



Memorandum

To: Bill Peters and Cory Ann Wind | Oregon DEQ
From: Philip Sheehy and Jeff Rosenfeld
Date: December 2016
Re: Task 3: Additional Electrification Draft Report

Background

The objective of Task 3 of ICF's contract with Oregon DEQ is to consider the potential for inclusion of additional sources of electrification in the Clean Fuels Program (CFP). This memorandum estimates the credit generation potential from additional electrification sources by analyzing the current and projected future electricity use by fixed light rail and street cars, and forklifts. The methodologies utilized to estimate future electricity consumption and credit generation potential are the same the methodologies utilized in the CalETC Phase 1 Transportation Electrification Assessment¹, the California Low Carbon Fuel Standard (LCFS) Final Regulatory Order² and the recent LCFS Staff Discussion Paper for Electricity as a Transportation Fuel³.

Fixed Light Rail and Street Cars

Historic and Projected Electricity Consumption

For historic electricity consumption, ICF utilized the data collected through the National Transit Database (NTD) for 2010 – 2014 for TriMet and City of Portland light rail, street cars and aerial tram (which is labeled as a trolley in the National Transit Database and in the below graph). This data was presented in thousands of kWhs per year of consumption. To project the annual increases in the consumption of electricity from 2014 to 2025, ICF utilized the updated 2040 Household Forecast Distribution for Portland⁴ to estimate annual population increases and potential resulting transit use. The forecast showed an average annual growth rate of 1.4%. The figure below shows the NTD historical electricity consumption of light rail (LR), street cars (SR) and trolleys (TR) and the projected annual electricity consumption to 2025.

¹ http://www.caletc.com/wp-content/uploads/2016/08/CalETC_TEA_Phase_1-FINAL_Updated_092014.pdf

² <https://www.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf>

³ https://www.arb.ca.gov/fuels/lcfs/lcfs_meetings/12022016discussionpaper_electricity.pdf

⁴ <http://pamplinmedia.com/documents/artdocs/00003551437334.pdf>

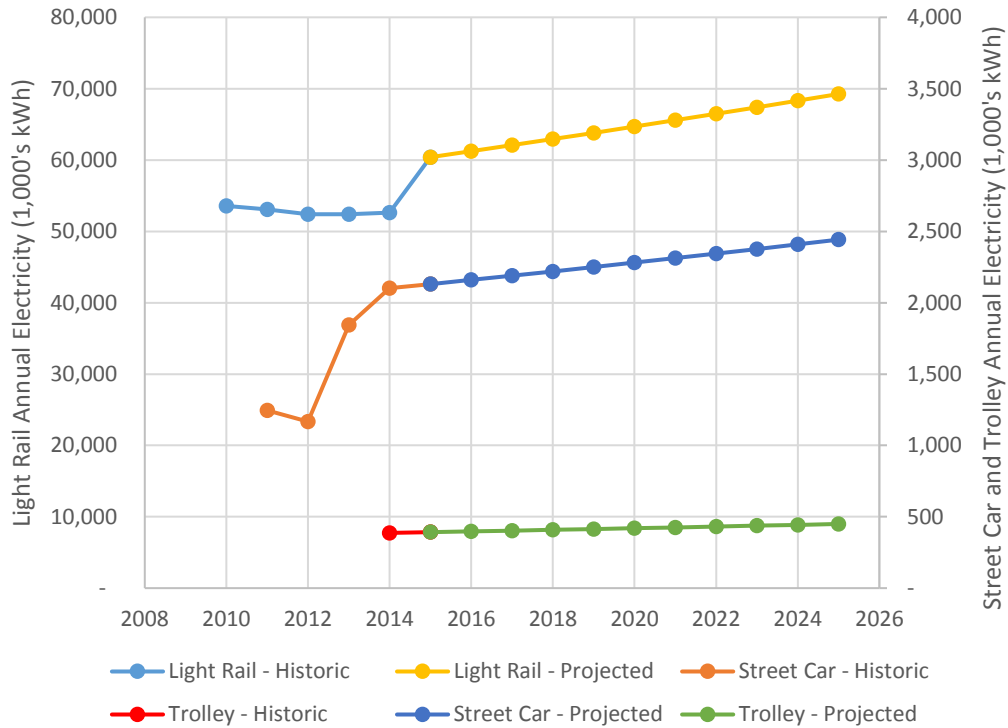


Figure 1. Historical and Projected Fixed Guideway Electricity Consumption

The jump in electricity consumption between 2014 and 2015 for the light rail is due to the line expansion that occurred in 2015. ICF assumed a proportional kWh/track mile from historical data for the new line.

Credit Generation Potential

ICF utilized the credit generation formula in the LCFS Final Regulatory Order for light rail and the electricity carbon intensity from the Oregon version of the GREET model of 120.27 g/MJ. The electricity carbon intensity of 31.85g/MJ in the Oregon regulation is energy economy ratio (EER) adjusted for light duty vehicles and the formula requires the non-EER adjusted carbon intensity. An EER adjusted carbon intensity means the base alternative fuel carbon intensity has been adjusted to account for the efficiency increase or decrease when compared to the conventional transportation fuel.

The table below presents the annual and total credit generation potential from fixed guideway for 2016 – 2025.



Table 1. Annual and Total Credit Generation Potential from Fixed Guideway

Year	Light Rail	Street Cars	Tram ⁵	Annual Total
2016	13,876	471	87	14,433
2017	14,011	476	88	14,574
2018	14,090	478	88	14,657
2019	14,172	481	89	14,741
2020	14,134	479	88	14,701
2021	14,093	477	88	14,658
2022	13,930	471	87	14,488
2023	13,758	465	86	14,309
2024	13,581	459	84	14,124
2025	13,272	447	82	13,802
Total	138,916	4,705	866	144,487

Forklifts

Projected Population and Electricity Consumption

There are limited data sources for forklift populations around the United States with little to no state level sources for forklift populations. ICF estimated the United States electric forklift populations by utilizing the same methodology as the CalETC Phase 1 TEA and ARB Electricity Discussion paper. The Industrial Truck Association (ITA) historical forklift sales⁶ and estimated forklift lifetime of 8 years for gas/diesel forklifts (Classes 4 and 5) and 9 years for electric forklifts (Classes 1 and 2) were combined to quantify the estimated forklift populations. Recent trends in forklift sales were used to forecast future sales from 2016 – 2025. Oregon's share of the national population (1.2%) was used to determine Oregon's share of the US forklifts population. The figure below shows the projected United States forklift populations and percent of total rider forklifts that are electric.

⁵ Aerial tram credit generation estimate is based off of California's EER for trolleys as an approximation.

⁶ <http://www.indtrk.org/market-intelligence>

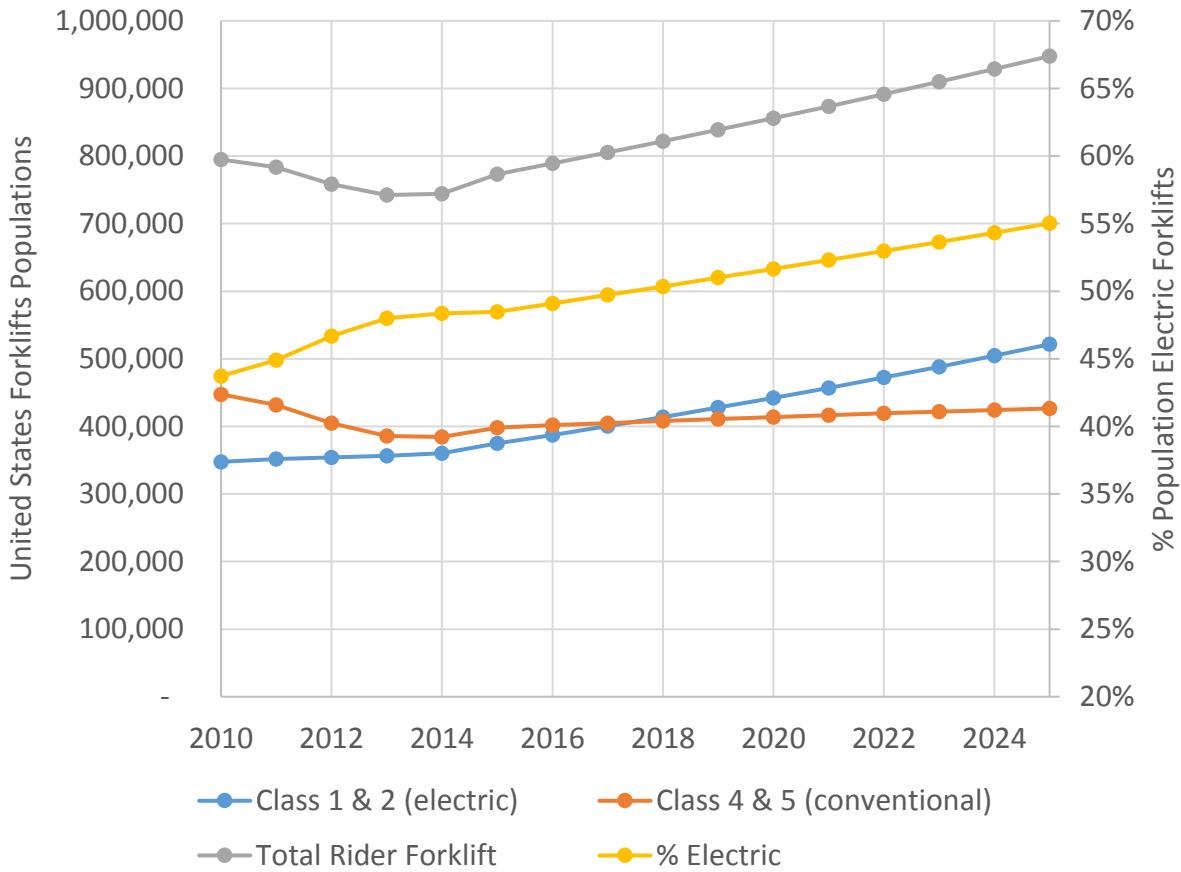


Figure 2. Historical and Projected US Forklifts Populations

The CalETC Phase 1 TEA estimates 18,312 kWh annually per 6,000lb electric forklift. This analysis assumes all electric forklifts are similar to the 6,000lb forklifts and no larger forklifts (similar to 18,000lb forklifts from the CalETC Phase 1 TEA) are electrified. In the LCFS, forklifts purchased before the start of the regulation (<2011) generate credits based only on their electricity consumption but forklifts purchased after the start of the regulation (2011 or later) generate credits based on conventional fuel displaced. ICF utilized the same methodology for Oregon’s forklifts but adjusted the initial year the regulation to 2016. The table below shows the estimated Oregon forklift population purchased in 2015 or earlier and those forklifts purchased 2016 or later, and the estimated electricity consumed by each category.



Table 2. Oregon Forklift Populations and Annual and Total Electricity Consumption

Year	Oregon <2015 Forklifts	Oregon 2016+ Forklifts	Total Oregon Forklifts	Oregon <2015 Forklift Electricity (kWh)	Oregon 2016+ Forklift Electricity (kWh)
2016	4,101	721	4,822	75,097,512	13,202,952
2017	3,747	1,237	4,984	68,615,064	22,651,944
2018	3,352	1,800	5,152	61,381,824	32,961,600
2019	2,795	2,530	5,325	51,182,040	46,329,360
2020	2,184	3,320	5,504	39,993,408	60,795,840
2021	1,526	4,162	5,688	27,944,112	76,214,544
2022	810	5,070	5,880	14,832,720	92,841,840
2023	-	6,077	6,077	-	111,282,024
2024	-	6,281	6,281	-	115,017,672
2025	-	6,492	6,492	-	118,881,504

Credit Generation Potential

ICF utilized the credit generation formula in the LCFS Final Regulatory Order for forklifts and the electricity carbon intensity from the Oregon version of the GREET model of 120.27 g/MJ. The electricity carbon intensity of 31.85g/MJ in the Oregon regulation is energy economy ratio (EER) adjusted and the formula requires the non-EER adjusted carbon intensity.

The table below presents the annual and total credit generation potential from forklifts for 2016 – 2025 taking into account energy displacement for forklifts purchased 2016 or later.



Table 3. Annual and Total Credit Generation Potential from Forklifts

Year	Credits from Oregon <2015 Forklifts	Credits from Oregon 2016+ Forklifts	Annual Total
2016	18,314	12,235	30,549
2017	16,671	20,914	37,585
2018	14,803	30,207	45,010
2019	12,253	42,147	54,400
2020	9,430	54,476	63,906
2021	6,489	67,249	73,737
2022	3,365	80,028	83,392
2023	-	93,639	93,639
2024	-	94,438	94,438
2025	-	94,374	94,374
Total	81,324	589,705	671,029

Comparison with 2014 Illustrative Compliance Scenarios

The 2014 Illustrative Compliance Scenarios quantified 10.0 – 13.6 million credits required for compliance. Fixed guideway electrified transportation could contribute between 1.1-1.4% of the credits for compliance. Forklifts could contribute between 4.9 – 6.7% of the credits for compliance. For forklifts, if Oregon decides limit credit generation for electricity consumed and not energy displacement for forklifts purchased 2016 or later, forklifts would generation over 400,000 fewer credits (236,510 credits generated) and contribute only 1.7-2.4% of the credits for compliance.