Modeling Electric Vehicle Energy Demand and Regional Electricity Generation Dispatch for New England and New York

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INTRODUCTION

The transportation sector is the largest emitter of greenhouse gases (GHGs) in the U.S., accounting for 28.6% of all 2016 emissions [EPA 2018]. Plug-in electric vehicles (PEVs) can reduce transportation emissions when charged using low carbon-intensity power. Crucially, the time of day that vehicles charge impacts the source of the electricity used to charge them.

RESEARCH OVERVIEW

This work investigates the net change in CO2 emissions as well as the impacts the regional electric power grid from increased PEV deployment in New England and New York.

- **PEV Charging Demand Model**: ***How do you get from travel behavior data to realistic hourly electricity demand?***
- **Regional Electricity Generation/Dispatch Model:** ***What power plants should be utilized at what times of day to serve demand for electricity?***
- **Combined:** ***How will vehicle electrification impact power generation costs and emissions?***

Model Scenarios

- **15% PEV fleet penetrations**
- **State Renewable Portfolio Standard targets for 2030 meet with wind and solar expansion**
- **Four Electric Vehicle Supply Equipment (EVSE) availability scenarios:**
  1. **Home charging available**
  2. **Home and Work charging available**
  3. **Probabilistic charging availability**
  4. **Universal charging available**

REGIONAL CHARACTERISTICS

- Population of approximately **34 million residents**
- Two independent system operators (ISO's) : **ISO New England & New York ISO**

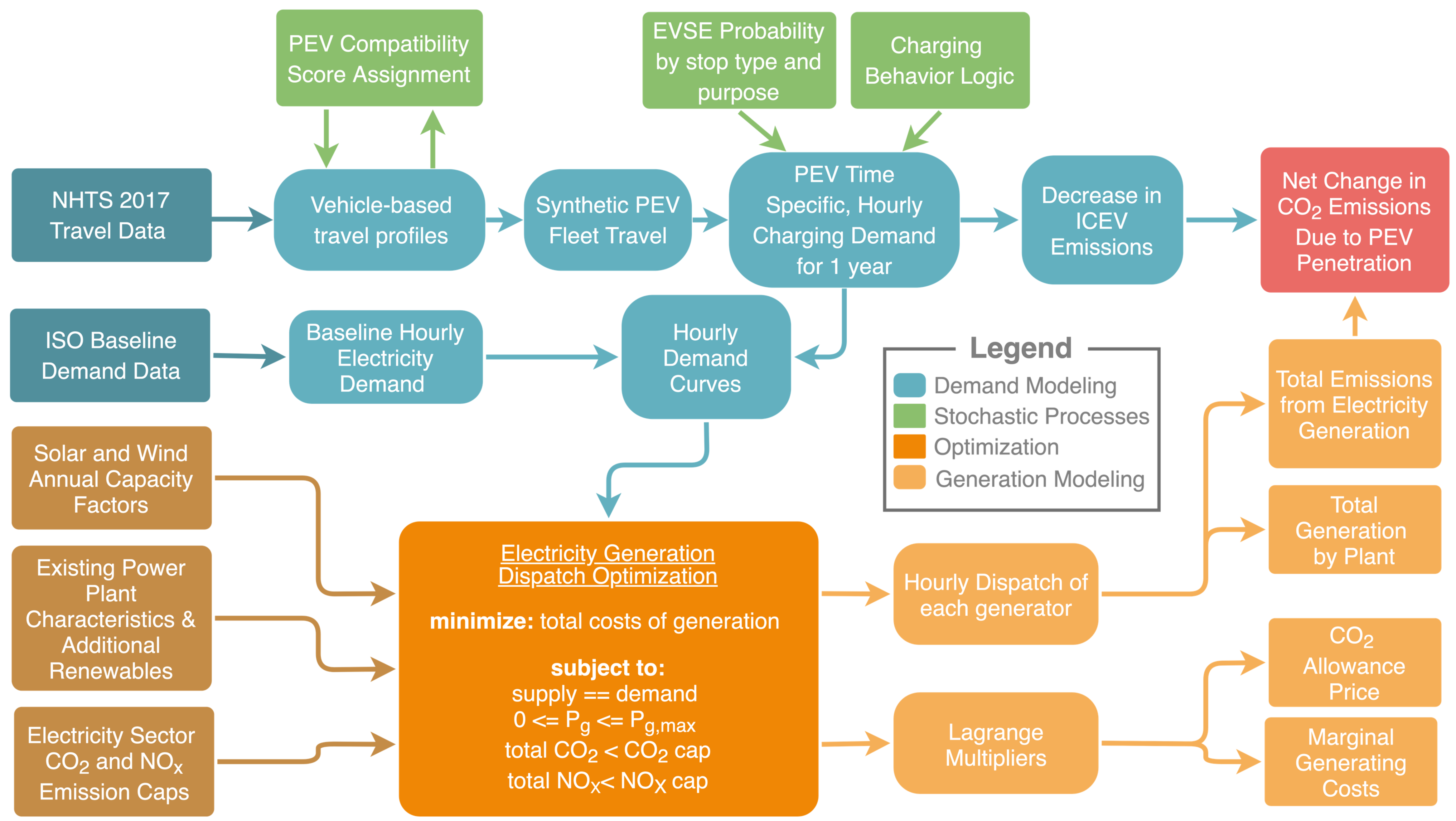


Figure 1. Full Model Diagram

CONCLUSIONS

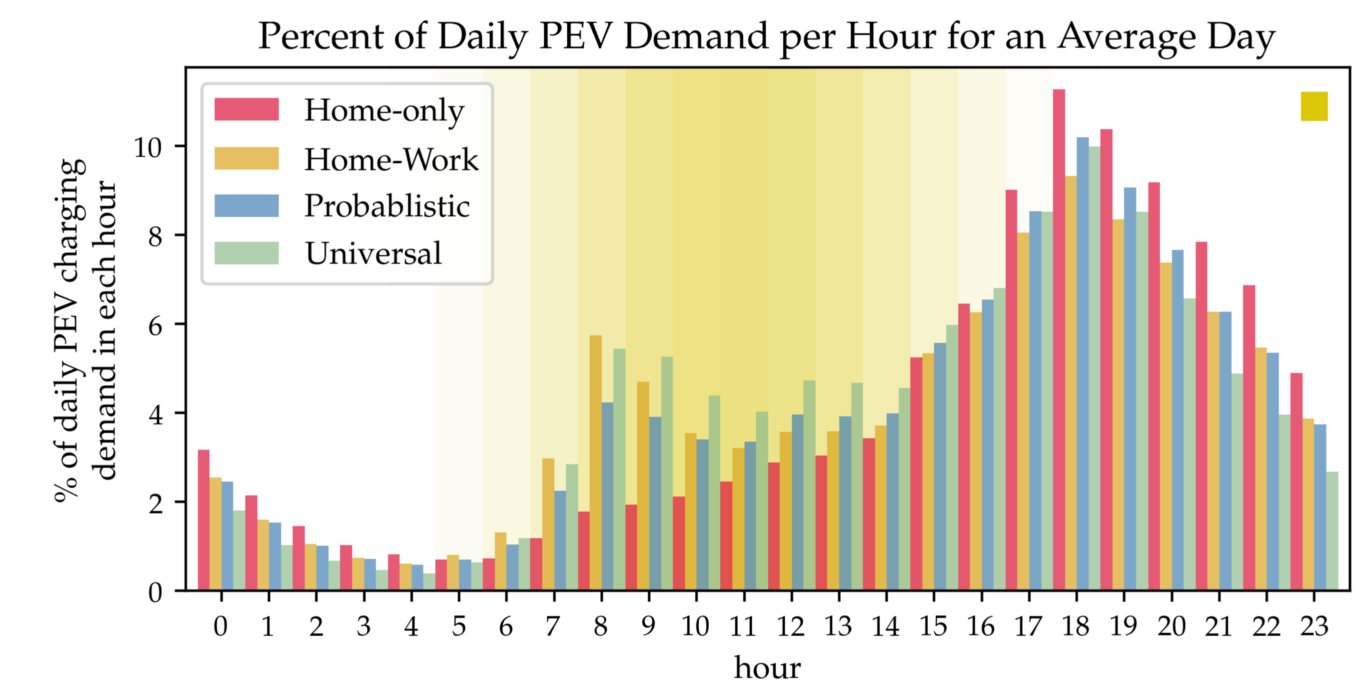
- **Model results support that PEVs are an effective strategy for GHG emissions reductions in the study region**
  - Average annual PEV GHG emissions were 90-92% lower than equivalent conventional vehicles
  - Emissions reductions where greatest when EVSE was universally available (Scenario 4)
- **Home-only EVSE availability (Scenario 1) resulted in the highest peak hour demand. Public charging infrastructure availability resulted in peak load reductions.**
- **Workplace charging infrastructure was particularly impactful**:
  - Home and Work charging (Scenario 2) shifted demand into morning and midday hours with higher solar availability.
  - Scenario 2 GHG emissions per PEV were the lowest of all EVSE scenarios
  - In the Universal EVSE scenario (Scenario 4)
    - 39% of all non-home charging demand was met at workplaces.
    - Work stops had the highest percentage of charging events of all stop types.

FUTURE RESEARCH QUESTIONS

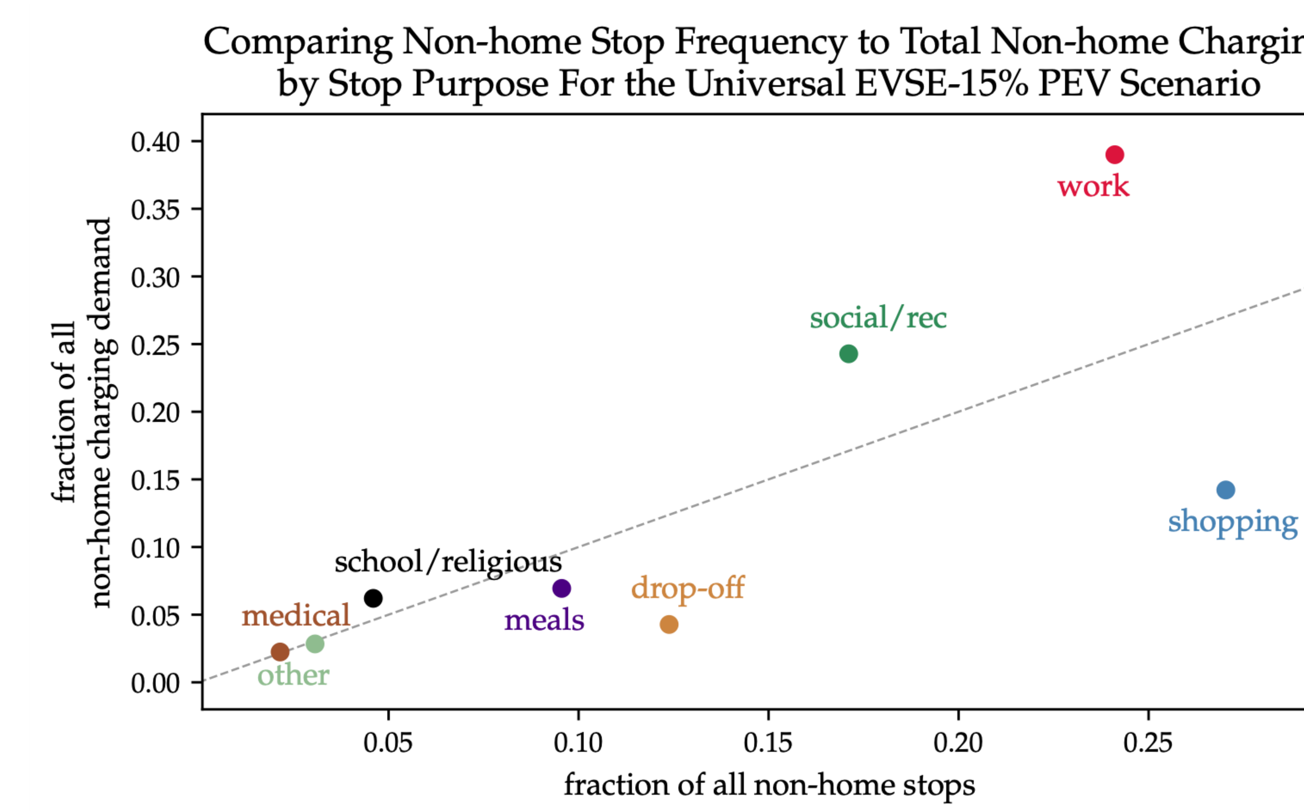
- How do Cap-and-trade and Renewable Portfolio Standards policies impact GHG outcomes?
- What are the systemic benefits that could be achieved through optimized charging?
- What are the impacts of considering a lager, transnational region (Quebec/Ontario)?

RESULTS

Away from home charging opportunities shift charging demand from the evening to morning and midday, aligning better with solar availability.



With universal EVSE availability, close to 40% of non-home charging occurs at the workplace.



System-wide GHG emissions reduction increase as EVSE availability increases.

Net GHG Emissions Changes

(Metric Tons)		Total GHG from Electricity Generation	Total GHG from ICEV Annual VMT	Total GHG Emissions	Reduction in Emissions	Percent Reduction in Emissions
0%	-	25,798,713	85,191,910	110,990,623	0	0.00%
15%	*Home*	28,255,397	77,743,286	105,998,683	4,991,940	4.50%
	Work	28,223,080	77,350,988	105,574,068	5,416,555	4.88%
	Prob.	28,238,224	77,346,823	105,585,047	5,405,575	4.87%
	Univ.	28,273,946	76,871,248	105,145,194	5,845,429	5.27%

Acknowledgments

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