Design of a Campus Motor Fleet for the FAA Technical Center to Meet E.O. 13514

System Engineering & Operations Research, George Mason University

Shane Armstrong, Caleb Benn, Alicia Kubokawa, Kelly Prim

Context: Climate Change & Sustainability

The Federal Aviation Administration (FAA)

FAA must comply with Executive Order 13514, to reduce greenhouse gas (GHG) emissions of motor fleet by 2020.

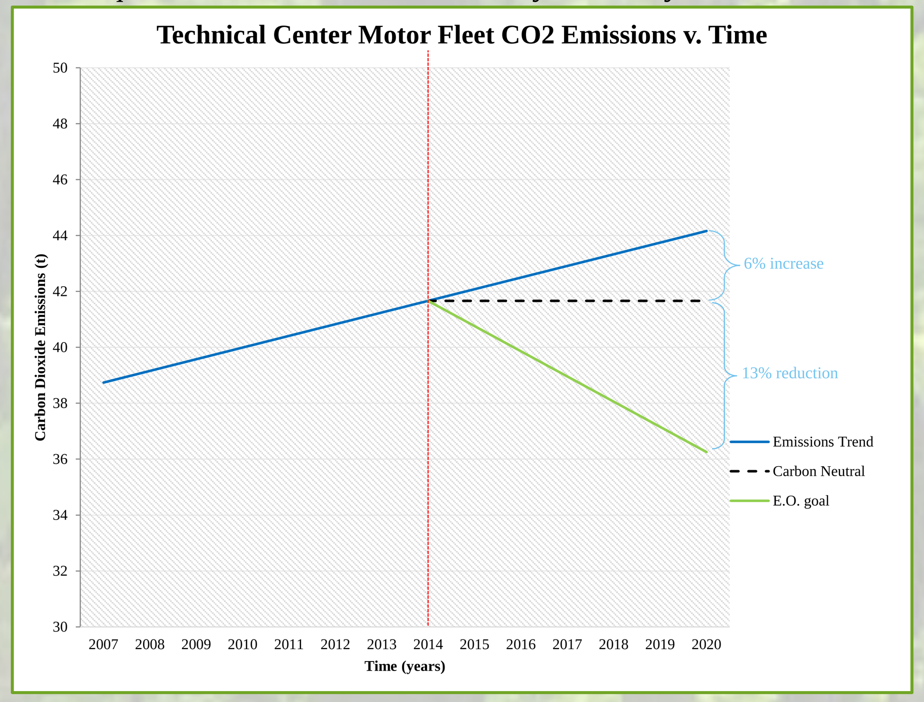
Presidential Environmental Initiatives

Executive Order 13514 October 5, 2009

- 30% reduction vehicle fleet petroleum usage
- Fleet size optimization
- Directs agency mandated reduction of GHG emissions

Presidential Memorandum – Federal Fleet Performance

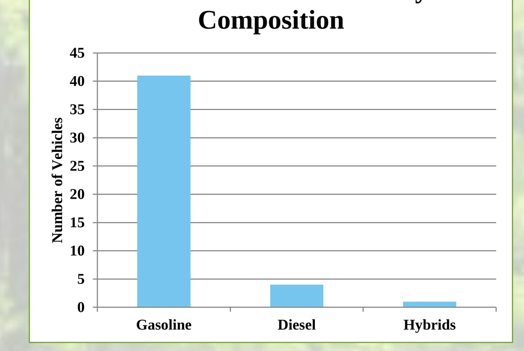
- Requires vehicles to be alternatively fueled by 2016



Scope

William J. Hughes Technical Center

Location: 10 miles north of Atlantic City, NJ
Size: ~ 5,000 acre or 7.8 square miles (7x GMU campus size)
Functions: Engineering research, development, testing
Vehicles: 42 GSA leased



Need Statement & Alternatives

Problem Statement

Based on direction by DOT and E. O. 13514, the FAA must reduce its GHG emissions by 12.3% by 2020 and meet campus demand within existing funding.

Need Statement

A system to be used by the ALO/Fleet Managers of FAA campuses to identify feasible modifications to the current motor fleet vehicle inventory to achieve a 12.3% reduction of GHG emissions.

Gasoline Vehicle

Low-Speed Electric Vehicle

Neighborhood Electric Vehicle

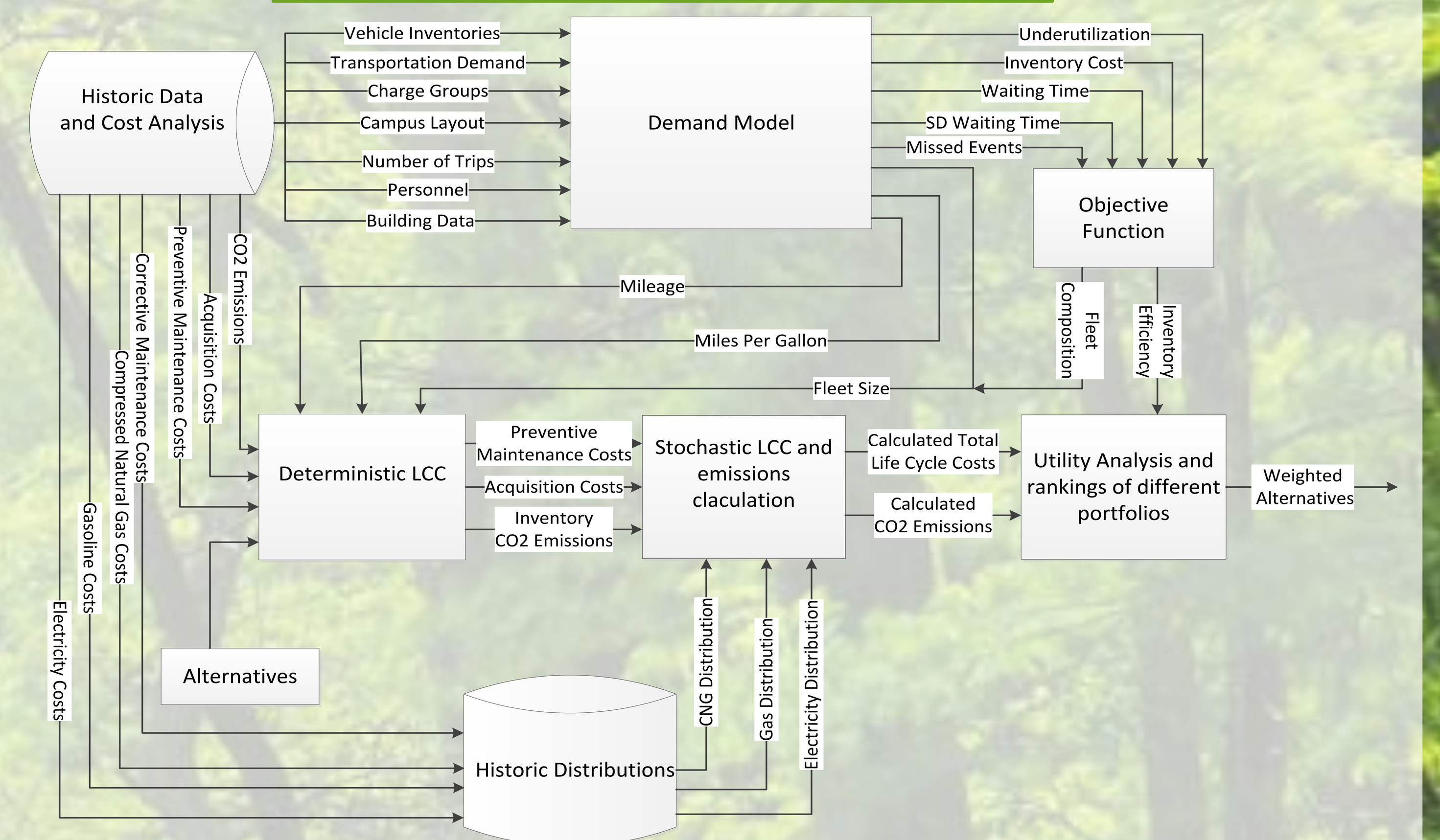
Compressed Natural Gas Vehicle

Does not meet requirement (red) / Meets requirement (green)

Alternatives	Optimize Inventory	Reduce Emissions	Meet Travel Demand	Maintain/Reduce LCC	Operational Suitability
Gasoline	✓	X	✓	✓	✓
LSEV's	✓	✓	✓	✓	✓
NEV's	✓	✓	✓	✓	✓
CNGV's	✓	✓	✓	X	✓

Method of Analysis

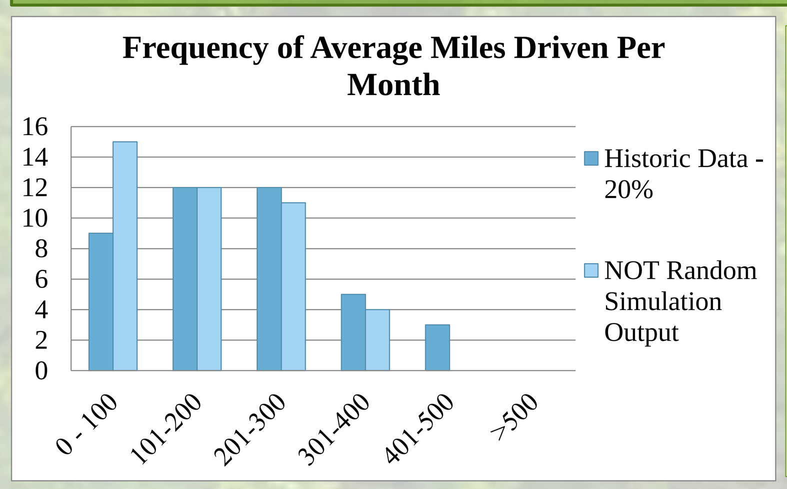
Complete Demand and Life Cycle Simulation



Demand Model	Discrete event queuing model evaluates inventories & estimates average vehicle mileage	Objective Function	Minimization function to filter out infeasible inventories for use in the LCC model	LCC Model	Monte Carlo simulation estimates LCC, CO_2 emissions, & forecasts energy prices

Results

Demand Model Validation



Demand model output matches historical mileage data with except for high mileage vehicles being out of scope; accounted for by more low mileage vehicles

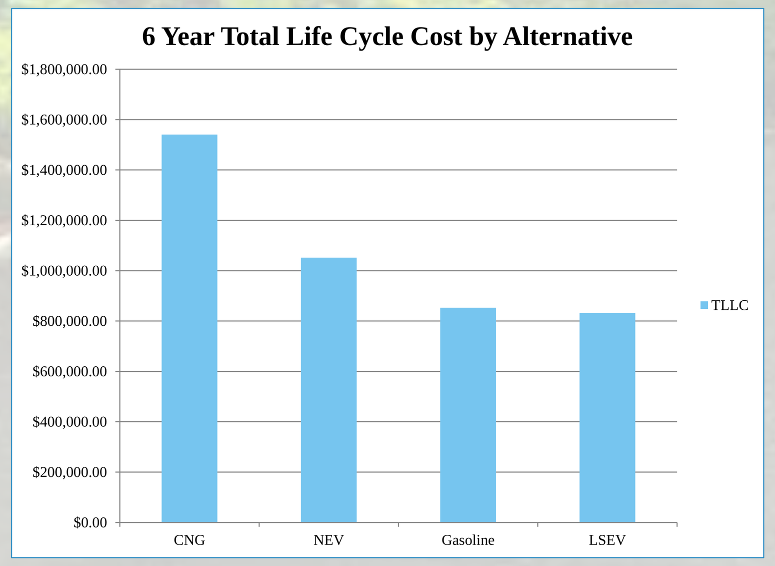
Objective Function Output

Inventory Size	Total Cost	Underutilization Avg	Underutilization cost	Inventory Avg	Inventory cost	Waiting Time Avg	Waiting Time cost	SD Waiting Time Avg	SD Waiting Time cost	Missed Events Avg	Missed Events cost
42	$18,113	122	$4,807	42	$1,764	170	$6,026	155	$5,489	0.8	$27
41 (5)*	$18,822	120	$4,679	41	$1,681	186	$6,604	164	$5,830	0.8	$28
41 (2)	$19,137	121	$4,750	41	$1,681	196	$6,947	161	$5,724	1	$35
41 (1)	$19,546	120	$4,898	41	$1,681	197	$6,988	167	$5,945	0.9	$34
39 (1,3,5)	$22,537	114	$4,462	39	$1,521	260	$9,234	205	$7,279	1.2	$41

The 42 vehicle inventory had the lowest cost. Reducing inventory size lowered underutilization costs but increased waiting time costs

*indicates which charge code was reduced

Life Cycle Cost Model Output

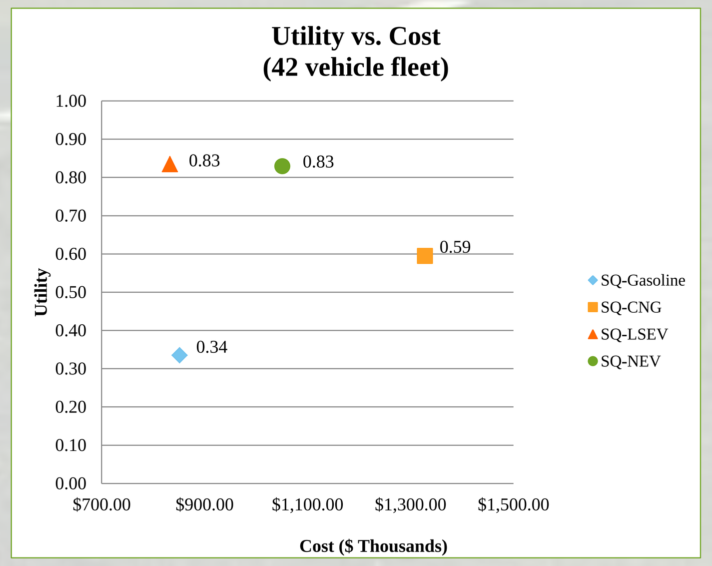


Gasoline fleets are more cost effective because they are leased from the GSA which also pays for their maintenance. The FAA would be responsible for all costs from LSEV fleets.

6-year Fleet Total Life Cycle Cost Breakdown

	CNG	NEV	Gasoline	LSEV
Energy	$23,900	$12,100	$96,800	$11,000
Corrective	$135,900	$21,100	$6,100	$21,100
Deterministic	$78,600	$52,400	$78,600	$52,400
Acquisition	$1,302,000	$966,000	$671,100	$747,600
TLLC	$1,540,400	$1,051,600	$852,600	$832,100

Utility Analysis

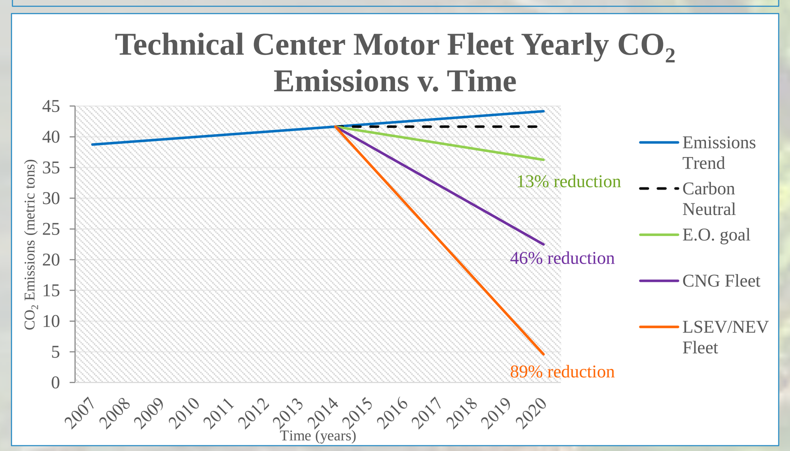


The graph shows the utility score of each alternative versus cost. LSEVs have the highest utility & lowest cost while gasoline vehicles have the lowest utility with nearly the same cost as LSEVs.

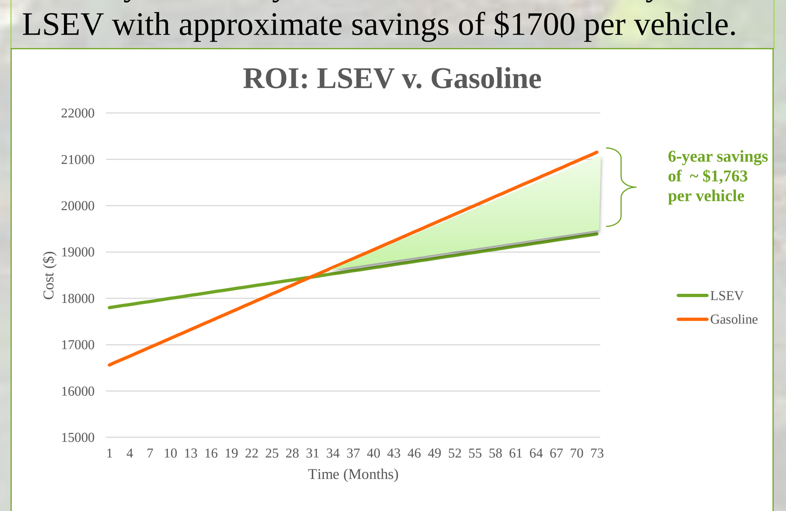
Conclusions & Future Work

Observations

The FAA can meet the emissions reduction goal by replacing 7 gasoline vehicles with LSEV's or NEV's



The only financially feasible alternative over 6 years is LSEV with approximate savings of $1700 per vehicle.



Recommendations

Improve Fleet Management

Implement a detailed fleet management system that tracks vehicle use.

Replace Inventory with Electric Vehicles

LSEV's and NEV's are the recommended alternative for vehicle replacement, as they have the lowest energy, deterministic maintenance costs, and significantly reduce CO_2 emissions.

Observations

The size of the fleet can be reduced, but utilization and waiting times are not linearly affected.

Decentralized fleets are effective at reducing inventory size while minimizing bottlenecks that occur in smaller inventories.

Utilization