Alameda- Contra Costa Transit District

Climate Action Plan

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1.0 Introduction

Alameda Contra Costa Transit District (AC Transit) has elected to prepare this Climate Action Plan to provide a roadmap for how AC Transit will reduce its entity-wide carbon dioxide (CO_2) emissions in the coming years. This plan provides a summary of AC Transit's direct (Scope 1) and indirect (Scope 2) CO_2 emissions, describes performance metrics and CO_2 emissions reduction targets, and provides a roadmap for reducing emissions through a combination of current and planned measures. It also includes a description of how progress will be monitored toward meeting the reduction targets.

1.1 Climate Change

The Intergovernmental Panel on Climate Change[1] (IPCC) defines climate change as "a change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity." Evidence of climate system warming includes increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level. In its Fourth Assessment Report: Climate Change 2007 (IPCC, 2007), the IPCC concluded that most of the observed increase in global average temperatures since the mid-20th century is very likely (greater than 90% chance) due to the observed increase in anthropogenic greenhouse gas (GHG) concentrations. When the Industrial Revolution began around 1750, atmospheric concentrations of CO_2 were approximately 280 parts per million (ppm) (IPCC, 2007). By 2010, this concentration had climbed to approximately 390 ppm, with most of the increase occurring since the mid-20th Century (Dr. Pieter Tans, 2010).

The effects of global warming are already being felt around the world through extreme temperature and weather patterns as well as changes in physical and biological systems. Negative impacts to

[1] The IPCC was established by the United Nations Environmental Programme and World Meteorological Organization (WMO). This scientific body is open to all member countries of the United Nations and WMO. The IPCC reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change.

ecosystems, coastal areas, human health and water supplies are predicted to intensify in the future as the planet continues to warm. Numerous plant and animal species are likely to face an increased risk of extinction. Coastal areas are likely to face increased erosion and flooding due to sea level rise and increased storm surges. The health of millions of people is likely to be impacted from increases in malnutrition; disease and injury due to extreme weather events; and increased frequency of cardio-respiratory disease due to higher concentrations of ground-level ozone in urban areas (IPCC, 2007). Climate change is also expected to exacerbate current stresses on water resources due to population growth as well as economic and land-use change. If the anthropogenic contribution to atmospheric GHG emissions continues at the current rate, these grim predictions are likely to become a reality.

CO_2, methane (CH_4), nitrous oxide (N_2O) and sulfur hexafluoride (SF_6), perfluorocarbons (PFCs) and hydrofluorocarbons (HFCs) have been identified as the gases that are primarily responsible for global warming. These six GHGs are also known as the "Kyoto gases."[2] CO_2 is the most important of these gases in terms of total atmospheric impact, and it typically represents more than 95% of total operational GHGs for an organization like AC Transit. This Climate Action Plan addresses only CO_2 since it is the only gas that AC Transit is currently monitoring and reporting.

1.2 Public Transportation & Greenhouse Gases

In 2008, transportation activities in aggregate accounted for 27 percent of U.S. GHG emissions (US EPA, 2010), second only to the electricity generation sector's 35 percent contribution. While public transit operations make a direct contribution to transportation sector emissions, they generally contribute to a net reduction in emissions by getting people out of their personal automobiles (mode shift), relieving road congestion (improved overall fuel efficiency), and enabling more compact land uses that are conducive to automobile alternatives such as walking and biking. Recent studies provide evidence that overall, public transportation significantly reduces total CO_2 emissions. In 2005, public transportation reduced CO_2 emissions in the U.S. by 6.9 million metric tons (Davis, et al., 2007). This estimate took into account several factors including: direct CO_2 emissions from public transit; CO_2

[2] The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing emissions of the six GHGs. The Kyoto Protocol is set to expire in 2012.

emissions from personal vehicles if no transit service was available; and, CO_2 emissions saved from transit reduced congestion.

Emissions from the transportation sector have increased steadily in recent years as urban areas have expanded and workers have moved further from their places of employment. There are three basic strategies available to curb the growth in transportation emissions:

- Reduce the carbon intensity of fuels;
- Improve vehicle fuel efficiency; and,
- Reduce overall vehicle miles traveled (VMT).

State and federal mandates are already in place to decrease the carbon intensity of fuels and to increase the fuel efficiency of new vehicles. The use of hydrogen fuel cell technology and the planned use of diesel-electric buses will help reduce AC Transit's fuel carbon intensity and increase fuel efficiency, but the greatest opportunity for reducing total transportation emissions lies in reducing VMT. According to a recent study, two-vehicle households could reduce their GHG emissions by 25-30% by eliminating one car and taking public transportation (Davis, et al., 2007). By providing public transportation AC Transit is dramatically reducing regional CO_2 emissions.

2.0 AC Transit's CO_2 Emissions Profile

In 2005, AC Transit became the first transit agency in the nation to join the California Climate Action Registry (California Registry) and commit to annual public reporting of their CO_2 emissions. AC Transit reported Calendar Year 2006 (CY2006) through CY2008 CO_2 emissions to the California Registry, and was named a "Climate Action Leader" for having these emissions inventories independently verified. In 2007, AC Transit joined The Climate Registry (TCR), the leading voluntary registry for reporting North American GHG emissions, and is now reporting to TCR starting with the CY2009 emissions inventory, which is still in the process of being verified. In their 2011 report to TCR, AC Transit will expand the GHG Inventory to include all six "Kyoto gases."

2.1 Emissions Categories

AC Transit annually calculates and reports its CO_2 emissions in the "Scope 1" and "Scope 2" categories, as defined by the GHG Protocol Corporate Accounting and Reporting Standard[3].

- The Scope 1 category includes direct emissions from the following sources owned or controlled by AC Transit:
    - Mobile combustion sources
    - Stationary combustion sources
    - Purchased natural gas
- The Scope 2 category includes indirect emissions from sources that occur because of AC Transit's actions:
    - Purchased electricity

AC Transit does not currently report Scope 3 emissions (other indirect emissions) to TCR. Scope 3 emissions tend to be difficult to quantify and, by definition, include sources that are not directly controlled by the reporting entity. This Climate Action Plan focuses on the reduction of Scope 1 and Scope 2 CO_2 emissions.

2.2 Inventory Description

Results of the CY2009 GHG Inventory[4] are summarized in Table 1 and Figure 1, below. Direct emissions from mobile sources make up approximately 93.5% of the Inventory. Other significant sources include indirect emissions from purchased electricity (3.6%) and direct emissions from the combustion of natural gas in furnaces and hot water heaters (2.9%). Minor sources (direct emissions), including forklifts, emergency generators, acetylene torches and compressed gas machining, account for less than 1% of the overall Inventory.

[3] World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), 2004.
[4] The CY2009 GHG Inventory has not been third party verified and is subject to change based on findings made during the verification process.

Table 1. AC Transit - CY2009 CO_2 Emissions Summary (metric tons)

Category	Source	Total	% of Total
Direct, mobile	Combustion engines	68,838.13	93.51%
Indirect, electricity	Purchased electricity	2,613.46	3.55%
Direct, stationary	Furnaces, water heaters	2,103.59	2.86%
Indirect, electricity	Leased office-space	28.70	0.04%
Direct, stationary (generators)	Emergency generators	29.69	0.04%
Direct, mobile (forklifts)	Forklifts	4.86	0.01%
Direct, stationary (acetylene)	Acetylene torches	0.24	0.00%
Direct, stationary (compressed gas)	Compressed gas-machining	0.06	0.00%
	Total	**73,619**	**100%**

Notes:
Simplified estimation methods were used for sources shaded in gray. In order to reduce the reporting burden, TCR allows reporters to use alternative, simplified estimation methods for any combination of individual emission sources and/or gases, provided that the emissions from these sources and/or gases are less than or equal to 5 percent of the entity's total emissions.

Figure 1 - AC Transit CY2009 CO_2 Emissions Summary – by Category

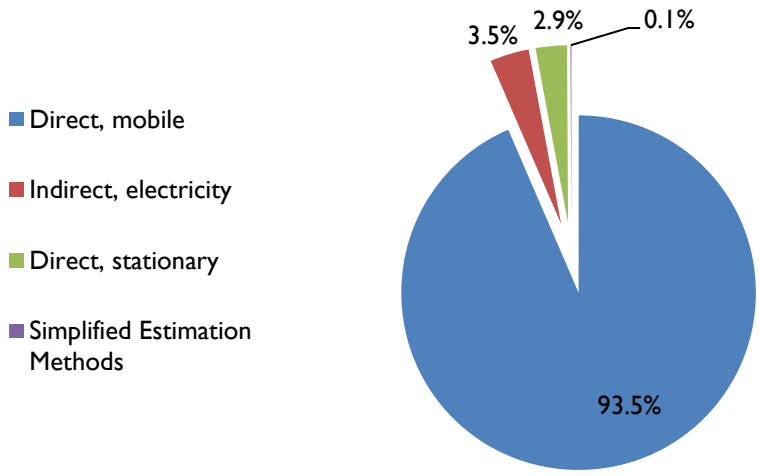


Table 2 presents the results of AC Transit's CY2006 through CY2009 GHG inventories. Total emissions increased each year from CY2006 through CY2008, and then decreased slightly in CY2009. The CY2009 Inventory is similar to the CY2008 inventory, with a year-over-year total decrease of 1,178 metric tons CO_2. This decrease of approximately 1.6 % is primarily due to a decrease in indirect emissions from imported electricity.

Direct emissions from vehicles owned or controlled by AC Transit typically contribute about 94% of the overall GHG emissions. AC Transit's fleet includes revenue and non-revenue vehicles. Currently, all revenue vehicles (bus fleet) use diesel fuel, with the exception of three hydrogen fuel cell buses. Diesel use by revenue vehicles represents the largest portion of AC Transit's greenhouse gas inventory, representing approximately 91% of total CO_2 emissions.

Table 2. AC Transit CO_2 Emissions (metric tons), Year-Over-Year Comparison

Emission Category (Source)	Total CO_2				2008 to 2009
	2006	2007	2008	2009	% change
Direct Mobile (combustion engines)	64,246	67,337	69,598	68,838	-1.10%
Imported electricity	2,438	2,289	3,074	2,613	-17.62%
Direct Stationary (Natural gas furnaces & water heaters)	1,965	2,131	2,060	2,104	2.07%
Imported electricity (leased office space)	-	-	28.4	28.7	1.03%
Direct Mobile (emergency generators)	134	54.1	29.7	29.7	0.00%
Direct Mobile (forklifts)	18	8	6.4	4.9	-31.76%
Direct Stationary (compressed gas-machining)	0.02	0.23	0.02	0.06	65.36%
Direct Stationary (acetylene torches)	0.07	0.02	0.24	0.24	0.00%
ALL SOURCES	**68,801**	**71,819**	**74,797**	**73,619**	**-1.60%**

Notes:

Simplified estimation methods were used for sources shaded gray.

3.0 Performance Metrics & Reduction Targets

While AC Transit already dramatically reduces regional CO_2 emissions by providing public transit (as described in the Introduction), they have decided to take this one step further by voluntarily electing to develop internal CO_2 emission reduction targets based on TCR guidance and state-wide emission reduction goals mandated by the California Global Warming Solutions Act of 2006 (Assembly Bill 32).

In June 2010, TCR released Performance Metrics for Transit Agencies Version 1.0. These performance metrics were developed with input from both the American Public Transportation Association (APTA) and the Canadian Urban Transit Association to, "provide transit agencies with a reliable, transparent, and clear communication tool that can be used to explain carbon efficiency to policy makers, funders, and the public (TCR, 2010)."

The recommended TCR metrics are calculated based on the combined total Scope 1 and 2 emissions divided by operational data, as follows:

- Emissions per passenger miles traveled (PMT) – PMT represents the distance traveled by all passengers. This metric accounts for the combined effects of vehicle efficiency and changes in ridership. It measures operational efficiency and service effectiveness.
- Emissions per vehicle miles traveled – Measures operational efficiency and is sensitive to efforts to purchased lower-emission vehicles, switch to lower-carbon fuels, or facility energy efficiency improvements.
- Emissions per revenue vehicle hour – This metric is another measure of operational efficiency, but it also captures efforts to reduce deadheading and roadway congestion.

Assembly Bill 32 (AB 32) directs the state to reduce state-wide GHG emissions to 1990 levels by 2020. However, an accurate assessment of GHG emissions in 1990 is often elusive due to gaps in data availability and quality. In lieu of such data, the California Air Resources Board recommends that

entities target their 2020 emissions at 15% below current levels[5] (California Air Resources Board, 2008), a percentage that parallels the statewide 2020 commitment.

AC Transit has adopted a 15% reduction target for entity-wide Scope 1 and 2 emissions as measured by the TCR intensity metrics: emissions per total vehicles miles, revenue vehicle hours and PMT. By selecting these intensity targets rather than absolute targets, AC Transit will be seeking to reduce the carbon intensity of their operations. These metrics do not reflect changes in total emissions that result from service level changes, such as recent service cutbacks. CY2006 was selected as AC Transit's baseline year since it is the organization's first verified emissions year. Performance metrics for the CY2006 baseline, CY2007, CY2008, along with the 2020 targets, are summarized in Table 3.

Table 3. GHG Performance Metrics[6]

	2006	2007	2008	2020 Target
MT CO_2 Per Passenger Mile Traveled	0.0003	0.0004	0.0004	0.00026
MT CO_2 Per Vehicle Mile	0.0028	0.0030	0.0031	0.0024
MT CO_2 Per Vehicle Revenue Hour	0.0378	0.0389	0.0397	0.0321

Table 3 shows that AC Transit's CO_2 intensity has increased slightly between 2006 and 2008. The goal of this Climate Action Plan is to focus AC Transit's efforts going forward to ensure that this trend is reversed and that for each metric a 15% reduction from 2006 is achieved by 2020.

[5]ARB made this recommendation in its Climate Change Proposed Scoping Plan pursuant to AB 32, released October 2008, and adopted December 2008. Most jurisdictions have interpreted "current" to mean 2008 or earlier.

[6] AC Transit reports their PMT, vehicle miles and vehicle revenue hours based on a July 1 to June 30 fiscal year. To ensure the greatest amount of precision, TCR advises its members to use monthly metrics when converting from fiscal year to calendar year. However, AC Transit currently only collects this data annually, necessitating an alternate conversion method. The annual data provided by AC Transit was disaggregated into monthly totals and recombined to calculate the calendar year metrics. So, for CY2006 metrics, 6/12 months (50%) of 2005/2006 and 6/12 months (50%) of 2006/2007 were combined. The calendar year GHG Inventory totals were then divided by the adjusted calendar year metrics.

4.0 Existing CO_2 Emissions Reduction Measures

Over the past several years, AC Transit has undertaken a number of CO_2 emission reduction measures and sustainability initiatives that help to reduce GHG emissions from sources under their operational control and regionally. Over the past three years, AC Transit has been reporting on their initiatives in an annual environmental sustainability report. The following sections summarize these initiatives.

4.1 Fuel Cell Buses

In February 2000, the California Air Resources Board's (ARB) Urban Bus Rule came into effect. The rule requires that transit operators choose a fuel path (diesel or alternative), which in turn affects bus purchases and dictates emission reduction deadlines. AC Transit is on the diesel fuel path. Under the Zero Emission Bus element of the Fleet Rule, public transit providers operating 200 or more buses must participate in zero emission bus demonstration projects. To date, AC Transit—in partnership with Golden Gate Transit—has completed a first-stage zero emission demonstration project known as the HyRoad, consisting of three fuel cell buses.

From November 2005 through September 2010, AC Transit was generating hydrogen from natural gas reformation. At the AC Transit facility, natural gas from PG&E was fed to a steam reformer that produces a hydrogen-rich gas. This gas, called reformate, is composed of 75% hydrogen and 25% carbon dioxide and other trace gases. The reformate was compressed and purified for use in the fuel cell buses.

In the next phase of the program, AC Transit has partnered with the San Francisco Bay Area's largest bus transit operators (San Francisco Muni, Samtrans in the Peninsula, Golden Gate Transit in Marin, and Valley Transportation Authority in San Jose) to establish a truly regional program, representing the interests of agencies with a combined fleet of more than 2,500 buses to demonstrate and prove the fleet readiness of the zero-emission fuel cell buses. This advanced demonstration program involves 12 next-generation, zero-emission buses, a new hydrogen fueling station in Emeryville, scheduled to open in 2011, and a new station in East Oakland, scheduled to open in late 2011 or early 2012. The Emeryville station will be indirectly powered in part by a new solar power system

financed with a $6.4 million federal stimulus grant, whereas the new Oakland station will feature a similar fueling arrangement, but the onsite electrolyzer will be fully powered by biogas-fed stationary fuel cells. The new fleet vehicles feature a number of major improvements and efficiencies over the original HyRoad fleet including:

- A 5,000 pound reduction in bus weight;
- Lighter, more efficient, and more reliable and durable energy storage system, featuring heavy duty lithium-ion batteries;
- Systems integration by the bus manufacturer as opposed to using a third party integrator, resulting in easier to maintain components and networks and improved reliability and durability;
- Enhanced control system featuring a unique dynamic interface that more efficiently manages drive, fuel cell, and accessory systems;
- Better weight distribution throughout the bus to improve on-the-road vehicle performance, ride and handling;
- Lighter, smaller, and more efficiently designed cooling systems and onboard hydrogen storage system; and,
- Better optimization of interior space by proper distribution of components that takes advantage of the uniqueness of fuel cell and all electric technology to make a better vehicle for passengers – not just a diesel bus powered by hydrogen.

As of December 28, 2010, five of the twelve next-generation buses are currently in service. The other seven buses are expected to go into service in the near future. Hydrogen at the new fueling station will be generated from two different sources. Liquid hydrogen will be delivered by an outside vender that generates the hydrogen through steam methane reforming. Hydrogen will also be generated at the Emeryville station by an electrolyzer that will be indirectly powered by a solar power system installed at AC Transit's Central Maintenance Facility. ARB evaluated the GHG emission reductions associated with use of hydrogen fuel vehicles (based on the pathway described above) versus conventional diesel buses using the ARB analysis for the Low Carbon Fuel Standard Regulatory Process. This Well-To-Tank life cycle analysis of hydrogen produced from North

American natural gas was based on the Greenhouse gases, Regulated Emissions, and Energy use in Transportation (GREET) model developed by Argonne National Laboratory. Use of hydrogen fuel buses (based on AC Transit's current hydrogen generation pathway) over conventional diesel buses results in a 44 percent reduction of CO_2 equivalent emissions (Deal, 2010).

In addition to the GHG reduction benefits of fuel cell buses, a UC Davis study (Wang, 2008) has shown that use of hydrogen fuel instead of fossil fuels can improve ambient air quality. The UC Davis study evaluated the air quality impacts of hydrogen and gasoline use in light duty vehicles. This study found that: "The examined gasoline pathway, even with advanced new gasoline vehicles, would lead to much higher ambient concentrations of pollutants than the hydrogen pathways, producing 273 times greater CO, 88 times greater quantities of total volatile organic compounds, 8 times greater PM10, and 3.5 times greater NO_x concentrations than those caused by the centralized/pipeline hydrogen pathway, assuming the same size vehicle population."

While steam methane reformation of natural gas for hydrogen generation results in significant GHG reductions, developing technologies for hydrogen generation promises even further reductions. Hydrogen generation from biomass and natural gas with carbon capture and storage have the potential to generate very low to no GHG emissions. The next-generation fuel cell buses, new fueling station and further expansion of the fuel cell fleet will contribute significantly to AC Transit's CO_2 emission reduction efforts.

AC Transit's Short Range Transit Plan[7] for fiscal years (FY) 2009-2019 includes an expansion plan for the fuel cell bus fleet. The plan calls for the replacement of 70 conventional diesel buses with fuel cell buses between FY2013 and FY2019.

4.2 Energy Measures

Solar Power

In 2006, AC Transit entered into a partnership with Sunpower, PG&E, and MMA Renewable Ventures to install photovoltaic panels on rooftops at two facilities (Hayward and East Oakland). The systems

[7]Adopted April 28, 2010

are designed to generate up to 767 MWh of emission-free electricity per year. Although AC Transit does not own the panels (and thus cannot claim the GHG emissions reductions), the solar panels help increase California's supply of renewable energy, reduce regional greenhouse gas emissions and reduce demand on the local power utility. After the electricity rate under the current six-year power purchase agreement expires in April 2013, AC Transit plans to purchase the photovoltaic systems.

A contract to install a new solar powered system on the Central Maintenance Facility was recently awarded. The system will comprised of Solyndra solar modules manufactured in Fremont, California. Solyndra's cylindrical modules capture sunlight across a 360-degree photovoltaic surface capable of converting direct, diffuse, and reflected sunlight into electricity. This 500 kW solar power system will be used to indirectly power the new hydrogen fueling station in Emeryville. Another 200 kW solar power system, financed with funds from the federal stimulus grant will be installed elsewhere on AC Transit property to provide power to the hydrogen station.

Facility Lighting Retrofits

In 2005, AC Transit initiated energy audits at several facilities to identify opportunities to reduce consumption and operating costs by replacement of inefficient lighting. AC Transit conducted the first lighting retrofit at the Central Maintenance Facility in 2006, where the result was a reduction in lighting electricity load by approximately 20 percent. Entity-wide lighting retrofits were completed between November 2008 and March 2009. AC Transit's electricity usage dropped more than 15 percent from calendar year 2008 to calendar year 2009 due in part to increased energy efficiency from the new lighting systems.

Facility Improvements

During 2008 and 2009, AC Transit undertook a number of facility improvements that reduced energy and fuel usage, and the resultant direct and indirect CO_2 emissions. The improvements included installation of the following:

- Occupancy sensors in D-2, D-3, and the corporate offices to reduce lighting energy consumption;

- HVAC system thermostat timers at the corporate office that minimize heating- and cooling-related energy and fuel usage during non-business hours;
- High-speed fabric roll-up doors at every AC Transit facility to reduce heat loss and related energy usage; and,
- Two new energy-efficient HVAC units, insulation, and a white roof at CMF to reduce energy and natural gas usage.

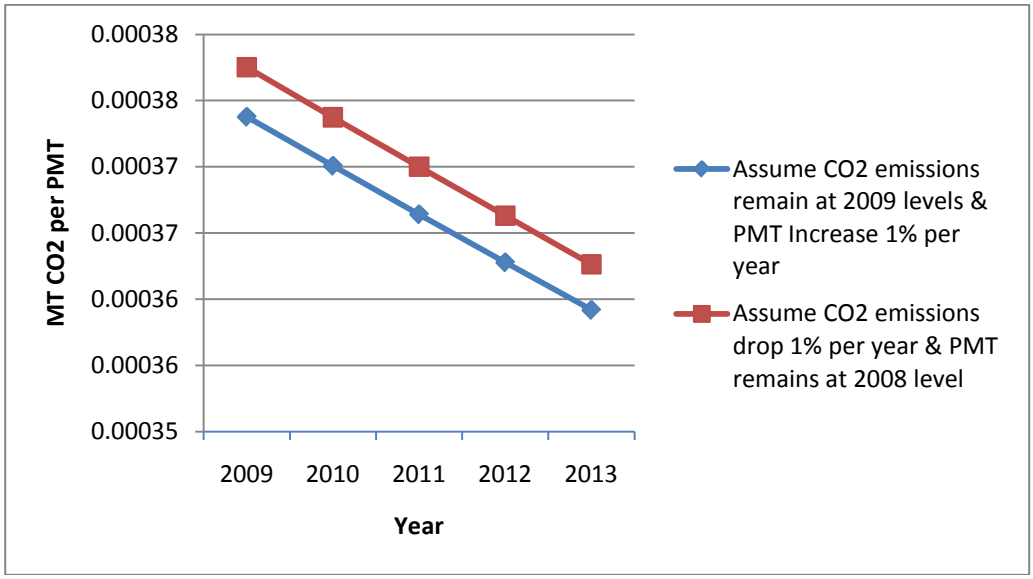
4.3 Ridership

Increasing bus ridership does not directly reduce AC Transit's total direct or indirect emissions. However, it does result in a reduction of emissions per PMT. Figure 2 below illustrates the relationship between ridership (PMT) and CO_2 emissions. Emissions per PMT decline if either ridership increases or CO_2 emissions decline. The CO_2 emissions per PMT metric captures efforts to improve carbon efficiency by attracting passengers and increasing service productivity (TCR, 2010). Furthermore, replacing individual vehicles with public transportation can greatly decrease the total VMT in a region, thereby decreasing regional GHG emissions.

AC Transit continually works to increase ridership on several fronts. Programs like Bus Rapid Transit (BRT) increase the speed or frequency of transit, making public transit even more commuter-friendly. AC Transit is also trying to improve the bus riding experience and boost ridership by offering free wireless internet service on transbay buses.

In addition to improving the bus riding experience, AC Transit focuses its services in the most populated areas. Approximately 70 percent of AC Transit's resources are targeted to demand-based service (lines with the highest levels of ridership), with the remaining 30 percent contributing to a basic level of geographic coverage. This 70-30 split promotes social equity, but is designed, first and foremost, to assure that resources are allocated to lines serving the greatest number of passengers, which in turn helps reduce regional vehicle miles traveled and transportation's overall impact on the environment.

Figure 2. CO_2 Emissions per PMT



Communication is another important component to increasing ridership. AC Transit has posted maps and schedules in public places, with real-time (NextBus) arrival information available at some bus stops and on the internet. In addition, improvements to the 511 regional website help provide information to riders and potential passengers. Along with the Metropolitan Transportation Commission (MTC), AC Transit is working to identify and implement upgrades at designated regional transit hubs.

4.4 Vehicle Use Policy

In October 2009, AC Transit amended its Vehicle Use Policy to minimize the number of directly-assigned non-revenue vehicles operated by the District and to encourage the concept of pool vehicles. This policy states, "It is the general policy of the District that personal use of a District vehicle is not permitted except in cases where the District specifically authorizes or requires such personal use. The District specially authorizes the use of vehicles for personal use only in those cases where an employee is subject to an employment agreement which includes the provision of a District vehicle for the employee's use." The effect of this policy amendment is a reduction in the use of non-

revenue vehicles by AC Transit staff, which in turn reduces fuel consumption and the resultant CO_2 emissions.

4.5 Waste Minimization

AC Transit initiated its recycling and waste reduction efforts over a decade ago, when a group of employees at its General Office in Oakland voluntarily formed a Recycling Committee. With the help of a grant from Alameda County's STOPWASTE program, the committee began to recycle office waste, including paper, cardboard, bottles, cans, ink cartridges, household batteries, e-waste (computer peripherals), and even eyeglasses. By 2007, the committee had expanded these programs to each AC Transit division, recruiting point persons to ensure optimum implementation at every location. Other items recycled on an ongoing basis include oil filters, used motor oil, vehicle batteries, fluorescent tubes, used tires, electronic equipment, graffiti shields, scrap metal, and wood pallets.

2009 marked another successful year for the recycling program. Over 93 tons of paper, cardboard and aluminum cans were recycled during 2009. This tonnage represents an increase of 82% over 2008. Based on EPA's Waste Reduction Model (WARM) this recycling effort resulted in a reduction of 350 MT of Scope 3 GHG emissions compared to the baseline landfill disposal scenario. However, this reduction does not affect AC Transit's inventory of Scope 1 and Scope 2 emissions.

4.6 Regional Climate Action Planning

With financial support from the Alameda County Transportation Improvement Agency (ACTIA) and the Federally-funded and California-administered Energy Efficiency and Conservation Block Grant (EECBG) program, every city in Alameda County has prepared or is in the process of preparing a CAP. Some jurisdictions in Contra Costa County are also preparing CAPs. Reducing emissions from transportation—in part by switching from single-occupant vehicles to public transit—is a component that is common to all of these plans, and AC Transit has been participating in their formulation and development. The District has provided background information, review, and comments, and has consulted with cities on implementation strategies. AC Transit anticipates doing more of this work in the future, and continues to participate in the joint ACTIA/CMA (Alameda County Congestion

Management Agency) Climate Action Working Group, which is developing countywide approaches to these issues.

5.0 Planned CO_2 Emissions Reduction Measures

5.1 Bus Replacement with Diesel-Electric Hybrid Buses

A "hybrid vehicle" refers to a vehicle with at least two sources of power. Diesel-electric hybrid buses generally use a parallel hybrid propulsion system that blends conventional bus engine power and electric motor power to provide propulsion power. The energy from the hybrid electric system is stored in batteries, and the system operates with regenerative braking (i.e., braking energy charges the bus battery pack and is used later for propulsion along with the energy stored in the batteries). The conventional bus engine is also capable of charging the energy storage system along with the regenerative braking energy.

Numerous public transit agencies nation-wide currently have diesel-electric hybrid buses in their fleets including three bay area transit districts: San Francisco Municipal Transportation Agency Golden Gate Transit and Santa Clara Valley Transit Authority. The National Renewable Energy Laboratory (NREL) has reported fuel economy improvements for diesel-electric hybrid buses over standard diesel buses ranging from 30.3 % for King County Metro Transit (KCMT) fleet serving the Seattle, Washington area, to 74.6% for New York City Transit (NYCTA) in Manhattan (Chandler, et al., 2006). The 30.3% improvement demonstrated by the KCMT diesel-hybrid buses is likely to represent the expected fuel economy improvement for diesel hybrid buses in AC Transit's fleet because the Seattle area has a similar topography to AC Transit's service areas. It is also likely that KCMT has a similar average speed to AC Transit, whereas NYCTA has one of the slowest average speeds of all U.S. transit agencies. A slower average speed results in more regenerative energy capture. Beginning in FY2010-2011, AC Transit had planned to start replacing older conventional diesel buses with diesel hybrid buses. AC Transit's Short Term Transit Plan includes replacing conventional diesel buses with diesel-electric hybrid buses. There is an interest by staff and the

Board to move forward with the acquisition of diesel-electric hybrid buses, but due to economic constraints, it will be postponed.

5.2 Energy Efficiency Audits

AC Transit is committing to developing a more comprehensive energy management plan for its operations. This plan will begin with energy audits offered by PG&E, which will identify energy efficiency and conservation opportunities related to buildings and facilities. Through the audit process, PG&E will also identify specific strategies and technologies that can deliver immediate energy savings for each facility audited. PG&E will help identify projects that have energy-savings potential, and recommend investments in energy-efficient equipment.

AC Transit's long term energy management plan will seek to reduce energy usage and associated costs through programs that include energy efficiency rebates for different types of equipment and appliances commonly used by businesses, including boilers and water heaters, HVAC equipment and refrigeration. As AC Transit reduces its energy usage, Scope 2 indirect CO_2 emissions will also decrease.

5.3 State of Good Repair Program

AC Transit recently received 5.4 million dollars in funding to implement a comprehensive State of Good Repair Program. This program will improve the performance of AC Transit's fleet by implementing new processes and software applications to improve fuel economy and reduce operating costs associated with road calls. A well-run vehicle maintenance program can result in better fuel economy and long-term cost savings. The US EPA reports that keeping a vehicle engine properly tuned (thus avoiding problems due to worn spark plugs, dragging brakes, low transmission fluid, or transmission problems) increased fuel economy by an average of 4%, while fixing a serious maintenance problem such as a faulty oxygen sensor can save as much as 40% in fuel (US Department of Energy, 2010). The US Department of Energy (2010) also reports that keeping tires properly inflated can have a fuel economy benefit of more than 3% while improving the safety and life of the tires. Using the motor oil recommended by the engine manufacturer can also have fuel economy benefits. A program that ensures or improves the monitoring and regular execution of these basic

maintenance tasks should result in significant improvements in fuel economy, and a corresponding reduction in GHG emissions per vehicle mile traveled.

AC Transit's State of Good Repair Program entails three discrete phases: Implementation of Asset Management Database; Inspection and Assessment of Vehicles, and Implementation of Vehicle Upgrades. The program will allow AC Transit to minimize bus breakdowns by getting part-level information on date of procurement, date of last maintenance, and upgrade for even the smallest components on its buses. It will also establish maintenance intervals for all components and not just major components. This program will result in a projected savings to AC Transit of one to three million dollars annually.

5.4 Stationary Fuel Cells

AC Transit will be utilizing biogas to fuel four advanced solid oxide fuel cell systems (SOFC) producing 400 kW of continuous power and more than 3.5 MWh of electricity annually, The power from the SOFC system will supply all of the electrical energy demand at AC Transit's Oakland Seminary operating and maintenance division, including the daily electrolysis of 65 kilograms of hydrogen, enough to supply fuel to operate fuel cell buses in excess of 128,000 miles per year. Annual energy savings will amount to 9,378 mmBTU, and CO_2 reductions will amount to 342 tons per year attributable to fuel cell buses. Actual emission reductions for the entire facility will amount to 1,445 tons CO_2per year.

Recent advances in SOFC designs have lead to very durable systems that are capable of producing electricity more efficiently than gas turbine generators (55% to 60% for SOFC, compared to 35% to 49% for centralized turbines feeding transmission networks), the source of 41% of California's grid power supply. SOFCs can also utilize biofuels as their source of fuel, so the net impact is to produce carbon-free electrical power more cheaply and efficiently than any foreseeable source of standard grid power.

6.0 CO_2 Emissions Reduction Measures For Future Consideration

The technology and science that will help drive CO_2 emissions reduction is constantly evolving. The most cost-effective and viable alternatives for reducing CO_2 emissions being considered today may be different than what should be considered in the future. Due to the dynamic nature of technology, AC Transit's Climate Action Plan will be a living document that is updated routinely to identify and assess new emission reduction opportunities. This section highlights just a few of the CO_2 emission reduction measures that AC Transit will consider in the near future.

6.1 Non-Revenue Fleet Replacement

AC Transit's current fleet of road supervisor and pool cars includes mostly large sedans such as Ford Crown Victoria and Taurus models. AC Transit's Short Range Transit Plan calls for replacement of select road supervisor and pool cars with hybrid and electric plug-in vehicles. AC Transit is currently in the process of evaluating their non-revenue fleet vehicle needs and the timing of the vehicle replacement. Replacement of AC Transit vans and trucks with hybrid alternatives will also be evaluated in the future, when they become commercially available.

6.2 Biodiesel Usage

Biodiesel is a non-petroleum-based diesel fuel made from vegetable oil, animal fats, or recycled greases. Biodiesel in its pure form is known as "neat biodiesel" or B100, but it can also be blended with conventional diesel, most commonly as B5 (5 percent biodiesel, 95 percent diesel) and B20 (20 percent biodiesel, 80 percent diesel). Biodiesel is registered with the U.S. Environmental Protection Agency (EPA) and is legal for use at any blend level in both highway and non-road diesel vehicles.

Recently, AC Transit partnered with Chevron and Cummins Incorporated to evaluate the performance of several diesel fuels, including soy-based B20, in AC Transit fleet vehicles in a controlled environment. The fuels were tested for 18,000 vehicle miles in several urban bus models (with modern engines and after-treatment devices), as well as in a laboratory environment using a heavy-duty chassis dynamometer. The results of this study showed no statistically significant difference in NO_x emissions, engine performance, or engine wear-and-tear between B20 and CARB-

approved ultra-low sulfur diesel (ULSD, with 15 ppm sulfur cap). The use of B20 resulted in slightly lower fuel economy overall (approximately 1.2% lower in road testing) compared to CARB diesel fuel (SAE International, 2009). Other studies confirm that biodiesel has a lower energy density than conventional diesel which can manifest as a measurable decrease in fuel economy (8 to 9 percent for B100) (National Energy Research Laboratory, 2009). All biodiesel, regardless of its feedstock, provides about the same amount of energy per gallon.

Biodiesel is considered renewable because it is made from plant or animal oils which are renewable. Gallon for gallon, it requires less fossil energy to produce biodiesel than to produce conventional diesel. It has almost no carbon footprint associated with combustion because the soy-based feedstock is considered biogenic. Life-cycle analyses show that biodiesel made from soybeans has a lower fossil carbon footprint attributed to production. However, consideration of the full lifecycle, from feedstock to combustion, should consider the indirect land use effects triggered by market demand, and this offsets much of the biogenic advantage. The indirect land use effects are difficult to estimate and vary considerably with crop yield and the extent of land transformation across cropland, pasture and forest land. When land is thus transformed to support increased biofuel production, the indirect effects include carbon released to the atmosphere from the lost cover vegetation and disturbed soils. If international land use impacts are included (as recommended by the EPA and included in the Low Carbon Fuel Standard), the net effect is that soy-based biodiesel is about 20% less carbon intensive than conventional diesel on a lifecycle per-gallon basis. If lifecycle emissions are not taken into account, the net benefit of using biodiesel to reduce GHG emissions from vehicles is small due to its lower energy density compared to conventional diesel (National Biodiesel Board, 2010).

AC Transit's primary operational barriers to shifting to biodiesel are the lack of a reliable local supplier and a slightly higher cost than conventional diesel. In the San Francisco Bay Area, biodiesel was approximately 25 cents more per gallon than conventional diesel in May 2010.[8] While use of B20 results in lower Scope 1 CO_2 emissions per gallon than ULSD diesel, the apparent advantage is largely offset by the slightly lower fuel economy and slightly higher fuel cost. Due to these reasons, AC

[8] Based on review of spot B20 prices in San Francisco area on Alternative Fuels Index, and conversations with fuel suppliers.

Transit has elected to not use biodiesel in their operations at this time. Use of biodiesel in AC Transit's operations will be reevaluated annually (at a minimum).

6.3 Carbon Offsets

A carbon offset is a credit representing a reduction of one MT of CO_2 or CO_2equivalent[9] emissions. Carbon offsets are generated through emissions reduction projects that would not have happened under a business-as-usual scenario and would not have been possible without the extra revenue gained from selling the offsets. Many organizations choose to purchase carbon offsets to indirectly reduce the size of their carbon footprint.

For offset projects developed in the United States, there are a range of voluntary and pre-compliance markets to consider. The value of the credits on each registry is usually tied to the credibility of the process for approving projects and the perceived likelihood that the credits would be transferable into a regional or federal cap-and-trade system. Every registry requires that the project sponsor follow a thorough and transparent "protocol" or set of guidelines for determining the project baseline and monitoring the resulting emission reductions. Without a protocol, no credits can be placed on a registry.

The Climate Action Reserve (CAR) is generally seen as the high-water mark in voluntary/pre-compliance offsets in the U.S. Offsets in the CAR have been generated under a number of emission reduction project types: reforestation, installing a manure biogas control system for livestock operations, composting of municipal food waste and others. CAR is noteworthy for its extensive stakeholder process for approving new offset protocols. It is because the protocol approval process is so long and complicated that the volume of credits is relatively low and the price per credit is relatively high compared to other U.S. registries.

If AC Transit is unable to achieve its 2020 emission reduction targets through operational changes, they will consider purchasing high quality carbon offsets to account for the shortfall.

[9] Carbon dioxide equivalent means a measure for comparing carbon dioxide with other greenhouse gases based on quantity of those gases multiplied by the appropriate global warming potential factor.

7.0 Achieving Reductions & Monitoring Progress

AC Transit will make significant progress toward meeting its 2020 CO_2 emissions reduction targets through its existing and planned measures: revenue fleet replacement with hydrogen fuel cell and diesel-electric hybrid buses; proper fleet maintenance; facility electricity use reduction; and increasing ridership. Table 4 summarizes the expected impact of existing and planned measures as a percent reduction of total emissions, using the best information available. Table 4 extends through CY2018-19 to parallel the AC Transit's Short Range Transit Plan.[10] Some of the measures can be quantified in terms of expected emission reductions, though the accuracy of the estimates varies widely and is dependent on the validity of assumptions and the quality of existing data for similar programs. AC Transit's Bus Replacement program, which replaces conventional buses with fuel cell buses and diesel-electric buses over time, is described in detail in the AC Transit's Short Range Transit Plan.[9] Table 4 shows how this program will reduce total CO_2 emissions by approximately 10% by 2019.

Table 4. Projected CO_2 Emissions Reductions from Existing and Planned Measures (cumulative inventory reduction)

Program/ Measure	FY 2011-12	FY 2012-13	FY 2013-14	FY 2014-15	FY 2015-16	FY 2016-17	FY 2017-18	FY 2018-19
Bus Replacement *	-0.9%	-1.2%	-1.2%	-2.1%	-5.3%	-6.0%	-7.6%	-9.9%
Electricity Use Reduction[11]	-0.3%	-0.3%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%	-0.5%
State of Good Repair Program[12]	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%	-1.0%
Stationary Oxide Fuel Cells	-2.0%	-2.0%	-2.1%	-2.1%	-2.1%	-2.1%	-2.1%	-2.2%
Vehicle Use Policy	Neg	Neg	Neg	Neg	Neg	Neg	Neg	Neg
Increase Ridership	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL	-4.2%	-4.5%	-4.8%	-5.7%	-8.9%	-9.6%	-11.2%	-13.6%

Notes: Neg = negligible effect

[10] Adopted April 28, 2010

[11] The 0.25% reduction to AC Transit's total GHG emissions for FY2011 thorough FY2013 assumes a 5% total reduction of electricity use from facility audits and equipment replacement. A 10% reduction is assumed for FY2013 through FY2019 based on AC Transit's purchase of the solar power systems at the Hayward and East Oakland facilities and the state's requirements to reduce the carbon intensity of power provided to customers.

[12] The 1% reduction is a conservative estimate based on US EPA's estimate that keeping a vehicle engine properly tuned fuel economy by an average of 4% (US Department of Energy, 2010).

*Even though bus replacement with diesel-electric hybrid buses is postponed as of December 2010, reductions are based on projected replacement plan.

N/A = not applicable - Increasing ridership will not directly reduce emissions; it will lead to a reduction of the emissions per PMT.

Many of the existing and planned CO_2 emission reduction measures described in Sections 4 and 5 are difficult to quantify at this time, but Table 4 includes rough estimates of the impact of Facility Energy Improvements and the State of Good Repair Program. These measures, in combination with the Bus Replacement Program, could achieve a 13.6% reduction in total CO_2 emissions by 2019.

If AC Transit's level of service were to remain constant through 2019, the gross CO_2 emissions reductions would translate into an approximate 13.6% improvement in the GHG Performance Metrics described in Section 3. To achieve a 15% improvement for each metric, AC Transit will need to consider replacement of additional conventional buses with diesel-electric or fuel cell buses beyond what is currently included in AC Transit's Short Range Transit Plan; development of additional maintenance measures or operational practices that improve fuel economy; and implementation of additional measures not included in Table 4. The key strategies for impacting each metric are summarized below:

MT CO_2 Per Passenger Mile Traveled – Increase ridership; improve fuel economy; increase use of low-carbon fuels;

MT CO_2 Per Vehicle Mile – Improve fuel economy; increase use of low-carbon fuels; and,

MT CO_2 Per Vehicle Revenue Hour – Improve fuel economy; reduce dead-heading; increase use of low-carbon fuels.

If AC Transit is not able to meet its 2020 reduction targets, the purchase of carbon offsets (as described in the previous section) could make up the gap.

4.1 Monitoring Progress

AC Transit will continue to calculate and report their GHG emissions and performance metrics to TCR on an annual basis. Setting interim performance goals is recommended (e.g., 5% improvement for each of the three GHG Performance Metrics for the 2015 reporting year). That way, the

effectiveness of key programs can be monitored and adaptive management can be employed to allocate resources to the most effective programs.

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