Estimating the Impact of Electric Vehicle Charging on Electricity Costs Given an Electricity-Sector Carbon-Cap

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Background

- Cap-and-trade has gained political traction as a greenhouse gas reduction measure
- Several current and proposed systems cover electricity generation but not transportation fuels e.g. RGGI, EU ETS
- EVs/PHEVs are increasing substitutability between gasoline and electricity and have lower life cycle GHG emissions than CVs

Background

Potential impact of PHEV charging with a electricity sector carbon cap:

Impact on	Tailpipe Emissions	Power Plant Emissions	Net Effect
Transportation Related $C0_2$ Emissions	↓	↑	↓
CO_2 Price	N/A	↑	↑
Electricity Prices	N/A	↑	↑

Decreasing overall CO_2 levels *increases* CO_2 allowance prices, electricity prices, and PHEV operating costs.

Research Objectives

Given the RGGI carbon cap, estimate the impact of PHEV charging on electric power generating costs in New England in terms of:

- Average fuel costs
- Marginal fuel costs
- CO_2 allowance prices

for three PHEV fleet penetration levels and three charging scenarios

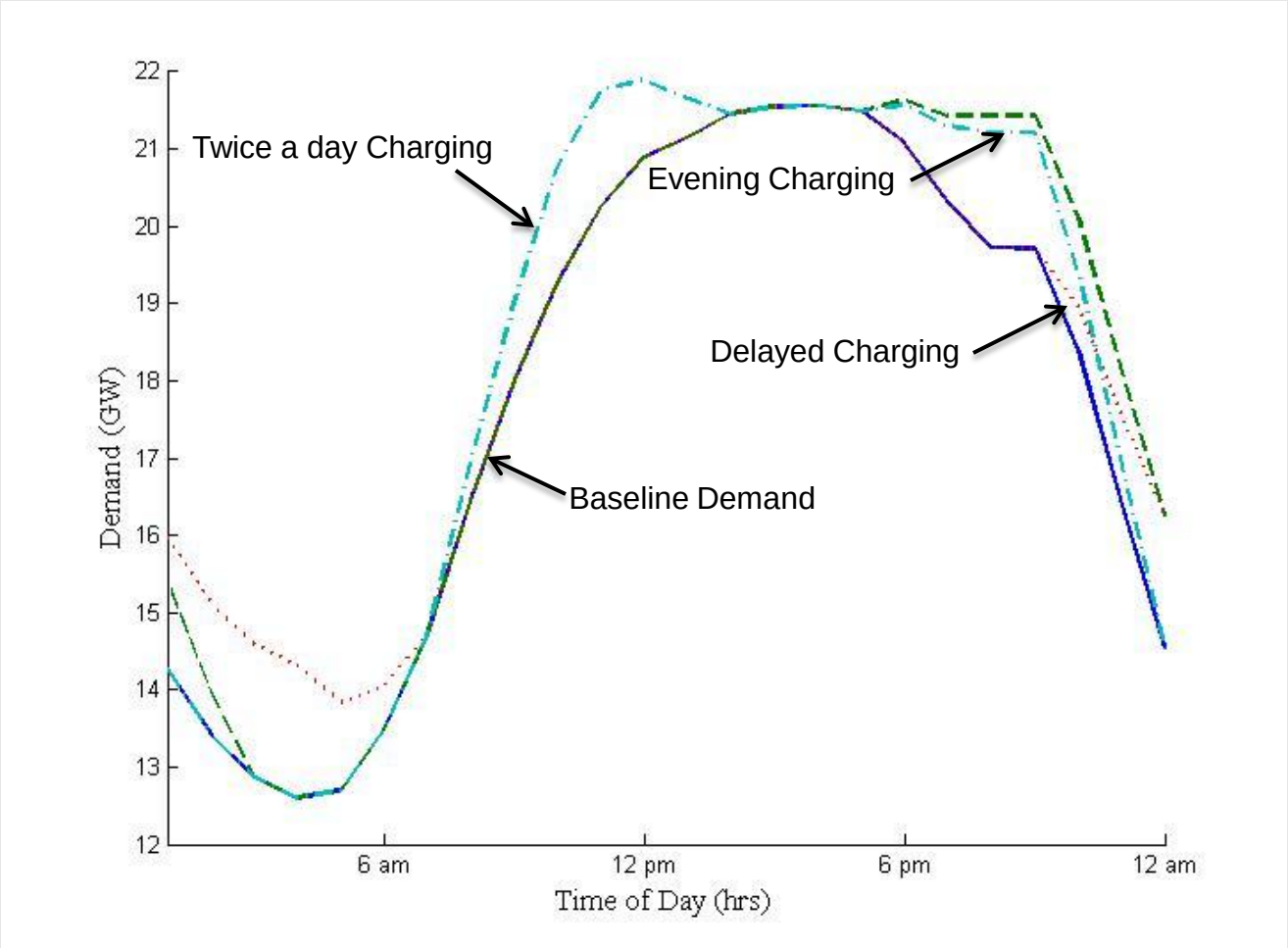
Modeling Approach

- Short-run, fixed capacity, dispatch model for New England power plants
- Use linear optimization to minimize system wide fuel costs subject to the constraints that:
  1) supply match demand for each hour of the year
  2) NO_x emissions not exceed CAIR cap
  3) CO_2 emissions not exceed RGGI cap
- Model Outputs: Electricity generation by plant, systemic marginal fuel cost, average fuel costs, CO_2 allowance price

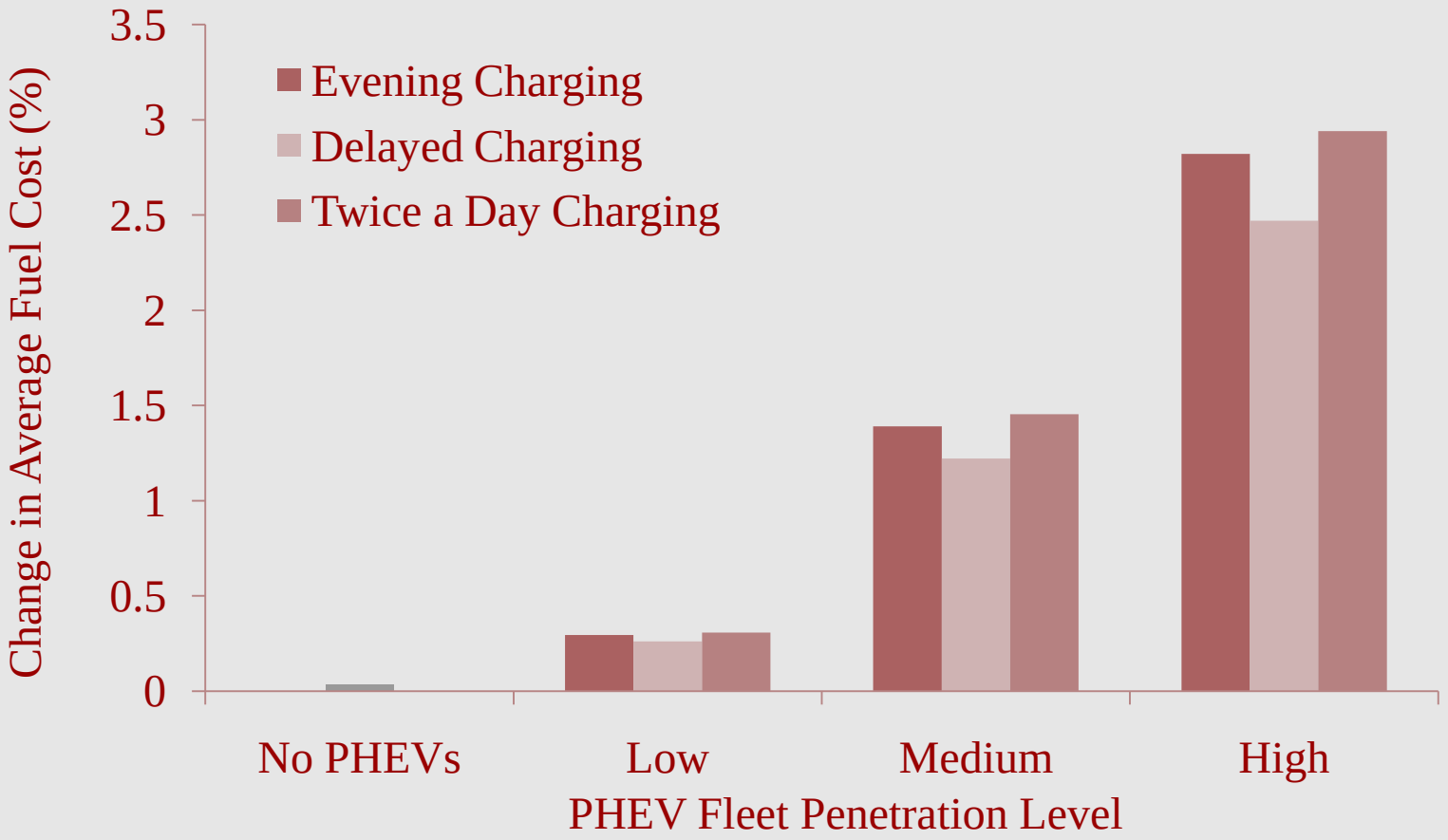
Model Scenarios

Scenarios		PHEV Fleet Penetration	Added Electricity Demand	Charging Scenario
Baseline – No Cap	(B_0)	0%	N/A	N/A
Baseline – RGGI	(B_R)	0%	N/A	N/A
Low	(L_1)	1%	0.33%	Evening Charging
	(L_2)	1%	0.33%	Delayed Charging
	(L_3)	1%	0.33%	Twice a day
Medium	(M_1)	5%	1.66%	Evening Charging
	(M_2)	5%	1.66%	Delayed Charging
	(M_3)	5%	1.66%	Twice a day
High	(H_1)	10%	3.26%	Evening Charging
	(H_2)	10%	3.26%	Delayed Charging
	(H_3)	10%	3.26%	Twice a day

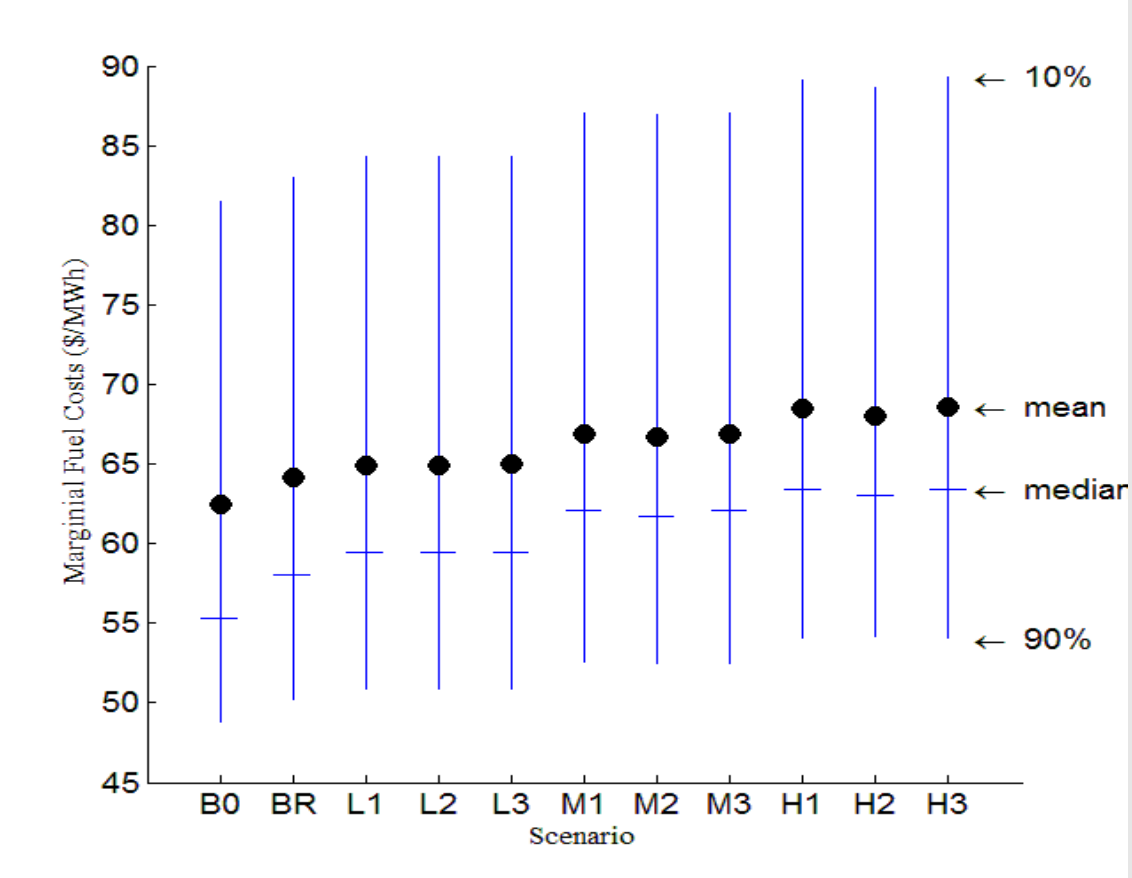
Model Scenarios – New Demand



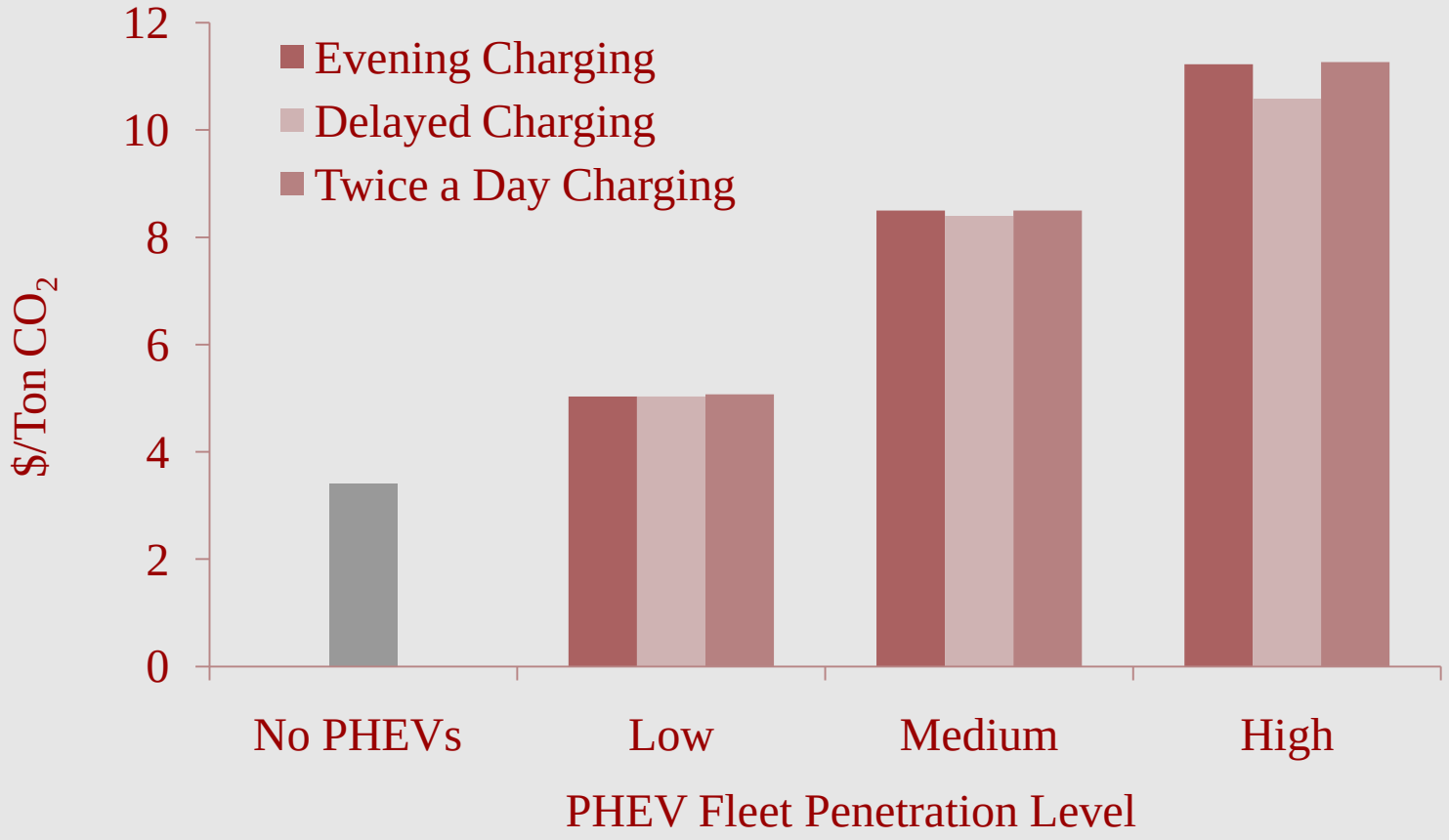
Model Results – Average Fuel Cost



Model Results – Marginal Fuel Costs



Model Results – CO_2 Allowance Cost



Conclusions

- Positive relationship between PHEV penetration and increased fuel and CO_2 costs
- Impact is lowest in delay charging scenario
- Impact on PHEV operating cost is modest under the RGGI cap but overall impact on electricity generating costs is substantial

Acknowledgements

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Questions?

Image Source: autobloggreen.com

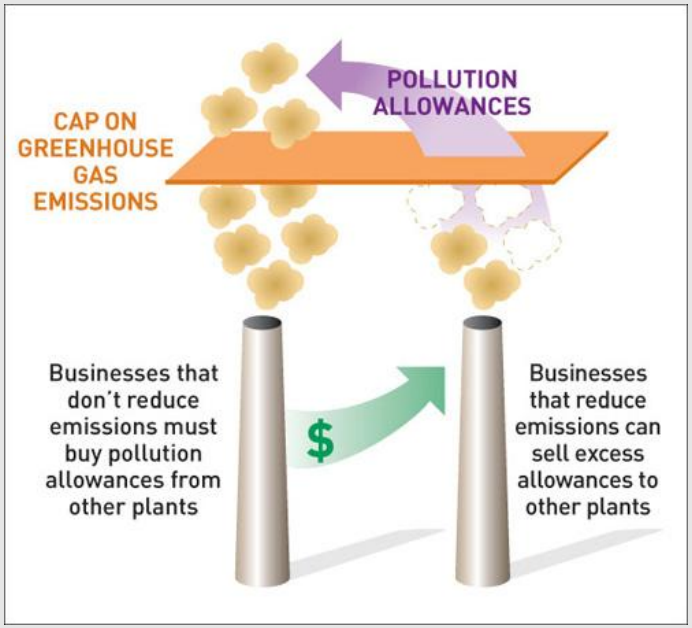

Image Source: edf.org