Modeling the interactions between the electric vehicles for transportation and renewable intensive electricity grids in California and the Western US

Saleh Zakerinia, Dr. Chris Yang, Dr. Sonia Yeh, Dr. Joan Ogden

Institute of Transportation Studies, University of California, Davis - *May 2017*

Introduction and Motivation

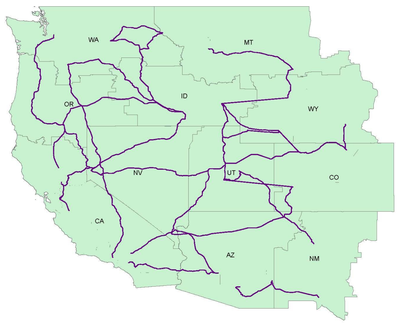
- Decarbonization scenarios for California and other regions to 2030 and 2050 show a number of relatively robust trends, including significant adoption of plug-in electric vehicles and investments in large quantities of renewable wind and solar generation. These two developments in disparate sectors are linked via the use of electricity for vehicle charging.
- In a grid with a high penetration of low-carbon generation, the use of electricity as a transportation fuel helps to reduce GHG emissions and criteria pollutants from the transportation sector. But perhaps as important as this reduction in pollutant emissions, are the benefits for the electricity grid.
- Using vehicle charging as flexible loads, along with energy storage and demand response to help shape overall load and ramp up when renewable generation exceeds other demands can reduce overall grid capacity requirements, reduce the use of peaking plants, reduce emissions and lower overall system costs.
- The synergies between flexible electric vehicle charging (along with other demand- and load-management strategies) and integration of renewable electricity are important and should be considered in conjunction with integrated models.
- This research will provide a better picture of how a future, high-renewable grid will be managed.

Research Questions

- How can the shift to electric vehicles help reduce GHG emissions and what is the impact of electric vehicles and flexible charging on the electricity system?
- How can we manage the seasonal and daily variability of supply and demand in systems with high renewable penetration through supply side options (energy storage) or demand side options (flexible charging and fuel production)?
- What are the effects of California's policies on the Western Interconnection (WECC) grid?

Methodology

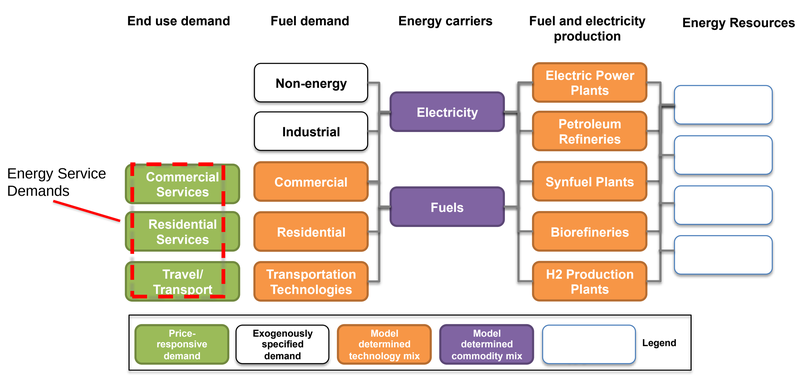
- This work focuses on increasing the spatial resolution of the CA-TIMES model in order to include a representation of the Western US electricity grid into the long-term energy system model of California.
- Using this framework we disaggregate WECC region into 11 subregions.



- The spatial modeling addition (inclusion of the entire WECC) will enable the CA-TIMES model to accurately represent electricity imports/exports, smooth out the variability of intermittent renewables by integrating renewables over a wider regional scale, and track spatial locations of power plants and related emissions.

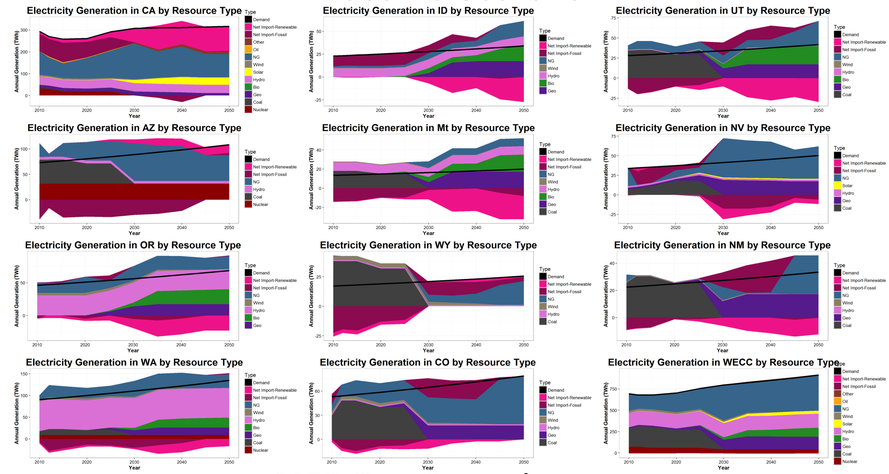
The CA-TIMES Model

- CA-TIMES encompasses all energy sectors and not just the electricity sector, but it will optimize electricity generation capacity and system dispatch while also optimizing the adoption of end-use cost reduction in fuel production (hydrogen and electricity) and storage technologies can facilitate the adoption of alternative fuel vehicles and pave the road for low-carbon energy future.

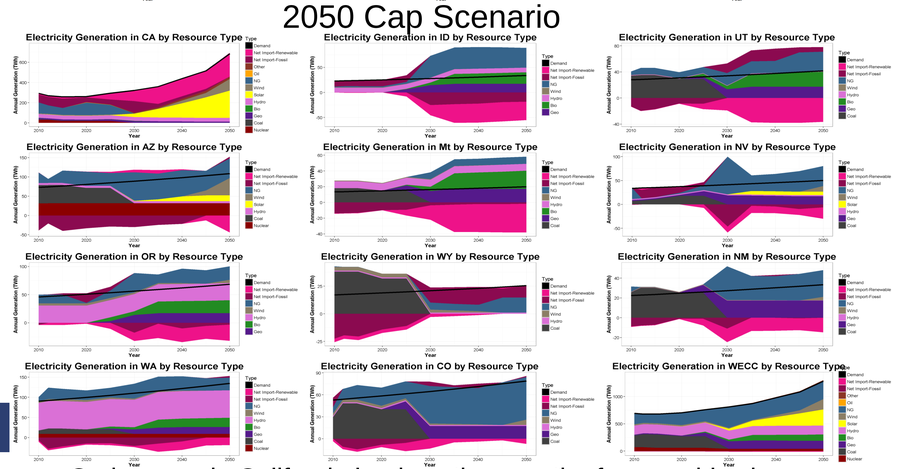


Results and Discussion

Baseline Scenario



2050 Cap Scenario



- Carbon cap in California leads to the growth of renewables in other states
- In the baseline scenario 50% RPS policy also contributes to the growth of renewables in the Western region.
- This project also will help identify system-level elements that contribute to the overall feasibility of implementing high renewable penetration electric grid. Furthermore, we can use benefits of the electric grid with high penetration of renewables to optimally charge electric vehicles.

Questions for Experts

- What is your expectation about the future growth of transmission lines in WECC region? What about transmission lines that are necessary for the integration of renewables into Western grid?
- What is your speculation about integration of WECC?
- Do you have any speculation about the possible evolution of electricity generation in different Western states ?
- How do you see the adoption of EVs and FCVs in WECC region?
- What is the chance of having a stringent carbon reduction policies in WECC states?
- How much renewable generation needed for CA decarbonization comes from out of state?

Contacting the Authors:

Saleh Zakerinia (*mzakerinia@ucdavis.edu*), *Chris Yang* (*ccyang@ucdavis.edu*), Sonia Yeh (*slyeh@ucdavis.edu*) , *Joan Ogden* (*jmogden@ucdavis.edu*).

SUSTAINABLE TRANSPORTATION ENERGY PATHWAYS

An Institute of Transportation Studies Program