

Ahead of the Curve: Building the Electrified Supply Chain

Dr. Constance Crozier explores the future of freight electrification, blending research-driven foresight with practical insights for fleet and infrastructure transitions.

LUNCH AND LEARN

Thursday, March 5, 2026 | 12pm ET



Constance Crozier

Thank you for attending!

Upcoming Course Calendar
scl.gatech.edu/course-calendar

scl.gatech.edu



Supply Chain and
Logistics Institute

Bio

University of Oxford



Electric vehicles

UK Government



EV Charging legislation

CU Boulder

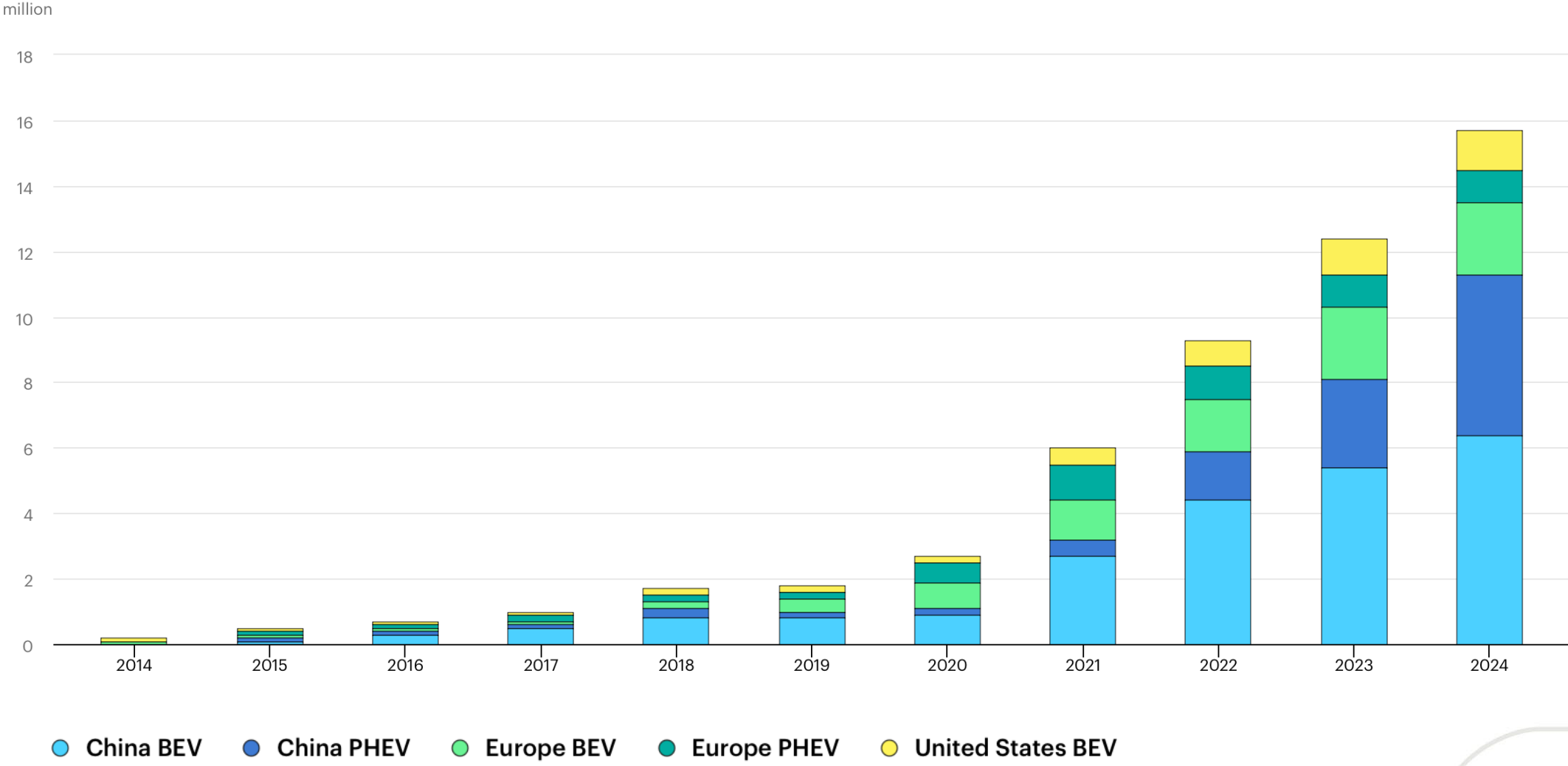


Power grids

Georgia Tech



IEA Estimates on electric vehicles



Longer ranges, bigger loads

2011



Nissan Leaf
100 miles

2017



Tesla X
200 miles

2022



Rivian R1
300 miles

2023



Rivian EDV
200 miles

Outline

Transition to electric freight

Will electric heavy-duty trucks become cost competitive, and what are the operational tradeoffs?

Flexibility from supply chains

Are there additional value streams possible from electrified supply chains?

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Long haul trucking

- There are electric alternatives available...



Tesla

Cost: \$180-290k!!
Range: 500 miles



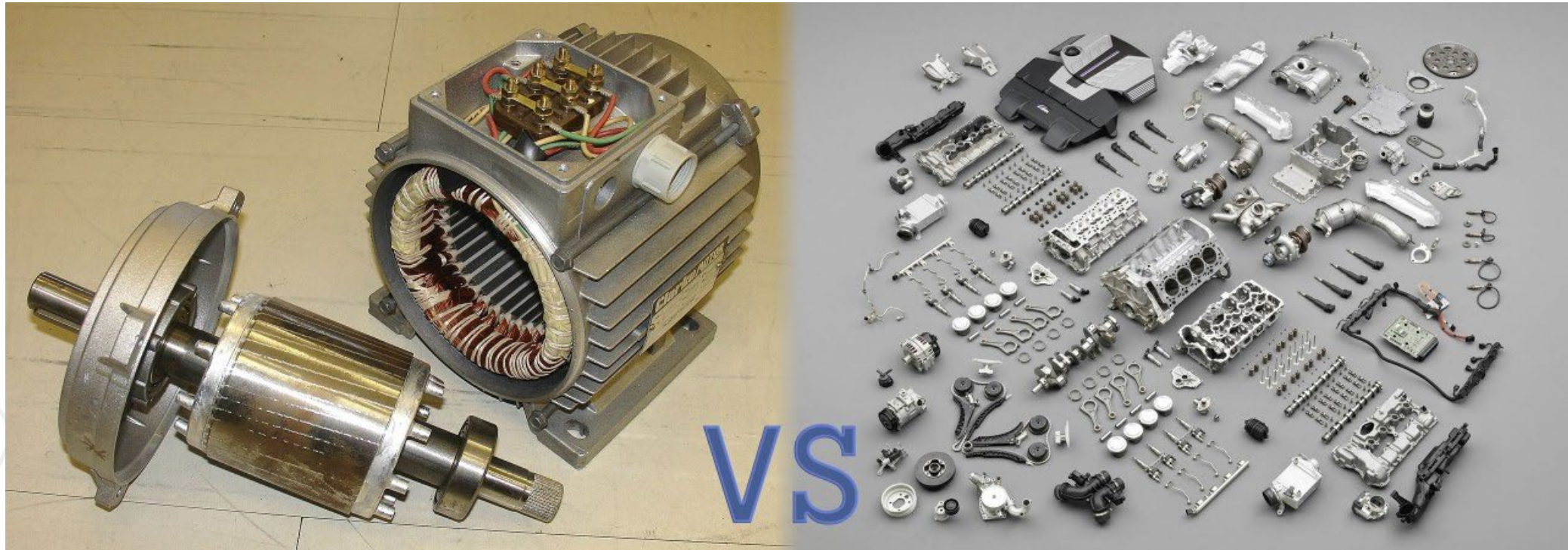
Nikola

Cost: \$280k
Range: 400 miles

...but there is big uncertainty on costs

Long haul trucking: pros and cons

Maintenance costs are typically much lower for electric alternatives

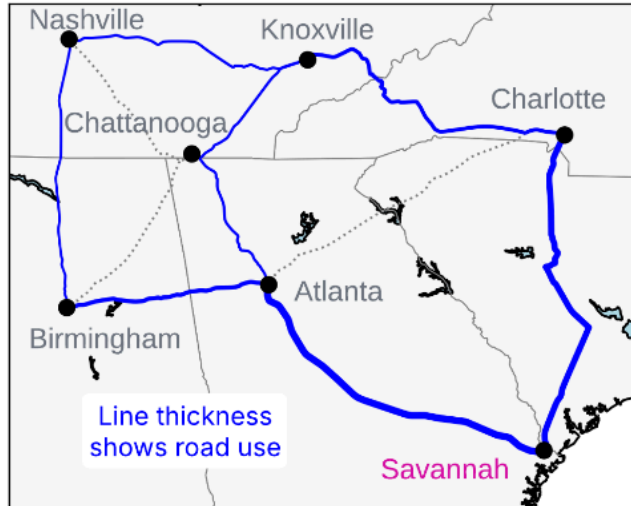


Long haul trucking: pros and cons

- Fuel costs per mile are typically lower (with depot charging however, batteries are heavy, so the payload is limited)
 - For weight-limited freight more truck loads are necessary
- Charging likely to take 30-60mins
 - This *may* count towards drivers' legal hours

Case Study: Should you buy diesel or electric trucks?

Savannah, GA

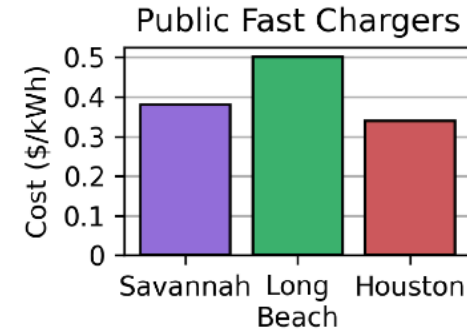
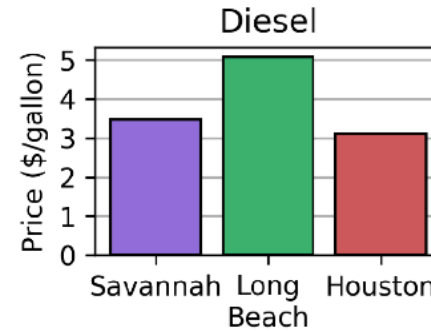
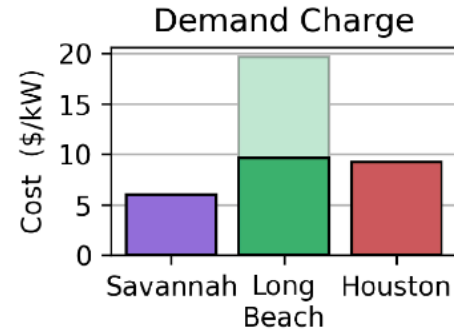
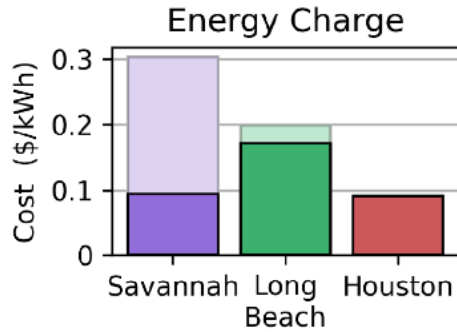
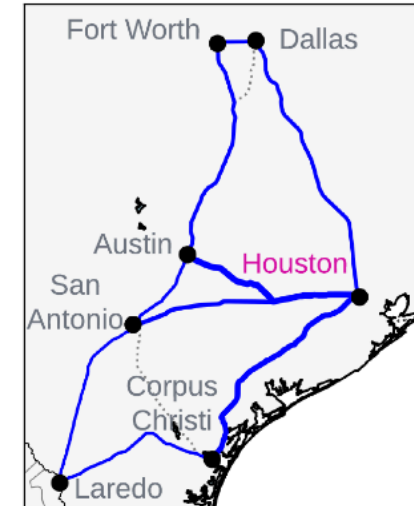


Shading indicates range between on and off peak

Long Beach, CA

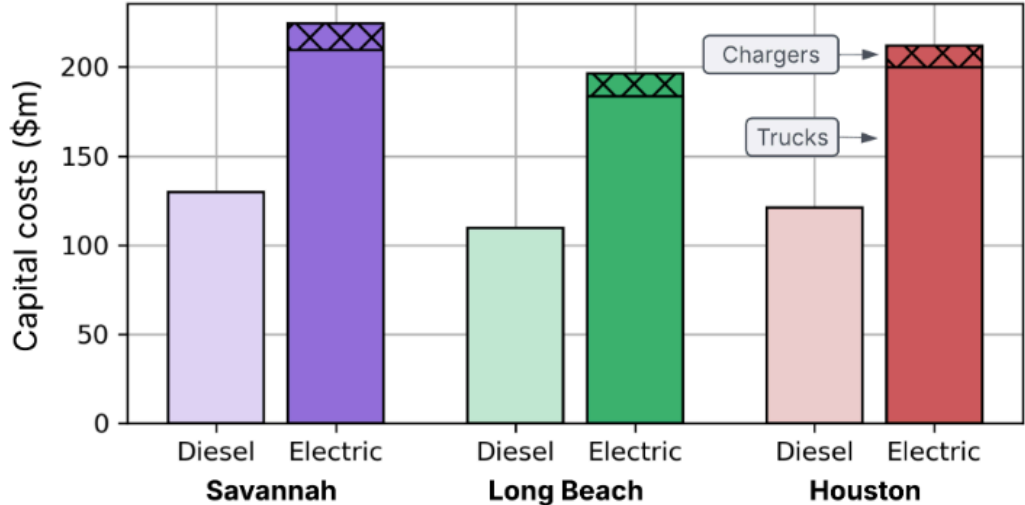


Houston, TX

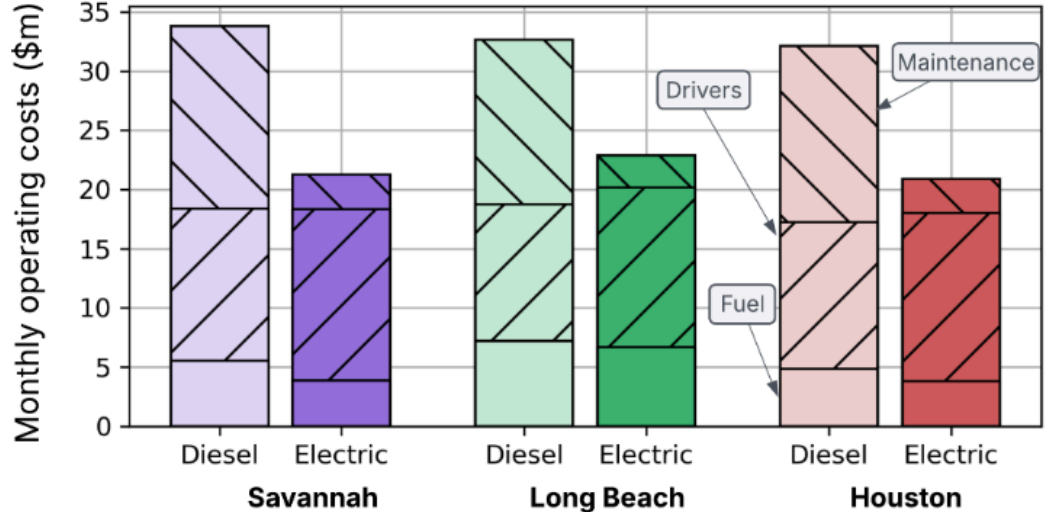


Cost differences: fully diesel vs. electric

Capital Costs



Operational Costs

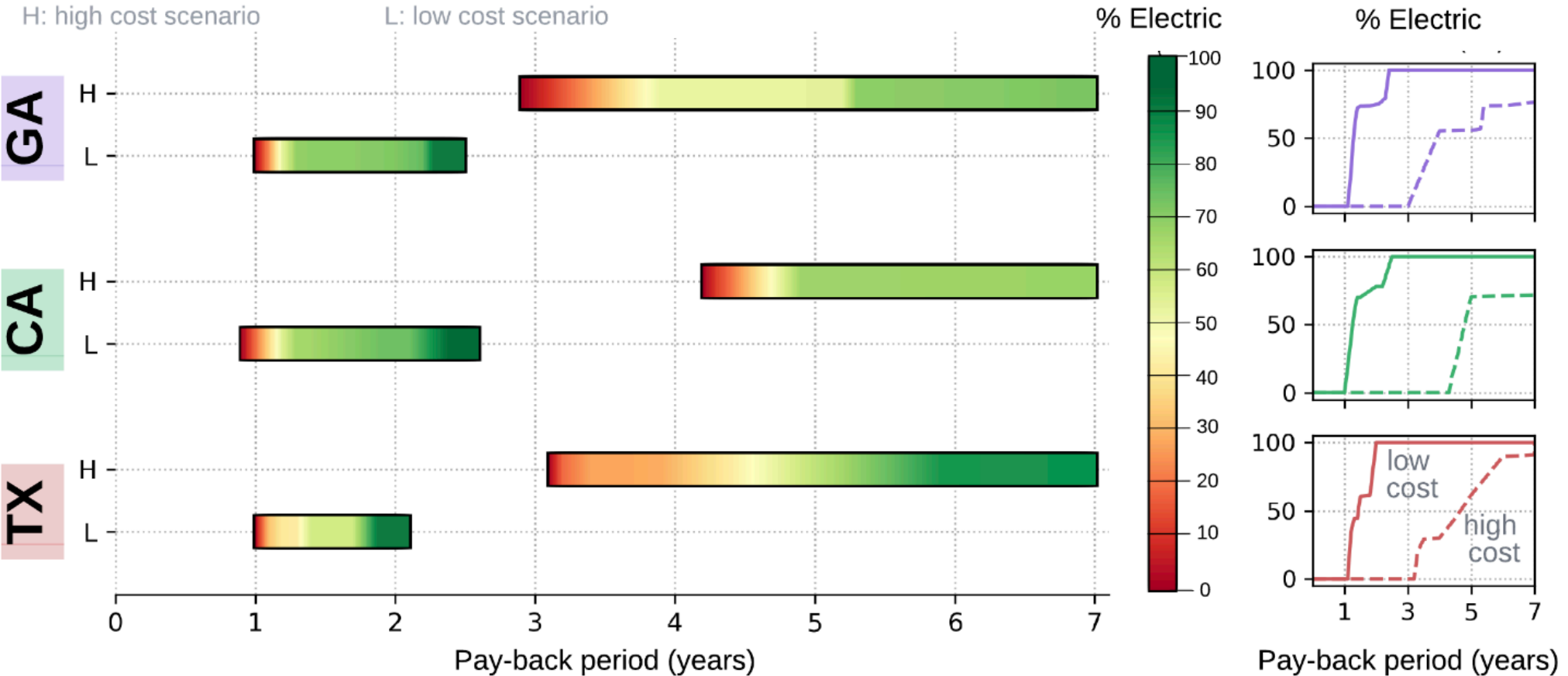


Savannah, GA

Long Beach, CA

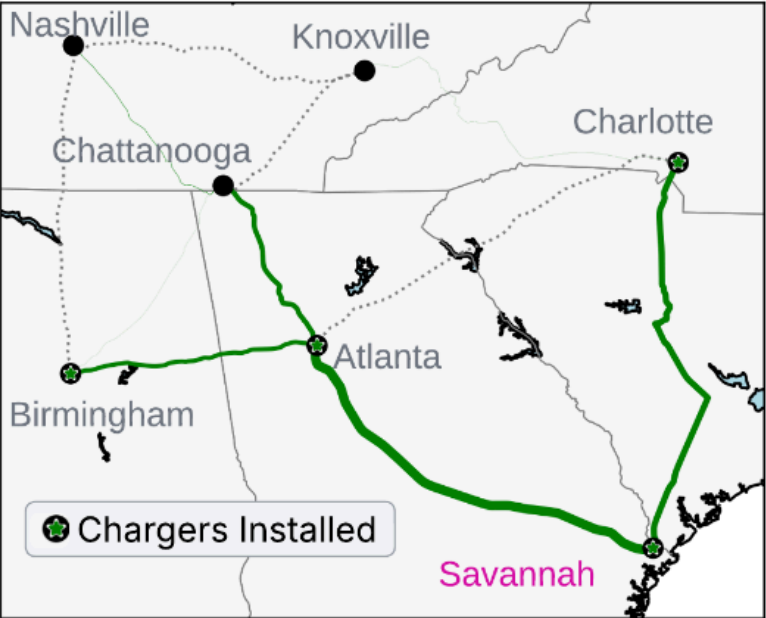
Houston, TX

Pay-back period

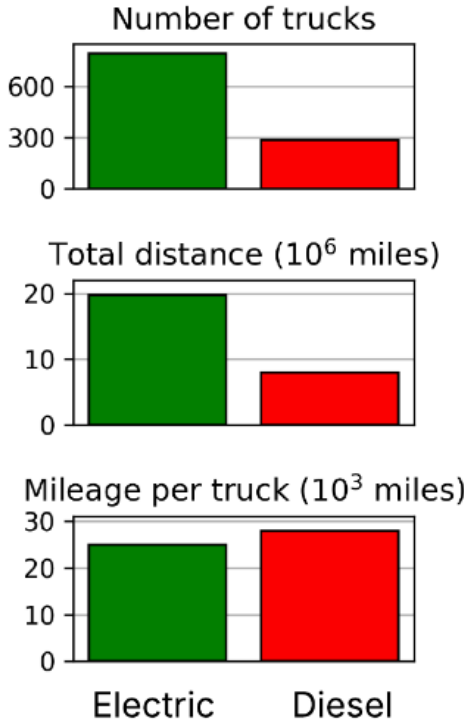


Mixed Fleet Operation

Electric



Diesel



Policy changes or incentives?

Policies

- Exemption from weight limit
- Driver hours policies

Incentives

- Carbon credits or taxes
- Subsidies on co-located solar

If you are interested in these topics, I am putting together an advisory board for a proposal to the Sloan Foundation – please reach out!

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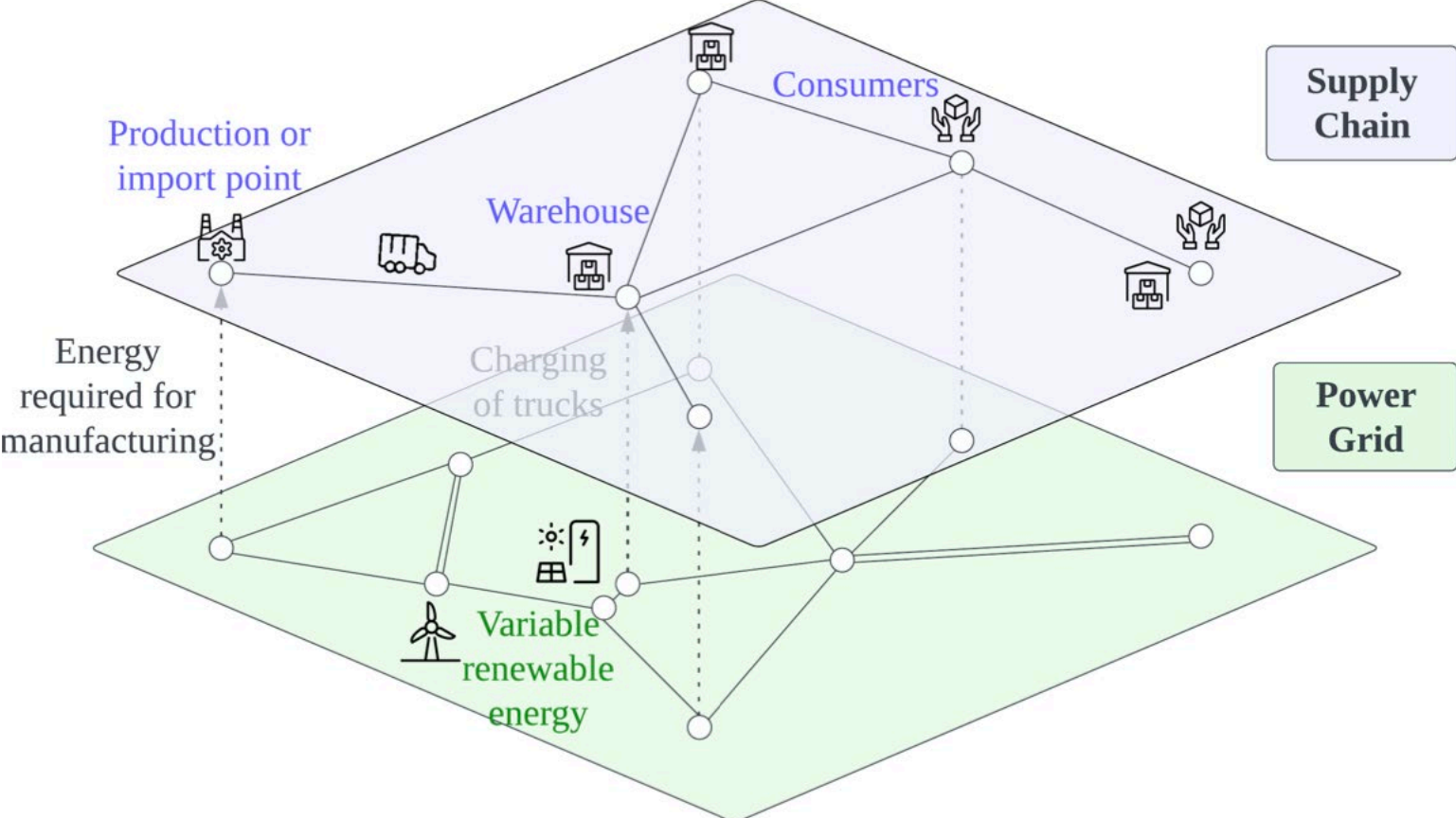
Flexibility from supply chains

Are there additional value streams possible from electrified supply chains?

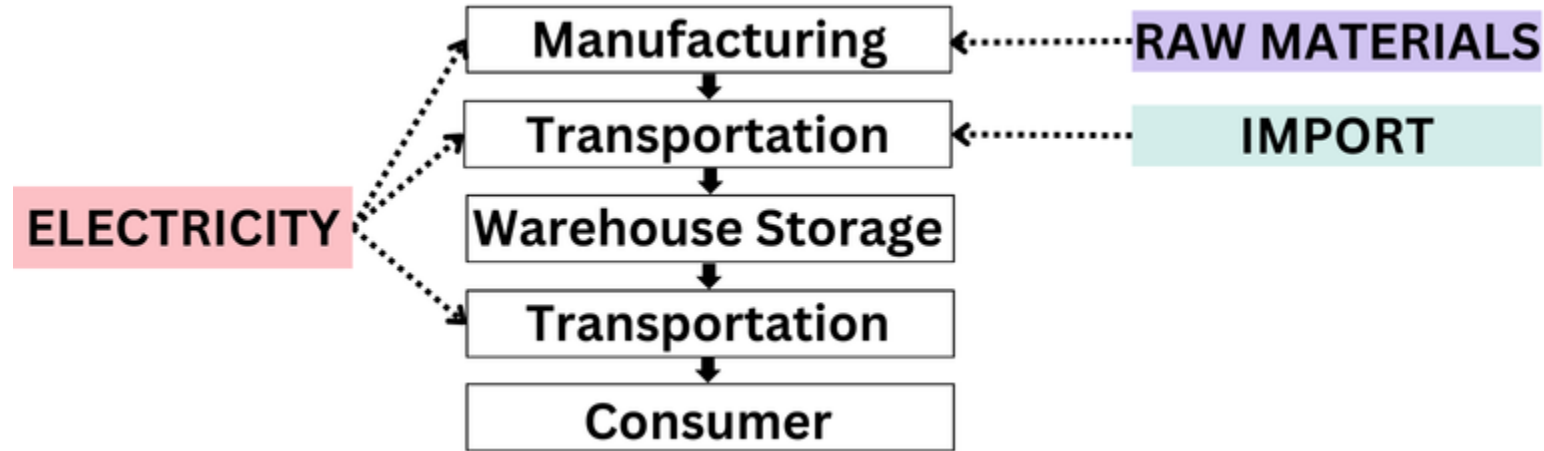
Balancing the electric grid



Beyond freight: supply chain optimization



How does a renewable incentive change supply chain design?



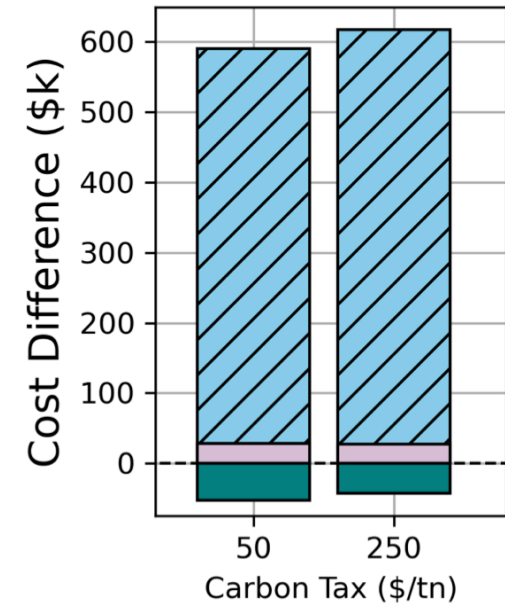
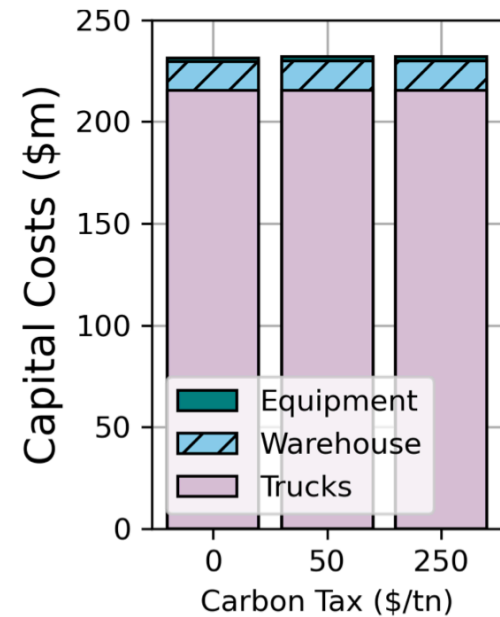
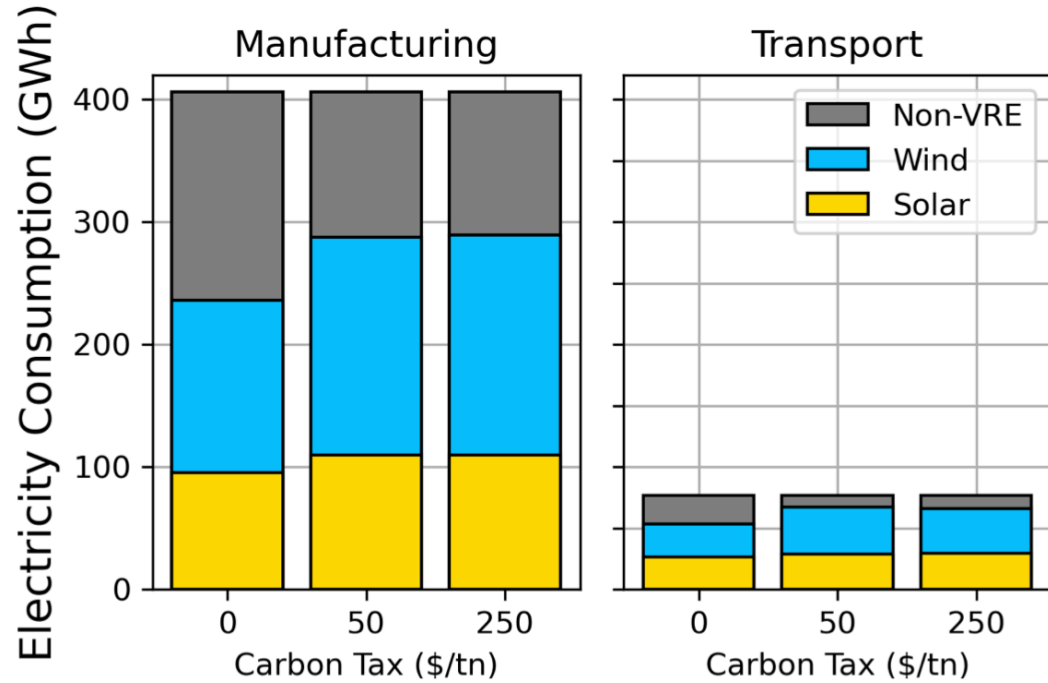
Centralized Operation of an Electrified Supply Chain

Electrified Transportation	Electrified Manufacturing	Renewable Generation
<ul style="list-style-type: none"> Fleet of electric trucks with battery capacity limits Vehicle-to-building (V2B) energy discharge capability 	<ul style="list-style-type: none"> Manufacturing processes consuming electricity and raw materials Fixed-duration production steps with specified energy and material requirement 	<ul style="list-style-type: none"> Location-and time-specific renewable availability for solar and wind Non-renewable energy usage penalized via a carbon tax

East Coast Case Study: Industrial heating



What changes in the supply chain?



Thanks for listening!

Questions?

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Upcoming Courses

Generative AI Application for Supply Chain Professionals

March 23-25, 2026 | Virtual (Instructor-led)

Register by March 19th

Creating Business Value with Statistical Analysis

April 13-16, 2026 | Virtual (Instructor-led)

Lean Warehousing

May 5-7, 2026 | Georgia Tech Global Learning Center in Atlanta

Georgia AIM Discount

Georgia residents are eligible to receive 50% off our professional education courses.

– *but only until August 1st.*

Thanks to a grant from the U.S. Department of Commerce's Economic Development Administration, this limited-time offer supports Georgia learners in gaining career-boosting skills.

- ✓ GA residency verification required
- ✓ Use code *SCL-GAAIM* at checkout
- ✓ Cannot be combined with other discounts

Upcoming SCL Lunch and Learn Opportunities

Ahead of the Curve: The Hidden Data Supply Chain Propelling AI

w/ **Dr. Rosemarie Santa Gonzalez**

Thursday, April 2nd | 12-1pm ET | Zoom Registration Link



scl.gatech.edu/Apr26-Inl



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Nomenclature

Variable	Description	Unit	Variable	Description	Unit
Product Decision Variables/Parameters			Power Decision Variables/Parameters		
f	The amount of raw material arriving	kg	p	The total consumed power	kW
q	Product injection (+) supply (-) demand	kg	r	The amount renewable power available	kW
X	The amount of product stored	kg	z	The total nonrenewable power	kW
F	The amount of raw material available	kg	C	The cumulative charge of vehicles	kWh
Truck Decision Variables/Parameters			E	The amount of energy required to drive	kWh
y	The number of loaded trucks	--	Manufacturing Decision Variables/Parameters		
y'	The number of empty trucks	--	α_s	Electricity consumption of process s	kW/unit
Y	The number of stationary trucks		β_s	Production rate of process s	kg/unit
\hat{Y}	The total number of trucks in the fleet		γ_s	Raw material consumption of process s	kg/unit
θ	The ratio of an unloaded vs. loaded truck weight	--	m_s	The amount of process s taking place	--
τ_{ij}	Number of time-steps to travel from i to j		M_s	Maximum rate of production of process s	

Problem Formulation: Objective

- A mixed-integer linear program (MILP) is formulated with constraints covering charging, manufacturing, electric truck movement, and finished product flow. The model is solved using Gurobi on a computing cluster.

- **Objective:**

$$\min \Delta_t N_t f_{capex} + f_{opex}$$

- **Capital Costs (f_{capex}):** Trucks, Warehouses, Manufacturing Equipment costs levelized over component lifetimes
 - N_t : the number of time steps in the planning horizon
 - Δ_t : the size of each time step in hours
- **Operational Costs (f_{opex}):** Energy Charges and Carbon Penalties on non-renewable energy

Problem Formulation: Dynamic Constraints

- Captures the change in accumulated charge based on power consumption, manufacturing, and charging

$$C_i^{(t)} - C_i^{(t-1)} = \Delta_t \left(p_i^{(t)} - \sum_s \sum_{\tau}^{\tau_s} \alpha_s m_{s,i}^{(t-\tau)} \right) - \sum_j E_{ij} \left(y_{ij}^{(t)} + \theta y_{ij}'^{(t)} \right)$$

- Tracks stationary truck changes from arrivals and departures

$$Y_i^{(t)} - Y_i^{(t-1)} = \sum_j \left(-y_{ij}^{(t)} - y_{ij}'^{(t)} + y_{ji}^{(t-\tau_{ij})} + y_{ji}'^{(t-\tau_{ij})} \right)$$

- Updates finished product and raw material inventories to ensure demand fulfillment across the supply chain

$$X_i^{(t)} - X_i^{(t-1)} = q_i^{(t)} + T_{load} \sum_j \left(y_{ji}^{(t-\tau_{ij})} - y_{ij}^{(t)} \right) + \sum_s \beta_s m_{s,i}^{(t-\tau_s)}$$

$$F_i^{(t)} - F_i^{(t-1)} = f_i^{(t)} - \sum_s \gamma_s m_{s,i}^{(t)}$$

Problem Formulation: Additional Constraints

$$\sum_i p_i^{(t)} \leq \sum_i r_i^{(t)} + z^{(t)}$$

(Power Balancing Constraint)

$$\sum_i Y_i^{(t)} + \sum_{ij} \sum_{\tau=0}^{\tau_{ij}} y_{ij}^{(t-\tau)} \leq \hat{Y} \quad \forall t$$

(Total Fleet Size Constraint)

$$\sum_{\tau=0}^{\tau_s} m_{s,i}^{(t-\tau)} \leq M_{s,i} \quad \forall i, s, t$$

(Manufacturing Constraint)

$$C_i^{(t)} \leq Y_i^{(t)} T_{batt} \quad \forall i, t$$

(Battery Capacity Constraint)

$$X_i^{(t)} + \sum_s F_{s,i}^{(t)} \leq W_i$$

(Warehouse Constraint)

Boundary and non-negativity constraints are also included