



The Cost and Environmental Impact of Electric Vehicles in the Azores

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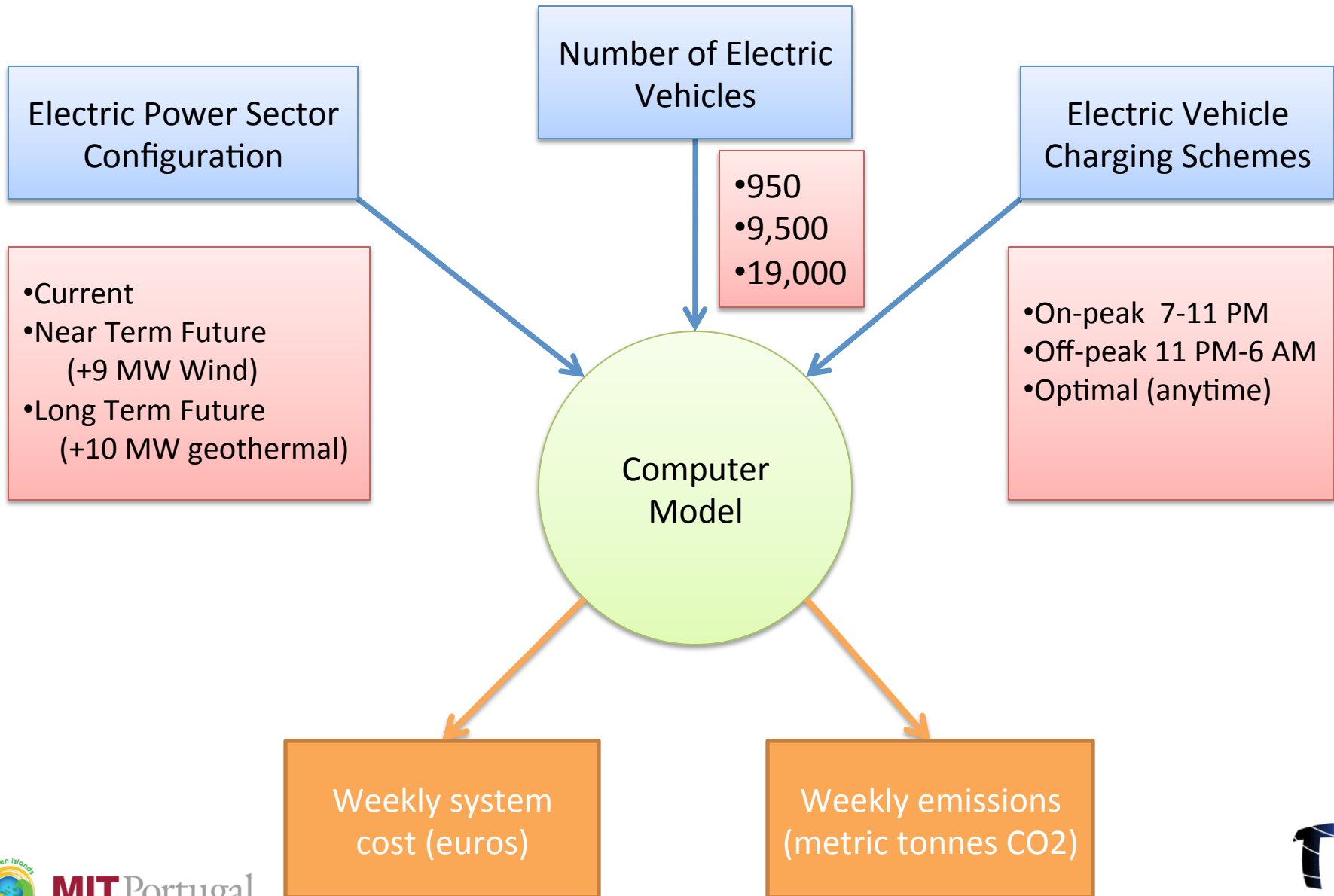
Motivation

- Azores (here, Sao Miguel) are increasing amount of renewable electric power generation
- Electric Vehicles (EVs) are an opportunity to shift emissions from tailpipes to smokestacks
- But at what (economic) cost?
- And what will the environmental impact (CO₂) be?

Modeling Techniques Employed

- Unit Commitment and Economic Dispatch
- Worked with EDA and manufacturers of Sao Miguel's eight fuel-oil generators to get costs and physical constraints (ramping rates, heat rates etc)
- Also includes run-of-river hydro, geothermal (current +10 MW expected expansion) and projected wind profiles

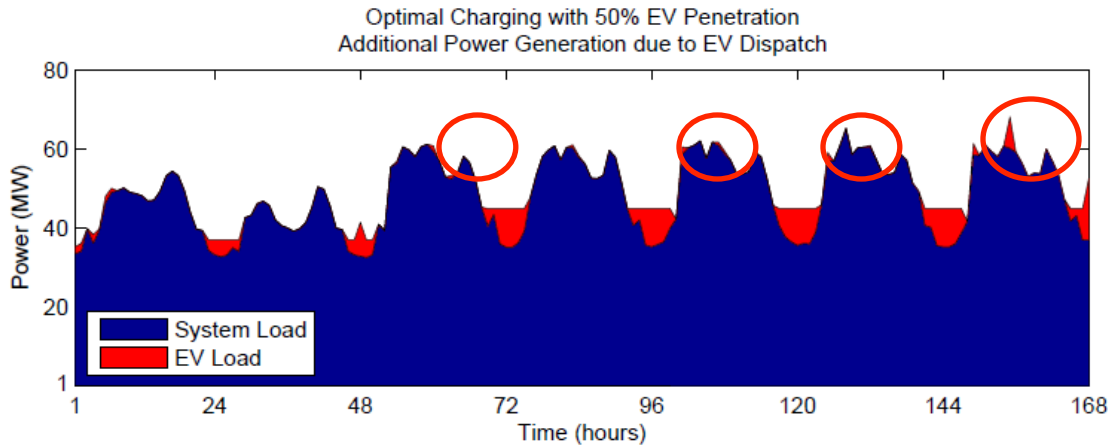
Model Flowchart



Key Benefits of Model

- Allows for detailed insight into what the effects of EV charging would be on dispatch
 - System costs
 - CO2 impacts
- Can vary charging scheme, fleet composition, electric power sector composition
 - Avoid using marginal/average emissions to calculate EV impacts
- Not meant to produce same dispatch as EDA
 - Goal is to produce a reasonable dispatch

Sample Weekly Dispatch for Current Power Sector Configuration

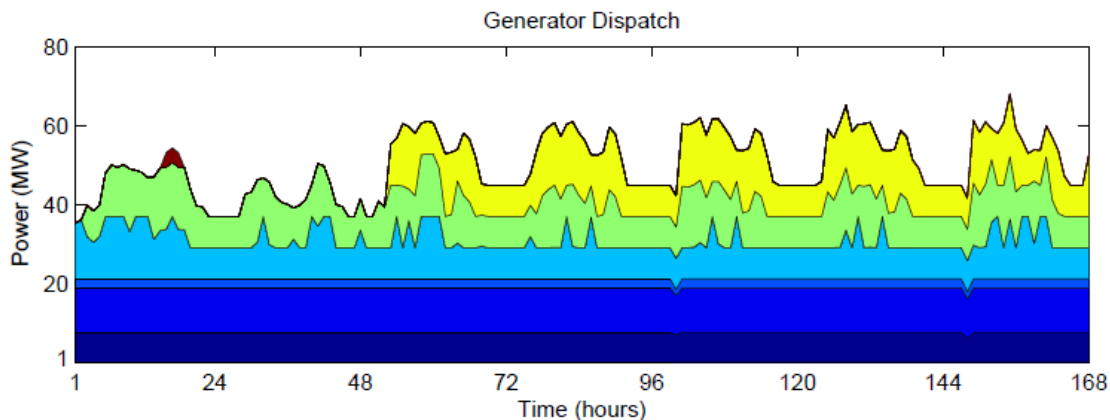


System Cost:
824,270 euros

Δ 2.79% wrt
Baseline

System Cost
Savings over ICE
fleet:

223,535 euros

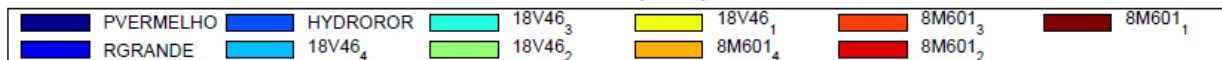


System
Emissions:
3681.1 metric
tonnes CO2

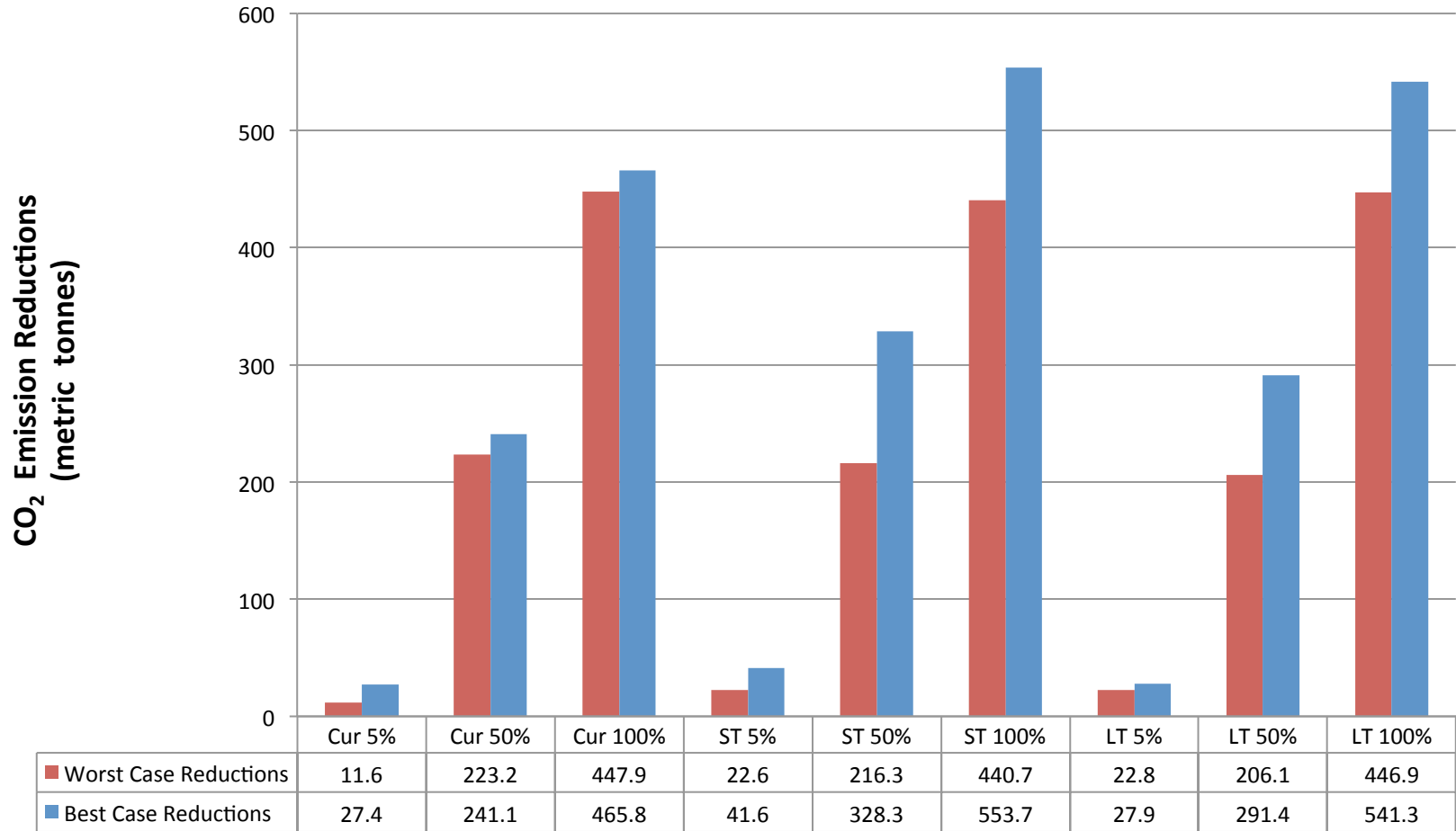
Δ 4.95% wrt
Baseline

System
Emissions
Savings over ICE:

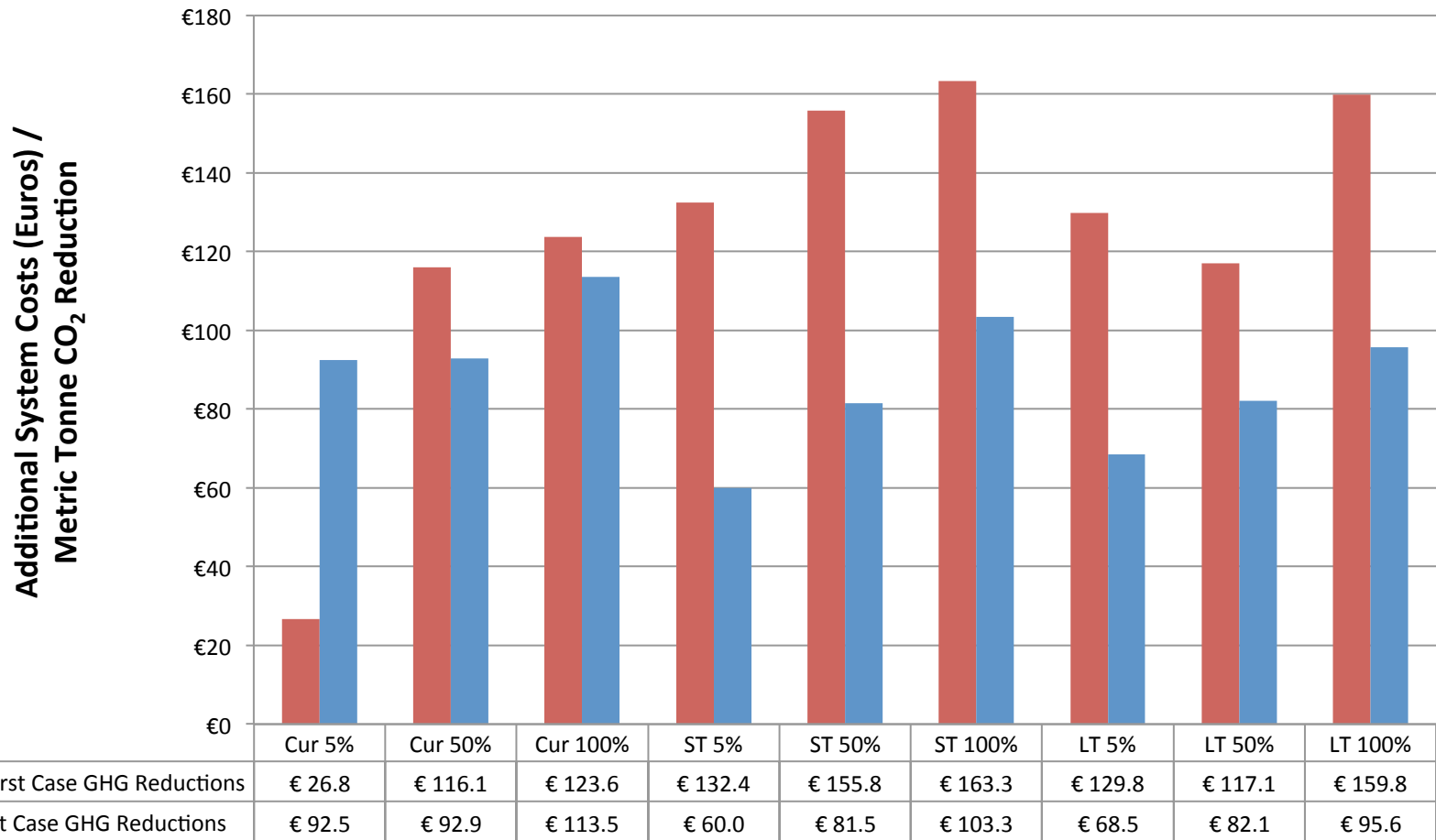
241.11 metric
tonnes CO2



CO2 Emissions Reductions per Week



CO2 Abatement Costs



Conclusions from Research

- Sao Miguel already has enough generation capacity to handle 19,000 EVs
- Smart charging and Off-peak charging produce very similar results in terms of cost/emissions savings
 - Implementing smart charging may have additional costs and require more infrastructure
 - Off-peak charging just needs a timer
- Cost and CO2 savings per EV per km driven (just mobility) are around 0.22 Euro and 0.07 – 0.17 kg, depending upon charging, number of EVs, and power sector

Conclusions (continued)

- A basic discounted cash flow model shows that, even with incentives for EVs and high tax on gasoline, the savings from EVs may not be enough to stimulate consumer interest
- Nonetheless, EVs represent an excellent opportunity to reduce transportation sector emissions in the Azores



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Questions?

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No. EVs	Charging Scheme	EV Electric Sector Impacts		Avoided ICE Vehicle Impacts		Savings/EV	
		Electricity Costs	CO ₂ Emissions	Gasoline Costs	CO ₂ Emissions	Avoided Costs	Avoided CO ₂ Emissions
950	On-Peak	2.53	14.10	24.59	41.47	23.22	28.81
950	Off-peak	0.31	29.90	24.59	41.47	25.56	12.18
950	Optimal	-0.84	22.10	24.59	41.47	26.77	20.39
9,500	On-Peak	31.51	184.10	245.93	414.71	22.57	24.27
9,500	Off-peak	25.91	191.50	245.93	414.71	23.16	23.50
9,500	Optimal	22.41	173.60	245.93	414.71	23.53	25.38
19,000	On-Peak	70.50	372.70	491.86	829.42	22.18	24.04
19,000	Off-peak	55.38	381.50	491.86	829.42	22.97	23.57
19,000	Optimal	52.88	363.60	491.86	829.42	23.10	24.52
		(+1000 Euro)	(+Metric Tonnes CO ₂)	(-1000 Euro)	(-Metric Tonnes CO ₂)	(Euro)	(kg CO ₂)