Exhibit No.: _____
Issue: Liberty-Empire's Missouri Transportation Electrification Program
Witness: Stacy Noblet
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Sponsoring Party: The Empire District Electric Company
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Before the Public Service Commission

of the State of Missouri

Direct Testimony

of

STACY NOBLET

on behalf of

The Empire District Electric Company

November 29, 2020

Liberty™

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I. INTRODUCTION

Q. Please state your name and business address.

A. My name is Stacy Noblet. My business address is 9300 Lee Highway, Fairfax, Virginia, 22031.

Q. By whom are you employed and in what capacity?

A. I am employed by ICF Resources, LLC ("ICF") as Senior Director, Transportation. I lead ICF's work in clean transportation, including transportation electrification. ICF and its role in this matter are described in the Direct Testimony of Company witness Robin McAlester.

Q. On whose behalf are you testifying in this proceeding?

A. I am submitting this Direct Testimony on behalf of The Empire District Electric Company ("Liberty-Empire" or the "Company").

Q. Please describe your educational and professional background.

A. I graduated from Western Michigan University in 2003 with a Bachelor of Science in Environmental Studies and a Bachelor of Science in Geography. I received my Master of Science in Environmental Sciences and Policy from Johns Hopkins University in 2012. I have been employed by ICF for approximately 16 years and currently serve as a Senior Director in ICF's transportation domain. I support federal, state, local and utility efforts to increase the use of alternative fuels and advanced vehicles in the on-road transportation sector, particularly through the use of electric vehicles ("EVs") and the associated charging infrastructure. In recent years I have been responsible for both EV program design and implementation on behalf of electric utilities.

Q. Have you previously testified before the Missouri Public Service Commission or any other regulatory agency?

A. No, I have not previously provided testimony before the Missouri Public Service Commission ("Commission") or any other regulatory agency.

Q. What is the purpose of your Direct Testimony in this proceeding?

A. My testimony addresses the pilot programs proposed in Liberty-Empire's On-Road Component of the Transportation Electrification Portfolio ("Portfolio"), the transportation electrification industry, and the analyses ICF conducted on behalf of the Company.

Q. Are you sponsoring any schedules with your testimony?

A. Yes, the following are attached to my Direct Testimony:

- Schedule SN-1 – Cost-Benefit Analysis of On-Road Transportation Electrification, and
- Schedule SN-2 – Liberty-Empire Transportation Electrification Rate Modeling.

II. <u>TRANSPORTATION ELECTRIFICATION LANDSCAPE</u>

Q. How is electrification affecting the transportation and power sectors?

A. Electrification is fundamentally shaping all levels of the transportation sector at a national level. In many cases, technology, policy, and economic drivers are beginning to bolster the adoption of transportation electrification and associated fueling infrastructure. Advances in battery technology are increasing the driving range of EVs, as well as performance. Federal, state, and local policies in various jurisdictions have supported transportation electrification on the grounds of economic development, public health, and energy security. In a growing number of cases, EVs are approaching cost parity with their internal combustion engine counterparts on a total cost of ownership ("TCO") basis.[1] The Edison Electric Institute projects that cumulative national light-duty EV sales will increase from 1 million in 2018 to 18.7 million in 2030.[2]

As the entities responsible for the development, operation, and maintenance of electrical infrastructure, utilities must be prepared and proactive as transportation electrification evolves. Currently, EV impact on the electricity system is minimal, even in areas with relatively high adoption of EVs.[3] As transportation electrification trends continue, utilities can expect to see greater electricity sales in terms of kilowatt-hours ("kWh") from, as well as electricity demand in terms of kilowatts ("kW") attributable to, EV charging. If properly integrated, this incremental load can enhance the flexibility and reliability of the grid while increasing overall system efficiency. Additionally, the emergence of electricity as a transportation fuel places greater importance on utilities' role as a trusted energy advisor to its customers: utilities must be able to find new ways to respond to customers' needs as they relate to transportation electrification including providing information on vehicles and fueling costs, refining processes for ensuring the safe and reliable deployment of charging infrastructure, and ensuring transportation electrification can reach a diverse group of customer segments.

Q. Have other utility regulatory commissions issued guidance and orders supporting utility on-road transportation electrification efforts?

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[1] International Council on Clean Transportation, *Update on electric vehicle costs in the United States through 2030*, published April 2, 2019, available at: https://theicct.org/publications/update-US-2030-electric-vehicle-cost.
[2] Edison Electric Institute, *Electric Vehicle Sales Forecast and the Charging Infrastructure Required Through 2030*, published November 2018.
[3] Pacific Gas & Electric, Southern California Edison, San Diego Gas & Electric, *Joint IOU Electric Vehicle Load Research Report – 7th Report*, published June 19, 2019.

A. Yes, many public utilities commissions across the country have affirmed their role and utilities' role in supporting investments that accelerate on-road transportation electrification to the benefit of utility customers, the electricity system, and the public. According to Atlas Public Policy, 45 utilities across 26 states have received regulatory approval to invest nearly $1.5 billion in transportation electrification programs as of June 2020.[4] These investments are intended to support the deployment of approximately 2,600 direct current fast charge (DCFC) stations and 49,000 Level 2 ("L2") chargers, among other transportation electrification efforts.

Company witness Robin McAlester's Direct Testimony provides a summary of the Commission's previous guidance and orders supporting transportation electrification. Two additional examples from the Midwest are particularly germane: the Minnesota Public Utilities Commission's ("MPUC")[5] and the Michigan Public Service Commission's ("MPSC")[6] respective exploratory proceedings on utilities' role in charging infrastructure deployment. In a proceeding that included comments from nearly 30 intervening parties, the MPUC noted that EVs provide multiple benefits to the state in its February 2019 order, including benefits to utility customers:

> *By using more electricity, EVs can benefit all ratepayers. An increase in electricity sales can drive down rates for all ratepayers 'by spreading the utilities' fixed costs over a greater amount of kilowatt-hour sales,' especially if EV charging occurs during times of low demand when not as much electricity is consumed by customers.*[7]

[4] Lepre and Smith, *Electric Utility Filing Bi-Annual Update*, October 2020, available at: https://atlaspolicy.com/wp-content/uploads/2020/10/Electric-Utility-Filing-Bi-Annual-Brief-2020a.pdf.
[5] *Order Making Findings and Requiring Filings,* Minnesota Public Utilities Commission, Docket No. CI-17-879, February 1, 2019.
[6] *Order Adopting Guiding Principles and Commencing a Second Collaborative Technical Conference,* Michigan Public Service Commission, Case No. U-18368, Filed December 20, 2017.
[7] *Order Making Findings and Requiring Filings,* Minnesota Public Utilities Commission, Docket No. CI-17-879, February 1, 2019.

The MPUC also concluded that barriers to EV adoption persist; chiefly, the lack of charging infrastructure and lack of consumer EV awareness pose challenges to the broader adoption of EVs and realization of associated benefits. Recognizing these challenges, the MPUC found that utilities have a critical role to play in accelerating transportation electrification in Minnesota through customer education initiatives and investments that facilitate the deployment of charging infrastructure. Furthermore, the MPUC's order directs the state's investor-owned utilities to file utility transportation electrification proposals for commission review based on the range of topics discussed in the order, including: customer education and outreach, charging infrastructure investment, medium and heavy-duty electrification, EV rate design, and renewables integration.[8]

The MPSC's transportation electrification order similarly supports utility transportation efforts in Michigan and adopts a set of guiding principles intended to shape future utility EV filings.[9] Additionally, the MPSC identified four key areas that regulated utilities could consider in the filing of transportation electrification applications: customer education, rate design and smart charging, grid impacts, and deployment of charging infrastructure.[10] Building on these focus areas, the MPSC noted that it would be reviewing filings to ensure they prioritize EV load management, safe installation of charging equipment, regular reporting to inform future program design, and incorporation of new, beneficial technologies.

[8] *Id.*
[9] *Order Adopting Guiding Principles and Commencing a Second Collaborative Technical Conference,* Michigan Public Service Commission, Case No. U-18368, Filed December 20, 2017
[10] *Id.*

III. ON-ROAD TRANSPORTATION ELECTRIFICATION PROGRAMS

Q. Please provide a summary of Liberty-Empire's proposed Portfolio of on-road pilot programs.

A. The On-Road Component of the proposed Portfolio contains the following: the Residential Smart Charge Pilot Program ("RSCPP"), which provides a subscription service for residential customers to install smart L2 charging stations that encourages beneficial, time-based EV charging; the Ready Charge Pilot Program ("RCPP"), which supports the deployment of smart L2 and DCFC charging infrastructure at publicly accessible commercial customer sites for public use; the Commercial Electric Vehicle ("CEV") Rate Pilot, which encourages third-party investment in DCFC and L2 infrastructure by providing a temporary incentive to lower EV charger operational costs; the Fleet Advisory Services Pilot Program ("FASP"), which provides business case analysis, support, and technical assistance for vehicle fleets in the Company's service area seeking to transition to EVs; the Commercial Electrification Pilot Program ("CEPP"), which supports the deployment of smart L2 charging infrastructure for fleets and workplaces; and the Electric School Bus Pilot Program ("ESBPP"), which supports the deployment of smart charging infrastructure for school bus applications in the Company's service area.

The separate Administrative Component will support the On-Road Component by providing for customer education and outreach activities to increase customer enrollment and encourage beneficial charging of EVs; annual reporting and evaluation, which enables the data collection, analysis, and reporting of key portfolio metrics to the Commission and interested stakeholders; and program implementation, which supports the set-up, launch, and on-going implementation of the transportation electrification portfolio.

Q. Why is the RSCPP valuable for customers and transportation electrification growth?

A. Access to residential charging is widely considered a virtual necessity to enable the transition to light-duty EVs. If properly managed to occur off-peak, residential charging provides the greatest opportunity to drive broad utility customer and grid benefits since most light-duty EV charging currently occurs at home. When EVs are charged at home overnight, they can put downward pressure on rates and integrate renewable resources, like wind power, that may peak during evening hours. However, many customers may not have information on how to properly install EV chargers, may not understand the fuel cost savings associated with home charging relative to gasoline fuel, and may not have proper incentives to charge EVs in a manner that supports the flexibility and reliability of the grid on existing residential rates.

The RSCPP would address these three barriers by providing a turnkey solution for residential customers seeking to deploy smart charging infrastructure and receive a predictable price signal for charging overnight. Sub-metered data via the smart charger will avoid costs associated with installing a second meter. Smart chargers will provide immediate value by allowing the Company greater visibility into residential charging behavior to inform future customer offerings. In addition, these chargers are capable of accepting demand response signals, enabling more active charging and grid management in the future.

The proposed subscription rate, compared to typical monthly gasoline expenditures, will also result in cost savings for the customer.

Q. Why is the RCPP valuable for customers and transportation electrification growth?

A. Deployment of L2 and DCFC charging infrastructure is very limited in the Company's service area and remains a barrier to broader EV adoption. This is compounded by the fact that very few of the DCFC ports in the area can be used by vehicles other than Tesla. The existing charging network is insufficient to support the growth of the EV market in a manner that provides widespread grid, utility customer, and societal benefits. Additionally, regional investment in fast charging infrastructure has been extremely limited to date. Yet DCFC stations remain critical for accelerating EV adoption, increasing customer confidence in availability of fueling infrastructure, enabling long-distance corridor EV travel, and providing essential recharging opportunities for customers who are not able to install residential EV charging. Deployment, operation, and maintenance of L2 and DCFC chargers is typically not a core capacity for site hosts, and installation costs can vary widely depending on site-host specific conditions.

Electric utilities are well-positioned to efficiently site and deploy chargers using qualified contractors, maintain electrical infrastructure to ensure it remains used and useful, facilitate the equitable deployment of charging stations to increase access to electric fuel, and collect data to support greater understanding of charging dynamics in the region. Moreover, the L2 and DCFC stations deployed by the RCPP would increase customer awareness of EVs and EV charging technologies while providing key refueling opportunities at long dwell-time locations such as retail centers. These stations would also provide critical electricity access for customers without access to residential charging.

Q. Why is the CEV Rate Pilot needed to support transportation electrification in the Company's service area?

A. The economics of operating DCFC chargers in current market conditions – particularly in the Company's service territory – are very challenging. Public DCFC stations are essential for providing a regional network of charging infrastructure that will be used by the public to scale EV adoption and associated benefits. However, public DCFC projects are capital-intensive and reliant on charger utilization to recoup costs. Moreover, at current levels of EV adoption, station utilization can be characterized by brief, infrequent spikes in demand – creating a load profile that may differ significantly from other commercial customers. Under this type of low load factor profile, demand charges can often make up a disproportionate share of a DCFC operators' monthly bill: in an analysis of DCFC operational costs across several utilities, the Rocky Mountain Institute found that demand charges accounted for a significant portion of DCFC chargers' monthly operational costs – upwards of 90% in some cases.[11] Large deployments of L2 chargers at a site may also experience similar demand-related economic challenges.

The combination of near-term low utilization rates and high demand charges often precludes investment from third-party station developers, as has been the case in Liberty-Empire's area. As EV adoption grows, charger utilization and the economics of operating DCFC and L2 equipment will continue to improve. However, near-term solutions are needed to catalyze investment in DCFC in a manner that will support long-term EV adoption in the region. The CEV Rate Pilot is intended to serve as a

[11] Fitzgerald and Nelder, *EVgo Fleet and Tariff Analysis*, published 2017, available at: http://rmi.org/wp-content/uploads/2017/04/eLab_EVgo_Fleet_and_Tariff_Analysis_2017.pdf.

temporary bridge to encourage deployment of third-party charging infrastructure in the near-term while station utilization may be relatively low, and the economics of station operation are challenging. While current challenges to DCFC charger investment are acute in the Company's service area, they are by no means unique to Liberty-Empire. Having recognized the challenge of catalyzing DCFC investment, other utilities have proposed and received regulatory approval for new commercial rates and incentives that mitigate demand charges for fast charging equipment.

Q. Why is the FASP valuable for customers and transportation electrification growth?

A. The FASP is, first and foremost, and opportunity to engage with and educate customers interested in electrifying both their on- and non-road fleets. Fleet electrification can provide operational and economic benefits in the form of improved vehicle reliability and lower fueling costs relative to internal combustion engine vehicles. However, given the relative nascence of the EV market, many fleets may be unsure of how to navigate the transition and identify core infrastructure needs. Fleets may not be aware of equipment or infrastructure funding that may be available. Factors such as vehicle price and performance, infrastructure costs, fuel costs, and maintenance costs can be difficult for fleets to assess in a rapidly evolving market. Many on-road EVs have only become available commercially in the last several years and many new models across an array of vehicle platforms will be commercially ready in the next 1-3 years.[12] Fleet advisory services can help fleet customers identify which vehicles are best positioned to transition to EVs based on technical analysis and determine minimum charging

[12] CALSTART, Zero-Emission Technology Inventory, available at: https://globaldrivetozero.org/tools/zero-emission-technology-inventory/.

infrastructure requirements to support fleet operations. The results and high-level recommendations from the FASP will be available to the Commission and potentially used to inform future Company program offerings to support the electrification of fleets. The Company anticipates the FASP will also result in customer case studies, which will contribute to the growing body of education material specific to fleet electrification.

Q. Why is the CEPP valuable for customers and transportation electrification growth?

A. Fleets may be well-suited for transportation electrification – particularly as more medium and heavy-duty EVs become commercially available in the near-term. Fleets with high-mileage vehicles that are able to manage their charging to occur during low-cost periods can potentially realize fuel cost and operational savings in comparison to internal combustion engine substitutes. However, charging infrastructure presents a barrier to many fleets looking to transition to EVs. Deployment of charging infrastructure may encourage fleet managers to electrify their vehicles, providing broad utility customer, grid, and societal benefits.

Workplaces serve as important segments for EV charging: after the home, workplaces are often the location where vehicles are parked longest and would benefit from refueling opportunities. Workplaces also provide greater visibility for EV charging and can raise awareness on related EV technologies.

The CEPP intends to support an iterative build-out of smart, network-capable L2 charging stations in these key market segments to increase the use of EVs, gather information about charging behaviors in fleet and workplace settings, and engage with customers to help support their transportation electrification needs. Fleet use of charging infrastructure tends to be similar to residential charging in that it can occur overnight; installing chargers capable of accepting and responding to a demand signal will allow for improved grid management.

Q. Why is the ESBPP valuable to customers and transportation electrification growth?

A. Buses are a particularly suitable vehicle platform for electrification: they usually run consistent, short-distance routes in a defined geography and are able to recharge at centralized depots. Electric school buses can significantly reduce children's exposure to diesel pollution – especially when buses are idling during their routes. One electric bus can reduce greenhouse gas emissions by 50% compared to a diesel bus when accounting for electricity used (charged on the national average energy mix)[13]. Electric buses are also quiet compared to their diesel counterparts, which can allow for better communication between drivers and passengers, and cost less than diesel buses to maintain. Many school districts within the Company's service area serve low-income communities, making it challenging to convert to electric buses given their higher upfront cost and infrastructure requirements. The ESBPP seeks to partially address this cost barrier by providing the charging infrastructure necessary to support school bus operations. The ESBPP will also provide Liberty-Empire with new insights into how EV batteries can be leveraged to support the flexibility and reliability of the grid: because school buses are primarily used during limited morning and afternoon shifts, there is ample opportunity to manage the buses' charging patterns to benefit utility customers and the electricity system as a whole. Looking ahead, advances in vehicle-

[13] Union of Concerned Scientists, *Electric Utility Investment in Truck and Bus Charging*, April 2019, available at: https://www.ucsusa.org/sites/default/files/attach/2019/04/Electric-Utility-Investment-Truck-Bus-Charging.pdf

to-grid technology may enable the use of bus batteries as back-up power sources, which is particularly valuable given that many schools serve as emergency shelters for the community.

Q. Are there similar utility programs elsewhere that the Company used as models or are useful for comparison?

A. Yes. The RSCPP follows a model very similar to Xcel Energy's EV Home Service Program[14], which is the third iteration of Xcel's EV charger subscription offerings and now a permanent offering for residential customers. Filed with the MPUC in 2019[15], the program gives residential customers the opportunity to pay a monthly subscription fee in exchange for a turnkey installation of qualified L2 chargers and ability to charge at lower rates during off-peak hours. The program eliminates the need for a second meter by leveraging the submetering capabilities of the L2 chargers, which sends billing-grade utilization data to the utility via the customers' Wi-Fi network and saves customers money. Xcel owns the charging station until the pilot ends or when customers pay back the full value of the chargers over time via the monthly subscription charge. Xcel set the monthly customer charge for participating customers at a level that covers all the costs associated with the programs – meaning that none of the cost of the pilots have been recovered from non-participating customers.

While not an investor-owned utility, Roanoke Electric Cooperative in North Carolina offers a residential EV charging subscription pilot program at a cost of $50

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[14] See https://www.xcelenergy.com/programs_and_rebates/residential_programs_and_rebates/electric_vehicles/ev_subscription_service_pilot

[15] See https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId=%7bE067E46C-0000-C51B-9F3A-CE1803EC2609%7d&documentTitle=20198-155611-01

per month.[16] The cooperative is leveraging the program as a means to engage and educate customers about potential cost savings, which are estimated at approximately $135 per month compared to the cost to fuel a gasoline vehicle averaging 20 miles per gallon.

Aspects of the RCPP are similar to Evergy's Clean Charge Network, which is owned and operated by the utility, as Liberty-Empire seeks to align with other utilities operating in Missouri to the extent possible. In particular, the Liberty-Empire's proposed pricing structure for public charging fees mirrors Evergy's current structure in Missouri.[17] Further, Evergy's robust Clean Charge Network education and awareness campaign provides an excellent model for Liberty-Empire as part of the Administrative Component.

With regard to the CEV Rate Pilot, the California Public Utilities Commission has approved similar commercial EV tariffs that meet cost-causation principles and avoid demand charges that do not align system costs with rates.[18] Beyond California, utility regulators in Minnesota,[19] Maryland,[20] New York,[21] and several other jurisdictions have approved various approaches to limit the financial impact of demand charges, at least

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16 See https://www.roanokeelectric.com/2020/10/roanoke-electric-co-op-offers-1000-incentive-to-first-ten-ev-rate-subscribers/.

17 KCP&L Greater Missouri Operations Company, Clean Charge Network Schedule CCN, effective December 6, 2018, available at: https://www.evergy.com/-/media/documents/billing/missouri/detailed_tariffs_mo/gmo/clean-charge-network-120618.pdf?la=en.

18 See https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M215/K783/215783846.PDF and https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M318/K552/318552527.PDF.

19 See https://www.xcelenergy.com/staticfiles/xe/Regulatory/Regulatory%20PDFs/rates/WI/2We_Section_2New.pdf.

20 See https://webapp.psc.state.md.us/newIntranet/Casenum/NewIndex3_VOpenFile.cfm?FilePath=//Coldfusion/Casenum/9400-9499/9478/109.pdf.

21 See http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={15AA7B65-DF8C-4511-8F3D-F19B37F3F48D}.

temporarily, to help scale the deployment of EV charging infrastructure needed to support EV adoption.

The FASP follows the example set by a growing number of utilities. National Grid received regulatory approval in Rhode Island[22] and Massachusetts[23] to conduct fleet electrification studies, the latter for a total of 100 fleet operators under a fleet advisory services program. The goal of these studies is to help customers make informed decisions about electrifying their fleets and to facilitate connections with charging providers and other vendors. The New York State Public Service Commission issued an Order in July 2020 that, among other things, directs utilities to establish a Fleet Assessment Service.[24] The service would include site feasibility and rate analysis.

While different in design, Liberty-Empire looked to Dominion Energy's electric school bus program in Virginia when scoping the proposed ESBPP. Dominion is partnering with school districts to replace diesel buses with electric, with no incremental vehicle purchase cost to the district. The first 50 buses are expected to be deployed by the end of 2020 and Dominion is exploring opportunities to leverage vehicle-to-grid technology in the future.[25]

Q. Please provide a basic overview of on-road electric vehicle chargers and related costs.

A. EV chargers are the means by which EVs are refueled. EVs typically refer to both battery electric vehicles and plug-in hybrid electric vehicles, with the latter type also

[22] Rhode Island, Amended Settlement Agreement, Docket Nos. 4770 and 4780, August 16, 2018, available at http://www.ripuc.ri.gov/eventsactions/docket/4770-4780-NGrid-ComplianceFiling-Book%201%20through%207%20-%20August%2016,%202018.pdf.
[23] Massachusetts Department of Public Utilities, 18-150 Order, September 30, 2019, available at: https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/11262053.
[24] New York Public Service Commission, *Order Establishing Electric Vehicle Infrastructure Make-Ready Program and Other Programs*, July 16, 2020.
[25] See https://www.dominionenergy.com/our-stories/electric-school-buses.

equipped with an internal combustion engine. Table 1 below provides an overview of available on-road charger types, their power requirements, miles of range provided, and where they are typically located.

Table 1. EV Charger Overview[26]

Station Type	**Typical Power Levels**	**Miles of Range per Hour of Charge**	**Typical Locations**
Level 1	110/120V (AC), 12-16 Amps, 1.2-1.4 kW	3-4 miles per hour	Residential
L2	208/240V (AC), 16-80 Amps, 3.3-6.6 kW	10-20 miles per hour	Residential, Public/Commercial, Workplace
DCFC	480+V (DC),100+ Amps 50-350 kW	150+ miles	Public/Commercial, Intercity

Level 1 ("L1") chargers provide a slow charge to vehicles and are typically suited for long dwell-time locations such as residences. L1 chargers are generally not network-enabled and cannot enable smart, managed EV charging. L2 chargers typically provide a moderate rate of charge and are well-suited for long dwell-time locations like residences, workplaces, recreational areas, and retail shopping centers. Many L2 chargers are network-enabled, also referred to as "smart," and able to relay station performance data to a network or site host. DCFC chargers provide a quick charge and refuel vehicles at a rate of 50 kW or above. These chargers are critical for providing refueling opportunities for EV drivers without access to home or workplace charging; they also can help enable intercity travel along major highway corridors and improve consumer confidence in EV technologies. DCFC stations are valuable in locations with heavy vehicle traffic or where vehicles park for short periods of time: urban/suburban

[26] Data adopted from *Estimating electric vehicle charging infrastructure costs across major U.S. metropolitan areas* (International Council on Clean Transportation), available at: https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf.

retail cores, grocery stores, gas stations, rest areas, and highway corridors. A combination of these charger types is necessary to create a regional network of charging infrastructure that supports the adoption of EV technologies.

EV charger costs vary depending on several factors, including the charger type, the location it is deployed, and the features included in the hardware. Table 2 below provides an estimate of the cost associated with chargers deployed in public and workplace settings. While precise costs for charging station hardware may differ in Liberty-Empire's service territory, these estimates are reasonable. Many L2 chargers are equipped with multiple plugs or "ports," which helps to improve the cost-effectiveness of deployment in certain settings.

Table 2. Public and Workplace Charging Station Hardware Costs[27]

Level	**Type**	**Estimated Cost**
L1 single charger	Non-networked[28]	$813
L2 single charger	Networked/smart	$3,127
L2 dual-port charger	Networked/smart	$5,586
DCFC 50 kW charger	Networked/smart	$28,401
DCFC 150 kW charger	Networked/smart	$75,000

The deployment of EV chargers also includes several other core costs components, including the cost of "make-ready" infrastructure. Make-ready infrastructure refers to

[27] Data adopted from *Estimating electric vehicle charging infrastructure costs across major U.S. metropolitan areas* (International Council on Clean Transportation), available at: https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf.
[28] Non-networked chargers refer to chargers that are not connected to a network and cannot send or receive data to or from external sources. Networked or smart chargers, on the other hand, do have this capability.

all necessary electrical equipment upstream of the EV charger necessary to provide power to a vehicle. These costs include conduit, wiring, site enhancements, panel upgrades, metering, utility-side distribution infrastructure, and the installation costs associated with this equipment.

Make-ready infrastructure costs will vary depending on the individual needs of each site as well as the ability of the local distribution system to accommodate incremental load. The International Council on Clean Transportation estimates that typical installation costs for L2 chargers are approximately $2,800-$3,100 per charger while installation costs for DCFC chargers are approximately $45,000-$47,000 per charger[29]; these estimates are reasonable for charging installation in the Company's service area. Modest per-charger installation cost reductions can be achieved by deploying multiple chargers at a single site.

A robust regional charging infrastructure network requires the deployment of multiple charger types across an array of locations. Charger installation costs are driven by additional electrical infrastructure requirements and often represent a non-trivial portion of overall deployment costs.

IV. TRANSPORTATION ELECTRIFICATION ANALYSIS

Q. What is the current state of the on-road electric vehicle market in the Liberty-Empire Missouri territory?

A. There are an estimated 568 light-duty EVs within Liberty-Empire's service territory as of the end of 2019, representing approximately 6% of all EVs registered in Missouri.[30]

[29] Data adopted from *Estimating electric vehicle charging infrastructure costs across major U.S. metropolitan areas* (International Council on Clean Transportation), available at: https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf.
[30] IHS Markit, County Vehicle Registrations by Fuel Type as of December 2019, purchased February 2020.

Currently, EVs represent less than 1% of total light-duty vehicles in the service territory. Compared to the national average of 2% of the total light-duty market share, this deficit indicates clear potential for additional adoption and encouragement of EVs in the area.

Q. Please describe the on-road EV forecasts the Company developed and their results.

A. To establish EV adoption beyond 2019, for the purpose of this filing, ICF used the Reference Case from the 2020 Energy Information Administration Annual Energy Outlook as a starting point for the baseline EV penetration case. The high scenario applies historical hybrid electric vehicle ("HEV") escalation rates, which can be considered a proxy for ideal market growth. The medium scenario takes the average of the baseline and high scenarios. ICF then adjusted all three scenarios to account for potential impacts of the COVID-19 pandemic on short term EV sales by applying historical Missouri vehicle sales escalation rates following the 2008 recession. Only the scenarios with potential COVID-19 impacts were employed in this analysis to be conservative. The total EVs forecasted for 2025 under the medium EV adoption scenario are 1,478. In 2030 the forecast grows to 2,211 total EVs for the medium scenario. ICF's cost-benefit analysis, provided as Schedule SN-1, includes a summary of the EV adoption forecasts.

Q. How much charging infrastructure is needed to support on-road EV adoption in Missouri and the Company's service territory?

A. There is no precise number of EV chargers needed to encourage EV adoption; however, it is clear that the current deployment levels of charging infrastructure are insufficient to support transportation electrification and associated benefits moving forward. The U.S. Department of Energy's EVI-Pro Lite tool provides estimates of public EV charging infrastructure needed to support a given number of vehicles in a jurisdiction.[31] In a scenario where approximately 10% of the light-duty vehicles in the state are electrified, approximately 12,474 public L2 plugs and 1,180 DCFC plugs are needed to satisfy demand.[32] In the Joplin area, EVI-Pro Lite estimates that 198 public L2 plugs and 20 DCFC plugs will be needed to support an EV adoption level of 10%. Table 3 below compares current levels of charger deployment against estimated infrastructure needs.

Table 3. EVI-Pro Lite Charging Infrastructure Demand Assessment (10% EV Adoption)

Missouri			*Joplin Area*[33]		
	Current Plug Count	**Estimated Plug Needs**		**Current Plug Count**	**Estimated Plug Needs**
Public L2	1,710	8,056	**Public L2**	16	122
Public DCFC	204	1,180	**Public DCFC**	8*	20

Source: U.S. Department of Energy

It is worth noting all eight available DCFC plugs in the Joplin area are Tesla Superchargers at one location, which can only be used by Tesla vehicles.[34]

ICF used the same methodology applied in the EVI-Pro Lite tool to project infrastructure needs for the baseline and medium EV adoption scenario within Liberty-Empire's service territory. In the baseline scenario where 1,700 vehicles are electrified by 2030, approximately 80 public L2 plugs and 16 DCFC plugs are needed to satisfy demand. In the medium EV adoption scenario where 2,211 vehicles are electrified by 2030, approximately 100 public L2 plugs and 17 DCFC plugs are needed to satisfy

[31] The EVI-Pro Lite tool does not provide outputs on where the charging infrastructure should be sited. It only quantifies estimated need. See https://afdc.energy.gov/evi-pro-lite.
[32] Analysis assumes that 100% of EV drivers have access to home charging.
[33] Note that Liberty Utilities' service area includes and extends beyond the Joplin area. These Joplin area charging infrastructure estimates likely underestimate charging need in the service area.
[34] U.S. Department of Energy, Alternative Fueling Station Locator, available at: https://afdc.energy.gov/stations/#/find/nearest.

demand. These figures are shown in Table 4 below. It is worth noting that 8 of the 12 DCFC plugs in the territory are restricted to Tesla use only. To serve the maximum number of EV drivers, infrastructure installed by the Company would be equipped with connectors that can be used by most EVs.

Table 4. Charging Infrastructure Demand Applied to Liberty-Empire EV Projections

	Current	2030 Baseline	2030 Medium
Total EVs	568	1,700	2,211
Public L2	72	80	100
Public DCFC	12*	16	17

Additional charging infrastructure will be necessary to account for workplace charging needs, residential charging needs, and charging needs of fleets, including medium and heavy-duty vehicles. Moreover, the Joplin area highlighted previously only represents a fraction of the Company's total service area and estimated need for charging infrastructure. In sum, there exists a charging infrastructure gap that limits widespread transportation electrification and associated benefits. Realizing the benefits of transportation electrification depends in part on the development of a robust, accessible network of charging stations.

Q. How were these projected infrastructure figures used to determine the scope of the proposed on-road pilot programs?

A. The infrastructure projections resulting from the EVI-Pro Lite tool, using ICF's EV adoption forecasts, provided the Company with valuable reference points to scale the scope of the pilot programs. For example, under the Ready Charge Pilot Program, the Company seeks to install *up to* 15 DCFC stations available for public use, all of which would be equipped with connector types that allow nearly any EV driver to charge.

Adding these chargers to the four non-Tesla DCFCs in the territory would bring the total installed DCFCs in line with the projected needs in 2030 under a relatively conservative EV growth scenario.

Q. What are the expected grid impacts from the proposed Portfolio of pilot programs?

A. The estimated annual load associated with the projected number of light-duty EVs on the road in Liberty-Empire's service area in 2025 is 3,506,407 kWh. This is determined by multiplying the projected EV population under the medium adoption scenario by 2,372 kWh per vehicle per year.[35] To that we add the estimated load resulting from the Non-Road Component, as described in Ms. Coletti's Direct Testimony, which is 30,480 megawatt-hours of gross annual load by the end of the five-year program.

This additional load, if managed properly, has the potential to result in downward pressure on rates, which would benefit all customers in the form of reduced energy costs. This has been observed in utility territories in California.[36] If additional load is unmanaged and left to grow without being monitored, given appropriate price signals, and potentially controlled through smart charging infrastructure, this increased load could put strain on the grid and result in costly utility investment to ensure additional capacity. The Company's proposed on-road pilot programs seek to build out smart, network-capable EV charging infrastructure used by multiple market segments. The Company will gather data to better understand charging patterns in a variety of settings and help inform future EV charging program needs. These pilot programs also

[35] Assumes 12,000 vehicle miles per year, 0.30 EV efficiency, 45% eVMT for PHEVs, 38% BEV and 62% PHEVs.
[36] Frost, et al, *Electric Vehicles are Driving Electric Rates Down*, June 2020 update, available at: //www.synapse-energy.com/sites/default/files/EV_Impacts_June_2020_18-122.pdf.

include an important customer engagement component, which will allow the Company to educate EV drivers and charging site hosts about how to leverage technology (e.g., smart chargers) in order to align with reduced time-based pricing.

While the realized impacts of properly managing the increased transportation electrification load are still to be determined, ICF conducted a modeling exercise to simulate the potential for downward pressure on rates. Our approach considered the Company's base case revenue requirement and kWh load and added to that the estimated revenue requirement and kWh associated with the proposed Portfolio. We then adjusted the resulting System Average Rate ("SAR") to account for the incremental supply cost of charging, drawing from our cost benefit analysis. We assumed the managed additional load does not result in additional infrastructure investment or utility costs beyond the proposed Portfolio costs.

This modeling shows the potential for a slight increase to the SAR during the first three years of the programs and then a decrease to the SAR in subsequent years. Refer to Schedule SN-2 for additional details of this modeling.

Q. What are the estimated customer bill impacts resulting from the proposed Portfolio of pilot programs and how were those impacts determined?

A. Similar to the rate pressure discussion above, the actual impact of these programs to customer bills are to be determined. The Company intends to closely track cost and participation data during the initial years of the pilot to gain an understanding of how costs should be recovered from which customers.

For the purpose of simulating what the customer bill impacts might be, ICF again leveraged the Company's authorized revenues and associated kWh figures by customer class. We calculated the average monthly bill for each customer class, providing a baseline or business-as-usual metric.

We then took the proposed pilot program costs and allocated those to what we anticipate will be the customers that will participate and/or benefit from each pilot program, recognizing that all customers are expected to benefit from these programs in the form of eventual downward pressure on rates. Those costs were then added to the class revenue requirement and baseline monthly bill to calculate a bill impact per month in dollars/cents and as a percent. Our modeling suggests a 0.4% increase in customer bills across all categories, with percentages ranging from 0.1% for residential customers to 0.8% for the larger commercial classes.

Schedule SN-2 reflects ICF's calculations and the results of this exercise. It is important to note, again, that ICF's modeling is only intended to simulate potential average customer bill impacts, not illustrate the exact impacts associated with the proposed Portfolio or customer-specific bill impacts.

Q. What is the overall impact of increased on-road transportation electrification in the Company's service territory?

A. ICF's cost-benefit analysis, provided in Schedule SN-1, demonstrates that there are net customer benefits associated with EV adoption, with a net present value ("NPV") of approximately $6 million between now and 2040. This is equivalent to customer benefits with an NPV of about $2,706 per EV deployed under the medium adoption scenario. It is important to note that this analysis does not include ancillary benefits that would likely increase the estimated benefits of EVs to customers—including by improving utility load factor and better distribution asset management. In scenarios where charging is managed and there is no net increase in demand charges at non-residential locations, then there may be a small decrease in the net benefit to customers.

Participants (EV drivers) benefit the most when EV pricing is assumed to be low and when they can take advantage of lower nonresidential rates. We report an NPV benefit of $2 million or $943 per EV deployed when the low incremental EV pricing scenario is used; this becomes a maximum NPV cost of $12 million for EV drivers or nearly $5,848 per EV deployed when the high incremental EV pricing assumption is employed.

The societal impacts of EV adoption are most sensitive to EV pricing. Under the low incremental EV pricing scenario, and medium rate of EV adoption, we report a net benefit of $8 million, valued at approximately $3,650 per EV deployed. However, as EV pricing increases to the high incremental cost, we report net societal costs of over $7 million or nearly $3,142 per EV deployed.

Q. Please describe the methodology used for the Company's benefit cost analysis.

A. ICF's analysis focuses on the notion that increased EV adoption can yield net societal and customer benefits, while also benefiting EV drivers. As has been emphasized in presentations, discussions, and filed testimony across the industry since transportation electrification programs emerged less than a decade ago, it is extremely challenging for any utility to accurately attribute the impacts of an EV charging program. The Company's proposed portfolio of pilot programs represent the critical first step in addressing and reducing multiple barriers to increased EV adoption and ultimately realizing the broader benefits characterized in ICF's analysis.

For the purpose of the benefit cost analysis, a participant is an EV driver in the territory, not specifically those that participate in one of Liberty-Empire's pilot programs. The benefit cost tests used in the analysis are displayed in Table 5 and further assumptions and details can be found in Schedule SN-1.

Table 5. Summary of Benefit Cost Tests Used

	Costs			Benefits		
Energy Costs	Societal	Participant	Customer	Societal	Participant	Customer
Energy Supply	C		C			
Capacity	C		C			
Retail Electricity Bills		C				B
Vehicle Costs						
Incremental Vehicle Price	C	C				
Federal Tax Credit				B	B	
O&M Costs				B	B	
Avoided Gasoline Costs				B	B	
Charging Infrastructure Costs						
Level 2	C		C			
DCFC	C		C			

V. CONCLUSION

Q. Does this conclude your direct testimony?

A. Yes.

VERIFICATION

I, Stacy Noblet, under penalty of perjury, on this 29th day of November, 2020, I declare that the foregoing is true and correct to the best of my knowledge and belief.

___/s/ Stacy Noblet________

Cost-Benefit Analysis of On-Road Transportation Electrification

Liberty-Empire, Missouri

November 2020

Prepared for:
Liberty-Empire

Prepared by:
ICF

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Executive Summary

Liberty-Empire has identified several critical investments in transportation electrification that will help encourage plug-in electric vehicle (EV) adoption in its Missouri service territory, including innovative pilot programs focused on direct investment in charging infrastructure. This cost-benefit analysis serves as a critical background document supporting Liberty-Empire's investments. ICF's analysis shows that increased EV adoption can yield net societal and customer benefits, while also benefiting EV drivers—and that these benefits have the potential to increase with more rapid EV adoption, managed charging, and including the costs of required DC fast charging infrastructure. Liberty-Empire's proposed pilot programs are a critical first step to realizing the broader benefits characterized in ICF's analysis. While the proposed pilot programs include efforts to promote medium-duty and heavy-duty vehicle electrification, this analysis focuses on light-duty vehicles.

ICF's analysis concludes that there are net customer benefits associated with EV adoption. Specifically, ICF estimates a net present value (NPV) across different assumptions in the range of $4 to $6 million between now and 2040.

ICF's analysis also demonstrates the overall beneficial impact of managed charging, such as through incentivizing the use of energy during off-peak periods. The comparison between the costs of charging that increases peak demand compared to no impacts on peak demand provides a proxy for potential benefits from managed charging. This analysis does not include the potential benefits of improved utility load factor and avoided distribution costs through improved asset management associated with managed charging. Even modest benefits from improved utility load factor and distribution asset management will likely offset any increases in costs presented by ICF.

The societal impacts of EV adoption are closely linked to EV pricing. ICF's analysis demonstrates a net benefit of $7.0 to $8.9 million (or $3,294 to $4,131 per EV deployed) under the low incremental EV pricing scenario. As EV pricing increases, however, the estimated net societal benefits decrease to -$0.1 to $1.1 million in the medium incremental EV pricing scenario. Actively managing charging may also help decrease net societal costs by reducing the increased demand through better utilization of charging infrastructure.

For the purpose of this analysis and report, a participant is an EV driver in the territory, not specifically to those that participate in one of Liberty-Empire's pilot programs. Participants benefit the most when EV pricing is assumed to be low, and these benefits will increase when participants can take advantage of lower cost non-residential charging (e.g., when a facility can reduce the fees that it collects from EV drivers). ICF reports an NPV cost of $3.8 million or $2,235 per EV deployed when the medium incremental EV pricing scenario is used; this becomes a net benefit with a maximum NPV benefit of $2 million for EV drivers or $1,227 per EV deployed under the low incremental EV pricing assumption.

1. Introduction

Liberty-Empire has identified several critical investments in transportation electrification that will help encourage EV adoption in Missouri. The EV market in Liberty-Empire's service territory has shown modest growth over the past two years, with EVs on the road increasing from about 251 EVs in 2017 to about 568 on the roads at the end of 2019.[1] Roughly 38 percent of those light-duty EVs are battery electric vehicles (BEVs) like the Tesla series (including Models 3, S, and Y), the Chevrolet Bolt, and the Nissan LEAF; and 62 percent of EVs are plug-in hybrid electric vehicles (PHEVs) like the Chevrolet Volt and the Toyota Prius Prime Model.[2]

This cost-benefit analysis serves as an important background document supporting Liberty-Empire's development of innovative pilot programs and infrastructure investments to encourage EV adoption in its Missouri service territory.

Table 1 below summarizes the costs and benefits for each of the three perspectives—Societal, Participant (or EV driver), and Customer—considered in this analysis, with costs listed in red (C) and benefits listed in green (B).

Table 1. Summary of Costs and Benefits

	Costs			Benefits		
Energy Costs	Societal	Participant	Customer	Societal	Participant	Customer
Energy Supply	C		C			
Capacity	C		C			
Retail Electricity Bills		C				B
Vehicle Costs						
Incremental Vehicle Price	C	C				
Federal Tax Credit				B	B	
O&M Costs				B	B	
Avoided Gasoline Costs				B	B	
Charging Infrastructure Costs						
Level 2	C		C			
DCFC	C		C			

Section 2 of this document provides an overview of data and assumptions employed in the analysis and Section 3 summarizes ICF's findings.

[1] IHS Markit, *County Vehicle Registrations by Fuel Type as December 2019*, https://ihsmarkit.com/index.html, purchased February, 2020.

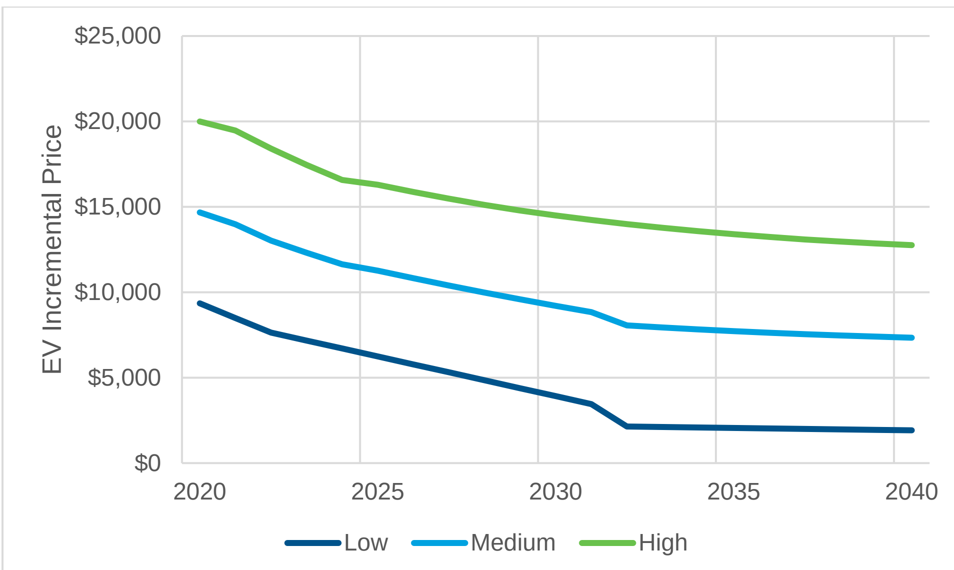
2. Data & Assumptions

Electric Vehicles

EV Pricing

The rate of anticipated decline of EV pricing has become a subject of considerable debate, particularly because of recent market research conducted by analysts such as Bloomberg New Energy Finance (BNEF). BNEF continues to forecast rapidly declining battery prices, which contrasts sharply with more conservative estimates from the U.S. Energy Information Administration (EIA), as outlined in the Annual Energy Outlook (AEO). The range of EV pricing assumptions makes for difficult choices in cost-benefit analyses; in this analysis, three different pricing outlooks were used. Figure 1 shows the assumed low, medium, and high EV incremental price trajectories employed in this analysis.

Figure 1. EV Incremental Pricing in ICF Modeling



The low EV incremental pricing (see dark blue line in Figure 1) is consistent with a methodology that ICF developed in partnership with E3 and MJ Bradley as part of a cost-benefit analysis of EV adoption in New York State. In that case, the project team modeled incremental EV pricing based on the cost of the "glider" (a simple vehicle chassis and body) and the cost of batteries ($/kWh), electric drive train ($/kW), and gasoline drivetrain (for PHEVs, in units of $/kW). The incremental vehicle pricing of the Ford Fusion was used as a baseline.

The high EV incremental pricing is consistent with 2020 AEO forecasts (see green line in Figure 1) across the various light-duty vehicle segments included in EIA's modeling, whereas the medium EV incremental pricing is simply an average of the low and the high values.

EV Purchase Incentives

ICF assumed that the federal tax credit (i.e., the Qualified Plug-in Electric Drive Motor Vehicle Credit) will be available until 2025. Note, however, that the federal tax credit has a nuanced sunset provision—the tax credit is phased out for each manufacturer based on total vehicle sales. The phase out is described here:

> The qualified plug-in electric drive motor vehicle credit phases out for a manufacturer's vehicles over the one-year period beginning with the second calendar quarter after the calendar quarter in which at least 200,000 qualifying vehicles manufactured by that manufacturer have been sold for use in the United States (determined on a cumulative basis for sales after December 31, 2009) ("phase-out period"). Qualifying vehicles manufactured by that manufacturer are eligible for 50 percent of the credit if acquired in the first two quarters of the phase-out period and 25 percent of the credit if acquired in the third or fourth quarter of the phase-out period. Vehicles manufactured by that manufacturer are not eligible for a credit if acquired after the phase-out period.[2]

Tesla and GM have already passed the 200,000-vehicle threshold. Given that there is no specific date for a phase out of the federal tax credit, ICF assumed that it would be available through 2025.

EV Operations and Maintenance Costs

Most market research indicates that EVs should have lower operations and maintenance (O&M) costs than conventional vehicles because of fewer oil changes, less wear and tear on brakes, and other factors. For the purposes of this analysis, ICF used a variety of data sources to estimate avoided O&M costs for EVs compared to conventional vehicles. We assumed about a 1.4 cents per mile difference between EVs and conventional vehicles; assuming 12,000 annual vehicles miles traveled (VMT), which results in $167 O&M savings per vehicle per year.

EV Adoption

Like forecasting battery EV pricing trajectory, EV adoption trajectory can stir considerable debate among stakeholders—including advocates and detractors of electrification alike. This analysis requires some estimates of year-by-year adoption (conducted out to 2040). To establish EV adoption beyond 2019, ICF used the Reference Case from the 2020 AEO as a starting point for the baseline EV penetration case. The high scenario applies historical hybrid electric vehicle (HEV) escalation rates to estimate supportive market conditions (e.g., state-level policy, ample vehicle availability). The medium scenario is the average between the baseline and high scenarios. All three scenarios were adjusted to account for potential impacts of the COVID-19 pandemic on short term EV sales by applying historical Missouri vehicle sales escalation rates following the 2008 recession.[3] Figure 2 shows the baseline and high forecasted EV adoption scenarios with and without the potential COVID-19 impacts applied. Figure 3

---

[2] Internal Revenue Service. Plug-In Electric Drive Vehicle Credit (IRC 30D), Accessed March 2019 online via https://www.irs.gov/businesses/plug-in-electric-vehicle-credit-irc-30-and-irc-30d.

[3] National Automobile Dealers Association. Accessed online June 2020 via https://www.nada.org/nadadata/

shows the baseline, medium, and high scenarios, all with the potential COVID-19 impacts applied, which were used in this analysis.

Figure 2. Impact of COVID-19 on EV Adoption in ICF Modeling Scenarios

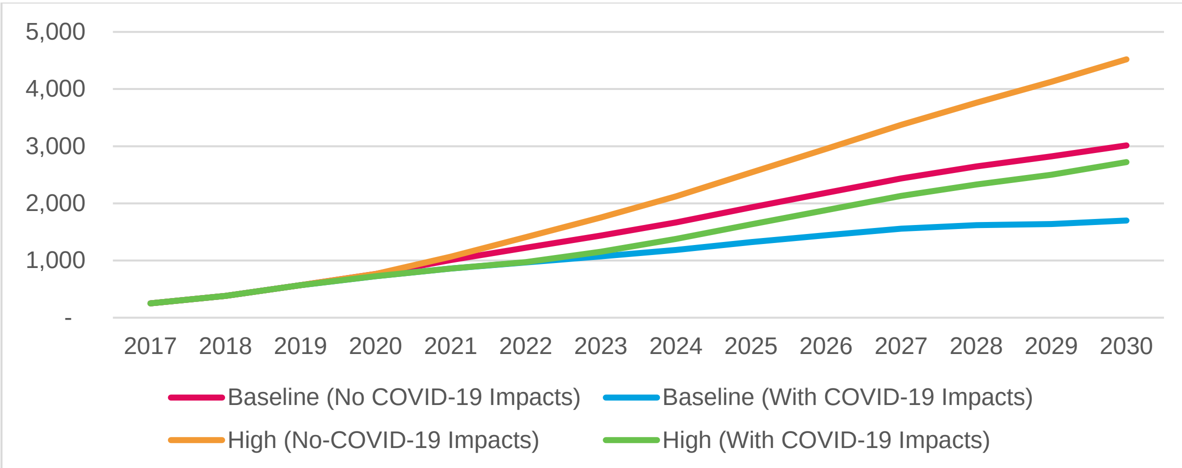
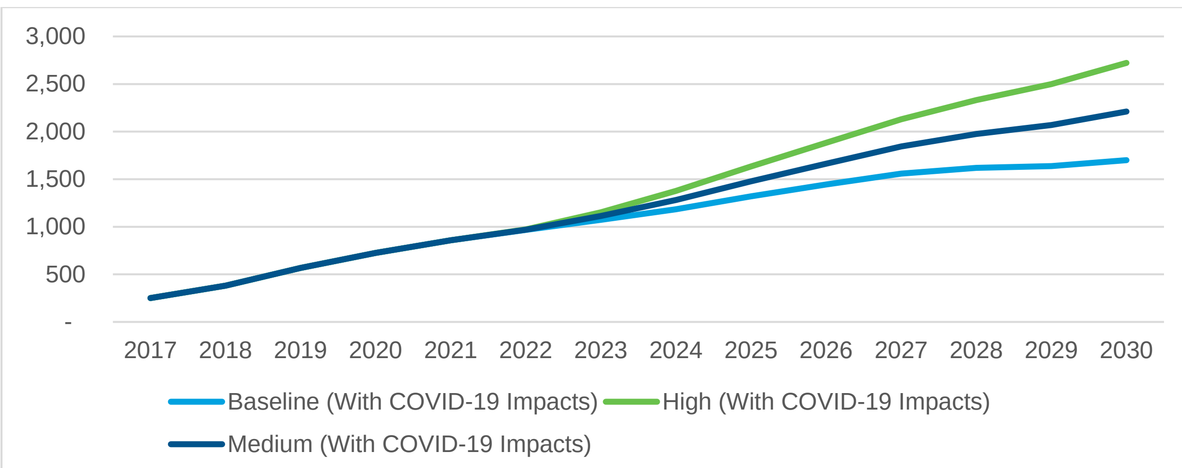


Figure 3. Liberty-Empire Utilities Baseline, Medium, and High EV Adoption Scenarios



Fuel Pricing

Electric Rates for EV Charging

For this analysis, rate information was provided by Liberty-Empire via their Rate Calculator. ICF's modeling uses a mix of residential and commercial rates to understand how early adopters might react to different price signals, and to be consistent with market observations in other jurisdictions. ICF extracted two rates for Residential Service (Schedule RG) and for General Service Demand (Schedule GP). ICF assumes that about 80 percent of charging will occur at EV drivers' residence,[4] and that the costs of EV charging are based on Schedule RG which equate to $0.13/kWh. ICF did not assume any

[4] Consider for instance, DOE's assumption stated at https://www.energy.gov/eere/electricvehicles/charging-home; this commonly referenced statistic is based largely on DOE EV Project data.

differences in charging behavior between the summer and winter, so an average residential rate was estimated based on the rate or tariff components outlined below. Further, we escalated residential rates in line with electric supply cost escalation rates.

Avoided Energy Costs

To calculate the incremental dollar costs to society and the utility customer resulting from the changes in electrical loads, avoided utility costs were used—including the energy costs and capacity costs. Liberty-Empire provided avoided energy costs—including for energy and capacity.

Gasoline Pricing

Gasoline pricing was developed using a combination of wholesale gasoline pricing, EIA forecasts for the 2020 AEO, and state and federal taxes. Table 2 below summarizes the gasoline pricing projections included in the modeling.

Table 2. Gasoline Pricing Components used in ICF Modeling

Parameter	Description
Wholesale price of gasoline	ICF used 2020 national average for wholesale gasoline prices and forecasted based on energy prices reported for the Transportation sector from the AEO 2020 Reference Case. Inclusive of Distribution & Marketing Costs.
Federal excise tax	Held constant at 18.4 ¢/gallon.
State gasoline taxes	Held constant at 17.0 ¢/gallon.

EV Charging Infrastructure

Charging Infrastructure Costs

Charging infrastructure costs for Level 2 and DC fast charge (DCFC) equipment were developed based on the following:

- For Level 2 charging at home, ICF assumed a total cost of $1,200 at residences and no Level 1 installations would occur in non-residential applications.

For Level 2 charging infrastructure, we distinguished between residential installations and non-residential installations.

- For residential installations, we assume a total cost of $1,200, including $500 for the charger and a make-ready cost of $700 per Level 2 installation.

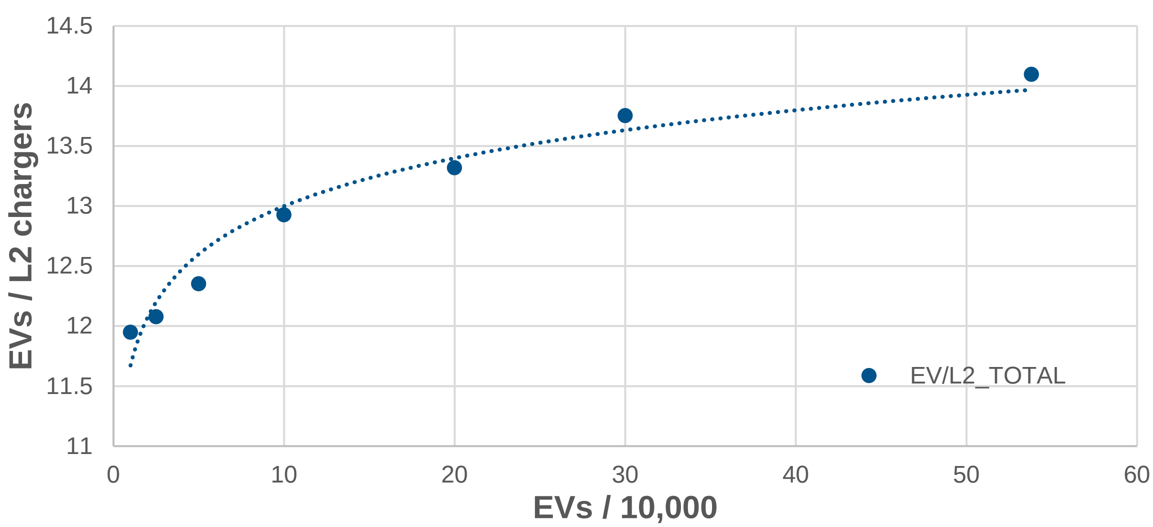
- For non-residential installations, ICF used data provided by various stakeholders across multiple jurisdictions, showing that the average per-port cost for Level 2 installations was around $9,000.[5]
- For DCFC equipment, we assumed that equipment would be able to deliver up to 150 kW, with a total cost of $75,000 per charger and a make-ready cost (not including the charging station) of $50,000.

Charging Infrastructure Deployment

ICF developed assumptions for the amount of charging infrastructure that is required to support EV adoption based on outputs from the National Renewable Energy Laboratory's EVI-Pro Lite tool.[6] These varied by level of charging (Level 2 and DCFC) and by charging location (residential and non-residential).

- For residential charging, we assumed that as many as 50 percent of EV drivers would opt for Level 2 charging.
- For non-residential Level 2 charging, we fit a curve to outputs from the EVI-Pro Lite tool across different EV penetration rates for the entire state to estimate the amount of public and workplace charging that would be needed (see Figure 4).

Figure 4. Level 2 Chargers as a Function of EVs in Liberty-Empire's Service Territory

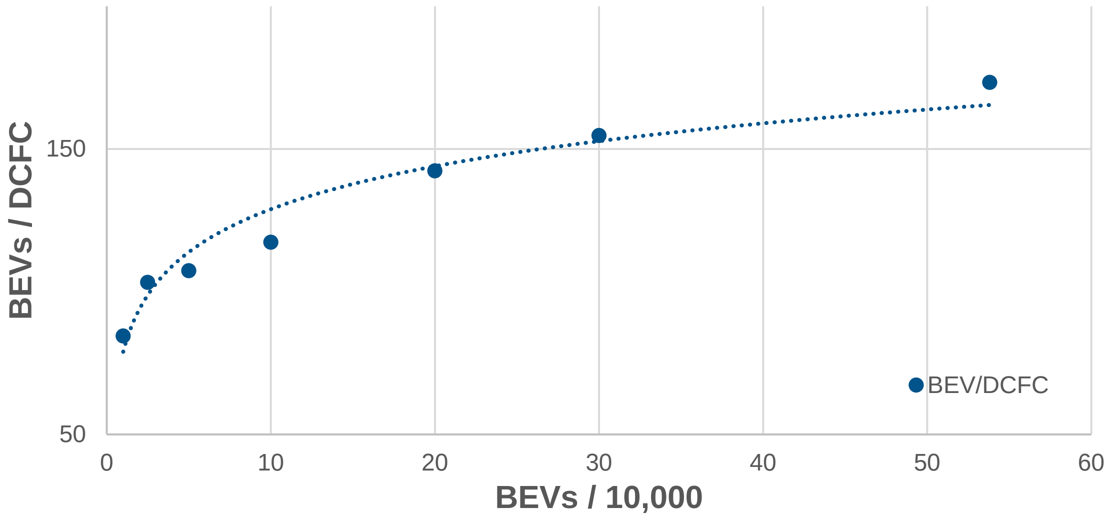


[5] Note that ICF's assumed per port installation cost is for non-residential charging across multiple applications including public, private, and workplace installations. ICF has separately provided an estimate of $12,500 for a publicly accessible Level 2 dual port installation (or $6,250 per port). Ultimately, these cost differentials have a small overall impact on the cost-benefit analysis, as charging infrastructure is a small portion of the overall programmatic impact.

[6] Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite, via the Alternative Fuels Data Center, accessible online at https://afdc.energy.gov/evi-pro-lite.

- For DC fast charging, we fit a curve to outputs from the EVI-Pro Lite tool across different BEV penetration rates for the entire state to estimate the amount of fast charging that would be needed (see Figure 5).

Figure 5. DC Fast Chargers as a Function of EVs in Liberty-Empire's Service Territory



These relationships were used to estimate the amount of Level 2 and DCFC ports that would need to be installed to support the forecasted EV adoption in Liberty-Empire's service territory.

3. Summary Results

ICF's analysis demonstrates that there are net customer benefits associated with EV adoption, with a net present value (NPV) of approximately $6 million between now and 2040 under the medium EV adoption scenario. This is equivalent to customer benefits with an NPV of about $2,706 per EV deployed. It is important to note that this analysis does not include ancillary benefits that would likely increase the estimated benefits of EVs to customers—including by improving utility load factor and better distribution asset management. In scenarios where charging is managed and there is no net increase in demand charges at non-residential locations, then there may be a small decrease in the net benefit to customers.

Participants (EV drivers) benefit the most when EV pricing is assumed to be low and when they can take advantage of lower nonresidential rates. We report an NPV benefit of $2 million or $943 per EV deployed when the low incremental EV pricing scenario is used; this becomes a maximum NPV cost of $12 million for EV drivers or nearly $5,848 per EV deployed when the high incremental EV pricing assumption is employed.

The societal impacts of EV adoption are most sensitive to EV pricing. Under the low incremental EV pricing scenario, and medium rate of EV adoption, we report a net benefit of $8 million, valued at approximately $3,650 per EV deployed. However, as EV pricing increases to the high incremental cost, we report net societal costs of over $7 million or nearly $3,142 per EV deployed.

The subsections below review the variations observed in ICF's analysis for incremental EV pricing and changes in EV adoption rates.

Variation in EV Pricing

As noted previously, ICF's modeling is most sensitive to EV pricing. ICF views this as reinforcement of the concept that increased adoption is needed to help reduce EV pricing through increased demand. Furthermore, lower incremental EV pricing will also reduce the impact as the federal tax credit is phased out with higher adoption.

The tables below summarize the net societal, participant, and customer impacts across the low, medium, and high incremental EV pricing scenarios. The other parameters, including EV adoption and rates are held constant.

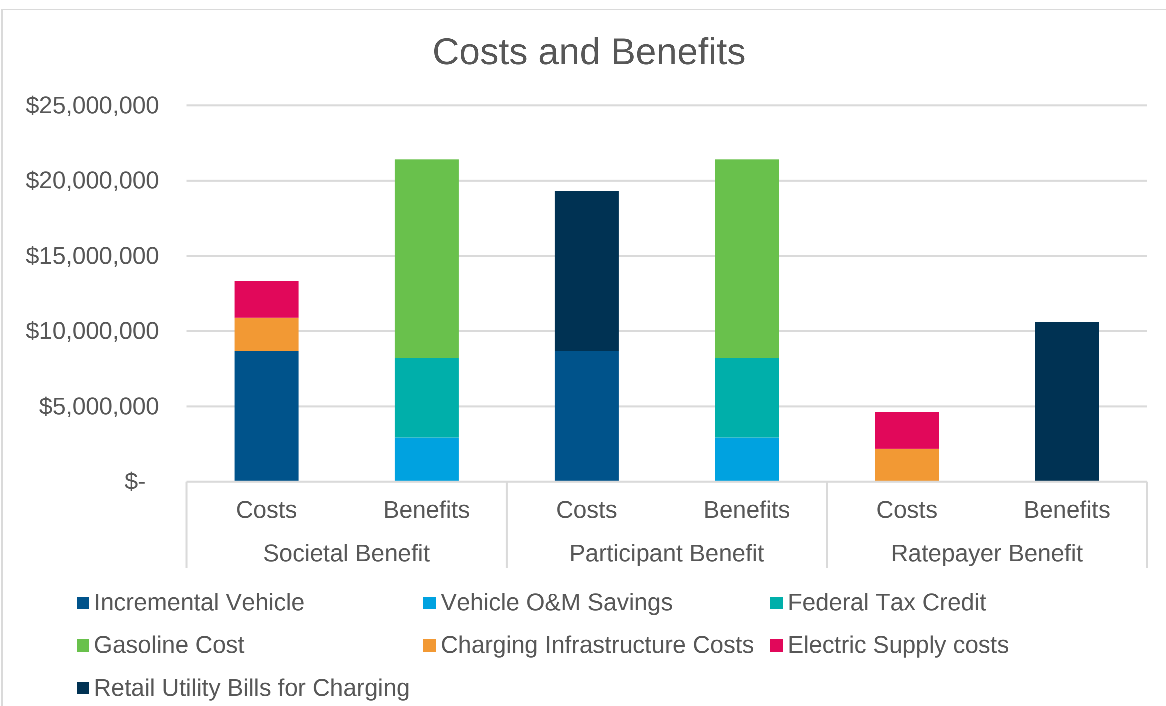
EV Adoption	Medium		
EV Pricing	Low		
Rate (Res / Comm)	Schedule RG / Schedule GP		
	Societal	Participant	Customer
Net, $M, NPV	$8.1	$2.1	$6.0
Per EV Deployed	$3,650	$943	$2,706

EV Adoption	Medium		
EV Pricing	Medium		
Rate (Res / Comm)	Schedule RG / Schedule GP		
	Societal	Participant	Customer
Net, $M, NPV	$0.6	-$5.4	$6.0
Per EV Deployed	$254	-$2,453	$2,706

EV Adoption	Medium		
EV Pricing	High		
Rate (Res / Comm)	Schedule RG / Schedule GP		
	Societal	Participant	Customer
Net, $M, NPV	-$6.9	-$12.9	$6.0
Per EV Deployed	-$3,142	-$5,848	$2,706

Figure 6 below shows the breakdown of NPV cost and benefit elements from the societal, participant, and customer perspectives in the case with medium EV adoption and low incremental EV pricing.

Figure 6. Impacts of Medium EV Adoption with Low Incremental EV Pricing



Variation by EV Adoption Rate

The tables below show the variation in societal, participant, and customer impacts as a function of changing the rate of EV adoption in Liberty-Empire's service territory across the baseline, medium, and high rates of adoption. Other parameters—including EV pricing and rates—are otherwise fixed. The higher rate of adoption yields more societal losses as the number of EVs increase, mainly because there is an increase in the amount of electricity demand (kW) during peak period. Without shifting charging to off- or even shoulder-peak periods, the net societal and net participant impacts remain negative, regardless of the EV adoption. This demonstrates the interconnectedness of the market—EV adoption needs to drive lower EV pricing to improve the societal and participant impacts, and shifting to off-peak periods can also help improve the societal and participant impacts without significant negative impacts to customers.

EV Adoption	**Baseline**		
EV Pricing	**Low**		
Rate (Res / Comm)	**Schedule RG / Schedule GP**		
	Societal	**Participant**	**Customer**
Net, $M, NPV	$7.0	$2.1	$4.9
Per EV Deployed	$4,131	$1,227	$2,904

EV Adoption	**Medium**		
EV Pricing	**Low**		
Rate (Res / Comm)	**Schedule RG / Schedule GP**		
	Societal	**Participant**	**Customer**
Net, $M, NPV	$8.1	$2.1	$6.0
Per EV Deployed	$3,650	$943	$2,706

EV Adoption	**High**		
EV Pricing	**Low**		
Rate (Res / Comm)	**Schedule RG / Schedule GP**		
	Societal	**Participant**	**Customer**
Net, $M, NPV	$9.0	$2.1	$6.9
Per EV Deployed	$3,294	$766	$2,528

Liberty-Empire Simulated Bill Impacts Analysis
November 2020

ER-2019-0374 Authorized Revenue by Class

Target Revenues	Residential (RG)	Commercial (CB)	Small Heating (SH)	General Power (GP)	Electric Building (TEB)	Large Power (LP)	SC-P PRAXAIR Transmission	PFM-Feed Mill/Grain Elev	Lighting & Misc	TOTAL
Authorized Revenues	$ 216,101,602	$ 43,967,106	$ 9,765,028	$ 87,194,878	$ 35,997,589	$ 61,738,335	$ 4,417,474	$ 79,608	$ 6,553,088	$ 465,814,708
kWh Usage	1,678,237,244	321,440,438	83,368,800	866,695,069	353,856,750	796,913,233	69,659,568	461,326	31,899,540	4,202,531,968
% of Energy Use by Category	*100%*	*79%*	*21%*	*71%*	*29%*	*100%*		*Not included*		

Unit Target Revenues ($/kWh)	Residential (RG)	Commercial (CB)	Small Heating (SH)	General Power (GP)	Electric Building (TEB)	Large Power (LP)	SC-P PRAXAIR Transmission	PFM-Feed Mill/Grain Elev	Lighting & Misc	TOTAL
Authorized Revenues/kWh (Avg Rate)	$ 0.12877	$ 0.13678	$ 0.11713	$ 0.10061	$ 0.10173	$ 0.07747	$ 0.06342	$ 0.17256	$ 0.20543	$ 0.11084
Authorized Revenues	$ 216,101,602	$ 43,967,106	$ 9,765,028	$ 87,194,878	$ 35,997,589	$ 61,738,335	$ 4,417,474	$ 79,608	$ 6,553,088	$ 465,814,708

CURRENT	Residential (RG)	Commercial (CB)	Small Heating (SH)	General Power (GP)	Electric Building (TEB)	Large Power (LP)	SC-P PRAXAIR Transmission	PFM-Feed Mill/Grain Elev	Lighting & Misc	TOTAL
# Meters	132,073	18,190	3,021	1,793	939	40	1	10	3	156,070
# Bills	1,584,876	218,280	36,252	21,516	11,268	480	12	120	35	1,872,839
kWh per Bill	1,059	1,473	2,300	40,281	31,404	1,660,236	5,804,964	3,844	911,415	2,244
$ Per Bill	$ 136.35	$ 201.43	$ 269.37	$ 4,052.56	$ 3,194.67	$ 128,621.53	$ 368,122.80	$ 663.40	$ 187,231.09	$ 248.72
$/kWh	$ 0.12877	$ 0.13678	$ 0.11713	$ 0.10061	$ 0.10173	$ 0.07747	$ 0.06342	$ 0.17256	$ 0.20543	$ 0.11084

	Residential (RG)	Commercial (CB)	Small Heating (SH)	General Power (GP)	Electric Building (TEB)	Large Power (LP)	SC-P PRAXAIR Transmission	PFM-Feed Mill/Grain Elev	Lighting & Misc	TOTAL
Allocation: Class Participation	**$ 278,342**	**$ 312,160**	**$ 78,040**	**$ 651,369**	**$ 279,158**	**$ 412,173**				**$ 2,011,242**
On-Road Programs										
Ready Charge Program (L2)	$ 61,281	$ 49,025	$ 12,256	$ 42,896	$ 18,384	$ -				$ 183,842
Fast Charge Program (DCFC)	$ 99,420	$ 79,536	$ 19,884	$ 69,594	$ 29,826	$ -				$ 298,259
Residential Smart Charge Subscription Program (L2)	$ -	$ -	$ -	$ -	$ -	$ -				$ -
Fleet Advisory Services Program	$ -	$ 8,000	$ 2,000	$ 21,000	$ 9,000	$ -				$ 40,000
Electric School Bus Charging Pilot	$ 11,041	$ 8,833	$ 2,208	$ 15,457	$ 6,624	$ -				$ 44,163
Fleet Electrification Program	$ 38,765	$ 31,012	$ 7,753	$ 27,136	$ 11,630	$ 38,765				$ 155,060
Off-Road Programs										
Non-Road Electrification Program	$ -	$ 81,486	$ 20,371	$ 427,801	$ 183,343	$ 305,572				$ 1,018,573
Administrative Components										
Education & Outreach	$ 20,000	$ 16,000	$ 4,000	$ 14,000	$ 6,000	$ 20,000				$ 80,000
Annual Reporting, Evaluation	$ 5,000	$ 4,000	$ 1,000	$ 3,500	$ 1,500	$ 5,000				$ 20,000
Program Implementation	$ 42,836	$ 34,269	$ 8,567	$ 29,985	$ 12,851	$ 42,836				$ 171,344

Allocation: Class Participation	Residential (RG)	Commercial (CB)	Small Heating (SH)	General Power (GP)	Electric Building (TEB)	Large Power (LP)	TOTAL
Total $	$ 278,342	$ 312,160	$ 78,040	$ 651,369	$ 279,158	$ 412,173	$ 2,011,242
$ Bill Impact Per Month	$ 0.18	$ 1.43	$ 2.15	$ 30.27	$ 24.77	$ 858.69	$ 1.07
% Bill Impact	0.1%	0.7%	0.8%	0.7%	0.8%	0.7%	0.4%

CAPEX Life	8	CAPEX	$3,946,480	$789,296						
WACC	**6.77%**	OPEX	$6,649,587	$1,329,917						

Program	Total (Socialized) Budget	# Years	Average $/yr	Participating/Benefitting Class Residential (RG)	Non-Res Under 40kW Commercial (CB) Small Heating (SH)	Non-Res Over 40kW General Power (GP) Electric Building (TEB)	Non-Res Over 1MW Large Power (LP)	TOTAL
On-Road Programs								
Ready Charge Program (L2)	$1,107,800	5	$183,842	33%	33%	33%		100%
Fast Charge Program (DCFC)	$1,797,260	5	$298,259	33%	33%	33%		100%
Residential Smart Charge Subscription Program (L2)	$0	5	$0	100%				100%
Fleet Advisory Services Program	$200,000	5	$40,000		25%	75%		100%
Electric School Bus Charging Pilot	$266,120	5	$44,163	25%	25%	50%		100%
Commercial Electrification Program	$775,300	5	$155,060	25%	25%	25%	25%	100%
Commercial EV Charging Rate	$0	5	$0		50%	50%		100%
Off-Road Programs								
Non-Road Electrification Program	$5,092,865	5	$1,018,573		10%	60%	30%	100%
Administrative Components								
Education & Outreach	$400,000	5	$80,000	25%	25%	25%	25%	100%
Annual Reporting, Evaluation	$100,000	5	$20,000	25%	25%	25%	25%	100%
Program Implementation	$856,722	5	$171,344	25%	25%	25%	25%	100%
	$10,596,067		**$2,011,242**					

Liberty-Empire Transportation Electrification Analysis - Potential Downward Pressure on Rates
November 2020
NOTE: Socialized costs only; includes all budget categories

		Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13
Base Case	Target Revenue Requirement	$ 465,814,708	$ 465,814,708	$ 465,814,708	$ 465,814,708	$ 465,814,708	$ 465,814,708	$ 465,814,708	$ 465,814,708	$ 465,814,708	$ 465,814,708	$ 465,814,708	$ 465,814,708	$ 465,814,708
	kWh Usage	4,202,531,968	4,202,531,968	4,202,531,968	4,202,531,968	4,202,531,968	4,202,531,968	$ 4,202,531,968	$ 4,202,531,968	$ 4,202,531,968	$ 4,202,531,968	$ 4,202,531,968	$ 4,202,531,968	$ 4,202,531,968
	System Average Rate (SAR) ($/kWh)	$ 0.11084	$ 0.11084	$ 0.11084	$ 0.11084	$ 0.11084	$ 0.11084	$ 0.11084	$ 0.11084	$ 0.11084	$ 0.11084	$ 0.11084	$ 0.11084	$ 0.11084
TE Programs	TE Programs - CAPEX (Socialized ONLY)	$ 789,296	$ 789,296	$ 789,296	$ 789,296	$ 789,296								
	TE Programs - CAPEX Amortization - Year 1		$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985				
	TE Programs - CAPEX Amortization - Year 2			$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985			
	TE Programs - CAPEX Amortization - Year 3				$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985		
	TE Programs - CAPEX Amortization - Year 4					$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	
	TE Programs - CAPEX Amortization - Year 5						$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985	$ 130,985
	TE Programs - OPEX (Socialized ONLY)	$ 1,329,917	$ 1,329,917	$ 1,329,917	$ 1,329,917	$ 1,329,917								
	TE Programs - Rev Req	$ 1,329,917	$ 1,460,903	$ 1,591,888	$ 1,722,874	$ 1,853,859	$ 654,927	$ 654,927	$ 654,927	$ 654,927	$ 523,942	$ 392,956	$ 261,971	$ 130,985
	TE Added kWh	4,366,952	9,686,408	16,665,301	25,291,924	33,987,347	34,428,614	34,855,646	35,166,430	35,389,436	35,726,316	36,995,768	36,382,232	33,572,501
	Implied Incremental Sales Cost per kWh	$ 0.30454	$ 0.15082	$ 0.09552	$ 0.06812	$ 0.05455	$ 0.01902	$ 0.01879	$ 0.01862	$ 0.01851	$ 0.01467	$ 0.01062	$ 0.00720	$ 0.00390
Base Case + TE Programs	New Revenue Requirement	$ 467,144,626	$ 467,275,611	$ 467,406,597	$ 467,537,582	$ 467,668,568	$ 466,469,636	$ 466,469,636	$ 466,469,636	$ 466,469,636	$ 466,338,650	$ 466,207,665	$ 466,076,679	$ 465,945,694
	New kWh Usage	4,206,898,920	4,212,218,376	4,219,197,269	4,227,823,892	4,236,519,315	4,236,960,582	4,237,387,614	4,237,698,398	4,237,921,404	4,238,258,284	4,239,527,736	4,238,914,200	4,236,104,469
	New System Average Rate ($/kWh)	$ 0.11104	$ 0.11093	$ 0.11078	$ 0.11059	$ 0.11039	$ 0.11010	$ 0.11008	$ 0.11008	$ 0.11007	$ 0.11003	$ 0.10997	$ 0.10995	$ 0.10999
	% Change in SAR	**0.18%**	**0.08%**	**-0.05%**	**-0.23%**	**-0.41%**	**-0.67%**	**-0.68%**	**-0.69%**	**-0.70%**	**-0.73%**	**-0.79%**	**-0.80%**	**-0.76%**

Adjusted for incremental supply cost of charging per cost-benefit analysis

	+ Electric Supply Costs	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13
TE Programs Supply	TE Programs Electric Cost (supply)	$ 94,726	$ 225,647	$ 412,804	$ 645,349	$ 891,293	$ 918,907	$ 950,428	$ 979,023	$ 994,874	$ 1,019,147	$ 1,061,037	$ 1,043,163	$ 975,497
	TE Added kWh	4,366,952	9,686,408	16,665,301	25,291,924	33,987,347	34,428,614	34,855,646	35,166,430	35,389,436	35,726,316	36,995,768	36,382,232	33,572,501
	Incremental Sales Electric Supply Cost per kWh	$ 0.02	$ 0.02	$ 0.02	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03	$ 0.03
Base Case + TE Programs + TE Supply	New Revenue Requirement	$ 467,239,351	$ 467,501,258	$ 467,819,400	$ 468,182,931	$ 468,559,860	$ 467,388,543	$ 467,420,064	$ 467,448,659	$ 467,464,510	$ 467,357,798	$ 467,268,701	$ 467,119,842	$ 466,921,191
	New kWh Usage	4,206,898,920	4,212,218,376	4,219,197,269	4,227,823,892	4,236,519,315	4,236,960,582	4,237,387,614	4,237,698,398	4,237,921,404	4,238,258,284	4,239,527,736	4,238,914,200	4,236,104,469
	New System Average Rate ($/kWh)	$ 0.11107	$ 0.11099	$ 0.11088	$ 0.11074	$ 0.11060	$ 0.11031	$ 0.11031	$ 0.11031	$ 0.11031	$ 0.11027	$ 0.11022	$ 0.11020	$ 0.11022
	% Change in SAR	**0.20%**	**0.13%**	**0.03%**	**-0.09%**	**-0.22%**	**-0.48%**	**-0.48%**	**-0.48%**	**-0.48%**	**-0.51%**	**-0.56%**	**-0.58%**	**-0.56%**