One billion electric vehicles: challenges, pitfalls, opportunities

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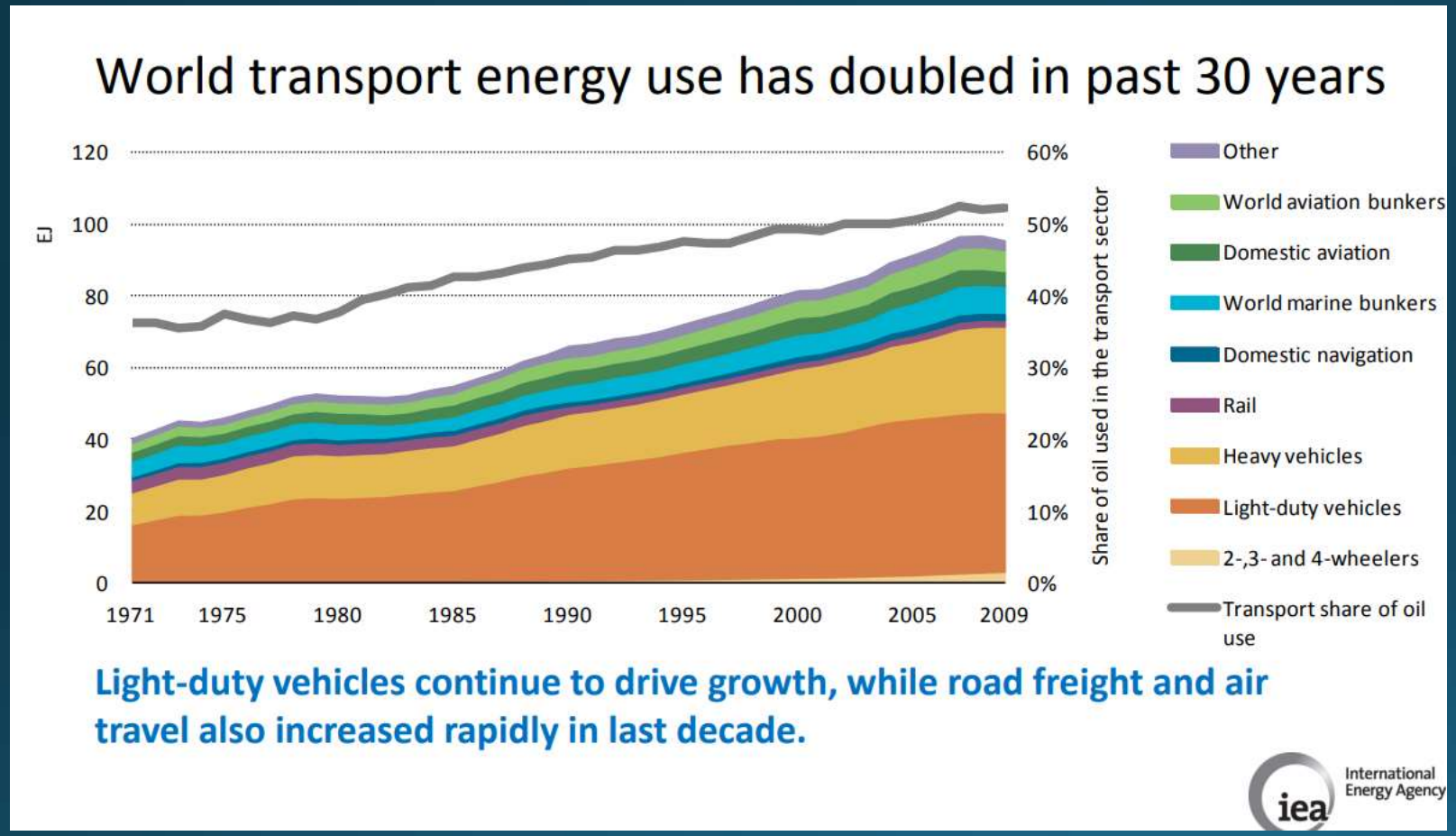
ERG

Why should we care?



- Transportation contributes about 20% of CO2 emissions from fuel combustion globally, over 30% in most western countries
- Fastest-growing sector of emissions
- Most studies predict there will be twice as many vehicles by 2050, increasing from 1 billion to 2 billion
- But transportation also provides a critical service: access to education, jobs, friends, recreation, etc.
- Need to drastically decrease the emissions per mile traveled

https://www.iea.org/media/workshops/2013/egrdmobility/DULAC_23052013.pdf

Why EVs?

(Why not mass transit or hydrogen?)

1. Private vehicles provide faster transportation that other methods
2. Infrastructure for EVs already exists
   - Two million EVs sold so far, only 6,000 hydrogen vehicles
3. EVs are already cleaner than hybrid vehicles in many areas
   - Emissions will decrease as renewable energy increases
   - Moves air pollution outside cities

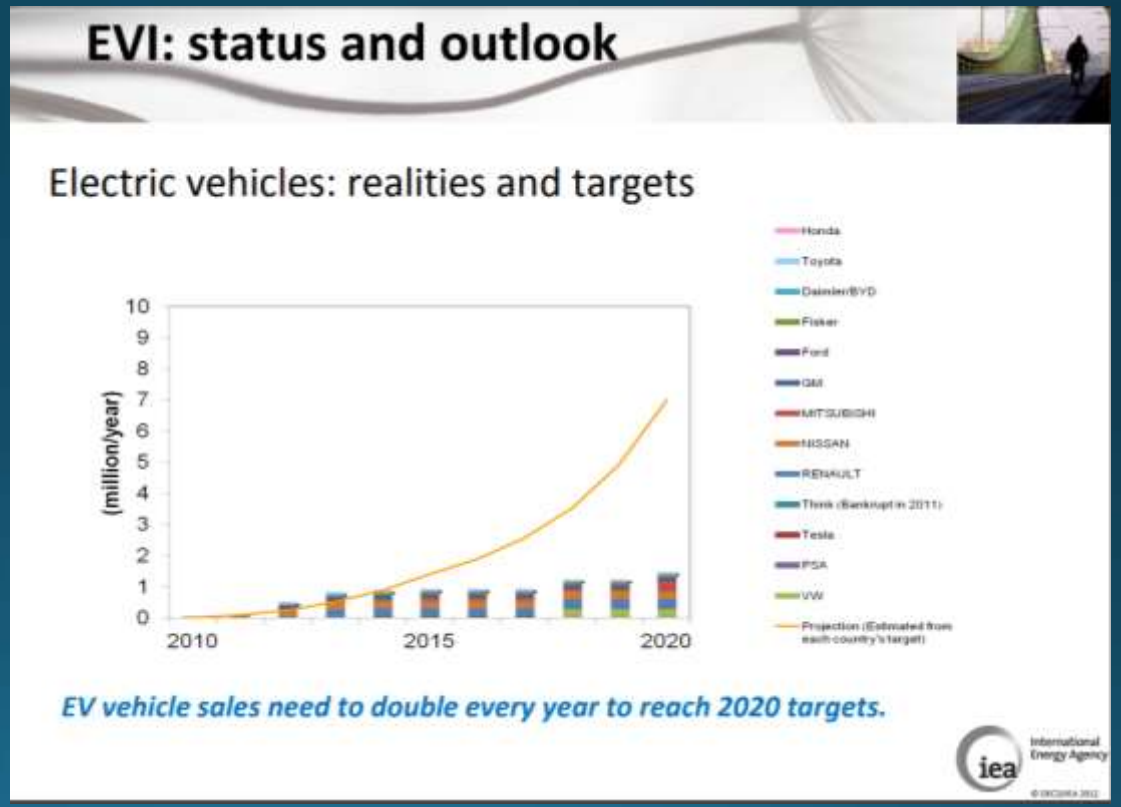
But electrification is moving too slowly

2°C: Half of passenger car fleet must be electric by 2050

- Today: roughly 1 billion cars, 2 million EVs

1.5°C: No new gasoline vehicles after 2035

2013 projections:



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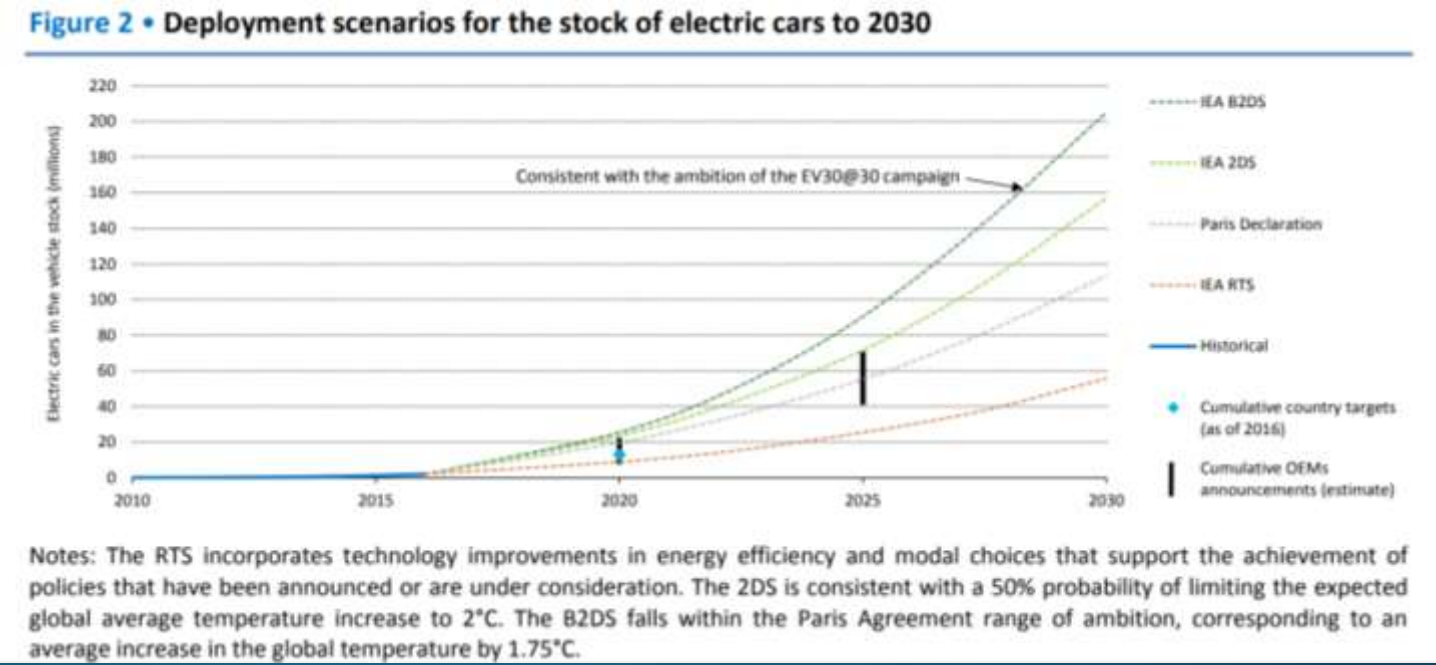
2017 projections:



http://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf

So how do we get there?

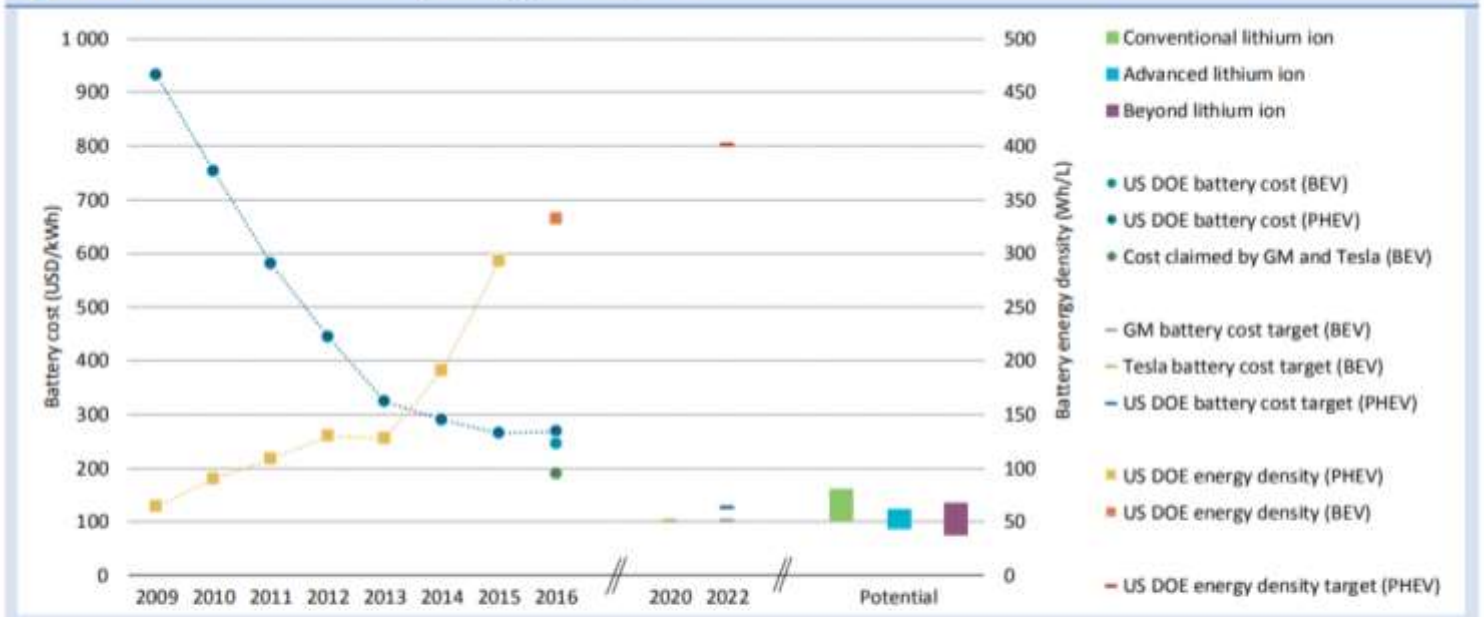
Three barriers:

1. Vehicle production
2. Charging
3. Adoption

The good news:

Battery costs are falling rapidly

Figure 6 • Evolution of battery energy density and cost

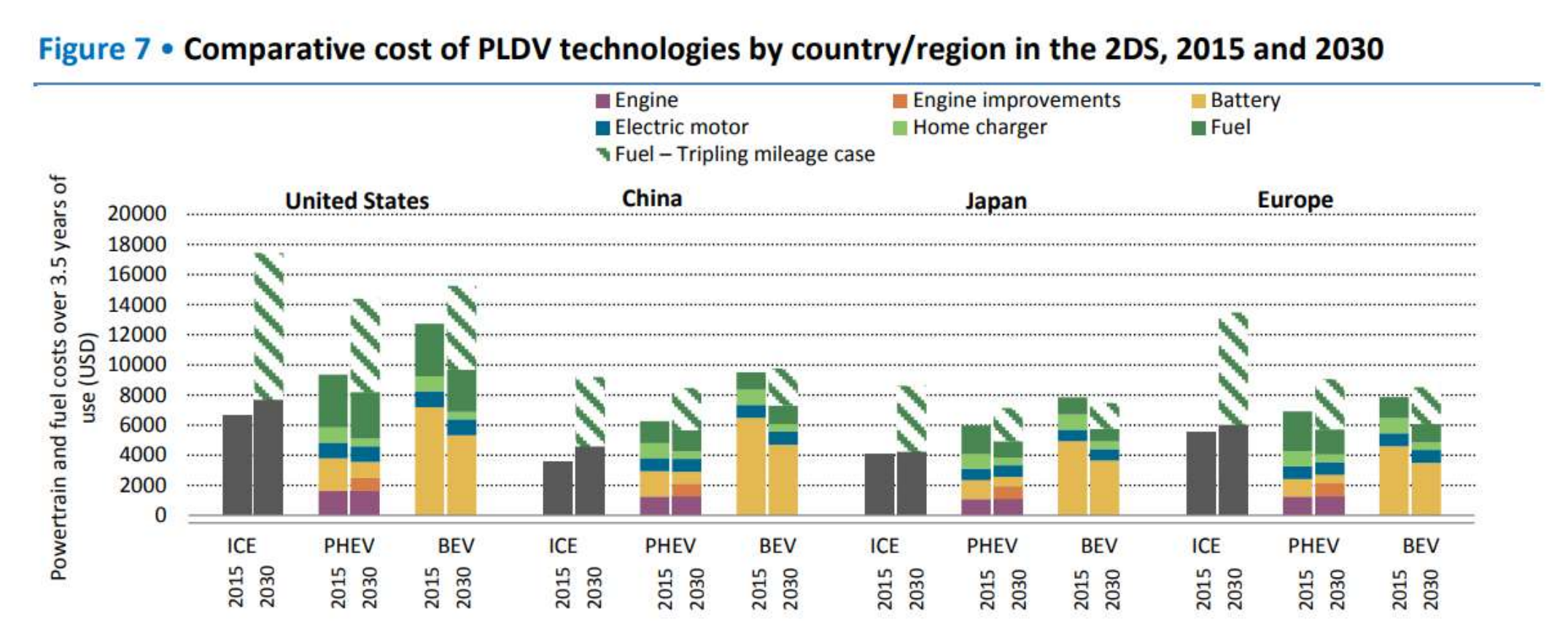


Notes: Contrary to the results assessed for 2009-15, which targeted PHEV batteries, the 2016 estimates of costs and volumetric energy density by the US DOE (costs are to be interpreted as projections for the high-volume production of technologies currently being researched) refer to a battery pack that is designed to deliver 320 km of all-electric range and is, therefore, suitable for BEVs. The latest update of this cost assessment was developed accounting for an advanced lithium-ion technology (with silicon alloy-composite anode). Being a technology that is still being researched today, this is currently deemed to have a greater cost but also a larger potential for cost reductions compared with conventional lithium-ion technologies.

http://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf

The bad news:

EVs may remain more expensive in most areas



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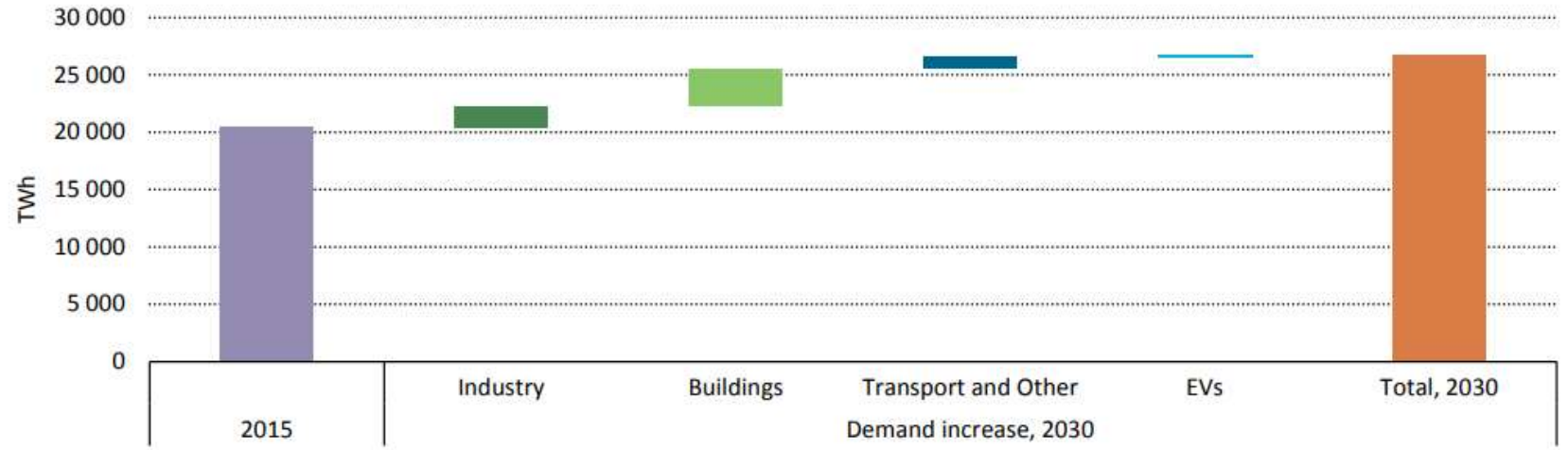
The good news:

- EVs will only use a small percentage of global electricity supply

Figure 17 • Impact of electric car deployment on global electricity demand, 2DS



Source: IEA (2017b).

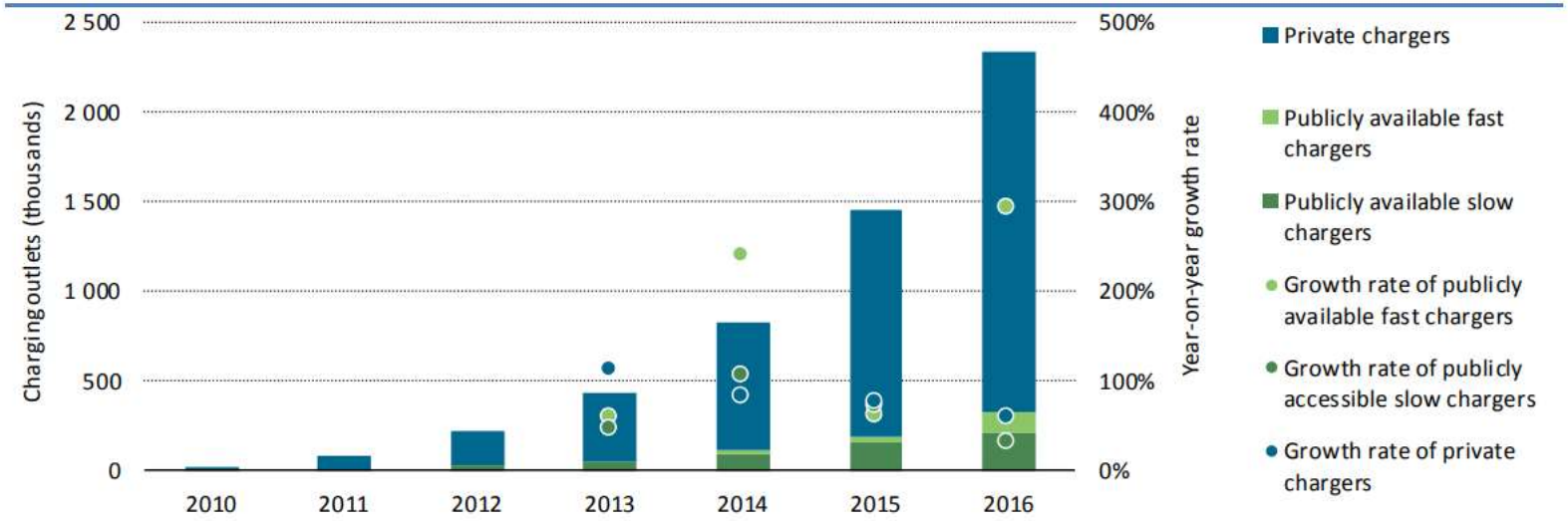
Key point: The additional energy demand from electric car loads is sizeable but largely manageable in comparison with total energy use and additional loads arising from the industry, other transport and buildings sectors

http://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf

The good news:

- EVs will only use a small percentage of global electricity supply
- Charging infrastructure is increasing exponentially

Figure 11 • Global EVSE outlets, 2010-16



Note: Private chargers in this figure are estimated assuming that each electric car is coupled with a private charger.

Sources: IEA analysis based on EVI country submissions, complemented by EAFO (2017a).

Key point: Publicly accessible infrastructure is growing to support the emerging EV market, especially publicly accessible fast chargers.

http://www.iea.org/publications/freepublications/publication/GlobalEVOutlook2017.pdf

The bad news:

- Fast charging is expensive
- Faster charging → shorter battery lifespan
- Hard to recover capital costs
- Peak charging could coincide with peak load

https://www.evgo.com/wp-content/uploads/2015/11/evgo-news-wholefoods.jpg

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Will people *want* an electric vehicle?

- High capital cost
- Range anxiety
- Slow charging
- Uncertainty

Introducing: the Shared Automated Electric Vehicle

EV barriers:

- High capital cost
- Range anxiety
- Slow charging
- Uncertainty

SAEV solutions:

- Operating costs dominate
- Right-size battery to trip needs
- Charge whenever idle
- Fleet provides guarantee

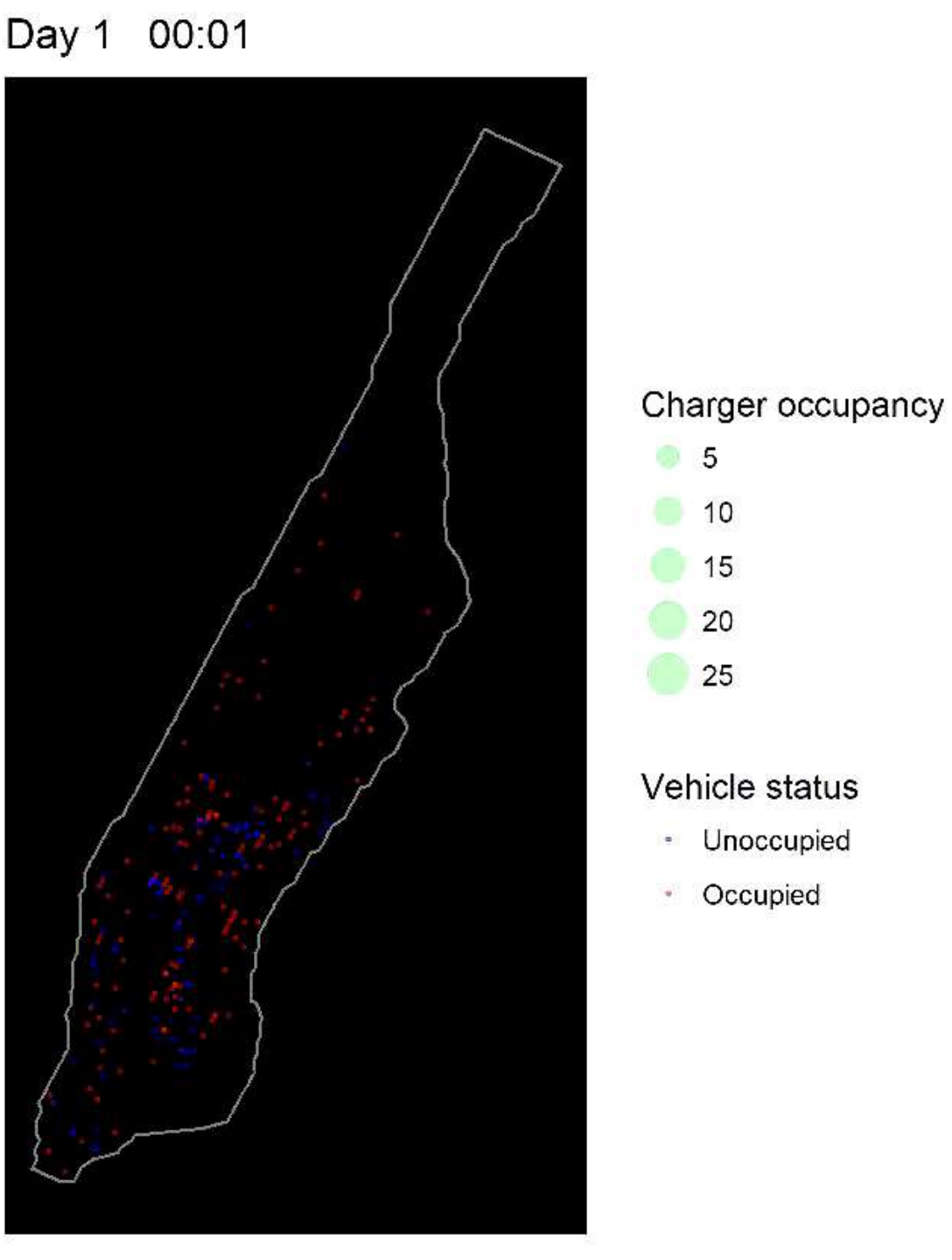
Artwork: Bert Monroy

Introducing: the Shared Automated Electric Vehicle

Waymo: 2020 release

Chevy Bolt: 2019 release

Artwork: Bert Monroy


Day 1 00:01
Charger occupancy
5
10
15
20
25
Vehicle status
Unoccupied
Occupied

Results:

- Only need 150km battery range
- No need for fast charging
- Greenhouse gas emissions 80% less than current taxi fleet, half that of private EVs
- Cost $0.25 - $0.50 per mile: less than the total cost of ownership for a private vehicle

But will people really stop owning cars?

https://farm1.staticflickr.com/788/40391806054_7b096bdf58_o.png

Conclusions:

- Electric vehicles hold huge potential, but major barriers remain
- The “free market” alone may not lead to replacing all cars with EVs
- Self-driving electric taxis may provide an alternative pathway, but car ownership may remain desirable

Grazie mile!

Domande?

(In inglese per favore)

Acknowledgements: Elisabetta Venezia, Automobile Club Bari-Bat,
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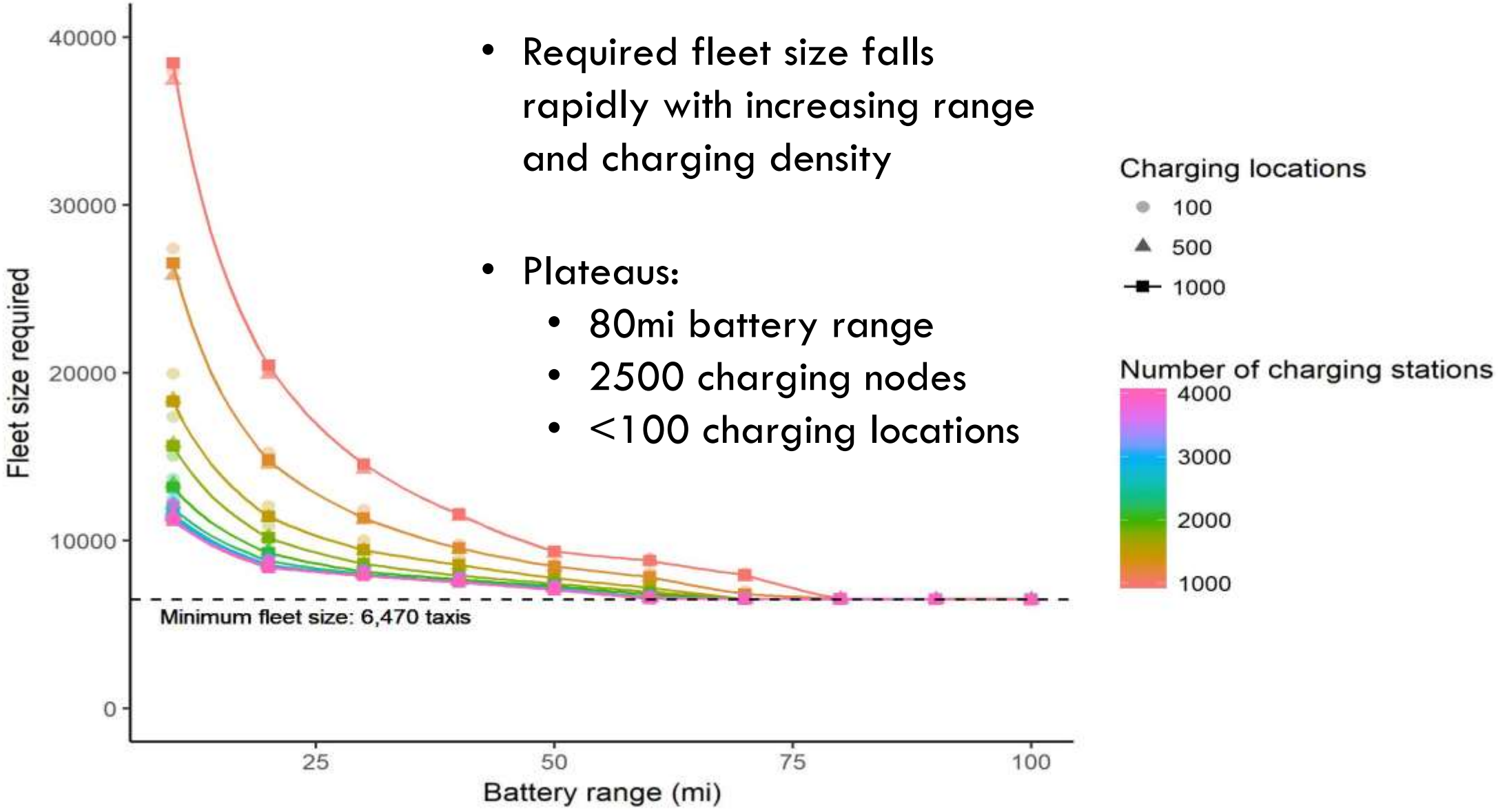
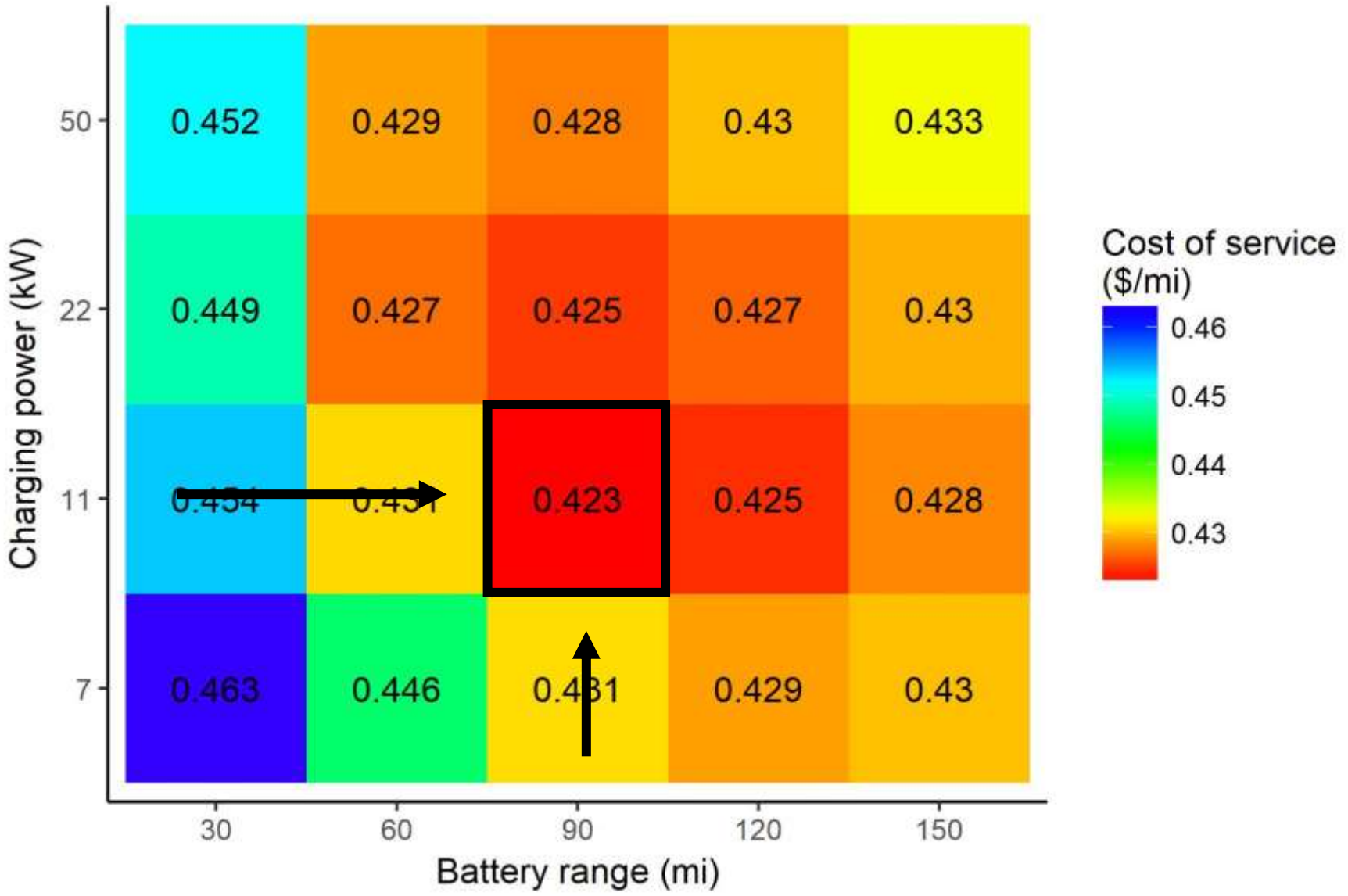
Back-up

Simulation results: fleet sizing

- Required fleet size falls rapidly with increasing range and charging density
- Plateaus:
  - 80mi battery range
  - 2500 charging nodes
  - <100 charging locations



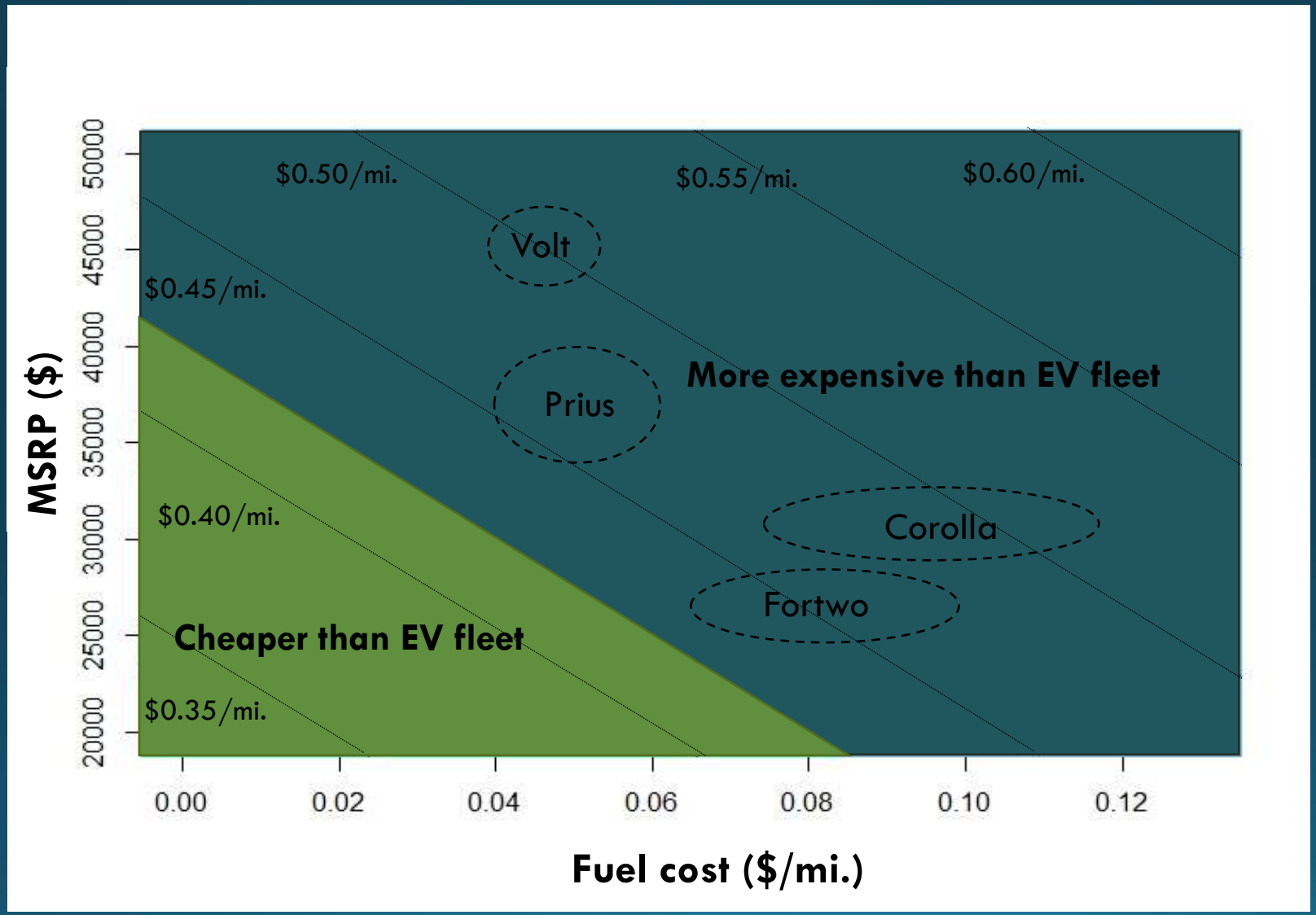
Cost projections, all charging powers, repeat day



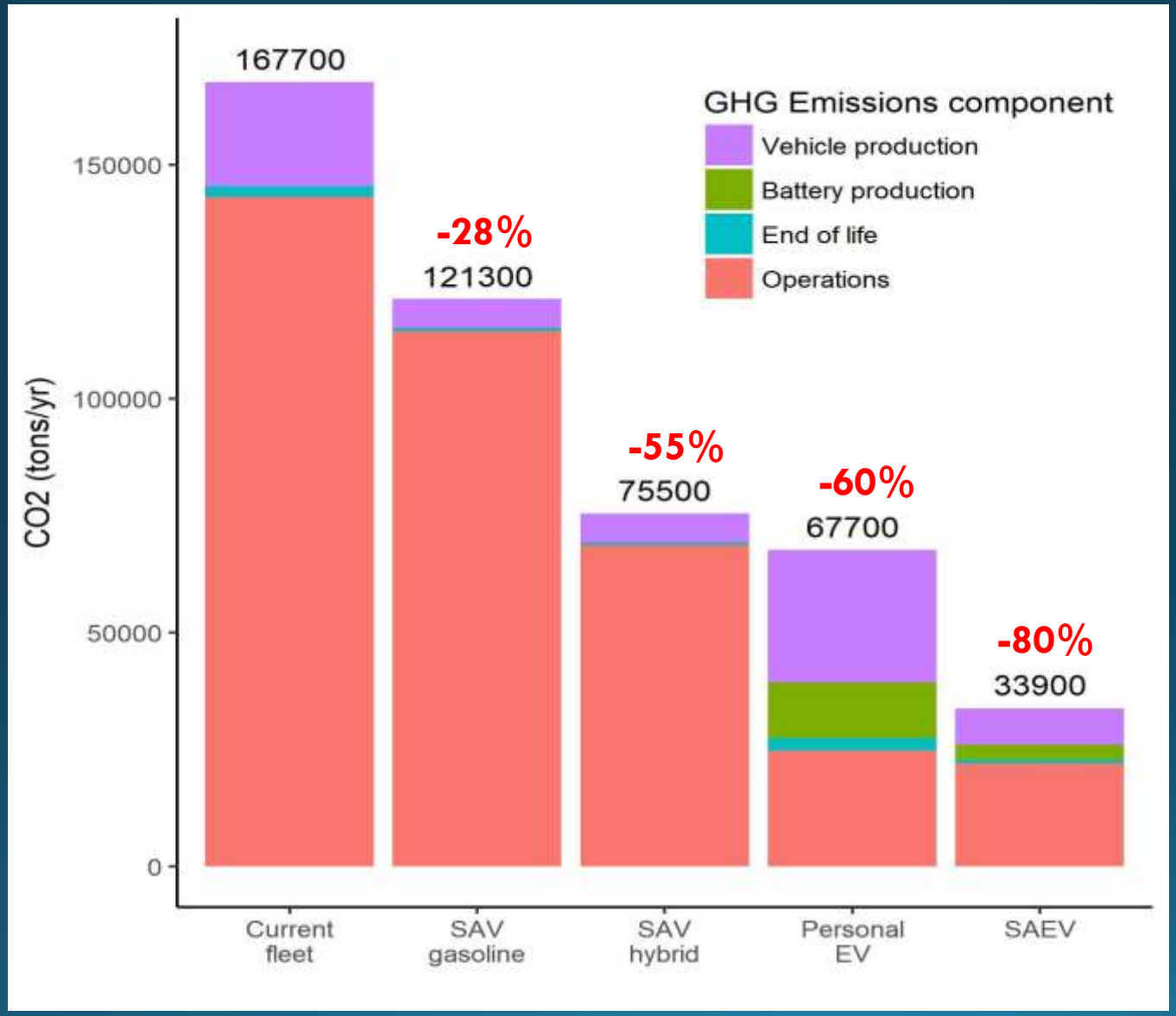
Lowest-cost fleet:

- 50-90mi. battery range
- 40-60 charging points per square mile
- No DC fast charging

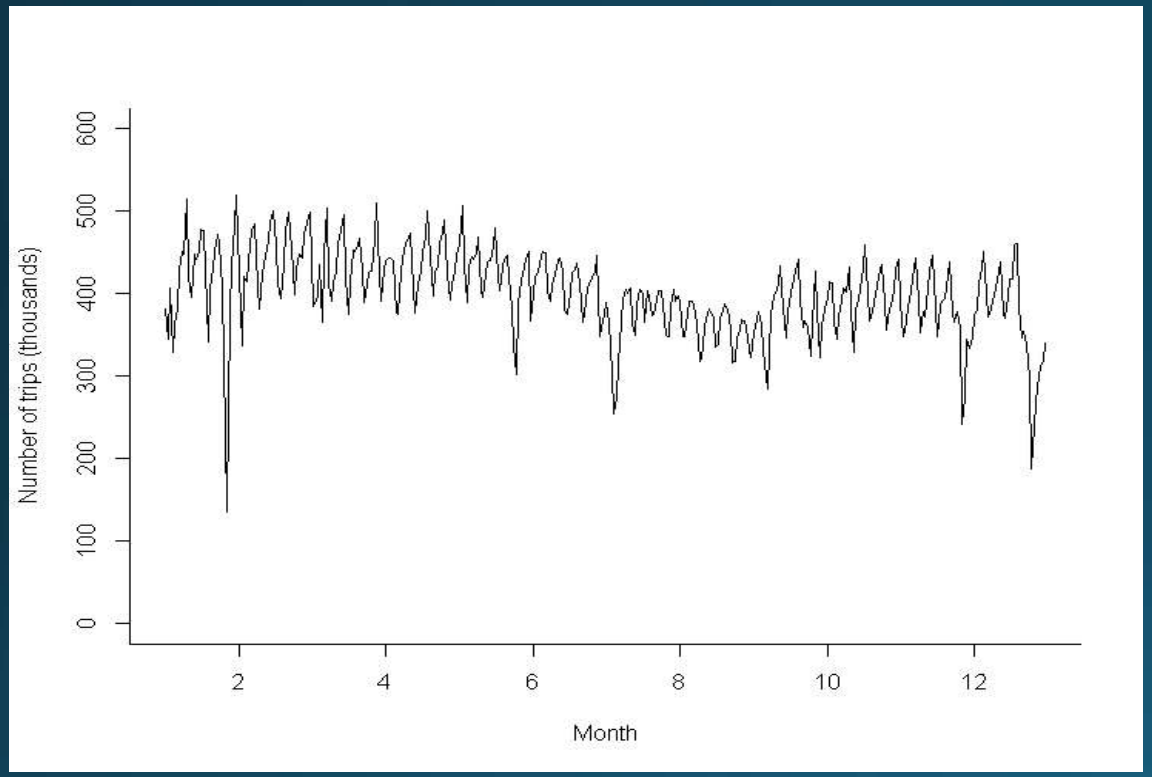
Cost comparison with conventional vehicles

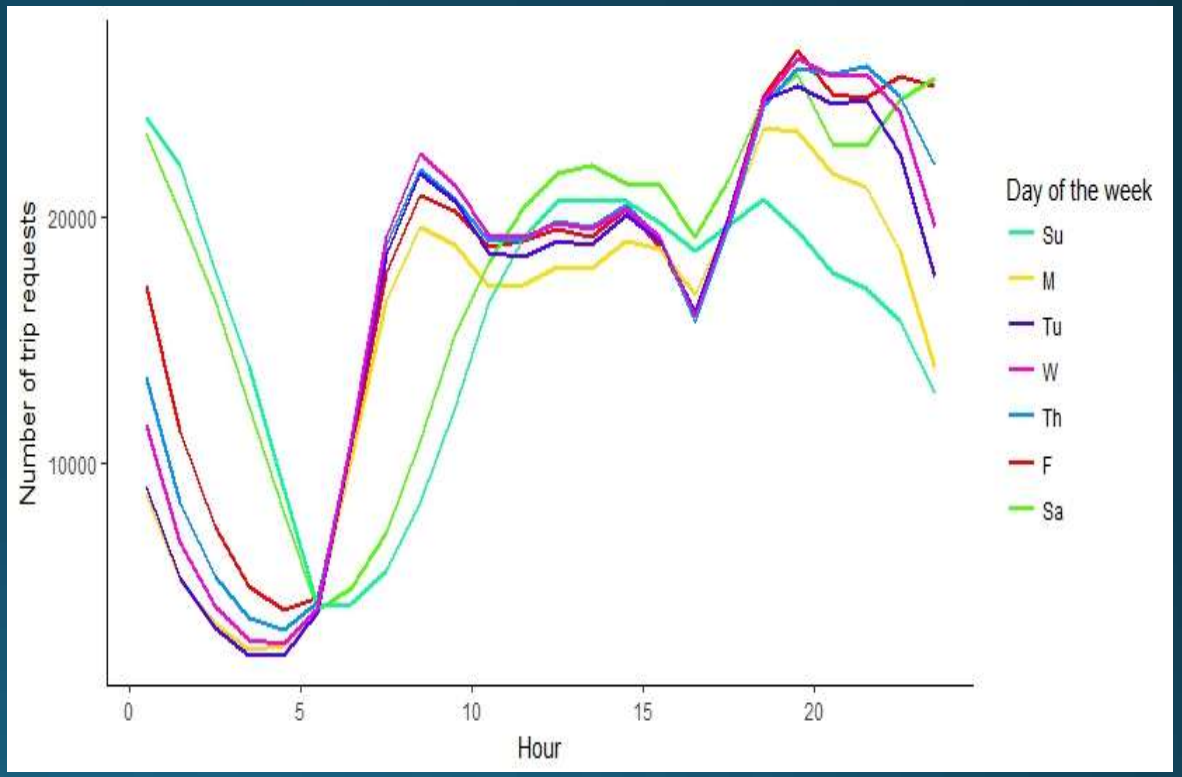


GHG comparison

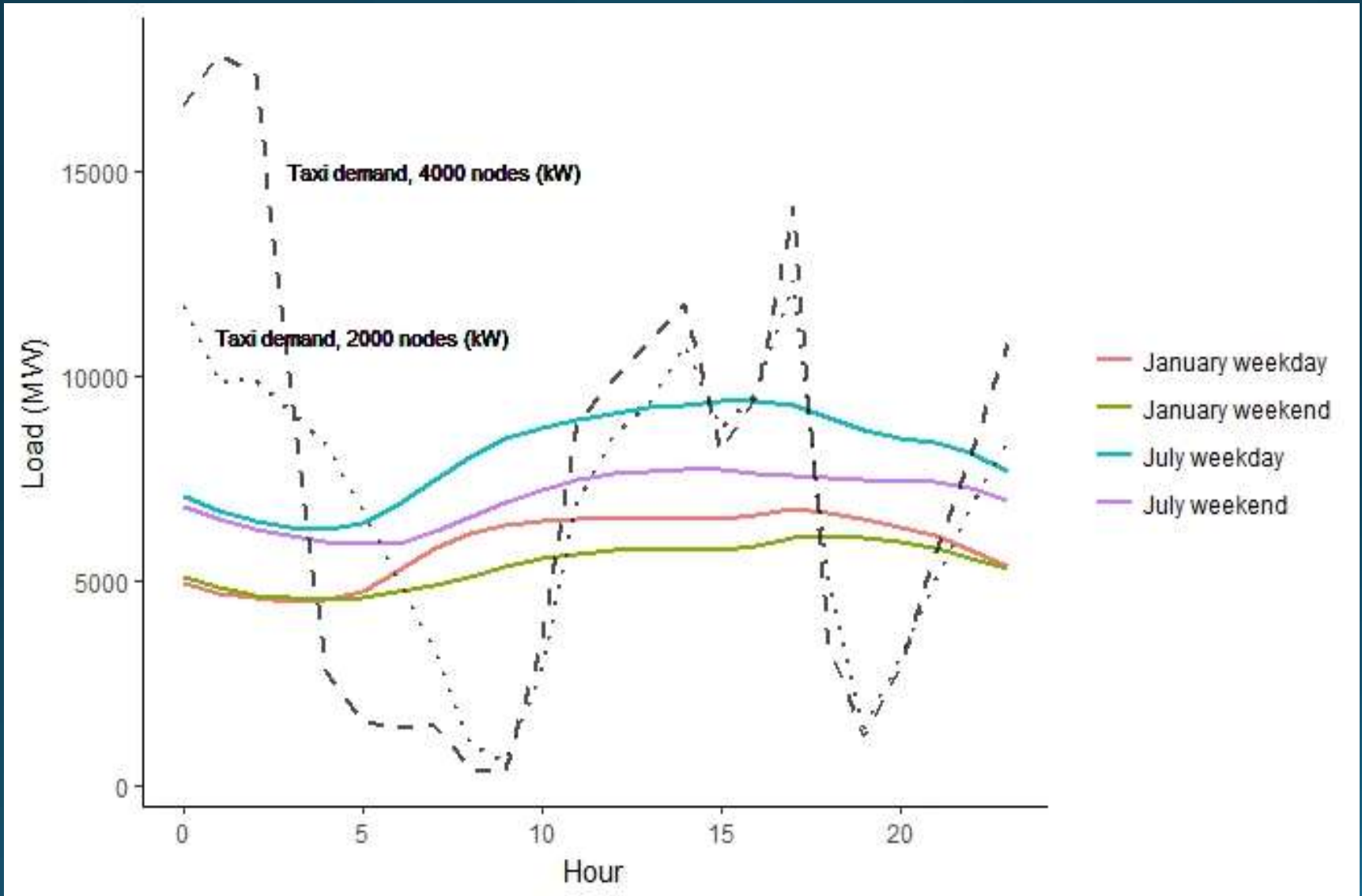


Data source: 2015 NYC Yellow Cab trips





Extension: impact of taxi charging on grid



Cost model: battery degradation

$$Q_{loss,\%} = k_1 e^{k_2 I} Ah + k_3 e^{-E_a/RT} t^{\frac{1}{2}}$$