

U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

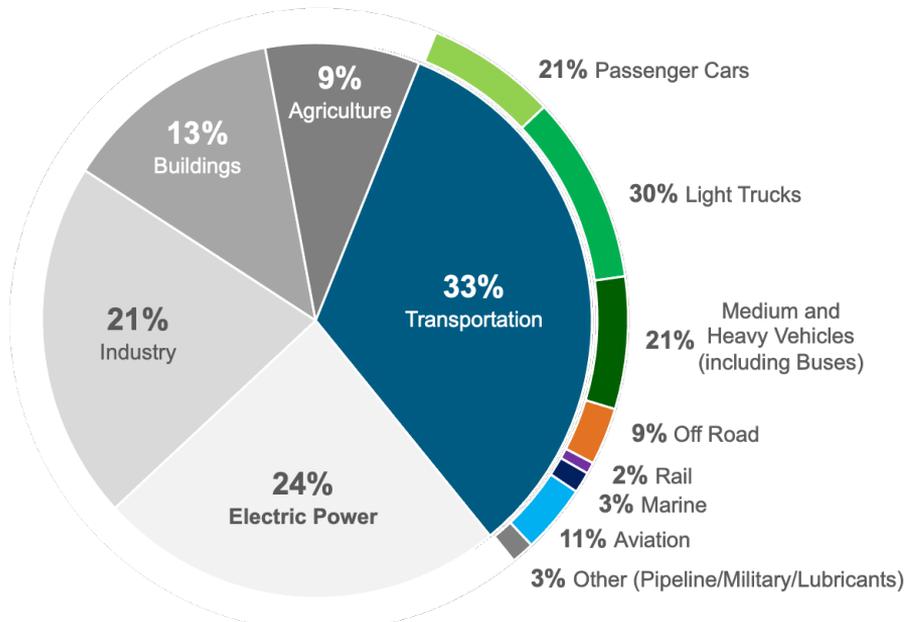
The Future of Transportation Energy Demand... *Maybe?*

NREL *Tomorrow's Sustainable Mobility Systems* Workshop | May 2023



Vehicle Technologies Office (VTO): Mission

2019 U.S. GHG Emissions



Aviation and marine include emissions from international aviation and maritime transport. Fractions may not add up to 100% due to rounding.

- **Light Duty** (cars/SUV/pickups) largest share (~52%), and can largely be electrified leveraging cheap and abundant clean electricity
- **MDHD** (~21%)
- **Rail, Marine, Aviation, and “Off Road”**
 - Electrification under exploration
 - Hydrogen and Biofuels (VTO partners with other ‘Sustainable Transportation’ offices) also likely to play a role in these other applications/sectors
- Full lifecycle emissions must be addressed
- Effective integration with the grid and energy infrastructure (e.g., charging infrastructure)
- Role of *technology* (e.g., automation) and alternatives to single-occupancy vehicles in reducing VMT: *Transit, Shared Mobility, Micromobility, etc.*

Vehicle Technologies – FY 2023 Budget

Subprogram Budget	FY23 Enacted	FY24 Request
Battery and Electrification	\$211,500,000	\$266,016,000
Technology Integration	\$106,000,000	\$117,162,000
Energy Efficient Mobility Systems	\$54,000,000	\$54,000,000
Materials Technology	\$45,000,000	\$42,500,000
Off-Road, Rail, Marine, and Aviation	\$35,000,000	\$35,000,000
Data, Modeling, and Analysis	\$6,000,000	\$9,185,000

What is "EEMS"?



Self-driving lorry 'crosses America in three days'

11 Dec 2019 | Technology



Are the days of the private car really over?

10 Jan 2019 | Business



Can robotaxis ease public transport fears in China?

8 May 2020 | Business

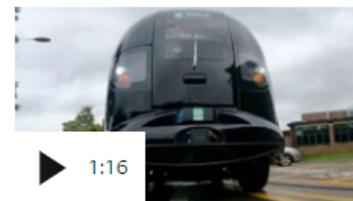


Could this car replace short haul flights?

Newsday

Volvo want you to sleep in this driverless car instead of flying

7 Sep 2018 | BBC World Service



Are driverless pods the future of food delivery?

15 Oct 2021 |

Birmingham & Black Country



Watching TV to be allowed in self-driving cars

20 Apr | Technology | 1489



Toyota restarts driverless vehicles after accident

31 Aug 2021 | Business



Uber self-drive crash 'mostly due to human error'

20 Nov 2019 | Technology

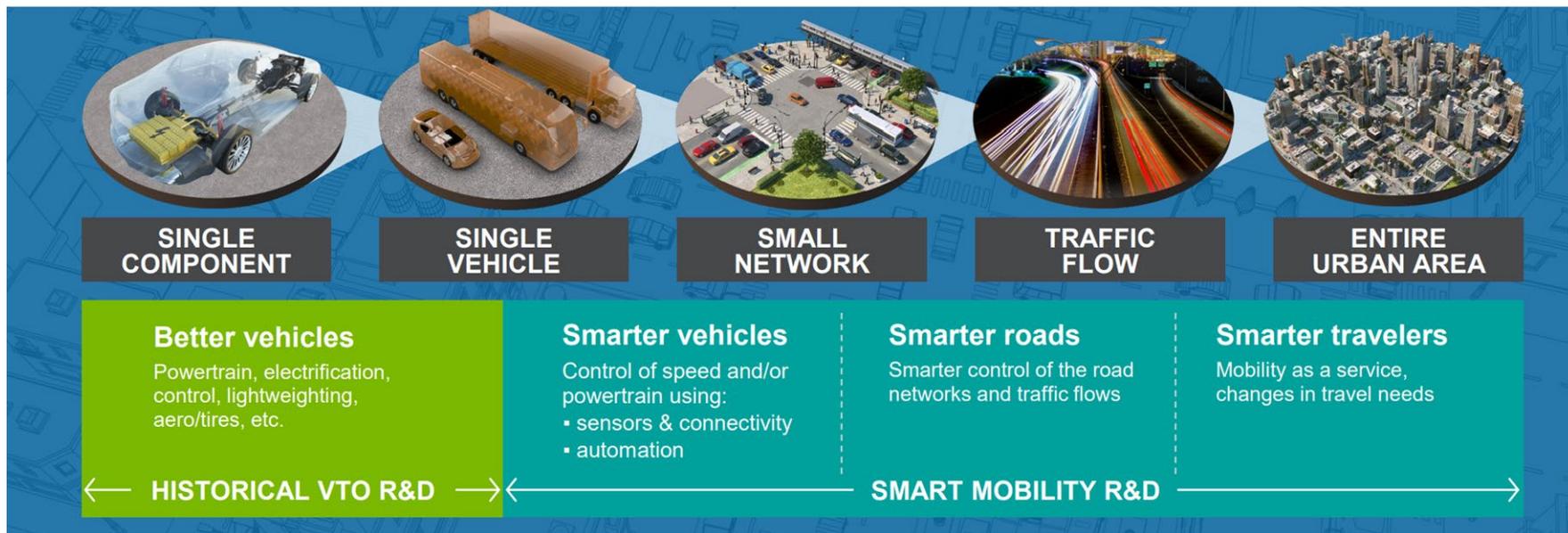


California approves driverless delivery service

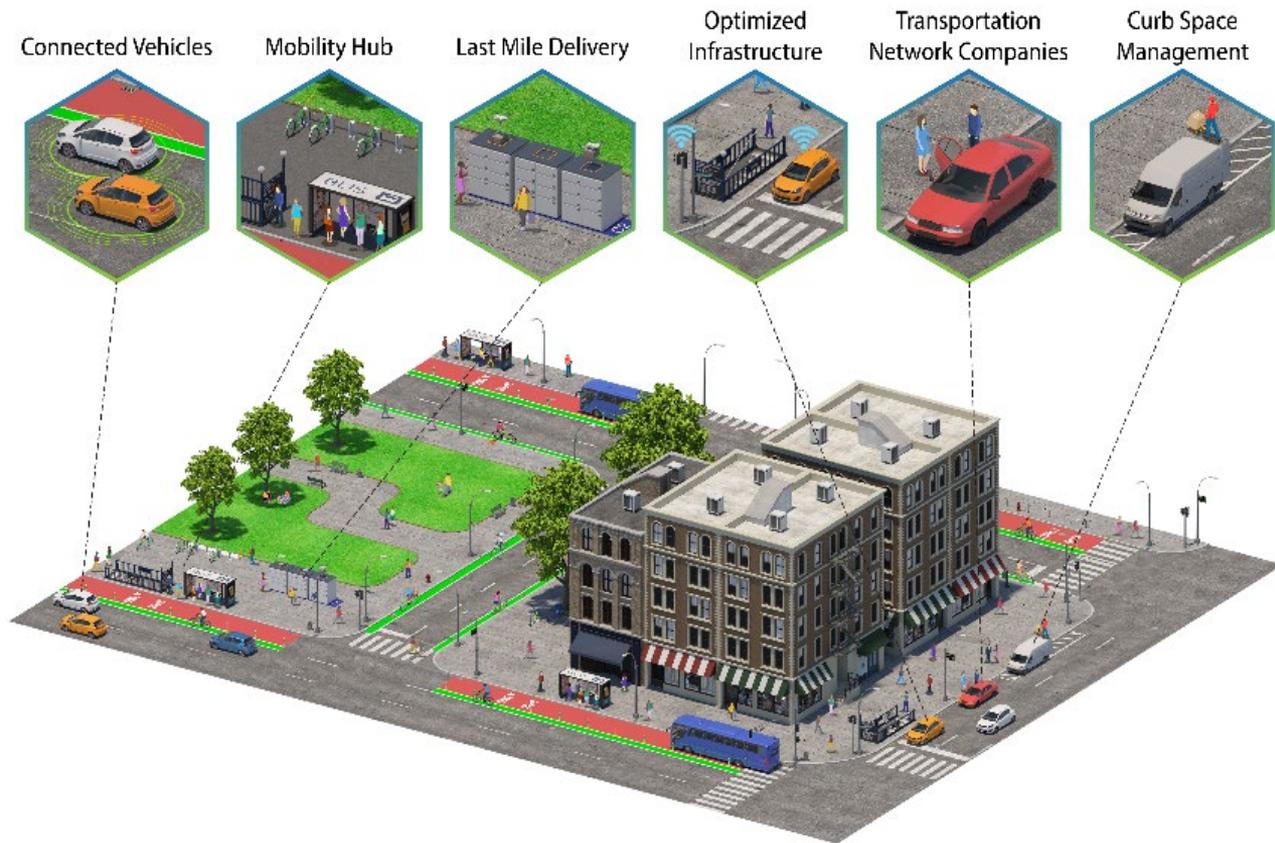
24 Dec 2020 | Technology

Images from: <https://www.bbc.com/news/topics/c90ymkd8lgt>

EEMS expands R&D beyond component vehicle design



Mobility as a system of systems



EEMS Supports the Transportation Decarbonization Blueprint

Convenient



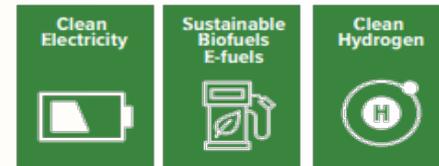
Improve Community Design
and Land-use Planning

Efficient



Increase Options to Travel
More Efficiently

Clean



Transition to Zero Emission
Vehicles and Fuels

Figure A. Summary of transportation decarbonization strategies.

EEMS connections to Blueprint Levers:



Research and Innovation

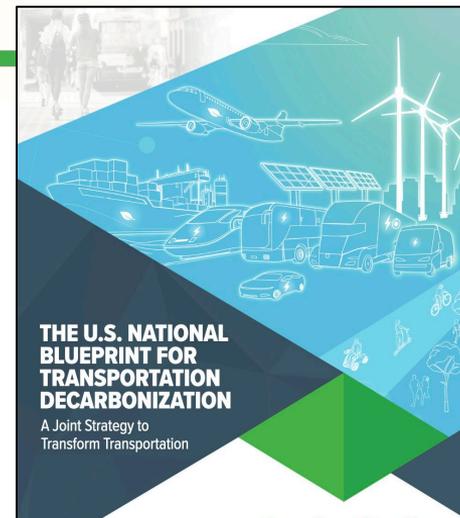


Data, and Tools



Stakeholder Engagement and
Public-Private-Partnerships

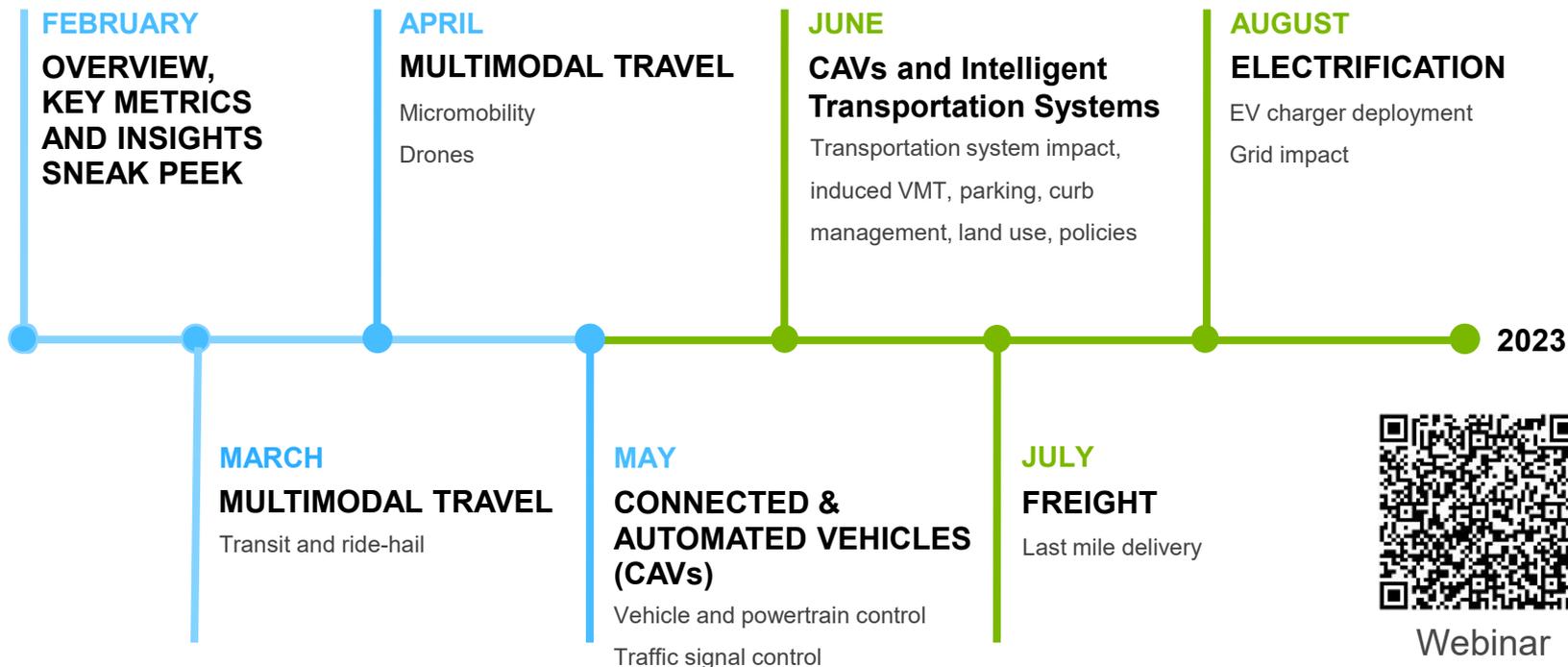
Access the
blueprint:



THE U.S. NATIONAL
BLUEPRINT FOR
TRANSPORTATION
DECARBONIZATION
A Joint Strategy to
Transform Transportation

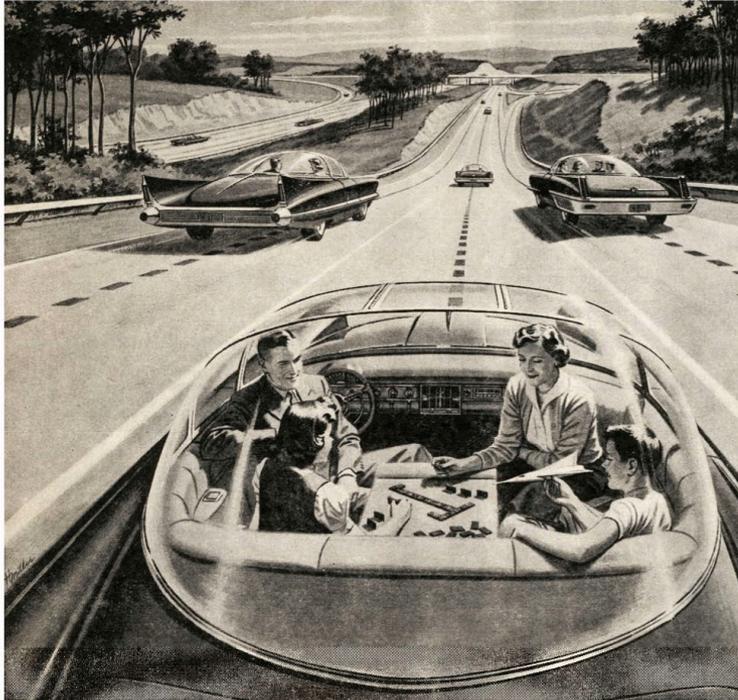


SMART 2.0 WEBINAR SERIES



Webinar Materials

Back to *Tomorrow's* Transportation



Sources: <https://onezero.medium.com/the-100-year-history-of-self-driving-vehicles-10b8546a3318> ;
<https://localmotors.com/2017/06/01/local-motors-celebrates-national-autonomous-vehicle-day/>

Why do we *need* mobility...?

- Marchetti's Constant (1994)
 - average 'commute' time over time
 - For more context, today's average commute in the U.S.:
 - Distance: 16 mi (25 km)
 - *Duration: 30 min*

ANTHROPOLOGICAL INVARIANTS IN TRAVEL BEHAVIOR

77

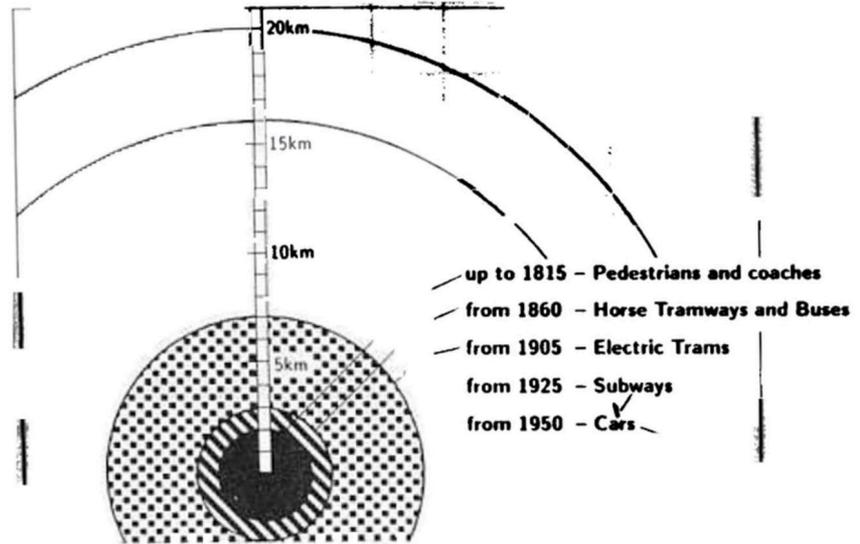
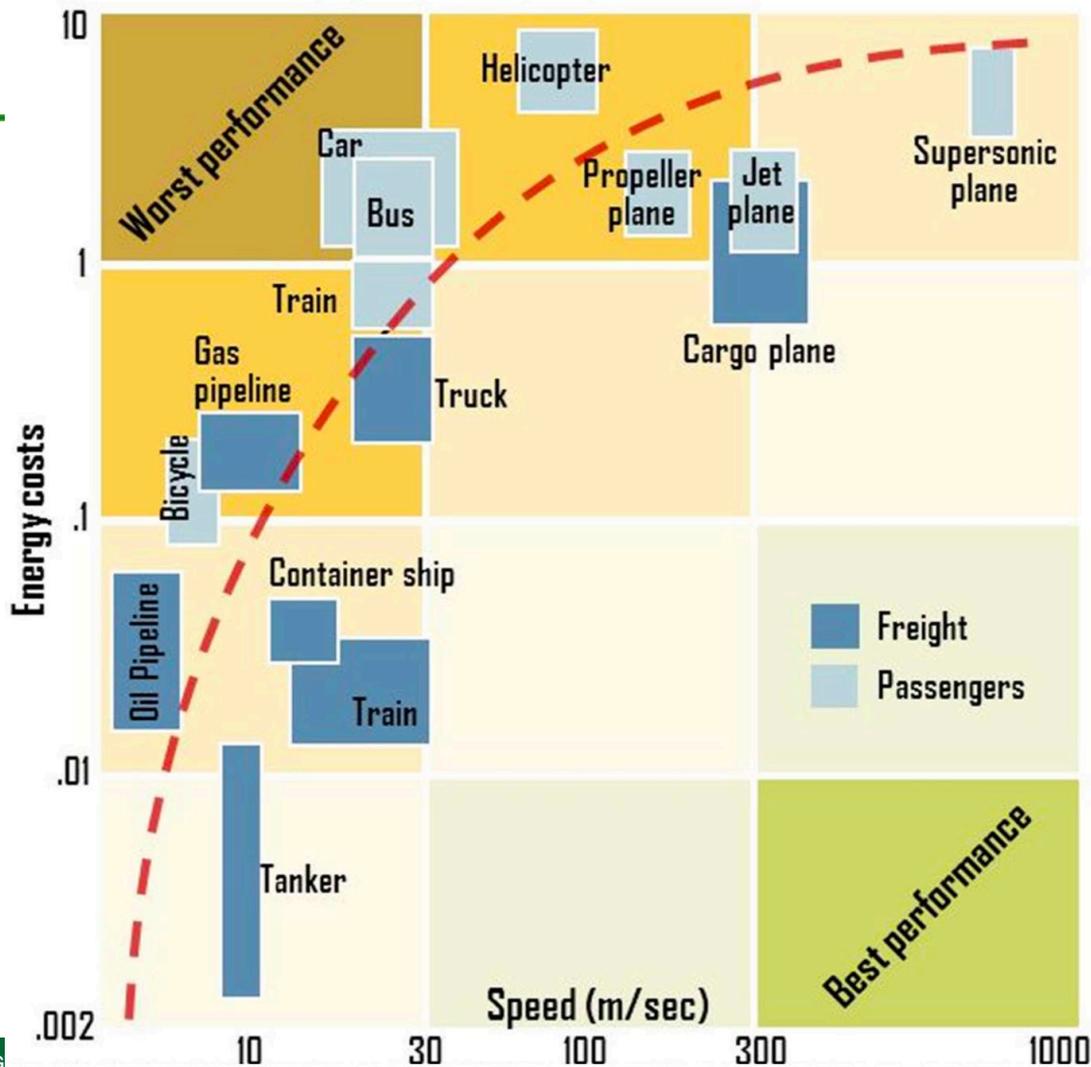


Fig. 2. City dimension and speed of transport: The case of Berlin. The fact that the "daily radius" depends on the speed of transportation is clearly manifested by the evolution of the size of the city of Berlin. The Berlin of 1800 was very compact with a radius of 2.5 km, pointing to a speed of 5 km/hr, the speed of a man walking. With the introduction of faster and faster means of transportation the radius of the city grew *in proportion* to their speed, and is now about 20 km, pointing to a mean speed for cars of about 40 km/hr. The center of the city can be defined, then, as the point that the largest number of people can reach in less than 30 minutes. Reducing the access to the geometric center, for example, through zoning, can displace the functional center elsewhere, for example, outside the city. Shopping centers are a typical consequence of poor transportation toward the center of the city.

Source: http://www.cesaremarchetti.org/archive/electronic/basic_instincts.pdf

Not all transportation modes are created equal...

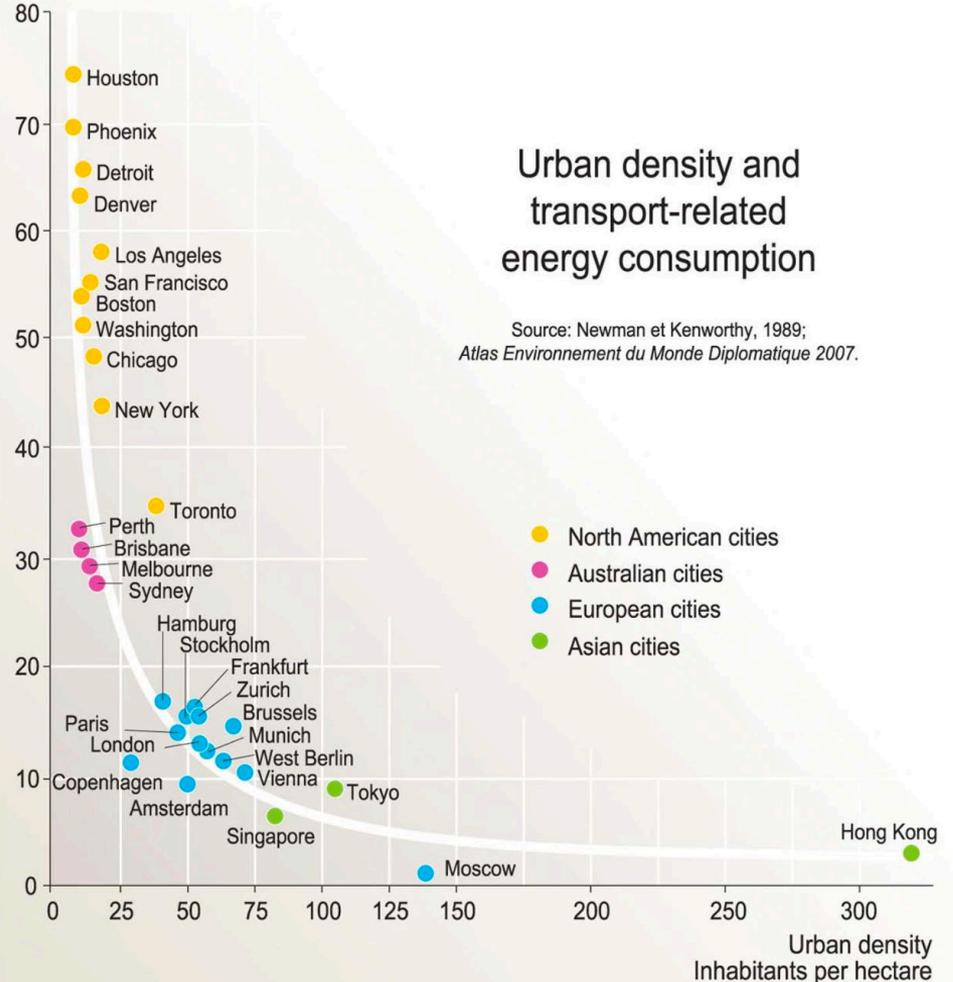


Source: <http://slideplayer.com/slide/4861087/>

...but neither are our cities.

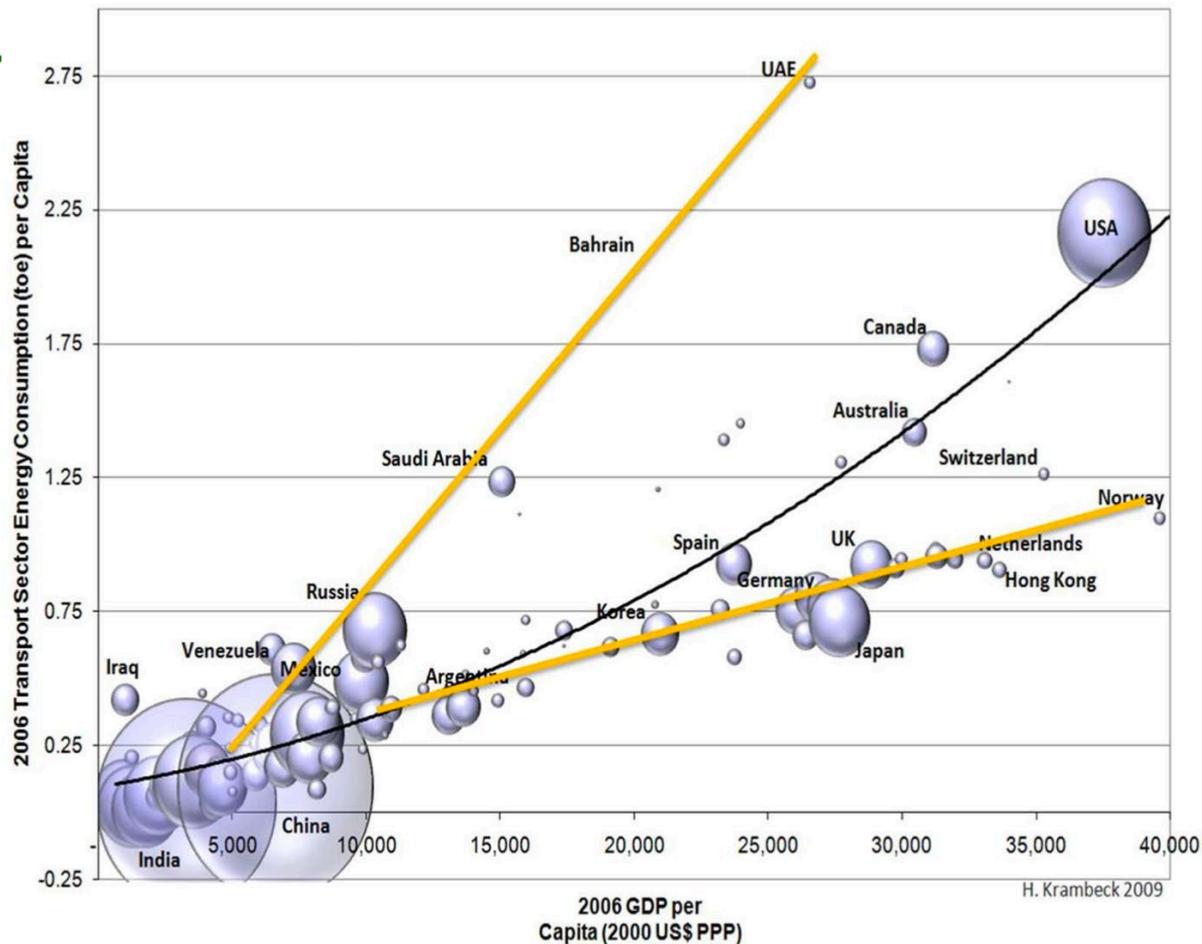
("Newman-Kenworthy Hyperbola")

Transport-related energy consumption
Gigajoules per capita per year

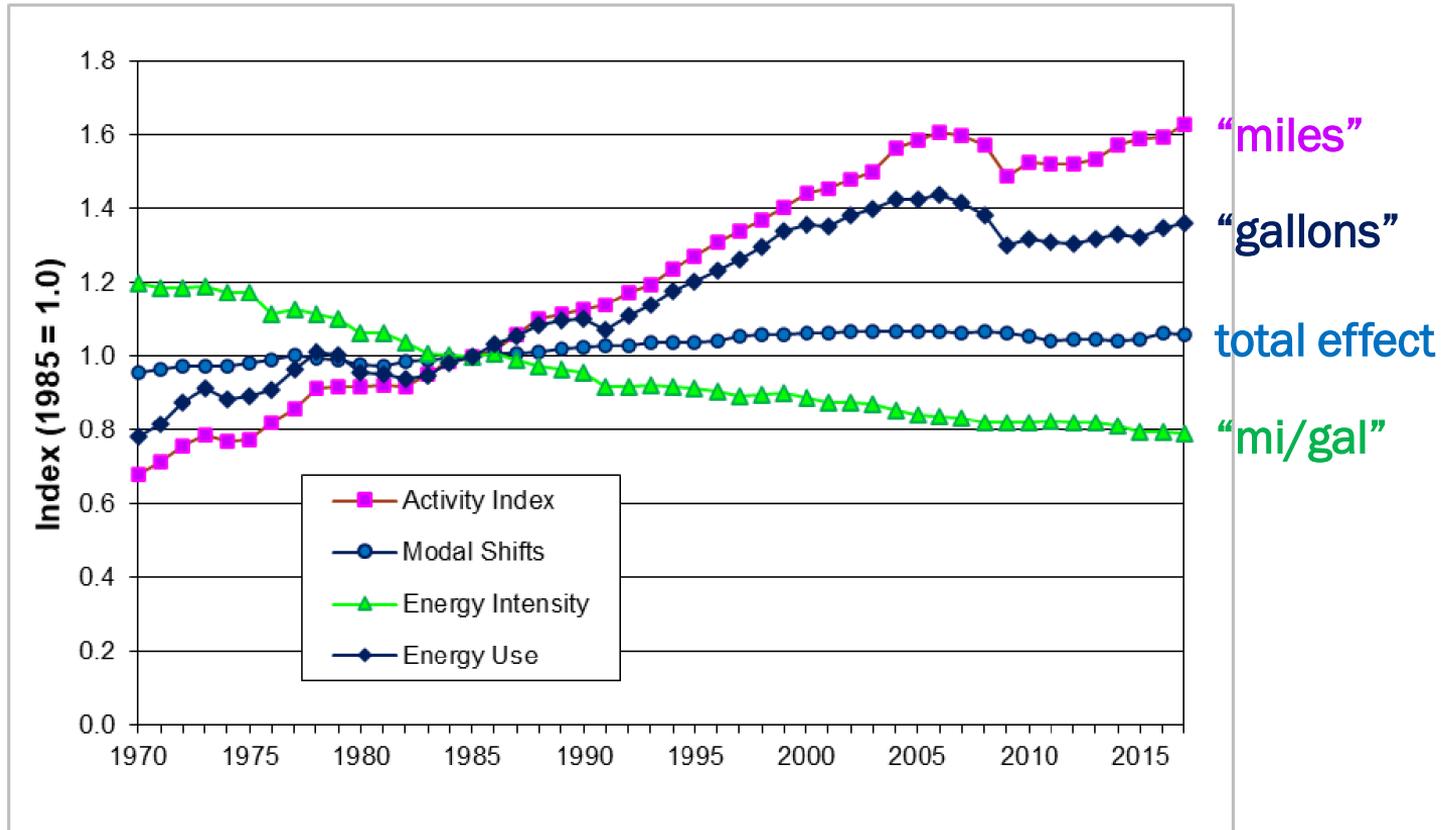


Source: <https://globalizationstudies.sas.upenn.edu/node/737>

Even if transport time investment is constant, transport energy is not:

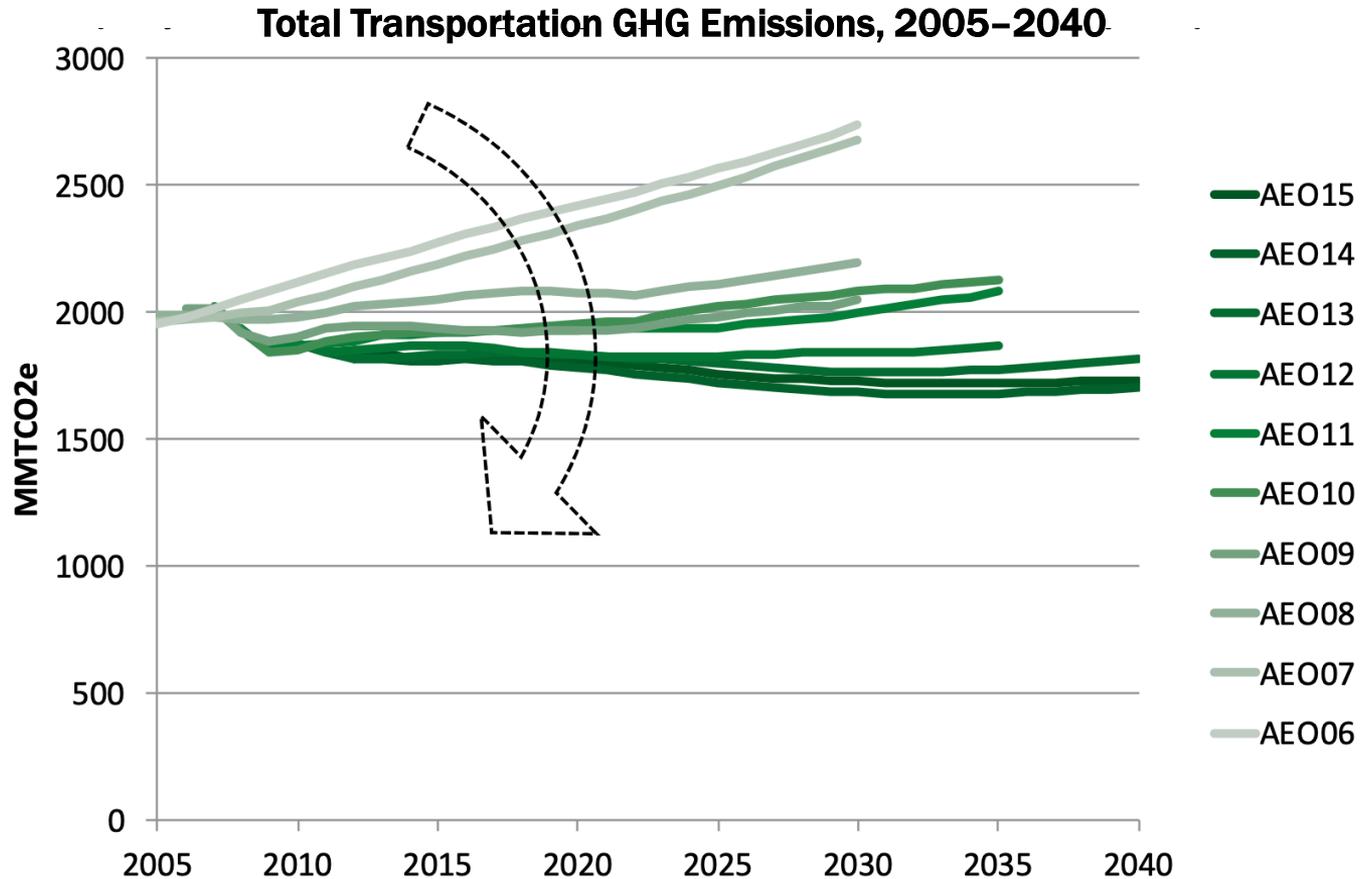


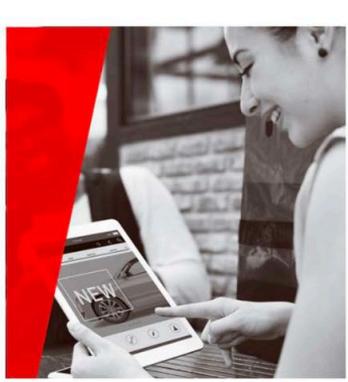
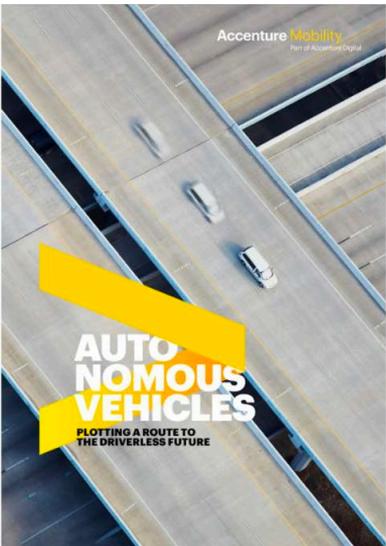
Energy intensity has changed domestically, too:



Source: <https://www.osti.gov/servlets/purl/1633858>

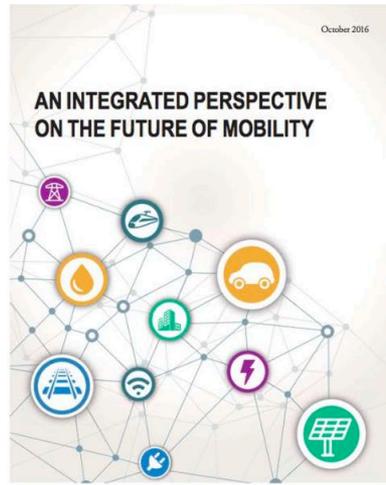
U.S. transportation energy demand projected roughly steady





facebook

BAIN & COMPANY

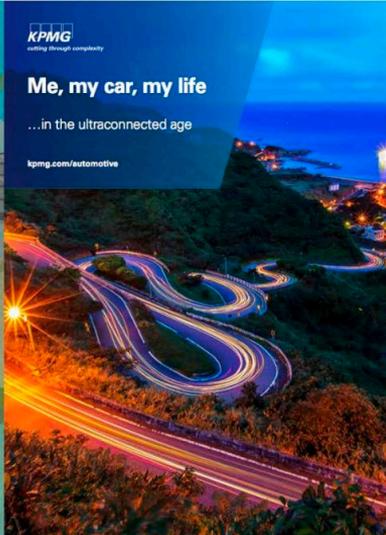


McKinsey & Company

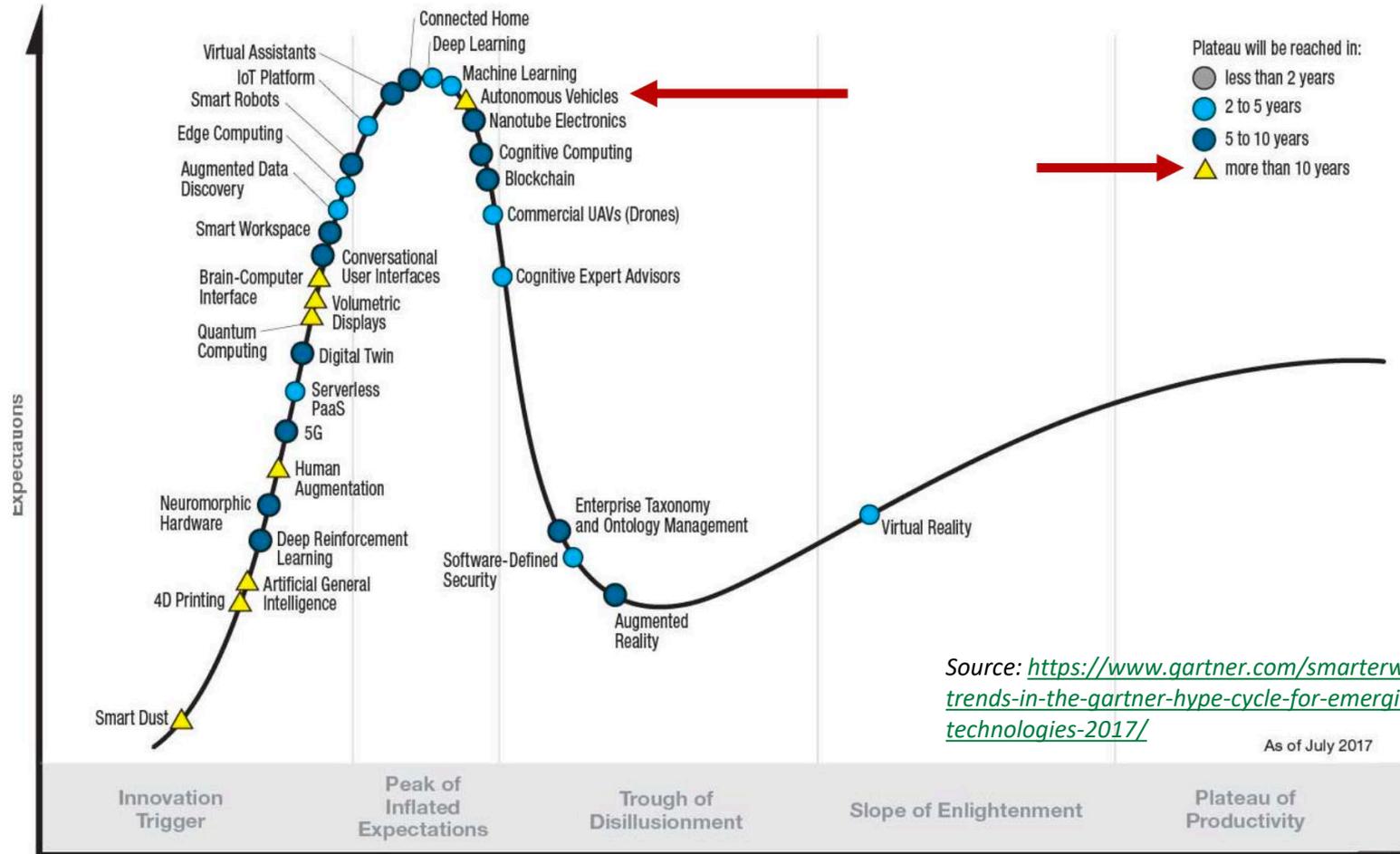
Bloomberg

SELF-DRIVING VEHICLES, ROBO-TAXIS, AND THE URBAN MOBILITY REVOLUTION

- **Automated**
- **Conected**
- **Electric**
- **Shared**

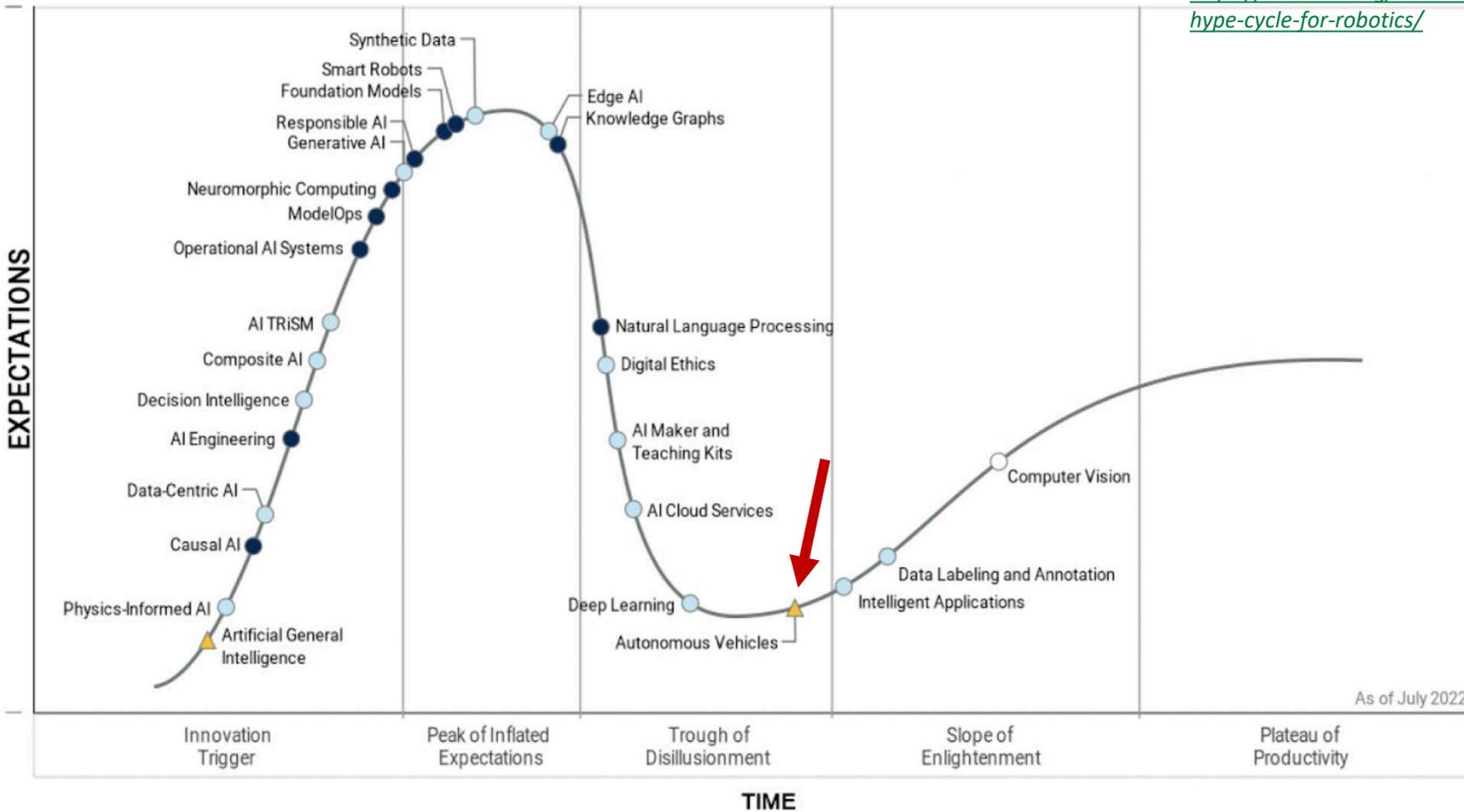


Gartner Hype Cycle for Emerging Technologies, 2017



Hype Cycle for Artificial Intelligence, 2022

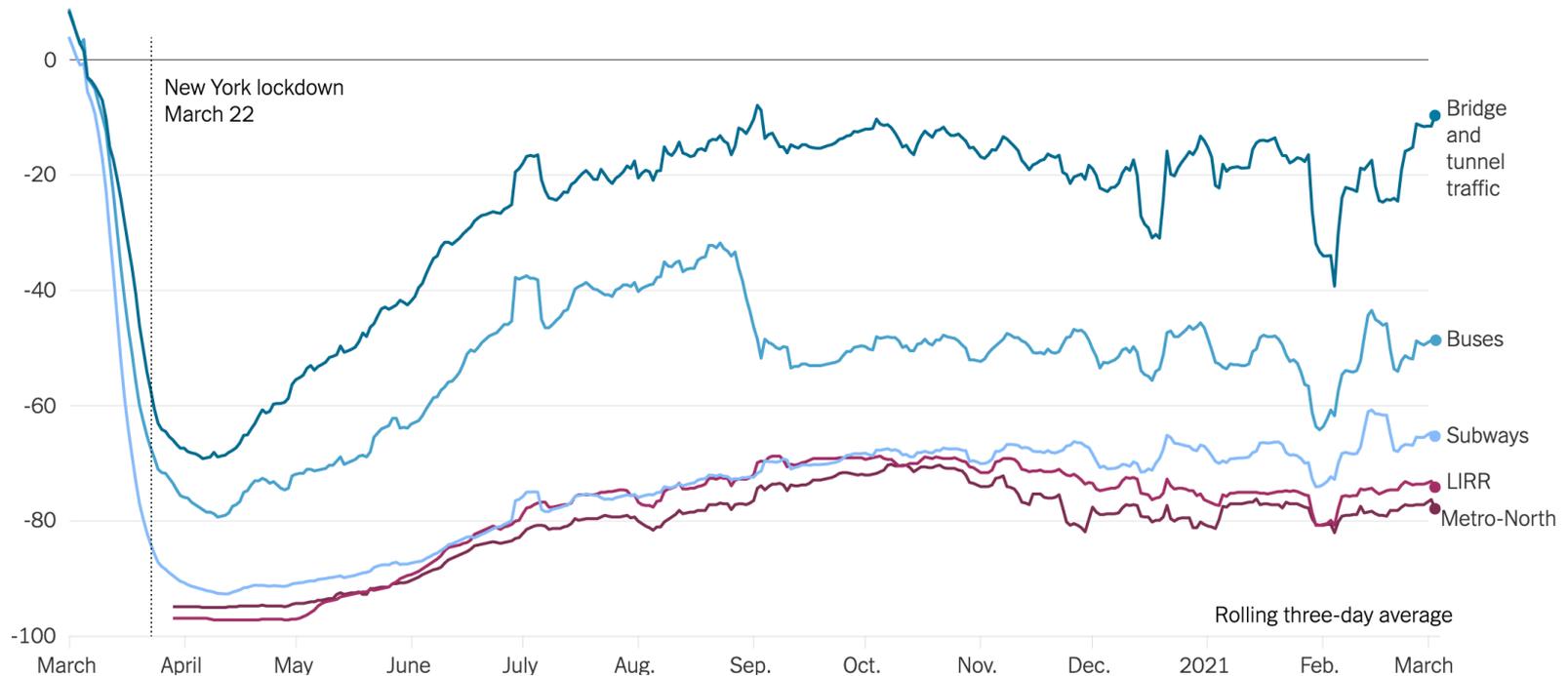
Source: <https://robohub.org/what-is-the-hype-cycle-for-robotics/>



Plateau will be reached: ○ <2 yrs. ● 2-5 yrs. ● 5-10 yrs. ▲ >10 yrs. ⊗ Obsolete before plateau

What happened...?

Percent decline from 2019 ridership



By Veronica Penney - Source: The M.T.A.'s day-by-day ridership numbers. | Percent change is calculated as a comparison with the preceding-year equivalent day, with the exception of the commuter rail systems, which are compared with the 2019 monthly weekday/Saturday/Sunday average. The M.T.A. began reporting data for the LIRR and Metro-North on April 1, 2020.

Start-up shut-downs: Disillusionment? Consolidation? Progress?

Startups

Local Motors, the startup behind the Olli Another Self-Driving Semi-Truck Company autonomous shuttle

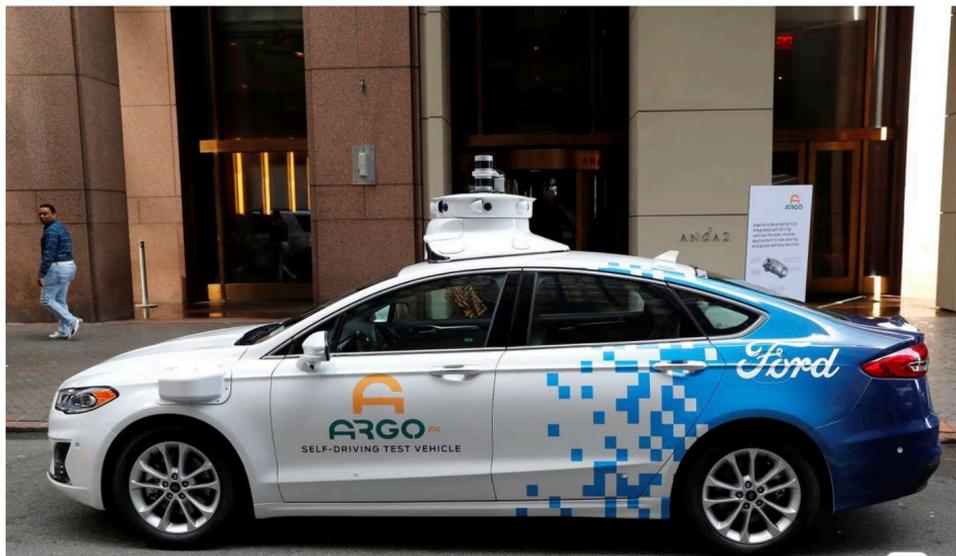
Rebecca Bellan @rebeccabellan / 10:00 AM MST

1 minute read · October 26, 2022 1:56 PM MDT · Last Updated 6 months ago

Ford, Volkswagen-backed Argo AI to shut down- TechCrunch

Reuters

Autonomous semis, is closing up shop. The CEO told



“Envisioning Tomorrow's Sustainable Mobility Systems”

- **ACES still applies!** (*but which ‘letters’ can/do contribute most to tomorrow’s sustainable mobility systems...?*)
 - Automated
 - Connected
 - Electric
 - Shared
- **New overarching themes / undercurrents to include?**
 - Equitable
 - Domestic
 - Sustainable [Transition]