Exhibit No.: 119 NP
Issue: Electric Vehicle Charging Stations
Witness: Darrin R. Ives
Type of Exhibit: Supplemental Direct Testimony
Sponsoring Party: Kansas City Power & Light Company
Case No.: ER-2014-0370
Date Testimony Prepared: February 6, 2015

MISSOURI PUBLIC SERVICE COMMISSION

CASE NO.: ER-2014-0370

SUPPLEMENTAL DIRECT TESTIMONY

OF

DARRIN R. IVES

ON BEHALF OF

KANSAS CITY POWER & LIGHT COMPANY

Kansas City, Missouri
February 2015

Certain Schedules Attached To This Testimony Designated "(HC)" Contain Highly Confidential Information And Have Been Removed Pursuant To 4 CSR 240-2.135.

SUPPLEMENTAL DIRECT TESTIMONY

OF

DARRIN R. IVES

Case No. ER-2014-0370

Q: Please state your name and business address.

A: My name is Darrin R. Ives. My business address is 1200 Main Street, Kansas City, Missouri 64105.

Q: Are you the same Darrin R. Ives that provided Direct Testimony on behalf of Kansas City Power & Light Company ("KCP&L" or "Company") in this case?

A: Yes, I am.

Q: What is the purpose of your Supplemental Direct Testimony?

A: I will explain the Company's request to recover costs related to KCP&L's Clean Charge Network, a plan to install and operate more than 1,000 electric vehicle charging stations throughout the Greater Kansas City region that was announced publicly on January 26, 2015. The news release issued by KCP&L on January 26, 2015, Support for KCP&L's Clean Charge Network and a Kansas City Star editorial are attached hereto as Schedule DRI-1 as additional information on the Clean Charge Network and the announcement.

Q: What is the Clean Charge Network?

A: KCP&L and KCP&L Greater Missouri Operations Company ("GMO") have launched an initiative to install and operate more than 1,000 electric vehicle charging stations throughout the Greater Kansas City region and within the KCP&L and GMO service territories. This initiative, in furtherance of the Company's commitment to environmental sustainability, is capable of supporting more than 10,000 electric vehicles.

Upon completion it will be the largest utility-owned electric vehicle charging station installation in the United States. The first charging stations deployed will provide "fast charging", enabling a vehicle to charge from empty to 80% of full charge in about 30 minutes. There are expected to be 15 of these sites. The remaining sites will provide approximately a 25 mile charge for every hour the vehicle charges. The stations will be located throughout the KCP&L and GMO service territories near where people live and work.

Q: How will the network be deployed?

A: KCP&L is partnering with organizations throughout our service territories. These organizations will host the charging station sites. Through these partnerships and a partnership with Nissan Motor Company ("Nissan"), the Clean Charge Network will offer free charging on every station to all drivers for a pilot period. The host sites' charging station energy usage will be separately metered; electricity costs for charging station usage will be paid, through the partnership with Nissan for the fast charging stations and by the hosts for the remainder of the charging stations, at standard tariff rates. Space for the charging stations will be provided by the host site.

Q: What happens after the pilot period?

A: The Company plans to learn from these installations, gathering information during the pilot period to be shared with stakeholders in developing a longer term view. KCP&L has asked the Commission to open a working docket so that interested stakeholders can learn more about KCP&L's Clean Charge Network and collaboratively discuss issues including, but not limited to, impacts on retail customers, impacts on utilities, pricing alternatives, and other issues.

Q: Why has KCP&L chosen to embark on this pilot project?

A: This pilot project is large enough to be impactful, but is moderately sized from a capital expenditure perspective and extends KCP&L's commitment to environmental sustainability. Along with KCP&L's environmental upgrades at several local power plants, renewable energy portfolio and energy efficiency programs and KCP&L's recent announcement regarding cessation of burning coal at certain KCP&L and GMO generating units between 2016 and 2021, the KCP&L Clean Charge Network will reduce carbon emissions and help the Kansas City region attain Environmental Protection Agency ("EPA") regional ozone standards which is beneficial to the entire Kansas City region.

In addition, the Clean Charge Network helps to eliminate 'range anxiety' in the region, which is the number one roadblock to greater electric vehicle adoption. As more drivers adopt electric vehicles, not only will vehicle emissions be reduced, but the cost of operating and maintaining the electrical grid will be spread over increased electricity usage.

Finally, the collaborative stakeholder working group docket that KCP&L has proposed can be used to explore other potential benefits, including the Company's integrated management of the Clean Charge Network, possibilities for vehicle to grid programs and potential impacts on implementation of the EPA's Clean Power Plan.

Q: What information did KCP&L rely upon in determining that this pilot project is in the public interest?

A: In addition to meetings with personnel at the Electric Power Research Institute ("EPRI") and participation on electric vehicle and electric vehicle infrastructure working groups and task forces through EPRI and the Edison Electric Institute ("EEI"), the Company reviewed and relied upon a number of electric vehicle-related reports and studies, including:

- California Transportation Electrification Assessment, Phase 1, Updated September 2014 (attached hereto as Schedule DRI-2);
- California Transportation Electrification Assessment, Phase 2, dated October 23, 2014 (attached hereto as Schedule DRI-3);
- Plug-in Electric Vehicle Deployment in California: An Economic Jobs Assessment (attached hereto as Schedule DRI-4);
- Economic Analysis, California Low Carbon Fuel Standard (attached hereto as Schedule DRI-5); and
- Introduction to ChargePoint, dated October 16, 2014 (attached hereto as Schedule DRI-6).

The Company also reviewed and relied upon KCP&L's own data from electric vehicle charging stations already deployed in KCP&L's service territory through federal grants and KCP&L's SmartGrid project (attached hereto as Schedule DRI-7).

Q: Do you consider the electric vehicle-related reports and studies listed above to be authoritative?

A: Yes.

Q: Do you believe it is reasonable to rely upon those reports and studies for the conclusion that implementing this pilot project is in the public interest?

A: Yes.

Q: Were costs related to its Clean Charge Network in the revenue requirement KCP&L requested in this case in its October 30, 2014 direct testimony filing?

A: Yes. Adjustment CS-49, Miscellaneous Expense (discussed by KCP&L witness Ronald Klote on page 43 and Schedule RAK-4, page 2 of his Direct Testimony) increases expense by $385,947 (KCP&L – excluding GMO – total company basis, approximately 55% of which is allocable to KCP&L's Missouri operations). Additionally, the Clean Charge Network is expected to be an overall Company investment of approximately $20 million serving the KCP&L and GMO service territories. The Company expects that the charging stations placed in service in KCP&L's Missouri service territory that are in service as of the end of the true-up period (May 31, 2015) will be included in plant in service that is included in rate base as a part of the revenue requirement in this case. KCP&L included in adjustment RB-20 a budgeted plant in service amount expected at the end of the true-up period. This amount will be trued-up to actual as of May 31, 2015 including reflection of KCP&L's Missouri service territory share of the Company's investment in the Clean Charge Network that is operational at that date, which is currently expected to be in the range of $7 to $9 million at that time if the Clean Charge Network is fully deployed in the service territory by that date.

Q: Did KCP&L identify these costs as being related to electric vehicle charging stations?

A: No. At the time of direct testimony filing, it was not known for certain whether KCP&L's Clean Charge Network initiative would come to fruition, and the costs identified above were included as placeholders in the event the initiative became a publicly announced plan.

Q: Has KCP&L made an adjustment for revenues expected to be generated from the Clean Charge Network?

A: No. It is not currently expected that any meaningful revenues will be generated by the Clean Charge Network before the end of the true-up period. To the extent that revenues have been generated by the Clean Charge Network before the end of the true-up period, a revenue adjustment can be considered based on that information at the time of the true-up.

Q: Does that conclude your testimony?

A: Yes, it does.

**BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI**

In the Matter of Kansas City Power & Light Company's Request for Authority to Implement A General Rate Increase for Electric Service	)))	Case No. ER-2014-0370

AFFIDAVIT OF DARRIN R. IVES

STATE OF MISSOURI)
) ss
COUNTY OF JACKSON)

Darrin R. Ives, being first duly sworn on his oath, states:

1. My name is Darrin R. Ives. I work in Kansas City, Missouri, and I am employed by Kansas City Power & Light Company as Vice President – Regulatory Affairs.

2. Attached hereto and made a part hereof for all purposes is my Supplemental Direct Testimony on behalf of Kansas City Power & Light Company consisting of Six (6) pages, having been prepared in written form for introduction into evidence in the above-captioned docket.

3. I have knowledge of the matters set forth therein. I hereby swear and affirm that my answers contained in the attached testimony to the questions therein propounded, including any attachments thereto, are true and accurate to the best of my knowledge, information and belief.

Darrin R. Ives

Subscribed and sworn before me this 6th day of February, 2015.

Notary Public

My commission expires: Feb. 4 2019

NICOLE A. WEHRY
Notary Public - Notary Seal
State of Missouri
Commissioned for Jackson County
My Commission Expires: February 04, 2019
Commission Number: 14391200

NEWS RELEASE

KCP&L energizing life

MEDIA CONTACT:
KCP&L 24-hour Media Hotline
(816) 392-9455

FOR IMMEDIATE RELEASE

KCP&L BECOMES ELECTRIC VEHICLE INFRASTRUCTURE LEADER WITH GROUNDBREAKING ANNOUNCEMENT

KCP&L's Clean Charge Network will be the largest utility electric vehicle charging station installation in the country

KANSAS CITY, Mo. (Jan. 26, 2015) — Today, at a kickoff event at its headquarters, Kansas City Power & Light Company (KCP&L), a subsidiary of Great Plains Energy Incorporated (NYSE: GXP), announced its plans to install and operate more than 1,000 electric vehicle charging stations, making it the largest electric vehicle charging station installation by an electric utility in the United States. KCP&L's Clean Charge Network is the next step in the company's leadership in environmental sustainability. Over the next several months, KCP&L will install more than 1,000 charging stations throughout the Greater Kansas City region. This network of stations will be capable of supporting more than 10,000 electric vehicles. Through partnerships with companies at host locations and with Nissan Motor Company, the Clean Charge Network will offer free charging on every station to all drivers for the first two years. The stations are manufactured by ChargePoint and will be part of the ChargePoint network of more than 20,000 charging spots in North America.

"The Kansas City region is quickly building a reputation as an innovative, sustainable place to live and work," said Terry Bassham, President and CEO of Great Plains Energy and KCP&L. "We're excited to continue being a leader in support of this growth by providing our customers and visitors to this region with an environmentally-friendly alternative to gasoline-powered vehicles. Thanks to our Clean Charge Network, everyone in our service territory will be able to charge up and hit the road."

Where can I charge my electric vehicle?

The charging stations will be installed strategically throughout KCP&L's service region, ensuring there will be a charging station near where electric vehicle owners live and work.

"We are committed to the electric vehicle industry and want to give residents and visitors the ability to join the electric vehicle revolution. As a utility, we will place the stations where they're needed most and support them as part of our electric grid, leveraging our expertise with electrical infrastructure," said Bassham. "Our Clean Charge Network eliminates 'range anxiety' in the region, which is the number one roadblock to greater electric vehicle adoption. Now, electric vehicle owners will have an answer to the question, 'Where do I recharge my vehicle?'"

Installation of the charging stations began in late 2014 and will be completed this summer. The first stations deployed on the network will include 15 fast charging stations provided by Nissan and KCP&L, which will charge any model of electric vehicle on the market. On the fast charging stations, an electric vehicle like the Nissan LEAF will charge from empty to approximately 80 percent in about 30 minutes. In addition, the Clean Charge Network will have more than 1,000 standard charging stations, which will give most electric vehicles a 25 mile charge for every hour it is plugged into the station.

"The number of stations allows electric vehicle owners to change their habits, charging as they go about their day, and giving them the freedom to drive that much further. It makes it easier for current electric vehicle owners and hopefully will remove the perceived barriers for potential electric vehicle owners," said Bassham.

What's in it for me?

"The most exciting part is that everyone benefits," said Kansas City Mayor, Sly James. "Not only do the owners of electric vehicles in Kansas City benefit, but with this project, KCP&L is also investing in the economic development and environmental sustainability of this region, which is a win for everyone. I applaud KCP&L for taking this groundbreaking step forward right here in Kansas City."

Kansas City is the largest auto manufacturing center in the United States, outside of Detroit. That position makes the region well suited for leadership in the transportation of the future. Range anxiety — the fear of running out of power before reaching the next charging station — is a top concern for potential electric car buyers. By alleviating that anxiety and enabling more people to purchase electric vehicles, KCP&L's Clean Charge Network continues Kansas City region's leadership as an automotive center by creating new jobs and, ultimately, attracting new businesses and talent.

This project extends KCP&L's position as an industry leader in environmental sustainability. Along with KCP&L's environmental upgrades at several local power plants, renewable energy portfolio and its energy efficiency programs, the KCP&L Clean Charge Network will reduce carbon emissions and help the Kansas City region attain EPA regional ozone standards.

"All our environmental investments, including the new network, advance our commitment to a more sustainable energy future," said Bassham. "We know our customers want more choice when it comes to their energy solutions, and we are committed to providing them with affordable, long-term energy solutions that offer them greater control of their energy use."

In addition to regional economic and environmental benefits, the Clean Charge Network can help keep electricity costs low for all KCP&L customers. As more drivers adopt electric vehicles, not only will vehicle emissions be reduced but the cost of operating and maintaining the electrical grid will be spread over increased electricity usage, benefitting everyone. Those who drive electric vehicles will see the bill for fueling their cars go down because electricity is less expensive than gasoline, even at gasoline's low current price. At the same time, increased efficient use of electricity will offset cost increases for operating the grid, which would otherwise become part of customer bills.

"People generally charge their cars at non-peak periods when KCP&L's electrical grid is being underutilized. By stimulating electric vehicle adoption with their Clean Charge Network, what KCP&L is doing is encouraging people to use the electrical grid more efficiently and drive down the cost of electricity for everyone," said Natural Resources Defense Council Senior Energy Economist Ashok Gupta. "KCP&L's efforts to encourage the use of electric vehicles, modernize the electrical grid, increase the use of renewable energy sources and invest in customers through robust energy efficiency programs are all critical parts of a sustainable energy future. More electric vehicles on the road means that people will be using more electricity during times when KCP&L already has enough generation and distribution capacity to meet their demand. That means savings on electricity bills for everyone and cleaner air for everyone."

Why KCP&L?

KCP&L is not new to electric vehicle infrastructure. In 2011, KCP&L worked with the Kansas City Regional Clean Cities Coalition to bring ten charging stations to the area. KCP&L also deployed additional stations through the KCP&L SmartGrid Demonstration Project. All of these stations offered the opportunity to test technologies and behaviors while monitoring usage, laying the foundation for KCP&L's Clean Charge Network.

"We've learned a lot over the last few years about how our customers use electric vehicles," said Bassham. "Combined with our knowledge of the electric grid and award-winning reliability, we think we're well-suited to operate the electric vehicle network."

KCP&L will install ChargePoint stations as part of this project. ChargePoint operates the world's largest electric vehicle charging network, making Clean Charge stations part of a nationwide cohesive network and not a series of one-off stations. As a result, electric vehicle owners in this region will have the same experience, the same customer service and a set of transparent and standard pricing options at every station. And for the next two years, charging a car in KCP&L's Clean Charge Network will be free to electric vehicle owners. KCP&L is partnering with Nissan and the host sites to cover the charging cost to further encourage electric vehicle adoption in this market.

Economies of scale with KCP&L's Clean Charge Network will help keep costs low. As a utility, KCP&L's costs are regulated by state commissions. These factors combine to ensure a fair price for the stations. The commissions will also help facilitate conversations to ensure all stakeholders have a voice.

Partners

"Our partners helped make this groundbreaking program a reality," said Bassham. "Each is a leader in the electric vehicle industry worldwide. We look forward to working together on making the Midwest a leader in the electric vehicle industry."

- **Nissan**, maker of the Nissan LEAF, the best-selling all-electric car, is providing funding toward 16 fast charging stations, including covering the costs of the electricity necessary to power the charging stations for two years.
- **ChargePoint**, the world's largest and most open electric vehicle charging network, will manufacture the standard charging stations in KCP&L's Clean Charge Network. ChargePoint manufactures the stations and this represents the single largest single

installation on the ChargePoint network. ChargePoint provides 24/7 driver support and offers a free mobile app that drivers can use to find stations and start charging.

KCP&L is also partnering with local companies to be host sites for the Clean Charge Network. Host sites have been selected using a variety of criteria, including ensuring KCP&L's Clean Charge Network is accessible at geographically diverse sites that are convenient for customers to access. There are still a limited number of spots available for sites. Interested business can apply online at www.kcpl.com/CleanCharge. Customers who would like to nominate a location can do so on KCP&L's Facebook page at www.facebook.com/KCPLConnect.

How to access the Clean Charge Network

To utilize the stations, all drivers have to do is sign up for a ChargePoint membership (https://na.chargepoint.com/register). Drivers will then have access to the more than 20,000 charging locations nationwide on the ChargePoint network, including these new stations offered by KCP&L. Drivers can find charging stations and see their availability in real-time at ChargePoint.com or with the free ChargePoint mobile app. To use the stations, drivers simply wave their ChargePoint card in front of the station, or use the ChargePoint mobile app.

For more information on this project and to see a map of locations already selected, please visit www.kcpl.com/CleanCharge.

###

About Great Plains Energy:
Headquartered in Kansas City, Mo., Great Plains Energy Incorporated (NYSE: GXP) is the holding company of Kansas City Power & Light Company and KCP&L Greater Missouri Operations Company, two of the leading regulated providers of electricity in the Midwest. Kansas City Power & Light Company and KCP&L Greater Missouri Operations Company use KCP&L as a brand name. More information about the companies is available on the Internet at: www.greatplainsenergy.com or www.kcpl.com.

About Nissan LEAF:
With more than 158,000 global sales since launch, Nissan LEAF is the world's best-selling electric vehicle. LEAF seats up to five passengers and boasts an estimated driving range on a fully-charged battery of 84 miles and MPGe ratings of 126 city, 101 highway and 114 combined. The effective price of a Nissan LEAF starts at about $23,000 after the available $7,500 federal tax credit, which is competitive with gas-powered cars while providing the benefits of lower running costs and less scheduled maintenance. For more information, visit www.nissanusa.com/LEAF.

About ChargePoint:
ChargePoint operates the world's largest electric vehicle (EV) charging network, with more than 20,000 spots to plug in and charge. We are transforming the transportation industry by providing the charging stations, mobile apps, analytics and the charging network that allow property owners and drivers to benefit from EV charging. We are also transforming the energy industry by providing intelligent solutions to help people and businesses shift away from fossil fuels and use electricity more efficiently. Our mission is to get all drivers behind the wheel of an EV and

provide them a place to charge whether at home, at work, around town or out-of-town. Real-time network information is available through the ChargePoint app and in many top-selling EVs. For more information, visit
www.chargepoint.com

Forward-Looking Statements:

Statements made in this release that are not based on historical facts are forward-looking, may involve risks and uncertainties, and are intended to be as of the date when made. Forward-looking statements include, but are not limited to, the outcome of regulatory proceedings, cost estimates of capital projects and other matters affecting future operations. In connection with the safe harbor provisions of the Private Securities Litigation Reform Act of 1995, Great Plains Energy and KCP&L are providing a number of important factors that could cause actual results to differ materially from the provided forward-looking information. These important factors include: future economic conditions in regional, national and international markets and their effects on sales, prices and costs; prices and availability of electricity in regional and national wholesale markets; market perception of the energy industry, Great Plains Energy and KCP&L; changes in business strategy, operations or development plans; the outcome of contract negotiations for goods and services; effects of current or proposed state and federal legislative and regulatory actions or developments, including, but not limited to, deregulation, re-regulation and restructuring of the electric utility industry; decisions of regulators regarding rates the Companies can charge for electricity; adverse changes in applicable laws, regulations, rules, principles or practices governing tax, accounting and environmental matters including, but not limited to, air and water quality; financial market conditions and performance including, but not limited to, changes in interest rates and credit spreads and in availability and cost of capital and the effects on nuclear decommissioning trust and pension plan assets and costs; impairments of long-lived assets or goodwill; credit ratings; inflation rates; effectiveness of risk management policies and procedures and the ability of counterparties to satisfy their contractual commitments; impact of terrorist acts, including but not limited to cyber terrorism; ability to carry out marketing and sales plans; weather conditions including, but not limited to, weather-related damage and their effects on sales, prices and costs; cost, availability, quality and deliverability of fuel; the inherent uncertainties in estimating the effects of weather, economic conditions and other factors on customer consumption and financial results; ability to achieve generation goals and the occurrence and duration of planned and unplanned generation outages; delays in the anticipated in-service dates and cost increases of generation, transmission, distribution or other projects; Great Plains Energy's ability to successfully manage transmission joint venture; the inherent risks associated with the ownership and operation of a nuclear facility including, but not limited to, environmental, health, safety, regulatory and financial risks; workforce risks, including, but not limited to, increased costs of retirement, health care and other benefits; and other risks and uncertainties.

This list of factors is not all-inclusive because it is not possible to predict all factors. Other risk factors are detailed from time to time in Great Plains Energy's and KCP&L's quarterly reports on Form 10-Q and annual report on Form 10-K filed with the Securities and Exchange Commission. Each forward-looking statement speaks only as of the date of the particular statement. Great Plains Energy and KCP&L undertake no obligation to publicly update or revise any forward-looking statement, whether as a result of new information, future events or otherwise.

Governor Jay Nixon, Governor of Missouri
"Today's announcement is another great example of how Missouri continues to lead the way toward a more sustainable energy future from right here in the heartland," said Gov. Nixon. "The Clean Charge Network will help cement Kansas City's position as a center of next-generation automotive technology and innovation, while benefiting drivers and communities alike."

Governor Sam Brownback, Governor of Kansas
"This program is an example of the strong partnerships that improve our communities and benefit our citizens," said Governor Brownback. "I congratulate KCP&L and their community partners on this effort that will help make our region more attractive to businesses."

Missouri Department of Energy Endorses the KCP&L Clean Charge Network

Tesla Motors
James C. Chen, Vice President of Regulatory Affairs & Associate General Counsel
Tesla congratulates Kansas City Power & Light on its announcement today to establish the Clean Charge Network. Tesla's mission is to catalyze the world's transition to electric vehicles and the bold steps taken by KCP&L help further this innovative and uniquely American solution to our transportation needs.

The proliferation of the Clean Charge Network charging stations will provide additional convenience and assurance for EV customers answering the question of where they can charge. These charging stations will encourage domestic production and distribution of electricity, which strengthens state and federal economies and diversifies our greater energy portfolio.

Tesla is proud to participate in this announcement and support KCP&L in its endeavors. Efforts by leaders in industry such as KCP&L will help more consumers learn about the benefits and advantages of driving electric.

Electric Research Power Institute
Dan Bowermaster, Program Manager of Electric Transportation
"This project is the first integrated regional approach to providing plug-in electric vehicle infrastructure in the country," said Dan Bowermaster, program manager of Electric Transportation at the Electric Power Research Institute (EPRI). "Research shows that a coordinated regional deployment of infrastructure is critical to supporting the widespread adoption of electric vehicles. By pursuing this coordinated approach, KCP&L is able to minimize costs and impacts to the power system."

Kansas City Area Development Council
Bob Marcusse, President and CEO
Today's announcement accelerates our region's ability to attract a new generation of tech-savvy, educated and skilled professionals. It also marks a key milestone in shedding the outdated image some still have of KC, and will provide a significant boost to our region's competitiveness. It will especially have a transformational impact on our ability to attract companies looking to hire a new generation workforce.

While on the surface this is about a new technology, in reality it is about the resurgence of Kansas City. It is a very big statement that the old days of "aw shucks" are only glimpsed in the rear view mirror.

I am especially eager to start sharing this new lifestyle asset with the corporate decision makers that are evaluating our region as a location where they will invest in their company's future.

KCP&L is truly breaking new ground with the launch of the Clean Charge Network in KC. This innovative endeavor provides a unique lifestyle advantage for KC residents today and into the future.

Ford Motor Company
Mike Tinskey, Global Director, Vehicle Electrification & Infrastructure
"We are pleased to see Kansas City Power & Light taking great steps to help drivers charge their plug-in vehicles," said Mike Tinskey, Ford Motor Company's global director, Vehicle Electrification & Infrastructure. "Ford customers drive over a half of a million miles a day on electricity, and we are fully supportive of any efforts to increase the number of all-electric miles and find innovative ways to maximize the number that are carbon-free."

Nissan
Brendan Jones, Director, EV Sales and Infrastructure Deployment
As the leader in electric vehicle sales with LEAF, Nissan is investing to install chargers across the country to support EV owners and to encourage further adoption," said Brendan Jones, director of EV Sales and Infrastructure Deployment. "We applaud KCP&L's commitment to provide EV charging, and we look forward to working to serve our shared customers - Nissan LEAF drivers in Kansas City.

General Motors
Britta Gloss, Director for Advanced Vehicle Commercialization Policy
"We applaud the leadership being shown by KCP&L when it comes to deploying EV charging infrastructure in the Midwest," said Britta Gross, General Motors' director for advanced vehicle commercialization policy. "This program will help accelerate the adoption of electric vehicles, like the Chevrolet Volt, which has developed a strong and enthusiastic fan-base. KCP&L is on the forefront when it comes to helping expand the electric vehicle market and we look forward to working together to keep this positive momentum going."

Mid-America Regional Council
David Warm, Executive Director
The Mid-America Regional Council (MARC) applauds the efforts of KCP&L as a regional leader in sustainable initiatives such as the Clean Charge Network. These infrastructure improvements encourage the use of electric vehicles, which can help reduce the impact of tailpipe emissions on our local air quality as we strive to maintain compliance with federal standards. Our region benefits in many ways from having forward-thinking and community-minded utility providers - we look forward to continued progress toward a cleaner and healthier Kansas City.

Greater Kansas City Chamber of Commerce
Jim Heeter, CEO
"With this announcement, KCP&L has just removed a huge impediment for anyone considering the purchase of an electric vehicle. This is a big deal and the new charging station network will immediately identify Kansas City as a leader in innovation and sustainability. KCP&L and its CEO Terry Bassham deserve both congratulations and applause."

Sierra Club
Jim Turner, Chair of the Missouri Chapter
"The Sierra Club is very pleased to see KCP&L make such a significant investment in electric vehicle infrastructure," said Jim Turner, Chair of the Missouri Chapter of the Sierra Club. "Plug-in vehicles are much cleaner for our air and our climate than conventional vehicles, and electric cars will become even cleaner over time as KCP&L continues the shift to more renewable sources of power."

Future of electric cars bodes well for the Kansas City area

02/01/2015 9:00 AM 02/01/2015

The plan to install more than 1,000 public electric charging stations in the Kansas City area is excellent news for current and future drivers of electric cars. They will have a lot more places to plug in and fuel up.

A quick sidenote: In these highly partisan times, it's not every project that can get a hearty thumbs-up from Democratic Gov. Jay Nixon ("another great example of how Missouri continues to lead the way toward a more sustainable energy future") and Kansas Republican Gov. Sam Brownback ("an example of the strong partnerships that improve our communities").

But it's the larger picture that carries the potential of long-term rewards for the local economy and the environment. This is where Kansas City Power & Light leaders, elected officials and others need to focus their attention as the project rolls out.

KCP&L already has sketched out a sensible "Clean Charge Network" scheme that is placing many of the facilities in downtown Kansas City, in Johnson County and north of the Missouri River, and in surrounding communities such as St. Joseph and Warrensburg. The utility is still seeking other sites in the region.

Related If the charging stations are convenient to electric car drivers, who worry about whether their battery power will last until they get to their destination, then more buyers likely will come along for the vehicles.

The increased use of clean-burning electric vehicles also is better than dealing with the harmful tail-pipe emissions from gasoline-powered cars and trucks.

KCP&L already is spending millions of dollars to clean up emissions from its coal-burning power plants. The utility, to its credit, is also investing in cleaner, renewable wind energy, while it recently announced plans to close or retrofit three smaller coal-fired plants.

All of these moves will help the utility produce power in cleaner ways, which will make charging electric cars even less of a burden on the environment.

That positive result is partly why the utility says it's appropriate to dun ratepayers an estimated $1 to $2 a year for the public electric chargers.

In addition, KCP&L says the increased use of electric cars will spread the burden of paying for its grid to more people, making it more efficient to operate, while also drawing extra revenue from the power sold to owners of electric vehicles.

This project makes sense, even with the plummeting price of gasoline. One expert estimated 70 cents of electricity is equivalent to gasoline sold at $1.75 a gallon.

Finally, installing the charging stations also will bump up Kansas City's image among millennials and others interested in coming to regions that are open to smart, progressive thinking on environmental and utility issues.

KCP&L is betting that this system could be successful and thus worth expanding. Already, the addition of more than 1,000 public charging stations will enable the Kansas City region to have more than every state except California.

That's a significant accomplishment. This is a venture worth rooting for, given its potential to reduce pollution and make Kansas City a more attractive place to live.
Related

Read more here: http://www.kansascity.com/opinion/editorials/article8837450.html#storylink=cpy

California Transportation Electrification Assessment

Phase 1: Final Report

August 2014; Updated September 2014

Prepared by
ICF International
620 Folsom St, Suite 200
San Francisco, CA 94107
415.677.7100

Energy+Enviromental Economics
101 Montgomery Street, Suite 1600
San Francisco, CA 94104
415.391.5100

Table of Contents

List of Tables

Schedule DRI-2

List of Figures

Schedule DRI-2

Abbreviations and Acronyms

AEO	Annual Energy Outlook
ARB	California Air Resources Board
BEV	Battery Electric Vehicle
CARB	California Air Resources Board
CEC	California Energy Commission
CH4	Methane
CHE	Cargo Handling Equipment
CNG	Compressed Natural Gas
CO2	Carbon Dioxide
CO2E	Carbon Dioxide Equivalent
CPI	Consumer Price Index
CPUC	California Public Utilities Commission
DER	Distributed Energy Resources
DGE	Diesel Gallon Equivalent
EER	Energy Equivalency Ratio
EIA	United States Energy Information Administration
EPA	US Environmental Protection Agency
EVSE	Electric Vehicle Supply Equipment
FCV	Fuel Cell Vehicle
GGE	Gasoline Gallon Equivalent
GHG	Greenhouse Gas
GSE	Ground Support Equipment
GWh	Gigawatt-hour
HOA	Home Owners Association
HP	Horsepower
HSR	High Speed Rail
IOU	Investor Owned Utility
ISOR	Initial Statement of Reasons
kW	Kilowatt
kWh	Kilowatt-hour
LCA	Lifecycle Analysis
LCFS	Low Carbon Fuel Standard
LEV	Low Emission Vehicle
MDU	Multi-Dwelling Unit
MT	Metric Ton
NMOG	Non-Methane Organic Gases
NOx	Oxides of Nitrogen
O&M	Operational and Maintenance

Schedule DRI-2

PEV	Plug-In Electric Vehicles
PHEV	Plug-In Hybrid Electric Vehicles
PHEV10	PHEV with 10 miles equivalent all electric range
PHEV20	PHEV with 20 miles equivalent all electric range
PHEV40	PHEV with 40 miles equivalent all electric range
PM	Particulate Matter
ROG	Reactive Organic Compounds
RTG	Rubber Tire Gantry
TE	Transportation Electrification
TEA	Transportation Electrification Assessment
TOU	Time of Use
TRU	Transport Refrigeration Unit
TSE	Truck Stop Electrification
TTW	Tank-To-Wheel
ULETRU	Ultra Low Emission TRU
VOC	Volatile Organic Compounds
WTT	Well-To-Tank
WTW	Well-To-Wheels
ZEV	Zero Emission Vehicle

Executive Summary

The key messages of this report are:

- Transportation electrification(TE) has the potential to provide significant benefits to society and utility customers
- The plug-in electric vehicle (PEV) segment shows particular promise, but increased utility involvement in the PEV market is necessary to accelerate adoption to achieve the maximum grid benefits of PEVs and the goals of the Governor's Zero Emission Vehicle (ZEV) Action Plan[1]
- The lack of a proven, sustainable third-party business model for owning and operating electric vehicle supply equipment (EVSE) is a significant market barrier to increased PEV adoption

Air quality and climate change concerns continue to be major drivers for transportation electrification in California. Electrified technologies have near-zero or zero tailpipe emissions of criteria pollutants, and electricity has much lower carbon intensity than fossil fuels like gasoline and diesel. Despite the environmental benefits of transportation electrification, the technologies still face many barriers. Most notably, electrified technologies often have higher upfront costs and/or require infrastructure investments, such as electric vehicle supply equipment, high load transformers and interconnections, and new recharging and electrical interconnections. In some cases, the barriers to adoption are attributable to misperceptions (e.g., that electrified technologies do not have the power needed to perform the required tasks).

This Transportation Electrification Assessment (TEA): (1) updates previous CalETC estimates of the market sizing, forecasts and societal benefits for each technology to 2030; (2) includes market sizing, forecasting and societal benefits for additional TE technologies; (3) performs a costing analysis of select TE technologies; (4) quantifies the grid benefits from PEVs; and (5) identifies the market gaps, barriers and potential solutions for PEV adoption to achieve the grid benefits.

The forecasting was done for three different cases: "In Line with Current Adoption", "In Between" and "Aggressive Adoption". The "In Line with Current Adoption" case is based on anticipated market growth, expected incentive programs, and compliance with existing regulations, and the "Aggressive Adoption" case is based on aggressive new incentive programs and/or regulations. The "In Between" case is in between the "In Line with Current Adoption" and "Aggressive Adoption" cases and varies by technology. For some technologies this is simply half-way in between and for other technologies this is a discretely separate case. The only exception is the plug-in vehicle (PEV) market penetrations. To avoid making market penetration the focus of the PEV grid benefit study, ICF and CalETC decided to use three different existing PEV penetration scenarios. The "In Line with Current Adoption", "In Between" and "Aggressive Adoption" cases were based on: California Zero Emission Vehicle (ZEV) compliance with a 50/50 split of PEVs and fuel cell vehicles (FCVs), ZEV "likely" compliance per the California Air Resources

[1] 2013 ZEV Action Plan: A roadmap toward 1.5 million zero-emission vehicles on California roadways by 2025, available online at: http://opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_(02-13).pdf

Board (CARB), and three times ZEV "likely" compliance, respectively. The detailed forecasting for each case and technology can be found in Appendix A and is summarized in Section 2. The detailed forecasting produced results that show the potential for significant increases in electricity consumption and societal benefits. Table 1 shows the potential electricity consumption and societal benefits in 2030 for the three cases and how these compare to statewide consumption and emission values.

Table 1. Electricity Consumption and Societal Benefits from the Detailed Forecasted Technologies in 2030

Case	Electricity Consumed (Mil kWh/yr)	Petroleum Displacement (Mil GGE/yr)	GHG Emissions Reduced (Mil MT/yr)	PM Emission Reduced (tons/day)	NOx+ROG Emissions Reduced (tons/day)
"In Line with Current Adoption" Case	6,230	558	4.92	0.44	24.8
"In Between" Case	14,300	1,330	11.5	0.73	43.5
"Aggressive Adoption" Case	33,200	3,310	28.9	1.29	71.9
California Statewide Consumption / Emissions	280,561 (Electricity – 2013)[2]	18,800 (Transportation – 2013)[3]	171 (Transportation – 2013)[4]	85 (Transportation – 2012)[5]	2,509 (Transportation – 2012)[6]
Percentage of California Statewide Values	2.2-11.8%	3.0-17.6%	2.9-16.9%	0.5-1.5%	1.0-2.9%

Transportation electrification has small projected criteria pollutant benefits compared to current emissions but significant potential for petroleum displacement and for helping California achieve its GHG emission reduction goals.

Many of these transportation electrification technologies, in addition to achieving significant societal benefits, have operational cost benefits including decreased fuel costs and lower operational and maintenance (O&M) costs. The costing analysis for PEVs, forklifts, truck stop electrification (TSE) and truck refrigeration units (TRUs) employed a benefit-cost ratio, which is the operational benefits (private benefits) and monetized societal benefits divided by the capital costs. A benefit-cost ratio greater than one indicates that the technology has overall lifecycle cost savings for the owner; societal benefit-cost ratio greater than one indicates there are monetized net benefits to society greater than the cost of the technology. The private benefits and cost effectiveness determined in this report are from both a consumer perspective and a TE technology owner and operator perspective.

[2] http://www.energy.ca.gov/2013publications/CEC-100-2013-001/CEC-100-2013-001-CMF.pdf

[3] California 2013 Weekly Fuels Watch Report http://energyalmanac.ca.gov/petroleum/fuels_watch/; all sectors

[4] http://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_by_sector_00-12_sum_2014-03-24.pdf

[5] http://www.arb.ca.gov/aqd/almanac/almanac13/pdf/chap213.pdf

[6] California Almanac of Emissions and Air Quality 2013 Edition - Chapter 2 Current Emissions and Air Quality http://www.arb.ca.gov/aqd/almanac/almanac13/pdf/chap213.pdf

Schedule DRI-2

Figure 1 below shows that for TE technologies in 2013, TSE has the potential for extremely high total and private benefit-cost ratios but the overall magnitude of the societal benefits (in this case petroleum displacement in 2030) is significantly lower than for PEVs and forklifts, and lower than for TRUs. The dotted line represents a benefit-cost ratio of one.

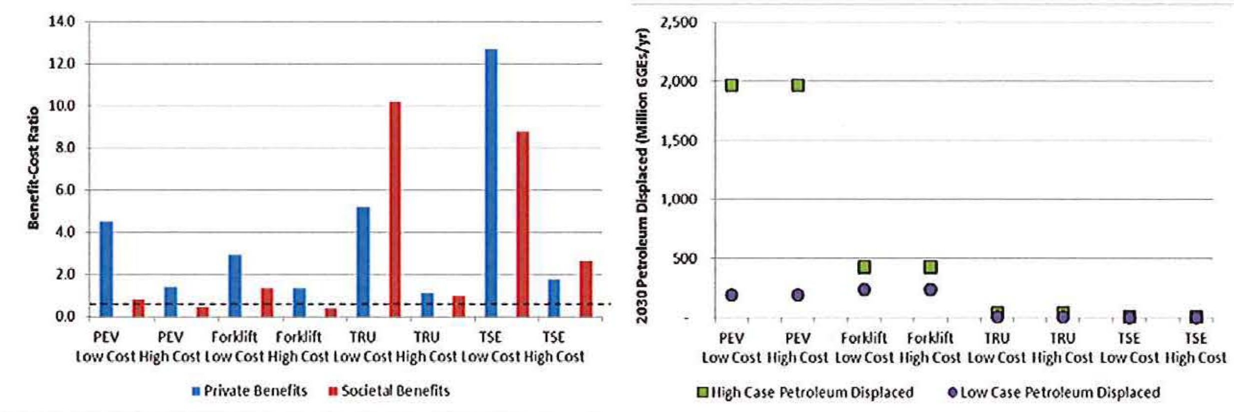

Figure 1. 2013 Benefit-Cost Ratio and 2030 Petroleum Displacement Potential of Select TE Technologies

In addition to the societal benefits from displacing conventional technologies, PEVs also have the potential for significant grid benefits to society and utility ratepayers. If utilities can serve PEV electricity demand with existing infrastructure, this increases the utilization of their existing assets, which could lower electricity rates for all ratepayers. The Phase 2 report will determine the cost effectiveness and value to the utility and ratepayer from PEVs.

To achieve the potential long-term grid benefits of PEVs, it is necessary to increase and maximize the market penetration of PEVs in the near term. ICF, with consultation from a utility stakeholder working group consisting of investor owned utilities and municipally owned utilities, identified the following major market gaps and barriers for PEV market penetration: consumer costs, charging infrastructure deployment, sustainability of third-party ownership of PEV charging equipment, consumer education and outreach, and vehicle features. Table 2 summarizes the major market gaps and barriers and potential solutions.

Table 2. Major Market Gaps and Barriers and Potential Solutions

Market Gaps and Barriers		Potential Solutions
Consumer Costs	• Upfront vehicle costs • Upfront charging infrastructure (EVSE) costs • Vehicle operating costs; need for competitive charging rates for PEVs and shift in traditional billing paradigm	• Increased publicity and continued availability of existing incentives • Creative use of utility LCFS credits or utility developed programs (e.g. battery second life) to reduce the upfront vehicle or EVSE costs • Improved PEV charging rate structures to increase the reduced fuel cost benefits for drivers
Charging Infrastructure	• Lack of information available to single family homeowners seeking to decide between Level 1 and Level 2 charging installation • Little to no progress made in deploying charging at multi-dwelling units; MDU installations are particularly challenging due to technical and logistical issues • Lack of investment in workplace charging infrastructure to date	• Engage MDUs/HOAs, employers and workplace parking providers as a trusted advisor regarding optimal and cost-effective EVSE solutions
Sustainability of Third-Party Ownership of EVSE Networks	• Sustainability of revenue model is frequently challenged and has not been convincingly demonstrated • Demand for non-home charging is unclear due to several factors: vehicle purchasing behavior, consumer willingness to pay for charging, and charging needs/behaviors	• Alternatives to additional public investment in charging infrastructure • Revisiting the CPUC ruling regarding utility investment in charging infrastructure • Improved evaluation of charging infrastructure deployment
Consumer Education and Outreach	• General lack of PEV awareness and knowledge • Total cost of vehicle ownership is poorly understood • Disparate efforts to improve PEV education	• The utility acting as a trusted advisor in the PEV market • Engage with PEV ecosystem partners
Vehicle Features	• Limited vehicle offerings in marketplace	• Modifications to the ZEV program to incentivize the development of PEVs outside of traditional market segments (e.g. subcompacts or midsize sedans)

The primary theme connecting the list of potential solutions is increased utility involvement to help accelerate PEV adoption. This includes increased consumer outreach, education, and incentives for charging infrastructure development, engaging customers by serving as a trusted advisor, and potential involvement in deployment and ownership of EVSE. Such increased utility involvement is an important catalyst for achieving the maximum grid benefits of PEVs. Similar activities could also be applied to other transportation electrification market segments.

1 Introduction

Regional air quality and climate change concerns and the associated federal and state policies continue to be major drivers for transportation electrification (TE) in California. Electrified transportation technologies have near-zero or zero tailpipe emissions and electricity has a much lower carbon intensity than fossil fuels such as gasoline and diesel. Furthermore, the transportation sector's petroleum dependency continues to be a national security concern while exposing consumers and businesses to price volatility. Despite the environmental benefits of transportation electrification, the technologies still face many barriers. Most notably, electrified technologies often have higher upfront costs and/or require significant infrastructure investments including electric vehicle supply equipment (EVSE), high load transformers and new electrical interconnections. Transportation electrification technologies include, but are not limited to on-road vehicles and off-road technologies such as forklifts, truck stop electrification (TSE), transport refrigeration units (TRUs), and cold-ironing at ports.

This Transportation Electrification Assessment (TEA) study (1) updates the market sizing, forecasts and societal benefits (e.g. petroleum displacement, GHG emission reductions and criteria pollutant emission reductions) of transportation electrification (TE) technologies from the previous CalETC Study[7], revising projections out to 2030; (2) includes new market sizing, forecasting and societal benefits for additional TE technologies such as medium and heavy-duty vehicles, high speed rail (HSR), commuter and light rail, and dual mode catenary trucks; (3) performs a costing analysis of select TE technologies; (4) quantifies the grid benefits from PEVs; and (5) identifies the market gaps, barriers and potential solutions for PEV adoption to achieve the grid benefits. Utility work groups made up of a cross section of investor owned utilities (IOUs) and municipally owned utilities (MOUs) were convened to provide input and consultation for critical aspects of the TEA study. In addition, feedback and comments were solicited and received from the California Energy Commission (CEC) and the California Air Resources Board (CARB).

The TEA has been split into two reports: Phase 1 and Phase 2. Phase 1 includes market sizing, forecasts and societal benefits, costing analysis of select TE technologies, a high level discussion of potential grid benefits from PEVs, and identification of market gaps and barriers and potential solutions for PEV adoption. The costing analysis in Phase 1 is from a TE technology consumer perspective and takes into account operational benefits and fuels savings in addition to societal benefits from decreased petroleum consumption, greenhouse gas (GHG), and criteria pollutant emissions. Phase 2 is the detailed modeling and quantification of the grid benefits from PEVs. Phase 2 focuses on the economic and cost effectiveness tests from a utility and overall ratepayer perspective including estimating increases in net revenue for the utilities from PEVs. The Phase 1 report is divided into the following sections:

- Section 1 – Introduction
- Section 2 – Market Sizing and Forecasting
- Section 3 – Costs and Benefits of Select TE Segments

[7] "Electric Transportation and Goods Movement Technologies in California: Technical Brief," TIAX LLC report for CalETC, revised/updated September 2008.

- Section 4 – Transportation Electrification Grid Benefits
- Section 5 – Market Gaps and Barriers to PEV Market Penetration
- Section 6 – Conclusions

2 Market Sizing and Forecasting

An extensive literature review was undertaken from publicly available documents and documents supplied directly from the utilities, and from the previous CalETC Study[8]. Some of the utilities have performed internal analyses of transportation electrification technologies and those resources and assessments were utilized in the following market sizing. Table 3 below shows the technologies researched in the literature review. Detailed market sizing and forecasting was performed for the technologies in the first and second columns for 2013, 2020 and 2030. Costing analysis (Section 3) was done for the select technologies in the first column. These technologies were selected by ICF with input and agreement from the utility workgroups. For the technologies in the third column, the review did not provide enough additional information for a comprehensive update to the previous assessment. Therefore the market sizing for these technologies was done by utilizing the forecasts from the previous CalETC report (which covered the period from 2010 to 2020) to cover the period from 2013 to 2030. There is not enough information to determine if the original forecasts for these technologies were achieved. However the previous forecasts were done prior to the start of the recession in 2008, likely resulting in delayed implementation of these technologies.

Table 3. Electric Technologies in this Forecast

Detailed Forecasting Update and Cost Analysis	Detailed Forecasting Update	Previous Forecast of 2010 to 2020 used for 2013 to 2030
• Light-Duty PEVs (PHEVs and BEVs) • Forklifts • Truck Stop Electrification (TSE) • Transportation Refrigeration Units(TRUs)	• Shore Power at the Ports • Port Cargo Handling Equipment • Airport Ground Support Equipment (GSE) • High Speed Rail (HSR) • Light (including trolley buses) and Heavy Passenger Rail (e.g. SDMTS[9],BART, LA Metro) • Commuter Rail (Caltrain) • Dual Mode Catenary Trucks on I-710/SR60 • Medium- and Heavy-Duty PEVs	• Lawn and Garden • Sweepers/Scrubbers • Burnishers • Tow Tractors/Industrial Tugs • Personnel/Burden Carriers • Turf Trucks • Golf Carts

The detailed market sizing and forecasting, in addition to the extensive literature review, included contacting industry and government experts (CARB, CEC, and the US Environmental Protection Agency)

[8] "Electric Transportation and Goods Movement Technologies in California: Technical Brief," TIAX LLC report for CalETC, revised/updated September 2008.

[9] http://www.sandag.org/index.asp?projectid=250&fuseaction=projects.detail: ten mile expansion of San Diego trolley system by 2018

to characterize current and future markets conditions and regulatory drivers for each technology. Utility work groups were convened to review the electrification forecasts prior to calculating electricity consumption and societal benefits and performing the cost analysis (Section 3).

The future populations and electricity consumption (and subsequent societal benefits) were estimated for three cases:

- The "In Line with Current Adoption" case is based on anticipated market growth, expected incentive programs, and compliance with existing regulations. For technology that could potentially not be built, like HSR and I710, build/no-build scenarios were considered.
- The "Aggressive Adoption" case is based on aggressive new incentive programs and/or regulations. "Aggressive Adoption" cases are not the hypothetical maximums, but are tangibly aggressive.
- The "In Between" case will fall somewhere in between the "In Line with Current Adoption" and "Aggressive Adoption" cases and will vary by technology. For some technologies it will simply be half-way between the two other cases, but for some technologies (e.g. large projects like high speed rail) a specific "In Between" case was developed. The "In Between" case in this study omits the technologies in the far right column of Table 3 since an "In Between" or medium case was not included in the previous 2007 study.[10]

The forecasts developed in Phase 1 of the study for PEVs will be used in Phase 2 to determine the grid benefits of light duty PEVs. To avoid making market penetration the focus of the PEV grid benefit study, ICF and CalETC decided to use three different existing PEV penetration scenarios: California Zero Emission Vehicle (ZEV) compliance with a 50/50 split of PEVs and fuel cell vehicles (FCVs) ("In Line with Current Adoption" case), likely California ZEV compliance as defined by CARB ("In Between" case) and three times the likely California ZEV compliance ("Aggressive Adoption" case).

While performing the market sizing and forecasting, conventional fuel consumption and criteria pollutant emission factors were gathered. These factors were used to determine GHG reductions, petroleum displacement and criteria pollutant emission reductions from the forecasted electrified technologies. GHG emissions and California based upstream criteria pollutant emission factors were used from California's State Alternative Fuels Plan (AB1007 analysis)[11], as shown in Table 32. However, the criteria pollutant emission factors for upstream emissions were conservative because they assumed that all of the electricity and refinery emissions occurred with the air basin where the electricity was consumed, when this is not the case in practice. The tables in the follow section detail the resulting market sizing and forecasting and resulting societal benefits (petroleum displacement, GHG emission reductions and criteria pollutant emission reductions). The detailed forecasting for each technology,

[10] The previous CalETC study contained "Expected" and "Achievable" cases which were converted to low and high cases for this study.

[11] "Full Fuel Cycle Assessment: Well to Tank Energy Inputs, Emissions and Water Impact," Consultant Report for the California Energy Commission, February 2007. http://www.energy.ca.gov/2007publications/CEC-600-2007-002/CEC-600-2007-002-D.PDF

including regulatory assumptions and data sources and assumptions for calculating societal benefits, can be found in Appendix A.

2.1 "In Line with Current Adoption" Case

The "In Line with Current Adoption" case for many technologies maintains the current population of electrified technologies, includes minimal anticipated natural growth, or achieves minimum compliance with current state and/or federal regulations. Electrification was not assumed to be the only avenue for compliance for regulations where multiple compliance options are available (e.g. anti-idling, ocean going vessels at-berth, TRUs). Table 4 shows the California electric technology population forecasts in the "In Line with Current Adoption" case. TSE penetration is shown as the number of electrified spaces, cold-ironing as the number of electrified ship visits, electrified rail as passenger-miles, and fixed guideway as truck-miles.

The anticipated connected load and resulting annual electricity consumption for populations in the table were calculated for each type of equipment. The data sources and assumptions for electricity load and annual consumptions for each type of equipment can be found in Appendix A. Table 5 shows the resulting annual electricity consumption in 2013, 2020 and 2030.

Table 4. "In Line with Current Adoption" Case Electric Technology Populations in Thousands (Total, Not Incremental)

Electric Technology		Population (in 000s, Total, Not Incremental)		
		2013	2020	2030
PEVs (50/50 FCV/PEV)	BEV	13.6	27.4	60.4
	PHEV	29.9	168	544
Forklifts	Class 1 + 2	42.9	57.2	82.0
	Class 3	51.5	66.9	92.6
Truck Stop Electrification (Spaces)		0.262	0.262	0.262
Transport Refrigeration Units		3.63	5.88	9.31
Shore Power (Ship Visits)		1.94	4.17	6.34
Port Cargo Handling Equipment	Yard Tractors	0	0.318	0.503
	Forklifts	0	0.122	0.193
	Cranes	0	0.022	0.068
Airport GSE		1.26	2.23	2.78
High Speed Rail (Passenger-miles)		0	1,880,000	2,640,000
Light and Heavy Passenger Rail (Passenger-miles)	Light	899,000	1,042,000	1,094,000
	Heavy	1,620,000	1,802,000	1,802,000
Commuter Rail (Passenger-miles)		0	0	0
Dual Mode Catenary Trucks on I-710 / SR 60 (Truck Miles)	I-710	0	0	0
	SR-60	0	0	0
Medium-Duty Vehicles		0.5	4.2	96.5
Heavy-Duty Vehicles		0.5	0.08	8.8
	Subtotal	**145** **2,522,000 (pass miles)**	**336** **2,845,000 (pass miles)**	**904** **2,896,000 (pass miles)**
Lawn and Garden		8,000	8,500	9,000
Sweepers/Scrubbers		27-28	28-30	28-31
Burnishers		101-102	104-104	106-107
Tow Tractors/Industrial Tugs		9	10	12
Personnel/Burden Carriers		37	40	44
Turf Tractors		0	3	7
Golf Carts		74-82	80-92	85-103
	Subtotal	**248-258** **8,000 (L&G)**	**262-276** **8,500 (L&G)**	**275-297** **9,000 (L&G)**

Table 5. "In Line with Current Adoption" Case Electric Technology Electricity Consumption in Million kWh

Electric Technology		Electricity Consumption (Annual Million kWh)		
		2013	2020	2030
PEVs	BEV	40.9	81.2	170
	PHEV	70.5	385	1,195
Forklifts	Class 1 + 2	786	1,048	1,501
	Class 3	271	351	486
Truck Stop Electrification		0.897	1.595	1.91
Transport Refrigeration Units		8.92	14.4	22.8
Shore Power		102	218	330
Port Cargo Handling Equipment	Yard Tractors	0 (2010)	20.5	32.5
	Forklifts	0	0.496	0.785
	Cranes	0	2.36	7.49
Airport GSE		5.9	10.4	13.0
High Speed Rail		0	756	1,051
Light and Heavy Passenger Rail	Light	274	314	332
	Heavy	373	400	400
Commuter Rail		0	0	0
Dual Mode Catenary Trucks on I-710 / SR 60	I-710	0	0	0
	SR-60	0	0	0
Medium-Duty Vehicles		0	25	550
Heavy-Duty Vehicles		0	1	183
	Subtotal	**1,930**	**3,630**	**6,280**
Percentage of CA Electricity Consumption – 250,561 GWh (2013)[12]		**0.7%**	**1.3%**	**2.2%**
Lawn and Garden		113	120	128
Sweepers/Scrubbers		9-30	10-31	10-33
Burnishers		57-79	58-81	60-83
Tow Tractors/Industrial Tugs		53-79	62-92	70-105
Personnel/Burden Carriers		75	82	90
Turf Tractors		0	9	20
Golf Carts		84-92	89-104	95-116
Subtotal		**391-468**	**421-510**	**453-555**

[12] http://www.energy.ca.gov/2013publications/CEC-100-2013-001/CEC-100-2013-001-CMF.pdf

Table 5 shows that even in the "In Line with Current Adoption" case, forklifts have significant electricity consumption. This is due to a relatively mature market with more than 40% market share of electric forklifts without additional incentives or drivers.

Table 6 shows the petroleum and GHG displacement for the "In Line with Current Adoption" case. Petroleum fuel displacement was calculated by determining the annual fuel consumption for the competing conventional fueled equipment combined with the population forecast. Increased use of certain rail systems would displace compressed natural gas (CNG) from transit buses rather than diesel. The quantity of displaced CNG is listed separately from the displaced diesel since CNG is not petroleum based. ICF calculated the GHG emissions displaced by combining petroleum displaced and electricity consumed, using the full fuel cycle GHG emission factors in Table 32.

Table 7 shows the criteria pollutant emission reductions in the "In Line with Current Adoption" case for 2013 2020, and 2030. ICF calculated reductions of criteria pollutant emissions (PM and NOx + ROG/NMOG) based on current regulations for criteria pollutant emissions (e.g. LEV III[13], ULETRU In-Use Performance Standard[14]) and current emission factors for conventional fuels. The California based upstream criteria pollutant emission factors used are shown in Table 32.

[13] "Low-Emission Vehicle Program - LEV III," http://www.arb.ca.gov/msprog/levprog/leviii/leviii.htm

[14] http://www.arb.ca.gov/diesel/tru/tru.htm

Table 6. "In Line with Current Adoption" Case Electric Technology Petroleum and GHG Displacement

Electric Technology	Petroleum Displacement (millions of GGE/year)			GHG Displacement (millions of tons/year)		
	2013	2020	2030	2013	2020	2030
BEVs	5.12	9.96	17.2	0.04	0.09	0.15
PHEVs	11.1	57.9	153	0.10	0.55	1.39
Forklifts	94.0	125	180	0.78	1.11	1.60
Truck Stop Electrification	0.15	0.27	0.33	0.001	0.003	0.003
Transport Refrigeration Units	1.04	1.69	2.67	0.009	0.015	0.024
Shore Power	8.78	18.8	28.5	0.064	0.15	0.23
Port Cargo Handling Equipment	0 (2010)	2.13	3.83	0	0.018	0.032
Airport GSE	0.47	0.83	1.04	0.003	0.007	0.008
High Speed Rail	0	32.8	45.9	0	0.15	0.21
Light and Heavy Passenger Rail	46.4 30.8 (CNG)	51.8 35.4 (CNG)	51.9 37.1 (CNG)	0.49	0.61	0.63
Commuter Rail	0	0	0	0	0	0
Dual Mode Catenary Trucks on I-710 / SR 60	0	0	0	0	0	0
Medium-Duty Vehicles	0	2.7	58.2	0	0	0.5
Heavy-Duty Vehicles	0	0.1	15.4	0	0	0.15
Subtotal	**167** **30.8 (CNG)**	**304** **35.4 (CNG)**	**558** **37.1 (CNG)**	**1.49**	**2.73**	**4.92**
Percentage of 2013 CA Consumption / Emissions 18.8 Billion GGE[15]/171 MMT[16]	**0.9%**	**1.6%**	**3.0%**	**0.9%**	**1.6%**	**2.9%**
Lawn and Garden	0	0	0	0	0	0
Sweepers/Scrubbers	2.9-3.0	3.0-3.2	3-3.3	0.04	0.04	0.04
Burnishers	0.7	0.7	0.7	0.01	0.01	0.01
Tow Tractors/Industrial Tugs	0.54	0.72	0.81	0.01	0.01	0.01
Personnel/Burden Carriers	0.5	0.58	0.64	0.01	0.01	0.01
Turf Tractors	0	2.1	4.5	0.00	0.02	0.05
Golf Carts	0.5	0.5	0.6	0.01	0.01	0.01
Subtotal	**5.1-5.2**	**7.5-7.8**	**10-11**	**0.08**	**0.10**	**0.13**

[15] California 2013 Weekly Fuels Watch Report http://energyalmanac.ca.gov/petroleum/fuels_watch/; all sectors

[16] http://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_by_sector_00-12_sum_2014-03-24.pdf

Schedule DRI-2

Table 7. "In Line with Current Adoption" Case Electric Technology PM and NOx + ROG/NMOG Displacement in California (Tons/Day)

Electric Technology	PM (Tons/Day)			NOX + ROG/NMOG (Tons/day)		
	2013	2020	2030	2013	2020	2030
BEVs	0.004	0.01	0.01	0.06	0.11	0.11
PHEVs	0.01	0.03	0.03	0.10	0.50	0.80
Forklifts	0.04	0.05	0.08	2.92	3.92	5.62
Truck Stop Electrification	0.000	0.000	0.001	0.03	0.05	0.06
Transport Refrigeration Units	0.002	0.003	0.005	0.33	0.53	0.87
Shore Power	0.075	0.162	0.246	4.39	9.40	14.3
Port Cargo Handling Equipment	0	0.001	0.002	0	0.05	0.09
Airport GSE	0.001	0.001	0.001	0.08	0.10	0.13
High Speed Rail	0	0.011	0.015	0	0.32	0.45
Light and Heavy Passenger Rail	0.020	0.023	0.024	0.47	0.55	0.56
Commuter Rail	0	0	0	0	0	0
Dual Mode Catenary Trucks on I-710 / SR 60	0	0	0	0	0	0
Medium-Duty Vehicles	0.0	0.0	0.0	0.0	0.1	0.6
Heavy-Duty Vehicles	0.0	0.0	0.03	0.0	0.02	1.33
Subtotal	**0.15**	**0.30**	**0.44**	**8.36**	**15.6**	**24.8**
Percentage of 2013 CA Emissions – 85 TPD PM[17]/ 2,509 TPD NOX +ROG[18]	**0.2%**	**0.4%**	**0.5%**	**0.3%**	**0.6%**	**1.0%**
Lawn and Garden	0	0	0	0	0	0
Sweepers/Scrubbers	0.03	0.022	0.02-0.03	0.58-0.61	0.53-0.57	0.55-0.60
Burnishers	0	0	0	0.04	0.04	0.04
Tow Tractors/Industrial Tugs	0	0	0	0.02	0.02	0.02
Personnel/Burden Carriers	0	0	0	0.07	0.08	0.09
Turf Tractors	0	0	0	0	0.12	0.25
Golf Carts	0	0	0	0.05-0.06	0.06-0.07	0.06-0.08
Subtotal	**0.03**	**0.022**	**0.02-0.03**	**0.76-0.80**	**0.85-0.90**	**1.0-1.1**

2.2 "In Between" Case

The "In Between" case for many technologies is halfway in between the "In Line with Current Adoption" and "Aggressive Adoption" cases except for PEVs, TRUs, cold-ironing, HSR, and fixed guideway. For these identified technologies, specific "In Between" cases were developed. These specific cases can be found in Appendix A. Table 8 shows the California electric technology population forecasts in the "In Between" case for 2013, 2020, and 2030 where TSE penetration is shown as the number of electrified spaces, cold-

[17] http://www.arb.ca.gov/aqd/almanac/almanac13/pdf/chap213.pdf

[18] California Almanac of Emissions and Air Quality 2013 Edition - Chapter 2 Current Emissions and Air Quality http://www.arb.ca.gov/aqd/almanac/almanac13/pdf/chap213.pdf

Schedule DRI-2

ironing as the number of electrified ship visits, electrified rail as passenger-miles, and fixed guideway as truck-miles.

Table 8. "In Between" Case California Electric Technology Populations in Thousands (Total, Not Incremental)

Electric Technology		Population (in 000s, Total, Not Incremental)		
		2013	2020	2030
PEVs ZEV Likely Compliance	BEV	24.1	147	734
	PHEV	29.9	249	1,580
Forklifts	Class 1 + 2	42.9	62.9	101
	Class 3	51.5	66.9	92.6
Truck Stop Electrification (Spaces)		0.262	1.52	2.45
Transport Refrigeration Units		3.63	15.9	67.3
Shore Power (Ship Visits)		1.94	5.48	8.53
Port Cargo Handling Equipment	Yard Tractors	0	0.795	2.64
	Forklifts	0	0.304	0.866
	Cranes	0	0.097	0.308
Airport GSE		1.26	3.00	4.91
High Speed Rail (Passenger-miles)		0	1,880,000	5,900,000
Light and Heavy Passenger Rail (Passenger-miles)	Light	899,00	1,150,000	1,330,000
	Heavy	1,620,000	2,010,000	2,250,000
Commuter Rail (Passenger-miles)		0	386,000	418,000
Dual Mode Catenary Trucks on I-710 / SR 60 (Truck Miles)	I-710	0	30,700	194,000,000
	SR-60	0	0	0
Medium-Duty Vehicles		0.5	6.3	183.7
Heavy-Duty Vehicles		0.5	0.38	23.5
	Subtotal	**156** **2,522,000 (pass miles)**	**559** **3,580,000 (pass miles)**	**2,804** **4,180,000 (pass miles)**

The anticipated connected load and resulting annual electricity consumption for populations in the table above were calculated for each type of equipment. The data sources and assumptions for electricity load and annual consumptions for each type of equipment can be found in Appendix A. Table 9 shows the resulting "In Between" case annual electricity consumption in 2013, 2020 and 2030.

Table 9. "In Between" Case Electric Technology Electricity Consumption in Million kWh

Electric Technology		Electricity Consumption (Annual Million kWh)		
		2013	2020	2030
PEVs	BEV	72	436	2,060
	PHEV	72	568	3,490
Forklifts	Class 1 + 2	786	1,180	1,940
	Class 3	271	351	486
Truck Stop Electrification		2.16	12.1	22.2
Transport Refrigeration Units		8.92	44.4	200
Shore Power		102	287	446
Port Cargo Handling Equipment	Yard Tractors	0	51.3	146
	Forklifts	0	1.24	3.53
	Cranes	0	10.6	33.7
Airport GSE		5.9	14.0	22.9
High Speed Rail		0	756	2,340
Light and Heavy Passenger Rail	Light	274	347	404
	Heavy	373	446	498
Commuter Rail		0	144	156
Dual Mode Catenary Trucks on I-710 / SR 60	I-710	0	82.9	525
	SR-60	0	0	0
Medium-Duty Vehicles		0	38	1,047
Heavy-Duty Vehicles		0	6	446
Subtotal		**1,970**	**4,770**	**14,300**
Percentage of CA Electricity Consumption – 250,561 GWh (2013)[19]		**0.7%**	**1.7%**	**5.1%**

Table 10 shows the petroleum and GHG displacement for the "In Between" case in 2013, 2020, and 2030. Petroleum fuel displacement was calculated by determining the annual fuel consumption for the competing conventional fueled equipment combined with the population forecast. Increased use of a certain rail systems would displace CNG from transit buses rather than diesel. The quantity of displaced CNG is listed separately from the displaced diesel since it does not come from petroleum. ICF calculated the GHG emissions displaced by combining petroleum displaced and electricity consumed, using the full fuel cycle GHG emission factors in Table 32.

[19] http://www.energy.ca.gov/2013publications/CEC-100-2013-001/CEC-100-2013-001-CMF.pdf

Schedule DRI-2

Table 10. "In Between" Case Electric Technology Petroleum and GHG Displacement

Electric Technology	Petroleum Displacement (millions of GGE/year)			GHG Displacement (millions of tons/year)		
	2013	2020	2030	2013	2020	2030
BEVs	9.04	52.8	205	0.08	0.47	1.72
PHEVs	11.2	84.9	450	0.10	0.80	4.09
Forklifts	94.0	139	225	0.78	1.23	2.00
Truck Stop Electrification	0.37	2.07	3.78	0.003	0.020	0.037
Transport Refrigeration Units	1.04	5.26	23.9	0.009	0.048	0.22
Shore Power	8.78	24.8	34.138.6	0.064	0.20	0.31
Port Cargo Handling Equipment	0	5.90	17.2	0	0.050	0.14
Airport Ground Support Equipment	0.47	1.12	1.84	0.003	0.009	0.014
High Speed Rail	0	32.76	102.7	0	0.15	0.49
Light and Heavy Passenger Rail	46.4 30.8 (CNG)	64.1 38.4 (CNG)	71.4 44.0 (CNG)	0.49	0.67	0.76
Commuter Rail	0	6.40	6.93	0	0.031	0.033
Dual Mode Catenary Trucks on I-710 / SR 60	0	5.93	37.5	0	0.043	0.28
Medium-Duty Vehicles	0	4	111	0.0	0.0	1.0
Heavy-Duty Vehicles	0	0	38	0.0	0.01	0.44
Subtotal	**195** **30.8 (CNG)**	**478** **38.4 (CNG)**	**1,430** **44.0 (CNG)**	**1.53**	**3.77**	**11.5**
Percentage of 2013 CA Consumption / Emissions 18.8 Billion GGE[20]/171 MMT[21]	**0.9%**	**2.3%**	**7.1%**	**0.9%**	**2.2%**	**6.7%**

Table 11 shows the criteria pollutant emission reductions in the "In Between" case for 2013 2020, and 2030. ICF calculated reductions of criteria pollutant emissions (PM and NOx + ROG/NMOG) based on current regulations for criteria pollutant emissions (e.g. LEV III[22], ULETRU In-Use Performance Standard[23]) and current emission factors for conventional fuels. The California based upstream criteria pollutant emission factors used are shown in Table 32.

[20] California 2013 Weekly Fuels Watch Report http://energyalmanac.ca.gov/petroleum/fuels_watch/; all sectors

[21] http://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_by_sector_00-12_sum_2014-03-24.pdf

[22] "Low-Emission Vehicle Program - LEV III," http://www.arb.ca.gov/msprog/levprog/leviii/leviii.htm

[23] http://www.arb.ca.gov/diesel/tru/tru.htm

Table 11. "In Between" Case Electric Technology PM and NOx + ROG/NMOG Displacement in California (Tons/Day)

Electric Technology	PM (Tons/Day)			NOX + ROG/NMOG (Tons/day)		
	2013	2020	2030	2013	2020	2030
BEVs	0.01	0.03	0.04	0.10	0.51	1.15
PHEVs	0.01	0.05	0.06	0.10	0.70	2.02
Forklifts	0.04	0.06	0.09	2.92	4.31	6.93
Truck Stop Electrification	0.000	0.003	0.005	0.03	0.36	0.67
Transport Refrigeration Units	0.002	0.006	0.019	0.33	1.4	5.6
Shore Power	0.075	0.21	0.33	04.30	12.4	19.3
Port Cargo Handling Equipment	0	0.003	0.009	0	0.14	0.39
Airport Ground Support Equipment	0.001	0.002	0.002	0.08	0.14	0.23
High Speed Rail	0	0.011	0.041	0	0.32	1.1
Light and Heavy Passenger Rail	0.019	0.026	0.029	0.47	0.61	0.69
Commuter Rail	0	0.002	0.003	0	0.07	0.07
Dual Mode Catenary Trucks on I-710 / SR 60	0	0.003	0.003	0	0.14	0.71
Medium-Duty Vehicles	0.0	0.0	0.0	0.0	0.1	1.2
Heavy-Duty Vehicles	0.0	0.0	0.09	0.0	0.09	3.54
Subtotal	**0.15**	**0.41**	**0.73**	**8.6**	**22.0**	**45.1**
Percentage of 2013 CA Emissions – 85 TPD PM[24]/ 2,509 TPD NOX +ROG[25]	**0.2%**	**0.5%**	**0.9%**	**0.3%**	**0.8%**	**1.7%**

2.3 "Aggressive Adoption" Case

The "Aggressive Adoption" case for many technologies includes aggressive new incentive programs and/or regulations, especially regulations similar to the mandate at the ports. "Aggressive adoption" cases are not simply the hypothetical maximums, but are tangibly aggressive and anticipate achieving compliance with regulations where electrification is not the only avenue for compliance (e.g. anti-idling, ocean going vessels at-berth, TRUs) solely through electrification. Table 12 shows the California electric technology population forecasts in the "Aggressive Adoption" case where TSE penetration is shown as the number of electrified spaces, cold-ironing as the number of electrified ship visits, electrified rail as passenger-miles, and fixed guideway as truck-miles.

[24] http://www.arb.ca.gov/aqd/almanac/almanac13/pdf/chap213.pdf

[25] California Almanac of Emissions and Air Quality 2013 Edition - Chapter 2 Current Emissions and Air Quality http://www.arb.ca.gov/aqd/almanac/almanac13/pdf/chap213.pdf

Table 12. "Aggressive Adoption" Case California Electric Technology Populations in Thousands (Total, Not Incremental)

Electric Technology		Population (in 000s, Total, Not Incremental)		
		2013	2020	2030
PEVs 3x ZEV Likely Compliance	BEV	24.1	441	2,200
	PHEV	29.9	745	4,750
Forklifts	Class 1 + 2	42.9	68.7	120
	Class 3	51.5	66.9	92.6
Truck Stop Electrification (Spaces)		0.262	2,790	4,640
Transport Refrigeration Units		3.63	46.1	263
Shore Power (Ship Visits)		1.94	7.58	11.3
Port Cargo Handling Equipment	Yard Tractors	0	1.270	4.030
	Forklifts	0	0.486	1.540
	Cranes	0	0.173	0.547
Airport GSE		1.26	3.77	7.04
High Speed Rail (Passenger-miles)		0	1,880,000	8,330,000
Light and Heavy Passenger Rail (Passenger-miles)	Light	899,000	1,250,000	1,560,000
	Heavy	1,620,000	2,210,000	2,810,000
Commuter Rail (Passenger-miles)		0	422,000	633,000
Dual Mode Catenary Trucks on I-710 / SR 60 (Truck Miles)	I-710	0	76,031	241,000
	SR-60	0	0	315,000
Medium-Duty Vehicles		0.5	16.4	834
Heavy-Duty Vehicles		0.5	0.795	65.8
	Subtotal	**155 2,520,000 (pass miles)**	**1,400 3,960,000 (pass miles)**	**8,360 5,560,000 (pass miles)**
Lawn and Garden		9,300	11,000	14,100
Sweepers/Scrubbers		29	32	35
Burnishers		103	106	109
Tow Tractors/Industrial Tugs		14	16	19
Personnel/Burden Carriers		51	54	57
Turf Tractors		9	18	27
Golf Carts		89	103	117
	Subtotal	**295 9,300 (L&G)**	**329 11,000 (L&G)**	**364 14,100 (L&G)**

Schedule DRI-2

The anticipated connected load and resulting annual electricity consumption for populations in the table above were calculated for each type of equipment. The data sources and assumptions for electricity load and annual consumptions for each type of equipment can be found in Appendix A.

Table 13 shows the resulting "Aggressive Adoption" case annual electricity consumption in 2013, 2020 and 2030.

Table 14 shows the petroleum and GHG displacement for the "Aggressive Adoption" case in 2013, 2020, and 2030. Petroleum fuel displacement was calculated by determining the annual fuel consumption for the competing conventional fueled equipment combined with the population forecast. Increased use of a certain rail systems would displace CNG from transit buses rather than diesel. The quantity of displaced CNG is listed separately from the displaced diesel since it does not come from petroleum. ICF calculated the GHG emissions displaced by combining petroleum displaced and electricity consumed, using the full fuel cycle GHG emission factors in Table 32.

Table 13. "Aggressive Adoption" Case Electric Technology Electricity Consumption in Million kWh

Electric Technology		Electricity Consumption (Annual Million kWh)		
		2013	2020	2030
PEVs	BEV	72	1,310	6,170
	PHEV	72.0	1,700	10,500
Forklifts	Class 1 + 2	786	1,310	2,380
	Class 3	271	351	486
Truck Stop Electrification		3.43	22.6	42.4
Transport Refrigeration Units		8.92	14.4	22.8
Shore Power		102	362	551
Port Cargo Handling Equipment	Yard Tractors	0	82.2	260
	Forklifts	0	1.98	6.28
	Cranes	0	18.9	59.9
Airport GSE		5.9	17.6	32.9
High Speed Rail		0	756	3,490
Light and Heavy Passenger Rail	Light	274	380	477
	Heavy	373	494	628
Commuter Rail		0	157	236
Dual Mode Catenary Trucks on I-710 / SR 60	I-710	0	160	722
	SR-60	0	0	945
Medium-Duty Vehicles		0	98	4,753
Heavy-Duty Vehicles		0	12	1,235
	Subtotal	**1,970**	**7,300**	**33,200**
Percentage of CA Electricity Consumption – 250,561 GWh (2013)[26]		**0.7%**	**2.6%**	**11.8%**
Lawn and Garden		185	197	209
Sweepers/Scrubbers		10-30	11-34	12-37
Burnishers		58-80	60-82	61-85
Tow Tractors/Industrial Tugs		84-125	97-146	111-167
Personnel/Burden Carriers		104	110	116
Turf Tractors		27	54	81
Golf Carts		100	116	132
Subtotal		**568-651**	**645-739**	**722-827**

[26] http://www.energy.ca.gov/2013publications/CEC-100-2013-001/CEC-100-2013-001-CMF.pdf

Table 14. "Aggressive Adoption" Case Electric Technology Petroleum and GHG Displacement

Electric Technology	Petroleum Displacement (millions of GGE/year)			GHG Displacement (millions of tons/year)		
	2013	2020	2030	2013	2020	2030
BEVs	9.04	159	614	0.08	1.42	5.15
PHEVs	11.2	255	1,350	0.10	2.40	12.3
Forklifts	94.0	153	273	0.78	1.35	2.40
Truck Stop Electrification	0.59	3.86	7.24	0.006	0.038	0.071
Transport Refrigeration Units	1.04	7.09	35.7	0.009	0.064	0.33
Shore Power	8.78	31.2	47.7	0.064	0.25	0.39
Port Cargo Handling Equipment	0	9.67	30.6	0	0.081	0.26
Airport GSE	0.47	1.41	2.63	0.003	0.011	0.020
High Speed Rail	0	32.8	145	0	0.15	0.63
Light and Heavy Passenger Rail	46.4 30.8 (CNG)	62.8 42.2 (CNG)	79.2 52.2 (CNG)	0.49	0.74	0.91
Commuter Rail	0	7.00	10.51	0	0.034	0.051
Dual Mode Catenary Trucks on I-710 / SR 60	0	14.7	107	0	0.12	0.74
Medium-Duty Vehicles	0	10	503	0	0.1	4.3
Heavy-Duty Vehicles	0	1	104	0	0.01	1.31
Subtotal	**171 30.8 (CNG)**	**749 42.2(CNG)**	**3,310 52.2 (CNG)**	**1.53**	**6.76**	**28.9**
Percentage of 2013 CA Consumption / Emissions 18.8 Billion GGE[27]/171 MMT[28]	**0.9%**	**4.0%**	**18%**	**0.9%**	**4.0%**	**17%**
Lawn and Garden	5-16	10-29	18-50	0.06-0.09	0.11-0.33	0.20-0.58
Sweepers/Scrubbers	6.0	12	17	0.07	0.14	0.21
Burnishers	3	2.8	2.6	0.04	0.03	0.03
Tow Tractors/Industrial Tugs	20	22.9	26	0.22-0.23	0.26-0.27	0.03-0.31
Personnel/Burden Carriers	21	20	20	0.25	0.24	0.23
Turf Tractors	6.0	12	18	0.06	0.13	0.19
Golf Carts	9.6	14	19	0.12	0.17	0.23
Subtotal	**71-82**	**94-113**	**120-152**	**0.82-0.86**	**1.1-1.3**	**1.4-1.8**

Table 15 shows the criteria pollutant emission reductions in the "Aggressive Adoption" case for 2013 2020, and 2030. ICF calculated reductions of criteria pollutant emissions (PM and NOx + ROG/NMOG) based on current regulations for criteria pollutant emissions (e.g. LEV III[29], ULETRU In-Use Performance

[27] California 2013 Weekly Fuels Watch Report http://energyalmanac.ca.gov/petroleum/fuels_watch/; all sectors

[28] http://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_by_sector_00-12_sum_2014-03-24.pdf

[29] "Low-Emission Vehicle Program - LEV III," http://www.arb.ca.gov/msprog/levprog/leviii/leviii.htm

Standard[30]) and current emission factors for conventional fuels. The California based upstream criteria pollutant emission factors used are shown in Table 32.

Table 15. "Aggressive Adoption" Case Electric Technology PM and NOx + ROG/NMOG Displacement in California (Tons/Day)

Electric Technology	PM (Tons/Day)			NOX + ROG/NMOG (Tons/day)		
	2013	2020	2030	2013	2020	2030
BEVs	0.01	0.10	0.12	0.10	1.54	3.47
PHEVs	0.01	0.14	0.18	0.10	2.09	6.07
Forklifts	0.04	0.06	0.11	2.92	4.70	8.24
Truck Stop Electrification	0.000	0.000	0.001	0.03	0.05	0.06
Transport Refrigeration Units	0.002	0.003	0.005	0.33	0.53	0.87
Shore Power	0.075	0.27	0.41	4.39	15.6	23.8
Port Cargo Handling Equipment	0	0.001	0.002	0	0.05	0.09
Airport GSE	0.003	0.003	0.004	0.08	0.11	0.14
High Speed Rail	0	0.011	0.015	0	0.32	0.45
Light and Heavy Passenger Rail	0.019	0.028	0.036	0.47	0.67	0.85
Commuter Rail	0	0.003	0.004	0	0.07	0.11
Dual Mode Catenary Trucks on I-710 / SR 60	0	0	0	0	0	0
Medium-Duty Vehicles	0.0	0.0	0.0	0.0	0.2	5.4
Heavy-Duty Vehicles	0.0	0.0	0.25	0.0	0.19	9.9
Subtotal	**0.15**	**0.66**	**1.29**	**8.41**	**28.8**	**71.9**
Percentage of 2013 CA Emissions – 85 TPD PM[31]/ 2,509 TPD NOX +ROG[32]	**0.2%**	**0.8%**	**1.5%**	**0.3%**	**1.2%**	**2.9%**
Lawn and Garden	0.07-0.12	0.77-0.87	1.8-2.0	6.7-8.2	10-13	14-20
Sweepers/Scrubbers	0.06	0.09	0.13	1.2	2.1	3.1
Burnishers	0.01	0.01	0.01	0.17	0.17	0.16
Tow Tractors/Industrial Tugs	0.01	0.01	0.01	0.75	0.87	1.0
Personnel/Burden Carriers	0.12	0.11	0.11	2.9	2.7	2.6
Turf Tractors	0.03	0.06	0.09	1.3	2.6	3.9
Golf Carts	0.03	0.04	0.06	1.1	1.7	2.2
Subtotal	**0.33-0.38**	**1.1-1.2**	**2.2-2.4**	**14-16**	**20-23**	**27-33**

[30] http://www.arb.ca.gov/diesel/tru/tru.htm

[31] http://www.arb.ca.gov/aqd/almanac/almanac13/pdf/chap213.pdf

[32] California Almanac of Emissions and Air Quality 2013 Edition - Chapter 2 Current Emissions and Air Quality http://www.arb.ca.gov/aqd/almanac/almanac13/pdf/chap213.pdf

3 Costs and Benefits of Select TE Segments

The following cost and benefit analysis includes both traditional elements (e.g. incremental capital cost, operational cost/savings, and fuel cost/savings) and non-traditional ratepayer benefits including GHG emission reduction, petroleum displacement and criteria pollutant reduction. The methodologies utilized in this section are consistent with those employed by agencies such as the California Energy Commission (CEC), Air Resources Board (ARB) and local air quality agencies to understand the costs and benefits of alternative fuels and emission reduction technologies and programs. Phase 2 will perform a more thorough analysis of the grid benefits from PEVs using CPUC consistent benefit and cost methodologies and considerations including analysis from both a ratepayer and utility perspective. The methodologies employed in Phase 2 will include the avoided cost methodology which has been adopted by the CPUC for evaluating distributed energy resources such as energy efficiency, demand response and distributed generation.

Public Utilities Commission (PUC) Code 740.8 calls for the inclusion of "interests" to ratepayers including activities "that promote energy efficiency, reduction of health and environmental impacts from air pollution, and greenhouse gas emissions related to electricity and natural gas production and use, and increased use of alternative fuels." [33] In addition, agencies such as the California Energy Commission (CEC) and Air Resources Board (ARB) are shifting to a more comprehensive approach when considering costs and multiple benefits (e.g. State Alt Fuels Plan (AB1007), Vision for Clean Air).Grant programs such as Carl Moyer look to monetize and provide incentives for criteria pollutant emission reductions (e.g. NOx, ROG, PM) and AB118 looks to monetize and reduce GHG emissions and petroleum consumption. Due to transportation electrification's higher capital costs and lack of a singular focus on one type of reduction, these programs do not reward the comprehensive benefits and operational cost savings of transportation electrification. The benefit-cost ratio was developed to incorporate the full range of societal benefits and operational cost savings. The cost analysis in this section is from the perspective of TE technology consumers.

The benefit-cost ratio categorizes cost elements as either costs or benefits (i.e., savings). Cost savings are characterized as a benefit and incorporated into the numerator. However, there are several trade-offs in this metric as well. For instance, a benefit-cost ratio requires that emission reductions (e.g., tons of GHG reductions) be monetized so that they can be included in the calculation. Monetized health and environmental benefits or damage costs can be controversial and also have their detractors. Both the cost-effectiveness metric and benefit-cost ratio can oversimplify the analysis of technologies. It is also important to consider the magnitude of the benefits.

[33] PUC Code § 740.8 - "As used in Section 740.3, 'interests' of ratepayers, short- or long-term, mean direct benefits that are specific to ratepayers in the form of safer, more reliable, or less costly gas or electrical service, consistent with Section 451, and activities that benefit ratepayers and that promote energy efficiency, reduction of health and environmental impacts from air pollution, and greenhouse gas emissions related to electricity and natural gas production and use, and increased use of alternative fuels." http://www.leginfo.ca.gov/cgi-bin/displaycode?section=puc&group=00001-01000&file=727-758

The analysis in the following section looks at the benefit-cost ratio for the selected technologies (PEVs, forklifts, TSE and TRUs) and compares them with the magnitude of potential benefits using the 2030 "Aggressive Adoption" case. The cost elements in the analysis include incremental costs (both vehicles and infrastructure), operational and maintenance (O&M) and fuel costs, and monetized societal benefits. Table 16 below shows the factors for monetizing the societal benefits. For each of the emission reduction benefits, the most conservative values (the highest discount rate) were selected for the analysis. The values for 2020 were escalated to 2030 using the consumer price index (CPI)[34] from the U.S. Bureau of Labor Statistics.

Table 16. Factors for Monetizing Societal Benefits

Societal Benefit	Unit	Discount Rate	2013	2020	2030
Displaced Petroleum[35,36]	$/GGE		$0.44	$0.43	$0.42
GHG [37,38]	$/MT	5%	$11	$12	$16
NOx[39,40]	$/ton	7%	$4,675	$5,082	$6,098
PM [41,42]	$/ton	7%	$1,450,038	$1,650,681	$1,977,357
VOC[41,42]	$/ton	7%	$1,118	$1,20	$1,423

For each of the following technologies analyzed, summary tables and figures are presented in the following section for annualized costs, private benefits and monetized societal benefits. The detailed analysis, data sources and assumptions can be found in Appendix B for all technologies.

3.1 Plug-In Electric Vehicles (PEVs)

The analysis for PEVs has been divided into two classes: passenger cars and light trucks. This is due to differences in incremental capital costs and fuel economies between the two classes of vehicles. For each class the analysis includes PHEV10, PHEV20, PHEV40 and BEV for 2013, 2020 and 2030 to account for the differences in gasoline and electricity consumption and cost, and incremental costs between

[34] http://www.bls.gov/cpi/

[35] Leiby, P. Estimating the Energy Security Benefits of Reduced U.S. Oil Imports, ORNL/TM-2007/028, March 2008

[36] EPA RFS Annual Rulemaking, Updated Energy Security Benefits, 2012. EPA-HQ-OAR-2010-0133-0252, Available online at: http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2010-0133-0252

[37] Interagency Working Group on Social Cost of Carbon. 2010. Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866. February. United States Government. http://www.whitehouse.gov/sites/default/files/omb/inforeg/for-agencies/Social-Cost-of-Carbon-for-RIA.pdf

[38] Interagency Working Group on Social Cost of Carbon. Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, United States Government, May 2013.

[39] Diesel Emissions Quantifier Health Benefits Methodology, EPA, EPA-420-B-10-034, August 2010. Available online: http://www.epa.gov/cleandiesel/documents/420b10034.pdf

[40] EPA/HNTSA, Draft Joint Technical Support Document: Proposed Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, EPA-420-D-11-901, November 2011.

Schedule DRI-2

each type of vehicle in each year. The detailed costing analysis, data sources and assumptions can be found in Appendix B.

3.1.1 Passenger Cars

Table 17 and Table 18 below show the resulting private and societal benefit-cost ratios. The private benefit from both a time of use (TOU) rate and a domestic rate are shown separately in the tables below and in Figure 2 and Figure 3. A domestic rate structure is a traditional tiered residential rate structure where the more electricity a household consumes from charging a PEV, the higher the marginal electricity rate no matter when the charging occurs. A TOU rate structure rewards off-peak electricity consumption (e.g. PEV charging) by applying a lower rate than is used during other time periods. The use of a domestic rate reduces the private benefit 7 to13% in 2013 and 16 to41% in 2030. To develop the benefit-cost ratio shown in Figure 2 and Figure 3 for passenger cars, the annual private benefits and monetized societal benefits are divided by the annualized private costs. A private benefit-cost ratio exceeding one means the technology has lifecycle savings. The red line in Figure 2 and Figure 3 delineate a benefit-cost ratio of one (1).

Table 17. TOU Rate Private and Societal Benefit-Cost Ratios

Passenger Cars	PHEV10			PHEV20			PHEV40			BEV		
	2013	2020	2030	2013	2020	2030	2013	2020	2030	2013	2020	2030
Private Benefit-Cost Ratio												
Operational Savings	4.47	7.82	12.53	1.63	3.01	7.49	1.76	3.59	3.84	1.57	3.67	8.89
Societal Benefit-Cost Ratios												
Petroleum Displacement	0.48	0.78	1.10	0.19	0.35	0.82	0.22	0.47	0.50	0.17	0.41	0.96
GHG Emission	0.12	0.22	0.41	0.04	0.09	0.28	0.05	0.12	0.16	0.04	0.10	0.30
NOx	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01
PM	0.22	0.24	0.02	0.13	0.16	0.01	0.18	0.25	0.01	0.16	0.24	0.01
VOC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Societal	**0.82**	**1.25**	**1.54**	**0.37**	**0.61**	**1.13**	**0.46**	**0.85**	**0.67**	**0.37**	**0.76**	**1.28**

Schedule DRI-2

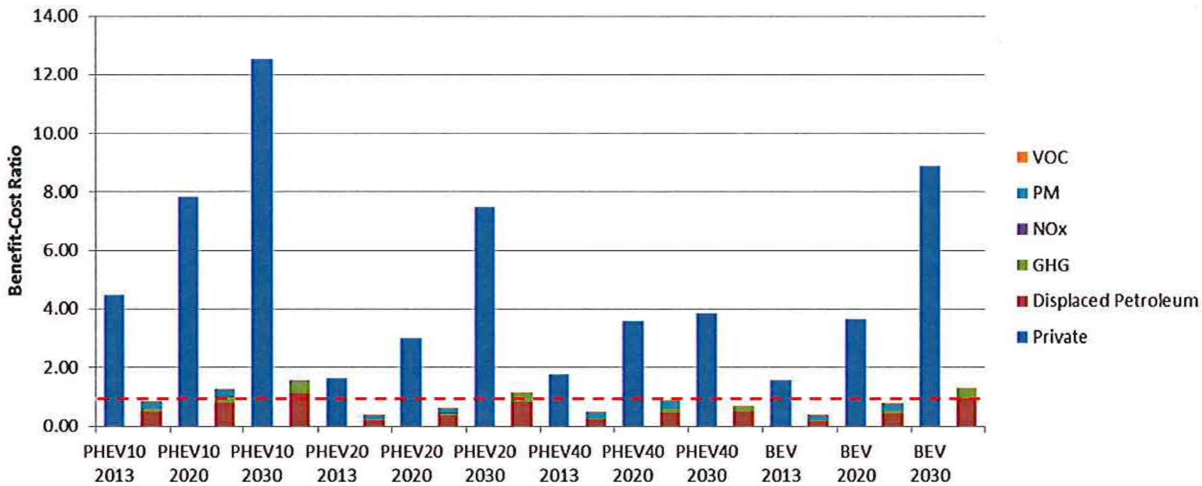

Figure 2. Benefit-Cost Ratio for Passenger Cars - TOU Rate

Table 18. Domestic Rate Private and Societal Benefit-Cost Ratios

Passenger Cars	PHEV10			PHEV20			PHEV40			BEV		
	2013	2020	2030	2013	2020	2030	2013	2020	2030	2013	2020	2030
Private Benefit-Cost Ratio												
Operational Savings	4.19	6.97	10.54	1.46	2.43	5.29	1.52	2.67	2.25	1.37	2.78	5.49
Societal Benefit-Cost Ratios												
Petroleum Displacement	0.48	0.78	1.10	0.19	0.35	0.82	0.22	0.47	0.50	0.17	0.41	0.96
GHG Emission	0.12	0.22	0.41	0.04	0.09	0.28	0.05	0.12	0.16	0.04	0.10	0.30
NOx	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01
PM	0.22	0.24	0.02	0.13	0.16	0.01	0.18	0.25	0.01	0.16	0.24	0.01
VOC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Societal	**0.82**	**1.25**	**1.54**	**0.37**	**0.61**	**1.13**	**0.46**	**0.85**	**0.67**	**0.37**	**0.76**	**1.28**

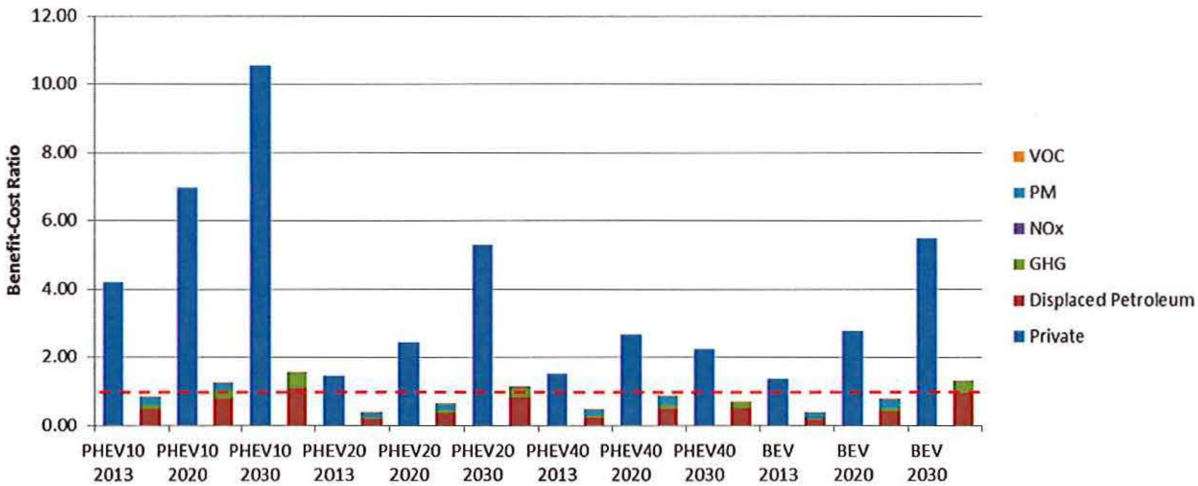

Figure 3. Benefit-Cost Ratio for Passenger Cars - Domestic Rate

Figure 2 and Figure 3 show the private and total benefit-cost ratios for all technologies and classes are above one (the dotted red line) and significantly above one for 2020 and 2030. Figure 2 and Figure 3 also show that for 2013, differences between the benefit-cost ratio from the TOU and domestic rates are much smaller than in 2030. This is due to rate differences of only $0.065 per kWh in 2010 and $0.14 in 2030. The ratio differences are also accentuated by the dramatic reduction of the incremental cost (denominator of the ratio) between 2013 and 2030. We can also see that due to increasingly more stringent tailpipe emission standards the 2030 NOx, PM and VOC reductions, and hence their resulting societal benefits, are almost zero.

3.1.2 Light Trucks

Table 19 and Table 20 below show the resulting private and societal benefit-cost ratios. The private benefit of both a TOU rate and a domestic rate are shown separately in the tables below and in Figure 4 and Figure 5. The use of a domestic rate reduces the private benefit 6 to 14% in 2010 and 13 to 33% in 2030. To develop the benefit-cost ratio shown in Figure 4 and Figure 5 for passenger cars, the annual private benefits and monetized societal benefits are divided by the annualized costs. A private benefit-cost ratio exceeding one means the technology has lifecycle savings. The red line in Figure 4 and Figure 5 delineate a benefit-cost ratio of one.