THE EASTERN SPECIALTY COMPANY

You Went AMI,
Where Will You Go Next?

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Group 3

INTRODUCTION

We are only now beginning to understand how much AMI has changed and is continuing to change our world. This presentation will touch on the power of this AMI data, new tools we can create and the challenges we are facing to use this data. We will look at just a few of the new opportunities already being presented to us that we can use this data to take advantage of.

The Promise of AMI

The introduction ten years ago and the continued development of an Advanced Meter Infrastructure (AMI) system promised more effective and more efficient Meter Service Operations.

This was to be accomplished in a variety of ways starting with:

- No need to read meters (if AMR had not previously been deployed)
- No need to roll a truck to perform a disconnect or a reconnect
- Better ability to detect and respond to outages
- Better ability to detect theft
- Better ability to detect (and eventually capture) unbilled energy
- Better understand customer usage and make better energy buying decisions

And with all of this came a promise of "Additional Capabilities and additional Operating data."

A Flood of Data: The Promise and the Curse of AMI

And so the data started coming in.

Once the investment in gathering this data was made the problem quickly moved from the collection of this data to developing the tools and infrastructure to analyze this voluminous data.

There was far more data than could be analyzed or even utilized at first.

MOVING INTO THE FUTURE

Utilities now collect hundreds of millions of events and readings every day from sources such as the following:

- Meters (status, manufacturer, purchase date, events such as reprogramming notifications and tamper alerts)
- Transformers (ID, circuit section, circuit ID)
- Service points
- Customer accounts (type, status, billing cycle)

What Data Are We Getting & How Are We Using It?

- **Meter quality assurance:** Focusing on meter reading performance enables utilities to ensure AMI reliability. For instance, when meter readings are expected but not delivered, the system takes note, and calculates overall performance statistics for the AMI system. Utilities are made privy to problems they never would have been able to identify in the past.

Good Start

The Basics

- **Outage event analysis and prevention:** Integration enables real-time, accurate, and complete outage event analysis that helps identify nested outages and optimize field crew dispatch – all to support efficient response and restoration.
  - We can often determine the exact piece of equipment causing a problem, along with the customers directly impacted by it.
  - We can use outage information that is delivered along with meter readings to identify and track outages.
  - These outage event reports help us to understand the overall impact of outages, then drill down to find the problem areas in the distribution network.
  - We can then isolate areas of high impact and work to understand how to address them.

AND OF COURSE…REPORT!

- We can filter planned outages and momentary from this data for reporting purposes and provide meaningful customer satisfaction and performance measures and trends

  - Average interruption durations
  - Number of interruptions
  - Number of customers impacted
  - These system performance indexes and information can be shared with management, regulators, customers, media, and other stakeholders.

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WHAT ELSE?

- Gain a better understanding of events, as well as what they mean. For instance, we can correlate power outage events or voltage alarms with the transformers involved to identify faulty or aging infrastructure. And we can roll trucks between 8 AM and 4 PM, Monday to Friday on non-storm days.
- Generate new customer insights
- Size distribution assets
- Implement preventive maintenance techniques
- Forecast and build predictive models for demand program planning
- Develop new rate plans and services for customers
- Address Line Loss in a meaningful and impactful way

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LINE LOSS

- Network energy inventory balancing – You can accurately compare feeder energy to aggregated meter data to track down unbilled energy. Some may be energy theft. Some is not but is still actionable once the root cause can be determined.
- Meter events and usage information can help paint an overall picture of what's happening with a customer's energy usage over time as well as the usage from an entire sub station. This unified view can help detect energy theft, meter tampering or a host of equipment problems that may be affecting service levels.
- Some typical filters for theft: Customers can be identified who have active accounts but no recorded usage, or the converse – energy usage but no active account. Customers with gas usage but no electrical usage over months or even years, indicate a very likely candidate for investigation, voltage issues for one customer and not others on the same transformer.

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What Else?

- Potentially bad metering
- Non metering of certain usage
- Failing equipment and bad connections
- Bad GIS integration and information. To make any of this work we need an up to date and integrated geographic information system (GIS) geodatabase. We need to be able to link our meters accurately to the rest of the system along with every other piece of equipment between the sub station and the meter. The initial investigative work will uncover not system errors but GIS errors and holes. Once corrected this work will begin to uncover correctible losses.

What else?

LONGER TERM PLANNING

- Load profiling – You have accurate and highly granular transformer load profiles, especially significant for effective distribution planning when electric vehicle (EV) charging and distributed generation are involved. What will the impact on your system be as isolated pockets of users influence each other and purchase electric vehicles; adopt home level energy storage and renewable energy solutions.
- Pricing analysis – Perform 'what if' rate and load shift analysis. Compare current tariffs with alternative pricing scenarios. Estimate energy costs for a new rate at different load levels.

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What are Some of the Challenges in Analyzing this "Flood of Data?"

The first issue is that currently data required for complete meter data analytics solution does not reside in the same database. While there is tremendous real time data being collected the information required to complete many types of analysis may reside in other data bases (e.g. system mapping data).

Another challenge is that while the MDM is configured as a "Fast Write" data base, since it needs to quickly record large volumes of real-time meter information, a useful analytics tool needs to be normalized for "Fast Reads," since it needs to provide fast access to data for users looking for real-time insights.

ADDITIONAL CHALLENGES?

- **No impact on billing:** Making sure that you can analyze the data in the MDM system (the "system of truth") without impacting basic billing operations in any way. As important as meter data analytics is, this capability cannot interrupt billing and other operational systems in terms of performance, data corruption or functionality. Bottom line: The analytics capability cannot threaten the utility's ability to collect revenues.
- **Near real-time:** Lastly, in order to retain its value to executives, engineers and operational staff, data analytics need to be performed in as near real-time as possible.
- **The ultimate goal:** To establish a repeatable data analytics discipline and infrastructure to reduce the time, cost and complexity of each incremental capability, and with the lowest risk possible to the existing MDM functionality.

How Should an "Analytics" Database Be Set-Up?

The analytics database should use a different design that classifies the attributes of an event into "facts," which would include the data itself, and "dimensions" that can give the facts context such as meters, transformers, service points, customer accounts, register reads, billing values, interval readings, register readings, missed reads, data quality information and meter events.

Using a "Fast Read" design, the analytics database correlates measured data ("facts") along many "dimensions" (e.g., location, by transformer, etc.) and stages them so that the data can be analyzed in many ways.

This enables users to gain more understanding of events, as well as what they mean. For instance, analysts can correlate power outage events or voltage alarms ("fact") with the transformers ("dimension") to identify faulty or aging infrastructure with a single simple calculation.

Business Use Cases for this Big Data

Now what can we do with this information? Well….To start;

- Isolate and determine where we have voltage issues, correct them and bring an entire line to the same level. This not only works better for our customers but also allows the utility to pursue voltage reduction in a meaningful and controlled way.
- Determine what transformers should be used in any location
- Determine which transformers to store in which inventory yards
- Determine when new loads are present and which transformers are in jeopardy
- Locate Bad connections
- Locate Undersized lines
- For Transformer Rated Services determine which ones are operating for a substantial amount of time below 10% of the rated current
- Find and remediate theft
- Find and remediate remote outages before the user knows they exist
- Find and address Power factor issues

New Skill Sets

- Utilities also need new skill sets to be able to perform this analysis. To use this data we need
  - Data base experts
  - Metering and operations experts
  - Business analysts

- In a perfect world all of these characteristics are rolled up into one. In a less perfect world into two. And is an even less perfect world – three individual groups or people. But too many utilities are missing one or more of these groups or people even after completing their AMI deployment.

New Tools for the Meter Shop and the Field

- Advanced functional test boards
- Automated firmware and setting comparison tools
- Site Verification equipment, procedures and data
- …….and data
- …….and data
- …….and data

And now we want MORE……

More data

Greater frequency

Whatever bandwidth you thought you needed, now you need more.

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AMI 2.0

Can we use our existing infrastructure?

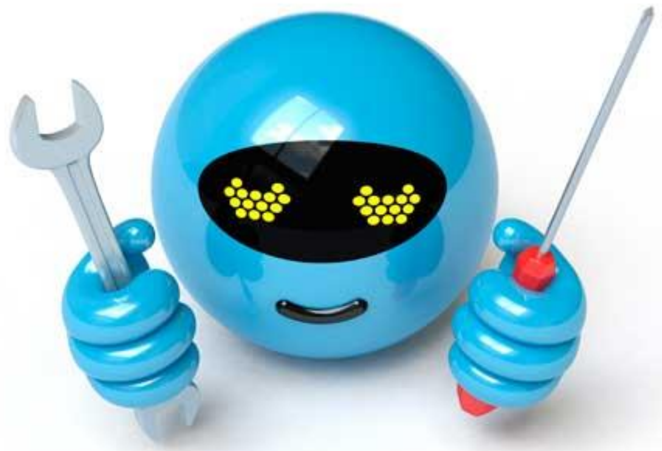
Do we have to rip out and replace with a new infrastructure?

What about LTL back haul or a Private Network?

What about Power Line Carrier? Is there life there for my most remote service areas?

NEW TOOLS

- Advanced visualization tools – Built-in tools provide an alternative to cumbersome data tables and provide enhanced visibility of your smart meters, AMI network, and distribution network
- AMI system health dashboards – A custom definable user interface enabling a visualization of real-time events and trending



2023 AND BEYOND (CONT.)

On the distribution side customers will be encouraged to put in more and more renewable energy and they will also add more and more energy storage

Residential loads will move further and further away from power factors of one and put increasing pressure to move to either a Blondel solution for them, a VA/VAR solution for them, or a correction factor for them as AMI systems begin to report back customer power factor for all metering solutions

- 12S or 2S?
- kVA/kVAR or kWh w/ PF correction?
- DC metering?

2023 AND BEYOND (CONT.)

On the distribution side customers will be encouraged to put in more and more renewable energy and they will also add more and more energy storage

- Larger customer based energy production and solutions will lead to expanded micro grids.
- Second Generation AMI and potentially new communication paradigms as LTL data becomes less and less expensive and reaches larger and larger areas.

Generation vs Storage

Utility grade energy storage will replace new generation at an increasing pace as some of the largest capital investment projects for utilities.

- The great tunnel under Niagara Falls, Ontario $1.6 Billion; 150 megawatts – part of an Ontario plan to shut all of their Coal generation Plants

New generation projects are increasingly becoming renewables coupled with energy storage

- Island communities are already showing us this on larger and larger scales – Ta'u American Samoa; 1.5 megawatts with battery storage for three days

AMI 2.0 Infrastructure

- Second Generation AMI and potentially new communication paradigms as LTL data becomes less and less expensive and reaches larger and larger areas – without new infrastructure

- Research in Power Line Carrier Technology may provide expanded bandwidth to allow for greater data transfer more frequently without as much new infrastructure

- Mesh networks continue to improve and AMI 2.0 is anticipating leveraging the infrastructure installed in AMI 1.0

THE SHAPE OF METERING TO COME: 2023 AND BEYOND

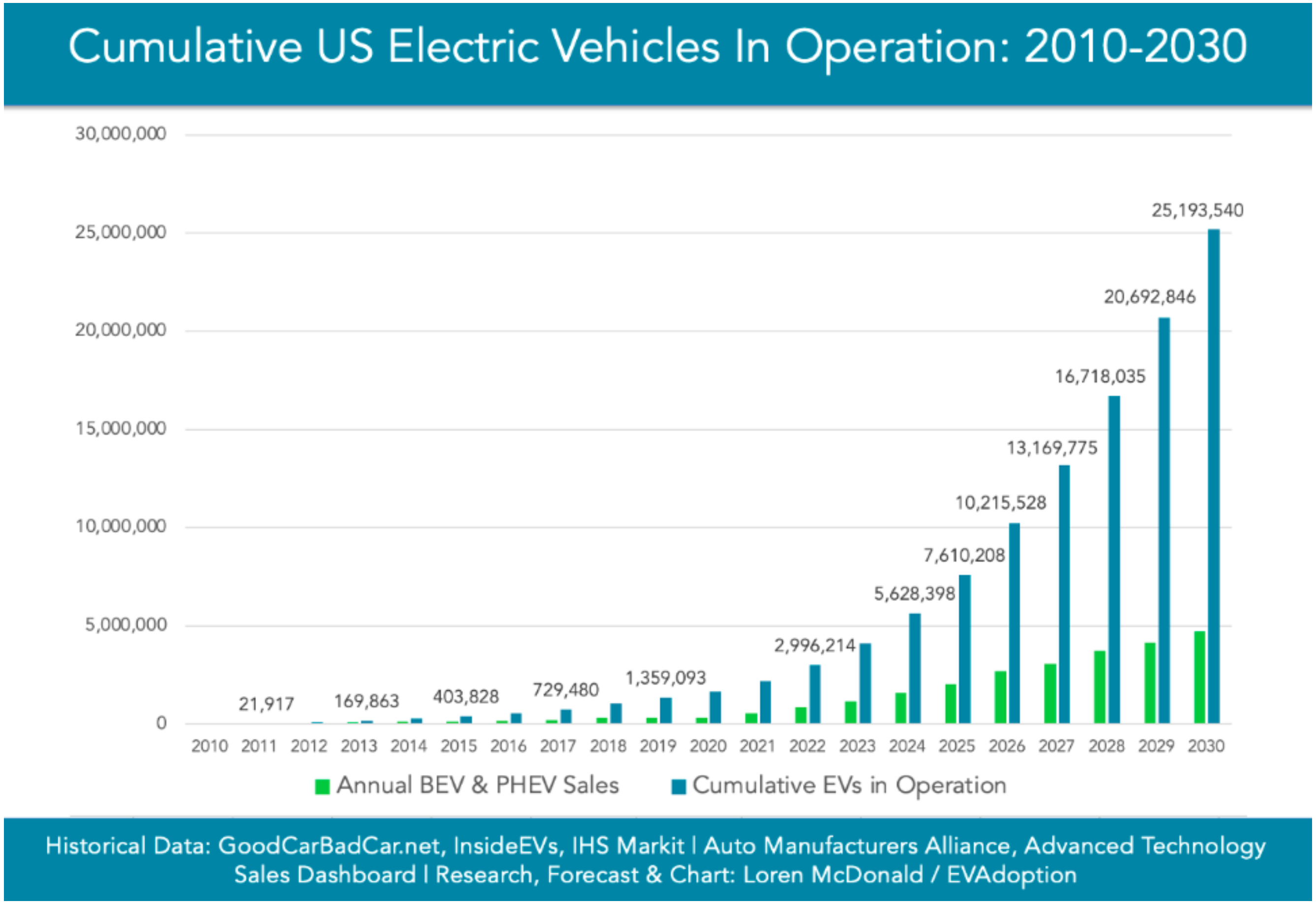
Meters that do not look like meters as we know them, will become a part of our world.

- Street lights
- Smart Poles
- Electric vehicle chargers
- Sub meters – which may now become our meters

The US EV Market

Where is the Market Going?

Upwards – in a big way



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

- As of December 31, 2021 there were 2,147,070 Electric Vehicles operating in the US
- By the end of 2022 there are 3,000,000 forecast to be on the road

Who are the Market drivers?

For 2021

Tesla: 72.3%

Ford: 5.6%

Chevrolet: 5.1%

THE US EV MARKET

ELECTRIC VEHICLE								
	Q4 Sales			YTD Sales			Segment Share	
	2021	2020	YOY	2021	2020	YOY	Q4	YTD
Audi e-tron	3,128	2,034	54%	10,921	7,202	52%	2.1%	2.2%
BMW i3	199	640	-69%	1,476	1,703	-13%	0.1%	0.3%
Chevy Bolt EV/EUV	25	6,701	-100%	24,828	20,754	20%	0.0%	5.1%
GMC Hummer	1	-	-	1	-	-	0.0%	0.0%
Ford Mustang Mach-E	8,285	3	-	27,140	3	-	5.6%	5.6%
Hyundai Ioniq	541	906	-40%	2,389	1,568	52%	0.4%	0.5%
Hyundai Ioniq5	153	-	-	153	-	-	0.1%	0.0%
Hyundai Kona	2,206	822	168%	7,645	2,986	156%	1.5%	1.6%
Jaguar I-Pace	136	205	-34%	1,020	1,658	-38%	0.1%	0.2%
Kia Niro	2,347	638	268%	8,063	2,569	214%	1.6%	1.7%
Lucid Air	577	-	-	577	-	-	0.4%	0.1%
Mazda MX-30	116	-	-	116	-	-	0.1%	0.0%
Mercedes EQS	443	-	-	443	-	-	0.3%	0.1%
Mini Cooper	680	10	-	1,906	158	-	0.5%	0.4%
Nissan Leaf	4,165	4,641	-10%	14,239	9,564	49%	2.8%	2.9%
Polestar 2	1,320	-	-	2,411	-	-	0.9%	0.5%
Porsche Taycan	1,517	1,192	27%	8,745	4,089	114%	1.0%	1.8%
Rivian RT1	575	-	-	575	-	-	0.4%	0.1%
Rivian RS1	8	-	-	8	-	-	0.0%	0.0%
Tesla Model 3	41,489	27,200	53%	121,877	122,700	-1%	28.1%	25.0%
Tesla Model S	4,610	1,325	248%	17,653	10,125	74%	3.1%	3.6%
Tesla Model X	5,763	675	754%	22,546	7,375	206%	3.9%	4.6%
Tesla Model Y	63,386	39,000	63%	190,393	65,400	191%	42.9%	39.1%
Volvo XC40	1,666	18	-	5,593	18	-	1.1%	1.1%
VW ID.4	4,463	-	-	16,742	-	-	3.0%	3.4%
Total (Estimates)	147,799	86,010	72%	487,460	257,872	89%	100.0%	100.0%

Source: ELECTRIFIED LIGHT-VEHICLE SALES REPORT Q4 2021 kbb.com

The EV Market

Manufacturers have announced over 100 EV models to be introduced by 2024.

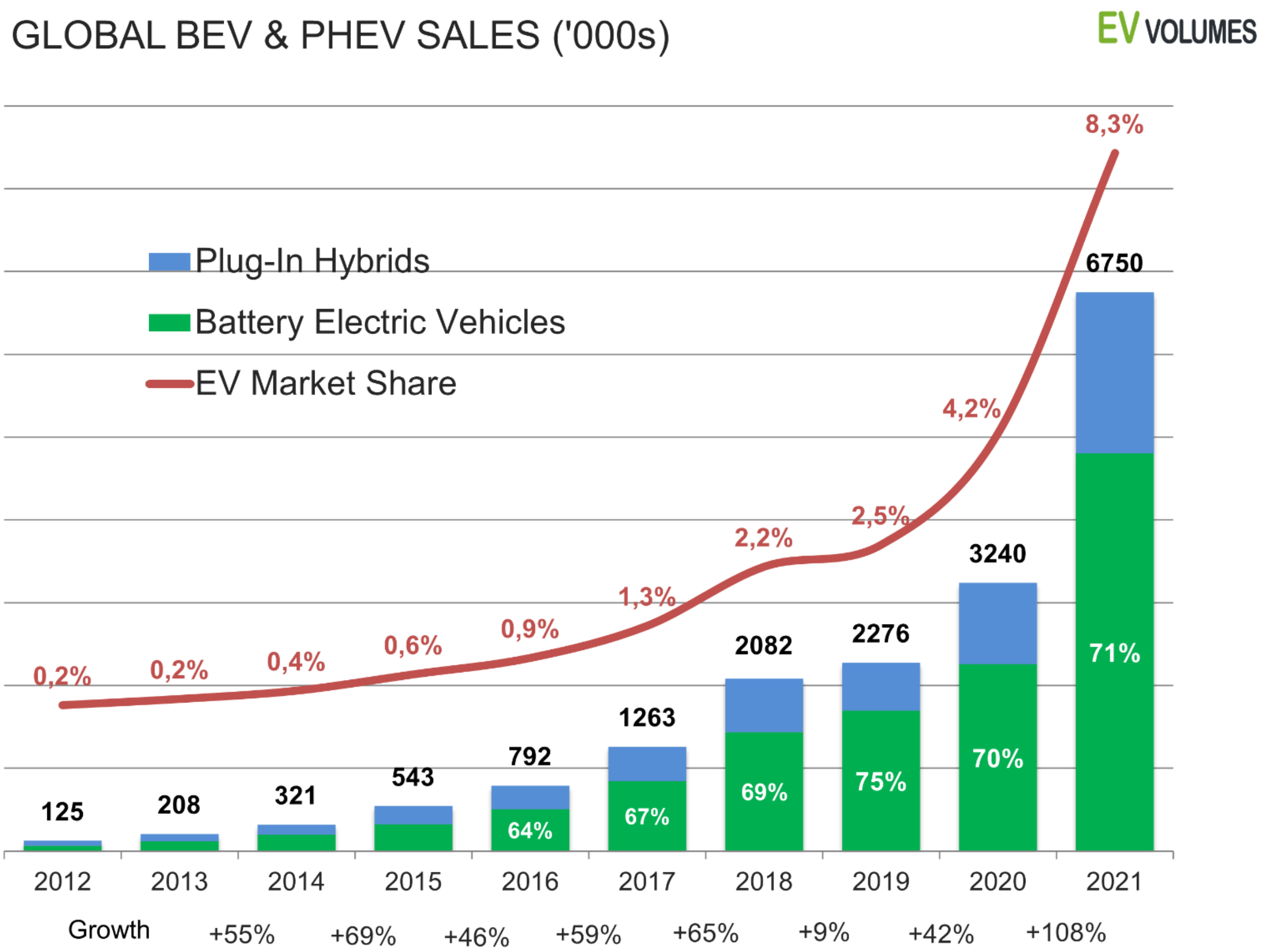








The World EV Market

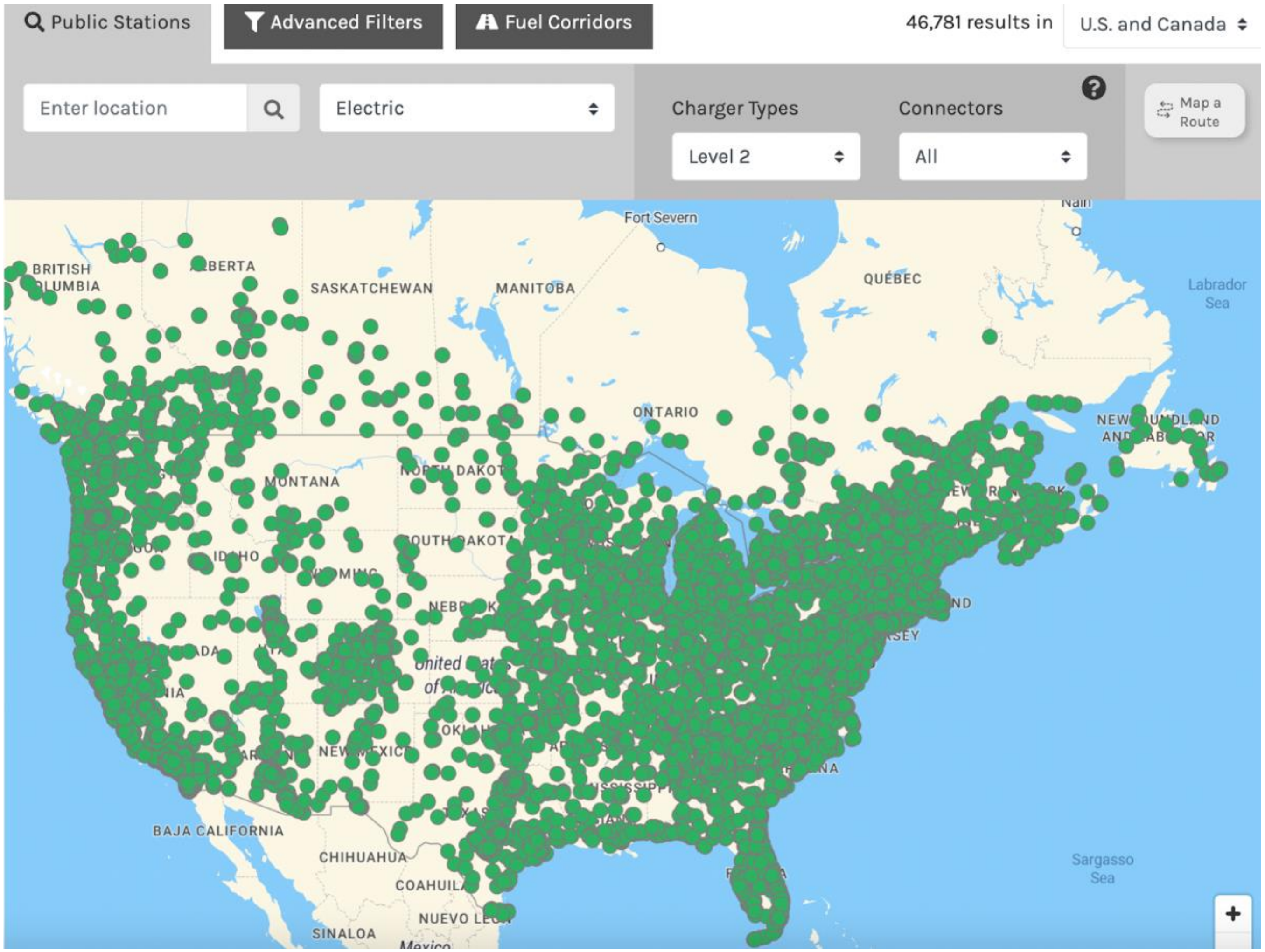


Source: https://www.ev-volumes.com/

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 $0.041/mile.
- Assuming you consumed 30 mpg, at a gas price of $2.00/gallon this is a $16.00 fill up for a similar drive distance 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 15 minutes. Cost is $0.067/mile
- At $4.00/gallon this is a $32 gallon fill up and at $6.00 per gallon this is a $48 gallon fill up and $0.133 and $0.198 respectively not counting the added cost of maintenance and depreciation.

J1772 AC Level 2 Public Stations



Source: March, 2022 Alternative Fueling Station Data afdc.energy.gov

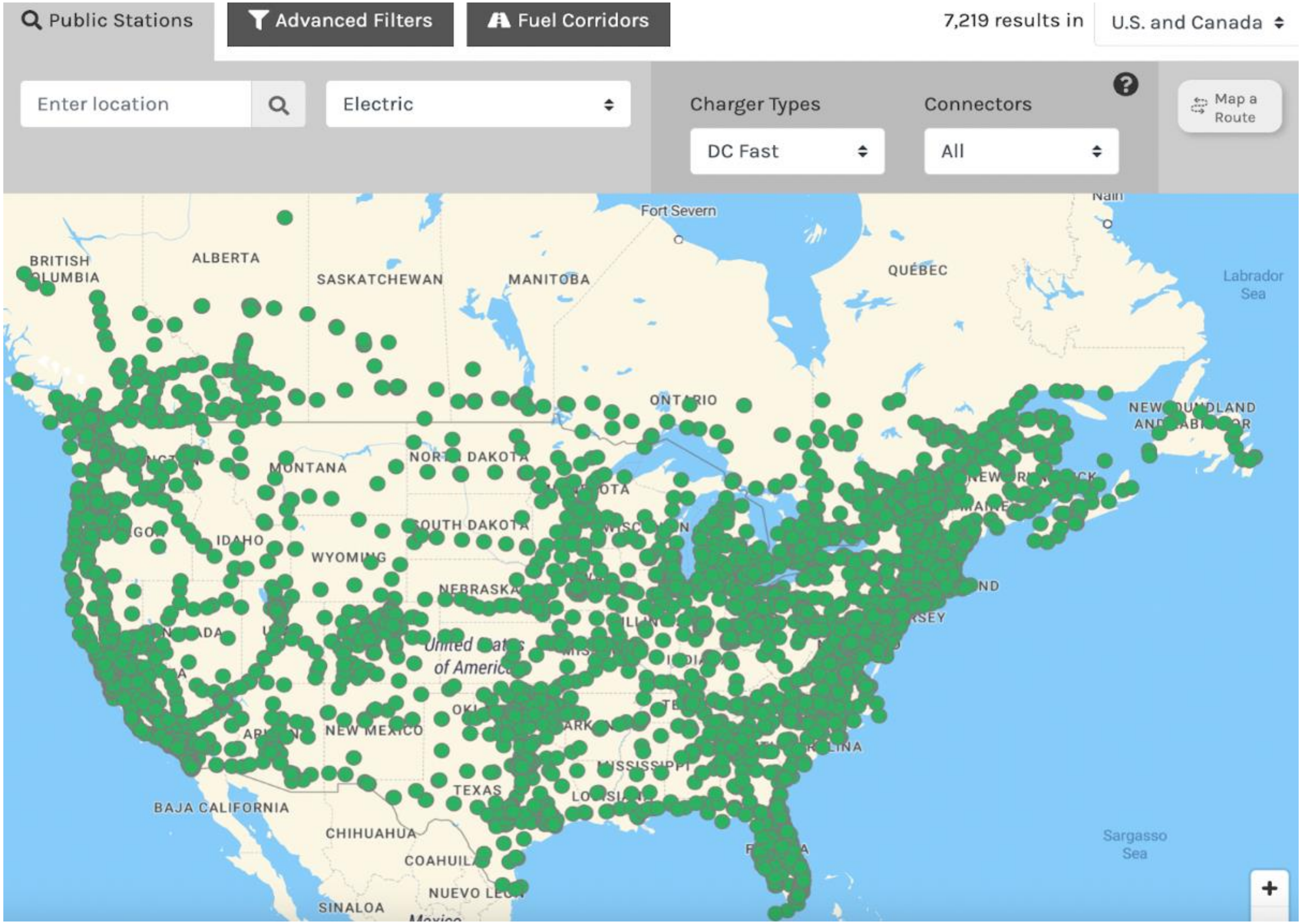
2019 Sites: 19,216

2020 Sites: 30,145

2021 Sites: 46,781

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

LEVEL 3, DC SUPERCHARGERS



Source: March, 2022 Alternative Fueling Station Data afdc.energy.gov

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 April of this year over 60 investor owned utilities plus one Coop and the TVA are signed up as partners in ***The National Electric Highway Coalition.*** Their footprint covers over 125 million of the 150 million connected customers in the US.

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 desirable.

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 (Average residential cost in the US for 2021 was $0.1375 per kWh). This is approximately an extra $1,000 per year per residential customer who charges at home.

THE SHAPE OF METERING TO COME: 2023 AND BEYOND

Planning for these new markets will start with the AMI data each of you is now gathering or will be gathering once you install your AMI systems.

- Street lights
- Smart Poles
- Electric vehicle chargers
- Sub meters – which may now become our meters

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Summary

- We are finding new uses for the data we are receiving as we continue to use these systems.
- This data is enabling us to roll fewer trucks for emergencies
- This data is allowing us to identify weak spots in our infrastructure and correct them between 8 AM and 4 PM Monday to Friday on non-storm days.
- The data is allowing us to perform long term planning and perform far better rate analysis for proposed new tariffs and to even help create new tariffs.
- The data allows us to better evaluate performance of hardware on our infrastructure.
- The data gives us the tools for the first time to measure, identify, and go after "system loss" in a meaningful and actionable way.
- Meter data analytics will enable utilities to tackle the biggest problems we face today, including failing transformers, unbalanced energy generation based on imprecise forecasts, operational inefficiencies and even addressing and reducing line loss.
- To do this we an analytics platform to allow us to provide the infrastructure to perform this work, dedicated personnel with both new and old skill sets and new tools for them to use.
- We need to continue to watch and understand what is happening in our industry and be ready to change our operations to keep pace and take advantage of all of the new developments. We have to learn to embrace change as we have never had to embrace change before and to educate our peers at our own utilities about the need to continue to change.

Questions and Discussion

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