EFFECT OF ELECTRIC VEHICLES ON THE TRADITIONAL UTILITY DISTRIBUTOR BUSINESS MODEL

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Abstract

This capstone explores changes North American Association of Utility Distributors (NAAUD) members should consider making to their business models as a result of the rapid growth in the use of electric vehicles, such as supporting additional manufacturers, modifying the services and systems they provide to utilities or expanding existing geographic footprints. The research provided in this project shows the growth potential in supporting transportation electrification as the primary rationale for business model modification. Research includes geographic data showing major shifts to urban areas along with the geographic coverage of the members of the NAAUD. The data adds a focus on the primary transportation corridors identified by the Federal Government. A variety of governmental agencies are key sources of the data used in deriving recommendations, including population growth by location and presence of charging infrastructure. The data sets were analyzed and correlated with a methodology that indicates geographies to target. Sources for recommendations are additionally based on examples of other countries, relevant non-profit organizations looking at the impact of electric vehicles on public charging infrastructures and other applicable sources. Using this framework of analysis and suggested sources of data will allow each member company to drive changes to their business models.

Keywords: ["electric vehicles", EVs, "charging infrastructure", NAAUD, "transportation electrification", "business model", "utility distributor"]

Executive Summary

From the First Industrial Revolution's use of steam and water to create power, to the Second Industrial Revolution's invention of electricity, to the Third's evolution of electronics; the push for the improvement of human productivity and comfort has been constantly evolving. Currently we are experiencing a 4th revolution; the digital revolution, consisting of the Internet of Things (IoT), Big Data, Artificial Intelligence, etc. At the same time, we are taking advantage of ubiquitous connectivity, we are more sensitive than ever that the world does not have infinite resources and we need to preserve the natural resources we have. This realization comes with widespread opposition to the damage caused by drilling for oil, scraping oil-sands and mining for coal. One of the most visible changes this revolution is bringing about is in the advent and accelerated growth of electric vehicles. This capstone dives into the background of utility distributors and where they can adapt their business models to support the charging infrastructure needed to support this growth.

The literature review explores numerous scholarly sources regarding EVs, the growth potential, charging station types, governmental involvement, and effect on the grid system.

The methodology section models a data driven approach that NAAUD members can use to prioritize possible business changes. This section addresses the data sets used, their sources, and how they were picked as well as the process used to develop recommendations. The author published the data analysis as sets of Tableau figures and reports that are publicly available here: https://public.tableau.com/profile/katie.carmody#!/vizhome/EffectofElectricVehiclesontheTraditionalUtilityDistributorBusinessModel/Capstone-Texas?publish=yes

The author picked Texas as the focal point for the research for many reasons: NAAUD member presence, economic growth, EV growth, and the presence of a major portion of the interstate highway system. The Texas data provides an example that can help motivate NAAUD members to explore geographic possibilities more suited to their companies. In Texas, members should focus their efforts on Del Rio and

Eagle Pass to expand their reach along with routes along the Alternative Fuel Corridor designated by the Federal Highway Administration.

Partnering with federal and local governments is a recommendation based on research provided in the literary review and further substantiated by the volume of data available from multiple divisions of the Department of Energy and the Department of Transportation. This is a way to become more visible in local communities and to gain market share from competitors. ChargePoint, a major player in the EV charging station space, announced a partnership with the National Association of Truck Stop Owners (NATSO) - investing $1 billion in charging stations across the United Stations (ChargePoint, 2020). Reaching out to ChargePoint or NATSO would be a major opportunity for members if they are able to secure a contract. Expanding value-added services offered is another aspect that members should explore as a way to support the growing need for charging infrastructure. The last recommendation proposed is exploring the way customers pay for a charge; using the technology solutions the members offer to support secure, one-time transactions.

ROI will vary amongst the various members and the levels of involvement they pursue. The paper does discuss that not all charging stations provide the same level of profit. Tapping into the EV infrastructure is complex and not an easy task. This capstone presents research and data sets to help NAAUD members find their opportunities.

Background

The demand for disruptive technologies is changing the revenue landscape in the power delivery industry. Electric utilities that have long controlled all aspects of their industry are experiencing a decline in revenue due to the power storage, delivery, and utilization efficiencies of the 21st century. Methods of commuting are transitioning from driving gas cars to riding bikes, walking, using electric cars, or sharing electric scooters. The use of mass transit for commuting is also on the rise, adding the potential of supporting additional types of vehicles, such as electric buses.

Utility distributors are major players in the power delivery supply chain, and as such are also missing revenue opportunities. The traditional model of a utility distributor supporting the generation, transmission, or distribution of electricity to end-consumers can cause revenue loss due to market shift and redefinition shaped by environmentally aware consumers and governmental entities. Business models need to be re-imagined to recognize the application of distributed energy resources, real time efficiency management and facilitated integration of electric vehicles (plug-in cars, trucks and electric scooters).

The North American Association of Utility Distributors (NAAUD) is a network of regional electric utility distributors that aim to provide a supply and communication network for their members and their manufacturing suppliers. Additionally, for NAUUD:

> The intent is to enhance and perpetuate the value of distributors in their role of providing sales and distribution services for manufacturers and the utilities in North America. NAAUD sponsored activities are aimed at expanding awareness and understanding for ways regional distributors can be used to provide services that deliver valued supply chain solutions (NAAUD).

This capstone explores changes NAAUD members should consider making to their business models as a result of the rapid growth in the use of electric vehicles, such as supporting additional manufacturers, modifying the services and systems they provide to utilities or expanding existing geographic footprints. The research provided in this project shows the growth potential in supporting transportation

electrification as the primary rationale for business model modification. Research includes geographic data showing major shifts to urban areas along with the geographic coverage of the members of the NAAUD. The data adds a focus on the primary transportation routes identified by the Federal Government as charging corridors. A variety of governmental agencies are key sources of the data used in deriving recommendations, including population growth by location and presence of charging infrastructure. Sources for recommendations are additionally based on examples of other countries, relevant non-profit organizations looking at the impact of electric vehicles on public charging infrastructures and the research referenced in the literature review.

The approach used for this capstone is broken up into 4 parts: analyze and correlate, assess, review, propose. Analysis and correlation starts with the collection of data, showing for example: shift in population density, locations growing in electric vehicle sales, coverage areas of the NAAUD member companies, and density of existing charging infrastructure.

Assessment includes electric vehicle manufacturers' supply chains (in particular those providing elements of charging mechanisms) and EV manufacturers' existing partnerships with governmental entities. The review phase evaluates best practices from other countries for developing charging infrastructure and their examples of public private partnerships. The last section describes the solutions proposed. Recommendations are based on geographic locations to consider, recommendations for new partnerships with suppliers of charging infrastructure and suggestions for NAAUD involvement with governmental entities and regulators.

Literature Review

Within the past few years electric vehicles have seen an uptick in popularity: “In early 2017, the two-millionth electric vehicle was sold, and electric vehicles have surpassed 10% of new vehicle sales in multiple local markets” (Hall & Lutsey, 2017). This increase in EV’s has left many to wonder how the necessary charging infrastructure will grow to keep pace. Specifically, the research provided gave context as to how utility distributors from other countries are trying to stay relevant and tap into potential income as the nature of those countries’ utilities evolve. Though other countries have “solved” this problem or are working on a solution, the United States has a much bigger and more complex economy to consider. Existing literature provides insight into potential solutions for the utility distributors to explore. The methodology described in more detail in the next section drives the documents that were reviewed as a part of this capstone. The methodology consists of four phases: “Analyze and Correlate”, “Assess”, “Review”, and “Propose”. The review will be structured by those four categories.

Analyze and Correlate

Hall and Lutsey (2017) examined the charging infrastructure for electric vehicles; they provide correlation between government-backed charging stations and the adoption of EV’s. Leading countries, such as Norway and the Netherlands “have more than 10 times as many public charging points per capita as average markets” (Hall & Lutsey, 2017). In 2016 30% of Norway’s new car sales were for EV’s. By exploring relationships with government entities, both local and federal, utility distributors can find ways to support utilities as they increase government-backed charging stations for EV’s, resulting in increased revenue generation for themselves.

Assess

There is more than one type of EV charger: Level 1, Level 2, and DC Fast. Before proposing a solution for distributors and utilities, a few questions need to be answered: “what type of charging stations need to be implemented?” and “How many?” Levinson and West (2018) provide an analysis of those questions. The research provides detailed statistics on ROI, saturation point, and course of action for states with a

Zero Emission Vehicle program. The authors make the important point that the adequacy of the charging infrastructure drives the pace of user adoption. Based on analysis of the source document, recommendations are made for the type of charging stations to support and composite parts distributors should sell and stock.

Most of the current transformers on the US grid are pre-EV. This poses a problem since they were not built to handle the increased energy consumption from charging vehicles every night or the increase at the peak hours of the day at commercial charging stations. Research performed at the University of Massachusetts Amherst investigates the impact of EV's and "how much grid energy storage and smart charging technologies can mitigate this increased demand" (Wamburu, Lee, Shenoy, & Irwin, 2018). Analysis of current transformers is presented, and the energy loads they experience are displayed. That analysis reviewed in the context of the current supply chain products and services provided to the utilities (coupled with location analysis from sources mentioned in the summary table) can help NAAUD members determine where the need might be greatest to help prevent grid overload.

As there is more of a national push to be environmentally friendly and to use renewable energy sources such as solar and wind power, the issue of power storage should be examined. The question that the journal article addresses is whether it is more beneficial for the end consumer to have energy storage at their home or office, or if the energy storage should be centralized and in the control of the utility (Gissey, Subskhankulova, Dodds, & Barrett, 2019). With the research gathered from this article utility distributors can propose power storage solutions to the utilities. Home charging infrastructure, although convenient for the consumer, is not as efficient (in the sense of both power-efficient and cost-efficient). Charging solutions will need to be provided that balance convenience and efficiency; the nature of the solution (home vs. publicly available charging stations) will be distributed both geographically and by the current/future abilities of utilities. The lack of current infrastructure in sparsely populated locales may drive utility distributors to additionally amplify their supply chain of solutions for the home.

The push for businesses, schools, and neighborhoods to be more self-sufficient using solar power might be intimidating if a utility distributor is not prepared. People are adding solar panels to roofs and utilities are starting to see themselves cut out of the energy equation. Distributors should not be wary of the push to solar, but excited at all the possibilities. Four researchers explored the use of a “mobile solar car park roof”; one that could not only store the energy gathered by the sun, but also feed the energy back to the grid if needed (Weigl, Bin, Pacheriwala, & Yi, 2015). Distributors could investigate the production and deployment of these car park charging stations to local businesses or governments. Through leasing or monthly maintenance, utility distributors can find solutions for supporting the solar car parks.

As more people move to urban areas and grow more environmentally conscious the use of shared bikes, e-bikes, and e-scooters will continue to grow. The National Association of City Transportation Officials (NACTO) published a report: “In 2018, people took 84 million trips on Shared Micromobility in the United States, more than double the number of trips taken in 2017” (NACTO, 2018). Some of the bike systems are sponsored by the city and some are private ventures and, in general, are a mix of docked and dockless bike shares. For docked e-bikes, distributors could help support the installation and maintenance of these stations as a potential revenue source. As the number of scooters abandoned during storms grows, distributors could provide e-scooter support such as storm services. For example, tradesmen out on calls fixing downed power lines could also collect scooters and bring them back to a central charging facility.

Hall, Byrnes, McMahon, Pontius, and Watts (2019) identify another potential category of revenue for utility distributors. Though the paper does not address revenue specifically, it recommends the steps the city of Columbus,Ohio should take to utilize eScooters. This gives potential steps a utility distributor could take to partner with a city in a contract to ensure that scooters are charged, maintained and operated correctly, as before, especially in the context of the NAAUD definition of storm services.

Review

China has the largest infrastructure for supporting EV's in the world. Wang & Ke (2018) discuss a Public-Private Partnership (PPP) in China for EV charging. A Public-Private Partnership is a venture between a government entity and a private company; for example, this could be to create infrastructure, parks, or buildings. The issue for charging infrastructure is start-up cost of the project versus the potential revenue. A PPP is in the starting stage in China and this paper explores one project. The profits and various risks are outlined in the paper and should be reviewed as utilities and their distributors consider PPPs in the US.

Propose

Picking the correct business model is important. A paper written in January 2015 produced by authors from the University of Cambridge explores four real life case studies for business models for EVs from three countries; the companies range from an auto manufacturer to public municipalities (Weiller, Shang, Neely, & Shi, 2015). This research provides a comprehensive framework analysis and recommendations for success. Although it lacks specific suggestions regarding utility distributors, the results of the case studies can be combined and examined to provide real-life solutions for distributors to consider.

Besides charging infrastructure in terms of "generic" stations for revenue, the impact of EV's on the grid needs to be evaluated. If more and more households have domestic EV charging solutions, there will be a spike in electricity usage once everyone comes home from work. A paper written by Trevor Morgan explores the relationship between electric vehicles and smart grids. A smart grid allows for more information to be passed through the system to help facilitate the effectiveness of the grid. The paper discusses how a smart grid can help with the daily load that EV's produce when they are plugged in at night at home or the predictable peak times at public charging stations and the effect of EV's on the pricing model (Morgan, 2012). The NAAUD has an additional reference, also from 2012, which provides a detailed review of smart grids and the changes in technology and services that can help to shape recommendations to the utility distributors (Auguero, 2012).

Previous sources discussed the issues of EV's attaching to a traditional grid system. The model presented in one journal article is "based on a Matlab/Simulink platform, to model distribution networks and analyze the impacts of charging of EVs, generation from local Renewable Energy Sources (RES) and the use of smart grid technologies to mitigate these impacts" (Nicoli, et al., 2018). This paper describes a tool that distributors and utilities can use in conjunction with smart grid technology to model the best times and places for controlled charging, in comparison with the uncontrolled charging that many EV owners rely on now.

The table at the end of this paper shows the correlation of the data from the sources described as a part of the literature review mapped to the relevant part of the following methodology.

Methodology / Analysis

The methodology proposed is the roadmap for analysis and solution extraction. The methodology consists of four phases: "Analyze and Correlate", "Assess", "Review", and "Propose". Different types of data were analyzed within each phase using many tools available. Tableau is a tool that can handle various data sets, making data set integrations visually appealing to the user. Overlaying various data sets collected suggested the areas of potential revenue growth for utility distributors. Useful data sets and visualizations are available from US Government sites (such as data.gov, energy.gov, doe.gov, eia.gov, nrel.gov and census.gov) and groups that aggregate relevant information (such as the Alliance of Auto Manufacturers, the Auto Alliance, the International Energy Agency, evadoption.com and data.world). Data.world is a Public Benefit Corporation (Certified B Corporation); "They are legally required to consider the impact of their decisions on their workers, customers, suppliers, community, and the environment" ("B Corporation") - it is a data bank of verified data sets from around the world. NAAUD member-specific information, for example operational locations, were found on member sites. Additional publications and sites for best practices and discussion of public private partnerships provided data to be analyzed for recommendations for involvement by NAAUD members. The analysis suggested options in

their specific states and municipalities and interactions with organizations such as the National Conference of State Legislature ("NCSL 2019 Capitol Forum").

Data sets overlaid on the Texas maps emphasized the first section: “Analyze and Correlate”. The data mappings summarized the locations of existing charging infrastructure (current state). When electric vehicle sales data, population density and population migration data is overlaid, the locations of current need (gap analysis) are indicated and where the future need will likely be. Data showing current coverage area of NAAUD members point out where the current ability to satisfy the need is and show locations with a high probability of desirable growth. As an example of the approach, graphics using data from Texas are at the end of this report; the interactive stories showing the data layering have been published by the author at:
https://public.tableau.com/profile/katie.carmody#!/vizhome/EffectofElectricVehiclesontheTraditionalUtilityDistributorBusinessModel/Capstone-Texas?publish=yes

The second step in the methodology is “Assess”; this step considered what should be suggested by looking at the current state of EV charging stations, energy storage, EV scooters, alternative resources and a variety of methods in the area of battery recycling for non-vehicle usage and battery swapping (evolving in China). There is not one solution that will work for each utility distributor; they all have their own core competencies and their strategic directions for the future. In addition to managing inventory, supporting implementations of charging stations and energy storage, some members of the NAAUD have value-added services such as supply-chain and program management solutions available to their customers that could be extended to cover the support for electric vehicles. Distributors that service mostly desert areas may want to start providing support for solar charging car ports for EV’s. Distributors in cities where e-scooters are on the rise may want to consider providing support for storm services (collection and charging of abandoned scooters). There are a mix of suggestions based on step one of the methodology and the data analyzed.

The “Review” phase explored best practices from other countries, additional publications and sites for best practices and discussion of public private partnerships provided data for analysis. Recommendations were developed for governmental involvement by NAUUD members based on their targeted states and municipalities. Data of interest included status of state bills and federal directives, partnerships with the government, the charging infrastructure in place, and the role that utility distributors play and could play in the future. Norway and the Netherlands have some of the highest rates of EV adoption, by percent of the country covered, but their charging stations are also partially funded by the government (Hall & Lutsey, 2017). China has the largest volume of EVs in use, which provides other dimensions of analysis.

“Propose” is the last stage of the methodology; this is where all the analysis came together into the final recommendations. Specific solution recommendations are provided in the next section as well as discussion on the potential ROI.

Recommendations

The first suggestion is that NAAUD members should look at the business potential in the areas of Del Rio and Eagle Pass. These locations had the highest population growth without NAAUD presence. Although residents of those cities combined currently had 26 EVs, the need for charging stations needs to expand for the volume of traffic going through that area. The data set of EV charging stations published in Tableau is from November 2019 and is provided by the Department of Energy. The PlugShare website provides updated charging data with the option to filter by plug type, network, or minimum power needed ("PlugShare"). Looking at Del Rio and Eagle Pass, besides the Nissan dealership, the charging stations are located at RV parks and a casino. This is important to note as it complements the Alternative Fuel Corridor initiative from the U.S. Department of Transportation; see Figure 3. NAAUD members can partner with RV parks and hotels for charging stations and support local governments charging infrastructure growth at rest stops. The NAAUD members can expand their reach beyond the fuel corridor as many parts of the United States still require charging stations.

Creating partnerships with both government and non-governmental organizations will be an important step for NAAUD members. Partnering with local cities or towns to provide easy access to charging stations or services at parks, libraries, schools, or hospitals can help raise consciousness as well as supporting good public relations. Getting your name out there is an important step - National Drive Electric Week is a way to get involved and to find opportunities. National Drive Electric Week was founded by Plug In America, a non-profit advocacy group; membership would give NAAUD members opportunities to meet potential customers, suppliers, and policy-makers, both at the state and federal level (Plug in America, "Policy"). Being a sponsor of National Drive Electric week at either a national or local level would show that NAAUD members are convinced that there is mutual benefit with the growth of charging infrastructure. The Alternative Fuels Data Center of the US Department of Energy provides extensive data sets on Federal and State Laws and Incentives; this will aid NAAUD members as they focus on their geographic starting points, as well as to stay up to date with progress on the federal level (U.S. Department of Energy , "Federal and State Laws and Incentives").

One of the major owners of charging stations, ChargePoint, is partnering with the National Association of Truck Stop Owners (NATSO) to invest $1 billion in charging stations across the United Stations (ChargePoint, 2020). NAAUD members with industrial/commercial focus should consider the benefit of reaching out to ChargePoint to discuss support of their charging stations. Members of NAAUD that are more utility focused should reach out to the utilities they support to ensure they have the resources and supplies needed to handle the demand; while the scope of the ChargePoint opportunity is over 4,000 additional charging station locations across the U.S, it is projected that by 2030 North America will need roughly 1.2 million charge points (see Figure 5).

Additionally, NAAUD members should explore expanding the services they provide. Some of the NAAUD members already provide storm services and maintenance to the utilities, adding services to support charging infrastructure could be the next step. Though ChargePoint does provide maintenance

and installation for its stations, the expected growth in locations could become difficult to manage. NAAUD members should consider a relationship with NATSO to address any concerns or explore any gaps in the support and maintenance area.

There are also opportunities to provide value-added services at charging points, such as security and internet access. Truckers and cross-country drivers would be more attracted to charging points with those solutions, supporting a more connected world, by enabling communication between customers and suppliers. These interactions will provide data points for future analysis.

An element that should be considered in supporting public charging infrastructure is how drivers pay for the charging. Many charging companies insist on a membership as a way to pay. Cross country drivers who use infrastructure from multiple vendors would welcome a business model that is more like a gas station, instead of juggling multiple memberships (Sakelaris, 2019). The digital solutions available by NAAUD members should make the change in payment mechanisms more attractive to owners and operators of charging infrastructure, especially solutions that stress the security of the payment mechanism.

ROI

Finding an exact ROI for the recommendations is challenging given the multiple varying opportunities, the amount a NAAUD member plans to invest, existing contract or partnership details, the economic market, and consumer habits and trends. However, one can look at the growth of the market for EVs and immediately see revenue potential. It is also important to realize the difference in profit from the various types of charging stations. A paper published by the Great Plains Institute provides detail on the profitability of the different levels of DC fast chargers (DCFC) (Great Plains Institute (GPI), 2019). In the appendix a series of graphs (Figure 4) from the paper displaying the various break points for the charging levels can be found; this information is an example of the cost data that should be taken into consideration as a part of investment decisions.

The Great Plains paper focused its research on the upper Midwest region, and although DCFC charging stations are less profitable, that area still does not have enough of them: “The Midcontinent region currently has 425 DCFC plugs, according to GPI's research, but the region needs more than 4,000 DCFC plugs by 2030 in order to grow EV adoption” (Walton, 2019).

The drive for EVs and a cleaner future is evident in the amount of investment and government action. During the Super Bowl this year there were electric vehicle ads from three different manufacturers. The push for EVs has never been stronger, so the decision to invest should be an easy one. Each NAAUD member has their own process for determining investment; the support for some types of charging make more economic sense to prioritize early in the process, similarly the electrification of transportation, by type, should be used as a starting point. Figures 4 and 5 show the projected growth in transportation type and the demand cost from a utility point of view. In keeping with the truck stop discussion above, it makes sense for NAAUD members to explore charging infrastructure for electric light-duty trucks first, then add support to electric medium duty trucks, before thinking about supporting the larger rigs. Similarly, looking at the markets, the NAAUD could think about supporting buses; whether to start with urban or cross-country will depend on the members’ current support geography, including both local and rural areas. Some states have been more active in stating goals for emission reduction; the top 9 are shown in Figure 6 below. Figures 5 and 6 are from an ABB presentation from the Utility Purchasing Management Group Forum of the Institute for Supply Management; an additional group that NAAUD members might want to become active in, if they are not already. The “Transportation Electrification Markets” slides also show incredible expected growth in the number of charging points and in the number of electric vehicles.

Conclusion

The world has been taking increasingly bigger steps towards making gas-combustion engines obsolete. Numerous companies and governments have provided support and resources to help the push for EV's; the evolution has been more pronounced in other countries such as China and the Netherlands. The traditional role of utilities must change to benefit from the disruptive nature of electric transportation; NAAUD members must adjust to the transformed business models of their customers. This capstone attempts to provide motivation for NAAUD members to explore and benefit from this disruption. As Figure 5 displayed, by 2030 there will be approximately 18.5 million electric vehicles on the road. Within the past year numerous automakers, US and non-US based, have announced plans to expand their breadth and depth in EV manufacturing. Through research and combined recommendations, utility distributors can ensure that they can benefit from this massive change in the provision and use of power.

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Tables

Table 1 – Methodology

Proposed Methodology		Documents from Literary review and additional data sources	Research questions answered
Analyze and correlate			
	Shift in population density	US Census Bureau; Census Bureau Reveals Fastest-Growing Large Cities	Where geographically the most potential may be found.
	Locations growing in electric vehicle sales	US Energy Information Agency; Research tools - https://www.eia.gov/tools/ including https://www.eia.gov/state/maps.php	Where geographically the most potential may be found.
	Coverage areas of the NAAUD member companies	from each NAAUD member website and annual reports	What geographical regions are most feasible for NAAUD members to explore.
	Revenue trending of NAAUD member companies	from each NAAUD member website and annual reports	Why trending of member revenue should motivate a change in business model.
	Density of existing charging infrastructure	from Department of Energy and related sites	Where geographically the most potential lies.
	Growth of addressable market	International Energy Agency; Global EV Outlook 2019	Why the outlook on the EV market should compel this exploration
	Analyze correlation between charging infrastructure and adoption of EV's	"Emerging Best Practices for Electric Vehicle Charging Infrastructure"	Why utility distributors should consider this change; the growth of EVs seems to be inevitable and available charging infrastructure must be developed.
Assess			
	Electronic vehicle manufacturers' supply chains (in particular those providing elements of charging mechanisms)	"Impact of public electric vehicle charging infrastructure"	How one market approach might be developed.

		Analyzing Distribution Transformers at City Scale and the Impact of EVs and Storage	How one market approach might be developed.
		Value of Energy Storage Aggregation to the electricity system	How one market approach might be developed.
		Multifunctional Solar Charging Station for Electric Vehicles	How one market approach might be developed.
		NACTO - Shared MicroMobility in 2018	How one market approach might be developed.
		"Identifying Best Practices for Management of Electric Scooters	How one market approach might be developed.
	EV manufacturers' existing partnerships with governmental entities	communication with NAAUD members	Which governmental entities might be worth approaching for policy changes and public-private partnerships.
Review			
	Best practices from other countries for developing charging infrastructure and their examples of public private partnerships	"Public-Private Partnerships in the Electric Vehicle Charging Infrastructure in China - an Illustrative Case Study"	how to approach public-private partnerships
Propose			
	Most likely geographic locations to take action		
	Recommendations for new partnerships with suppliers of charging infrastructure		
	Action plans for NAAUD involvement with governmental entities and regulators		
	Recommendations for business models for NAAUD to consider	"Competing and Co-existing Business Models for Electric Vehicles - Lessons Learned from International Case Studies"	how to choose and structure business approach
		"Smart grids and electric vehicles: Made for each other"	
		Smart Grid Modeling tool for evaluating Optimal Control of Electric Vehicles	

Chart/Graphics

1. **Texas Population with NAAUD Member Locations**

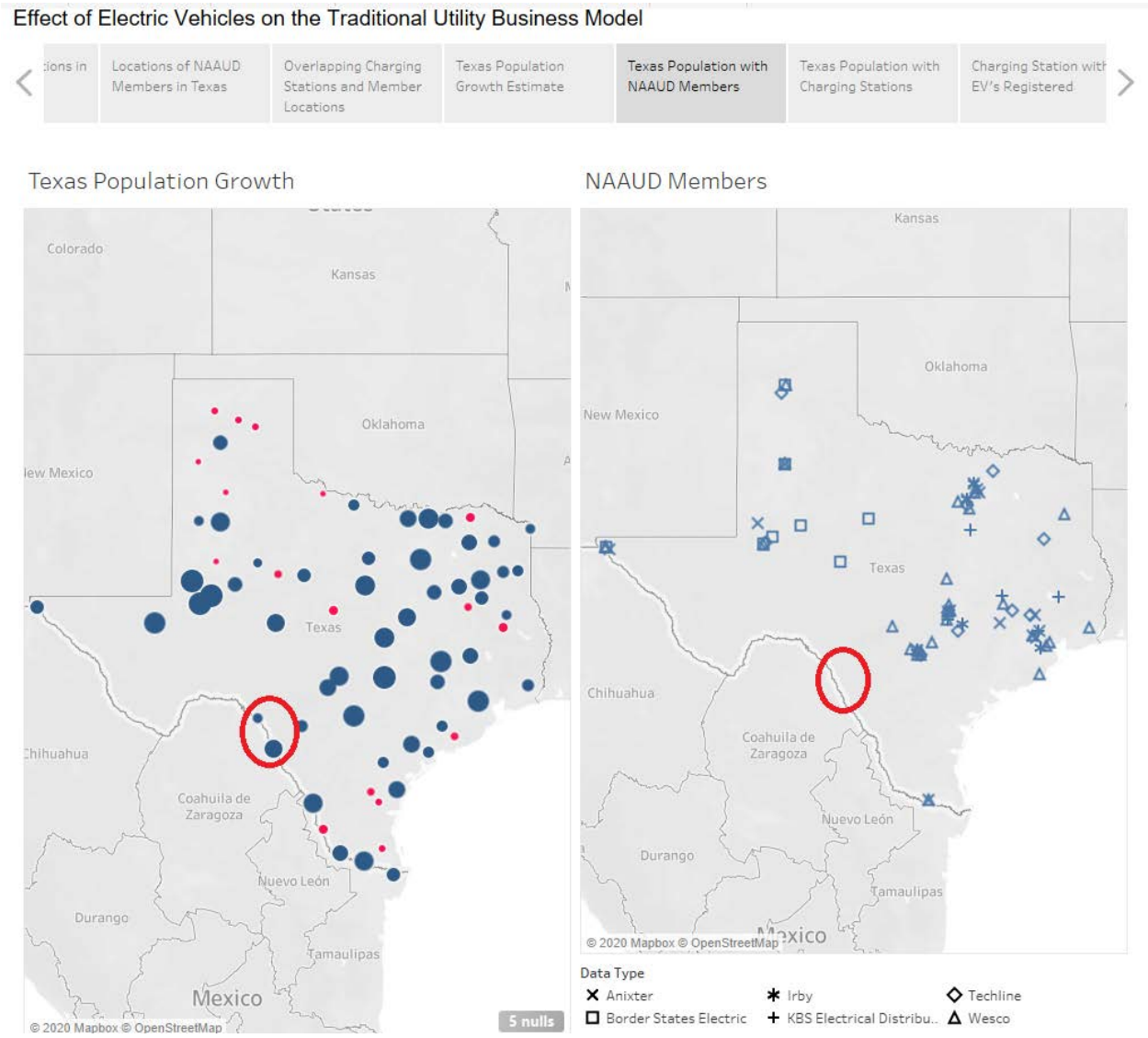

Figure 1 - Here is the estimated population growth by percentage change from 2011 to 2018. These numbers were provided by the US Census bureau. The pink dots are cities that declined in population. Here you can see Eagle Pass and Del Rio exhibit an increase in population growth. On the right are the locations of NAAUD members in Texas, this information was obtained from going to each member's website and collecting the public information. You can see Eagle Pass and Del Rio contain no member locations.

2. **Charging Stations with EV's registered**

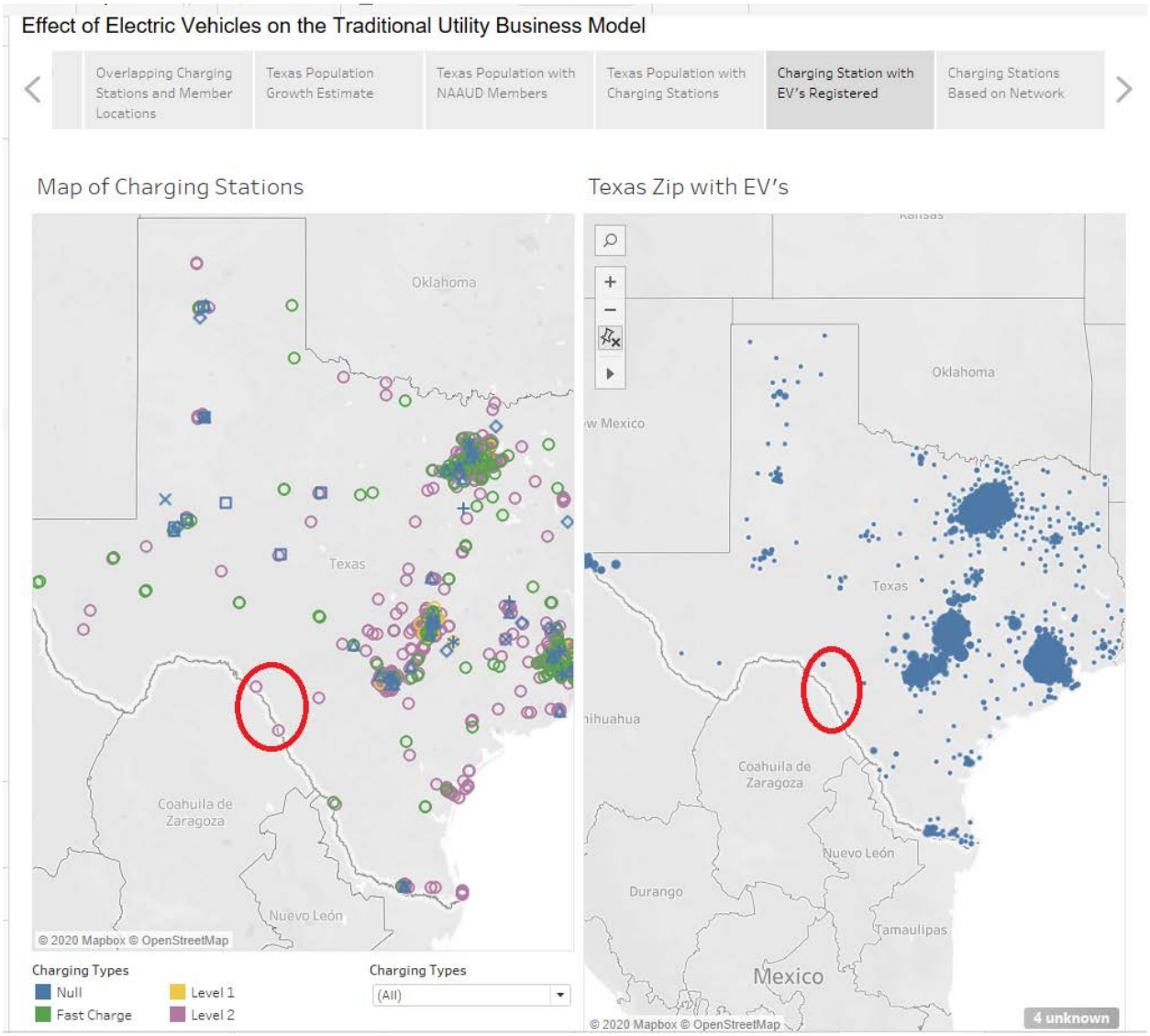

Figure 2 - Here are the 2 maps side by side of the EV charging Stations and the EVs registered by Zip Code. In the Del Rio and Eagle pass area there are only 3 public charging stations; all of which are Level 2 chargers. For the Del Rio and Eagle Pass Area, a total of 26 EV's are registered.

3. **Map provided by the Department of Energy overlapping the charging stations**

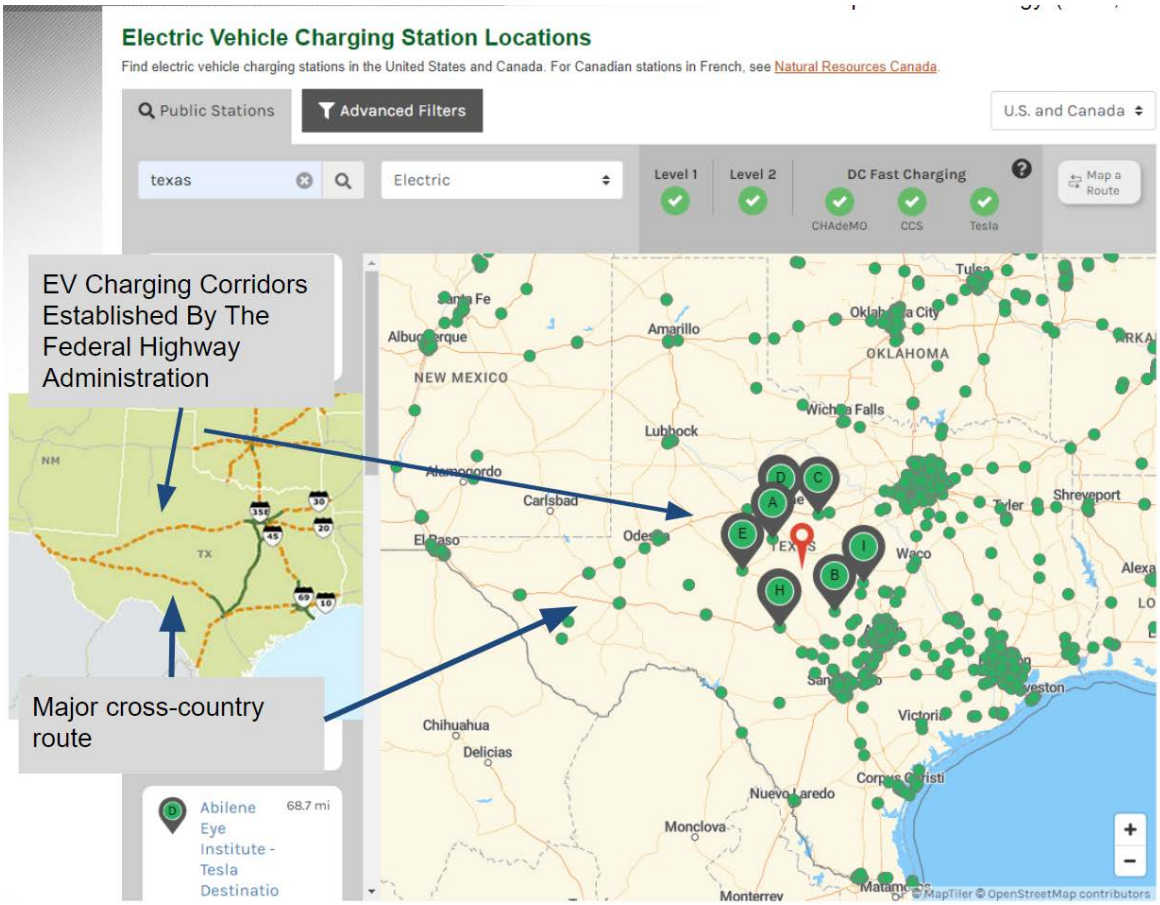

Figure 3 - highways from Google maps, showed 2 of the highways indicated as potential Alt Fuel Corridors by the Federal Highway Administration.

4. **Example Charging Model for Demand Planning**

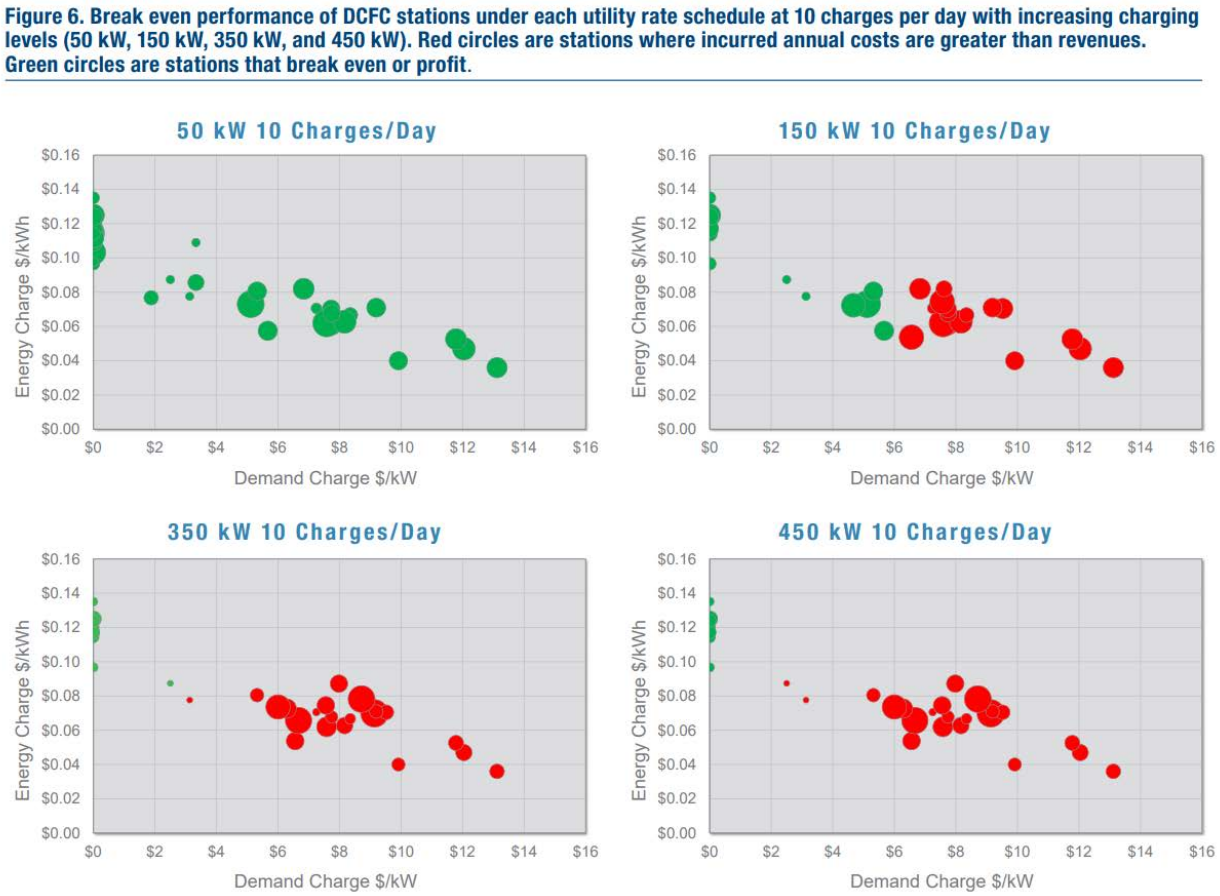

Figure 4 – Break even performance of Charging Stations

5. **Transportation Electrification Markets**

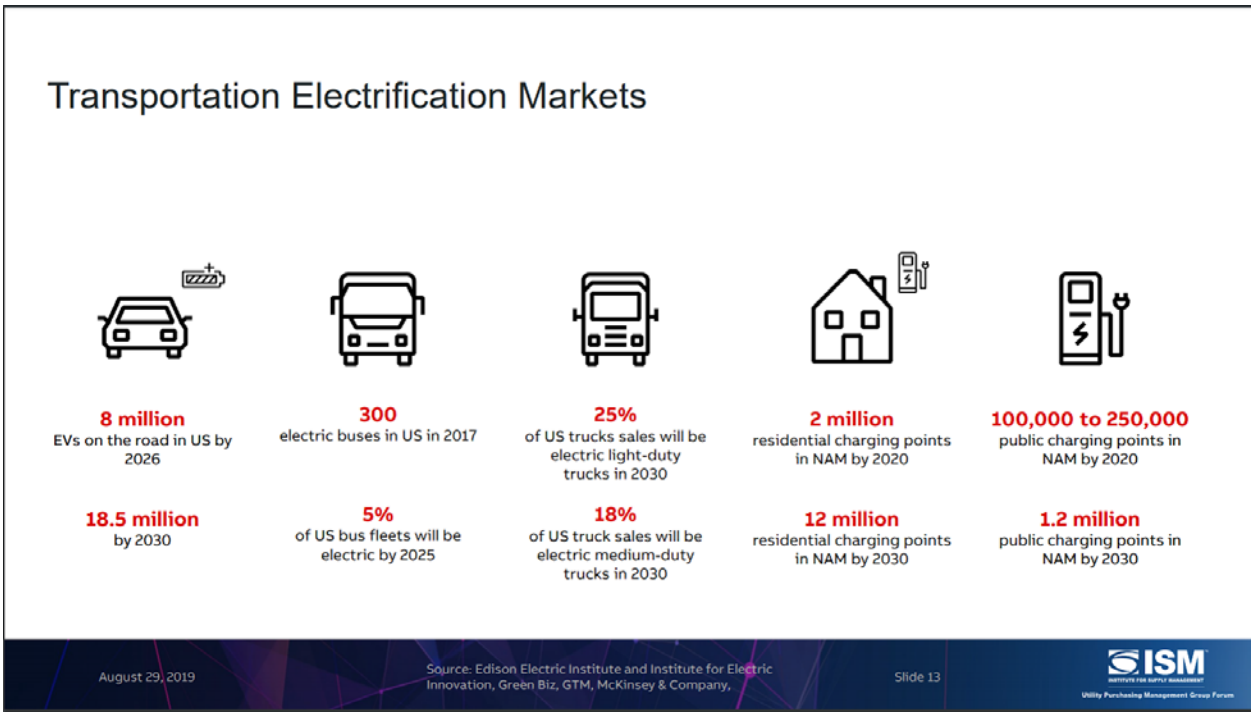

Figure 5 – Growth of EVs in the United States

6. **Commitments to emission reduction and renewable energy goals**

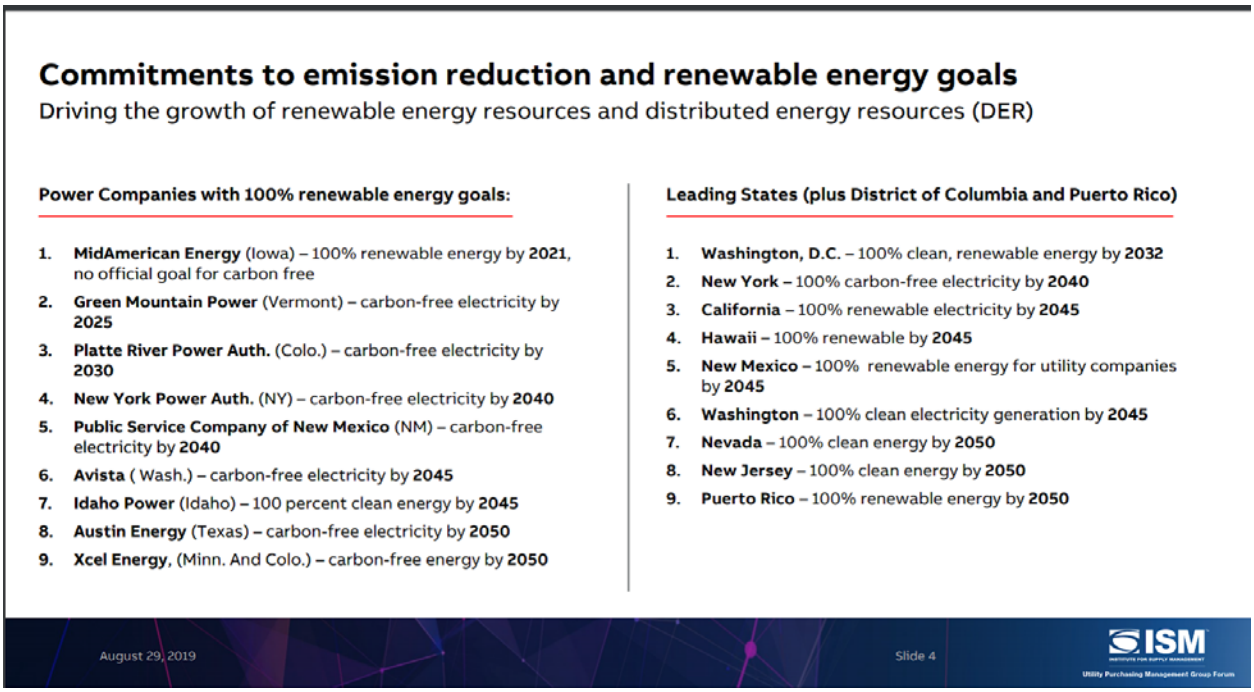

Figure 6 – Companies and States with goals for going green