Modeling 100% Electrified Transportation in NYC

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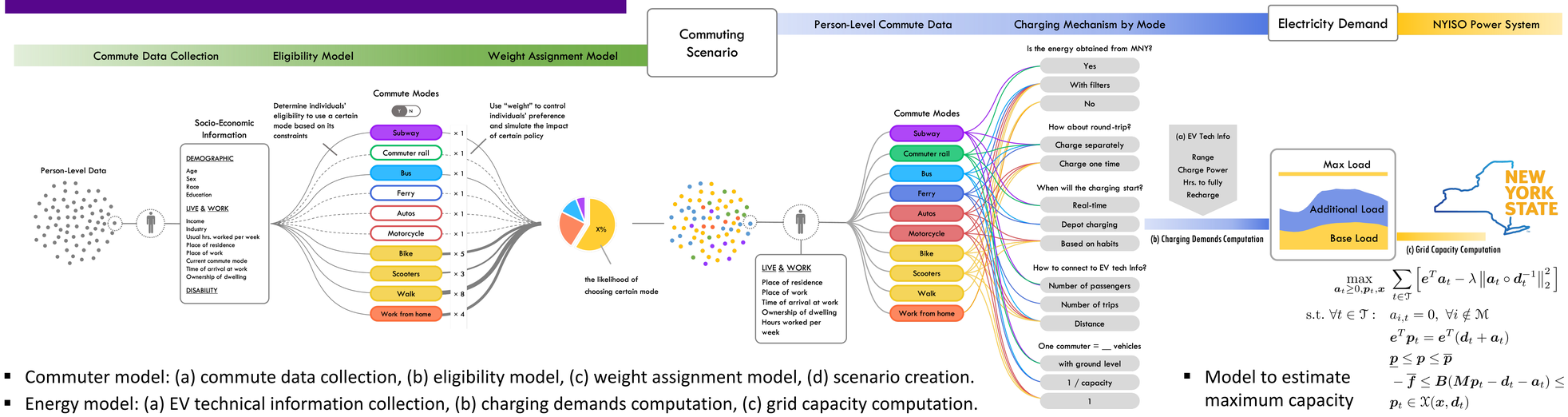
Motivation

- Electrifying transportation is essential for decarbonization
- Increased electricity demand changes with **mode-mixture** which depends on individual availability, cost, and safety.
- Most studies ignore electrified alternatives to EVs
- This study quantifies mode-mixtures and charging demands as a function of socioeconomic data, geographical information, and state-of-the-art electric mobility specifications.

Model Overview



$$\max_{\boldsymbol{a}_t \geq 0, \boldsymbol{p}_t, \boldsymbol{x}} \sum_{t \in \mathcal{T}} \left[\boldsymbol{e}^T \boldsymbol{a}_t - \lambda \left\| \boldsymbol{a}_t \circ \boldsymbol{d}_t^{-1} \right\|_2^2 \right]$$

$$\text{s.t. } \forall t \in \mathcal{T}: \quad a_{i,t} = 0, \ \forall i \notin \mathcal{M}$$

$$\boldsymbol{e}^T \boldsymbol{p}_t = \boldsymbol{e}^T (\boldsymbol{d}_t + \boldsymbol{a}_t)$$

$$\underline{\boldsymbol{p}} \leq \boldsymbol{p} \leq \overline{\boldsymbol{p}}$$

$$-\overline{\boldsymbol{f}} \leq \boldsymbol{B}(\boldsymbol{M}\boldsymbol{p}_t - \boldsymbol{d}_t - \boldsymbol{a}_t) \leq \overline{\boldsymbol{f}}$$

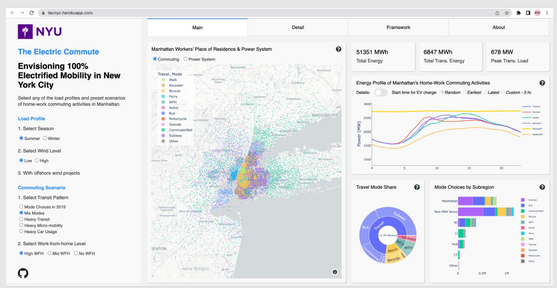
$$\boldsymbol{p}_t \in \mathcal{X}(\boldsymbol{x}, \boldsymbol{d}_t)$$

- Commuter model: (a) commute data collection, (b) eligibility model, (c) weight assignment model, (d) scenario creation.
- Energy model: (a) EV technical information collection, (b) charging demands computation, (c) grid capacity computation.
- Model to estimate maximum capacity

Dashboard & Visualization

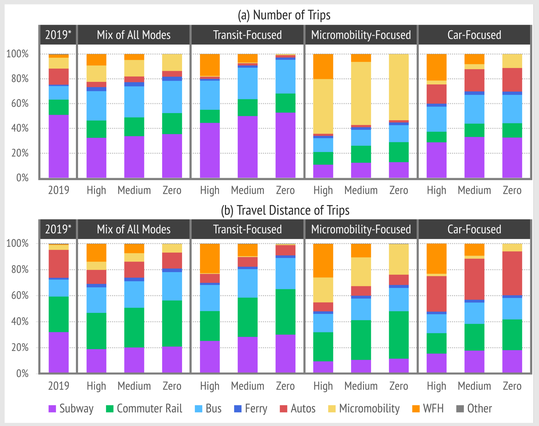
- **Open-source** model and dashboard
- Provide accessible information to citizens, policy- and decision-makers
- Interactive dashboard to explore and visualize pre-computed model scenarios
- Model API for new scenario generation

Try it for yourself!
tecnyc.herokuapp.com



Mode Scenarios

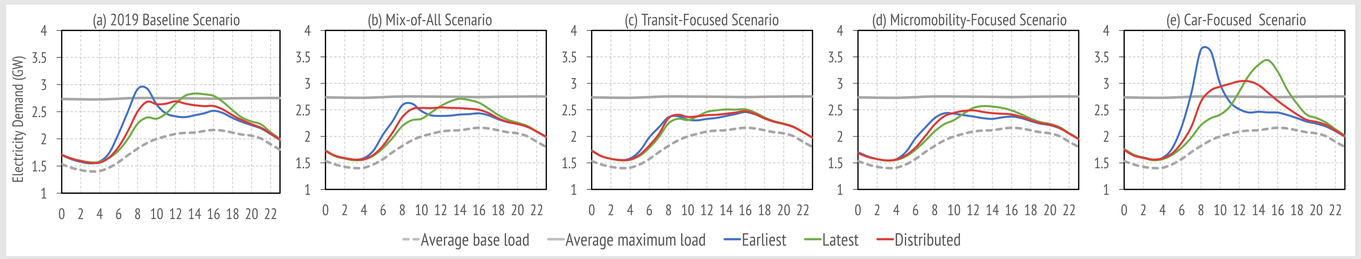
- 4 indicative scenarios based on mode potentials and **existing** infrastructure
- Less potential for additional capacity for public transit, particularly subway ridership
- Significant potential for electrified micro-mobility even with current infrastructure and commuting patterns.



Mode shares with different work-from-home assumptions

Energy Demand

- Charging peaks will often approach or exceed the system limit.
- Scenarios with lower demand show significant shifts in mode choice towards **public transit** and **micro-mobility**.
- Our results highlight the value of incentivizing smart charging and demand response technology allowing **time-distributed charging**.



Resulting total electricity demand for the 4 scenarios assuming different charging patterns. “Earliest”: Current state-of-technology of charging upon arrival. “Latest”: Just-in-time charging so that each vehicle is charged briefly before it is scheduled for its next use. “Distributed”: Minimizes load peaks by distributing charging start times of each vehicle as evenly as possible throughout the day, while respecting the energy demand and vehicle schedule.

Conclusion

Implication

- Models supporting the creation of customized scenarios and offering quantitative decision supports

Possible future work

- Extensions to stochastic- or agent-based models with context information (e.g., weather)

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