Optimizing Interconnection Costs for California's Future Grid

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Motivation

- Electrification and data centers are rapidly increasing electricity demand in California
- To meet this demand, the state must interconnect more energy projects
- Approving projects is complicated and long—there is more capacity in the interconnection queue than on the grid
- This model identifies which projects should be prioritized for interconnection, based on forecasted load growth so that system planners can reduce infrastructure costs

Data Inputs

Data	Source
Solar Projects Proposed or Built (Since 2020)	EIA, 2025
Wind Projects Proposed or Built (Since 2020)	EIA, 2025
Gas Projects Built (Since 2016)	EIA, 2025
Planned Storage Projects	Internal CEC Dataset
Bus Capacity Availability	CAISO Points of Interconnection Website
Transmission Cost Raster	Emily Lesile
Bus Upgrade Amounts and Costs	2024 CPUC TPP Data Dashboard
Solar & Wind Capacity Factors	CPUC System Reliability Modelling Datasets
Demand Profile Changes	CPUC System Reliability Modelling Datasets

Methods

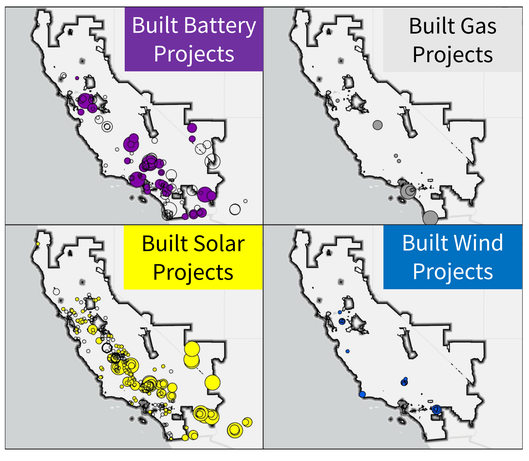
- Linear program that minimizes cost of interconnecting projects from the queue, while:
  - expanding needed lines or substations
  - dispatching resources to meet power balance
  - accounting for battery SOC over time
- Ran over a medoid year found using k-means time series clustering.
- Projects built to only meet the load increase expected in 2035

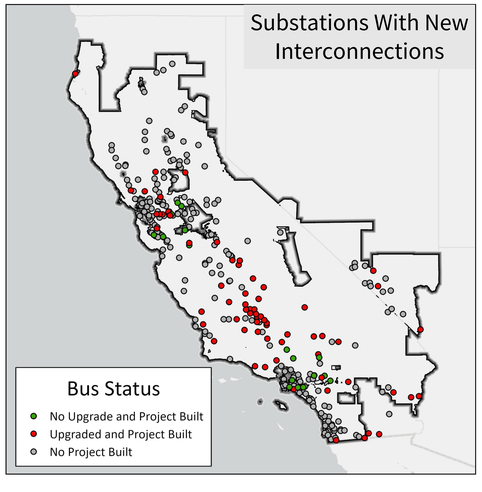
$$\min \sum_{i\in\mathcal{S}} c_i^{\text{sol}} x_i^{\text{sol}} + \sum_{i\in\mathcal{W}} c_i^{\text{win}} x_i^{\text{win}} + \sum_{i\in\mathcal{G}} c_i^{\text{gas}} x_i^{\text{gas}} + \sum_{i\in\mathcal{B}} c_i^{\text{bat}} x_i^{\text{bat}} + c^{\text{curt}} \sum_{t\in\mathcal{T}} C_t$$

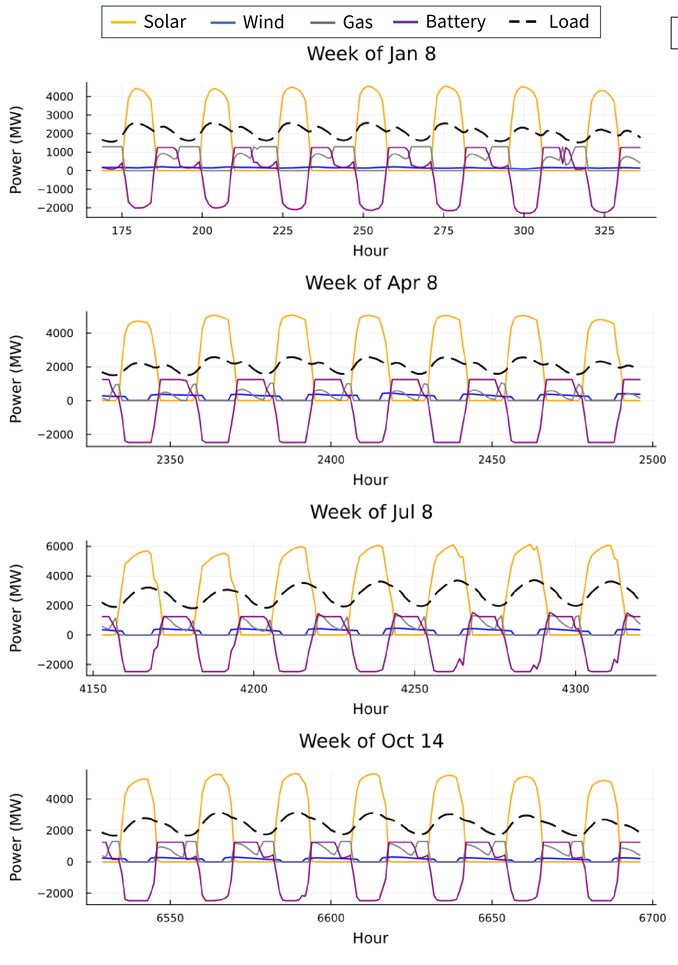
$$+ c^{\text{CO}_2} E^{\text{CO}_2} + \sum_{c\in\mathcal{C}} y_c\, k_c^{\text{up}} + 10^{12} P_1^{\text{out}} + c^{\text{wear}} \sum_{t=2}^{|\mathcal{T}|} s_t$$

Results

- Interconnection costs are $11.4 billion to support future demand
- Solar (11 GW) and Battery (4 GW) dominate the queue, and thus are built in large quantities to meet load
- Most Gas (1.3 GW) and Wind (0.8 GW) projects in the queue are built

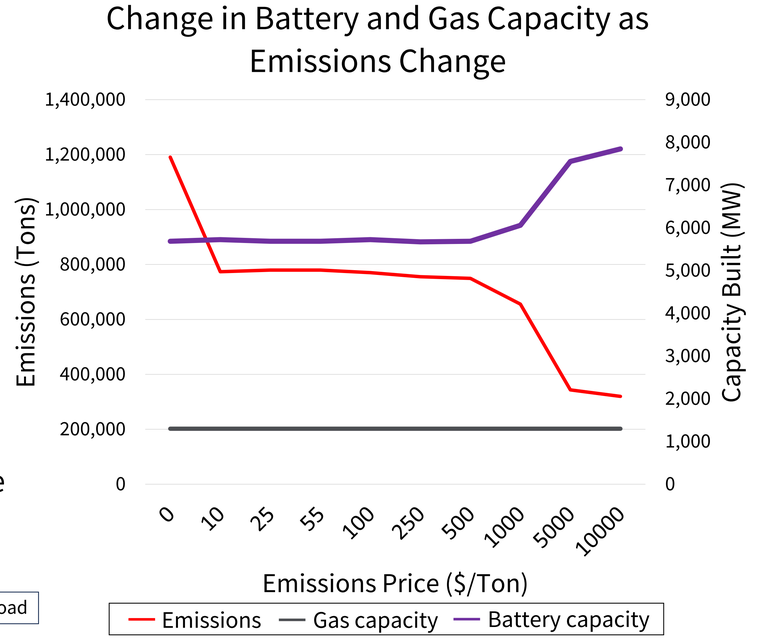






Sensitivity Analysis

- Higher emissions prices reduce emissions and increase battery capacity, but gas capacity remains unchanged



Future Work

- Calculate total costs from system building instead of just interconnection costs
- Add location-specific capacity factors for each project
- Consider more accurate line upgrade constraints
- Add the Choke Cherry Wind Project (WY wind) back to our possible projects

Acknowledgments

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