

The Future of Transportation

Piero Scaruffi

Silicon Valley

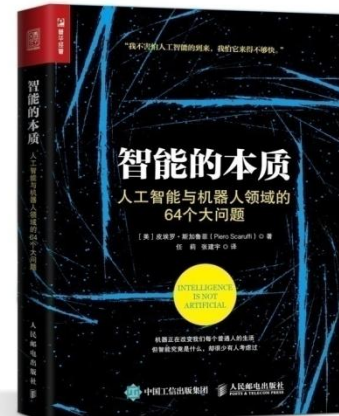
September 2018

Piero Scaruffi



- 30+ years in Silicon Valley
- Written 20+ books
- Pioneered A.I. and Internet applications

- Founded international inter-university programs (LASERs, LAST Festival)
Interdisciplinary research at Stanford, UC Berkeley, etc



What I am Going to Discuss

1. The new-energy vehicle (NEV) industry in the USA and innovative transportation vehicles
2. The smart-city infrastructure for the future of transportation
3. Designing the Future

1. The NEV industry in the USA

NEV industry

- Software (shared, connected, autonomous mobility)
- Hyper-transportation
- New energy
- Wireless charging
- Lightweight materials
- 3D Printing

NEV industry

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- Hyper-transportation
- New energy
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- Lightweight materials
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Rationale for Shared Mobility

- Cars are people's second most expensive household expenditure...
- ... but they sit unused 20+ hours a day
- When they are used, they also need to find parking



Shared Autonomous Mobility

- Mercedes (2016)
- NTU (2017)
- Drive.ai (Mountain View, 2018)



Driverless car startup Drive.ai is launching a ride-hailing service in Texas

By [Alison Griswold](#) • May 7, 2018



Ride-sharing Problem

- Schaller Consulting (2018): Ride-sharing increased traffic by 160% (*“cities are likely to be overwhelmed with more automobility, more traffic and less transit”*)



Connected Mobility

- An "internet of cars": a system to share real-time data from vehicles, roads, traffic signals, etc
 - Infotainment
 - Diagnostics
 - Parking
 - Ride sharing
 - Driver behavior
 - ...

By 2020, it's estimated that

90%

of cars will be connected to the Internet.

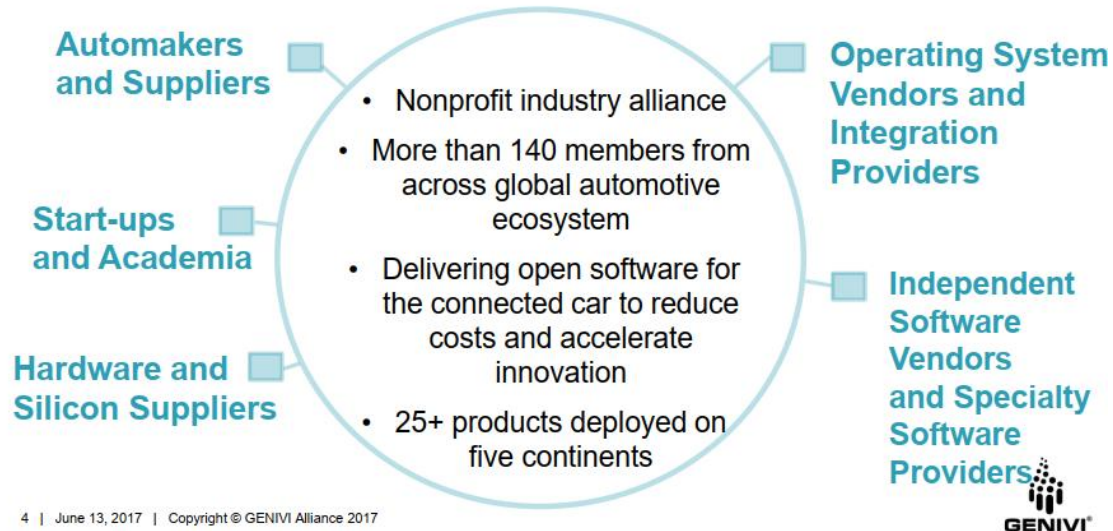


Image Credit: U.S. Department of Transportation

GENIVI

Genivi: open-source alliance based in the Bay Area

GENIVI Alliance: An Open, Connected Car Community



GENIVI



GENIVI Alliance Membership

OEMs



First Tiers



OSV, Middleware, Hardware, and Services Suppliers



Silicon



GENIVI

- Case study: Nevada Department of Transportation: connected cars for pedestrian safety (2017)
 - Bus Stop Warnings
 - High-Risk Warning Areas – using a
 - Speeding Warning



Self-driving Cars

- GM's Chevy Bolt
- GM Cruise

GM unveils autonomous Bolt EV without steering wheel or pedal, aims to bring it to market next year

Fred Lambert - Jan. 12th 2018 8:14 am ET [@FredericLambert](#)

GM Cruise Prepping Launch Of Driverless Car Pilot In San Francisco: Emails

Ryan Felton
6/05/18 2:57pm



Self-driving Cars

State of self-driving in 2019: <https://youtu.be/qf6VrDZ04EQ>



Self-driving Cars

- The Players

Chipmakers: Intel, Nvidia, Qualcomm, Samsung

Component makers: Bosch, Valeo,

Software: Google/Waymo,

Automakers: GM, Ford, Toyota, BMW, Daimler,

Ride services: Uber, Lyft,

Self-driving Cars

- Las Vegas (2018) first fully autonomous electric shuttle
- Drive.ai (2018) taxi service in Texas
- Voyage (2018) service for gated community in San Jose
- California (2018) first license for fully-autonomous cars (Waymo)



The first completely autonomous, fully electric shuttle ever to be deployed on a public roadway in the United States



Self-driving Cars

- Uber (San Francisco)
- Nuro (Boston)
- Zoox (Bay Area)
- Google (Bay Area)



Self-driving Cars

- Zoox (2014): an autonomous vehicle built “from the ground up”, not as an evolution of the traditional car



July 17, 2018



**Self-driving car startup
Zoox is raising \$500 million
at a \$3.2 billion valuation**

Inc.

August 23, 2018

**\$3.2 Billion Autonomous Car
Startup Zoox Suddenly Fired Its
CEO and Won't Explain Why**



Tim Kentley-Klay

Self-driving Cars

- Aurora (2016, former Google-Uber-Tesla engineers)
- Nuro.ai (2016, former Google engineers)



JANUARY 30, 2018

California start-up Nuro unveils autonomous delivery van, raises \$92 million

Our first step is a self-driving vehicle for local goods transportation



Self-driving Cars

- Autox (2016): grocery delivery in San Jose in 2018



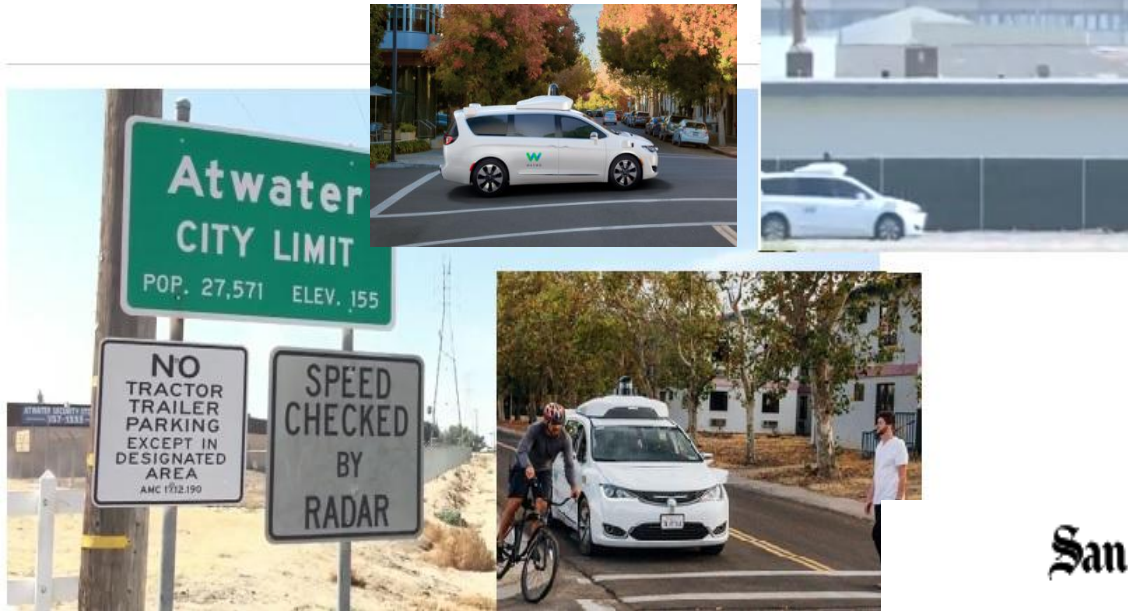
August 27th 2018



Autonomous vehicle startup **AutoX** ⓘ has launched a grocery delivery and mobile store pilot

Self-driving Cars

Google Autonomous Car Spinoff Waymo Builds Town As Test Track



San Francisco Chronicle

Waymo gets green light for robot cars
in California; no humans needed

Oct. 30, 2018

Self-driving Cars

- Waymo launch commercial service in Arizona

Alphabet Inc. (GOOG) (GOOGL) Q3 2018 Earnings Conference Call Transcript

Oct 26, 2018

“Waymo... we moved into very early days of commercialization. So, we do now have people paying for rides” (Ruth Porat)

FINANCIAL TIMES

OCTOBER 26, 2018

Alphabet's Waymo begins charging passengers for self-driving cars

Walmart  TODAY

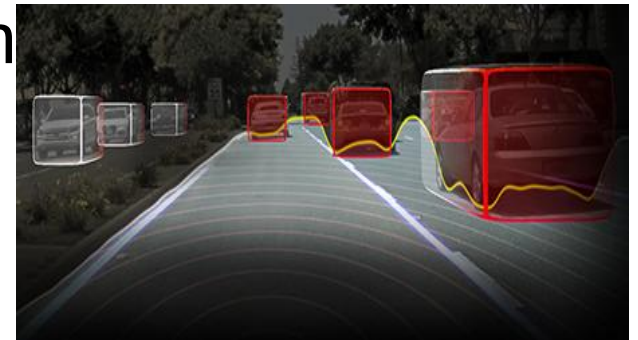
July 25, 2018

Meet Waymo, Your New Self-Driving Grocery Chauffeur



Self-driving Cars

- Nvidia:
 - chips for autonomous driving
 - A.I. software for assisted driving



Self-driving Cars

- Nvidia: Audi, Volvo...



SELF-DRIVING CARS

Partners

AUDI AND NVIDIA Automotive Partners

2019 Audi A8 won't get Traffic Jam Pilot driver-assist tech in the U.S.

By Stephen Edelstein — Posted on May 16, 2018 - 8:00AM



News

Volvo Selects NVIDIA DRIVE

Oct 10, 2018

New AI-Based NVIDIA DRIVE AGX Xavier System Enables Level 2+ Assisted Driving, Market Introduction Early 2020s



Volvo Cars and Autoliv Select NVIDIA DRIVE PX Platform for Self-Driving Cars

Monday, June 26, 2017

Self-driving Cars

- Nvidia's competitors: AI hardware startups

Startup	Founded	Number of Rounds	Total Funding Amount
Wave Computing (Campbell, Calif.)	2010	4	\$117.3 million
Cerebras System (Los Altos, Calif.)	2016	3	\$112 million
Graph core (Bristol, UK)	2016	3	\$110 million
ThinCI (El Dorado Hills, Calif.)	2010	3	\$85 million
Samba Nova Systems (Palo Alto, Calif.)	2017	1	\$56 million
Mythic (Austin, Texas)	2012	5	\$55.2 million
Groq (Palo Alto, Calif.)	--	1	\$20 million
AlphaICs (Bengaluru, India)	2016	1	\$2.4 million

(Source: Company filings, EE Times)

Self-driving Cars

- AI hardware startups

Forbes
AI Chip Boom: This
Stealthy AI
Hardware Startup Is
Worth Almost A
Billion



SambaNova
SYSTEMS



AI for Everyone

Stanford University



SambaNova Systems Emerges from Stealth and Secures \$56 Million in Series A Funding Led by Walden International and GV

March 2018

ThinCI raises \$65 million to develop its processors for autonomous and connected vehicles



crunchbase news

September 6, 2018

Groq, A Stealthy Startup Founded By Google's TPU Team, Is Raising \$60M

Self-driving Cars

- DeepMap (2018): centimeter-level real-time localization for various road types and driving conditions



Autonomous vehicle mapping startup DeepMap raises \$60M+ on \$450M valuation

MENU SILICON VALLEY BUSINESS JOURNAL Nov 2, 2018

The Funded: 10 Bay Area companies raise over \$1.4B at week's end

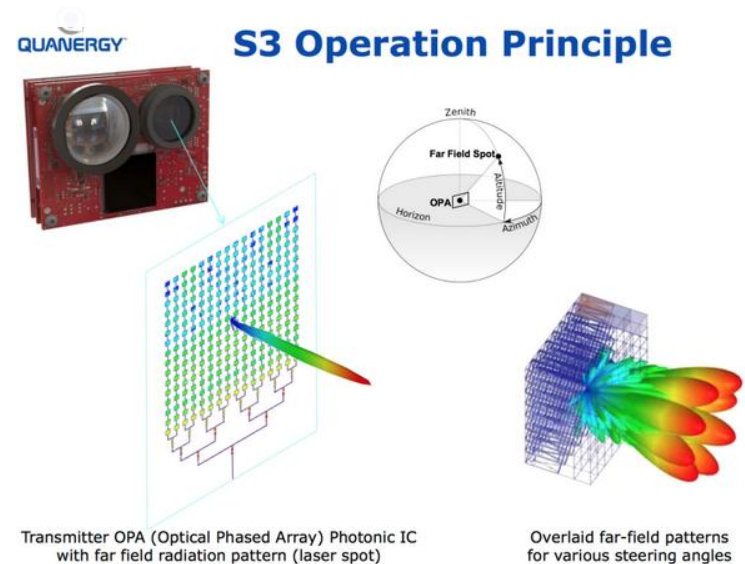
- **View Inc.**, Milpitas, \$1.1 billion: The SoftBank Vision Fund led the late-stage funding of this [smart glass startup](#). Read more here.
- **HashiCorp Inc.**, San Francisco, \$100 million: Institutional Venture Partners led the Series D round for this [cloud infrastructure automation company](#), which reportedly came at a valuation of \$1.9 billion. It was joined by Bessemer Venture Partners, GGV Capital, Mayfield, Redpoint Ventures and True Ventures.
- **Neo4j Inc.**, [San Mateo](#), \$80 million: One Peak Partners and Morgan Stanley Expansion Capital co-led the Series E round for this [developer of graph databases](#). They were joined by Creandum, Eight Roads and Greenbridge Partners. [Read more here.](#)
- **DeepMap Inc.**, Palo Alto, \$60 million: The Series B round for

Self-driving Cars

- Solid-state LIDAR (Quanergy, 2012)
 - Fisker EM 2019



Fisker EMotion
EV 2019



© 2016 Quanergy Systems, Inc.

Self-driving Cars

- Yes, we know about Pony.ai...



Self-driving Cars



Joshua Brown, the first person to die in a self-driving car accident (June 2016)



REUTERS

MARCH 30, 2018

Tesla says crashed vehicle had been on autopilot prior to accident



REUTERS

MARCH 19, 2018

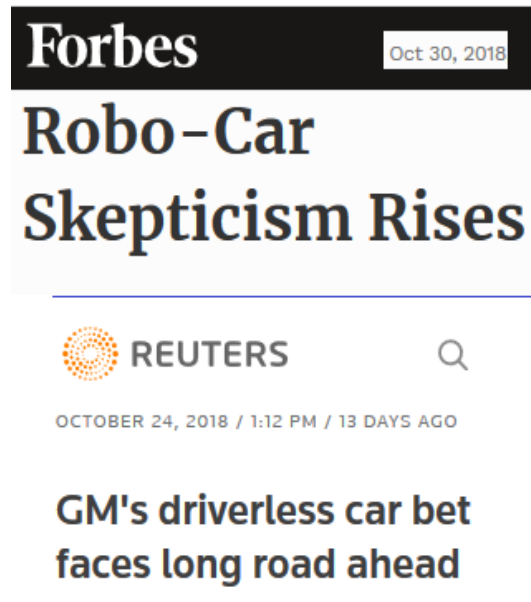
Self-driving Uber car kills Arizona woman crossing street



Waymo's cars with safety drivers have been involved in dozens of accidents in California,

Self-driving Cars

- 2018: Year of the Skepticism



MOTORTREND

OPINION

**TAPPING THE BRAKES: WHY THE
AUTONOMOUS-CAR SOCIETY IS
STILL DECADES AWAY**

THE WALL STREET JOURNAL.

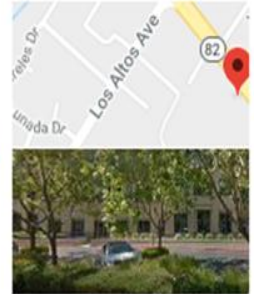
Driverless Hype Collides With Merciless Reality

Sept. 13, 2018

Self-driving Cars

- Investment:
 - While big automotive and technology companies are investing billions, **Silicon Valley investors have spent very little** money in autonomous vehicle startups

Toyota
AI Ventures



Ford Research
and Innovation
Center

GM General Motors

CRUISE



Sergio Marchionne, CEO of Fiat Chrysler: *"You can destroy a lot of value by investing... in autonomous driving."*

Self-driving Cars

Largest 2018 investment rounds:

1. WeWork (New York): \$1B
- 2. Lucid Motors (Newark, CA): \$1B**
3. Peloton (New York): \$550M
- 4. Zoox (Menlo Park, CA): \$500M**
5. Letgo (New York): \$500M
6. Uber (San Francisco): \$500M
7. Samumed (San Diego, CA): \$438M
8. Slack Technologies (San Francisco): \$427M
9. AppLovin (Palo Alto, CA): \$400M
10. OpenDoor Labs (San Francisco): \$400M

[Xconomy](#) [Xperience](#) [EXOME](#) [National](#) [Regions](#) [Channels](#) [Events](#)

U.S. Venture Capital Deals on Pace to Exceed \$100B in 2018



NEV industry

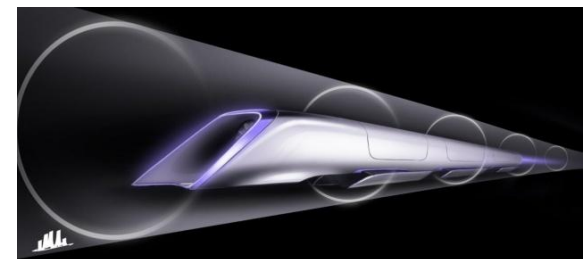
- Software (shared, connected, autonomous mobility)
- Hyper-transportation
- New energy
- Wireless charging
- Lightweight materials
- 3D Printing

Hyper-transportation

- Elon Musk's white paper (2013): the hyperloop

Hyperloop Preliminary Design Study Technical Section

Elon Musk (2013)



1. Abstract

Existing conventional modes of transportation of people consists of four unique types: rail, road, water, and air. These modes of transport tend to be either relatively slow (e.g. of relatively slow transport that seem inexpensive for people design concept, simulation can help advance the

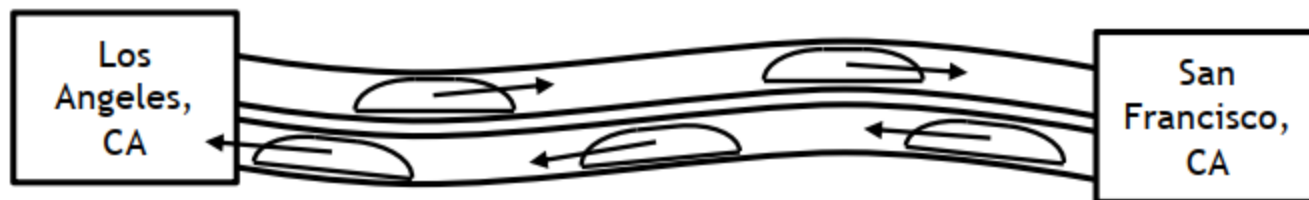


Figure 2. Hyperloop conceptual diagram.

Hyperloop consists of a low pressure tube with capsules both low and high speeds throughout the length of the tube supported on a cushion of air, featuring pressurized air. The capsules are accelerated via a magnetic linear motor at various stations on the low pressure tube with rotors and stators. Passengers may enter and exit Hyperloop at stations located at the ends of the tube, or branches along the tube length.

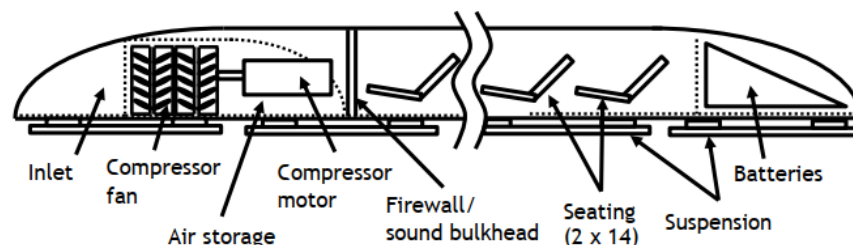


Figure 4. Hyperloop passenger capsule subsystem notional locations (not to scale).

Hyper-transportation

- SpaceX (Elon Musk - Los Angeles)
- Hyperloop Tech/One (Shervin Pishevar - Los Angeles, 2014)
 - Test tube in Nevada (2017)
 - cargo in 2019
 - passengers in 2021



Hyper-transportation

- Hyperloop TT (Dirk Ahlborn - Los Angeles, 2014)

HYPERLOOP
TRANSPORTATION TECHNOLOGIES

Hyperloop Transportation Technologies to Build China's First Hyperloop System

| Jul 19, 2018

HyperloopTT to open Chinese entity and begin work on China's first Hyperloop starting with an initial 10 km commercial agreement at Tongren in Guizhou Province.



Sep 6, 2017

HTT signs agreement to develop a Hyperloop in India

Hyper-transportation

- SpaceX Hyperloop Pod Competition

2019 SpaceX Hyperloop Pod Competition Rules and Requirements

August 23, 2018

VTOL

- VTOLs - Vertical Take Off and Landing vehicles
- EVTOLs - Electric VTOLs
- Mark Moore (NASA): white paper “Personal Air Vehicles” (2003) and concept VTOL (2010)

AIAA Paper 2003-2646

PERSONAL AIR VEHICLES: A RURAL/ REGIONAL AND INTRA-URBAN ON-DEMAND TRANSPORTATION SYSTEM

Mark D. Moore[†]
NASA Langley Research Center
Hampton, VA 23681-2199



VTOL

- EVTOLs - Electric VTOLs
 - Kitty Hawk (California): flying car Flyer (unveiled in 2017) and autonomous flying taxi Cora (unveiled in March 2018)
 - Cora = electric power + self-piloting software + vertical take-off

BUSINESS
INSIDER

Jun. 6, 2018,

The flying car backed by Google's cofounder just got a big update, and people can pilot it with less than an hour's training

Bloomberg

June 9, 2016

Hyperdrive

Welcome to Larry Page's Secret Flying-Car Factories

With Zee.Aero and Kitty Hawk, the Google co-founder looks to the skies.



Kitty Hawk Conducts Flying Car Trials in Las Vegas



VTOL

- EVTOLs - Electric VTOLs
 - A³ (Airbus in Silicon Valley): Vahana (first tested in January 2018)



**Vahana, the Self-Piloted,
eVTOL aircraft from A³ by
Airbus, Successfully
Completes First Full-Scale
Test Flight**

January 2018



VTOL

- VTOLs - Vertical Take Off and Landing vehicles
 - Joby (California): air taxi (\$100m in February 2018)



Bloomberg Businessweek

February 1, 2018

Air-Taxi Startup Has a Working Prototype and a Fresh \$100 Million

● Joby Aviation hides its craft at a secretive private airfield.

Flying Car

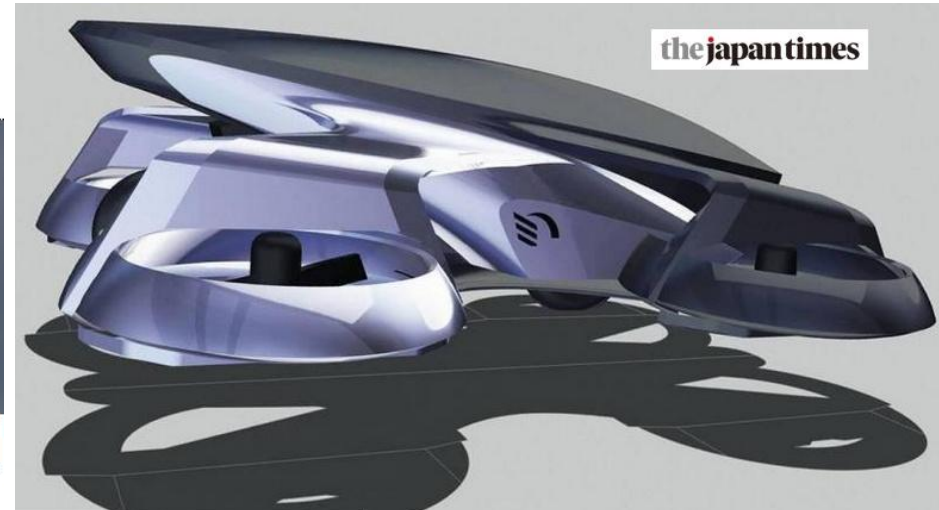
- Flying cars
 - Boeing
 - Japan: Boeing, Airbus, Japan Airlines, NEC , ANA Holdings, Yamato Holdings, Toyota's startup Cartivator, etc

March 1, 2018,

Bloomberg



Boeing Is Getting Ready to Sell Flying Taxis



Flying Car

- Flying cars
 - Uber

Bloomberg

February 6, 2017,

Technology

Uber Hires Veteran NASA Engineer to Develop Flying Cars

The man who inspired Google's co-founder



Uber Is Opening a Flying-Car Lab in Paris

Bloomberg

May 24, 2018,



Uber Elevate Concept Air Taxi Source: Uber

NEV industry

- Software (shared, connected, autonomous mobility)
- Hyper-transportation
- New energy
- Wireless charging
- Lightweight materials
- 3D Printing

Clean-tech



GOVERNOR BROWN CLOSES GLOBAL CLIMATE ACTION SUMMIT: “WE’RE LAUNCHING OUR OWN DAMN SATELLITE”

Sep 14, 2018 | Feature, Summit News



Clean-tech

- Planet (founded by ex-NASA scientists in 2010) operates the world's largest constellation of satellites in history
- Planet has launched over 150 Earth-imaging satellites
- State of California + Planet Labs to develop a satellite that will track climate change-causing pollutants
- Climate Data Partnership to serve as a common platform for reporting data from satellite systems studying climate variables



Clean-tech

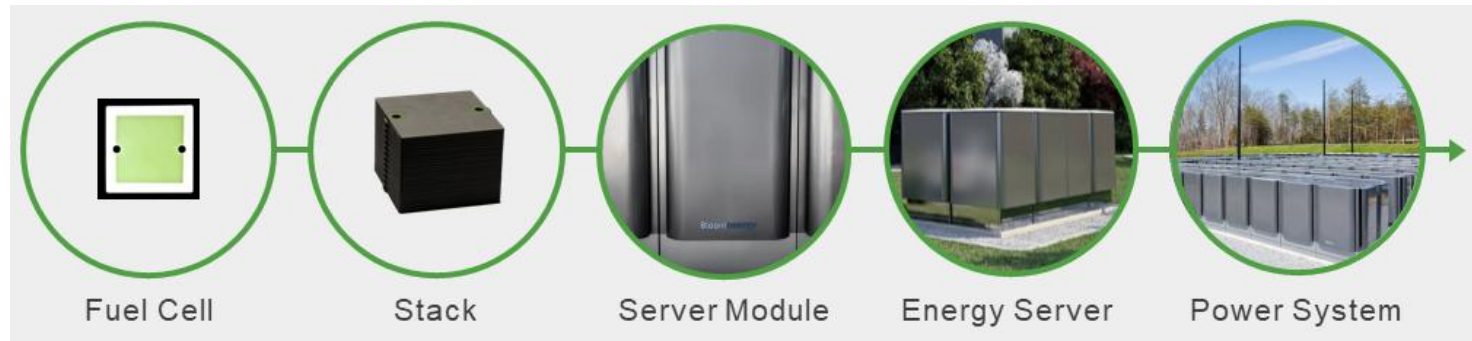
- Powerhouse (Oakland, 2013): incubator for cleantech startps



Clean-tech

- Bloom (Sunnyvale, 2001): fuel cells that can produce electricity at costs that are competitive with grid power

Bloomenergy®



Clean-tech

- Genability (San Francisco, 2010): new-energy use optimization
- Autogrid (Redwood City, 2011): new-energy use optimization
- Advanced Microgrid Solutions (San Francisco, 2012): software to ensuring electricity from generators, renewable energy, batteries and the grid itself will always perfectly match the needs of the buildings



Clean-tech



- Aclima (San Francisco, 2010): air-quality mapping platform - mobile sensing platform on Street View cars in collaboration with Google Earth Outreach (IoT of city-wide network of sensors)



Clean-tech

- DBL Partners - Double Bottom Line Venture Capital (San Francisco, 2016): the first venture capital fund specializing in “impact investment” to achieve significant financial returns to scale



OFF-GRID:ELECTRIC

Advanced Microgrid Solutions

SolarCity



NEXTracker
Unleashing Solar Profits

Siva^{power}

view

PRIMUS
POWER



POWERGENIX

BrightSource

Akros Silicon

KAIAM

Oopx^{bio}
good chemistry.

POWERLIGHT
RURAL ELECTRIC SYSTEMS

Clean-tech

- The garbage industry has traditionally been low-tech
- How to disrupt the \$60 billion garbage industry?
- Rubicon Global (Kentucky, 2008): a cloud-based “Uber for trash”
- \$1 billion in 2017 (most valued cleantech startup in the US)
- Controversy: *“a trash brokerage business masquerading as a tech company”* (Fortune)

Bloomberg

Can the ‘Uber of Trash’ Clean Up Its Own Business?

Rubicon Global aimed to improve garbage-hauling through technology, but it’s not always easy to solve terrestrial problems with cloud-based solutions.

Clean-tech

- Aemetis Company (Cupertino, 2006): renewable fuels
- Alphabet Energy (Berkeley, 2009), spinoff of Lawrence Berkeley National Laboratory: generate power from waste heat



Clean-tech

- Problems: BrightSource leaves California after building the largest solar thermal power plant in the world at Ivanpah (2014)



Clean-tech

- No cleantech unicorn in the top 100

Company	Valuation (\$B)	Date Joined	Country	Cbinsight.com - August 2018			
Uber	\$72	8/23/2013	United States	Lu.com	\$18.5	12/26/2014	China
Didi Chuxing	\$56	12/31/2014	China	JUUL Labs	\$15	12/20/2017	United States
Airbnb	\$29.3	7/26/2011	United States	Pinterest	\$12.3	5/19/2012	United States
SpaceX	\$21.5	12/1/2012	United States	Bitmain Technologies	\$12	7/6/2018	China
Palantir Technologies	\$20	5/5/2011	United States	Lyft	\$11.5	3/12/2015	United States
WeWork	\$20	2/3/2014	United States	GrabTaxi	\$11	12/4/2014	Singapore
Toutiao (Bytedance)	\$20	4/7/2017	China	Global Switch	\$11.08	12/22/2016	United Kingdom
Stripe	\$20	1/23/2014	United States	Infor	\$10	11/16/2016	United States
				DJI Innovations	\$10	5/6/2015	China

Electric Cars

From: 06/29/2010 To: 11/05/2018 Zoom: 3M 6M 1Y 2Y 3Y 5Y A



Electric Cars

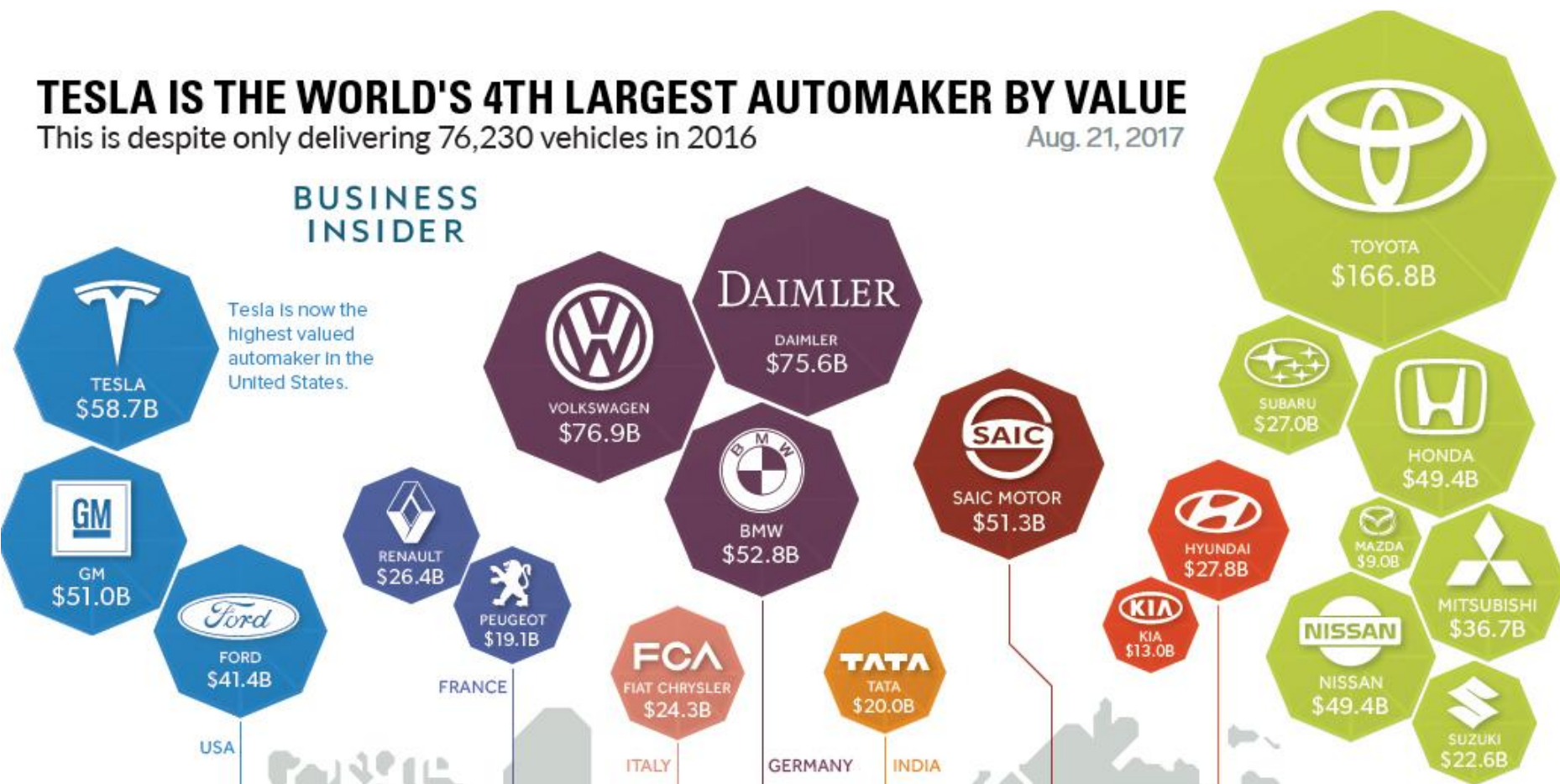
TESLA IS THE WORLD'S 4TH LARGEST AUTOMAKER BY VALUE

This is despite only delivering 76,230 vehicles in 2016

Aug. 21, 2017

BUSINESS
INSIDER

Tesla is now the
highest valued
automaker in the
United States.



New-Energy Vehicles

- National programs to ban internal combustion engine (ICE) vehicles in favor of electric ones: Norway by 2025, India and China by 2030, Britain and France by 2040, California by 2040



Assemblymember Ting Introduces Clean Cars 2040

Wednesday, January 3, 2018

New-Energy Vehicles

- 2017:
 - Opening of Tesla's largest charger station, halfway between Los Angeles and San Francisco



New-Energy Vehicles

- China rules!
 - 2017: China's electric vehicle production is **50% of global production** (EU 21%, USA 17%, Japan 8%, South Korea 3%)
 - 2017: China's battery cell production for electric vehicles is **11 times that of the USA**
 - 2017: Largest stock of electric vehicles in the world, with cumulative sales of more than **1.7 million units**



New-Energy Vehicles

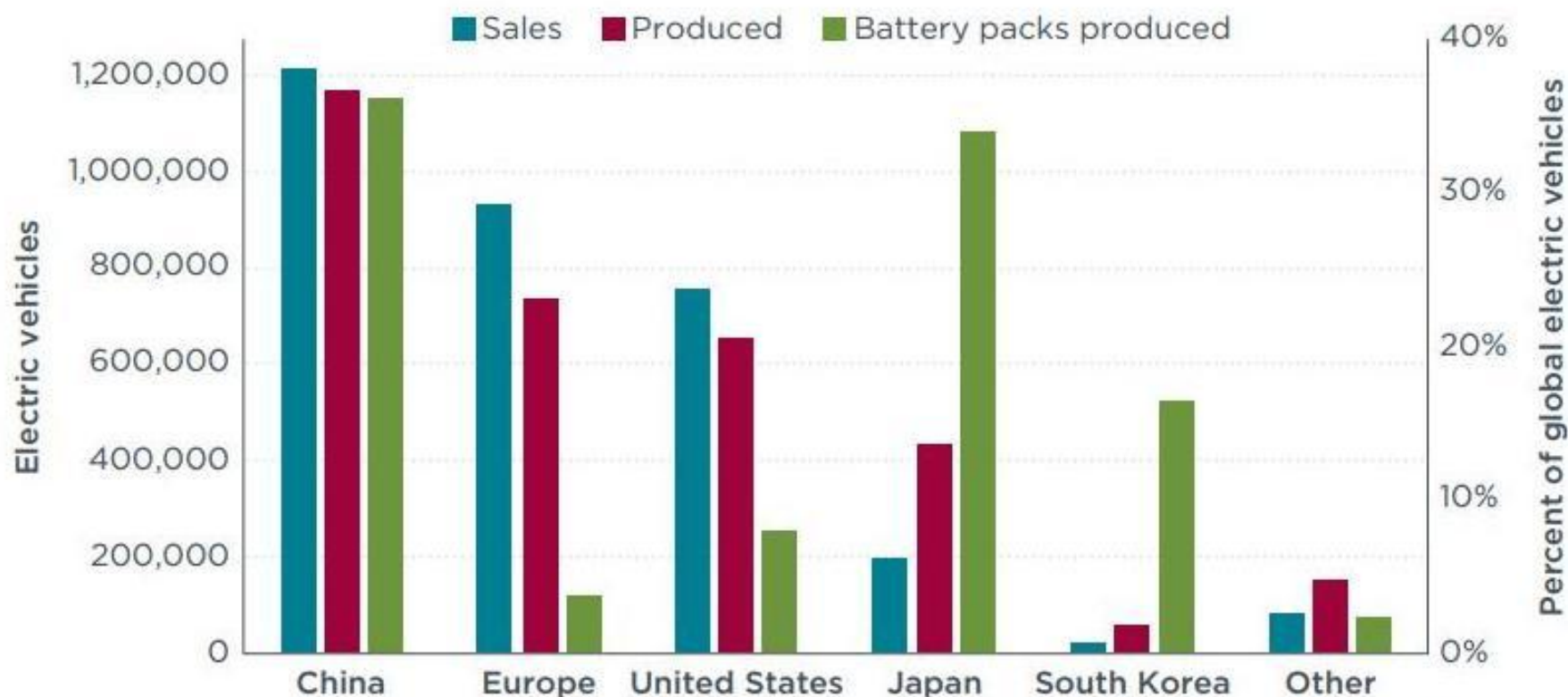
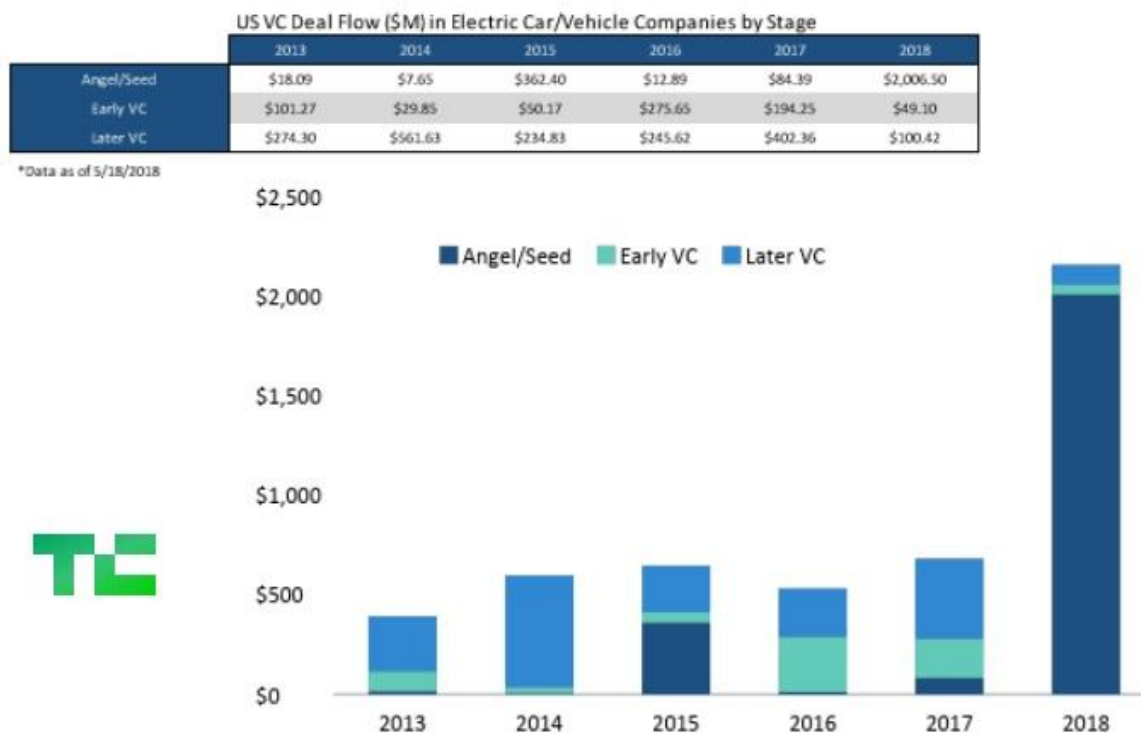


Figure ES-1. Electric vehicle sales, electric vehicle production, and electric vehicle battery production by region through 2017.

New-Energy Vehicles

- US startups
 - Electric vehicle startups raised more than \$2 billion in the U.S. over the first months of 2018 alone, a huge increase over the \$650 million raised in 2017



New-Energy Vehicles

- California startups

Table 1. Electric vehicle and general data for California and the United States.

		U.S.	California	California as percent of U.S.
General	Population	326 million	39.5 million	12%
	Gross domestic product	\$19.4 trillion	\$2.75 trillion	14%
	Light-duty vehicle sales in 2016	16.2 million	2.0 million	12%
Electric vehicles	New 2017 electric vehicles	193,000	96,000	50%
	Cumulative 2010-2017 electric vehicles	749,000	366,000	49%
Electric vehicle public charging	Level 2 charge points	38,100	12,000	32%
	Fast charge points	6,200	1,600	25%
	Total charge points	44,300	13,600	31%

Population data from U.S. Census; income data from U.S. Bureau of Economic Analysis; vehicle registrations from IHS Automotive; public charging data from Alternative Fuels Data Center.

New-Energy Vehicles

- California startups

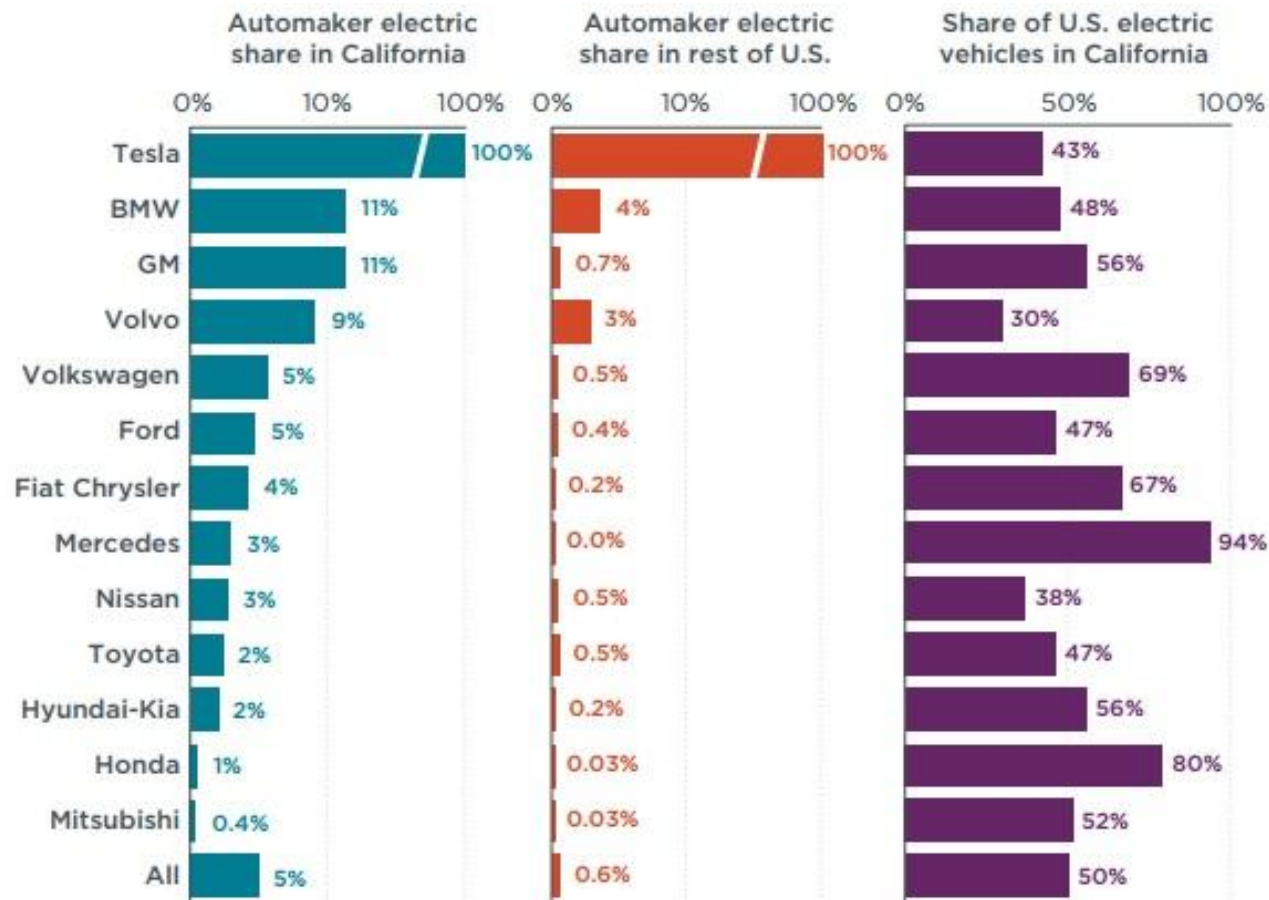
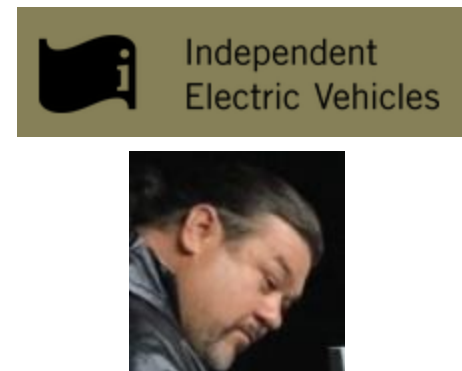


Figure 4. Automaker group electric vehicle share in California and the United States, and share of U.S. electric vehicles deployed in California. (Vehicle registrations from IHS Automotive)

New-Energy Vehicles

- Karma Automotive (2015, ex Fisker, owned by Wanxiang Group)
- Evelozcity (2017)
- Independent Electric Vehicles (2017, Steve Osorio)



New-Energy Vehicles



- SF Motors (2016, John Zhang) – with Tesla's founder Martin Eberhard
- Lucid Motors (2017, Peter Rawlinson)



Forbes

China-Backed SF Motors Debuts Electric SUVs



Largest 2018 investment rounds:

1. WeWork (New York): \$1B
2. **Lucid Motors (Newark, CA): \$1B**
3. Peloton (New York): \$550M
4. Zoox (Menlo Park, CA): \$500M

New-Energy Vehicles

- The problem: the range
 - Chevy Bolt EV (238 miles)
 - Tesla Model 3 (220 miles)
 - Nissan Leaf (150 miles)
- Solutions
 - Charging stations
 - New kind of batteries
 - Wireless charging
 - Lighter materials



2018 Nissan LEAF

New-Energy Vehicles

- Volta Charging (San Francisco, 2010): network of free charging stations
- FreeWire (San Leandro, 2014): portable electric vehicle charging stations



New-Energy Vehicles

- New-energy vehicles use... OLD energy!
- The lithium-ion battery was introduced in 1991



New-Energy Vehicles

Energy@Stanford & SLAC 2018

Energy Research for the 21st Century

Monday - Thursday, September 10 -13
Friday, September 14 (optional half-day)

Stanford | Precourt Institute
for Energy

SIMES

SLAC

NATIONAL
ACCELERATOR
LABORATORY

SLAC NATIONAL
ACCELERATOR
LABORATORY

August 30, 2018

Chuntian Cao wins 2018 Klein Award for lithium-ion battery research



Using SLAC's X-ray synchrotron SSRL, Cao improves fundamental knowledge about how a new lithium-ion battery material works

New-Energy Vehicles

- Cryo-electron microscopy (Cryo-EM) to study battery materials
 - 2016: Yi Cui at Stanford uses Cryo-EM for research on battery material: the first time ever that scientists can see atomic-level microscopic images of lithium metal

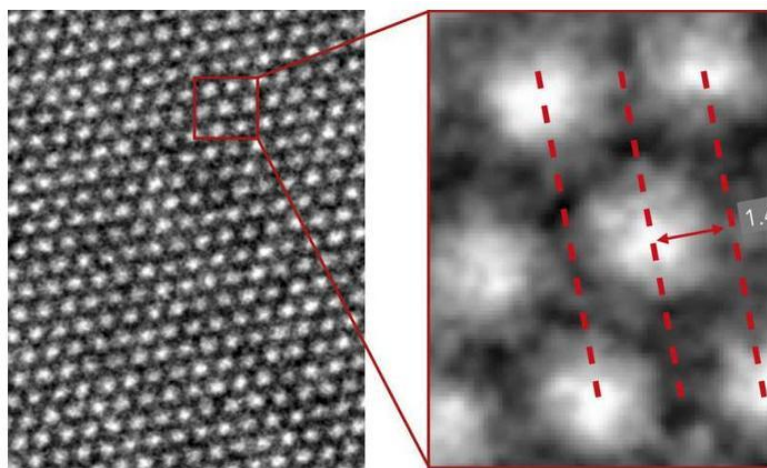
Yi Cui: 500Wh/kg Batteries | GCEP Symposium – October 18, 2017

YouTube



Yi Cui

Pathway to 500Wh/kg Batteries



the locations of individual atoms (left)

the distance between atoms (right)



New-Energy Vehicles

- Cryo-electron microscopy (Cryo-EM)
 - 2017 Nobel prize in chemistry

The Nobel Prize in Chemistry 2017 ▼

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Chemistry 2017 to

Jacques Dubochet

University of Lausanne, Switzerland

Joachim Frank

Columbia University, New York, USA

Richard Henderson

MRC Laboratory of Molecular Biology, Cambridge, UK

“for developing cryo-electron microscopy for the high-resolution structure determination of biomolecules in solution”



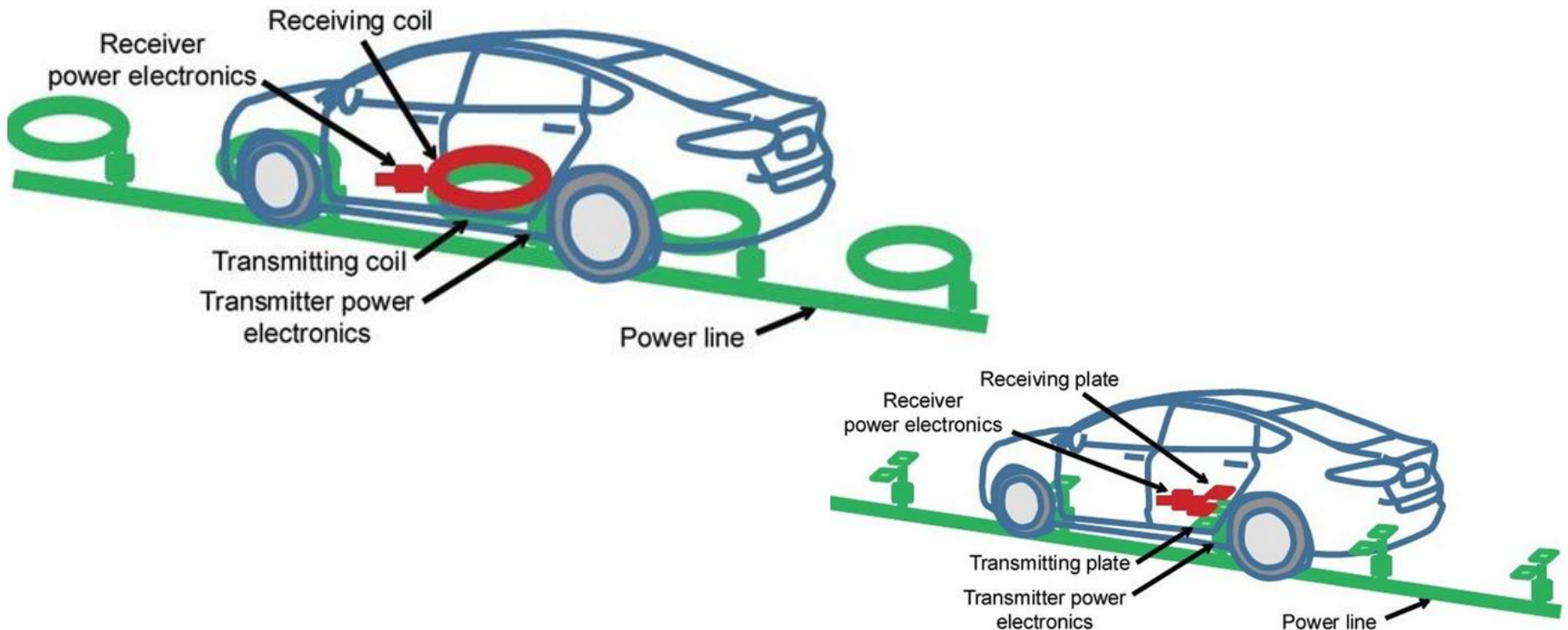
NEV industry

- Software (shared, connected, autonomous mobility)
- Hyper-transportation
- New energy
- Wireless charging
- Lightweight materials
- 3D Printing

New-Energy Vehicles

- Wireless Charging: Near-field WPT (wireless power transfer), inductive or capacitive

Power
Electronics®



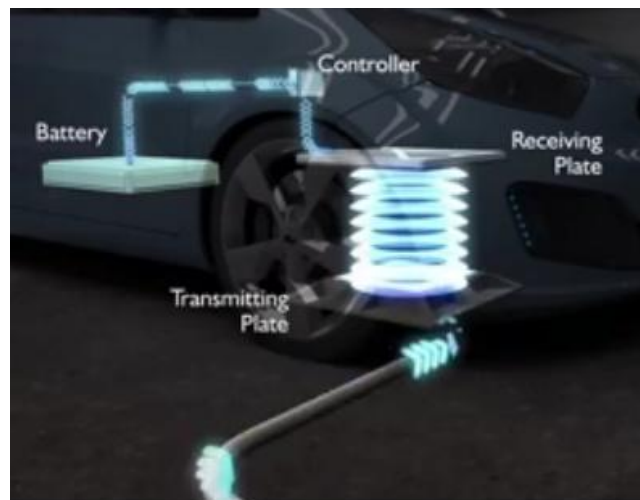
New-Energy Vehicles

- Wireless Charging: energy.gov/eere



Office of
ENERGY EFFICIENCY & RENEWABLE ENERGY

Wireless Charging for Electric Vehicles



New-Energy Vehicles

- Wireless Charging based on magnetic resonance technology
 - WiTriCity (Boston)
 - Qualcomm's wireless charging system Halo



New-Energy Vehicles

- Wireless Charging of moving electric vehicles
 - Shanhui Fan (Stanford)

JUNE 14, 2017

Wireless charging of moving electric vehicles

Stanford | Precourt Institute for Energy



 nature
International journal of science

Letter | Published: 14 June 2017

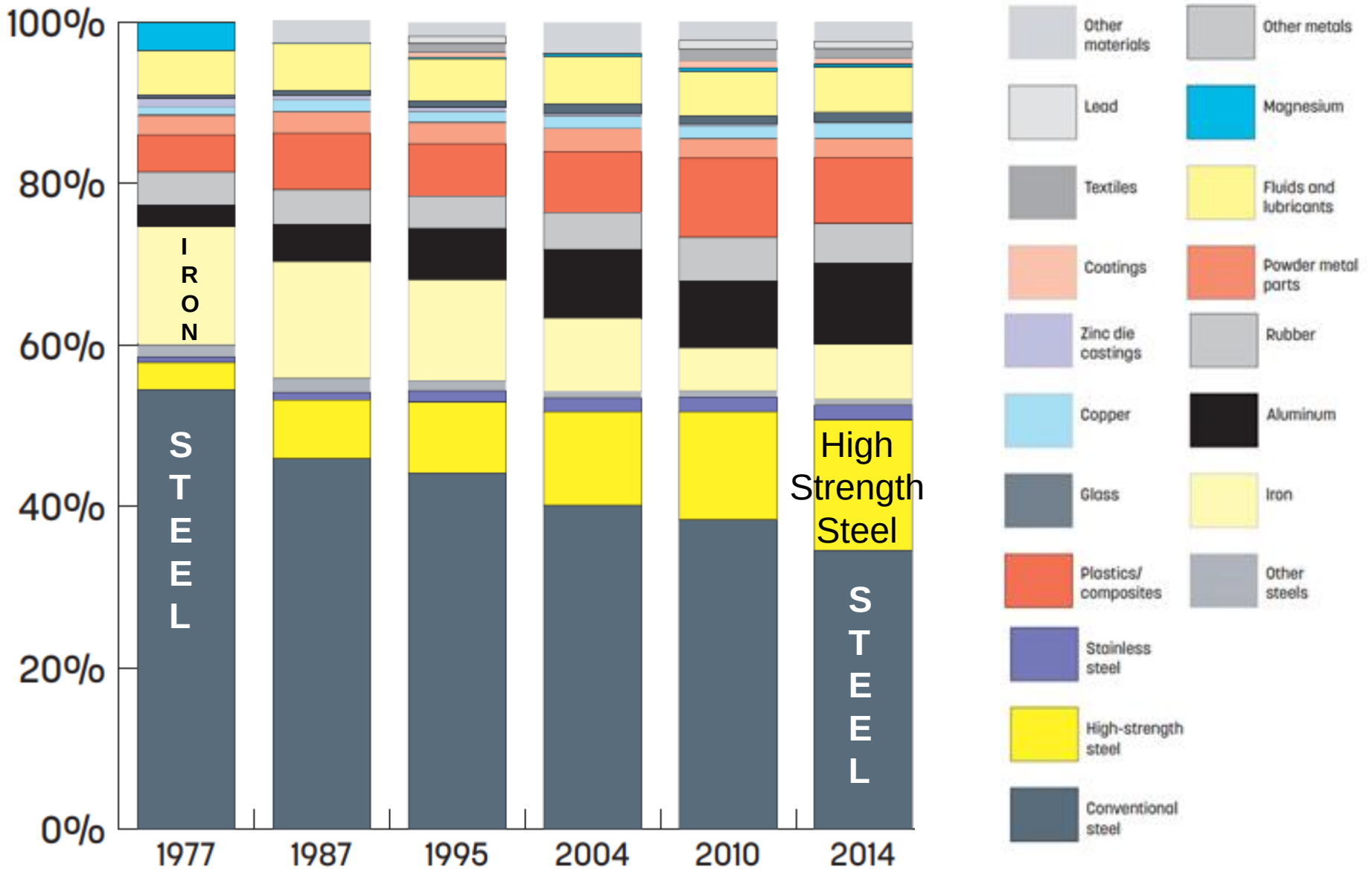
Robust wireless power transfer using a nonlinear parity–time–symmetric circuit

Sid Assawaworrarit, Xiaofang Yu & Shanhui Fan 

NEV industry

- Software (shared, connected, autonomous mobility)
- Hyper-transportation
- New energy
- Wireless charging
- Lightweight materials
- 3D Printing

Materials



Materials

- Carbon fiber instead of steel?



Stanford Solar Car (2018)

Materials

- Ford+Novomer (Boston): make auto parts using durable plastics made from CO₂ (inspired by plants that take in carbon dioxide and create complex sugars)



PRESERVING MOTHER EARTH: FORD FIRST AUTOMAKER TO USE CAPTURED CO₂ TO DEVELOP FOAM AND PLASTIC FOR VEHICLES

May 17, 2016 | DEARBORN, Mich.



NEV industry

- Software (shared, connected, autonomous mobility)
- Hyper-transportation
- New energy
- Wireless charging
- Lightweight materials
- 3D Printing

3-D Printed Cars

- Forcing a simplified design of cars (20-50 parts, not thousands)
- Divergent3D's prototype Blade Supercar
- Local Motors' Strati (first 3-D printed electric car)
- Local Motors' OLLI, a self-driving electric vehicle built with 3-D printing technology and piloted by IBM Watson



3-D Printed Cars

- March 2017: Ford announces testing of large-scale 3-D printing



FORD TESTS LARGE-SCALE 3D PRINTING WITH LIGHT-WEIGHTING
AND PERSONALIZATION IN MIND

Mar 6, 2017 | DEARBORN, Mich.



NEV industry

- Software (shared, connected, autonomous mobility)
- Hyper-transportation
- New energy
- Wireless charging
- Lightweight materials
- 3D Printing

Software (addendum!)

- The automobile as an environment for entertainment and socialization will create a new platform for the delivery of content and media

Software

- A typical application: the Personal Mobility App
 - The concept of the mobility network (car, subway, bus, train, airplane...)
 - Plan the best combination for your trip (car, subway, bus, train, airplane...)

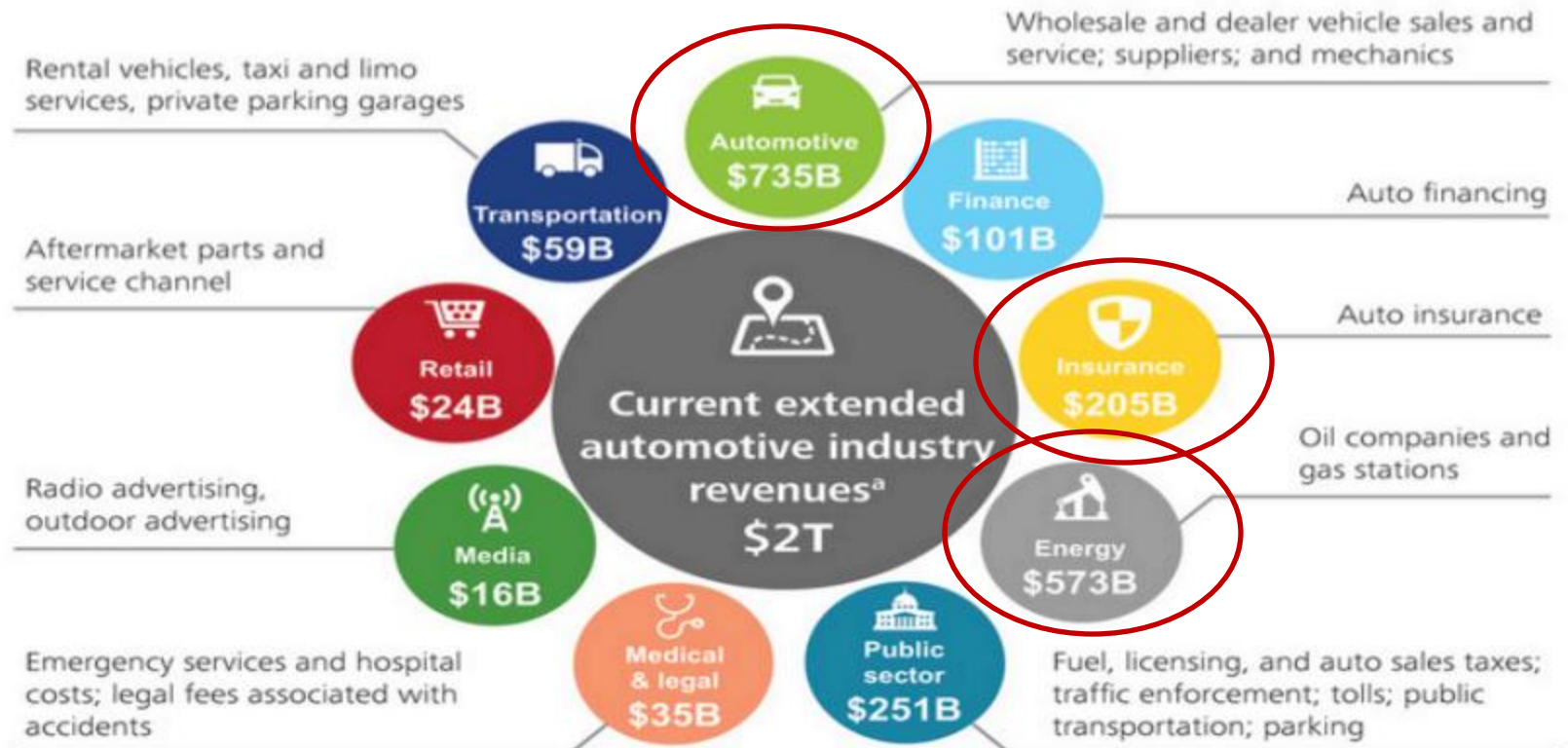


Software

- Auto companies will transition from building and selling vehicles to “apps” such as data analysis, ride-sharing, fleet maintenance, ...
- Passengers will think of the automated vehicle as a multi-purpose environment (socializing, relaxing, work...)
- Consumers will transition from owning to sharing, from capital investment to on-demand rent
- Mobility as a Service

Economics

- Summarizing: disruption at multiple levels



NEV industry in the USA

- Conclusions
 - The USA lags behind China in NEVs
 - Modest investment in flying cars
 - Strong research in new energy
 - Research on lighter materials
 - Shared connected autonomous vehicles are made mostly of software, not steel
 - The car industry will become a software industry
 - 3D-printing may force a simplified design of cars
 - Disruption at multiple levels

2. Smart-city Infrastructure

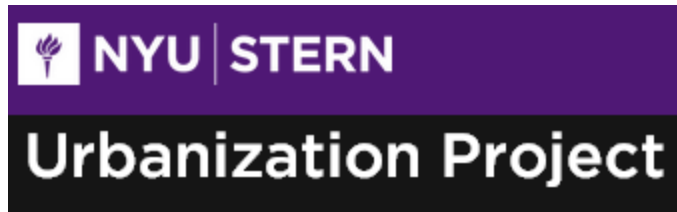
The Infrastructure

- Today's cities are built around the car
- Tomorrow's cities may not need roads and parking lots



Charter Cities

- Build completely new cities
 - Paul Romer’s “charter cities”
 - Y Combinator’s “New Cities”
 - NYU’s Urbanization Project
 - Sidewalk Labs (Google)



Paul Romer at TED2011

The world's first charter city?



New Cities

By Adora Cheung

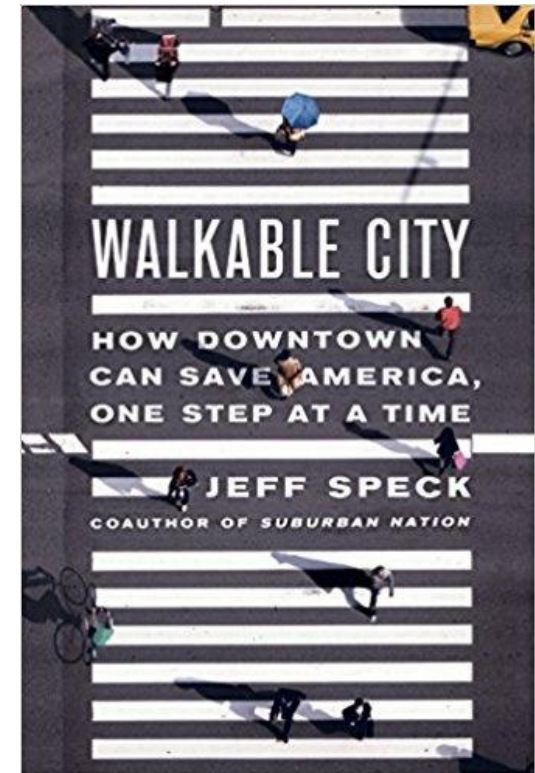


June 27, 2016

We want to study building new, better cities.

City Planning

- City planners increasingly focus on creating environments for humans rather than for cars
- The “walkability” principle: A city is only as livable as it is walkable
- Design for cars is optional



City Planning

- San Francisco
 - Connected and collision avoidance technology
 - Shared, connected, autonomous vehicles
 - Wi-Fi
 - Charging
 - Smart signals
 - Sensors and beacons
 - Fleet operations
 - First-last mile
 - Transit shuttles
 - Open spaces
 - Delivery services
 - Parking management



SFMTA
Municipal
Transportation
Agency

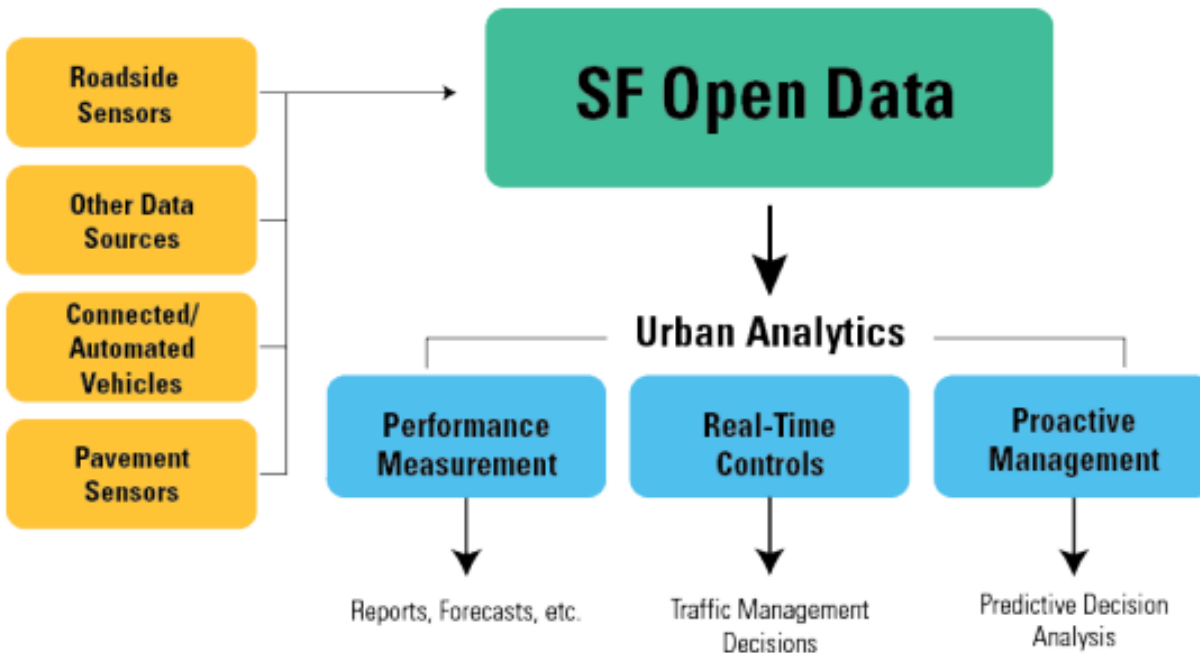
City Planning

- San Francisco
 - Shifting from Ownership to Experience
 - Open Data strategy
 - Civic Innovation Lab (City Innovate)



SFMTA
Municipal
Transportation
Agency

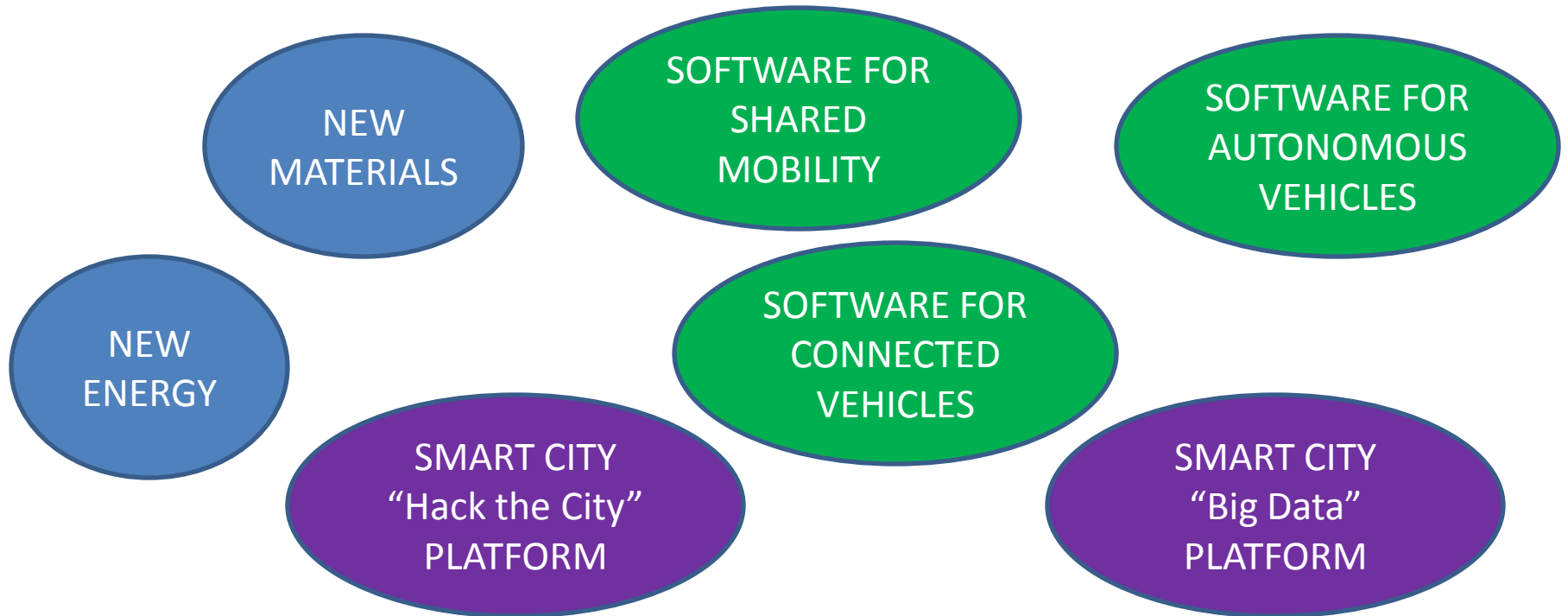
CITY INNOVATE
STR
Startup in Residence



3. Designing the Future

Designing the Future

- Industry Crossover and Technological Convergence
 - Software: shared connected autonomous mobility
 - Materials: new energy and new materials
 - Infrastructure: the “hackable” smart city



Designing the Future

The Future of Mobility = The Future Of Accessibility

- Identify points of interests to monitor for mobility activity (e. g. around train stations, tourist sites, public parks, shopping malls, ...)
- Deploy sensors and beacons
- Collect, organize, analyze data
- Provide data-access dashboards to the public
- Encourage the public to build the “apps” that utilize those contextualized data analytics

Designing the Future

Urban planners should hack: "Hack the City"

- Provide the community with access to city data
- Gather: urban designers, neuroscientists, social scientists, architects, engineers, shop owners, home owners, commuters, tenants, landlords, ...
- Hack: access data, explore ideas, design solutions
- Create collaborations, interest groups, laboratories, startups
- The economy of popular enthusiasm