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Scalable Probabilistic Estimates of EV Charging (SPEECh)

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Introduction

We propose a fast, flexible, data-driven framework based on graphical modeling to take a statistical view of more detailed EV modeling methods.

SPEECh + _____	Outcome	Collaborators
EVI-Pro	EVI-Pro Turbo	Eric Wood at NREL
SCRIPT	Control model	Gustavo Cezar at SLAC
CEC	Policy insights	Noel Crisostomo and Matt Alexander

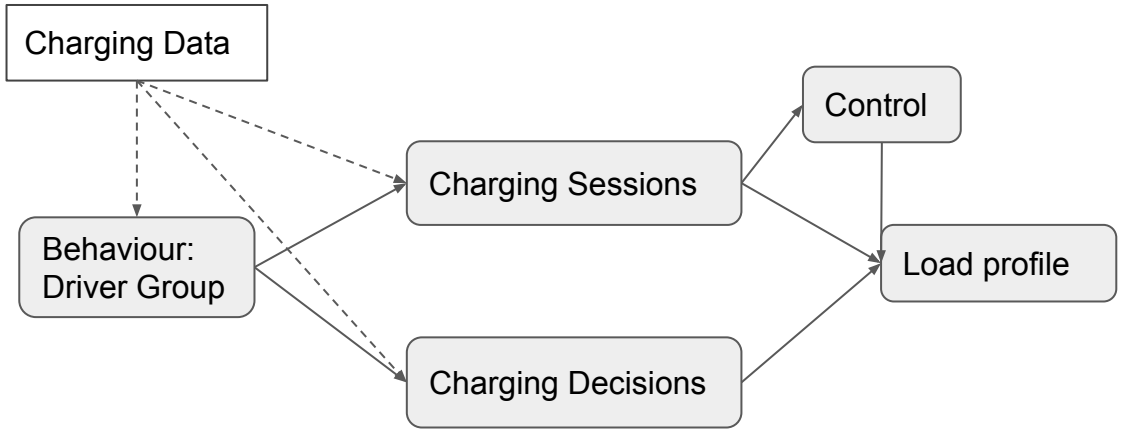
SPEECh is designed to capture the wide range of driver types, behaviours, uncertainties and use-cases that drive scenarios of EV charging, for communities both in California and around the world, and create scenarios of EV load to support and help plan for electrification.

Outline

1. Methodology
2. Five key points:
    a. Discovering driver behaviours from data
    b. Combining multiple data types and sources
    c. Interacting with the model as a fast scenario tool
    d. Offering insight on uncertainty
    e. Estimating flexibility through controlled charging
3. Next Steps

Methods

The framework uses a graphical modeling framework to capture charging, probability distributions over key parameters, and quickly generate new profiles.



All components and distributions can be learned from drivers' charging history and charging sessions data.

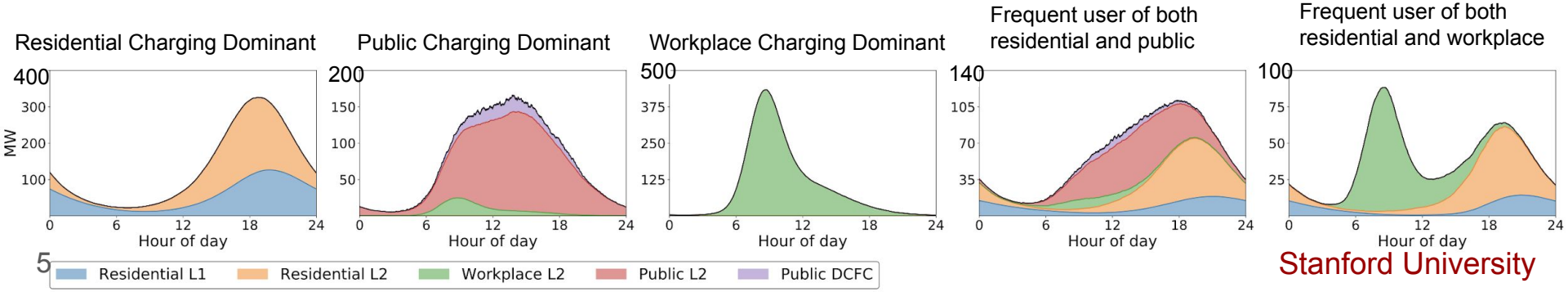
Clustered Drivers

We cluster drivers by their charging history and identify many unique behaviours.

- ➔ Frequent “topping up” of small amounts of energy
- ➔ Regular, habitual use of multiple charging types
- ➔ Dependence on residential timers

Clustering is driven by driver preferences and access, frequency of charging, and battery capacity.

EVI-Pro Turbo example with EVI-Pro 1, 5 clusters:

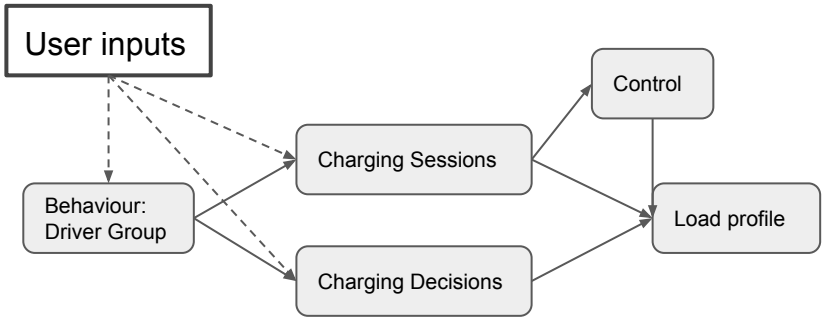


Implication: Applies across datasets and continents

Framework allows driver groups to:

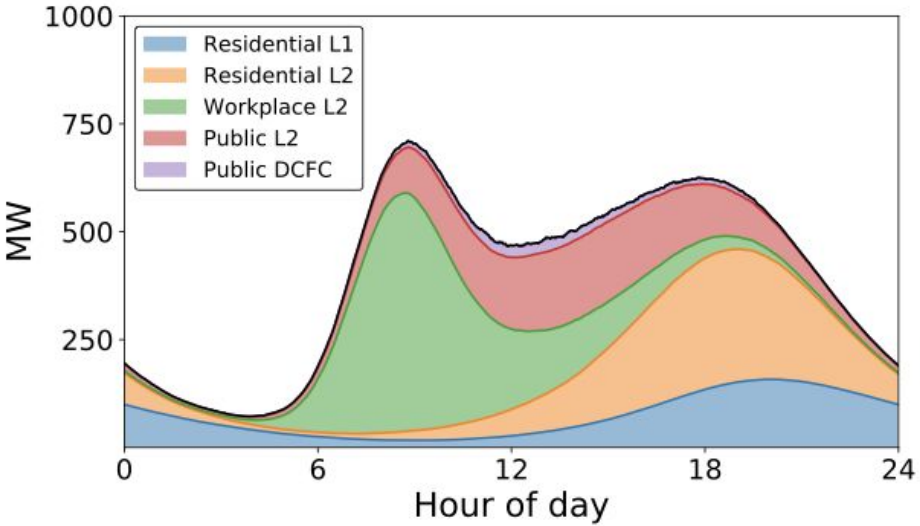
1. Represent different segments of the load (fleets, commercial drivers, …)
2. Span multiple data sets, creating rich catalogue of behaviours
3. Incorporate range of inputs where data is scarce

(Wikipedia)



Scenarios in EVI-Pro Turbo

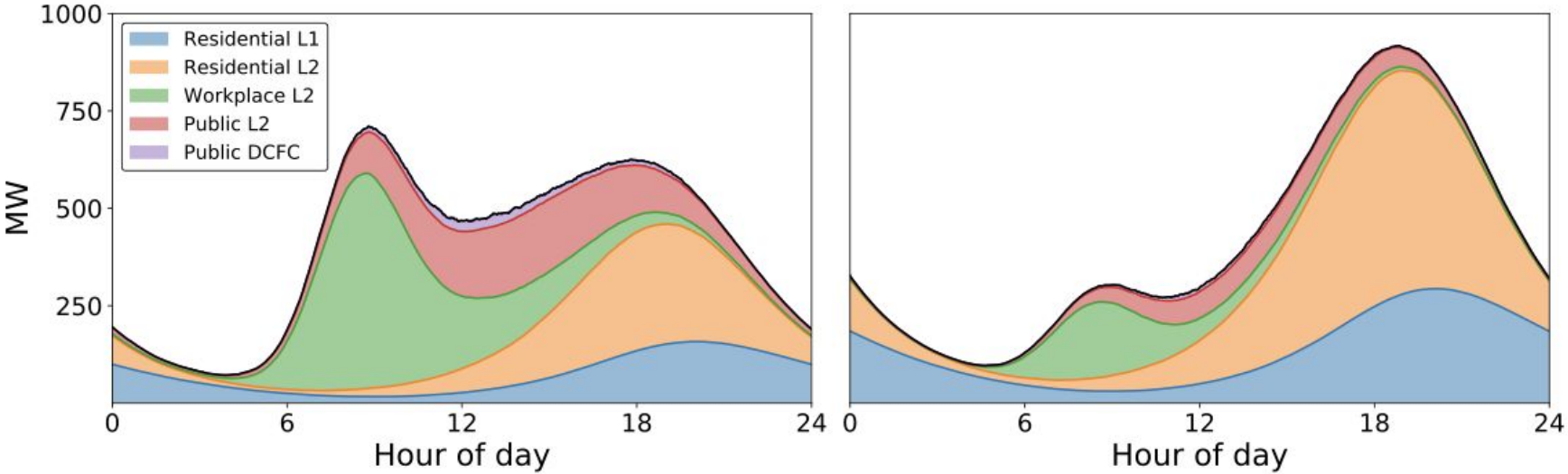
(a) 1 million drivers. Base distribution from data with even distribution of access, preference, and vehicle.



Scenarios in EVI-Pro Turbo

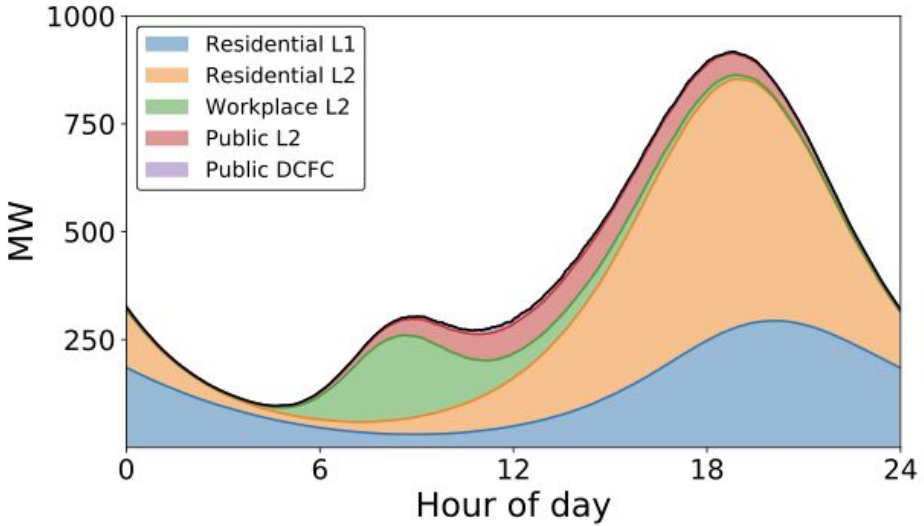
(a) 1 million drivers. Base distribution from data with even distribution of access, preference, and vehicle.

(b) Increase weight of driver groups which primarily use residential charging



Scenarios in EVI-Pro Turbo

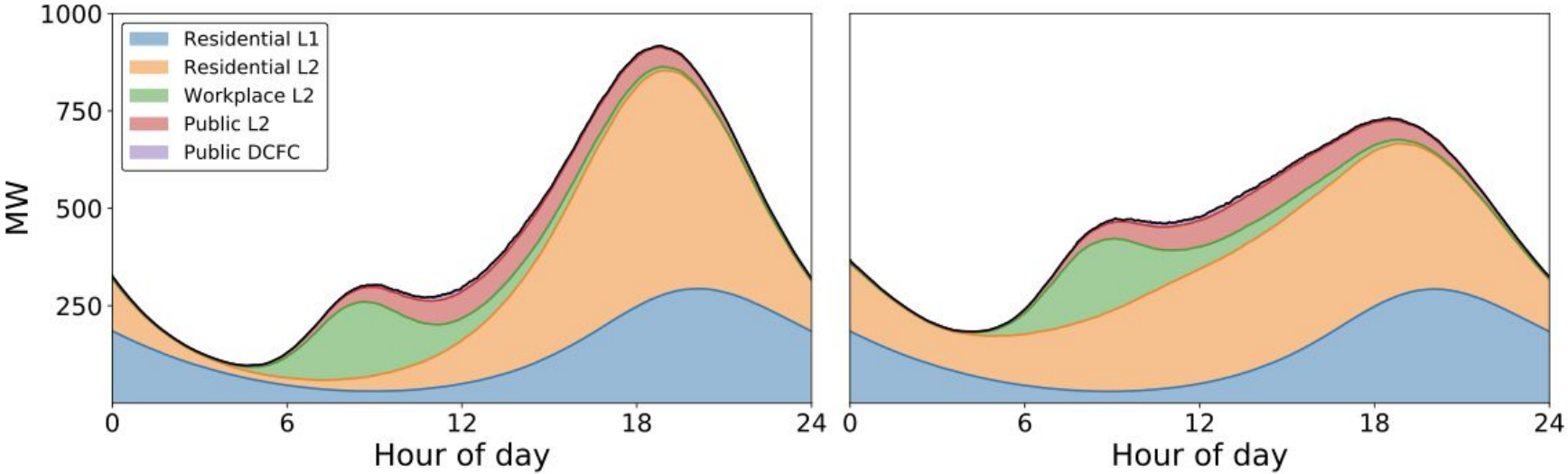
(b) Increase weight of driver groups which primarily use residential charging



Scenarios in EVI-Pro Turbo

(b) Increase weight of driver groups which primarily use residential charging

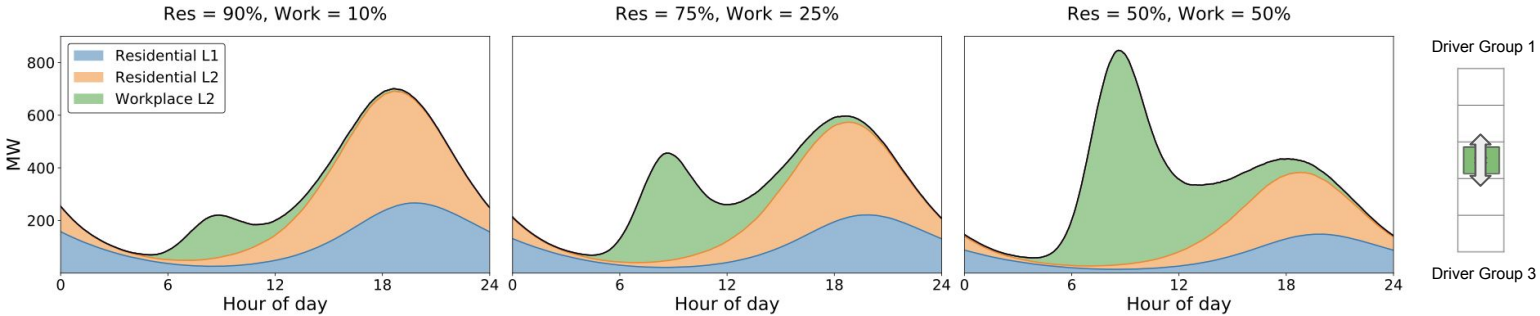
(c) In addition, increase weight of morning start time in residential L2 users



Policy Implication: Interactive Tool

An interactive, real-time tool enables policy-makers to explore ideas, understand the modeling, and compare specific “what-if” scenarios.

Knobs include: drivers, charging segments, vehicle models, specific behaviours, controls



All code will be open-source and computationally inexpensive to run.

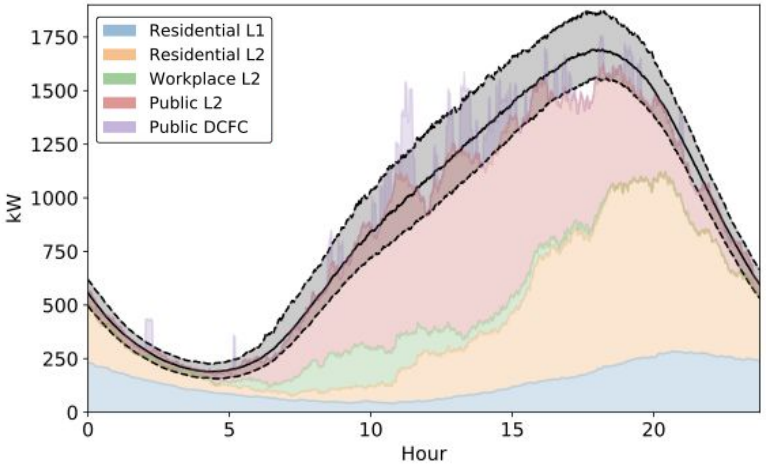
Current research focuses on extending the model to study policy questions affecting particular communities: What is the demand for public chargers by housing type? What is the behaviour of later adopters?

Implication: Modeling Sensitivities

The framework can estimate the uncertainty in each scenario.

In this example:

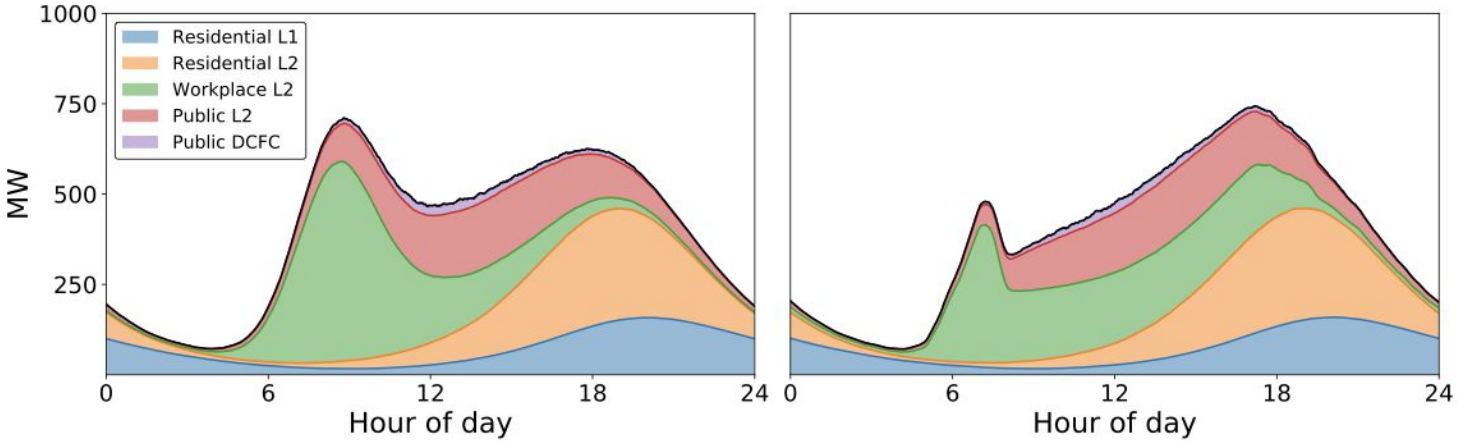
- 1000 driver scenario for Group 4
- Re-generate 1000 times
- Figure shows median, 10-90th percentile sleeves
- Runs in ~30 seconds on a laptop



Uncertainty is important for planning, and for understanding the assumptions behind each scenario. The framework's probabilistic elements and the distributions underpinning the graphical model are key to enabling this.

Controlled Charging Adds Flexibility

The SCRIPT* project at SLAC National Accelerator Laboratory developed a data-driven approach for rapidly estimating controlled load shape at scale.



We plan to incorporate this and add a probabilistic element to the estimate.

*CEC EPC-16-057

Conclusion

SPEECh weaves together a broad catalogue of behaviours, datasets, and assumptions to create insightful scenarios for policy and planning.

Why is this important?

- ➔ By design the model has flexible data requirements, and it is fast and inexpensive to run, so the tool can be applied anywhere
- ➔ Helps bring EV modeling expertise from California to planners around the world

Planning to support EVs is key to enabling decarbonization. Our goal is for this work to contribute to that EV planning, accelerate electrification, and decrease global emissions.

Thank you. Please contact me at siobhan.powell@stanford.edu

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