

# LEGAL STATEMENT

The purpose of the information in this presentation is to guide ICA programs and provide members with information to make independent business decisions.

# ANTITRUST GUIDELINES

## Antitrust Guidelines for Copper Industry Trade Association Meetings

The following guidelines with respect to compliance with antitrust laws of the United States, Japan and European Community<sup>1</sup> are intended to govern the conduct of participants in copper industry trade association meetings, both at the meeting itself and in informal discussions before or after the formal meeting.

**Price:** Competitors should not discuss future prices (including terms of sale) of their products. There is no blanket prohibition against the mention of or reference to current or past prices but limits must be observed. Such references or mentions should occur only when necessary in connection with the development of association programs. For example, reference to a particular price level in comparing the cost of a copper product to a competing product is permitted. Whenever possible, such references should be discussed in advance with legal counsel.

**Competitive Information:** Competitors should not discuss the market share of a particular copper producer or copper fabricator's products. Furthermore, nothing should be said at a meeting which could be interpreted as suggesting prearranged market shares for such products or producer production levels. The overall market share of copper products may be discussed with regard to competition with non-copper products and general market acceptance.

**New Products:** Competitors should not encourage or discourage the introduction of a new product by another competitor or reveal a particular copper company's plans to change the production rate of an existing product or to introduce a new product. No company should disclose to another company whether it is in a position to make or market a new product. New products may be discussed in a technical manner or from the standpoints of competition with non-copper products and general market acceptance. In addition, proposed methods for and results of field and laboratory testing can be considered.

**The Role of Legal Counsel:** Legal counsel attends association meetings to advise association staff and other meeting attendees regarding the antitrust laws and to see that none of the matters discussed or materials distributed raise even the appearance of antitrust improprieties. During the course of a meeting, if counsel believes that the discussion is turning to a sensitive or inappropriate subject, counsel will express that belief and request that the attendees return the discussion to a less sensitive area.

A paper entitled 'Copper Industry Trade Associations and Antitrust Laws' is available upon request.

10/92, 5/93, 10/10

1. Other foreign competition laws apply to International Copper Association, Ltd. (ICA)'s activities worldwide.



# THE EV CHARGING INFRASTRUCTURE MARKET

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CONFERENCE 2018

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# PEVS AND CHARGING: THE BIG PICTURE

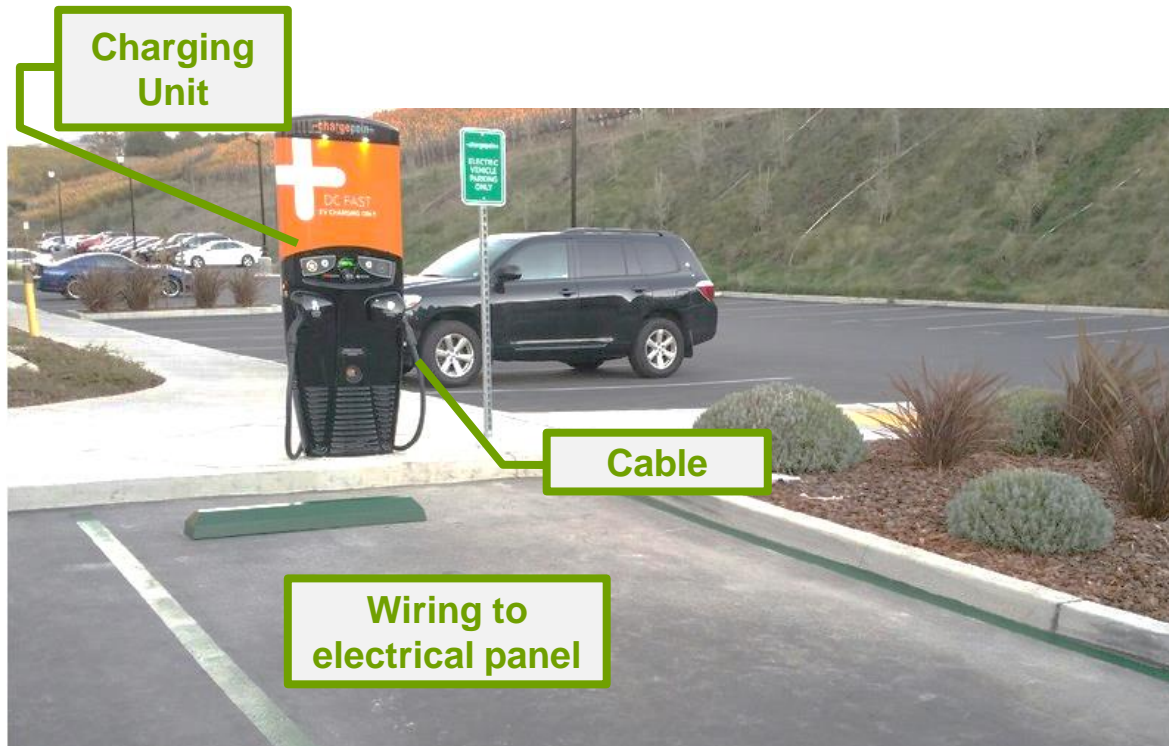
- Though 1%-2% of global sales today, plug-in electric vehicles (PEVs) are positioned to become **the leading global road transportation technology by 2050**
- This is due to a combination of policies pushing automakers to develop PEVs that will sell and improvements in battery technologies that are **making PEVs more attractive to consumers**
- Charging infrastructure today is being funded by utilities, automakers, and governments to fill a gap in the market
- **Power ratings for EV chargers are rising** as PEV range increases
- **New mobility concepts**—driverless cars, ride-hail apps like Uber, carshare services—will further drive PEV demand and change infrastructure needs from the mid-2020s on



*(Source: Edison Electric Institute)*

# ANALYZING COPPER DEMAND FROM FOUR ELEMENTS OF NEW EV CHARGING INFRASTRUCTURE

For this presentation three of the four elements have been assessed for tonnage demand. Plug in vehicles (PEVs) on world roads drive demand for charging infrastructure, in turn driving **new demand for copper**



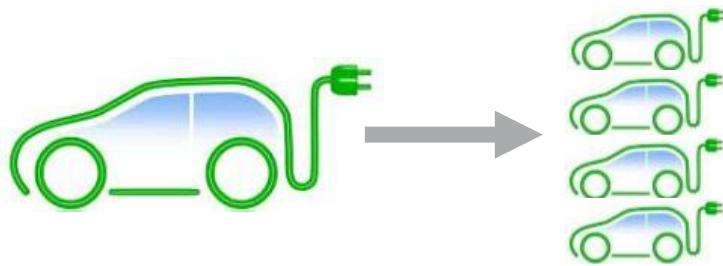
New electricity generation

(Source: ChargePoint)

# EV CHARGING GROWTH TO DATE

## VEHICLES

2010-2017



- Total PEVs reached almost **3 million** globally as of the end of 2017

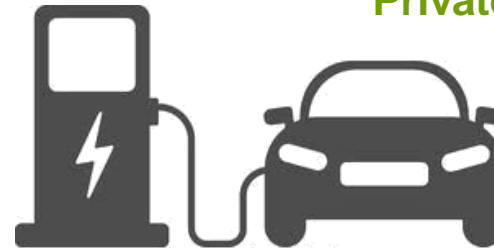
## CHARGING

Residential

Public

Private

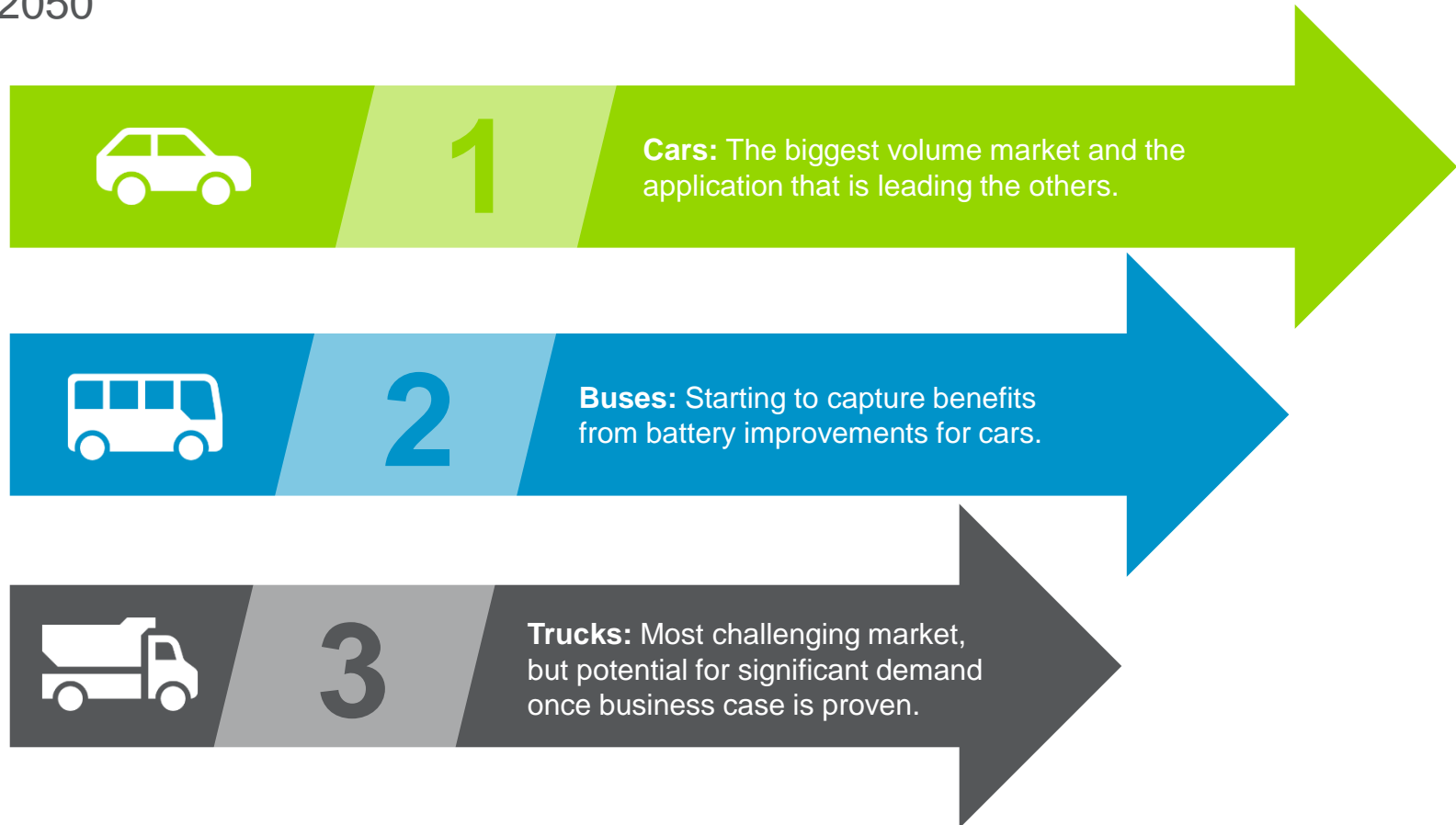
Fleet



- Navigant estimates total chargers installed reached **1.6 million** as of the end of 2017

# WHAT IS THE FUTURE POTENTIAL OF PEVS?

- PEVs are positioned to become the leading global road transportation technology by 2050

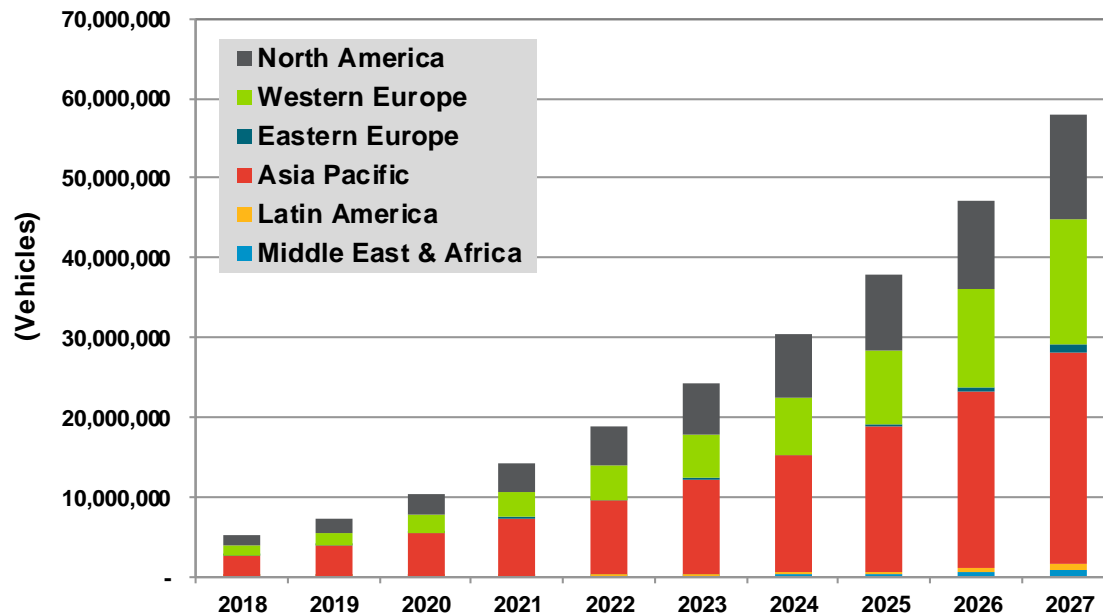




# RISING PEV POPULATION → RISING CHARGING DEMAND

- In Navigant's baseline 10-year forecast, **total global PEV population** rises from 3 million in 2017 to **58 million by 2027**
- Leading regions are Asia Pacific, North America, and Western Europe, which is where most new copper demand from infrastructure will be through 2027

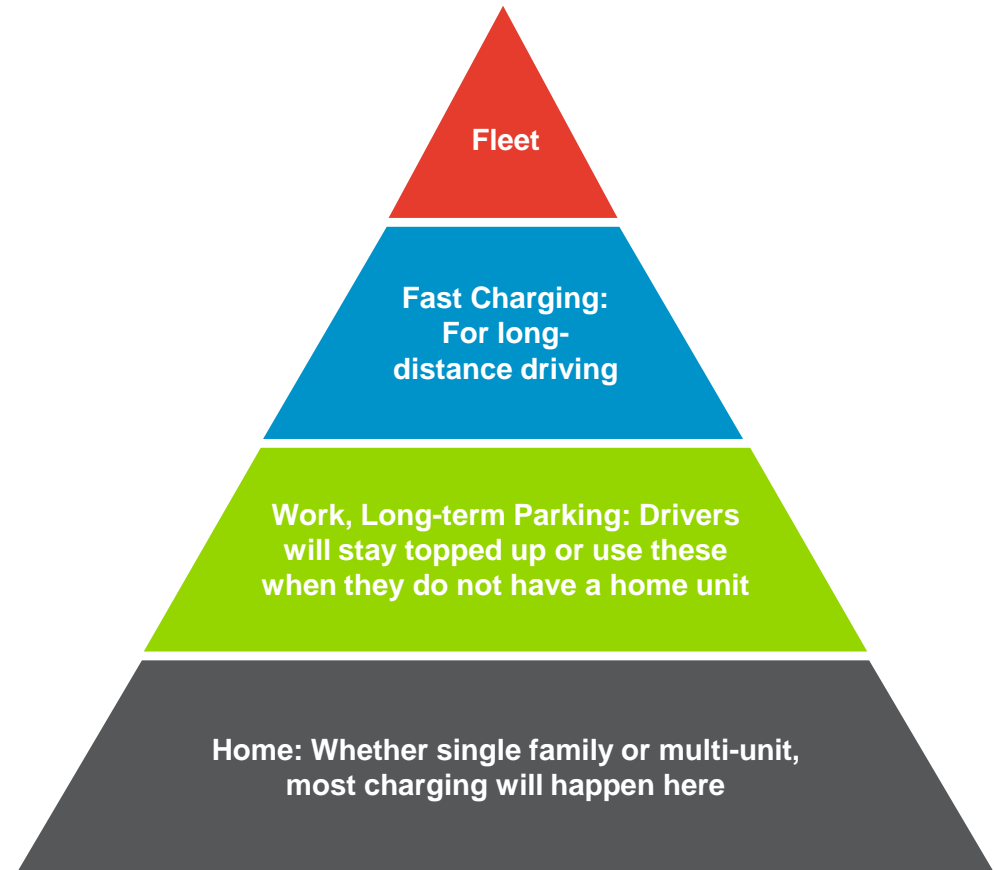
PEV Population by Region, World Markets: 2017-2026



Source: Navigant Research

# WHERE WILL CHARGING OCCUR?

- PEVs shift the fueling dynamic away from centralized retail to “charge where I am”
- Most drivers will want to charge at home
- After home, drivers will charge where they park for 2 or more hours
- Areas without home charging access will rely long-term public parking opportunities
- Drivers will need highway fast charging to drive long distances



# POWER LEVEL DETERMINED BY COST VERSUS TIME

## Level 1

- Least expensive option, no electrical upgrade required
- Can charge up to 1.9 kW
- Widespread today for home use and some deployment in low cost long-term parking settings (workplace, airports)
- Will lose to higher power Level 2 chargers over time as PEV battery size increases

## Level 2

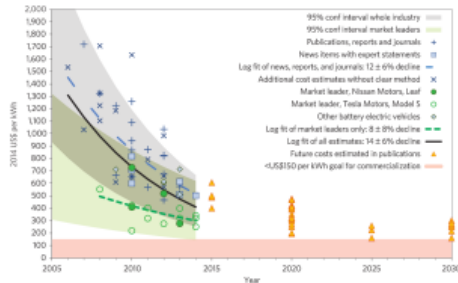
- More costly than Level 1 but is the most widely deployed option for commercial applications
- Typically charges from 3.3 kW-7.2 kW, may go to 22 kW
- Also used for home charging where more power is wanted and cost is not a concern
- Increasing power to meet the needs of larger battery EVs

## DC

- Significantly higher cost for charger, installation, and energy use
- Today, most often 50 kW, some at 20 kW-25 kW
- Used in public charging where speed offers value; also used for buses and trucks
- Market moving strongly toward 100 kW minimum and potentially much higher

# TRENDS AFFECTING CHARGING POWER LEVELS AND OVERALL DEMAND

Battery cost declines and fuel efficiency regulations give cost advantages to EVs



New ultrafast options coming → power considerations

100 kW  
350 kW



**Longer Range**  
**Vehicle Automation**

**Higher Power Infrastructure**  
**Grid Impacts**



Likely to eventually upend vehicle ownership model and infrastructure needs

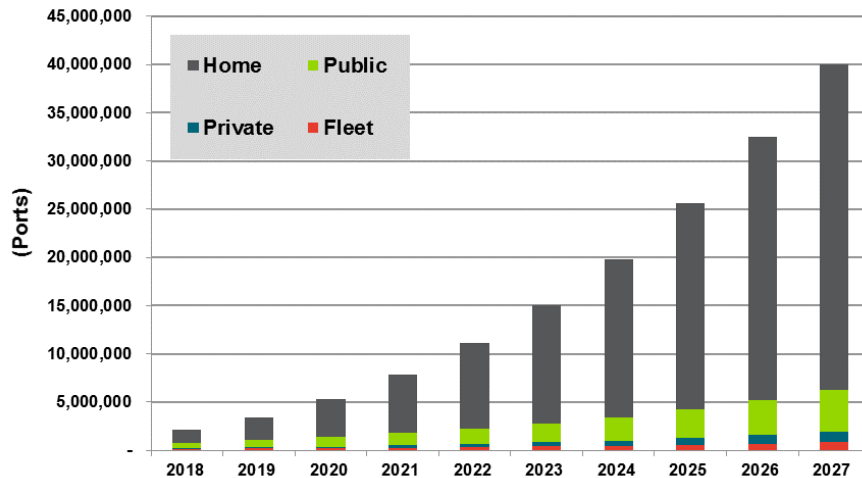


Utilities will want to manage grid impacts, leading to more power sharing charging options

# EV CHARGING INSTALL BASE TO GROW CONSIDERABLY

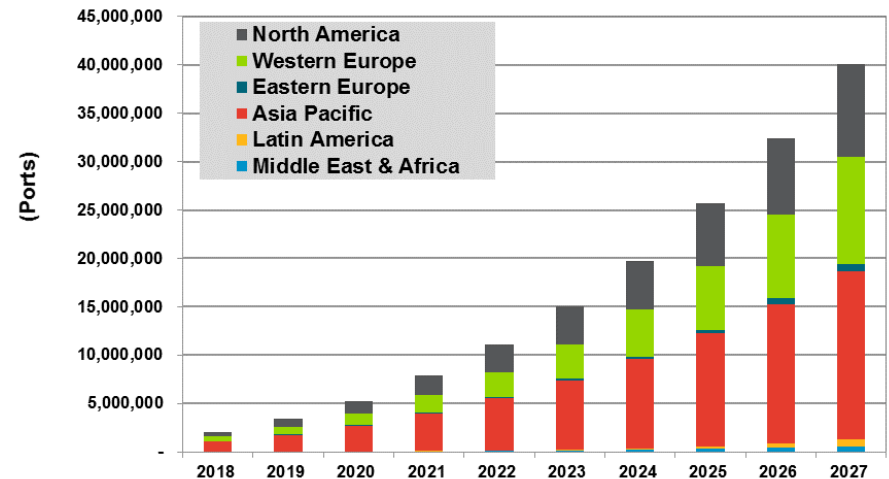
- Navigant Research forecasts that the growing PEV population will drive demand for over **40 million charging ports by 2027**
- Infrastructure will be clustered in Asia Pacific, North America, and Western Europe

Installed Charging Ports by End Use, World Markets: 2018-2027



Source: Navigant Research

Installed Charging Ports by Region, World Markets: 2018-2027

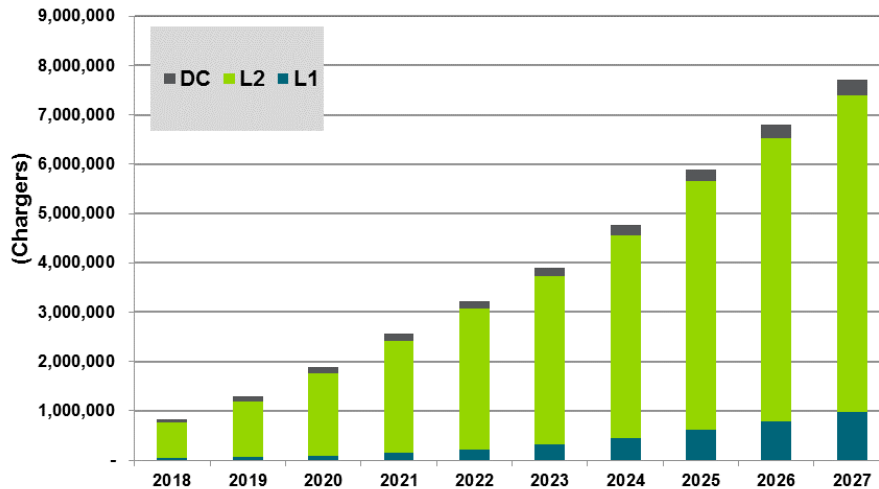


Source: Navigant Research

# ANNUAL NEW EV CHARGING ASSETS BY POWER LEVEL

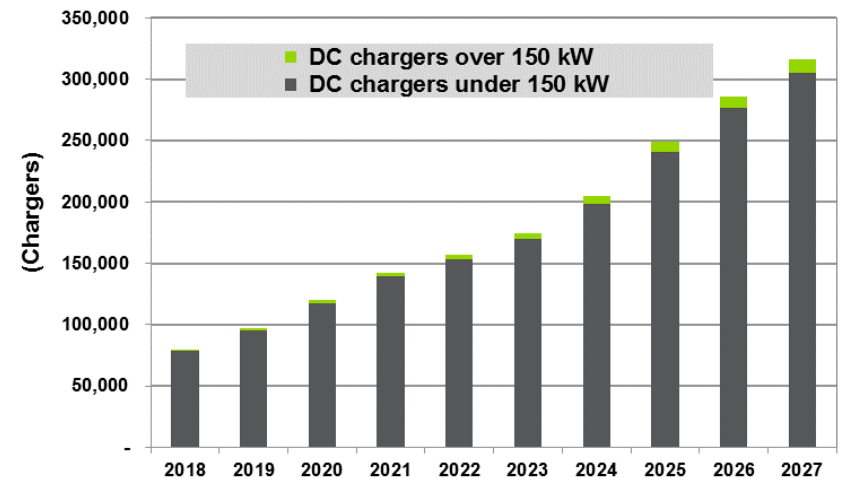
- Most new EV charging assets each year will be **Level 2**
- DC fast chargers will reach over 300,000 in annual sales by 2027, with **most under 150 kW**; higher power charger sale will rise thanks to longer range EVs and greater deployment of buses and trucks

Annual Charger Sales by Power Level, World Markets: 2018-2027



Source: Navigant Research

Annual DC Charger Sales by Power Level, World Markets: 2018-2027



Source: Navigant Research

# COPPER IN FOUR INFRASTRUCTURE ELEMENTS

## CHARGING UNIT

- Minimal amount of copper used
- Driver in the charging unit is toward reduced copper content, to lower costs, given price sensitivity of charging market
- Each manufacturer varies but typical use is around 3 feet of wires and the trend will be toward this level of use

## CHARGING CABLE

- Main source of copper in the charging unit
- Three wires for power, one for communications
- Standardized across EVSE units
- Charging cable length varies, but standard is 25 feet
- Short cables are offered as a cost reduction mechanism, but typically cables no less than 18 feet

## WIRING TO ELECTRICAL PANEL

- Largest source of new copper demand directly related to infrastructure installations
- Varies by the end use
- Home chargers will have little to none, whereas any chargers in public spaces or covering large parking areas will have hundreds of feet

## NEW ELECTRICITY GENERATION

- EVs will drive thousands of gigawatts of demand in just 2018, with significant increases through 2027
- How much new generation this drives is less clear, as utilities will look to load shift and utilize excess capacity, and as charging site hosts will try to minimize power demand

# TYPICAL WIRING USED IN EV CHARGING EQUIPMENT

CHARGER TYPE AND POWER	CONNECTOR (25 feet)	EV CHARGING UNIT (3 feet)
Level 1 1.5 kW	<ul style="list-style-type: none"> <li>• 3 #16 AWG or 1.5</li> <li>• 1 #18 AWG</li> </ul>	<ul style="list-style-type: none"> <li>• 16 AWG</li> </ul>
Level 2 3.3 kW	<ul style="list-style-type: none"> <li>• 3 #14 AWG or 2.5</li> <li>• 1 #18 AWG</li> </ul>	<ul style="list-style-type: none"> <li>• 14 AWG</li> </ul>
Level 2 6.6 kW	<ul style="list-style-type: none"> <li>• 3 #12 AWG or 6.0</li> <li>• 1 #18 AWG</li> </ul>	<ul style="list-style-type: none"> <li>• 12 AWG</li> </ul>
Three phase 22 kW	<ul style="list-style-type: none"> <li>• 5 x 6.0</li> <li>• 1 #18 AWG</li> </ul>	<ul style="list-style-type: none"> <li>• 6 AWG</li> </ul>
DC Charger 50 kW	<ul style="list-style-type: none"> <li>• 3 #2 AWG</li> <li>• 5 #18 AWG</li> <li>• 4 #18 AWG</li> </ul>	<ul style="list-style-type: none"> <li>• Varies</li> </ul>

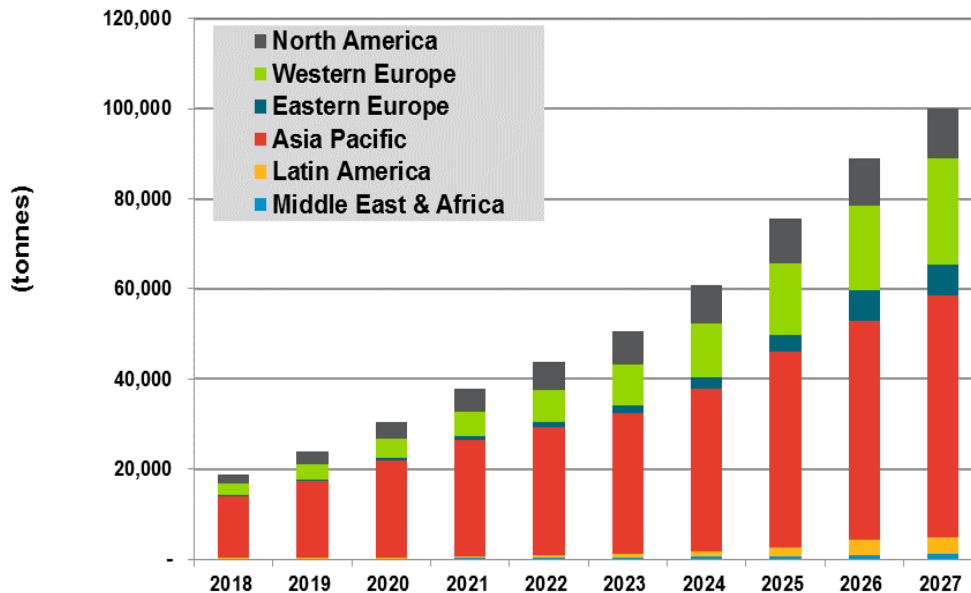
(Source: Navigant Research)



# NEW COPPER DEMAND

- Using Navigant's forecasts for EV charging sales annually (based on our PEV forecasts) and estimates for copper content in EV charging equipment provided by industry players, Navigant estimates that annual sales of EV charging equipment only will drive demand for 20,000 tonnes of copper in 2018, rising to over 100,000 tonnes by 2027. Additional demand from e.g. new electricity generation will be added in the final report.

**Annual New Copper from EV Infrastructure Installation by Region, World Markets: 2018-2027**

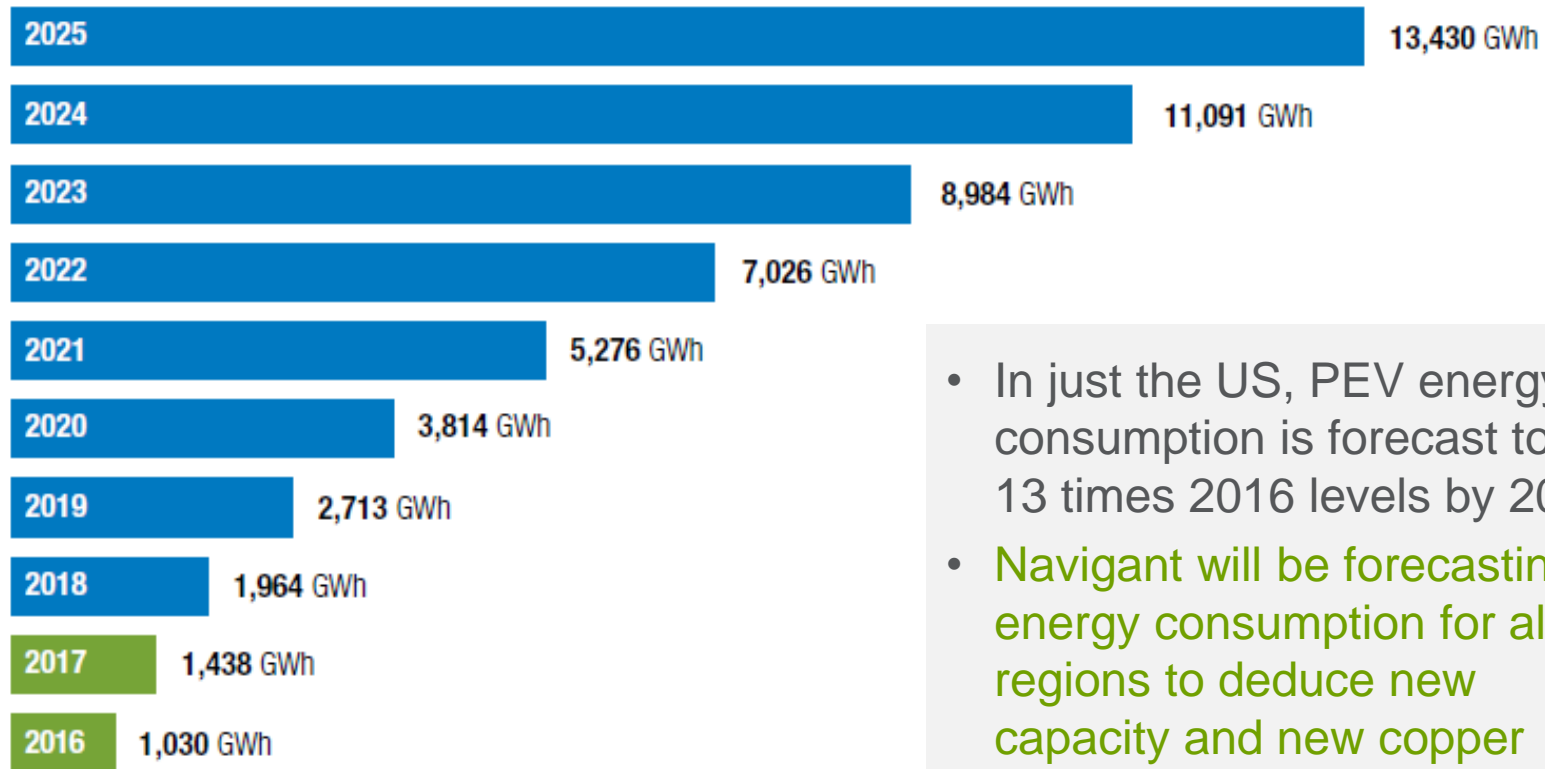


Source: Navigant Research

- The amount of copper from the charging units is modest compared to wiring installed to connect chargers to electrical panels.
- Navigant's initial analysis suggests this will drive 4-9 times as much copper depending on the placement of the chargers (e.g., outdoor parking lots vs workplaces)

# ELECTRICITY CONSUMPTION FROM PEVS WILL DRIVE NEW GENERATION

## PEV Electricity Consumption, US: 2016-2025

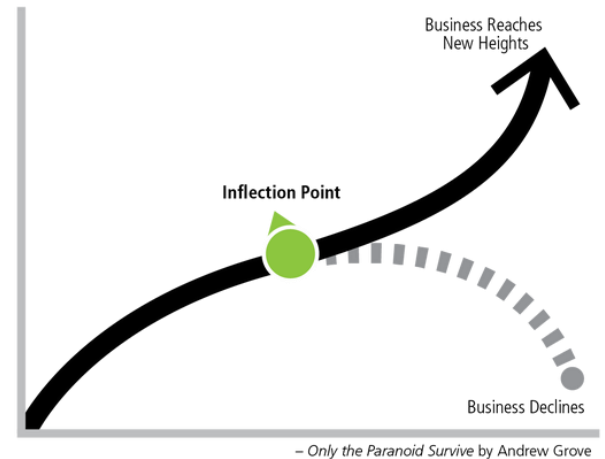


Source: Navigant Research

- In just the US, PEV energy consumption is forecast to be 13 times 2016 levels by 2025
- Navigant will be forecasting energy consumption for all regions to deduce new capacity and new copper demand

# WHAT COULD DISRUPT THESE PROJECTIONS?

- **Vehicle availability** and **consumer education** are key levers for increasing EV sales
  - If carmakers do not introduce vehicles on time or if there are issues with production or performance, the market will slow down
  - Consumers still need to be educated on what PEVs are and what they can do
- **Charging infrastructure** (fast charging network, workplace, multifamily) enables the market but is still confusing for drivers and unproven as a business
  - If charging does not keep pace with where real demand is or is not reliable and maintained, the market could face a setback
- **Government regulations** are still a key driver until PEVs reach cost parity
  - If US regulations are lessened, automakers may slow introduction of PEVs in the US market, but Europe and China are likely to continue apace



# KEY TAKEAWAYS



For equipment only copper demand will rise to over 100,000 tonnes by 2027.



More (and longer-range) PEV models are entering the market, driving demand to rise significantly.



PEVs will drive the need for chargers at all power levels for homes, garages, offices, and long-distance highway driving.



Over time, EV charging will rise in average power ratings to serve the longer-range PEVs and the deployment of electric trucks and buses.



New copper demand will come from the charging cables and the wiring to connect chargers to the electrical panels. While there are overall drivers to reduce costs of charging, this demand is likely to be relatively stable.

EVs will drive new electricity demand, but there will be increasing focus on managing new demand.



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