TESCO METERING

Electric Vehicle Chargers: An Exploding Energy Market

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What is it all about and why should I care?

Topic Summary

- Overview of Electric Vehicles (EV's) in 2025
  - Who is in the market?
  - Who dominates the market?
  - How many EV's are on the road?
  - Where is the market going?
- Types of Electric Vehicle Supply Equipment (EVSE's or chargers)
- Electric Vehicle Charging Networks
- Regulatory environment
- Business Segment – revenue opportunities and expectations

Overview of Electric Vehicles in 2026

WHO IS IN THE EV MARKET?

Anyone who is not will be in the near future. The following automobile manufacturers have an Electric Vehicle offering in 2025:

- Audi
- BMW
- Chevrolet
- Coda
- Fiat
- Porsche

- Ford
- Honda
- Hyundai
- Kia
- Jaguar
- Lucid

- Mercedes
- Mitsubishi
- Mini
- Nissan
- Polestar

- Rivian
- Smart Car
- Tesla
- Toyota
- VW
- Volvo
- Fisker

Who are the Market drivers?

(Q2)2026

TESLA: 46.2%

GM: 14.9%

FORD: 5.3%

(HTTPS://CAREDGE.COM/GUIDES/ELECTRIC-VEHICLE-MARKET-SHARE-AND-SALES)

The EV Market

- Affordable EVs on the horizon: Model Q, Slate, Ford, etc.
- Robotaxi Revolution e.g. WAYMO, Tesla
- Battery Innovations: GM developing low-cost LFP and lithium manganese-rich cells, 2027
- Domestic Battery Plants (Tesla, Ford, etc)

THE EV MARKET

There are more than 300 EV models in production worldwide.[1]

(BEVs, PHEVs)









1: List of battery electric vehicles - Wikipedia

How many EV's are on the road in the US?

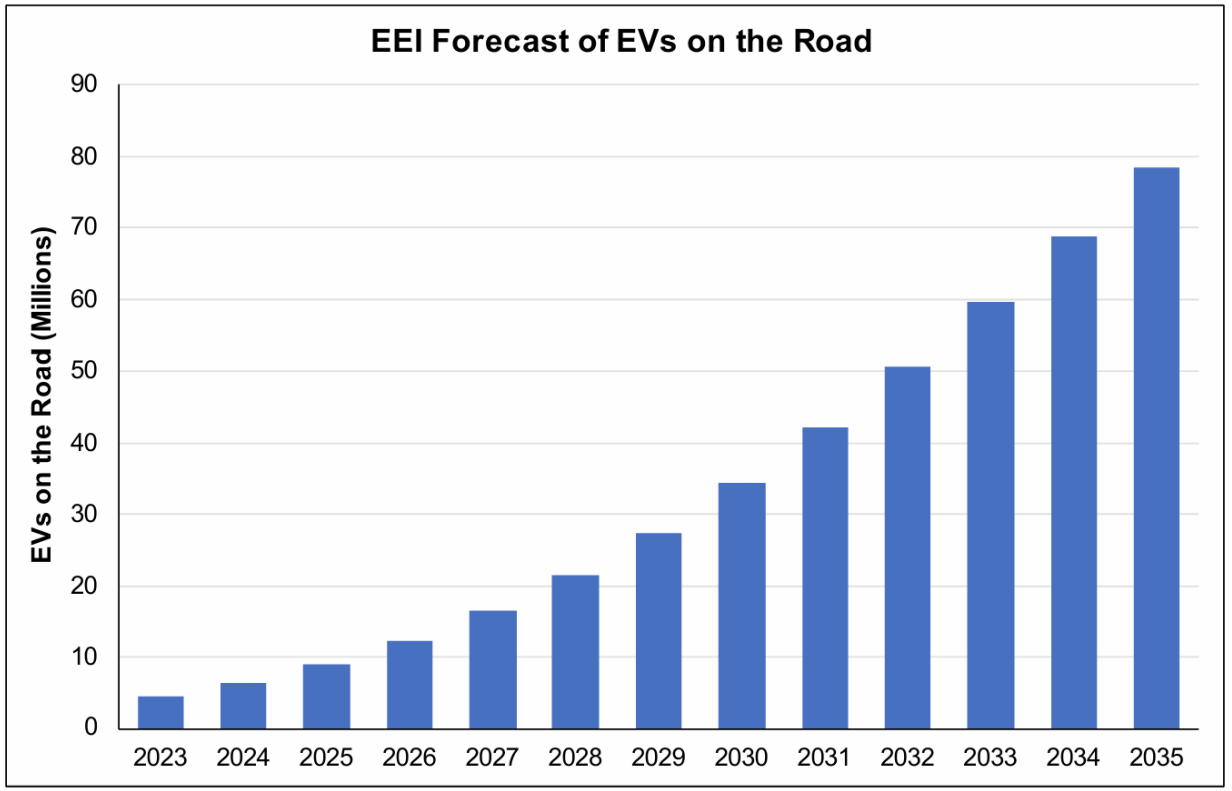
- As of December 31, 2024 there were **6.2 million** Electric Vehicles operating in the US[1]
- By the end of 2025 there are **10.4 million** forecast to be on the road in the US[2]

1: Get Connected EV Quarterly Report 2025 Q1.pdf

2: 85 million EVs will be on the road by the end of 2025 • The Register

Where is the Market Going? Upwards – in a big way

Figure 1. EEI Forecast of EV Stock: 78.5 Million EVs on U.S. Roads in 2035



Electric Vehicle Sales and the Charging Infrastructure Required Through 2035

THE US EV MARKET

ELECTRIC VEHICLE (BRAND)								
	Q2 Sales			YTD Sales			Segment Share	
	2025	2024	YOY	2025	2024	YOY	Q2	YTD
Acura	5,522	338	-	10,335	338	-	1.8%	1.7%
Audi	5,654	5,407	4.6%	11,559	11,121	3.9%	1.8%	1.9%
BMW	11,094	14,081	-21.2%	24,632	24,793	-0.6%	3.6%	4.1%
Cadillac	11,795	7,294	61.7%	19,767	13,094	51.0%	3.8%	3.3%
Chevrolet	28,453	11,707	143.0%	47,639	20,664	130.5%	9.2%	7.8%
Dodge	2,352	-	-	4,299	-	-	0.8%	0.7%
Ford	16,438	23,957	-31.4%	38,988	44,180	-11.8%	5.3%	6.4%
Genesis	954	2,249	-57.6%	2,450	3,241	-24.4%	0.3%	0.4%
GMC	6,032	2,929	105.9%	10,760	4,597	134.1%	1.9%	1.8%
Honda	6,756	1,535	340.1%	16,317	1,535	-	2.2%	2.7%
Hyundai	15,564	16,858	-7.7%	28,407	29,076	-2.3%	5.0%	4.7%
Jeep	3,668	-	-	6,263	-	-	1.2%	1.0%
Kia	4,975	18,107	-72.5%	13,631	29,508	-53.8%	1.6%	2.2%
Lexus	2,325	4,036	-42.4%	3,778	5,639	-33.0%	0.7%	0.6%
Lucid	2,635	2,394	10.1%	5,164	4,361	18.4%	0.8%	0.9%
Mercedes	4,611	9,640	-52.2%	8,083	17,976	-55.0%	1.5%	1.3%
Nissan	9,073	7,128	27.3%	15,544	12,412	25.2%	2.9%	2.6%
Porsche	2,833	807	251.1%	7,191	2,054	250.1%	0.9%	1.2%
Rivian	10,599	13,653	-22.4%	19,152	27,241	-29.7%	3.4%	3.2%
Subaru	3,370	4,238	-20.5%	6,501	5,385	20.7%	1.1%	1.1%
Tesla	143,535	164,264	-12.6%	271,635	304,451	-10.8%	46.2%	44.7%
Toyota	3,639	7,571	-51.9%	9,249	9,468	-2.3%	1.2%	1.5%
Volvo	2,898	1,081	168.1%	5,639	2,077	171.5%	0.9%	0.9%
VW	2,556	5,690	-55.1%	12,120	11,857	2.2%	0.8%	2.0%
Additional EV Brands	3,508	6,889	-49.1%	7,986	12,766	-37.4%	1.3%	1.3%
Total (Estimates)	310,839	331,853	-6.3%	607,082	597,834	1.5%	100.0%	100.0%

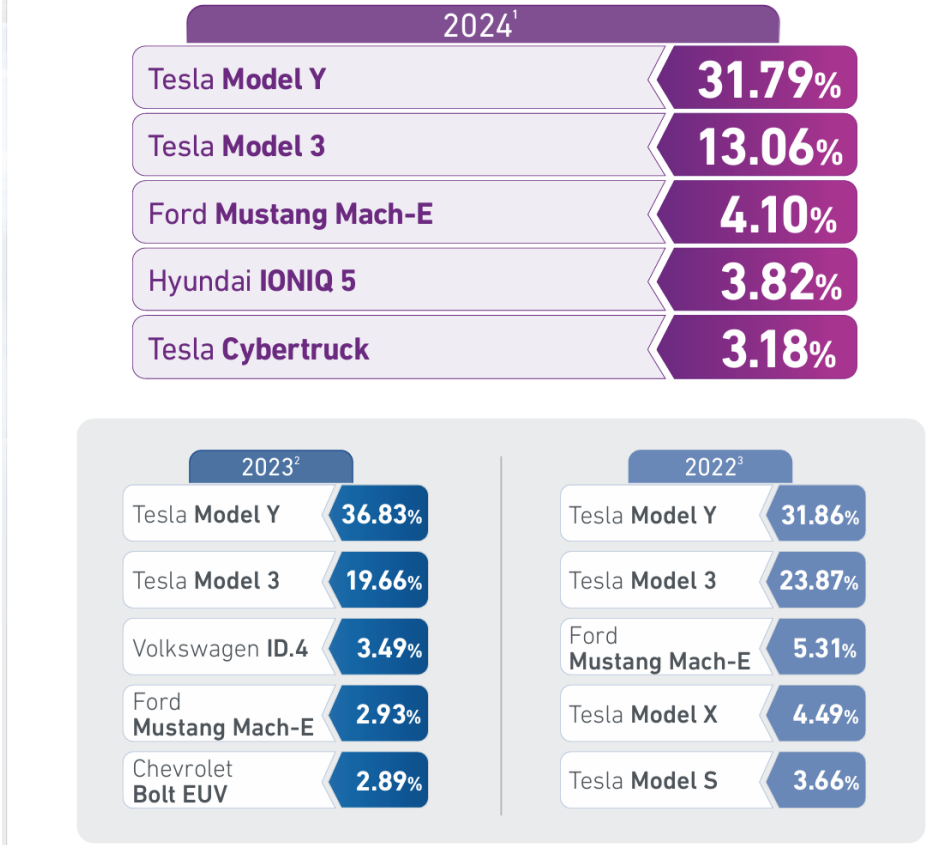
Toyota	73	1,054	-93.1%	245	1,722	-85.8%		
Hyundai	26	40	-35.0%	77	105	-26.7%		
Total EV & FCEV (Estimates)	310,938	332,947	-6.6%	607,411	599,661	1.3%		

Q2-2025-Kelley-Blue-Book-EV-Sales-Report.pdf

THE EV MARKET

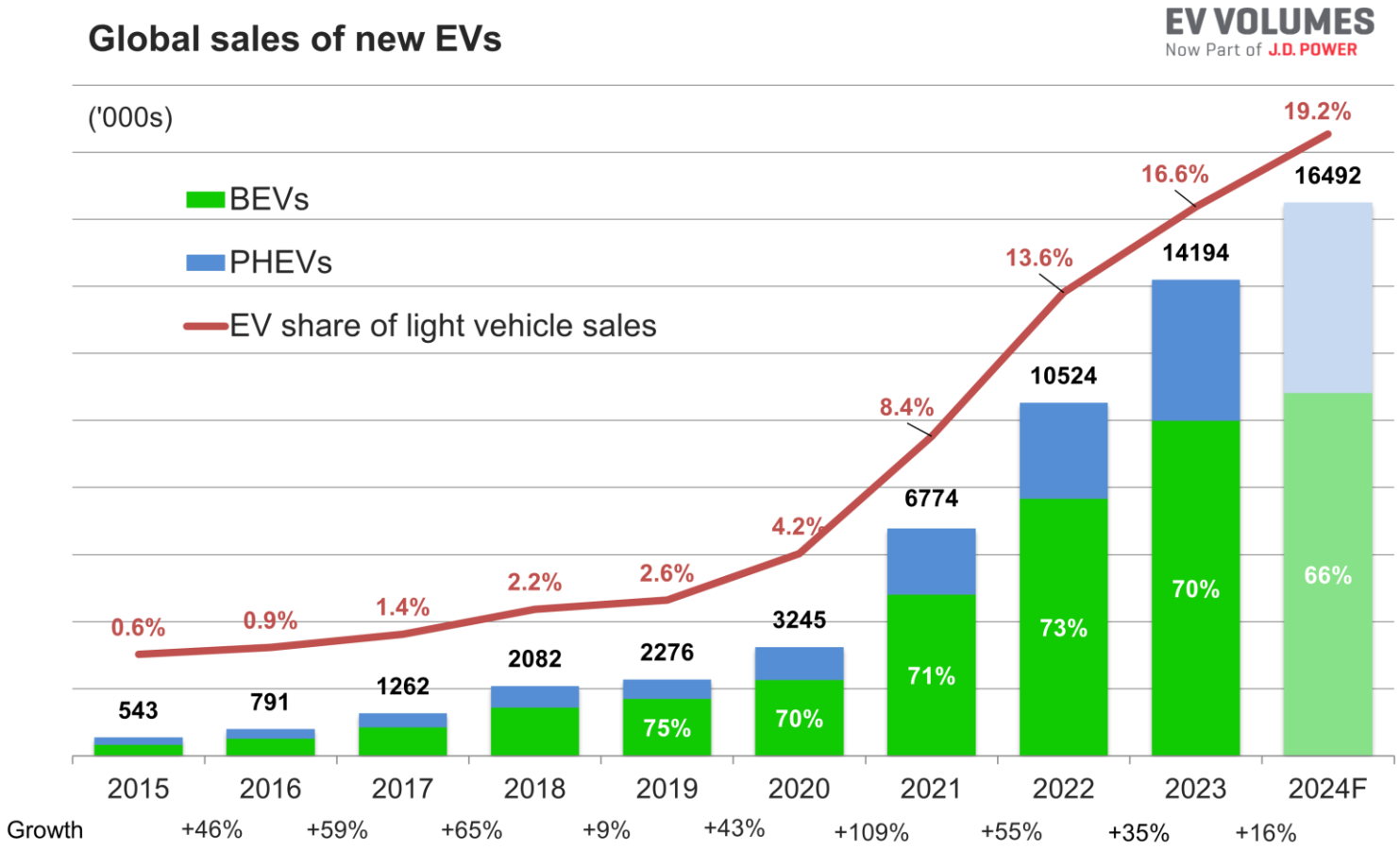
TOP 5 New EV Registrations by Make & Model

New, retail individual registrations.



electric-vehicles-2024-year-in-review.pdf

THE WORLD EV MARKET



Source: https://www.ev-volumes.com/

EV Continues to Boom

- Sales for light duty vehicles slightly up YoY for 2025[1]
- EV sales held steady compared to 2024[2]
- **EVs accounted for 10.1% of all new cars sold in the US in 2024, an increase from 7.6% the year before[3]**

1: U.S. share of electric and hybrid vehicle sales reached a record in the third quarter - U.S. Energy Information Administration (EIA)
2: 10.1 percent of all U.S. light-duty vehicles sold in 2024 were electric vehicles, a market record – Atlas EV Hub
3:

How much energy and how long to charge?

Mfg	EV Offering	Range (miles)	Battery	Battery Capacity	Battery Charge Time (hours)
Tesla	S / 3 / X / Y	S - 405 3 - 272-358 X - 333-351 Y - 303-330	S - 407 V lithium-ion 3 - 50-82 kWh 350 V lithium-ion X - 100 kWh 410 V lithium-ion Y - 75 kWh 350 V lithium-ion	S - 103 kWh 3 - 50 to 82 kWh X - 100 kWh Y - 75 kWh	S - 8 -15h at 240V 3 - 8.5 to 10h at 240V X - 10.5h at 240V Y - 10h at 240V
Porsche	Taycan	199-212	79.2-93.4 kWh 723 V lithium-ion	79.2 to 93.4 kWh	24 hrs @ 120V 12h @ 240V 15m @ 440V
Kia	EV6 / Niro	EV6 - 232-310 Niro - 258	EV6 - 58-77.4 kWh 523-697 V lithium polymer Niro - 64 kWh 356V lithium-ion	EV6 - 58 to 77.4 kWh Niro - 64 kWh	EV6 - 51-68h @120V 6.3-8.7h @240V 1.1-1.2h @440V Niro - 9.25 at 240V 1.07h at 440V

CHANGING THE GAME - RANGE

- Range – In excess of 400 miles with models announced that will achieve over 600 miles.
- However, this is not the effective range. Effective range is rarely more than 70% of this number and in colder, hilly climates, traveling on highways this range may only be 50% of the rating.

CHANGING THE GAME - RANGE

- For a 200 mile range car this may only give you 100 miles before needing to charge again in a northern climate in the winter.
- For a 650 mile range car this should typically give 400 to 450 miles before needing to stop and charge.

CHANGING THE GAME - TIME

- Charge time – Charging at home is a game changer. You leave every day from home fully charged. This is huge.
- We typically are willing to pay for conveniences, but in this case convenience is less expensive.
- On the road the DC Superchargers are now capable of getting you on the road in under 10 minutes.
  - This is now similar to if not the same as fueling with gas.

CHANGING THE GAME - COST

- Charging even 90% of a 90kwh battery at home for $0.12/kwh is $9.72 and typically will take you 240 miles under typical circumstances for a cost of $0.04/mile.
- Assuming you consumed 30 mpg, at a gas price of $4.00/gallon this is roughly a $48.00 fill up and took an extra 10 to 15 minutes out of your life. If you have waited in line at COSTCO you may have spent more time than that and your cost per mile is over $0.13.

CHANGING THE GAME – THE REST OF THE WORLD

- Small wonder that electric vehicles took off in the rest of the world faster than the US. Gas is significantly more expensive and the distances traveled are typically much less.
- On 4/26/23 the average price per gallon in New York State $3.70, in Paris the same gallon of gas was $8.21 or 2.2 times more expensive.
- Electricity, on the other hand, is roughly only 1.5 times more expensive. This price advantage coupled with shorter average drive distances makes electric vehicles very attractive to the average driver in Europe.

THE EV MARKET

Ford to go all electric in Europe by 2030

Ford announced during its fourth-quarter earnings report that it will invest $22 billion in electric vehicles and $7 billion in autonomous vehicles through 2025 and will be “all electric” in Europe by 2030.

Types of Electric Vehicle Supply Equipment (EVSE's or chargers)

Types of Electric Vehicle Supply Equipment (EVSE)

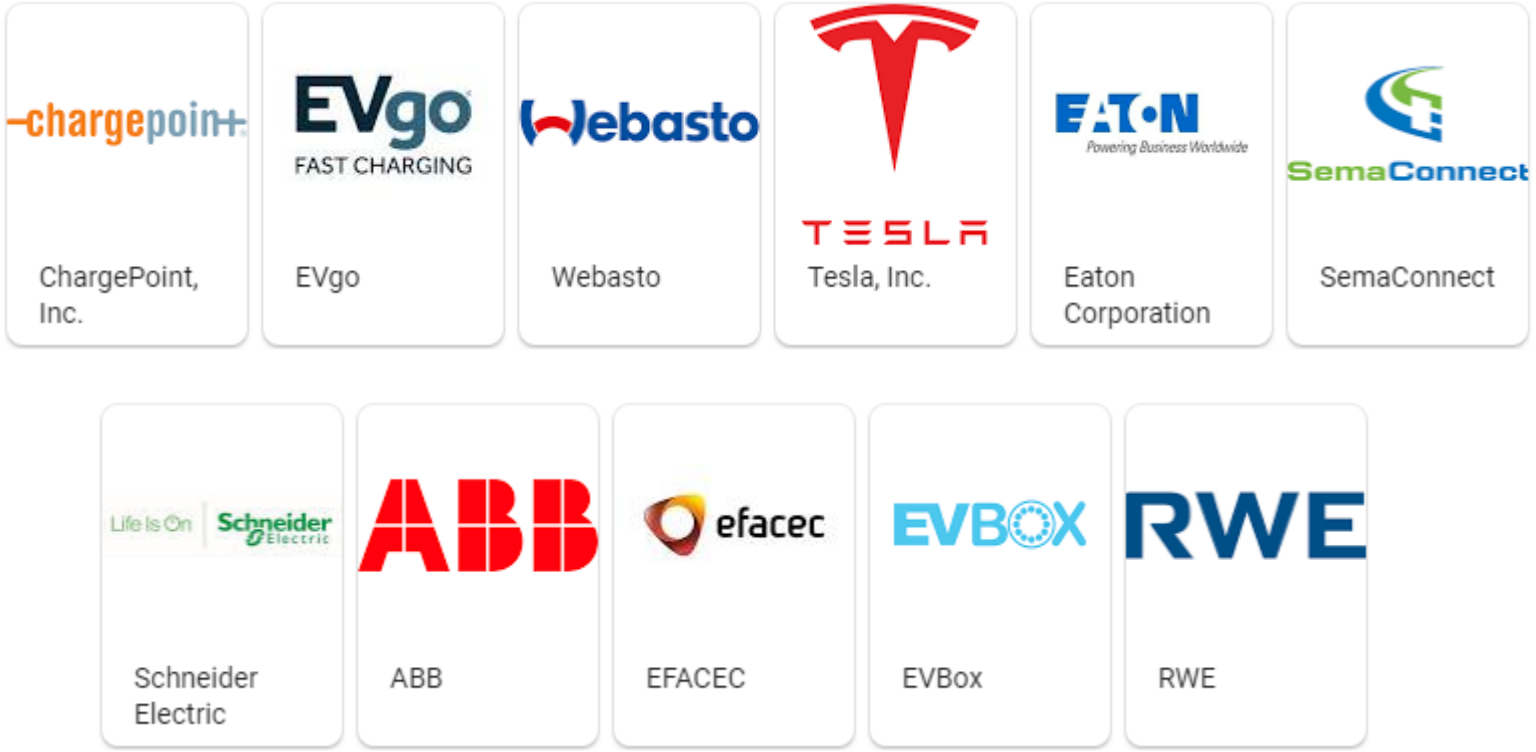
EV Charging Speed on Level 1, 2, 3 Chargers			
Charging Level	Power Delivery	Range Added Per Hour	Time to Charge 60 kWh EV
Level 1	1-1.4 kW	3-5 miles	30-40 hours
Level 2	3.9-19.2 kW	12-80 miles	2.5-4.5 hours
Level 3	24-300 kW	75-1,200 miles	30-40 minutes
Time to Charge EV with a 60-kWh battery is the time to raise the battery's charge level from 10% to 80%			

Source: forbes.com

At the high end of the Level 3 chargers (350 kw and up) – A 90 kwh battery charging from 10 to 80% and adding 210 miles of range will only take 10.5 minutes

EVSE MANUFACTURES

- **Major charging system manufacturers**



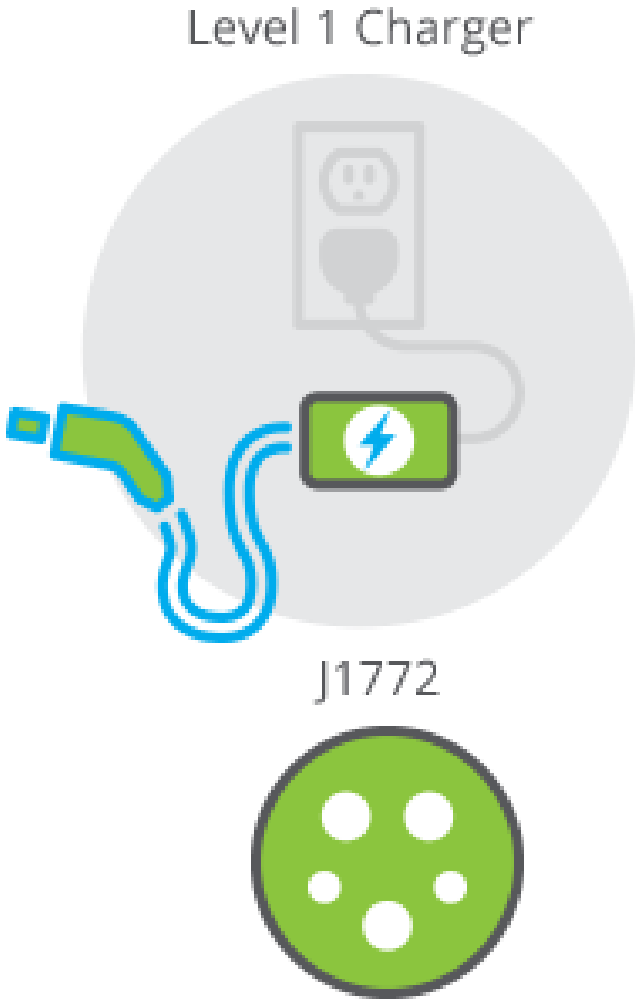
CHARGING STATIONS

- **Deployment is growing rapidly in US**
  - **The current administration has set a goal of having 500,000 charging stations by 2030**
- Total PUBLIC chargers installed as of April 2023:
  - AC Level 1 — 226 locations
  - AC Level 2 — 51,508 locations
  - Level 3 (DC Fast Charger/Superchargers) — 8,832 locations

NOTE: As a point of reference, for TESLA Superchargers there are an average of 9 charging stations per location.

AC EVSE STANDARDS

- **J1772 AC Level 1**
  - Home Installation
  - 120 Volts at between 12 and 16 Amps
  - Maximum Power Delivery (1.4 kW)
  - Typical time to charge between 30-40 hours
  - 3-5 miles per hour of charge @ 16A
  - Charging 100% can take 2-3 days for most models on a L1 Charger



Source: calevip.org; forbes.com

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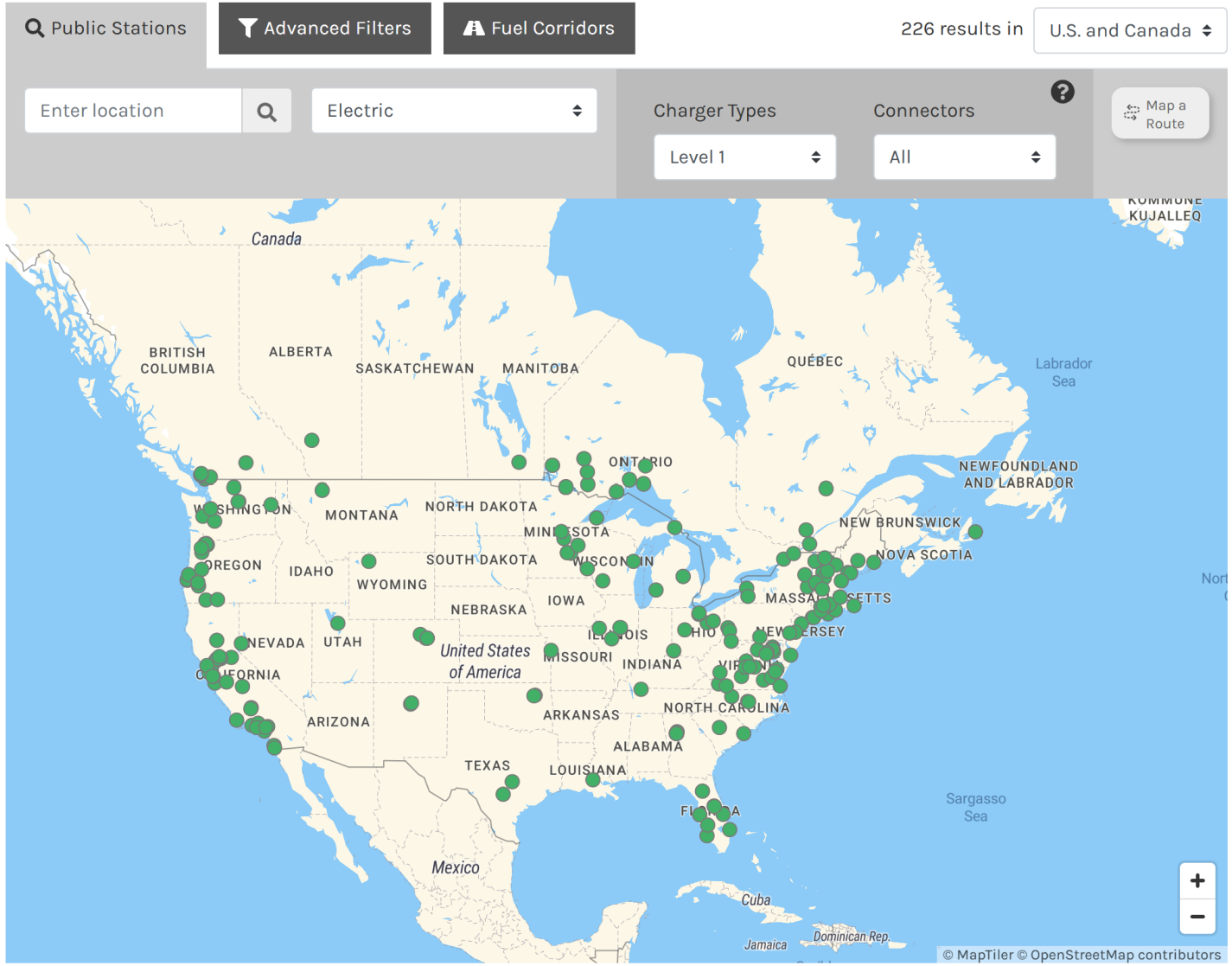
LEVEL 1, AC CHARGERS

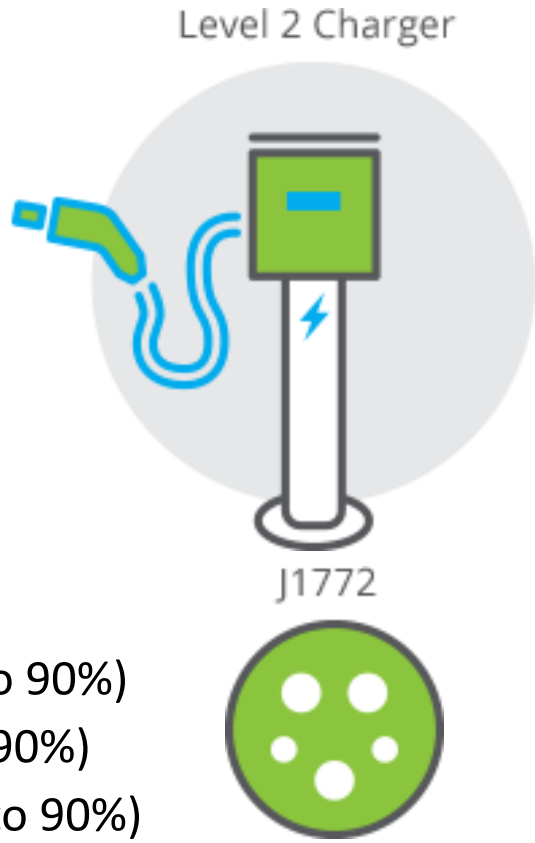


Source: April, 2023 Alternative Fueling Station Data afdc.energy.gov

AC EVSE STANDARDS

- **J1772 AC Level 2**
  - Over 85% of commercial EVSEs are AC Level 2
  - All current EV/PEV in US can use this type though some (Tesla) need adapters
  - Stations cost $5K to $8K per port including installation

AC EVSE STANDARDS



- **J1772 AC Level 2**
  - Home and Commercial Installation
  - 240 Volts at up to 80 Amps
    - 30A most common
    - Home 30A, Commercial 30A, 50A, 75A
  - Maximum Power Delivery (19.2 kW)
    - Mostly vehicle limited to 7.2kW
  - Typical time to charge
    - Pluggable Hybrid (0.5 – 1.5 hours, 0% to 90%)
    - EV 80 Mile Range (1.5 – 4 hours, 20% to 90%)
    - EV200 Mile Range (3.2 – 10 hours, 20% to 90%)
  - 21 miles per hour of charge @ 30A and over 30 mph @48A
  - You can virtually always recharge overnight and can typically take advantage of TOU vehicle charging rates where offered.

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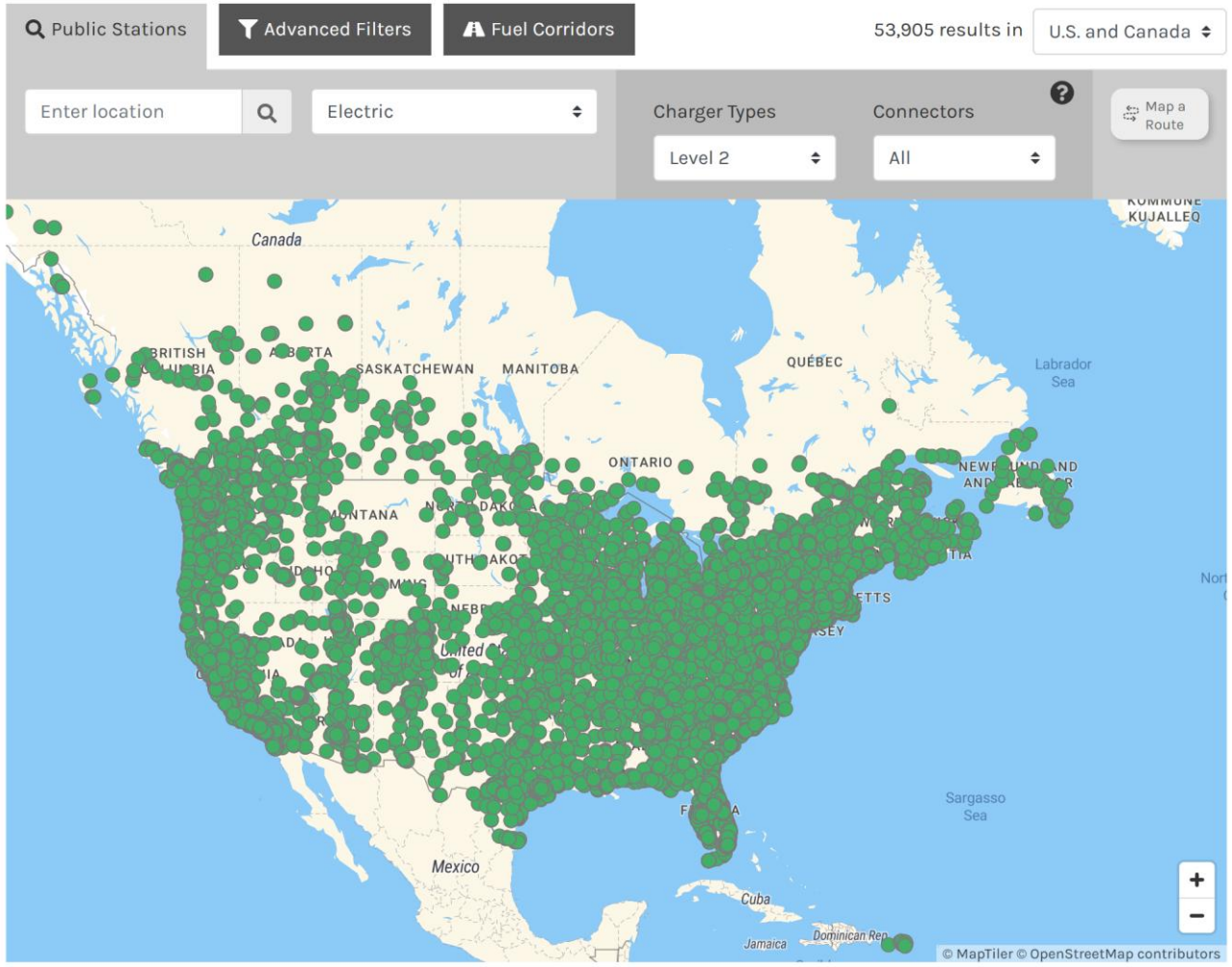
LEVEL 2 PUBLIC STATIONS



Source: April, 2023 Alternative Fueling Station Data afdc.energy.gov

2020 Sites: 19,216

2021 Sites: 30,145

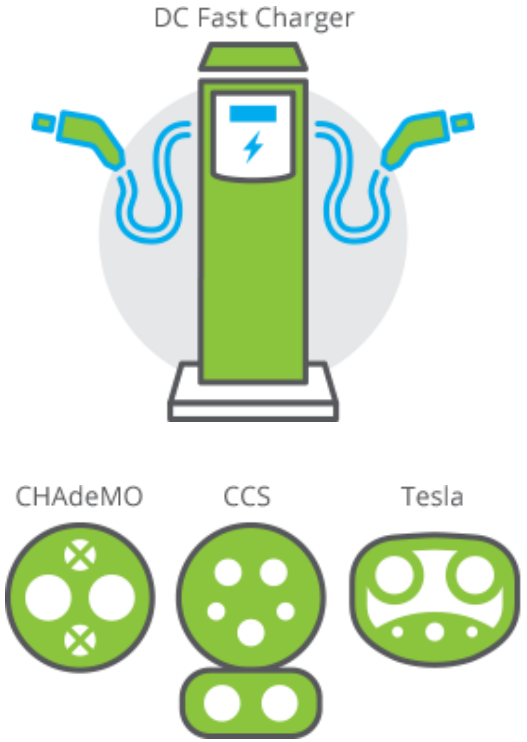
2022 Sites: 46,781

2023 Sites: 51,508

Note: Number of sites, not ports. A site typically has many ports.

DC EVSE STANDARDS

- **Standards evolving rapidly**
  - Combined Charging System
    - CCS1 SAE J1772 North America
    - CCS2 Europe
  - CHadeMO (Only Nissan and Mitsubishi)
  - Tesla V1
  - Tesla V2/V3 (Introduced in 2019)
  - Chaoji (China, Japan, India
    - Successor to CHadeMO and GB/T
  - >100kW is considered “high end” (400V Systems)
  - First US **350kW** units installed Dec 10, 2018 (800V)

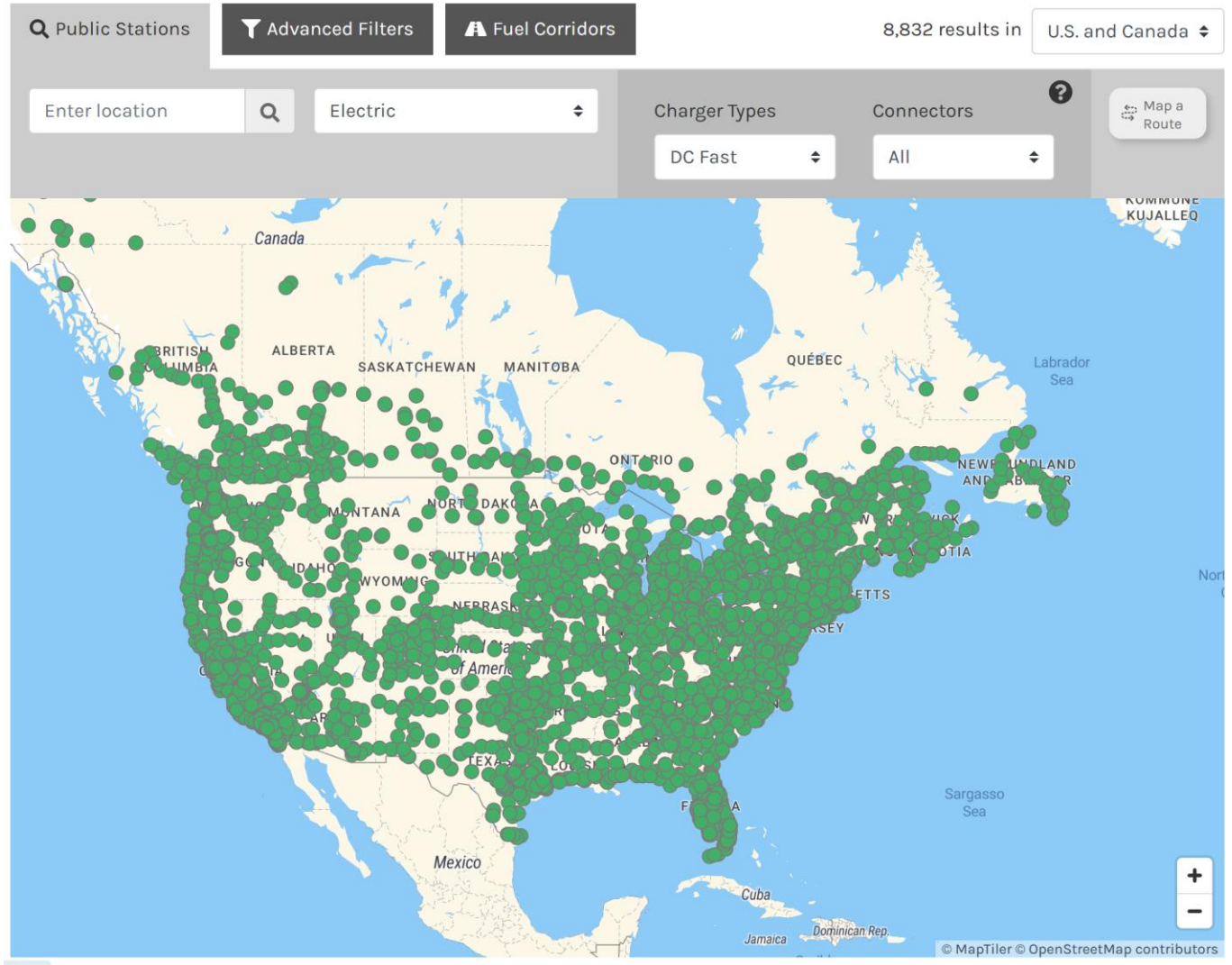


Source: calevip.org; forbes.com

DC EVSE STANDARDS

- **Market Direction**
  - DC Generation 1 (less than 150kW)
    - Nominal 400-500 VDC
    - Up to 300 A max
    - All current EV's except one
  - DC Generation 2 (up to 400 kW)
    - Nominal 800 VDC (1000VDC max)
    - Up to 350A typ, 500 A max
  - Expected to be the norm by 2025
  - Stations cost roughly $50K per charger

LEVEL 3, DC SUPERCHARGERS



2022 Sites: 7,219

2023 Sites: 8,832

Source: April, 2023 Alternative Fueling Station Data afdc.energy.gov

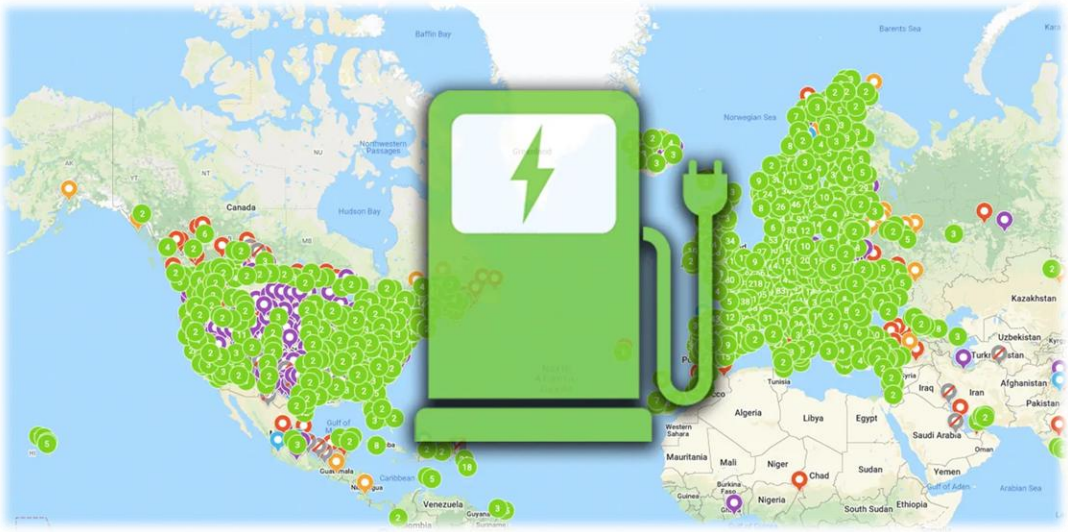
Electric Vehicle Charging Networks

CHARGING NETWORKS

- Major charging system networks
  - Blink
  - Chargepoint
  - Electrify America
  - EvGo
  - National Electric Highway Coalition
  - SemaConnect
  - Tesla
  - Volta

Utility Involvement

- Many Electric Utilities from small to large offer some electric vehicle charging stations in their service territory. Some are free to promote greater EV adoption, but most charge for the energy.
- March 2, 2021 – six electric utilities proposed a network of chargers from Texas to the Carolina's to be funded by, built by and administered by (i.e. energy sold by) these same utilities.
- By December 7, 2021 there were 53 utilities signed up (all Investor owned other than one Coop and TVA) whose footprint covered 120 million of the 150 million connected customers in the US.



Utility Involvement

- National Electric Highway Coalition members in New York State;
  - Avangrid
  - Central Hudson Gas & Electric
  - Con Edison
  - Orange and Rockland Utilities
  - PSE&G
  - National Grid

Several of you are already involved with the NY State EV Managed Pilot Project.

Utility Involvement – why?

- Utilities can now sell or will be able to sell significantly more electricity
- Potentially this power can be sold for two to three times the cost offered to the average consumer at home.
- This is now infrastructure that the utility can control and can be placed both in locations where the market needs the charging stations and where the Utility infrastructure can best support these charging stations.
  - Being able to add 1MW of usage where the utility wants to add this is highly desireable.

Regulatory Environment

REGULATORY BACKGROUND

- Sales of electricity as a vehicle fuel are regulated by the Department of Commerce
- Like all sales of all things based on quantity sold, EVSE sales are regulated by NIST Handbooks 130 and 44.
- HB130 establishes that all sales of electricity as a vehicle fuel must be based on the quantity delivered.
- HB44 sets performance requirements for devices (Electric Vehicle Service Equipment) used to dispense electricity for sale.

HB44 APPLICABILITY

- **A.1. General.** – This code applies to devices, accessories, and systems used for the measurement of electricity dispensed in vehicle fuel applications wherein a quantity determination or statement of measure is used wholly or partially as a basis for sale or upon which a charge for service is based.

HB44 REQUIREMENTS

- Metrological Requirements of HB44
  - **S.3.1. Metrological Components.** – An EVSE measuring system shall be designed and constructed so that metrological components are adequately protected from environmental conditions likely to be detrimental to accuracy.
  - **S.3.5. Temperature Range for System Components.** – EVSEs shall be accurate and correct over the temperature range of – 40 °C to + 85 °C (– 40 °F to 185 °F).
  - **S.8. Minimum Measured Quantity (MMQ).** – The minimum measured quantity shall satisfy the conditions of use of the measuring system as follows:
    - (a) Measuring systems shall have a minimum measured quantity not exceeding 2.5 MJ or 0.5 kWh.

HB44 APPLICABILITY

- **Use Cases – COVERED**
  - ANY transaction which is based on the amount of energy delivered
  - Examples
    - A network of charge stations charges a monthly fee to belong AND a fee based on the amount of energy used
    - A EVSE charges for the amount of energy delivered
    - A parking lot charges for parking and EVSEs located in it also charge for the amount of energy delivered if used

HB44 APPLICABILITY

- **Use Cases – NOT COVERED**
  - A store provides a free EVSE in its parking lot.
  - A paid parking lot provides EVSEs for which there is no charge based on the amount of energy delivered.
  - Tesla provides free charging services for some owners.
  - An organization charges a monthly fee for unlimited use of its network of EVSEs.

HB44 APPLICABILITY

- **Exceptions-This code does not apply to:**
  - The use of any measure or measuring device owned, maintained, and used by a public utility or municipality only in connection with measuring electricity subject to the authority having jurisdiction such as the Public Utilities Commission.
  - Electric Vehicle Supply Equipment used solely for dispensing electrical energy in connection with operations in which the amount dispensed does not affect customer charges or compensation.
  - The wholesale delivery of electricity.

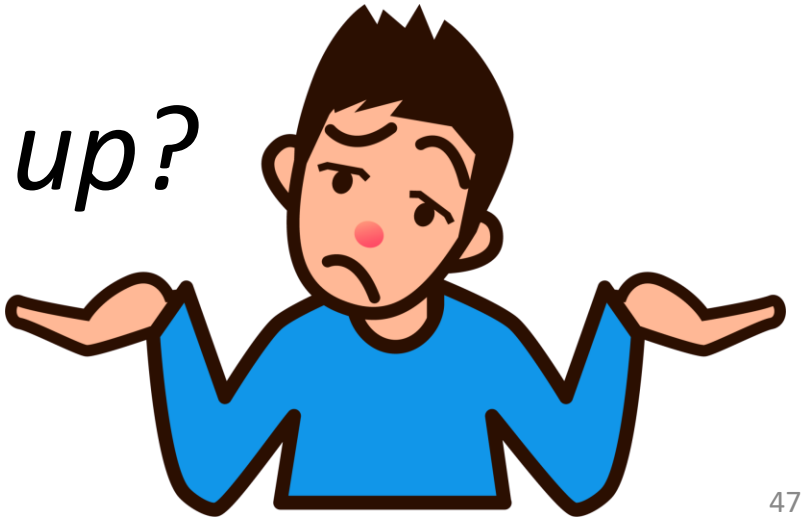
Certification and Traceability

- None of this means anything if we can not certify and provide traceability for these tests.
- Two general approaches – New York approach and California Approach
- Traceability through a National Lab to an International Standard
  - This requires a DC “Standard”
  - Fortunately, DC Power = VA
    - Need a certifiable voltage source and a certified current source and the ability to measure down to the appropriate levels for both Volts and Amps, then have a National Lab do the same test on the lab equipment
- ANSI has also spent a great deal of time creating a new Standard to cover DC Metering – ANSI C12.32. This standard is being updated as quickly as the industry changes, and another standard is being prepared for DC Transducers. C12.32 is the DC version of C12.1 for AC metering.

AC vs. DC Chargers and accuracy testing

- **Effective January 1, 2023:** All AC charging stations that charge for power must be tested and certified once per year by the state's bureau of weights and measures.
- **Effective January 1, 2028:** Current regulations call for DC charging stations that charge for power to be tested once per year as well.

Why the hold up?



WHY THE DELAY?

- Electric Vehicle chargers are not like ANSI electric meters. ANSI meters typically do not operate at their rated current limit. Electric vehicle chargers start at this limit and then taper off from there as the battery being charged approaches a full charge.

TESCO TS-400 Test System

We need to find a way to test 400 Kw chargers at 80% of full load and keep the equipment reasonably sized and without obsoleting what was purchased in the past.

New York State Weights and Measures testing

Note: This data is courtesy of New York State Weights and Measures NEWMA presentation at the 2022 annual meeting on Electric Vehicle Fueling System and Testing

New York State Weights and Measures testing

- Prerequisites
  - HB 44
  - Smart Phone
    - Applicable App for testing particular charging platform
    - Method of Payment

Note: This data is courtesy of New York State Weights and Measures NEWMA presentation at the 2022 annual meeting on Electric Vehicle Fueling System and Testing

RESULTS

- Number of tests:
  - 265 total
- Out of maintenance tolerance:
  - Plus: 37 13.9%
  - Minus: 40 15%
  - Combo 4 1.5%
- Failed transaction/Charger malfunction:
  - 25 9.4%

Note: This data is courtesy of New York State Weights and Measures NEWMA presentation at the 2022 annual meeting on Electric Vehicle Fueling System and Testing

TAKEAWAYS

- Specific Charging Networks/Manufacturers
  - Some had no out of tolerance, others nearly all are out of tolerance
- Cold vs Hot Weather Testing
  - Very small sample size but no discernible difference in test results

Note: This data is courtesy of New York State Weights and Measures NEWMA presentation at the 2022 annual meeting on Electric Vehicle Fueling System and Testing

Business Segment – Revenue Opportunities and Expectations

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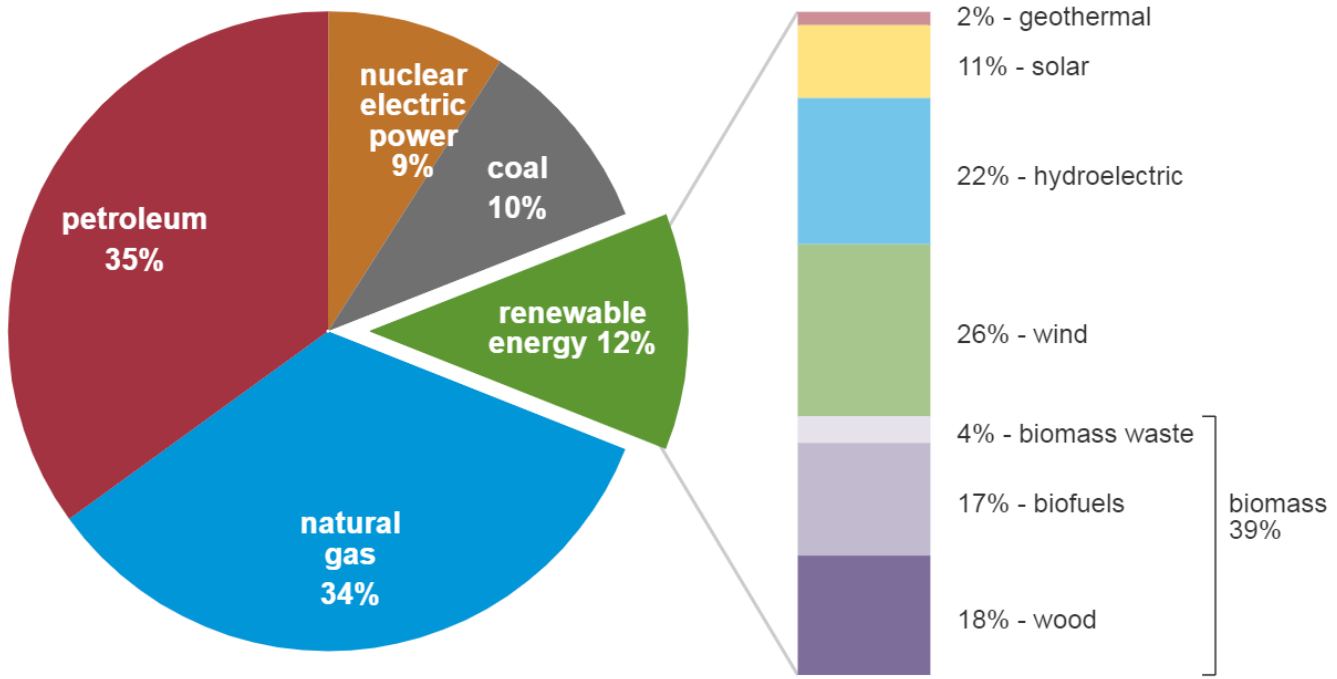
US Primary Energy by Source

U.S. primary energy consumption by energy source, 2020

total = 92.94 quadrillion British thermal units (Btu)

total = 11.59 quadrillion Btu



Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.3 and 10.1, April 2021, preliminary data
Note: Sum of components may not equal 100% because of independent rounding.

US TOTAL ENERGY CONSUMPTION

January 2023:

- Generated 352,140.3 GWh
- Average Residential retail price: 13.75* cents/kwh

US ELECTRIC ENERGY CONSUMPTION

Americans drove 3.23 trillion miles in 2021. If this was all done in electric vehicles getting 3 mi/kWh, then we would need 1.1 GWh of energy just to charge cars.

Average household uses 10.7 MWh/yr (2021).
Charging our cars could use an additional 8.8 MWh/yr.

Charging at home is a potential market worth $145 billion per year in added revenue to electric utilities.

TOPIC SUMMARY

- Overview of Electric Vehicles (EV's) in 2023
  - Who is in the market?
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- Types of Electric Vehicle Supply Equipment (EVSE's or chargers)
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- Regulatory environment
- Business Segment – revenue opportunities and expectations

ELECTRIC VEHICLE SERVICE EQUIPMENT - EVSE

What is it all about and why should I care?

Course Feedback

Please Take a Few Minutes To Provide Feeback About The Course & Instructor

Questions and Discussion

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This presentation can also be found under Meter Conferences and Schools on the TESCO website: tescometering.com

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TESCO HOSPITALITY SUITE

We would like you to join us in the TESCO Hospitality Suite for networking and more discussions about metering. The discussion will not be exclusively metering…….but we love metering and that is the most common topic.

TESCO Hospitality Suite 301 – Brighton Tower

Monday and Tuesday 8:00 PM – 10:00 PM

We Hope you Can Join Us!

TESCO METERING