Equity Implications of Emissions and Health Impacts of EV Adoption on Disadvantaged Communities

Behavior, Energy, and Climate Change
2023

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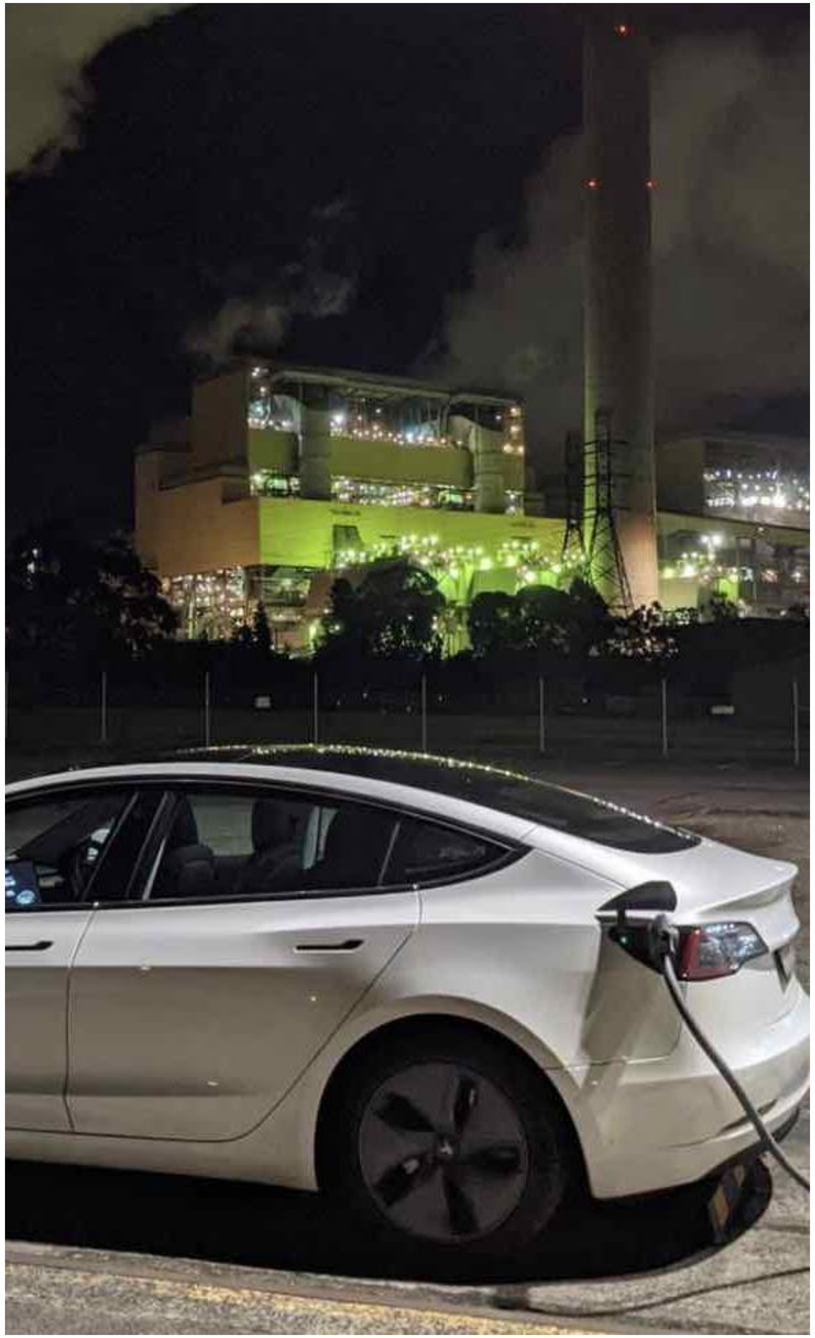
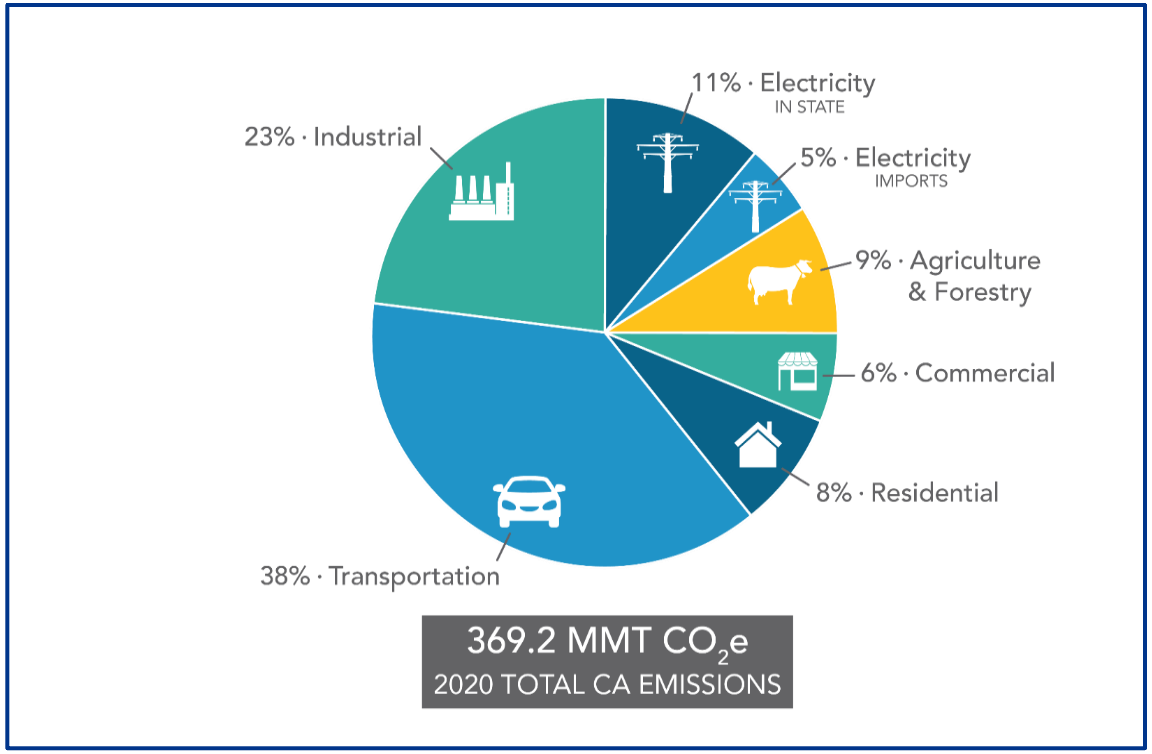
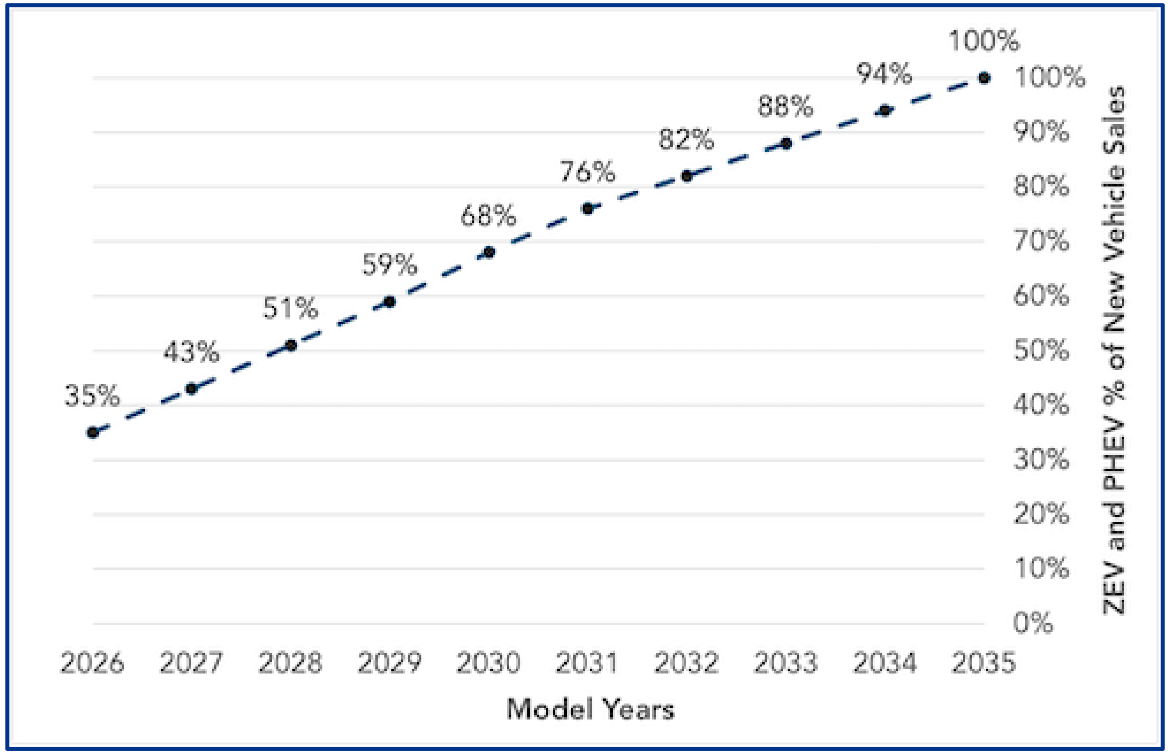


Rapid EV transition will have strong emissions impacts



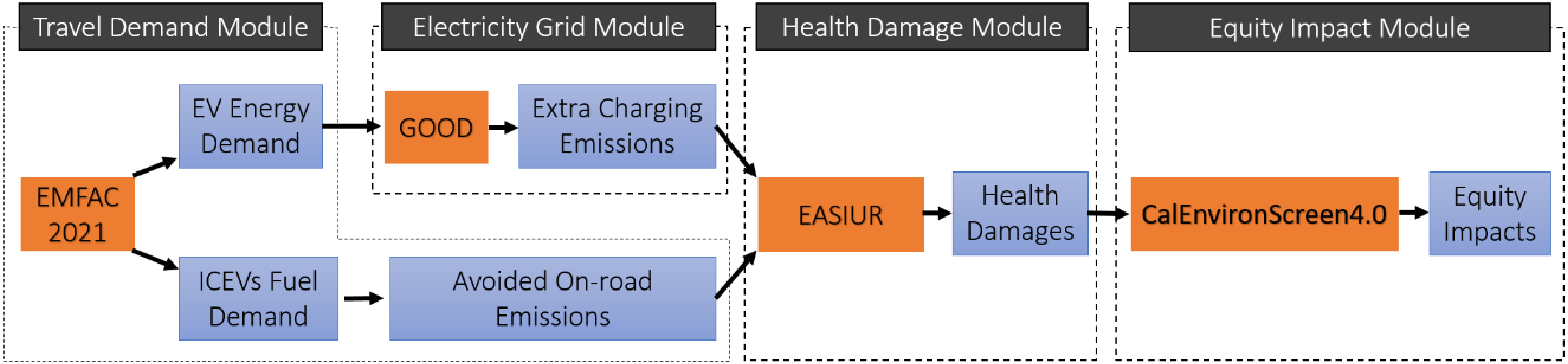
Source: CARB, California GHG Emission Inventory

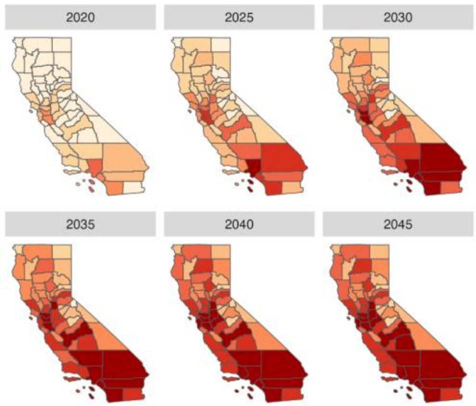


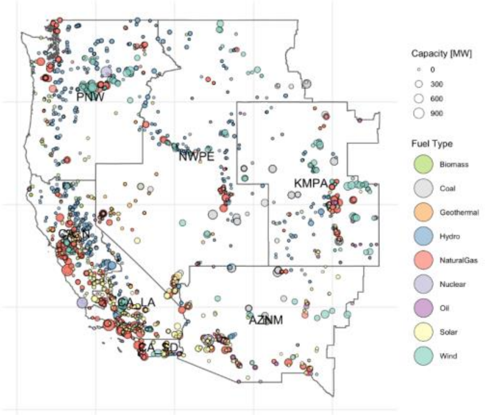
Source: CARB, Advanced Clean Cars II

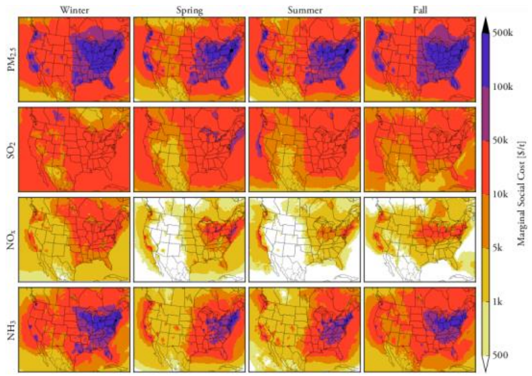
How will changes affect disadvantaged communities and will air quality benefits be equitably distributed?

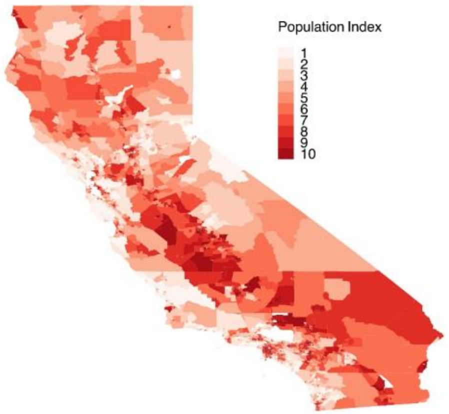
An aggregated assessment approach





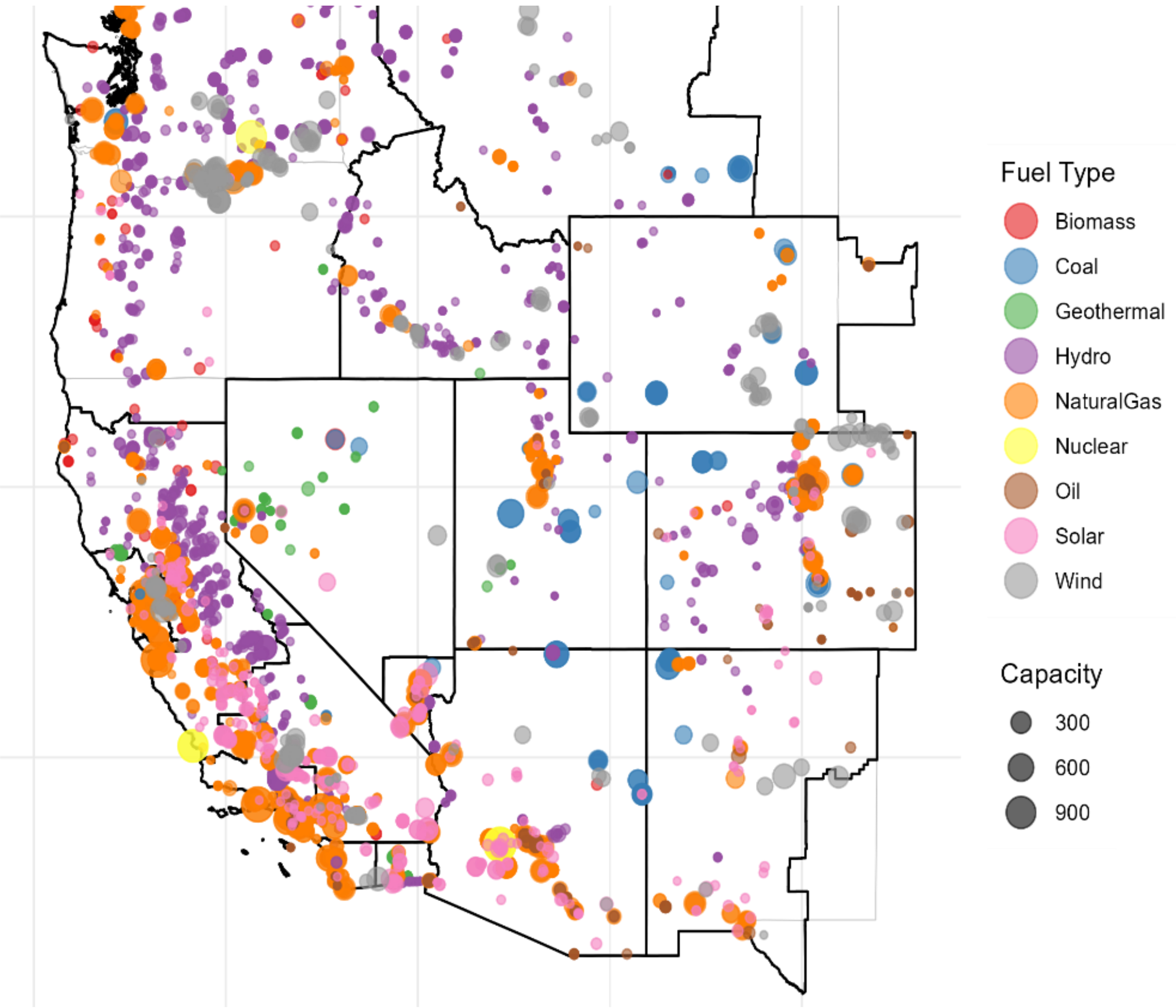






The Grid Optimized Operation Model (GOOD)

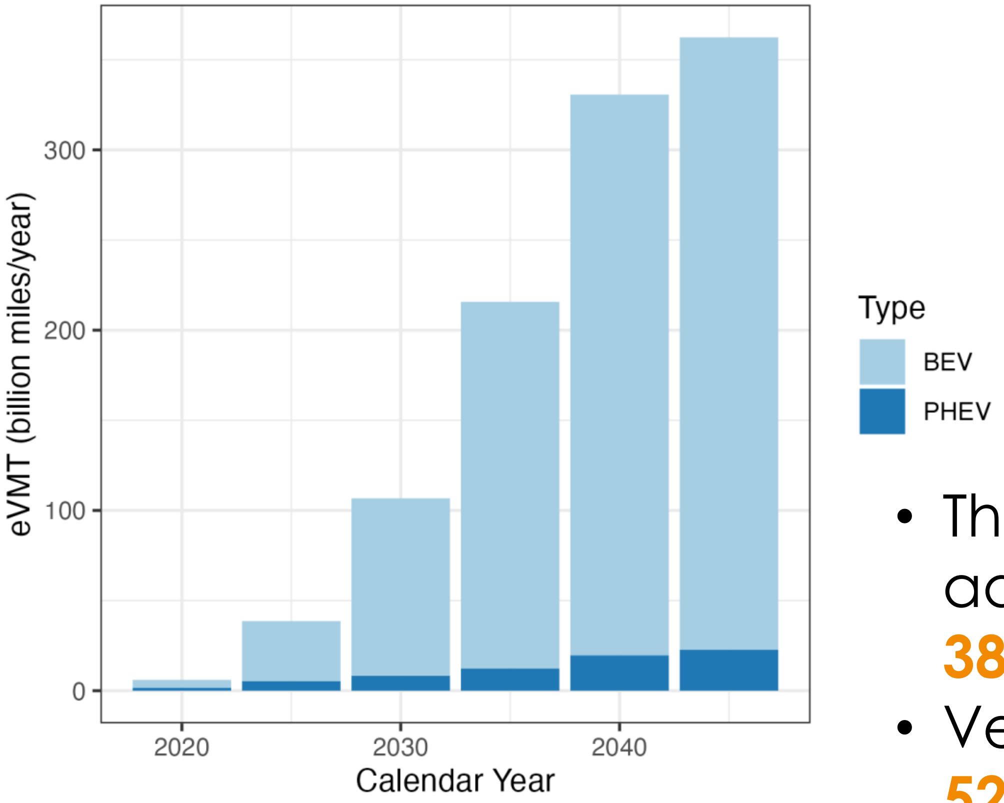
- The GOOD model simulates the grid:
  - Operation (economic dispatch)
  - Deployment (capacity expansion)
- Developed to handle changes in both **supply** of electricity and **demand** across any number of end-use sectors
- Flexibly considers different temporal and spatial resolutions

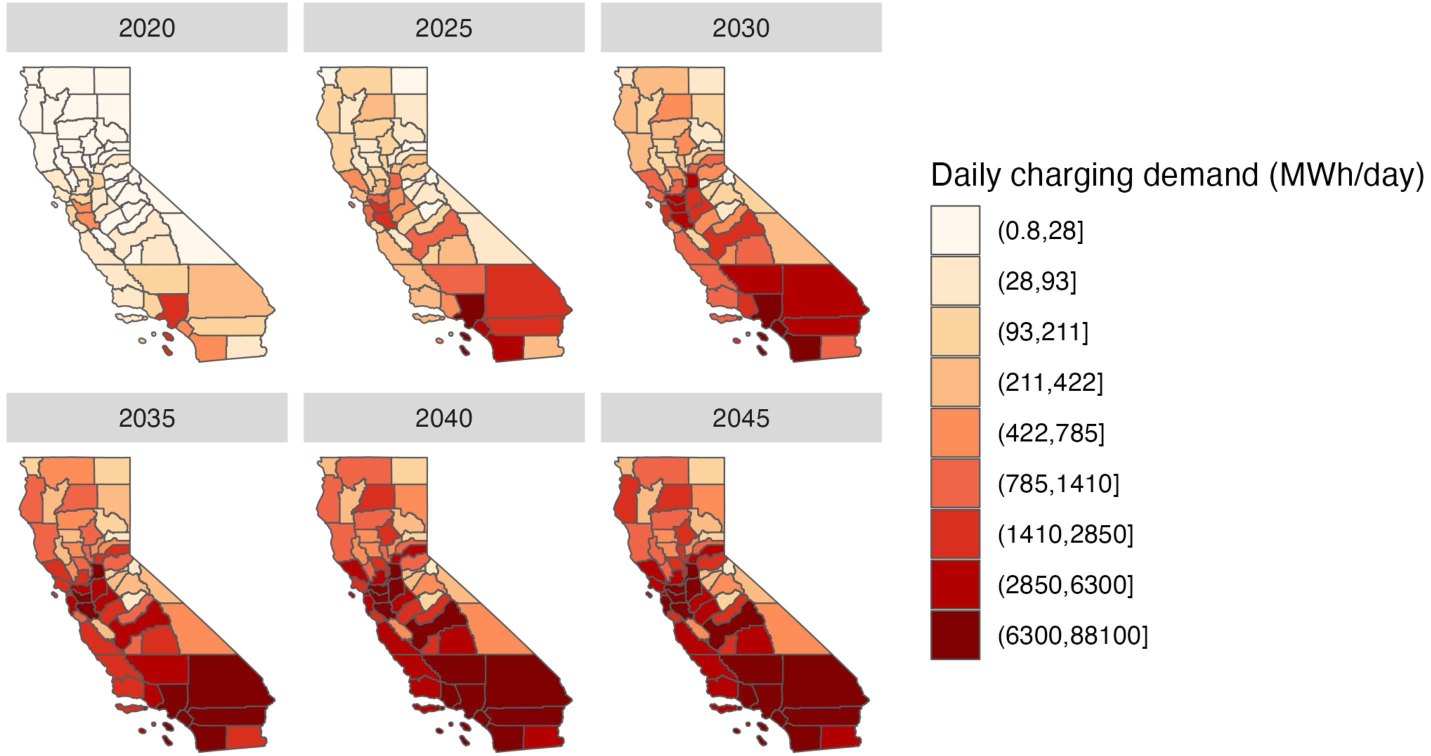


Alan Jenn. "Emissions of electric vehicles in California's transition to carbon neutrality". *Applied Energy* (2023).

Charging demand is distributed across regions unevenly

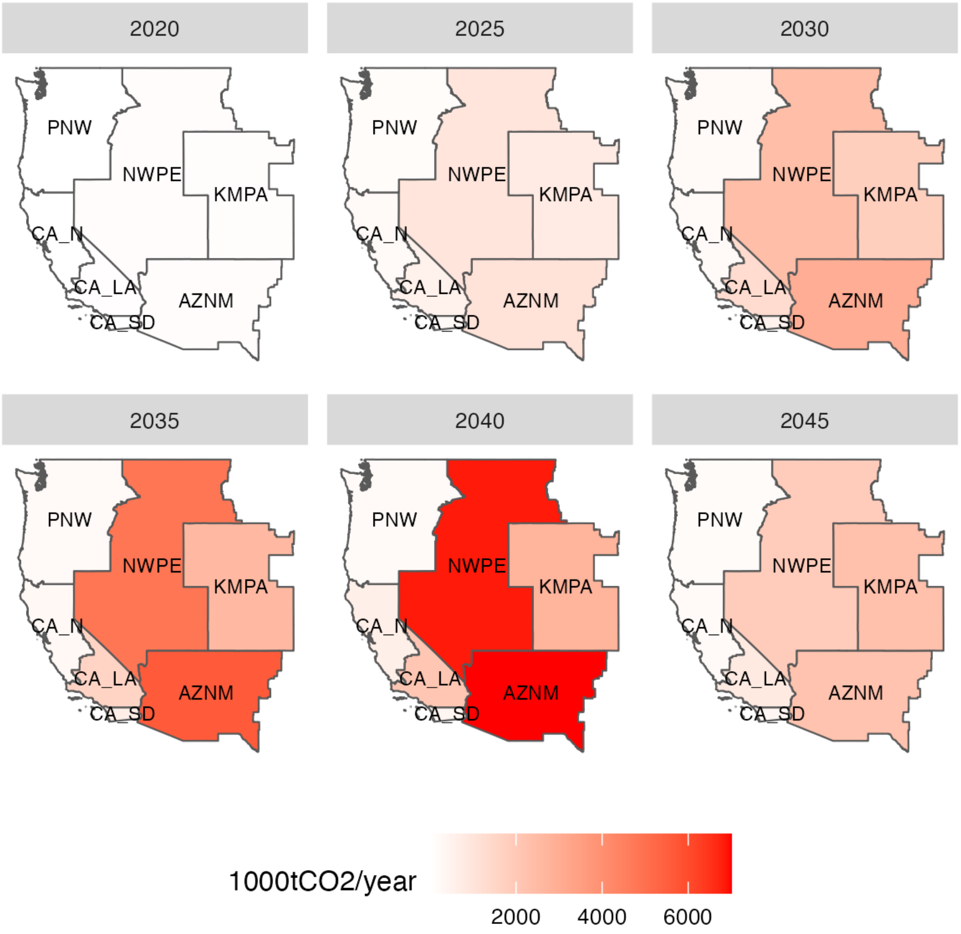
- California's travel demand from light-duty PEVs grows from **6** billion miles/year in 2020 to **362** billion miles/year in 2045.

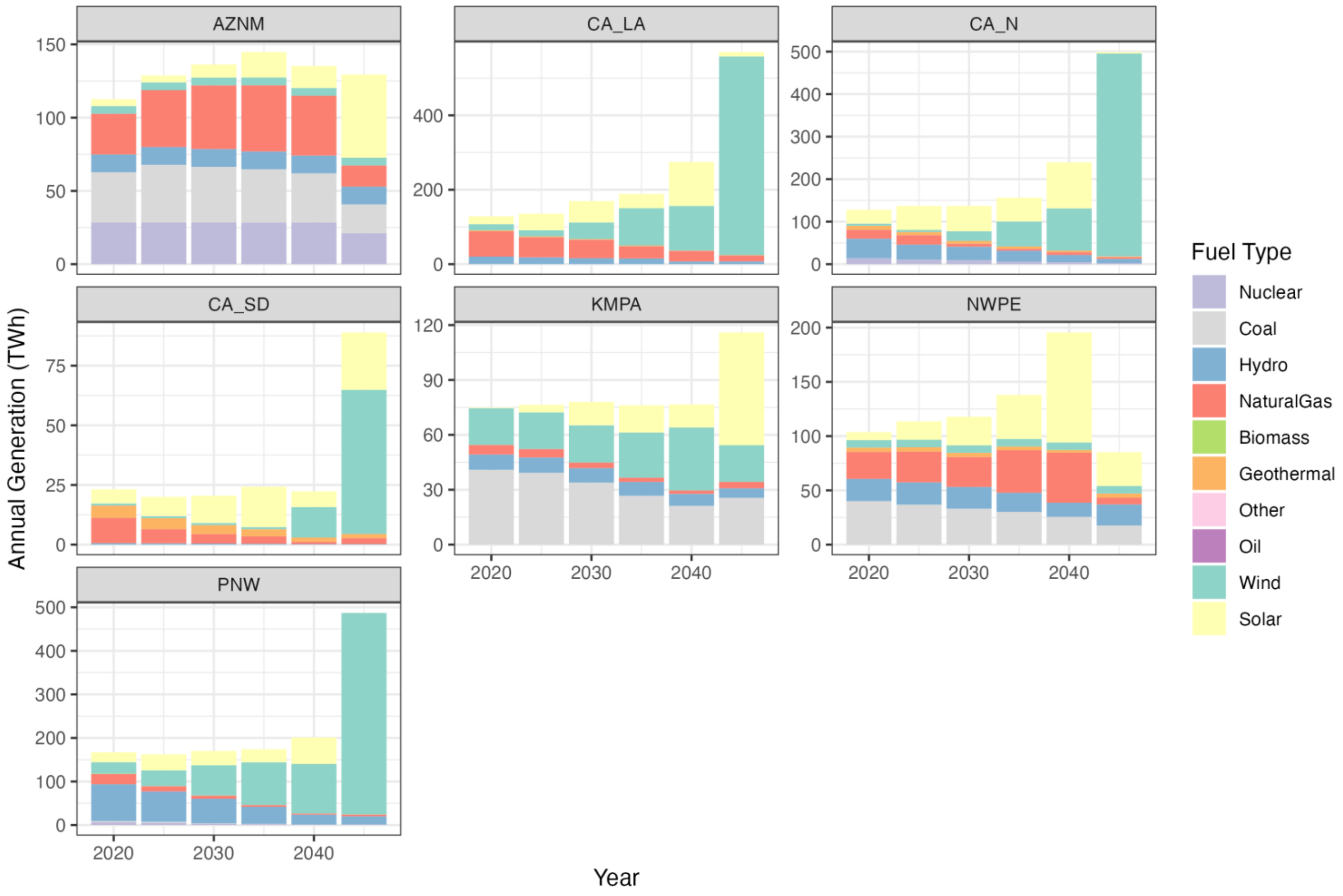




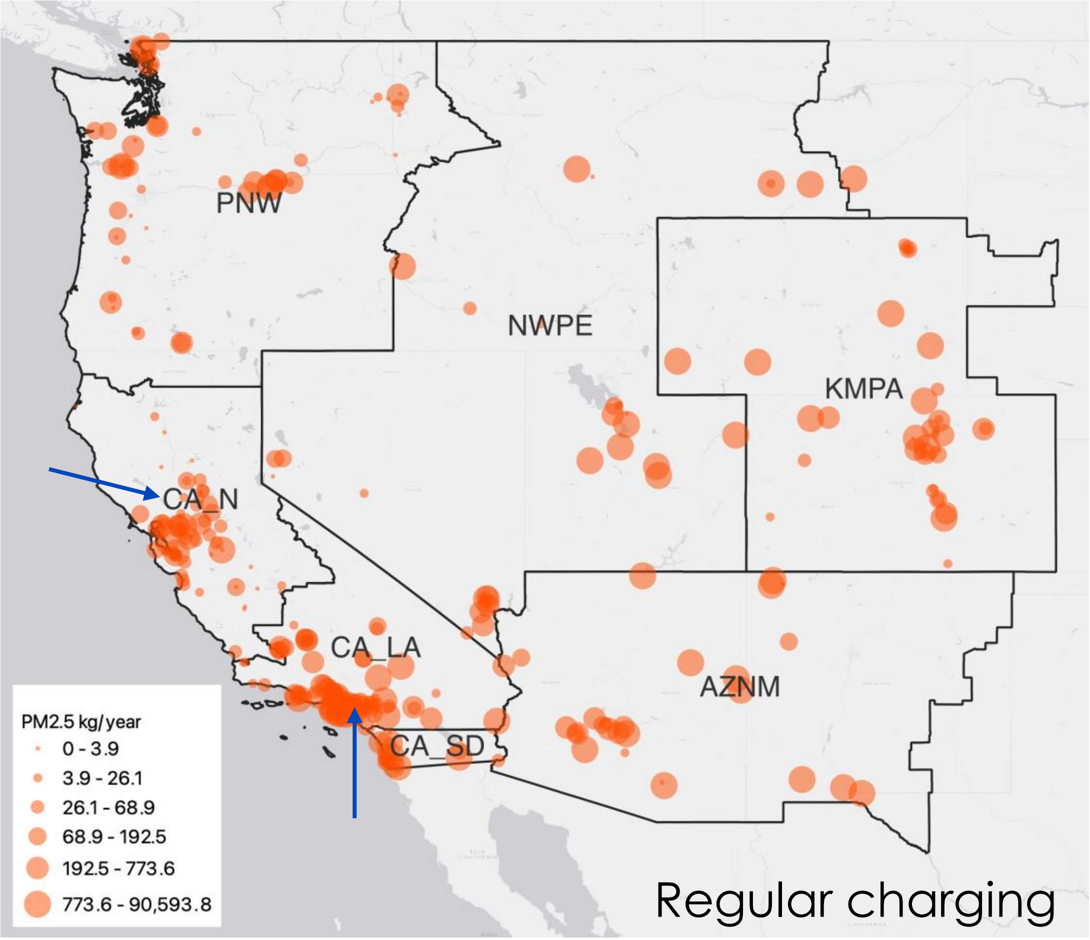
- The total statewide energy consumption from EV adoption will increase from **6** GWh/day in 2020 to **380** GWh/day in 2045.
- Vehicle adoption is unevenly distributed, leading to **52%** of total charging demand in California in just **5 counties**.

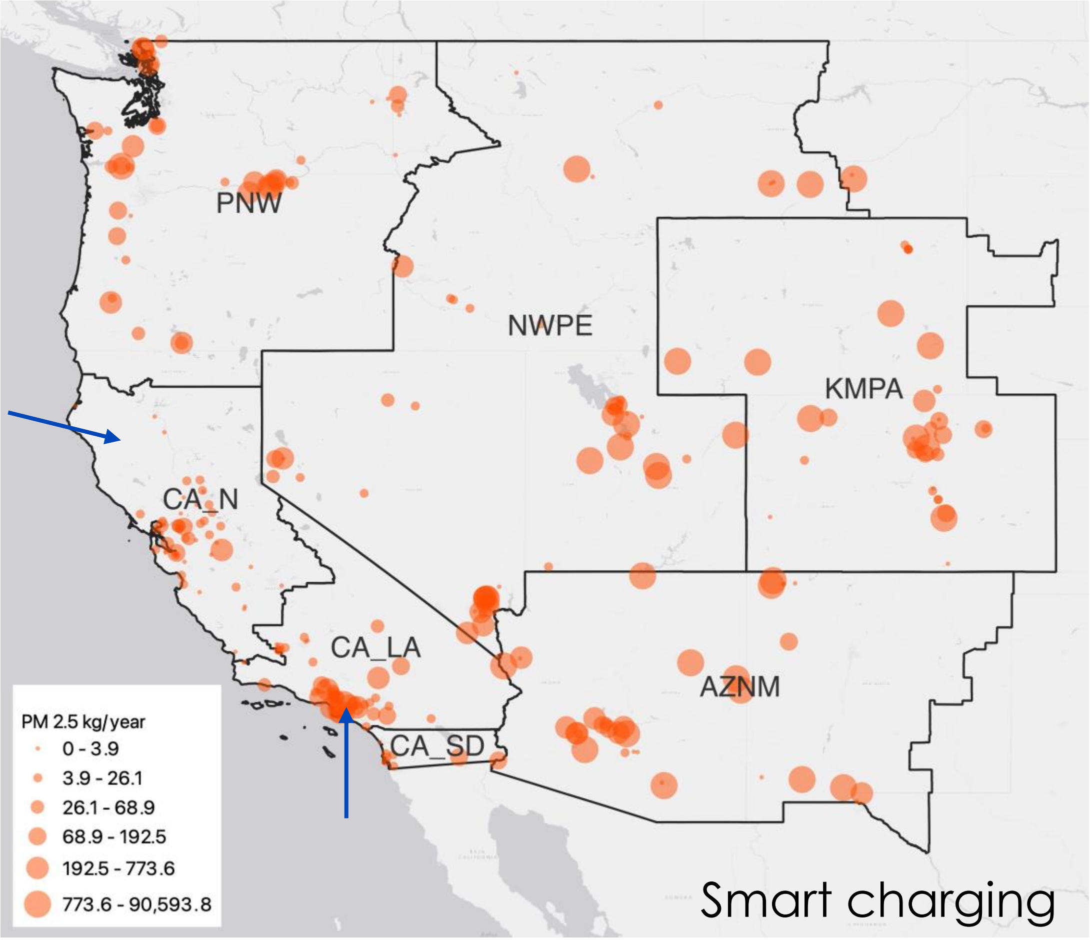
Increasing renewables halts the trend of emissions from charging





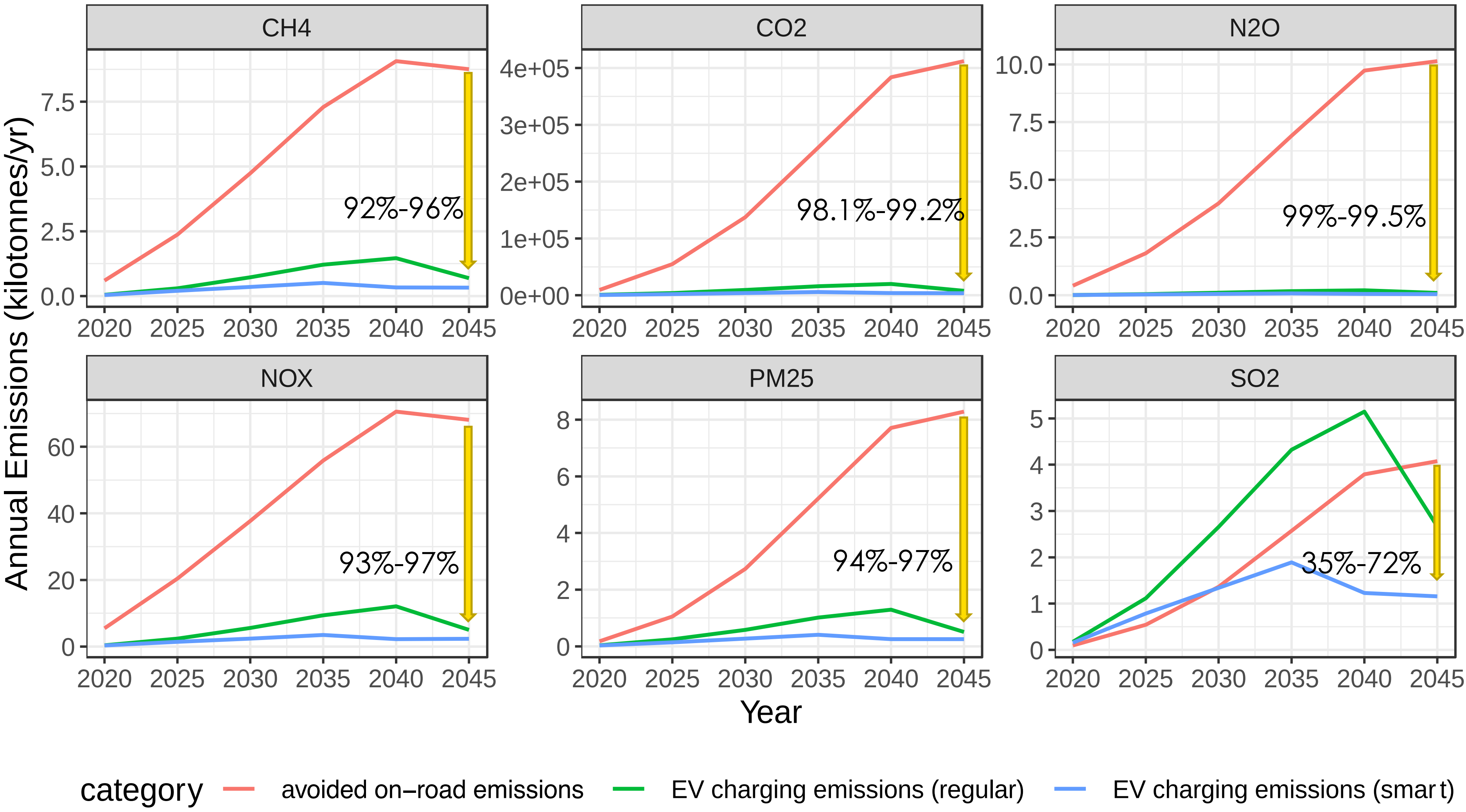
PM2.5 emissions by generator, 2045





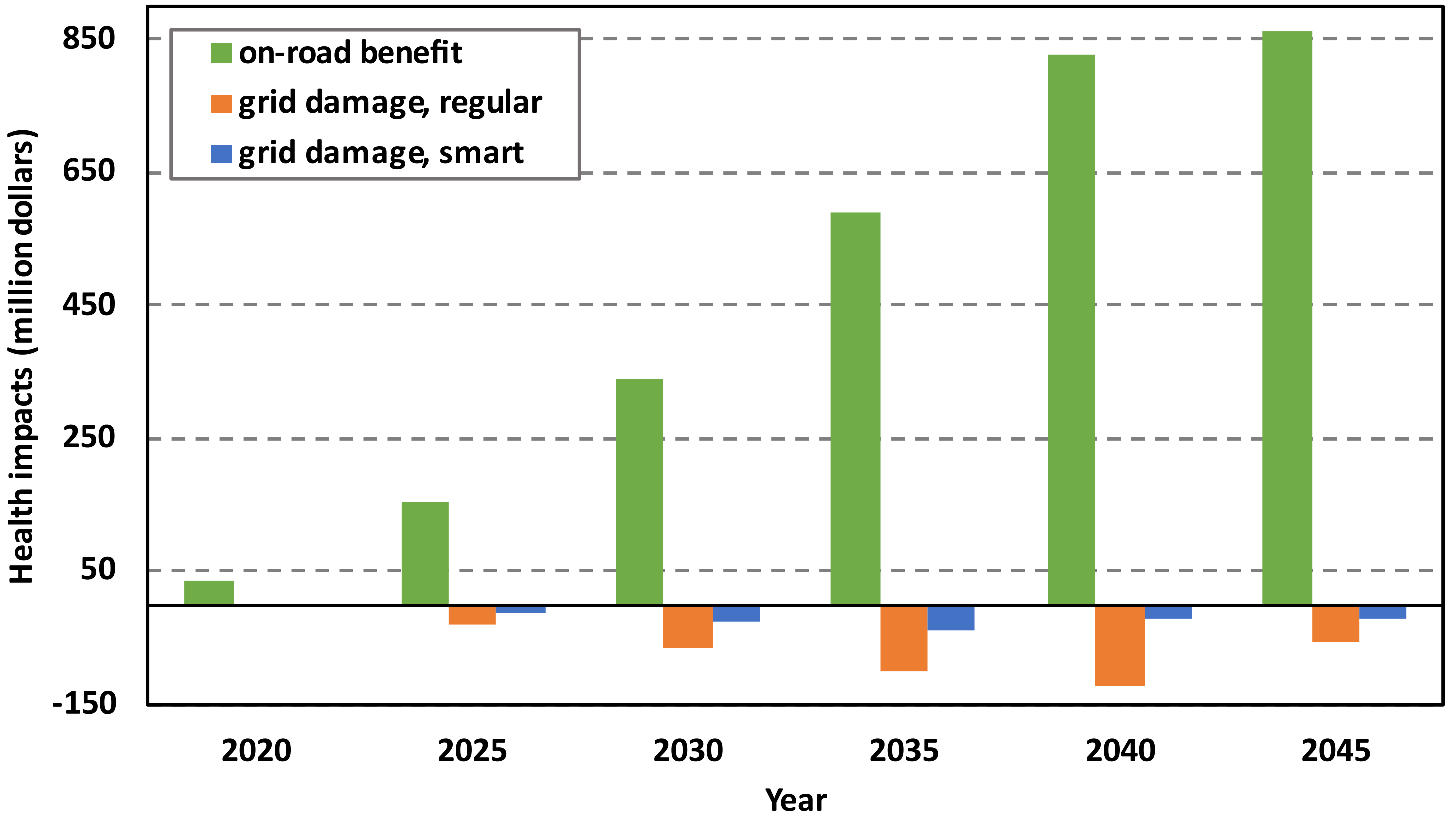
EV adoption cuts road transport emissions dramatically

- EV adoption will reduce total primary $PM_{2.5}$ emissions by **22-24 kilotonnes** and CO_2 emissions by **1,200-1,238 megatonnes** through 2045.
- Smart charging enables greater environmental and health benefits.

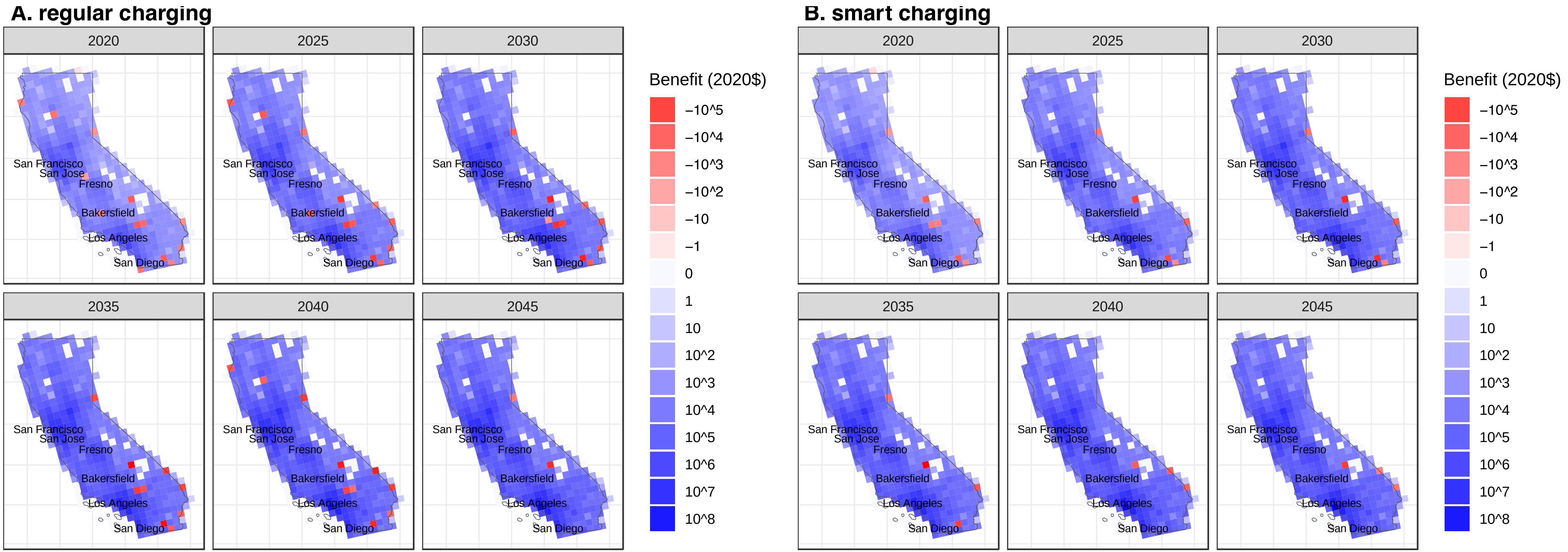


Health impact of PEVs is 14-36 times lower than ICEVs

- Damages from electricity production **will increase from 2020 to 2040** as the more charging demand is required.
- But higher wind and solar penetration offsets the trend and decrease the grid damage since 2040.
- Air pollutant related health impact of electric vehicles is **14-36 times lower** compared to a gasoline vehicle fleet in 2045.



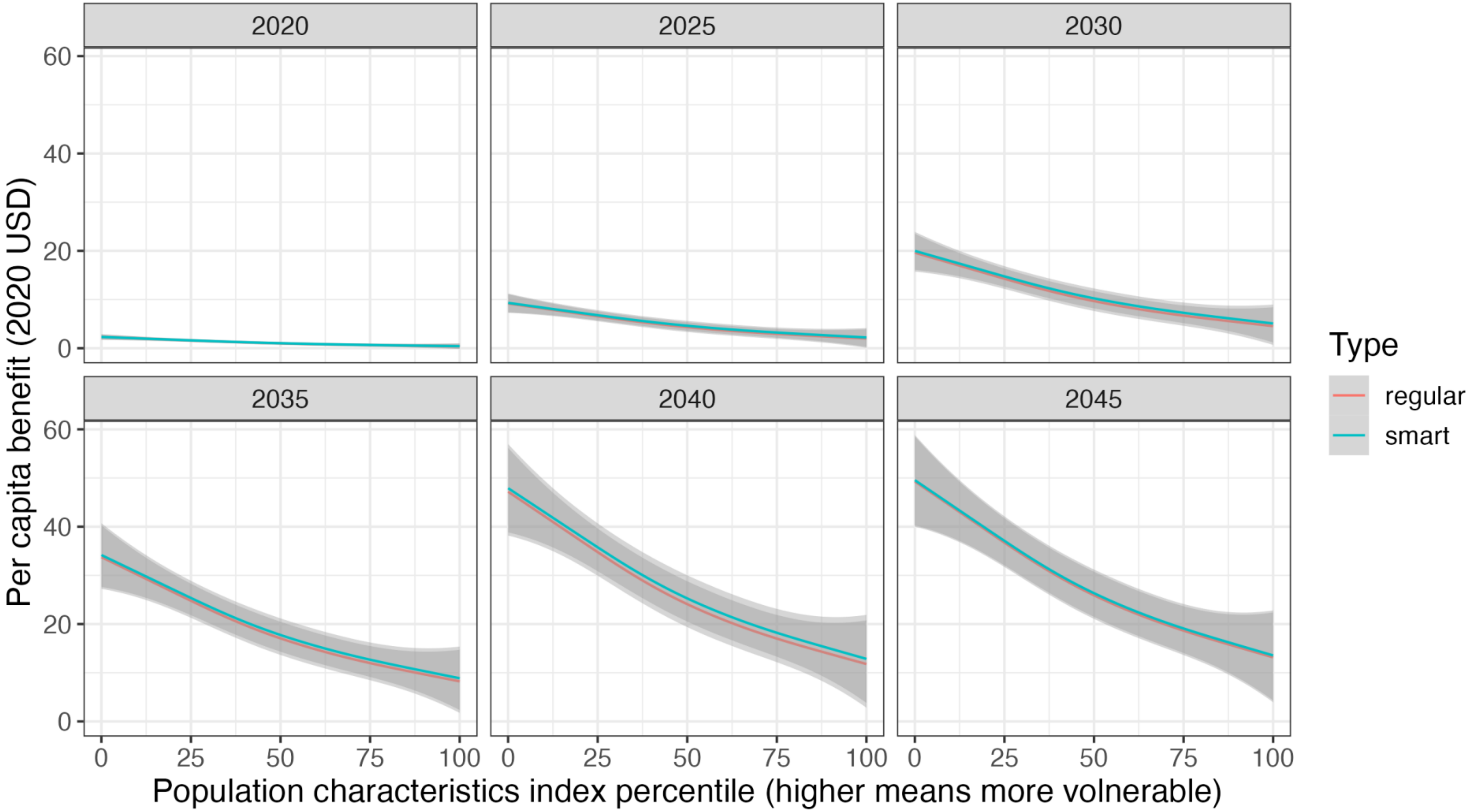
But some areas will suffer from increased air pollution damages



- Regions with higher EV adoption (eg. Los Angeles, Santa Clara) will benefit the most from improved health impacts.
- Damages under smart charging will be lower since wind and solar are better used for EV charge.

EV adoption brings benefit overall, but disparity exists

- Average per capita benefit in DACs is about **$1.6 lower** than that in the least 10% vulnerable communities in 2020, growing to **over $31** in 2045.
- EVs are adopted in regions with wealthier and less vulnerable populations; fossil fuel plants are more concentrated near DACs.



Conclusions

- Transition to electrifying passenger fleets bring dramatic emissions and air-pollution health benefits but **disparity still exists**.
- Our study underscores the need for **policy to improve clean transportation options** for DACs.

Thank you!

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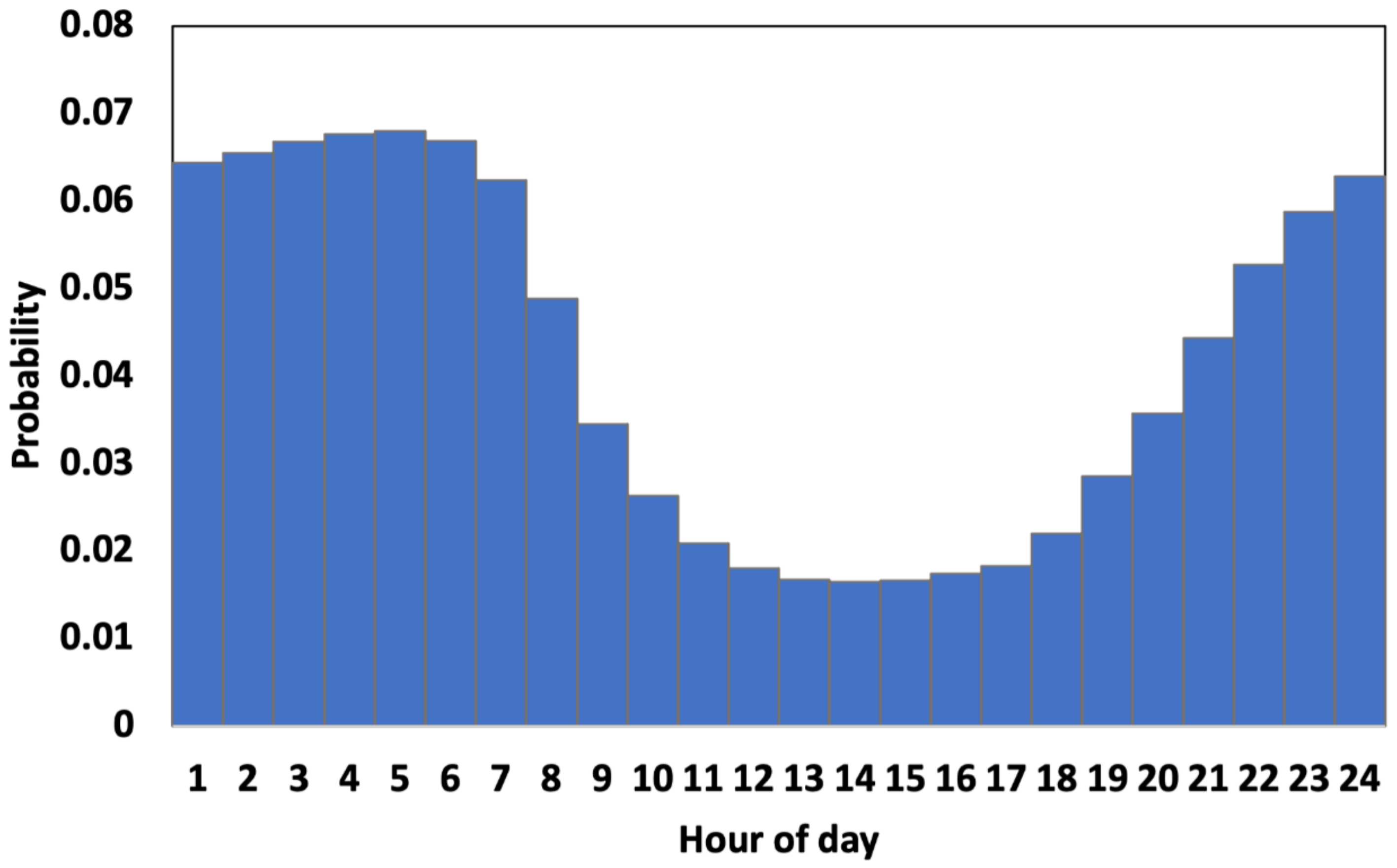
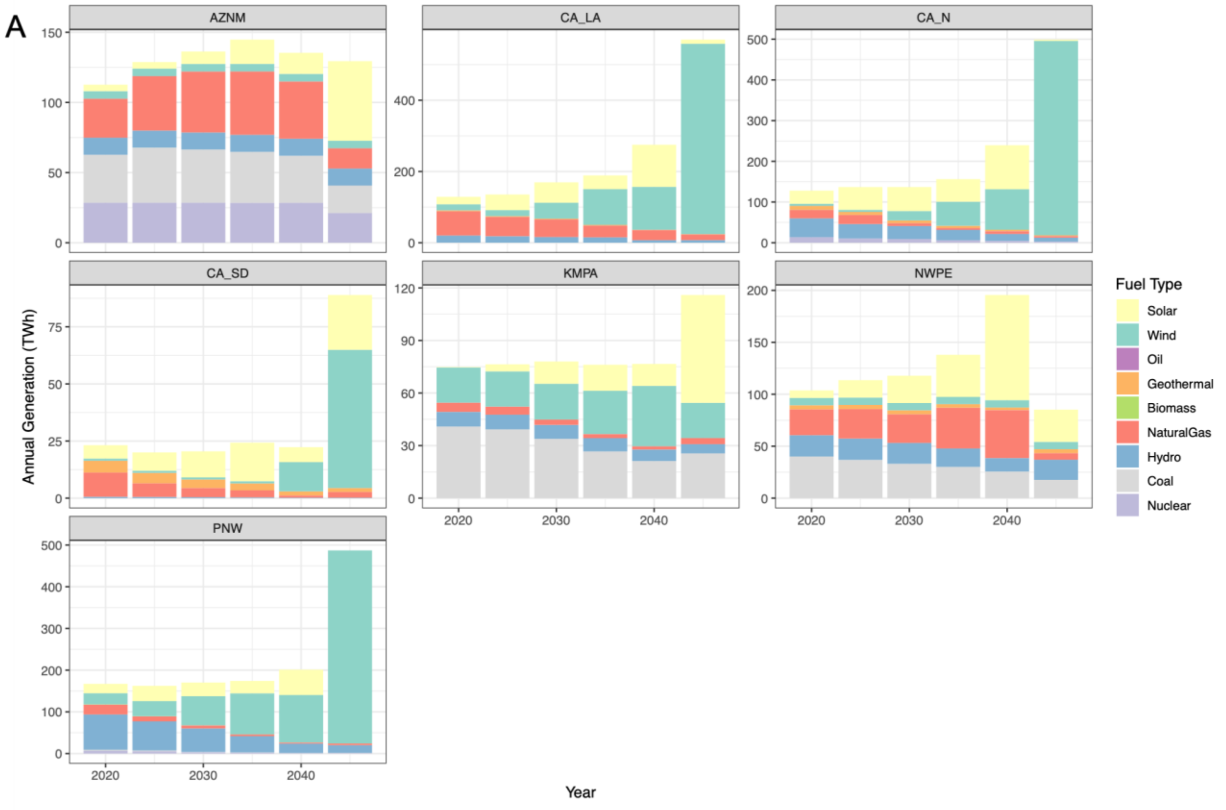
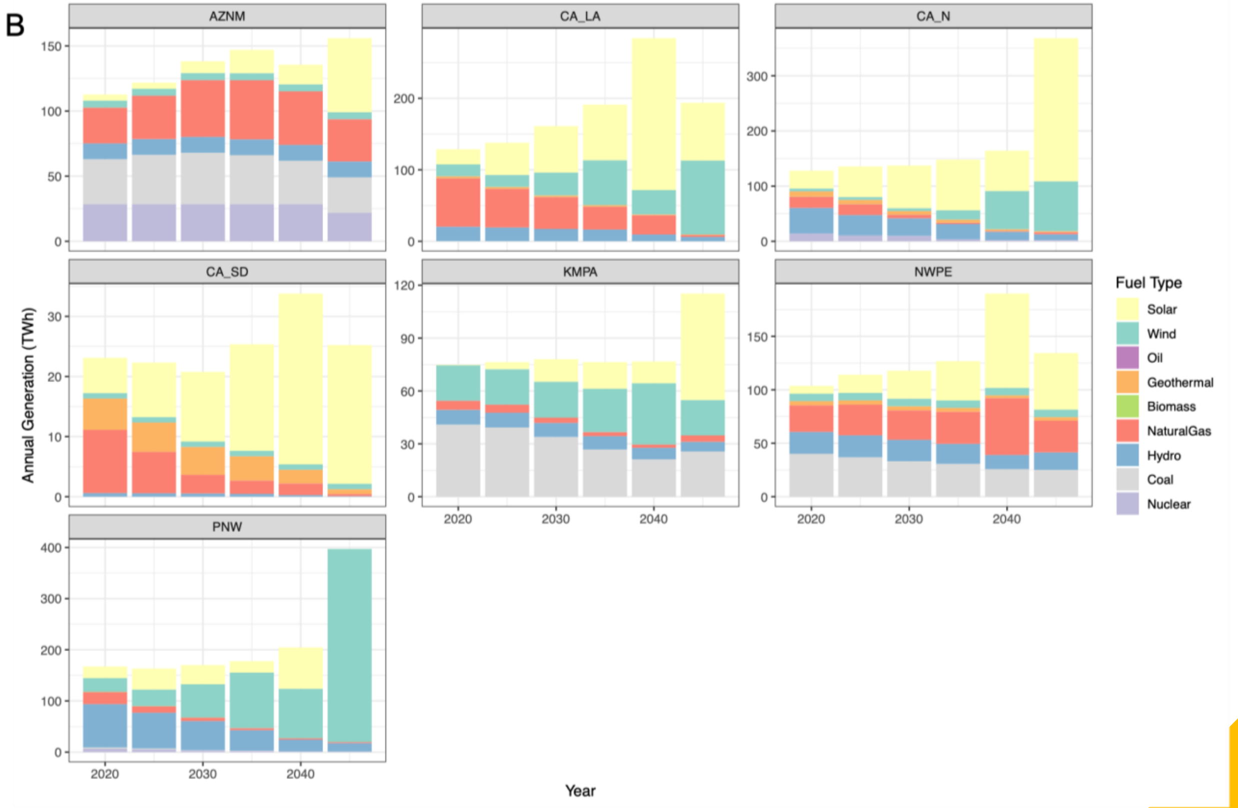
Appendix

Regular charging profile



Generation mix under A) regular charging, B) smart charging





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