

2nd November 2018

EV Charging Infrastructure: Present and Future

SIEW 2018 Roundtable: Electric Vehicles & Smart Infrastructure



Confidential

greenlots

Presentation Overview

- How is the global EV market performing?
- E-Mobility Ecosystem
- Powering the Ecosystem
- EV Charging: Present and Future
- Conclusions

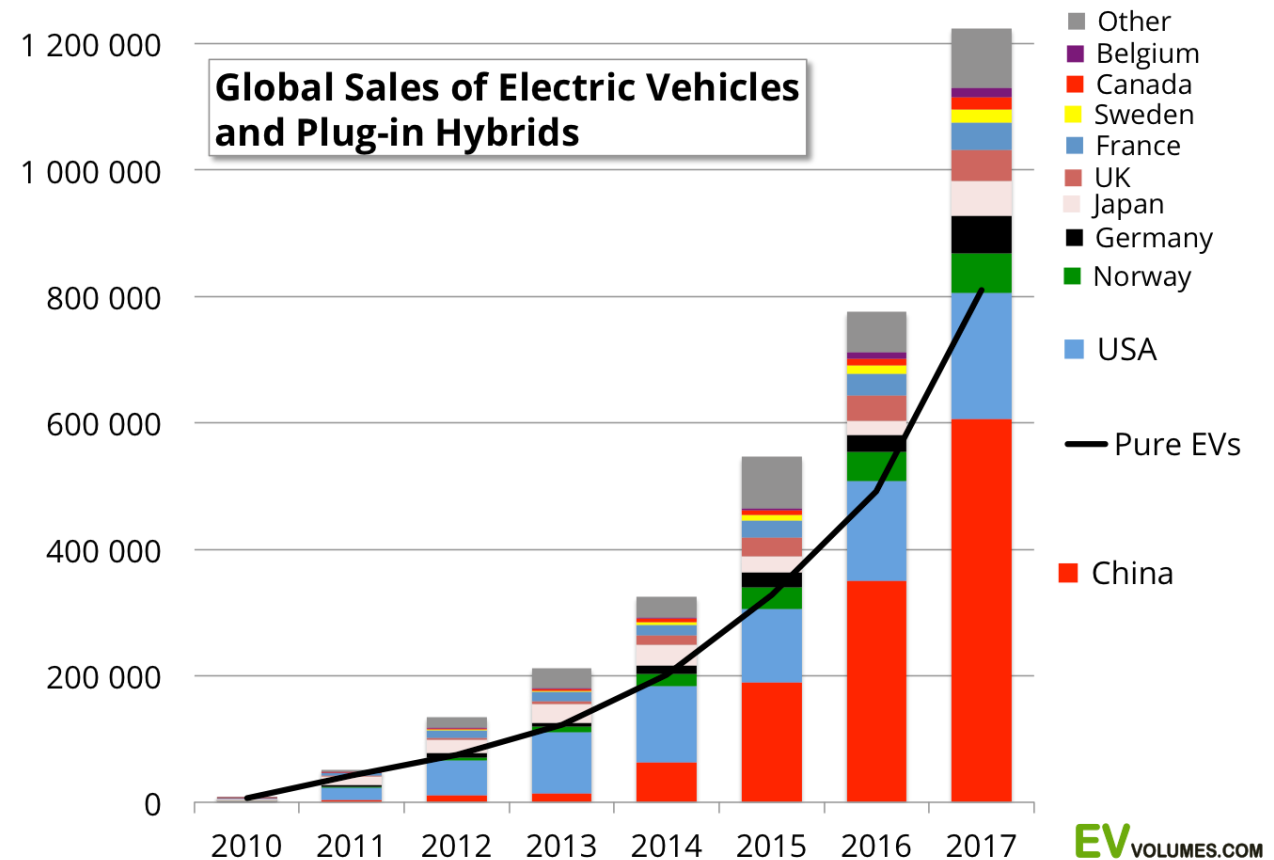
How is the global EV market performing?

Global EV Sales:

- Surpassed 1-million mark in 2017
- Growth mostly unaffected by sustained low oil prices (2014 – 2018)
- 2-million mark expected in 2018

Cumulative EV Population milestones:

- 1st million: 2014-07
- 2nd million: 2016-02
- 3rd million: 2017-11
- 4th million: 2018-09
- 5th million: 2019-03 (estimated)



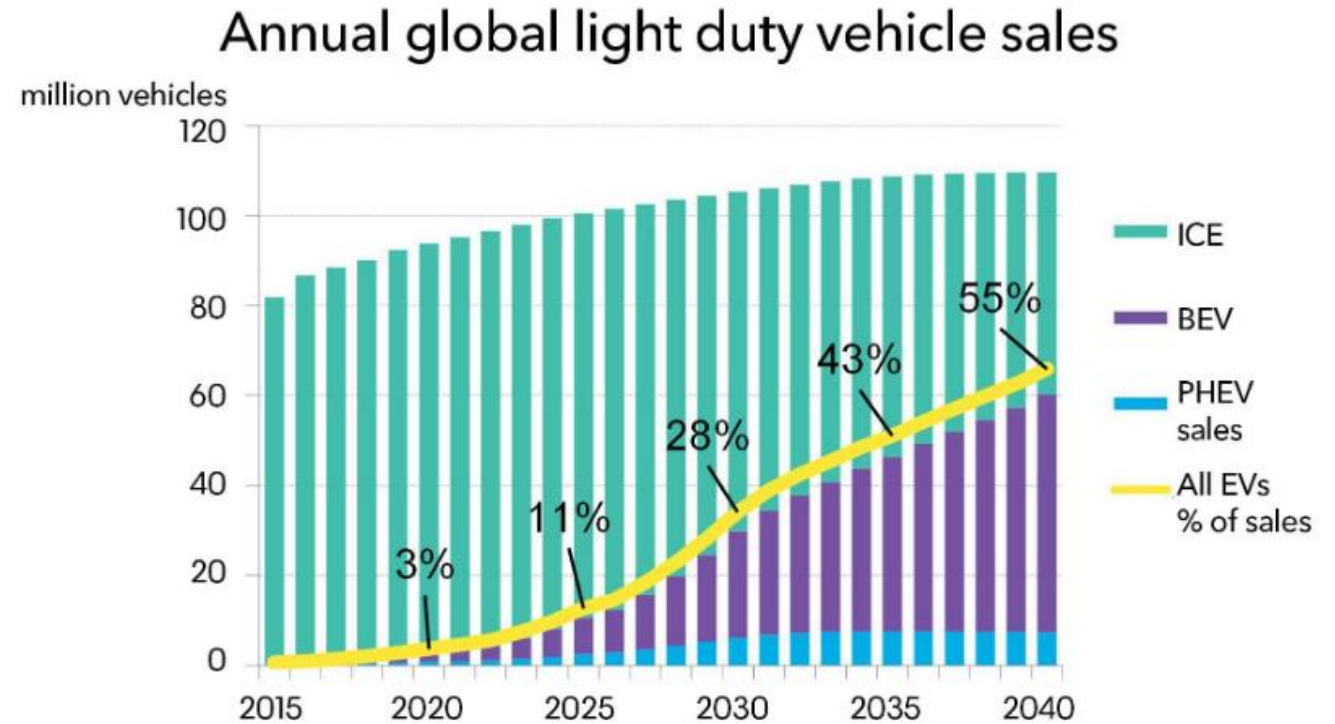
Source: EV-Volumes, Global Sales of Plug-In Electric Vehicles

<http://www.ev-volumes.com/news/global-plug-in-vehicle-sales-for-2017-final-results/>

Putting this in context of global vehicle market...

Electric Mobility:

- Impressive growth, but...
- There are over 80 million passenger vehicles in total
- 4 million EVs is just 5% of global vehicle population
- Only at the beginning of the electric S-curve



Source: Bloomberg New Energy Finance, Global EV Outlook 2018
<https://about.bnef.com/blog/electric-vehicles-accelerate-54-new-car-sales-2040/>

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E-Mobility Ecosystem



Sustaining the Ecosystem:

- Automakers -> EV models
- Building Owners -> Locations
- Hardware OEMs -> EV Chargers
- Utility Companies -> Electricity supply
- EV Owners -> Consumption

Greenlots to coordinate by providing technology solutions for every stakeholder

E-Mobility Ecosystem: SKY™ EV Charging Network



Network Management

- Network-wide monitoring system
- View status of each charging station

Add Price

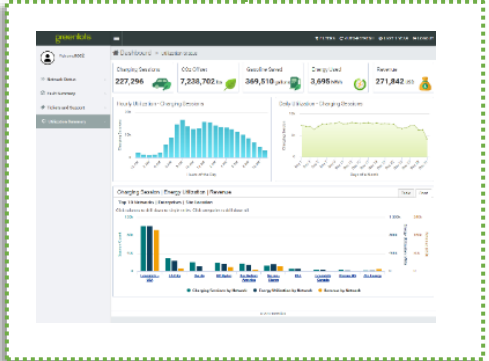
Enterprise: Enterprise02
 Price Group: Standard
 Day of Week: All (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday)
 Time: Full Day (From: 00:00, To: 23:59)
 Price Unit: kWh
 Price Tier: UTD
 Transaction Fee (USD): 0.0

Note: All prices are in USD and rounded to 4 decimal places.

| Level | Power | Price | Price Unit | Price Type | Step |
|-------|--------|--------|------------|------------|--------|
| 0 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 1 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 3 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 4 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 5 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 6 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 7 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 8 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 9 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 10 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 11 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
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| 13 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 14 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 15 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 16 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 17 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 18 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 19 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 20 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
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| 23 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 24 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 25 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 26 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 27 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
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| 29 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 30 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

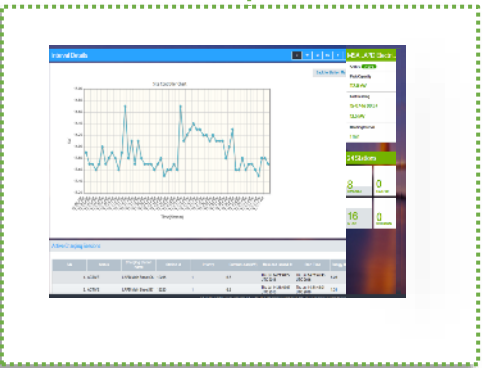
Flexible Retail Pricing

- Set different charging rates
- Dynamic time-of-use rates



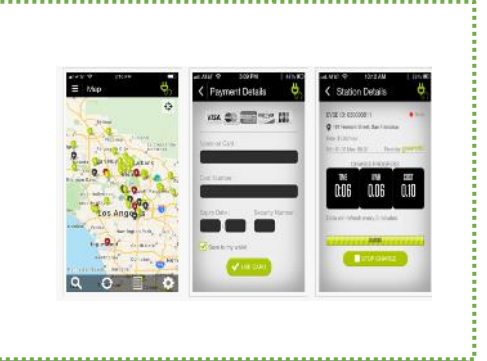
Predictive Analytics

- Analytics and reporting on utilization
- Predict maintenance requirements



Smart EV Charging

- Automatically curtail charging during periods of peak demand



Driver Mobile App

- Easily locate chargers
- Multiple payment options
- Check charging status

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Powering the Ecosystem

Challenges:

- Large consumption of energy by EVs (e.g. BMW i3 battery: 33kWh)
- Unregulated EV charging can destabilize, or even overload the grid distribution network

Opportunities:

- Revenue from EV charging
- Smart charging & Demand response
- Battery storage is a future grid asset!



Powering the Ecosystem: City of Los Angeles, L.A.P.D

Project Overview

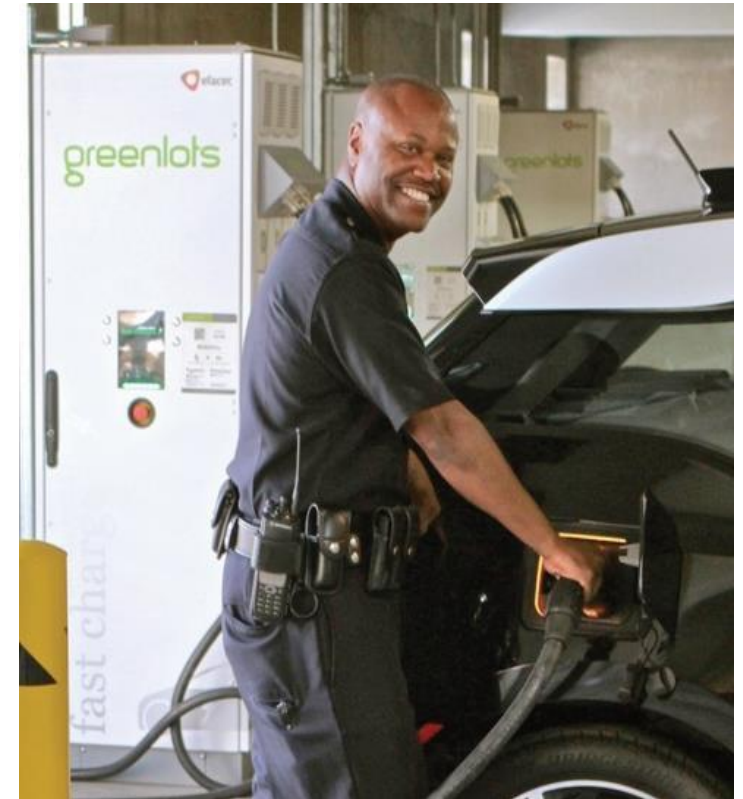
The City of Los Angeles has a target of 50% of new city fleet vehicles to be electric by 2017 and 80% by 2025.

- LAPD is the largest fleet in the city and the first department to “go electric” with the first 150 BMW i3s out of 500 EVs in total
- Building on open standards allows HW to be selected based on specific site requirements
- Greenlots was selected to provide 100 AC and 4 DC Fast Chargers at one location with demand response capabilities

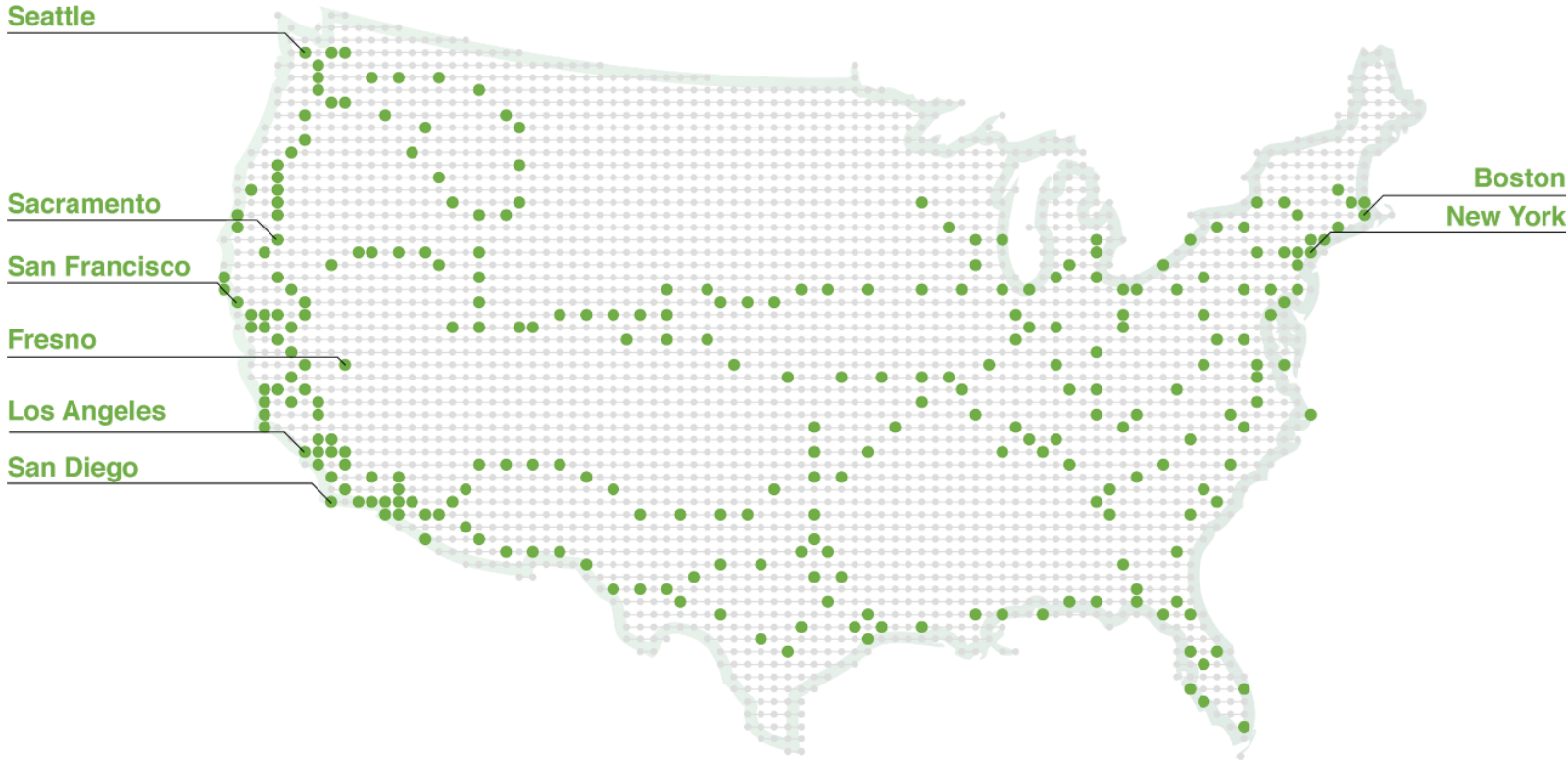
Key Benefits

Load management avoids electrical infrastructure upgrades and reduces demand charges.

- Responds to real-time electricity demand of building
- Charge optimization and prioritization ensures vehicles are charged when they are needed
- Fleet reporting tracks fleet data, operating cost and efficiencies of an all-electric fleet.
- Rolling out charging infrastructure at 25 facilities across city



Powering the Ecosystem: Electrify America



Community-Based Destination Charging

Greenlots selected to deploy **900** stations in eight cities at more than **140** sites



Nationwide Fast Charging Network

Greenlots selected to provide the network operating platform to manage **2000+** high power chargers across the US

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The Four Automotive Megatrends...

A Autonomous

- EV vehicle architecture has a central control unit to facilitate autonomy
- Autonomous charging could add convenience



C Connected

- A connected EV ecosystem could increase the convenience of charging
- Connected car grid solutions could enable cost-effective load balancing



S Shared

- Greater annual driving distances can offer a decisive TCO edge for EVs
- Some consumers may prefer access to multiple vehicle types over ownership (including EVs)



Automotive industry megatrends.



E Electrified

- Tightening emissions efficiency rules make EVs necessary to meet standards
- Lower battery costs improve EV economics

Source: McKinsey & Company, Electrifying Insights (Advanced Industries), January 2017

EV Charging: Present and Future

EVSE trends must also follow EV trends closely...

- Autonomous driving
- Shared vehicles
- Connected
- Bigger Batteries



- Wireless Charging Capabilities
- Shared & Social Charging
- Interoperability between networks
- High Power & Smarter Charging

EV Charging: Present and Future

Present Expectations of EV Charging Networks:

- Must be user-friendly
- Must be easily located & navigated to
- Must operate reliably
- Must be convenient to make payment
- Must be able to charge quickly



EV Charging: Present and Future

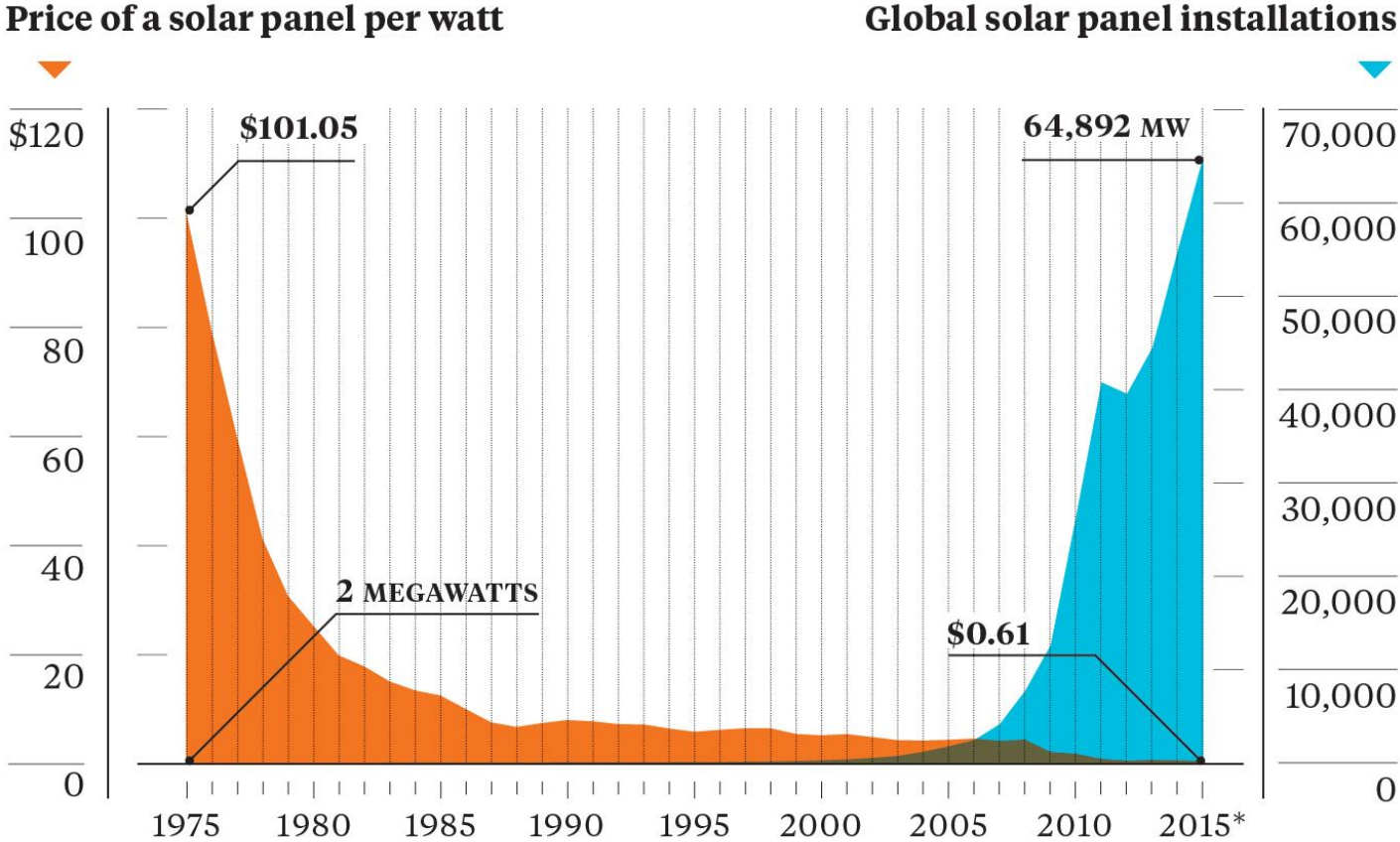
Future Expectations of EV Charging Networks:

- Must be user-friendly
- Must be easily located & navigated to
- Must operate reliably
- Must be convenient to make payment
- Must be able to charge quickly
- Must be grid-friendly
- Must be easily scaled & managed
- Must interoperate across networks
- Must be convenient to save money
- Must charge optimally within building load requirements

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*Estimate. Sources: Bloomberg, Earth Policy Institute, www.earth-policy.org

Conclusions

1. E-mobility will be a huge business for utility & energy companies
2. EV Charging must be future-proofed for emerging EV trends
3. Robust EV Charging Management platforms will be key to scaling EV infrastructure