

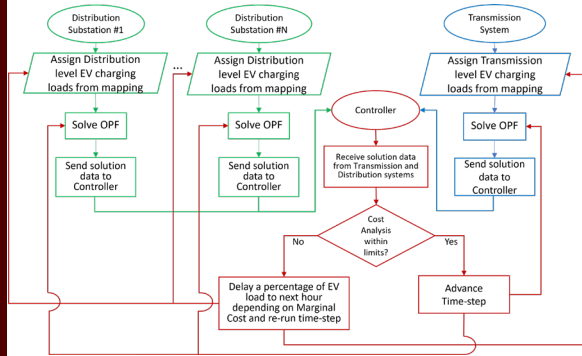


Overview

- Objective: To develop a unifying co-simulation infrastructure integrating transportation demand, grid assets, land use, demographics, and emissions to optimally accelerate electric vehicle (EV) development as well as measure the impact of EV integration.
- 96 electrification scenarios of urban and long-haul truck charging demand were developed and integrated into a combined transmission and distribution (T&D) simulation
- The T&D simulation results are used to develop charging strategies that minimize operational, infrastructure and environmental costs.

T&D Co-Simulation Analysis

- PowerWorld Simulator's OPF analysis is used for the transmission system, and OpenDSS is used for the unbalanced distribution system power flow
- The T&D shared variables are the bus voltage magnitudes angles, and load values.
- Buses with marginal cost above a set threshold have a portion of their EV load delayed or shed.

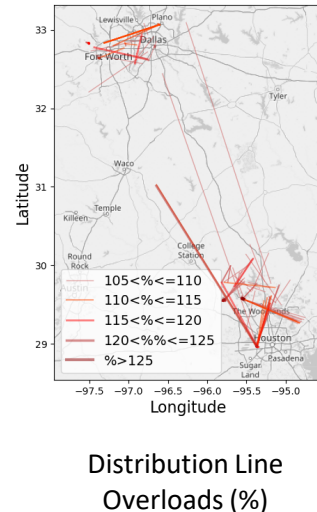
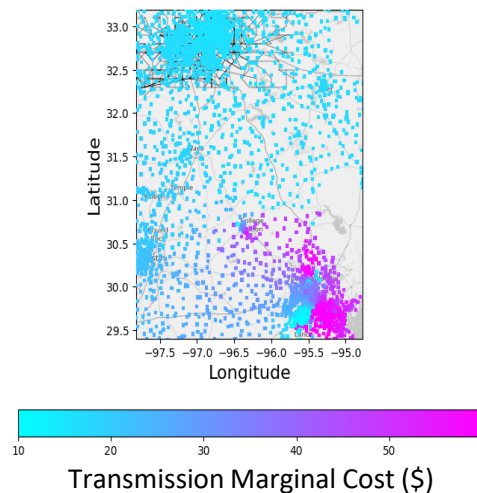


Background and Motivation

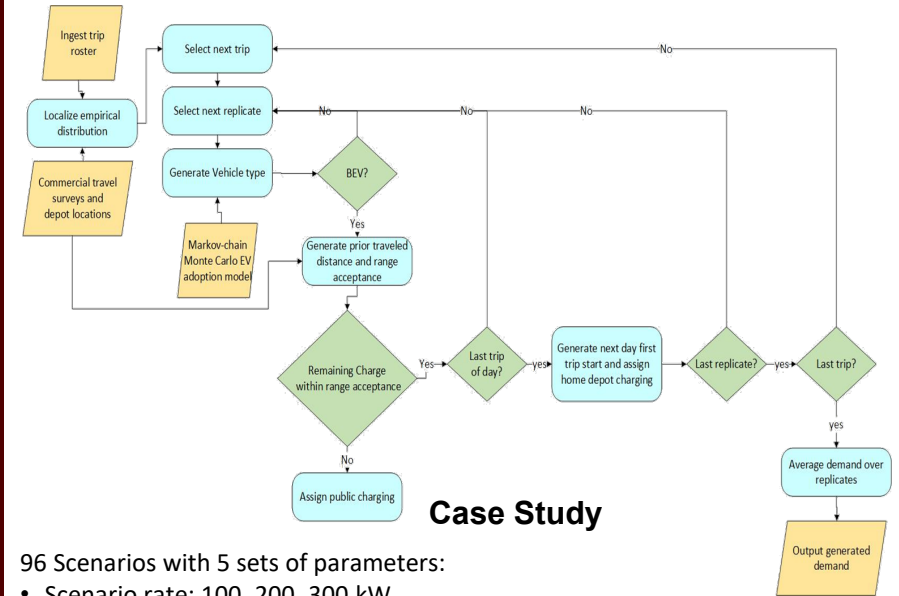
- Most EV integration studies either neglect the transportation and/or electric grid dynamics and detailed modeling
 - The Transportation and/or grid models are substantially oversimplified
- Most studies only use a small transmission and/or distribution model
 - The largest known combined T&D study used a 240-bus transmission grid with an 8,500-node distribution feeder replicated 19 times.

Simulation Results

- Capital cost is around 12% of the total yearly cost of EV adoption
- Charging at midnight results in cost savings in all scenarios and decreases operating cost up to 21%
- Delaying (or reducing) charging at nodes with high marginal cost (LMP) can reduce or eliminate most of the transmission overloads
- Emissions increase based on an increase in concurrent load as more polluting plants are dispatched. However, rate of increase slows as market adoption rate increases



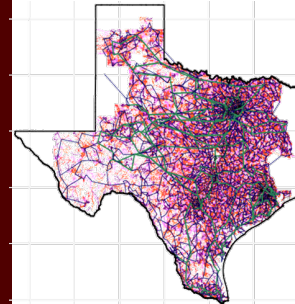
Transportation/Charging Model



Case Study

96 Scenarios with 5 sets of parameters:

- Scenario rate: 100, 200, 300 kW
- Season: Peak (summer), Shoulder (spring/fall)
- EV market adoption rate: 25%, 50%, 75%, and 100%
- Charging logic: upon arrival and starting at midnight
- I-45 charging location: midpoint between Houston and Dallas or near Dallas



Transmission System Parameters		Houston/Dallas Distribution System Parameters	
Attribute	Value	Attribute	Value
Buses	6,717	Number of Substations	1841
Substations	4,894	Number of Feeders	6,566
Areas	8	Line Length (km)	298,259.51
Transmission lines	7,173	Number of Lines	10,052,796
Transformers	1,967	Number of Transformers	1,729,184
Loads	5,095		
Generators	731		
Shunts	634		
Peak load (GW)	75		