Deep Dive on Transportation

FIFTH ANNUAL EPRI-IEA EXPERT WORKSHOP: CHALLENGES IN ELECTRICITY DECARBONISATION

Paris, November 8, 2018

THE Brattle GROUP

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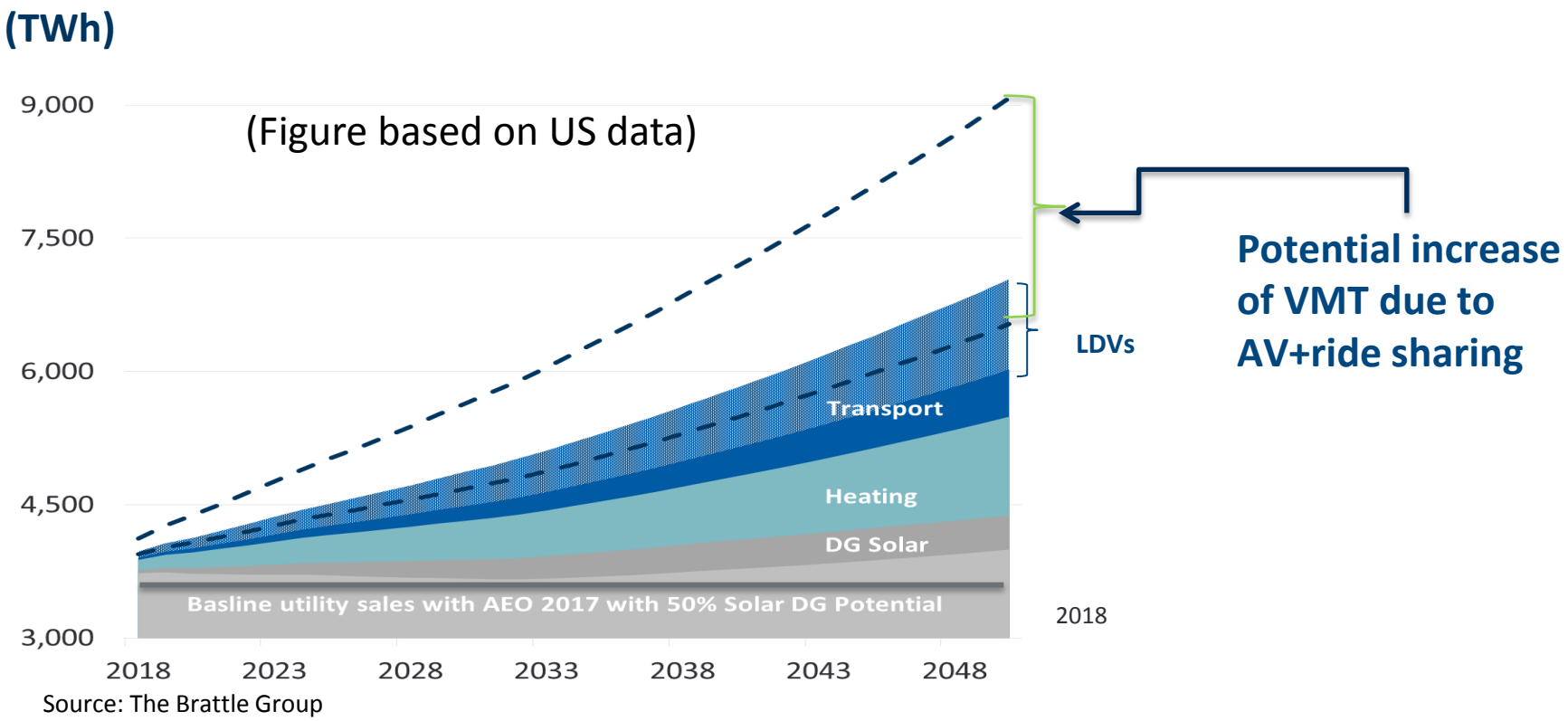
More?

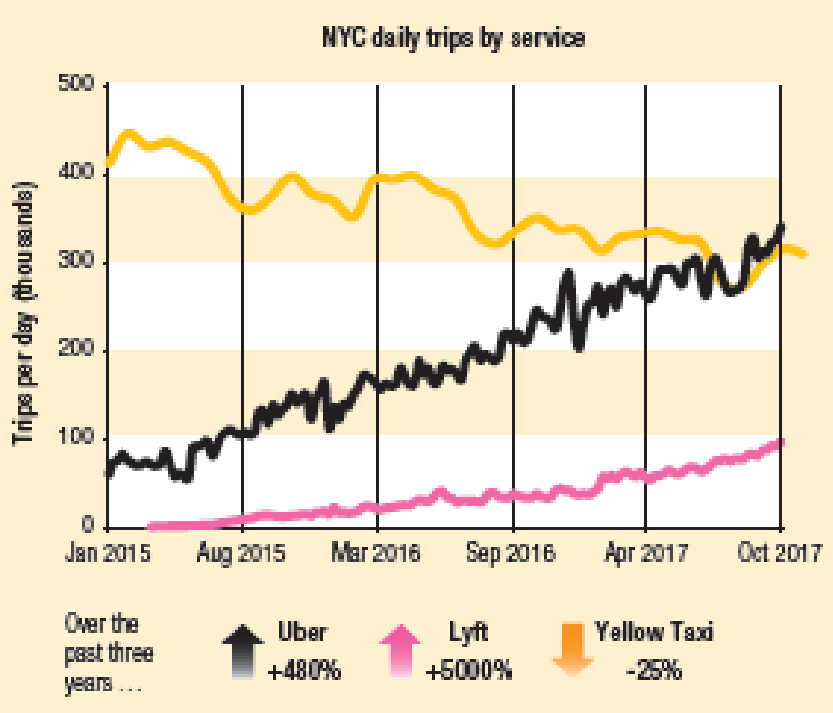
The electricity impact of transport electrification could be larger than often assumed



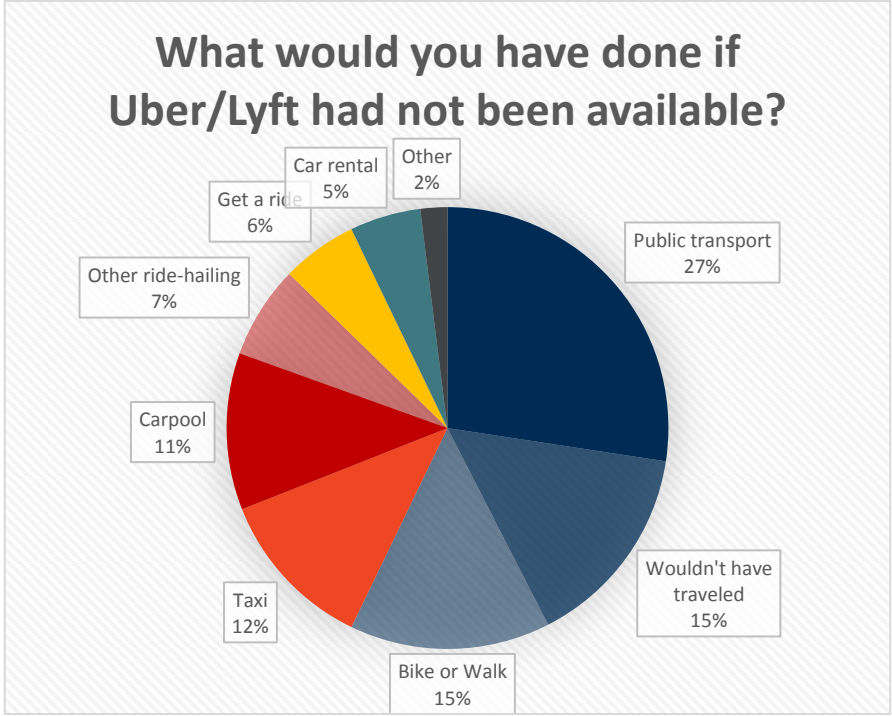
Source: The Brattle Group

- AV+EV=lower cost/km => potentially significantly **higher** transportation demand
- AVs are also supercomputers on wheels => requires large amounts of energy on board and off board

The impact of shared transport could be significant



Source: Weiss, The Electrified Future is Shared, PUF 2.0, Mid-February 2018



Source: Henao and Marshall, The impact of ride-hailing on vehicle miles traveled, Transportation, September 20, 2018 (Figure7)

VMTs could increase through new travel demand, mode shifting and deadheading (estimated at +/-50% of VMT)

Faster?

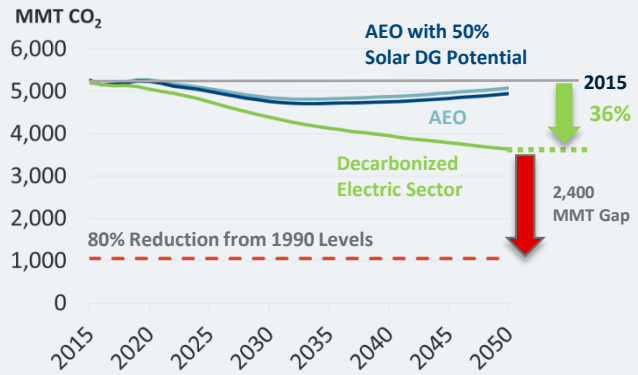
Technology, preferences, and policies make transportation electrification likely and desirable

- Sharing Economy (Ride- and car sharing)
- New modes of transport (bikes, e-bikes,…)
- *Autonomous driving*
- EV technology and cost progress
- Changing role of cars as status symbol
- Urbanization
- Climate change
- Government policies
- New Entrants

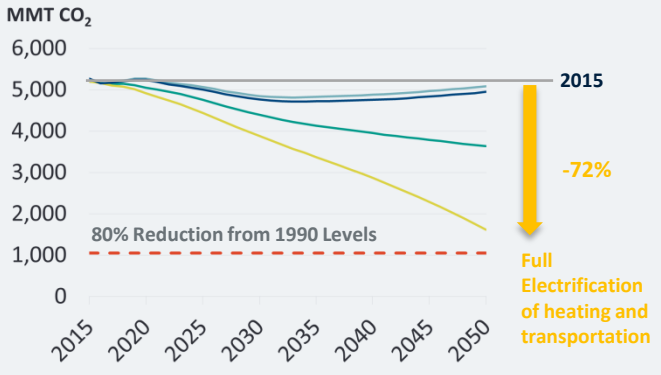
Electrification

Economy-Wide GHG Emissions

Without Electrification

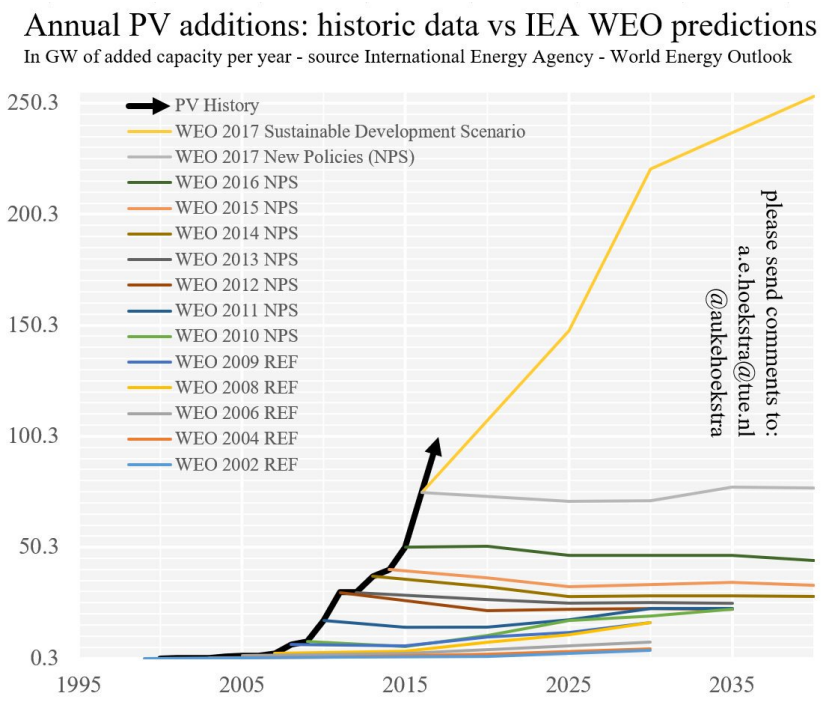


With Electrification (Technical Potential)



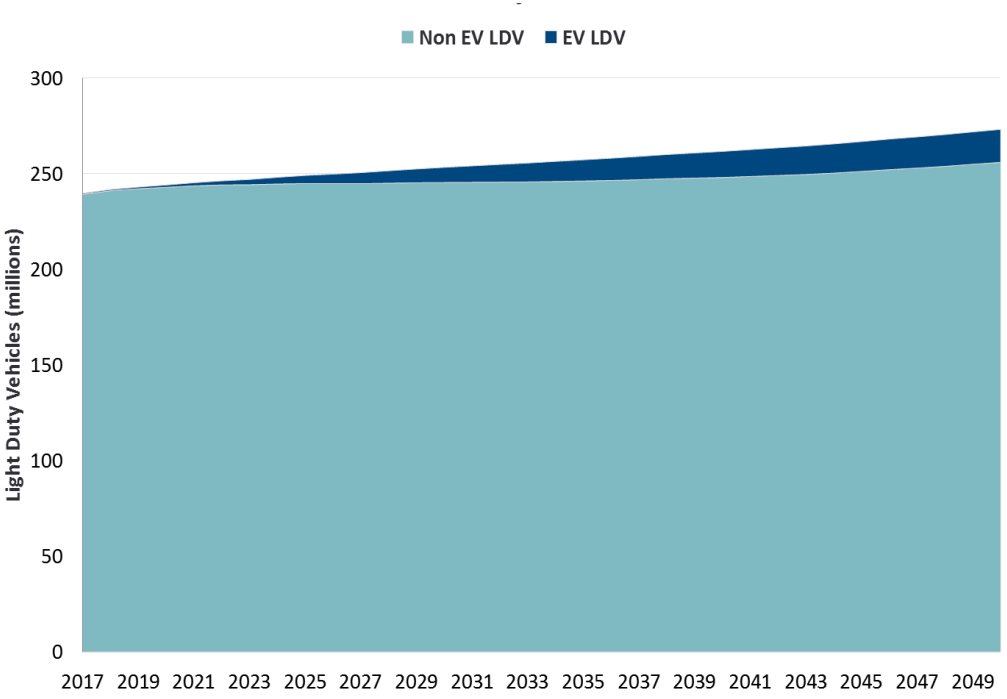
It is possible to underestimate the potential adoption (speed) of new technologies (sorry, IEA, EIA!!)

IEA PV Projections over time



Source: A.E. Hoekstra based on IEA WEO

EIA current EV Projections

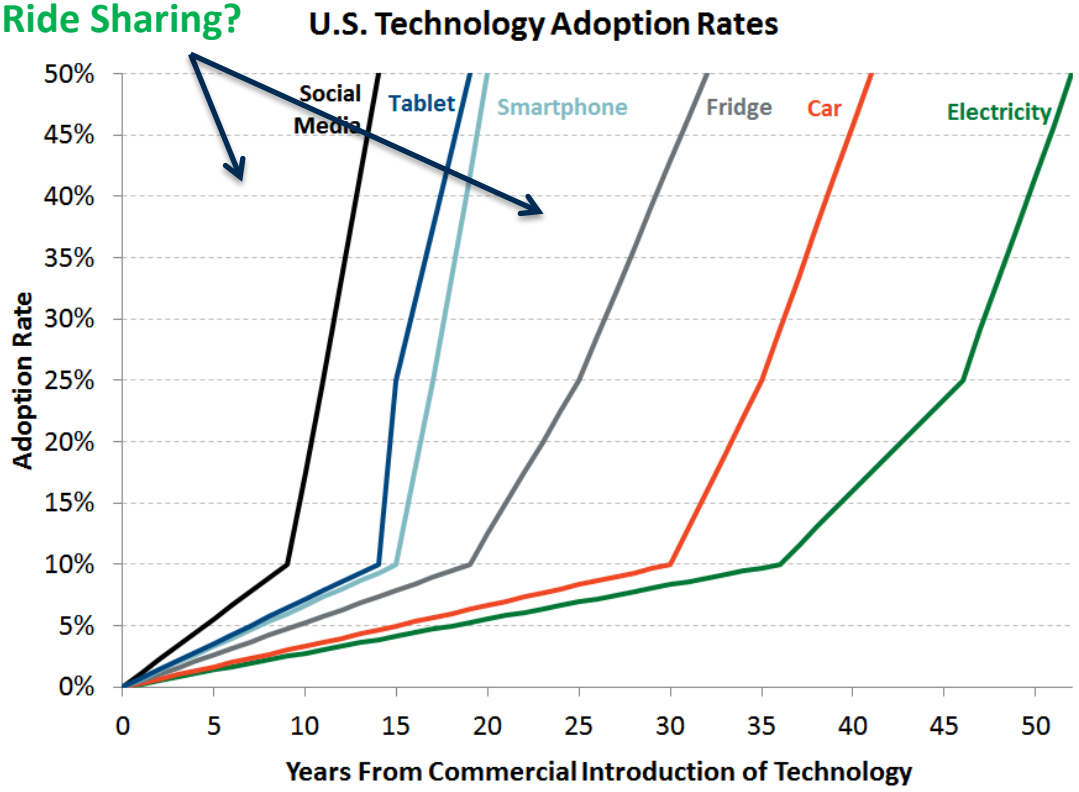


Source: EIA 2017 AEO

PV and EV share various factors that are relevant for adoption: both are hard to model/predict (rapid technological change, important non-economic drivers of adoption)

Electrification has elements of smartphones rather than appliances and could happen quickly

Ride Hailing/ Ride Sharing?



Sources: https://www.linkedin.com/pulse/part-2-megaproject-paradox-what-chances-barrel-oil-being-john-noonan and Brattle analysis

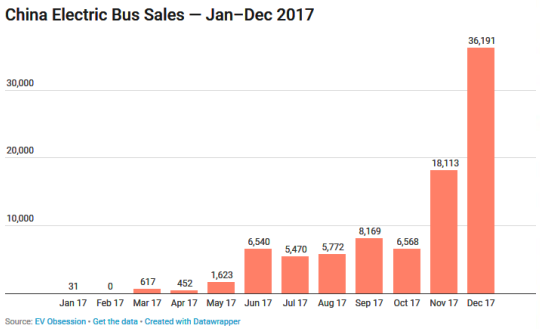
Uber was launched in 2010: In 2016, 15% of Americans have used a ride-sharing app – 29% of under 30 year-olds (Source: Pew Research Center)

In spite of the Uber accident: April 16, 2018 – **Waymo,** the driverless technology division of Google's parent company, Alphabet, has applied to test completely autonomous cars on California roads, without safety drivers onboard.

April 1, 2018 – Series production of the fourth-generation Cruise AV (self-driving Chevrolet Bolt EVs) is to start in 2019 as GM intends to go large-scale.

So far, more than 200 Cruise AV prototypes were made.

The pace of (R)EVolution is very fast



Shenzhen confirms completion of transition to 100% electric buses

On December 27, the Shenzhen municipal transport commission announced it had completed the transition of its bus fleet to 100% electric buses. (Source: Han Ximin on *EyeShenzhen*)

The announcement that it had 16,359 electric buses will not come as a surprise to *CleanTechnica* readers, as it was reported earlier in 2017 that the city would reach this target ahead of schedule. Nonetheless, it's a shocking achievement. For context, imagine the bus fleets of NYC, Los Angeles County, New Jersey Transit, suburban Chicago, and Toronto all went electric — that still wouldn't be as many buses as Shenzhen electrified.

500 ELECTRIC TRASH TRUCKS TO ROLL OUT IN SHENZHEN (CHINA), 200 IN INDAIATUBA (BRAZIL)

by Kyle Field | May 22, 2018 | 0 comment

Waymo's Fleet Size Is Set to Soar

Google's self-driving spinoff currently has 600 Chrysler Pacific minivans in its more than 100 times.

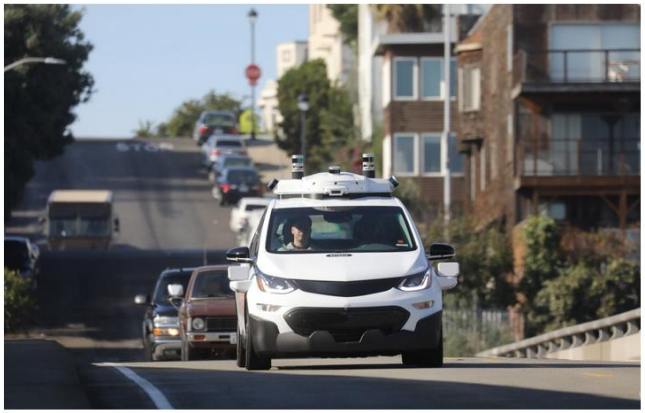
Danny Vena (TMFLifeIsGood)
Jun 4, 2018 at 9:03PM

Waymo, the self-driving subsidiary of Google-parent **Alphabet** (NASDAQ:GOOGL) (NASDAQ:GOOG), took its first delivery of 100 Chrysler Pacifica minivans supplied by **Fiat Chrysler Automobiles** (NYSE:FCAU) in December of 2016, adding an additional 500 to its corral in April 2017. Earlier this year, the companies announced that Waymo would be adding "thousands" more minivans to its fleet, though it didn't specify how many.

The companies just revealed the extent of their partnership, which will see Waymo adding up to 62,000 Chrysler Pacific Hybrid minivans to its fleet, more than 100 times the 600 it currently drives. While terms of the deal weren't made public, this total could exceed $2 billion, and delivery of the cars is expected to begin later this year. This marks a dramatic escalation of the partnership between the two companies and the biggest deal yet for Waymo.

DealBook / Business & Policy

SoftBank Fund Puts $2.25 Billion in G.M.'s Driverless Unit



A G.M. autonomous car driving through San Francisco last year. Jim Wilson/The New York Times

MAY 31

DHL's StreetScooter opens second factory as it emerges as an important EV manufacturer

There could be an entire line of Dyson electric cars

The vacuum cleaner tycoon is also pursuing solid-state battery technology

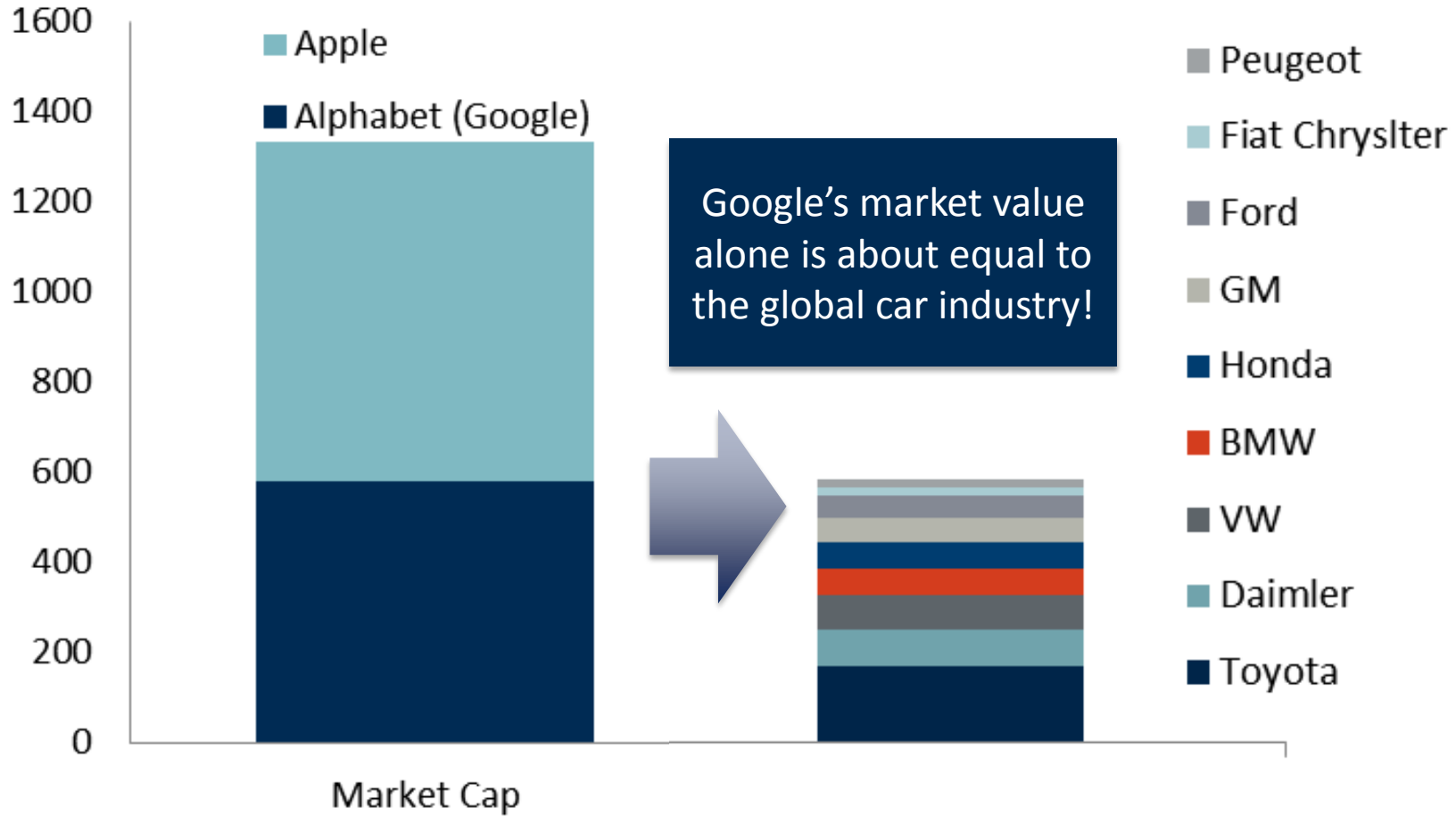
By Zac Estrada | @zacestrada | Feb 14, 2018, 5:50pm EST

Photo by Jason Kempin/Getty Images for Dyson

"Globally, there are an estimated 385,000 fully electric buses, and according to a recent Bloomberg New Energy Finance report, 99 percent of them are in China."

Sources: New York Times, Fools.com, Evobsession.com, citylab.com

New players in the transportation area have the capital to disrupt and accelerate electrification

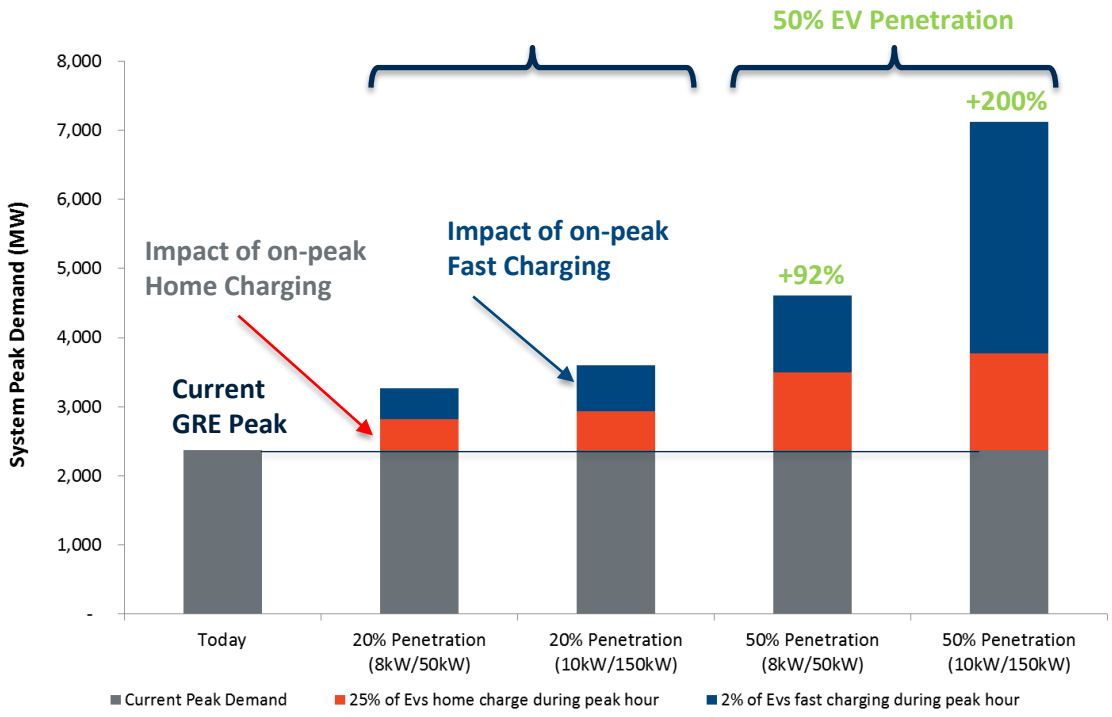


Sources: Yahoo Finance, Google Finance

Less “Beneficial”?

Small deviations from full off-peak charging could have large implications for peak load

- 11,500 VMT and 1.9 cars/HH means **2.67 kW charge speed for 8 hours per day** and HH on average
- *Charging infrastructure:*
  - Level 2 charging in homes at **8-10kW** feasible/likely
  - DCFC currently **50-150kW**
  - In Europe, already installing **350kW**
- Modest amount of on-peak charging has very significant impact on peak



Higher peak demand could still be **very beneficial** for customers based on EV savings.

On-peak home/DCFC charging amount likely depends on **price signals** and **evolution of ride sharing**.

Presented By

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Dr. Jurgen Weiss is an energy economist with 20 years of consulting experiences. He specializes in issues broadly motivated by climate change concerns, such as renewable energy, energy efficiency, energy storage, the interaction between electricity, gas and transportation. He spearheads Brattle's electrification efforts. He works for electric utilities, NGOs and government entities in North America, Europe, and the Middle East.

Dr. Weiss holds a B.A. from the European Partnership of Business Schools, an M.B.A. from Columbia University, and a Ph.D. in Business Economics from Harvard University. As a high school student growing up in Stuttgart, he worked on the Mercedes assembly line putting gas tanks into cars.

The Brattle Group Electrification Reports

Electrification: EU Emerging Opportunities for Utility Growth, Jürgen Weiss, Maria Castaner, Tony Lee, June 2018 (Best Paper Award, Electrify Europe, Vienna, June 2018)

The Electrified Future is Shared, Jürgen Weiss, Public Utilities Fortnightly, PUF 2.0, Mid-February 2018

The electrification accelerator: Understanding the implications of autonomous vehicles for electric utilities, Jürgen Weiss, Ryan Hledik, Roger Lueken, Tony Lee, Will Gorman, The Electricity Journal 30 (2017) 50–57, December 2017

New Sources of Utility Growth: Electrification Opportunities and Challenges; Retail Energy Practice Briefing Series; The Brattle Group, November 2017

Electrification: Emerging Opportunities for Utility Growth, Jürgen Weiss, Ryan Hledik, Michael Hagerty and Will Gorman, January 2017

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