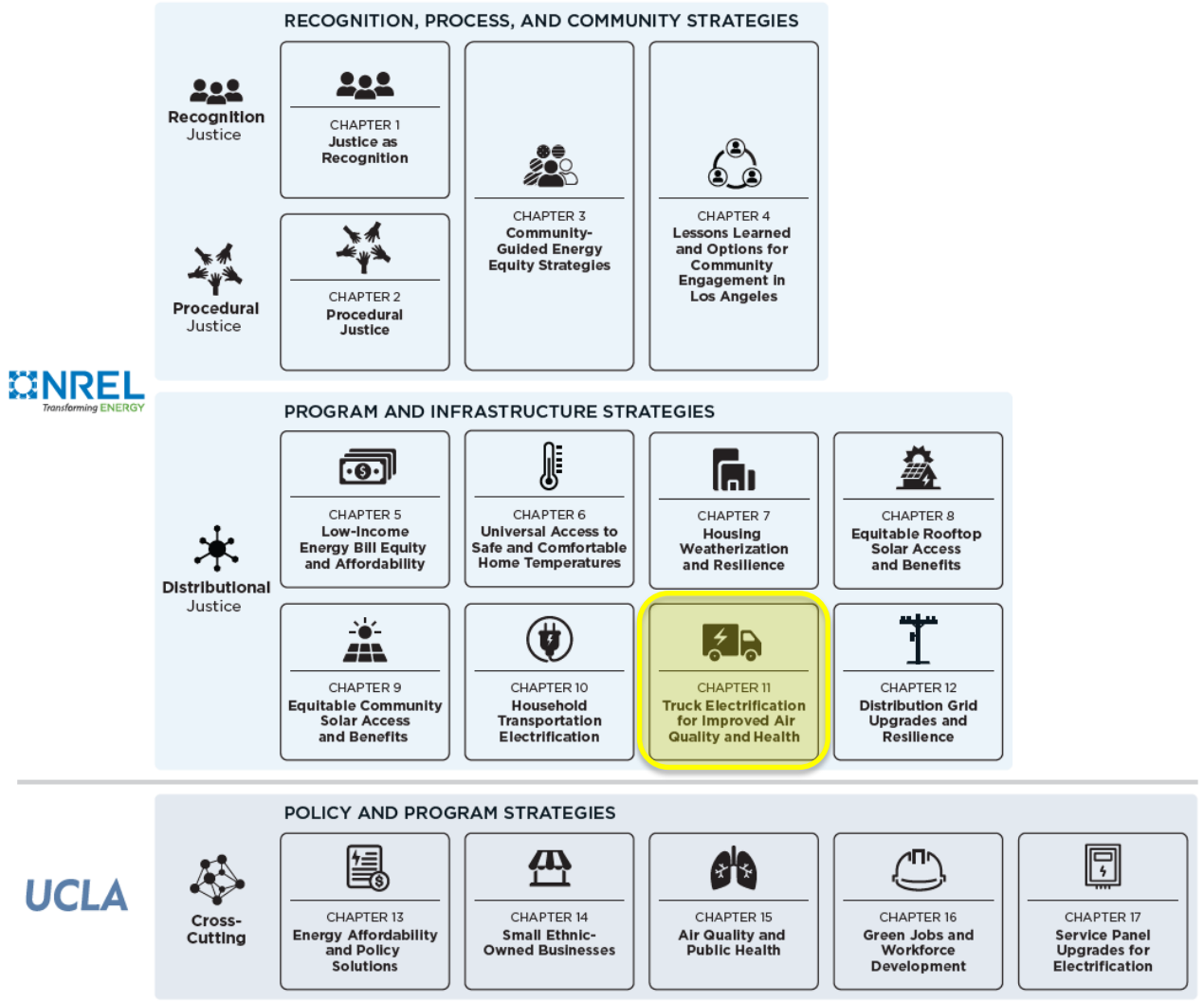
Photo from Getty Images 683451678

Study Overview

Study results available at:

https://maps.nrel.gov/la100/equity-strategies

Anderson et al. (2023)



Community- and Data-Informed Strategies

NREL analysis included input from:

- **100+ community members**
- **14 community-based organizations**
- **19 Steering Committee meetings**
- **9 Advisory Committee meetings**
- **32 city and nonprofit agencies**

NREL **modeled business-as-usual and multiple equity scenarios** for:

- Energy bill affordability and equity
- Access to safe home temperatures
- Solar bill savings
- EV adoption and charging access
- E-bike & shared EV time & cost savings
- Truck electrification air quality and health benefits
- Grid reliability and resilience

Impacts analyzed by **equity metrics** including:

- Disadvantaged community status
- Income
- Homeowner/renter status
- Housing type (multifamily, single-family)
- Neighborhood
- Pollution exposure

For example, in housing, NREL modeled **hourly electricity and gas usage** for:

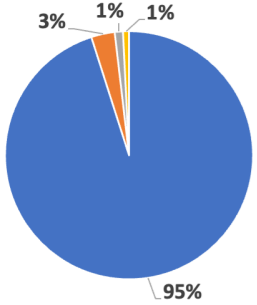
- **50,000 representative households**
- Across **100** household and building characteristics
- Representing diversity of **1.57 million LADWP customers**

Truck Electrification: Why is it important?

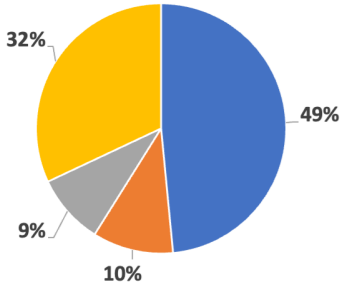
Heavy-duty truck (HDT) categories
(Class 2b-8: 8,501 lbs. and over):

- Light heavy-duty truck (LHDT, Class 2b-3)
- Medium heavy-duty truck (MHDT, Class 4-7)
- Heavy heavy-duty truck (HHDT, Class 8)

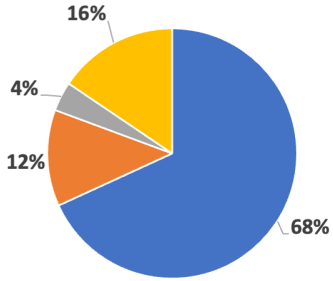
On-Road Motor Vehicle Population



Daily On-Road Motor Vehicle NOx Emissions

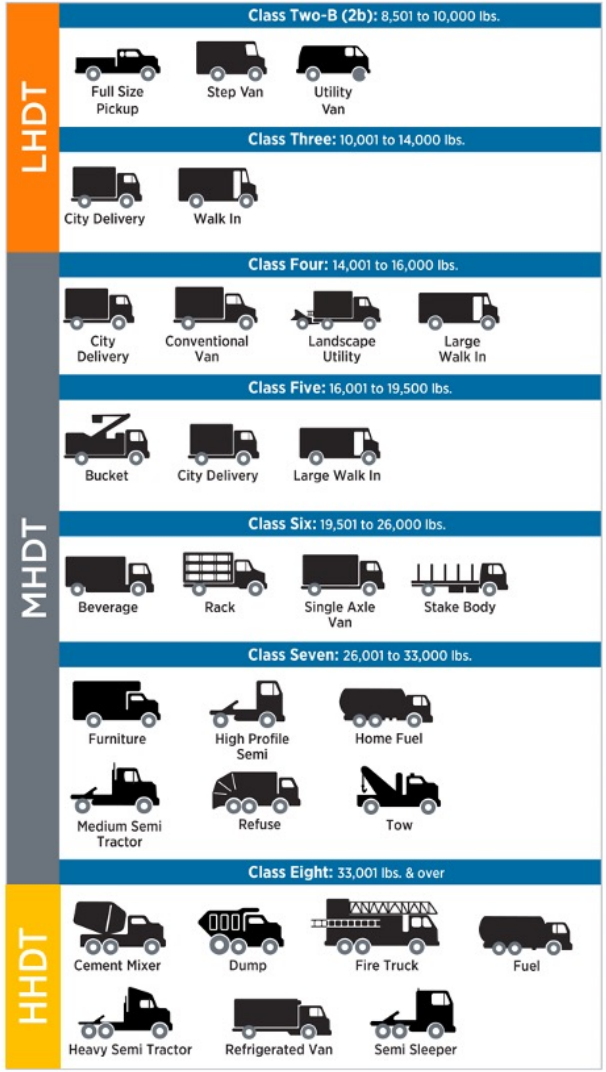


Daily On-Road Motor Vehicle Primary $PM_{2.5}$ Emissions



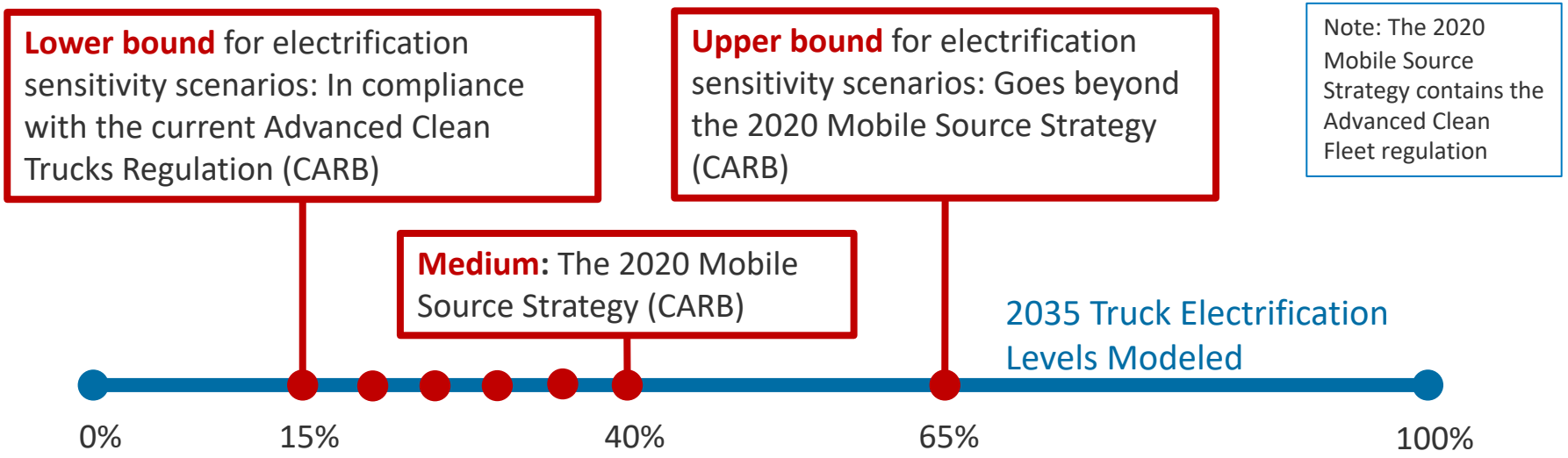
Other Vehicle Categories | LHDT | MHDT | HHDT

* Based on California Air Resource Board (CARB) Emission FACtor (EMFAC2021) model for LA (South Coast sub-area) for 2022

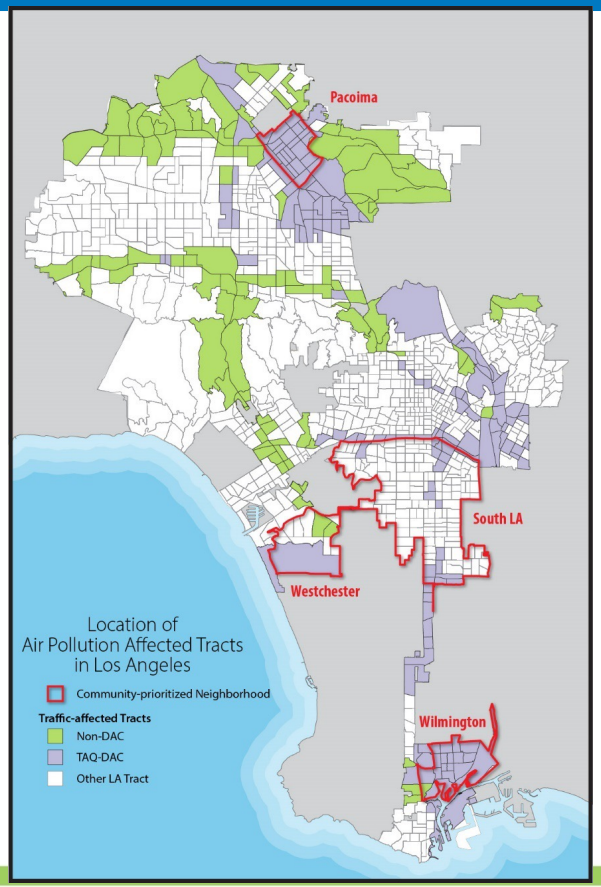


Truck Electrification: Scenarios

- We modeled multiple truck electrification scenarios in **2035** under electrification levels tested for each of the three HDT categories:
  - 15%, 20%, 25%, 30%, 35%, 40%, 65%
  - The percentages represent the number of electric-HDTs in total HDTs population



Focus Census Tracts and Communities for Air Quality and Health Analysis



- We devised a methodology inspired by CalEnviroScreen to identify disadvantaged communities (DAC) tracts affected by traffic air quality (TAQ-DACs).
- Traffic-impacted non-DAC tracts were also identified for statistical comparison.
- Data and models:
  - High resolution meteorology from real-time mesoscale analysis
  - Dispersion modeling using RLINE
  - High resolution truck traffic data projected to 2035 from South Coast Area Governments

Truck Electrification Air Quality Impacts by Communities

How much reduction in annual NO_2 (ppb) and primary $PM_{2.5}$ ($\mu g/m^3$) concentrations can be achieved with every 1% additional electrification for each truck category?

Tract Category	Near-Road NO_2			Near-Road Primary $PM_{2.5}$		
	LHDT	MHDT	HHDT	LHDT	MHDT	HHDT
TAQ-DAC	0.0034	0.0055	0.099	0.0009	0.0004	0.0062
Non-DAC	0.0028	0.0041	0.077	0.0007	0.0003	0.0051
Increased Benefits for TAQ-DAC Versus Non-DAC						
(TAQ-DAC - Non-DAC) / Non-DAC	21%	34%	28%	28%	33%	22%

Key Finding:

- TAQ-DAC tracts benefit >20% more than non-DAC tracts from electrifying trucks

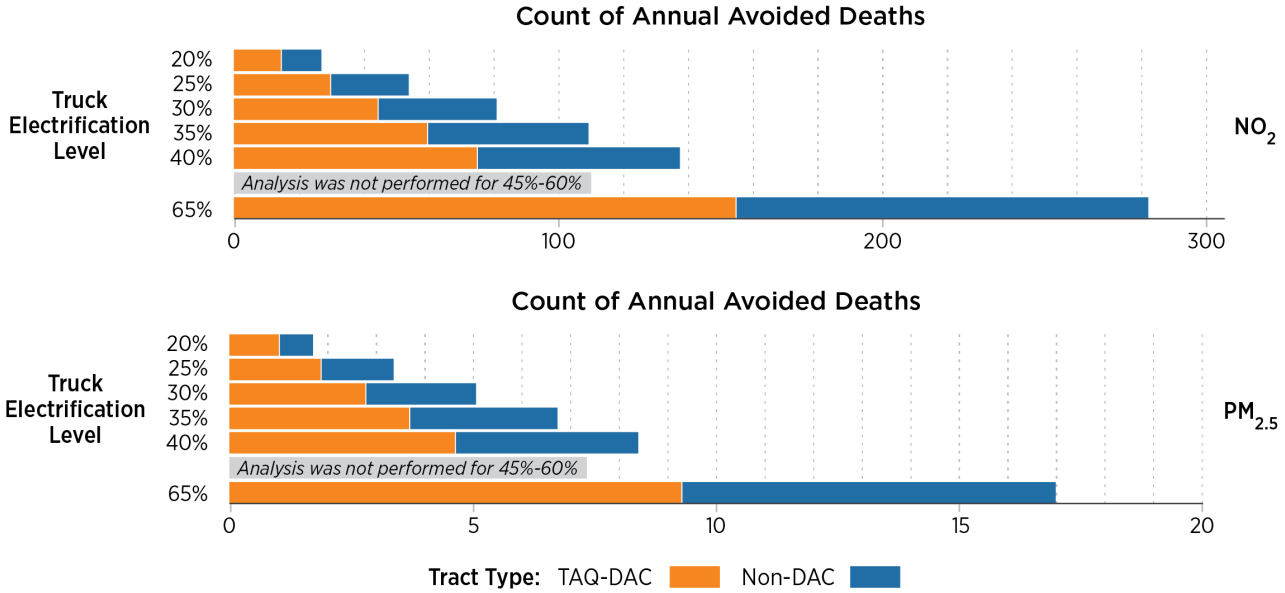
Public Health Benefits from Truck Electrification

Key findings:

- Electrification of HDTs could yield significant health benefits, including avoided premature deaths (shown on the right), and morbidity incidences such as ER visit and asthma.
- TAQ-DACs benefit more than non-DACs for each increment of additional truck electrification fraction across most health endpoints assessed.

Ravi et al., NREL, 2023

Annual avoided premature deaths from different electrification levels of HDTs for NO_2 and $PM_{2.5}$ relative to 15% electrification baseline



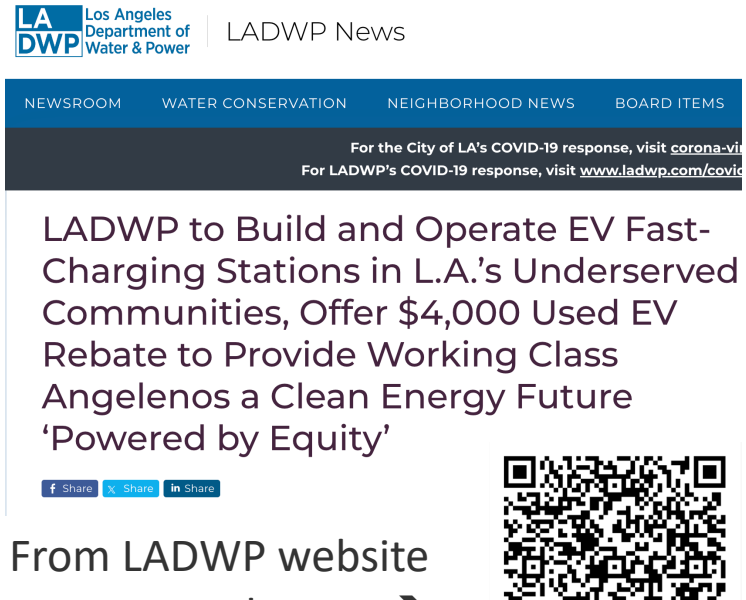
Charging Needs for Electrifying HDTs

Electrification Level	Percentage of LA-Registered Heavy-Duty Trucks Electrified in 2035 (excluding buses)	Number of Electrified Heavy-Duty Trucks (excluding buses)	Percentage Reduction in Incremental Near-Road NO_2 Concentration from Heavy-Duty Trucks in TAQ-DACs	Percentage Reduction in Incremental Near-Road $PM_{2.5}$ Concentration from Heavy-Duty Trucks in TAQ-DACs	Estimated Increased Demand (GWh/year)	Estimated Number of Chargers Needed
Charge Up LA! electrification level (assuming 2025 target met in 2035)	5%	3,800	4.7%	2.9%	55–230	1,900–3,300
EPA-approved ACT regulation, 2035 mandate	15%	10,000	14%	8.6%	140–640	5,000–8,700
Charge Up LA! electrification level (assuming 2030 target met in 2035)	16%	11,000	15%	9.2%	160–690	5,400–9,600
CARB-approved Advanced Clean Fleets regulation, 2035 goal	40%	28,000	38%	23%	400–1,700	14,000–24,000

Ravi et al., NREL, 2023

Key Findings and Equity Strategies

- TAQ-DACs experience approximately **25% more reductions** in near-road NO_2 and $PM_{2.5}$ concentrations than non-DACs from heavy-duty truck electrification.
- Electrification of heavy-duty trucks could yield significant health benefits, which are **greater in TAQ-DACs** than in non-DACs.
- **Prioritization of heavy heavy-duty trucks** (>33,000 lbs, HHDT) can lead to achieving the highest and most equitable air quality and health improvements.
- Utilities need to plan and prepare for **increased loads** from vehicle electrification.



From LADWP website

Read more ➔

Acknowledgement

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  - **USC**: Jiachen Zhang, George-Ban Weiss
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References

- Li, Yun, Vikram Ravi, Garvin Heath, Jiachen Zhang, Pouya Vahmani, Sang-Mi Lee, Xinqiu Zhang, Kelly T. Sanders, and George A. Ban-Weiss. "Air quality and public health co-benefits of 100% renewable electricity adoption and electrification pathways in Los Angeles." *Environmental Research Letters* 19, no. 3 (2024): 034015. https://doi.org/10.1088/1748-9326/ad24cc
- Cochran, Jaquelin, Paul Denholm, Meghan Mooney, Daniel Steinberg, Elaine Hale, Garvin Heath, Bryan Palmintier,…, Vikram Ravi et al. "Integrated multimodel analysis reveals achievable pathways toward reliable, 100% renewable electricity for Los Angeles." *Cell Reports Sustainability* 1, no. 4 (2024). https://doi.org/10.1016/j.crsus.2024.100078
- Anderson, Kate, Megan Day, Patricia Romero-Lankao, Sonja Berdahl, Casandra Rauser, Thomas Bowen, Eric Daniel Fournier et al. *LA100 Equity Strategies: Executive Summary*. No. NREL/TP-5C00-85947. National Renewable Energy Laboratory (NREL), Golden, CO (United States), 2023. https://www.osti.gov/servlets/purl/2221830
- Ravi, Vikram, Yun Li, Garvin Heath, Isaias Marroquin, Megan Day, and Julien Walzberg. *Truck Electrification for Improved Air Quality and Health*. No. NREL/TP-6A20-85958. 2023. https://www.nrel.gov/docs/fy24osti/85958.pdf
- LA100 and LA100 Equity Strategies webpage: https://maps.nrel.gov/la100/#home-1

Thank you. Questions?

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Contact: Vikram.Ravi@nrel.gov

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