San Francisco International Airport

SFO Climate Action Plan

Vision: Mitigate the Total SFO Controlled Carbon Emissions

MARCH 2012

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Airport Director's Message

The Mayor and the Board of Supervisors of the City and County of San Francisco have been in the forefront of the U.S. movement for addressing climate change issues by reducing greenhouse gas emissions. In 2008 as a result of this commitment the Board of Supervisors adopted and the Mayor signed into law Ordinance No. 81-08 Climate Change Goals and Action Plan, which mandates the achievement of the following greenhouse gas (GHG) emission targets by each City Department:

- 25% below the 1990 emission level by 2017
- 40% below the 1990 emission level by 2025
- 80% below the 1990 emission level by 2050

The Airport Commission has vigorously supported the City's climate change initiatives and has established the total mitigation of the carbon footprint of SFO controlled operations by 2015 as an additional goal for the Airport. SFO management developed a Departmental Climate Action Plan (DCAP) in FY 2008 as the blueprint for meeting the Ordinance 81-08 objectives and achieving total mitigation of the carbon footprint of SFO controlled operations. The current revisions to the DCAP incorporate information related to Airport operations in FY 2011, as well as more detailed data for the GHG emissions of airlines, tenants, concessionaires, and from the commute by airport passengers.

In FY 2011 we were able to reduce our gross baseline carbon footprint to 15.6% below the 1990 emission level for Airport controlled operations. In addition we achieved an offset of 5.2% of the 1990 emission level for a combined reduction of 20.8%. We also voluntarily mitigated 151% of our FY 2011 net baseline carbon footprint by enabling other SFO enterprises to reduce their own GHG emissions. More information on our achievements is provided in this DCAP and is summarized below:

- In 1990 SFO generated an estimated GHG emission of 52,219 metric tons (tons) from operations that were under the control of the Airport Commission. Accordingly, Ordinance No. 81-08 mandates the following maximum GHG emission levels for SFO:
    - by 2017 not to exceed a GHG emission of 39,164 tons per year,
    - by 2025 not to exceed a GHG emission of 31,331 tons per year, and
    - by 2050 not to exceed a GHG emission of 10,444 tons per year.

    - Emission Reduction Measures. In FY 2011 the gross GHG emission from SFO controlled operations was 44,071 tons. This emission level was achieved by implementing the following emission reduction measures. In FY 2011 these measures reduced the GHG emissions at SFO by 19,632 tons, as itemized below:
        - General reduction in the GHG emission factor for electricity supplied by SFPUC to SFO in FY 2011 and implementation of electric energy efficiency measures resulted in a GHG emission reduction of 12,716 tons in comparison with the corresponding 1990 emission level
        - GHG emission from SFO Fleet decline by 974 tons from the 1990 level due to improved fuel efficiency of the fleet vehicles and the use of alternate fuels which compensated for the rise in the number of vehicles

- Reducing the quantity of landfilled solid waste from 6,000 tons in 1990 to 2,348 tons in FY 2011 reduced the GHG emissions for landfilling operations by 1,808 tons
- Reducing the emission of fugitive refrigerant gases and using more climate friendly refrigerant gases resulted in an emission reduction of 4,134 tons compared to 1990 emission level.

The impact of the above emission reduction measures was balanced by growth induced increases in consumption of energy and various fuels resulting in a net GHG emission reduction of 8,148 tons from 1990 to FY 2011, or a reduction of 15.6%.

o Emission Offset Measures. These measures relate to Airport operations or actions that yield a direct reduction in the GHG emissions to the atmosphere. In FY 2011 the following offsets were achieved by SFO:

- SFO recycled about 75% of the general solid waste collected at the Airport yielding an emission offset of 2,619 tons.
- SFO has planted 2,020 trees of various species around the Airport which sequester about 121 tons of carbon dioxide from the air per year.

As the result of the above offset measures SFO's Category 1 carbon footprint was reduced by an additional 2,740 tons in FY 2011, thereby yielding an additional 5.2% reduction from the 1990 emission level. The combined emission reduction and offset measures implemented at SFO yielded a net GHG emission of 41,331 tons for FY 2011, indicating 20.8% reduction from the 1990 emission level.

o Voluntary Emission Mitigation Measures. These measures relate to direct or indirect actions taken voluntarily by SFO to reduce the GHG emissions from the operations of airlines, car rental agencies, passengers' travel to and from SFO, etc. We believe that SFO is entitled to claiming the emission mitigation resulting from the expenditure of funds and other resources to enable other entities to save money and reduce their own GHG emissions. In FY 2011 these measures mitigated the GHG emissions at SFO by 62,381 tons or 151% of the net GHG emissions from SFO controlled operations, as itemized below:

- In FY 2011, the PC Air system mitigated the GHG emissions at SFO by 48,295 tons. The significant increase in the PC Air emission mitigation from FY 2010 to FY 2011 was due to the installation of dedicated PC Air units at 12 jet bridges in Boarding Areas C and F and the utilization of these units by airlines for the entire FY 2011. SFO has also installed 14 PC Air units at jet bridges in the renovated Terminal 2 which became operational in April 2011.

- In 2009 SFO initiated a three year Green Car Rental Incentive Program (GCRIP) in conjunction with the rental car companies operating at the Airport. This program provided financial incentives to the rental car companies to increase the number of EPA Green cars to 15% of their rental vehicle inventory. The program

also provided a $15 discount to the customers who rent a Green Car. In FY 2011 the net emission mitigation from the GCRIP was estimated at 9,946 tons.

- SFO provided partial funding for BART extension to SFO which in FY 2011 resulted in a reduction of about 72 million miles of travel by airline passengers based on monthly passenger data provided by BART to SFO staff. SFO shares approximately 9.1% of this mitigation based on the SFO contribution of 200 million dollars to the capital cost for extending BART from Colma to SFO and Millbrae. In FY 2011, it is estimated that BART extension mitigated SFO's GHG emissions by 2,180 tons.

- In 2003 SFO completed the construction of AirTrain which has eliminated the need for the use of shuttle buses by all on-Airport Rental Car Agencies. In FY 2011, the AirTrain system mitigated SFO's GHG emissions by 1,960 tons.

A graphic representation of gross GHG emissions versus emission offset and mitigation levels at SFO is shown in the diagram below.

Additionally, SFO has developed a number of new and expanded GHG emission reduction, offset, and mitigation (ROM) measures, which are currently underway or are in the planning stage. These planned measures are estimated to yield a combined GHG emission ROM of 13,183 tons per year by 2017. The major elements of the planned GHG emission reduction / offset/ mitigation measures include:

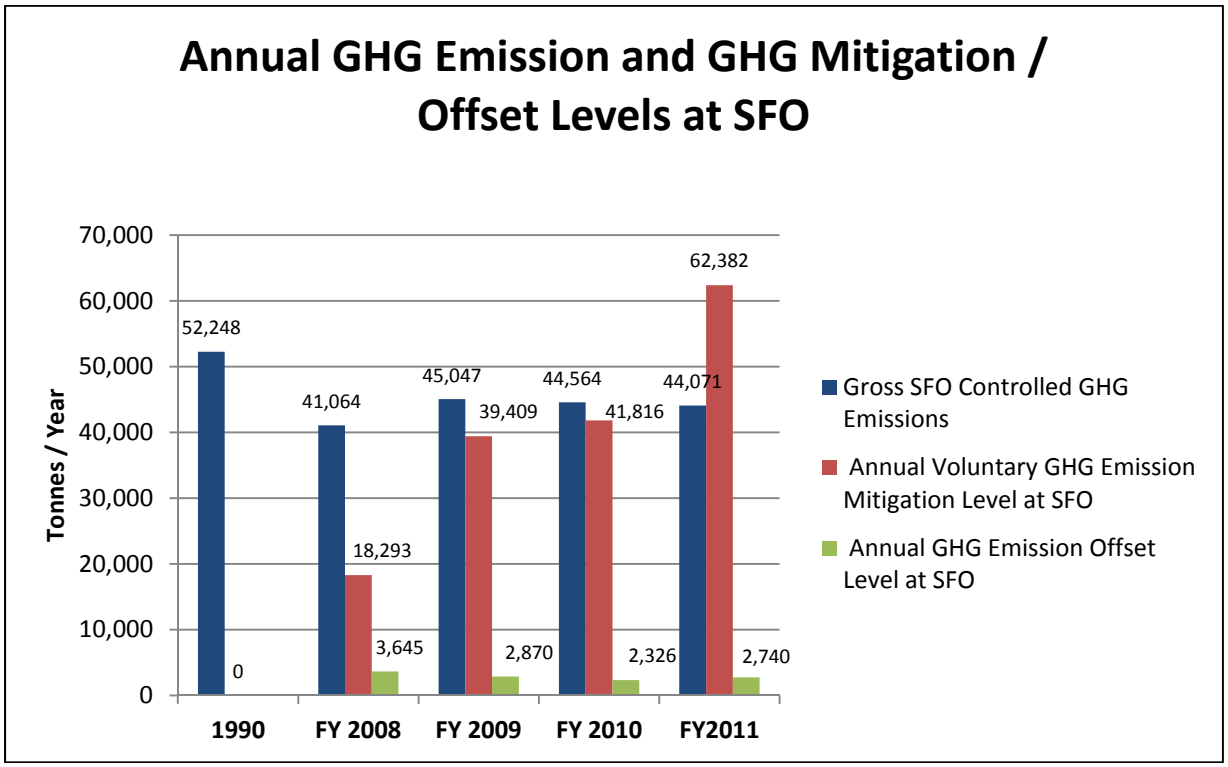
- Energy efficiency, enhanced solid waste recycling, fleet vehicle upgrade undertakings, and
- Activation of planned additional PC Air and 400 Hz power supply equipment at the renovated Boarding Area E.

We believe that by implementing the planned and other future emission reduction measures SFO will be able to meet the Ordinance 81-08 targets for 2017 and 2025 and, additionally, we plan to continue mitigating the total SFO controlled GHG emissions in the future years.

SFO has also compiled estimated data for GHG emissions from the operations of airlines, airline support services, concessionaires, and other activities at the Airport. Reduction / mitigation of GHG emissions from these operations will be addressed in cooperation with all of the stakeholders as a part of SFO's future climate action initiatives.

John L. Martin

Airport Director


Annual GHG Emission and GHG Mitigation / Offset Levels at SFO
Tonnes / Year
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
52,248
0
41,064
18,293
3,645
45,047
39,409
2,870
44,564
41,816
2,326
44,071
62,382
2,740
1990
FY 2008
FY 2009
FY 2010
FY2011
Gross SFO Controlled GHG Emissions
Annual Voluntary GHG Emission Mitigation Level at SFO
Annual GHG Emission Offset Level at SFO

Report Summary

Background

The Board of Supervisors enacted Ordinance No. 81-08 in 2008 entitled Climate Change Goals and Action Plan to establish City greenhouse gas emission (GHG) targets and departmental action plans, and to authorize the Department of Environment (SFE) to coordinate efforts to meet these targets, and to make environmental findings. Ordinance No. 81-08 establishes the following greenhouse gas emission limits for the City and County of San Francisco:

- By 2008, the Commission on the Environment shall determine the 1990 greenhouse gas emission levels within the City and County of San Francisco, including private enterprise activity;
- By 2017, City shall reduce the greenhouse gas emissions by 25% below 1990 levels;
- By 2025, City shall reduce the greenhouse gas emissions by 40% below 1990 levels; and
- By 2050, City shall reduce the greenhouse gas emissions by 80% below 1990 levels.

The Ordinance requires that all City departments shall consider the effect of all decisions and activities within their jurisdiction on greenhouse gas emissions and undertake their responsibilities to the end that the City achieves greenhouse gas emission limits described above.

Section 903 (c) of the Ordinance further states that "On or before January 30, 2009 all City departments shall assess GHG emissions associated with their activities and submit in a format specified by the Department of Environment a written action plan that identifies and makes recommendations on GHG emission reduction / offset measures applicable to:

- Operations of the department and other city greenhouse gas emission sources within its jurisdiction, and
- Private sector greenhouse gas emission sources regulated by the department.

Such plan shall identify potential costs of identified measures and the estimated potential benefits of elements in the plan for reducing greenhouse gases, and may also identify other economic and non-economic impacts to the City's economy and environment."

Section 904 of the Ordinance states that "Beginning at the Close of fiscal year 2008-2009, no later than 90 days after the close of each fiscal year, all City departments shall submit to SFE, in a format specified by the Department of the Environment, a written update of the plans, status of any recommendations required by Section 903, and the GHG emission reductions achieved due to actions taken by the department. Such updates are to provide, to the extent feasible, adequate information to enable the Department of the Environment to calculate the City's progress toward meeting the GHG emission reductions set forth in the Ordinance."

This updated Climate Action Plan for SFO has been developed in the format prescribed by SFE and in compliance with the provisions of Ordinance No. 81-08 of the City and County of San Francisco. A copy of the Climate Change Goals and Action Plan Ordinance is included in Attachment A.

Report Summary

An expanded summary of the first two sections of the Climate Action Plan is provided below, followed by a brief summary of the remaining sections of the Plan.

Section 1. Profile of SFO

San Francisco International Airport (SFO) is Northern California's premiere airport serving hundreds of destinations throughout the United States and abroad. SFO is consistently rated as one of the top airports in the world for the efficiency and quality of service rendered to the travelers.

Located on the shore of San Francisco Bay, 14 miles south of San Francisco, SFO covers approximately 5,200 acres with 2,400 acres developed for Airport use and approximately 2,800 acres remaining as natural tidelands and wetlands. In FY 2011, SFO served 39,726,471 passengers with 354,582 takeoffs and landings on 58 airlines. Also, 393,483 metric tons of cargo was shipped to and from SFO during the same period. More than 180 vendors operate at SFO to serve the travelers; including restaurants, shops, and various services.

SFO is served by the Bay Area Rapid Transit (BART) system and travelers are using BART at an ever increasing rate to travel to and from the Airport. SFO's new AirTrain system provides a seamless connection to BART and rental car facilities for access to all Airport terminals.

SFO is governed by the Airport Commission, a five-member body appointed to four-year terms by the Mayor of San Francisco. The Commission appoints the Airport Director. The Airport personnel are organized in several divisions with each division serving specific needs of the Airport, the travelers, and/or the enterprises operating at SFO.

Section 2. SFO's Carbon Footprint

SFO's carbon footprint can be defined by the following three categories of greenhouse gas (GHG) emissions in the context of Ordinance 81-08 requirements:

Category 1 - SFO Controlled Emissions - GHG emissions from operations that are under the control of SFO, including SFO employees' commute emissions, and emissions from all modes of travel on SFO controlled roads.

Category 2 - Airlines, Concessionaires, and Airline Support Services Emissions - GHG emissions, within the physical boundaries of SFO; by airline operations, including landing and take-off (LTO) cycles; ground service equipment (GSE) and other support services; and by various concessionaires and other tenants.

Category 3 - Optional Emissions – U.S. Environmental Protection Agency (EPA) defines optional emissions as those emissions that are not directly emitted by but are connected with the reporting enterprise's operations. Examples include GHG emissions from: 1) passengers' travel, on public roads or by public transit, to and from SFO, 2) outbound cruising aircraft, 3) delivery trucks, 4) construction equipment, and 5) commute travel by employees of airlines, concessionaires, and airline support services.

Estimated GHG emissions for the categories listed above are summarized in Table 1. SFO has developed fairly complete and detailed data for Category 1 emissions, whereas some data gaps remain in the estimates of GHG emissions for the remaining two categories.

The focus of the current Climate Action Plan is on the assessment and reduction of Category 1 GHG emissions. Reduction measures for Category 2 and 3 GHG emissions will be evaluated in cooperation with the various stakeholders as a part of SFO's ongoing Environmental Sustainability Program.

Table 1. Summary of Estimated GHG Emissions for 1990 and FY 2009 through FY 2011 at SFO

WRI Emission Category	SFO Emission Category	GHG Emission (Tons)			
		1990	FY 2009	FY 2010	FY 2011
Scopes 1, 2, and 3	Category 1- Gross SFO Controlled Emissions	52,248	42,177	42,236	41,331
Scopes 1, 2, and 3	Category 2- Gross Airlines, Concessionaires, and Aitrline Support Services Emissions	839,000	668,037	676,169	749,398
Scope 3	Category 3. Optional Emissions	7,127,543	7,937,546	8,195,369	8,487,665
	Total	**8,018,791**	**8,647,760**	**8,913,773**	**9,278,393**

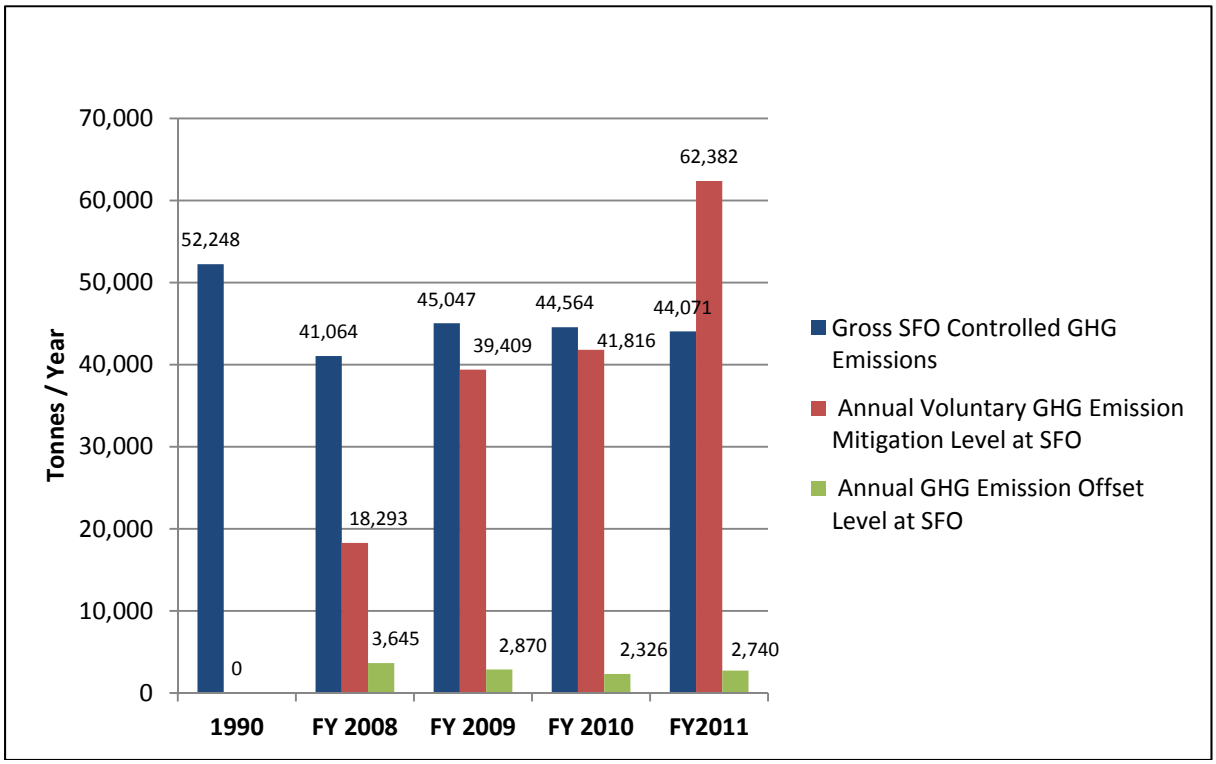
Components of Category 1 SFO Controlled GHG Emissions. As shown in Table 2 GHG emissions at SFO are generated mainly as the result of the consumption of energy and various fuels and to a lesser extent from the release of fugitive refrigerant gases. The net GHG emission of 41,331 metric tons in FY 2011 includes the impact of all efficiency measures that have been implemented to reduce electric energy and fuel consumption, enhance solid waste recycling, and minimize fugitive refrigerant gas emissions. These emissions also reflect the estimated impact of offset measures such as solid waste recycling and tree planting at SFO. In addition estimates of SFO GHG emission mitigations that were achieved by supplying preconditioned air (PC Air) and 400 Hz power to the aircraft at various terminals, implementing the Green Car Rental Incentive Program, extending BART to SFO, and constructing the Air Train system are also provided in this table. The details of GHG emission calculations are provided in Section 2 of this report.

Table 2. Summary of Historical and Current Category 1 GHG Emissions, Emission Offset and Emission Mitigation Levels at SFO

Activity	Category 1 SFO Controlled GHG Emissions (tonnes per year)			
	1990	FY 2009	FY 2010	FY 2011
GHG Emission Levels				
Electric Energy and Natural Gas Consumption	29,267	23,363	22,478	25,008
Fuel Consumption	15,246	17,118	17,430	17,162
Fugitive Refrigerant Gas Emissions	4,875	3,176	3,513	740
Solid Waste Disposal	2,596	1,065	820	788
Wastewater Treatment	234	287	281	373
Total Gross Baseline Category 1 GHG Emission	52,218	45,009	44,522	44,071
GHG Emission Offset Levels				
Solid Waste Recycling Offset	0	-2,749	-2,205	-2,619
Tree Sequestration Offset	0	-121	-121	-121
Total GHG Emission Offsets	0	-2,870	-2,326	-2,740
Net Category 1 GHG Emission	52,218	42,139	42,196	41,331
GHG Emission Mitigation Level				
Total GHG Emission Mitigation	0	-39,409	-41,817	-62,382

A graphical representation of gross Category 1 GHG emission, emission offset, and emission mitigation levels are shown in Figure 1.

Figure 1. Graph of Historical and Current GHG Emission, Emission Offset, and Emission Mitigation Levels at SFO



Category 1 GHG Emission Reduction, Offset, and Mitigation (ROM) Measures

SFO has implemented a number of GHG ROM measures in the past several years. Additional emission ROM measures have also been planned for future implementation. The implemented and planned GHG emission ROM measures are summarized below.

Implemented GHG Emission ROM Measures. A number of GHG emission reduction measures have been implemented in the past several years including various energy efficiency measures, fleet vehicle upgrade using hybrid/electric and compressed natural gas (CNG) cars, conversion of buses and trucks to biofuel and CNG, etc. The impacts of these emission reduction measures are included in the calculated baseline emission values shown in Table 2 and these items are not tallied separately. The GHG emission offset and mitigation measures that have been implemented by SFO over the past several years are summarized in Table 3. These data indicate that, in FY 2011, a total GHG emission mitigation of 62,381 tons and a total GHG emission offset of 2,740 tons were generated at SFO. The mitigation measures included supplying preconditioned air and 400 Htz power to aircraft parked at the gates, providing incentive for rental of green cars, recycling of construction and demolition waste, partial funding for extension of BART to SFO, and construction of AirTrain facility. The offset measures included solid waste recycling and tree plantation. SFO does not claim an offset or mitigation for the solar power generated at the Airport because the funding for the solar power system was supplied by San Francisco Public Utility Commission.

Table 3. Summary of Implemented GHG Emission Mitigation and Offset Measures at SFO

Type of mitigation Measure	Resources Saved in FY2009	Resources Saved in FY 2010	Resources Saved in FY 2011	GHG Emission Mitigation or Offset (tonnes per year)		
				FY 2009	FY 2010	FY 2011
GHG Emission Mitigation Measures						
PC Air and 400 Hz Power Supply Installation at International and Domestic Terminals	1,445,979	2,226,413	4,912,280	-14,216	-21,889	-48,295
Green Car Rental Incentive Program	862,033	1,224,329	1,118,473	-8,055	-11,442	-9,946
Construction & Demolition Waste Recycling	7,708	13,041	0	-13,096	-4,545	0
SFO's Share of GHG Mitigation for BART Extension to SFO	249,063	229,753	241,262	-2,250	-2,076	-2,180
AirTrain Facility	176,654	183,856	193,281	-1,791	-1,864	-1,960
Subtotal Emission Mitigation				-39,409	-41,816	-62,381
GHG Emission Offset Measures						
Solid Waste Recycling, tons	5748	6,560	6,661	-2,749	-2,205	-2,619
Tree Planting Operations	2020	2020	2020	-121	-121	-121
Total GHG Emission Offset				-2,870	-2,326	-2,740

Planned GHG Emission Reduction, Offset, and Mitigation Measures. SFO has also planned and developed a number of additional initiatives to further reduce the direct GHG emissions from Airport operations and to offset or mitigate the remaining emissions by reducing the emissions from other sources

at or off the Airport. The estimated impacts of planned GHG emission ROM measures are summarized in Table 4 and indicate that about 12,283 tons of GHG emissions per year could be reduced /offset and mitigated after all of the planned measures are implemented. Most of these ROM measures are expected to be carried out by 2017.

Table 4. Summary of Planned GHG Emission Reduction, Offset, and Mitigation Measures at SFO

Activity	Planned GHG Emission Reduction/ Offset /Mitigation Measures, tonnes per year
GHG Emission Reduction Measures	
Natural Gas Use Reduction	5,219
Fleet Vehicle Replacement	354
Electric Energy Efficiency Measures	473
Subtotal Emission Reductions	**6,047**
GHG Emission Offset Measures	
Enhanced Solid Waste Recycling	2,000
Subtotal Mitigation Measures	**2,000**
GHG Emission Mitigation Measures	
PC Air and 400 Hz Power Supply System at B/A E	5,136
Subtotal Mitigation Measures	**5,136**
Grand Total	**13,283**

Projected Category 1 GHG Emissions. Ordinance 81-08 requires the development of estimates for future GHG emissions. One method of estimating the future baseline GHG emissions at SFO is to base the upper limit of these emissions on the projected number of enplaned passengers. This approach provides a fairly high estimate of the future emissions and the actual emissions might be significantly below

these projected levels, especially in light of the fact that baseline GHG emissions have remained fairly stable over the past three years. An uncertainty factor in estimating future GHG emissions arises from the level of hydroelectricity generated by SFPUC's Hetch Hecthy power plants, which depends on annual precipitation levels. This factor could cause significant variations in the carbon footprint of electricity consumption at the Airport but could not be anticipated in advance.

Projected GHG emissions for 2017 and 2025 were, therefore, developed on the basis of the estimated rate of growth of enplaned passengers at 14.5% by 2017 and 37.54% by 2025, as supplied by SFO Finance Department. The projections shown in Table 5 indicate that net GHG emission could potentially reach 39,901 tons per year by 2017 and 47,759 tons per year by 2025, assuming the implementation of planned emission reduction/offset measures yielding 7,147 tons of emission savings. Based on this data SFO could need additional emission reduction/offset of 737 tons by 2017 and 16,428 tons by 2025, assuming the materialization of the projected increases in GHG emissions. However, based on past experience SFO believes that the increases in GHG emissions would be substantially below the levels shown in Table 5.

Table 5. Projected 2017 and 2025 Category 1 GHG Emission and Emission Reduction Targets for SFO (Tons per Year)

Item	FY 2011	2017	2025
Allowable GHG Emission Level (Ordinance 81-08)		39,165	31,332
FY 2011 and Projected Net GHG Emissions	44,071	50,479	67,450
Implemented Emission Offset Measures	-2,740	-2,740	-2,740
Planned Emission Reduction / Offset Measures		-8,047	-8,047
Total Potential GHG Emission Levels	41,331	39,692	56,663
Required GHG Emission Reduction / Offset Level under Ordinance 81-08		527	25,331
Implemented GHG Emission Mitigation Measures	-62,382	-62,382	-62,382
Planned GHG Emission Mitigation Measures		-5,136	-5,136
Total Potential GHG Emission Mitigation Levels	-62,382	-67,518	-67,518

Relative Cost of the GHG Emission ROM Initiatives

Different costs are associated with the various emission ROM initiatives that have been implemented or are currently under consideration at SFO. The unit capital costs in dollars per ton of reduced GHG emission

per year are summarized in Table 6 and indicate a cost ranging $16 to $1,454 per ton of reduced GHG emission for various emission offset/reduction initiatives. The data also show that significant cost savings would be associated with the implementation of the majority of planned initiatives and the required capital costs could, generally, be recovered in 2 to 6 years. Also, no additional operation and maintenance (O&M) costs are envisioned for any of the emission ROM initiatives beyond the normal O&M costs of the related operations.

Table 6. Summary of Capital Cost of Implemented and Planned GHG Emission Reduction, Offset, and Mitigation Measures at SFO

Type of Measure	Emission Reduction / Offset Tons per Year)	Present Worth of Total Cost (Dollars)	Estimated Useful Life (Years)	Unit Capital Cost (Dollars per Ton)	Annual Cost Savings Dollars	Pay-back Period, Years
PC Air and 400 Hz Power Supply System at B/A C, E, and F	8,727	4,000,000	15	30	3,913,635 [a]	1.05
Energy Efficiency Measures	15,368	33,704,000	15	146	4,956,470	6.8
PC Air and 400 Hz Power Supply System at Terminal 2	5,140	3,000,000	15	39	1,568,514 [b]	1.91
Enhanced Solid Waste Recycling	2,000	300,000	15	10	0	-
Fleet Vehicle Replacement	528	10,158,000	12	1,603	144,000	-
Green Rental Car Subsidy Program [c]	11,442	22,898,670	10	200	4,285,181	5.34
Total	43,205	$74,060,670			$14,887,800	4.97

[a] Based on an estimated annual jet fuel saving of 1,304,545 gallons at $3.00 per gallon and offset by the cost of 3.376 gwh of electricity at $0.10 per kWh

[b] Based on an estimated annual jet fuel saving of 522,838 gallons at $3.00 per gallon and offset by the cost of 1.525 gwh of electricity at $0.10 per kWh

[c] No cost savings are realized by SFO for this program because all of the savings of $4,897,316 per year accrue to Car Rental customers as the result of a reduction in gasoline use at 1,224,329 gallons per year at FY 2010 consumption rate. Also the cost data shown is for an assumed program length of 10 years, a discount rate of 4%, and a green car rental subsidy rate at the same level as in FY 2010

Summary of Other Climate Action Plan Elements

A brief summary of the topics covered in the remaining sections of the Climate Action Plan is provided below:

- *Section 3 - SFO Energy Use.* Information on various initiatives for reducing electrical energy and natural gas use at SFO are provided in Section 3 along with a detailed investment grade level estimate of the costs and benefits of energy efficiency measures that could be implemented at SFO over the next several years. *These data indicate a combined GHG emission reduction/offset of approximately 7,729 metric tons per year when all of the planned measures have been implemented at an estimated capital cost of $34,593,000*. The data also indicate that most of the estimated costs could be recovered through energy cost savings over a period of 3 to 8 years.

- *Section 4 - Fleet Vehicle Replacement.* Information on fuel consumption level for SFO fleet is provided in this section. The planned fleet improvement program would replace 234 out of the total 354 vehicles over a six year period with new CNG powered vehicles and more energy efficient biodiesel powered vehicles. This program would reduce the GHG emissions from the fleet vehicles by an estimated 528 tons per year. The cost of the vehicle replacement program is estimated at $10,158,000.

- *Section 5 – Zero Waste Plan.* In FY 2011, SFO collected 9,309 tons of solid waste at the terminals and at other facilities. A total of 6,961 tons (74.6%) of this waste was recycled by the Airport contractor. On-site source separation contributed 1,413 tons (15.2%) of the recycled waste and the remainder was separated at off-site facilities of South San Francisco Scavenger Company (SSFSC). No demolition and construction waste recycling was reported as there were no major construction activities occurring during this time period. In FY 2011 the solid waste reduction and recycling programs mitigated GHG emissions at SFO by 1,831 tons.

  SFO has progressively increased the rate of recycling of solid waste achieving 75% recycling in FY 2011. SFO is continuing to enhance the source separation operations with the aim of achieving the City's recycling goals of 85% by 2017 and 100% by 2020. This is attributed to ongoing efforts by the airport to promote waste reduction, increase the convenience of recycling and composting, and improve public awareness of these programs.

- *Section 6 – Employee Commute.* The results of the latest employee survey carried out in January 2011 indicated the following:
  - 79.8% of the 900 respondents drive alone to work
  - 10.5% use carpool and vanpool
  - 8.1% use public transit (BART, Samtrans, and Caltrain)
  - 1.6% use other modes (motorcycle, bicycle, walking, etc.)

  The GHG emissions from all modes of commute, by SFO's 1,843 employees, were estimated to be about 2,548 tons in FY 2011. Several incentive programs are currently offered to SFO employees to encourage the use of public transit. A BART fare discount has been put in place, and a North McDonnell Road-San Bruno shuttle service is being developed in partnership with the City of San Bruno. The San Bruno shuttle is estimated to cost from $200,000 to $600,000 per year. The BART incentive program has reduced the current BART surcharge, levied for Airport passengers, by 62%, for SFO employees, in exchange for joint marketing efforts and information booth initiatives at the Airport.

- *Section 7 – Other Measures.* This section covers the miscellaneous sustainability activities undertaken at SFO as follows:
    - Obtaining LEED Gold certification for all new building construction and for remodeling projects. SFO received LEED Gold certification for Terminal 2 Renovation and for Building 575 remodeling projects.
    - Evaluating the feasibility of obtaining LEED O&M certification for the SFO Terminal Complex.
    - Installation of PC Air and 400 Hz power supply facilities at Terminal 2 and at Boarding Areas C, E, and F
    - Continuation of the Green Car Rental Incentive Program
    - Enhancement of water conservation practice in new and existing buildings.
    - Continued compliance with Precautionary Purchasing Ordinance and Executive Order 08-02 by purchasing the required items from the SF Approved Catalogue to the maximum extent possible.

- *Section 8 – Community-Wide Impacts.* SFO operations and travel by SFO employees, air passengers, taxis, shuttle buses, delivery trucks, BART, Samtrans, etc. to and from the Airport impact the regional and local air quality and contribute to the regional emissions of greenhouse gases. Regulation and control of air quality impacts of SFO operations and the various modes of travel to SFO fall under the jurisdiction of Bay Area Air Quality Management District and are not directly addressed in the Climate Action Plan. However, any reductions in the emission of greenhouse gases would also aid in reducing the emission of other air pollutants. The community-wide impact of SFO operations in the context of GHG emissions are summarized in Section 8.

- *Section 9 – Measuring Progress.* The vision of SFO is to mitigate its carbon footprint by employing environmentally sound and economic measures. As discussed in Section 9 SFO has instituted a systematic approach for assessing the GHG emission rates and for quantifying the impact of the various planned emission reduction / offset / mitigation measures.

1. SFO's Profile

Summary

San Francisco International Airport (SFO) is Northern California's premiere airport serving hundreds of destinations throughout the United States and abroad. SFO is consistently rated as one of the top airports in the world for the efficiency and quality of service rendered to the travelers.

Located on the San Francisco Bay, 14 miles south of San Francisco, SFO covers approximately 5,200 acres with 2,700 acres developed for Airport use and approximately 2,500 acres remaining as natural tidelands and wetlands.. In FY 2011, SFO served 39,726,471 passengers with 354,582 takeoffs and landings on 58 airlines. Additionally, 431,990 metric tons of cargo was shipped to and from SFO during the same period. Also, more than 180 vendors operated at SFO to serve the travelers, including restaurants, shops and various services.

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SFO is governed by an Airport Commission, a five-member body appointed to four-year terms by the Mayor of San Francisco. The Commission appoints the Airport Director. The Airport personnel are organized in several divisions with each division serving specific needs of the Airport, the travelers, and/or the enterprises operating at SFO.

SFO's Environmental Goals

SFO's Strategic Plan for 2008-2012 establishes the following environmental sustainability goals:

1. Improve air quality (measured by the percentage of passengers arriving by public transit and by clean air vehicles) through implementation of Clean Air Vehicles and Transit First policies that will reduce vehicle emissions.
2. Meet environmental commitments and improve efficiency of compliance with environmental regulations and procedures by implementing an Environmental Management System (EMS) to track and initiate performance improvements to the environmental programs administered by various Airport Divisions.
3. Construct and activate a new industrial waste treatment facility within 30 months after the construction bid is awarded.
4. Improve upon SFO's stewardship of the environment by developing and implementing an annual Environmental Sustainability Plan and producing an annual report on accomplishments and upcoming projects.
5. Devise and implement other sustainability initiatives.

Airport Operations

There are two major types of operations at SFO i.e. landside operations and airside operations. Both of these operations are carried out within the following organizational structure at SFO:

- Airport Director
  - Business & Finance
  - Communications & Marketing
- Chief Operating Officer
  - Administration
  - Operations & Security
  - Design and Construction
  - Airport and Environmental Planning
  - Museums

Tenant Operations

Airport tenants are classified into the following categories:

- Airlines
- Aviation Support
- Concessionaires
- Federal Government Agencies
- State and Local Government Agencies

Airlines

In FY 2009 fifty nine airlines, including domestic and foreign flag airlines and cargo carriers, used SFO as a base of operations. United Airlines is the anchor airline at SFO and operates a major aircraft maintenance and repair facility at the Airport. American Airlines also operates maintenance and repair facilities at SFO.

Aviation Support Services

Tenants providing aviation support services range from aircraft fueling operations to in-flight food services. The major categories of aviation support services at SFO are listed below:

- Aircraft Fuel Suppliers
- Air Cargo Services
- Ground Logistics
- Aircraft Maintenance
- In-Flight Food Services
- Security Services

Concessionaires

Various concessionaires operate in the Airport terminals providing food services, merchandise, gift shops and other conveniences to the travelling public.

Federal Government Agencies

Several Federal government agencies, including the Federal Aviation Administration, Department of Home land Security, Transportation Security Administration, U.S. Postal Service, and U.S. Department of Justice maintain offices and facilities at SFO.

Local Government Agencies

The Bay Area Rapid Transit (BART) system operates train transportation services to the Airport and City College of San Francisco operates an aviation services campus at SFO. San Mateo County also maintains offices at SFO.

Land Use

Land uses at SFO are broadly categorized as either airside or landside facilities. Airside facilities consist of approximately 1,700 acres of runways, taxiways, and ramp systems. Landside facilities consist of approximately 1,000 acres and are divided into the following functional classes: terminal complex; airport administration; office and facilities complex; non-terminal airline support; airline support; airline maintenance; general aviation; air freight; airport transport; commercial; transportation; miscellaneous facilities; parking facilities; and roads.

Airside Land Uses

SFO maintains four intersecting runways: two parallel east-west runways and two parallel north-south runways. All four runways are 200 feet wide. The east-west runway 28R/10L is 11,870 feet long; its parallel Runway 28L/10R is 10,600 feet long. The north-south Runway 1R/19L is 9,500 feet long; its parallel Runway 1L/19R is 7,100 feet long. The majority of aircraft landings occur on Runways 28R/28L and the majority of takeoffs occur from Runways 1R/1L.

Landside Land Uses

Prior to 2001, the passenger terminals covered approximately 6 million square feet. In 2000, SFO completed construction of its Master Plan that added more than 5 million square feet of new landside improvements including a new International Terminal, two new boarding areas, a new people-mover (AirTrain) (2003), a new BART station, a new rental car facility, three new parking garages, various other office/administrative buildings, airline maintenance and services support, and air cargo facilities, as well as major roadway, and other transportation related improvements.

Other Airport facilities support public service functions and airport operations. These facilities include airport administration, airport engineering buildings, maintenance facilities, utilities, emergency response facilities, airport police facilities, aircraft fuel tank farms, as well as commercial enterprises and rental car facilities.

Activity Levels

Airport activity levels can be measured by a number of parameters such as aircraft operations, annual passenger count, and annual cargo shipments. The number of Airport and private enterprise employees is another indication of the activity level.

Figure 1-1. Annual Number of Flight Operations at SFO (in thousands)

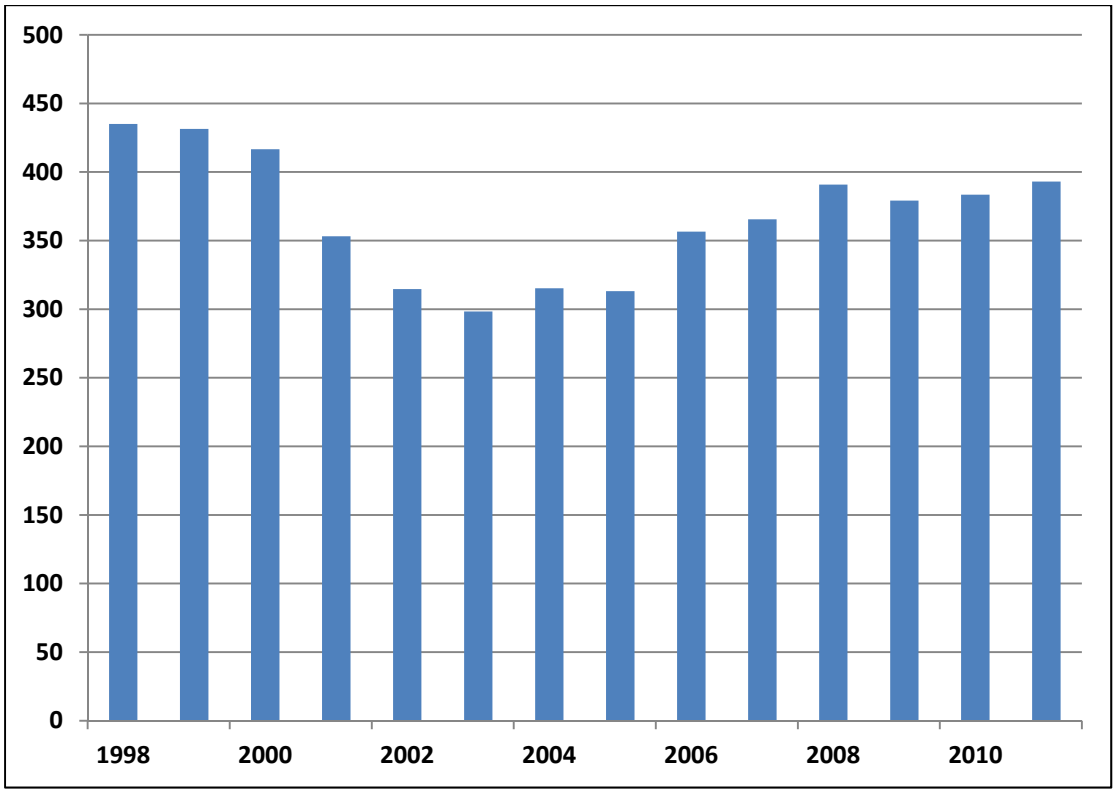


Figure 1-2. Annual Passenger Traffic at SFO (in Millions)

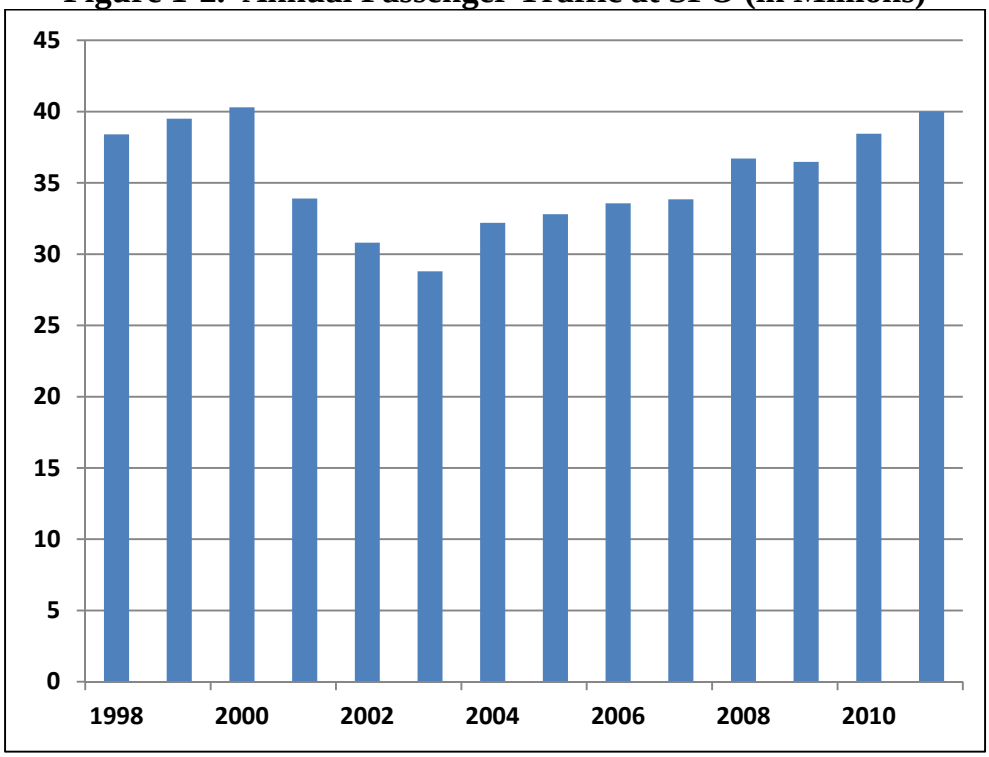
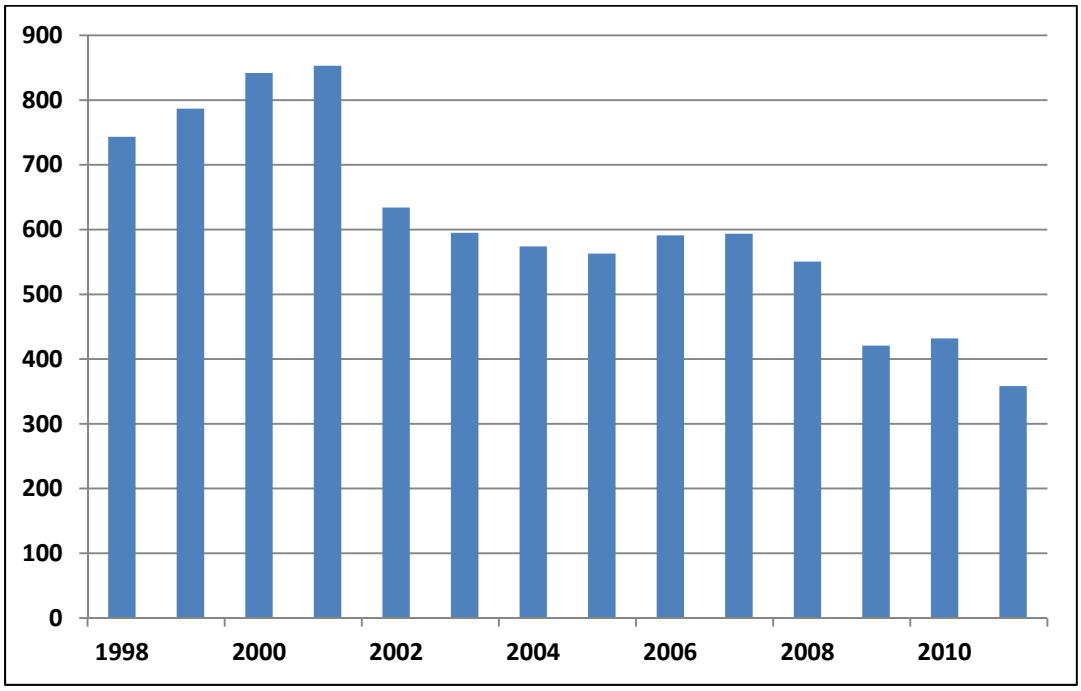


Figure 1-3. Annual Cargo Shipment at SFO (Thousand Tons)



Aircraft Operations, Passenger Activity Levels and Cargo Shipment

In 1997, aircraft operations (aircraft landings and takeoffs) peaked at SFO at 447,000 and remained fairly stable for the following four years, Figure 1-1. The number of operations dropped to as low as 298,000 after the events of September 11, 2001 but have recovered in subsequent years. In FY 2011 there were 393,669 flight operations at SFO.

The number of passengers flying to or from SFO peaked at 40,300,000 in 2000 and then declined to 28,800,000 in 2003. In FY 2011 the passenger traffic at SFO was 39,726,471, Figure 1-2. Aircraft load factors have continued to increase in response to high fuel costs and other economic factors, and most airlines are flying their aircrafts at the highest historical load factors.

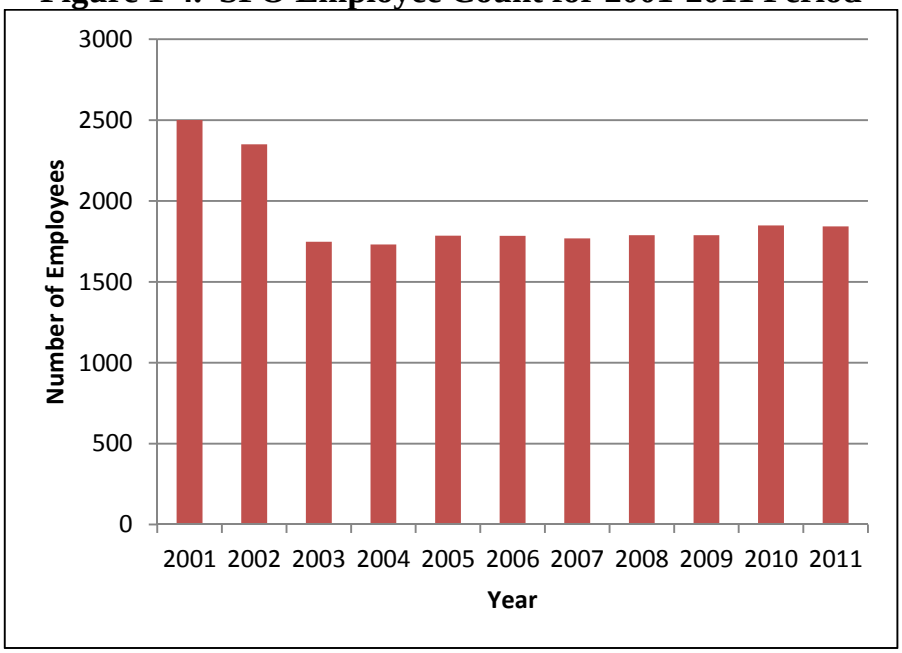
Cargo shipments at SFO peaked at 853,000 metric tons in 2000 and had ranged near 600,000 metric tons in recent years, Figure 1-3. However, cargo shipment at SFO had declined to 420,784 tons in FY 2009, reflecting the impact of the current economic recession. In FY 2011 cargo shipments declined further to 398,383 tons from 431,990 tons in FY 2010.

In 1990 SFO handled 29,939,835 passengers and 558,078 metric tons of cargo with 427,475 aircraft operations (SFO Master Plan, Final Environmental Impact Report, May 1992).

Employment

The number of SFO employees, including the Airport Commission's operating and project positions, Airport Police Bureau, Airport Fire Department, and City Attorney's SFO staff for the period 2001-2010 is shown in Figure 1-4. The combined number of employees was 1,849 in FY 2010.

Figure 1-4. SFO Employee Count for 2001-2011 Period



Key Partners

SFO partners with airlines, tenants, City Departments, local, State, and Federal Government agencies, and community organizations to achieve the various environmental, economic, and social goals. SFO will continue to work cooperatively with the various stakeholders, including airlines and tenants, to develop and implement a broad range of greenhouse gas emission reduction / offset measures in the future.

The San Francisco International Airport/ Community Roundtable is one the longest established community-based airport noise reduction organizations in the country, and is an example of neighborhood groups working cooperatively with the Airport and the aviation industry to reduce aircraft noise impacts on the surrounding communities. SFO has worked closely with San Francisco Public Utilities Commission (SFPUC) to evaluate and implement a broad range of energy efficiency measures, as well as installing extensive photo voltaic panels on the roof of Terminal 3 and Airport Engineering Building. SFO has also worked cooperatively with tenants and airlines to increase the rate of solid waste recycling. Additionally, SFO has installed electric outlets and CNG dispensing facilities to minimize the emission of air pollutants and greenhouse gases from taxis, buses, and passenger cars.

In 2009 SFO initiated a Green Car Rental Incentive Program in conjunction with the rental car companies operating at the Airport. This program provides financial incentives to the rental car companies to increase the number of fuel efficient cars with an EPA score of 17 or higher from 10% to 15% in their rental vehicle inventory. The program also provides a discount to the customers who rent a Green Car. This program was continued in 2011 and has resulted in significant reductions in GHG emission from rental cars as described in detail in sections 2 and 7 of this report.

2. SFO's 2010 Carbon Footprint

Summary

In the context of Airport Cooperative Research Program's Guidebook on Preparing Greenhouse Gas Inventories at Airports[1], SFO's carbon footprint can be defined by the following three categories of greenhouse gas (GHG) emissions:

Category 1 - SFO Controlled Emissions - GHG emissions from operations that are under the control of SFO, including SFO employees' commute emissions, and emissions from all modes of travel on SFO controlled roads.

Category 2 - Airlines, Concessionaires, and Airline Support Services Emissions - GHG Emissions, within the physical boundaries of SFO; by airline operations, including landing and take-off (LTO) cycles; ground service equipment (GSE) and other support services; and by various concessionaires and other tenants.

Category 3 - Optional Emissions – U.S. Environmental Protection Agency (EPA) defines optional emissions as those emissions that are not directly emitted by but are connected with the reporting enterprise's operations. Examples include GHG emissions from: 1) passengers' travel, in personal vehicles or by public transit, to and from SFO, 2) outbound cruising aircraft, 3) delivery trucks, 4) construction equipment, and 5) commute travel by employees of airlines, concessionaires, and airline support services.

Other classifications have been proposed for quantifying the GHG emissions in the context of international global warming initiatives such as the Kyoto Treaty. For example the World Resources Institute (WRI) has proposed GHG emission categories as Scope 1 through Scope 3 as follows:

Scope 1 Emissions - These emissions are directly generated by the controlling entity within the defined boundaries of the facility. Examples include emissions from fuel and natural gas consumption.

Scope 2 Emissions – Scope 2 emissions which are also called indirect emissions are associated with the energy sources used by the entity, such as electric energy and steam, which are generated at off-site facilities.

Scope 3 Emissions - These emissions include both direct and indirect emissions generated by enterprises operating at the reporting facility which are not under the control of the reporting enterprise. At SFO, Scope 3 emissions include emissions from airlines, airline support services, and concessionaires' operations within and outside the defined boundaries of SFO. Examples include emissions from aircraft landing and takeoff operations, cruising aircraft, passenger and enterprise employees travel to and from SFO, etc. Emissions related to solid waste recycling/disposal operations at off-site facilities also fall under this scope.

Carbon dioxide is the major component of the GHG emissions. Other greenhouse gases include methane, nitrous oxide, refrigeration gases, and sulfur hexafluoride. The Transportation Research Board of the National Academies[1] provides the following classifications for GHG emission data depending on the type of gases included in such data:

Level 1 Emissions - This level includes only the carbon dioxide emission from the subject facilities and operations.

Level 2 Emissions - This level includes the Kyoto Treaty gases including carbon dioxide, methane, nitrous oxide; refrigerant compounds hydrofluorocarbons (HFC) and perfluorocarbons (PFC), and sulfur hexafluoride (SF_6) which is used as an insulator in electrical transmission and distribution systems.

[1] Guidebook on Preparing Airport Greenhouse Gas Emission Inventories, Report 11, Prepared for Airport Cooperative Research Program, Transportation Research Board of the National Academies and Sponsored by the Federal Aviation Administration, By Wyle Laboratories, Ian A. Waitz Consultant, and Synergy Consultants, Inc., 2009

Level 3 Emissions – This level includes the Kyoto Treaty gases plus any precursors and other gases with potential for global warming.

Data on Level 2 Emissions are provided in this report. The physical boundary of SFO's carbon footprint is defined as the geographic boundary of the Airport plus the airspace around SFO to an elevation of 3,000 feet for landing and takeoff (LTO) operations.

In this report data on SFO's carbon footprint are provided for emission Categories 1 through 3 to clearly distinguish the emissions from SFO controlled operations; on-site activities of the airlines, concessionaires, and airline support services; and the off-site emissions of these entities. This information is needed for devising policies and practices for reducing the GHG emissions of SFO as well as the emissions of airlines, concessionaires, and airline support services in the context of Ordinance No. 81-08. Available data on GHG emissions for the categories listed above are summarized in Table 2-1. Correlations between SFO emission categories and the WRI classifications are also provided in this table. Based on this information the GHG emissions at SFO in FY 2011 were 41,331 metric tons (tons), which was 21% below the 1990 emission level. In addition the voluntary emission mitigation measures implemented by SFO yielded a total mitigation of 62,382 tons in FY 2011, as detailed in Table 2-7 of this chapter. Although these voluntary emission mitigation measures might not strictly meet the definition of emission offsets, nevertheless, these measures more than compensated for the climate impact of SFO controlled operations.

Table 2-1. Summary of Estimated GHG Emissions at SFO

WRI Emission Category	SFO Emission Category	GHG Emission (Tons)			
		1990	FY 2009	FY 2010	FY 2011
Scopes 1, 2, and 3	Category 1- SFO Controlled Emissions	52,248	42,177	42,236	41,331
Scopes 1, 2, and 3	Category 2- Airlines, Concessionaires, and Airline Support Services Emissions	839,000	668,037	676,169	749,398
Scope 3	Category 3. Optional Emissions	7,127,543	7,937,546	8,195,369	8,487,665
	Total	**8,018,791**	**8,647,760**	**8,913,773**	**9,278,393**

Baseline Category 1 SFO Controlled GHG Emissions

Baseline GHG emissions are defined in this report as the sum of direct and indirect emissions from operating facilities at SFO.

Direct Emissions

Greenhouse gases are generated on-site at SFO from the operations listed below in approximate quantitative order:

- Consumption of various fuels by vehicular traffic on SFO controlled roads, SFO fleet vehicles, emergency generators, SFO Shuttle buses, etc.
- Consumption of natural gas
- Fugitive refrigerant gas releases, and
- Process emissions at SFO's wastewater treatment facilities

Indirect Emissions

Greenhouse gas emissions generated off-site which are associated with the consumption of resources by SFO controlled operations or by the activities connected to such operations, are classified as indirect emissions. The various categories of indirect emissions for SFO controlled operations are listed below in quantitative order:

- GHG emissions from various modes of commute travel by SFO employees
- Electrical energy consumption
- Solid waste disposal and recycling operations

Data for various elements of SFO controlled Category 1 GHG emissions are provided in the following sections.

Electric Energy and Natural Gas Consumption

The combined SFO and tennants' electric energy consumption increased from 323,000 mWh in FY 2010 to 327,000 mWh in FY 2011, showing a 1.2% increase. The increase in electric energy consumption was, in part, due to the activation of Terminal 2 in April 2011. The combined natural gas consumption increased from 3,330,555 therms in FY 2010 to 3,796,000 therms in FY 2011 indicating a 14% increase. This increase was also partly due to the activation of Terminal 2. Electric energy and natural gas consumption by SFO tenants are also included in Table 2-2 because these utilities are supplied by SFO to the tenants. Based on Ordinance 81-08 and the general GHG emission calculation protocols the emissions associated with these SFO supplied utilities are included in the SFO carbon footprint. The increases in energy consumption from the 1990 base year are attributable to the significant expansion of SFO facilities following the completion of the SFO Master Plan Program.

The GHG emissions for electric energy and natural gas consumption at SFO are also shown in Table 2-2 and indicate an increase in these emissions from 22,477 tons in FY 2010 to 25,007 tons in FY 2011. The increases in the GHG emissions are in line with the increases in energy consumption in FY 2011. The relatively low GHG emissions associated with electric energy consumption at SFO are due to the use of

SFO Energy Use

SFPUC supplied hydroelectric power for almost all of the electric energy needs at the Airport. The variations in the GHG emissions for electricity consumption in various years were partly due to the variations in the unit GHG emission for electricity supplied to SFO by SFPUC. These variations reflect the percentage of electricity supply that was purchased on the open market by SFPUC to make up the shortfall in hydroelectricity generation in each year, and to implement State mandated efficiency measures.

Table 2-2. GHG Emissions from Electric Energy and Natural Gas Consumption at SFO

Activity	Energy Consumption				GHG Emission (Tonnes)			
	1990	FY 2009	FY 2010	FY 2011	1990	FY 2009	FY 2010	FY 2011
Electric Energy Consumption by SFO, mWh	131,435	165,846	173,100	160,702				
CO_2 Emission[a]					8,656	3,302	2,544	2,362
CO_{2e} for CH_4 Emission[b]					6.58	2.89	2.14	1.99
CO_2e for N_2O Emission[c]					26.06	11.45	7.30	6.78
Subtotal					8,689	3,317	2,553	2,371
Electric Energy Consumption by Tenants[d], mWh	133,807	166,232	149,827	165,950				
CO_2 Emission[a]					8,812	3,310	2,202	2,439
CO_{2e} for CH_4 Emission[b]					6.70	2.90	1.86	2.05
CO2e for N_2O Emission[c]					26.53	11.48	6.32	7.00
Subtotal					8,845	3,325	2,210	2,448
Total Electrical Energy Consumption	265,242	332,078	322,927	326,652	17,534	6,641	4,764	4,818
Natural Gas Consumption by SFO[e], therms:								
SFPUC Supply	1,700,000	2,482,924	2,621,643	3,086,496				
CO_2 Emission					9,020	13,174	13,910	16,376
CO_{2e} for CH_4 Emission[e]					17	25	26	31
CO2e for N_2O Emission[e]					5	7	8	9
PG&E[f,g] Supply	505,833	660,948	708,912	709,378				
CO_2 Emission					2,684	3,507	3,761	3,764
CO_{2e} for CH_4 Emission					5	7	7	7
CO2e for N_2O Emission					1	2	2	2
Subtotal	2,205,833	3,143,872	3,330,555	3,795,874	11,732	16,721	17,714	20,189
Total					**29,266**	**23,362**	**22,477**	**25,007**

[a] Based on an emission factor of 145.19 lbs of CO_2 per mWh for 1990, 3.67 lbs for 2008, and 43.9 lbs for 2009, and 32.4 lbs for 2010 and 2011 for San Francisco Public Utilities Commission's electric power mix for the respective years.
[b] Based on an emissions factor of 0.0302 lbs of CH_4 per mWh for non-hydro portion of San Francisco Public Utilities Commission's power mix for 2008 and 2009. A factor of 1.3 lbs per GWH was used for 2010 per SFPUC communication.
[c] Based on an emissions factor of 0.0081 lbs of N_2O per mWh for non-hydro portion of San Francisco Public Utilities Commission's power mix for 2008 and 2009. An emission factor of 0.3 lbs of N_2O per GWH was used for 2010 and 2011 per SFPUC communication.
[d] Electricity is supplied to all Airport tenants by SFO. The GHG emissions attributable to the related energy consumption by tenants are, therefore, included under Category 1 in SFO's carbon footprint
[e] Based on an emission factor of 14.7 Kg of Carbon per mmBtu (Direct Emissions from Stationary Combustion Sources, US EPA , EPA430-K-08-003, May 2008). NO_2 and CH_4 emission of 0.095 and 4.75 grams/MMBTU were also used from the same publication http://www.epa.gov/climateleaders/documents/resources/stationarycombustionguidance.pdf
[f] Natural gas is supplied to most of the tenants by SFO. The GHG emissions attributable to the related energy consumption by tenants are, therefore, included under Category 1 in SFO's carbon footprint
[g]The 1990 natural gas supply by PG&E to SFO was estimated on the basis of the ratio of natural gas supply to electric energy use in FY 2008.

Fuel Consumption

Various types of fuel are consumed at SFO for operating the fleet vehicles, shuttle buses, and the emergency standby generators. A summary of the estimated fuel consumption levels for 1990 and FY 2009 through FY 2011, and the corresponding GHG emissions are shown in Table 2-3. GHG emissions from the consumption of various fuels at SFO increased from 15,245 tons in 1990 to 17,168 tons in FY 2011. In recent years a portion of the fleet vehicles, and all of the SFO shuttle buses, have been converted to biodiesel or compressed natural gas (CNG) use. These actions have been effective in maintaining the GHG emissions from the overall fleet fairly stable and have compensated for any growth in the fleet size. Emissions attributable to biodiesel use are not included in the subtotal and total GHG emission values shown in Table 2-3 due to the biogenic nature of these emissions.

Employee vehicular travel in 1990 was estimated by assuming that all of SFO employees commuted to work by car for 237 days per year, with an average round trip travel of 19 miles and an average gasoline use efficiency of 23.3 miles per gallon. The FY 2010 emissions for all modes of employee travel were developed on the basis of a survey conducted by the Operations Division at SFO as described in Section 8 of this Climate Action Plan. The corresponding FY 2011 emissions for these categories were estimated by applying an adjustment factor to FY 2010 values based on the ratio of the total number of SFO employees for the respective years.

Table 2-3. GHG Emissions from Consumption of Various Fuels at SFO

Activity	Consumption				GHG Emission (Tonnes)			
	1990	FY 2009	FY 2010	FY 2011	1990	FY 2009	FY 2010	FY 2011
General Fleet Gasoline Consumption, gallons	166,583	163,778	121,155	94,491				
CO_{2e} Emission [a]					1,467	1,443	1,067	832
N_2O Emission [b,c] ***as CO_{2e}***					64.66	28.59	21.15	16.50
CH_4 **Emission** [b,c] **as CO_{2e}**					6.64	2.08	1.54	1.20
General Fleet Biodiesel Consumption:								
Diesel Fuel, gallons	93,175	42,257	45,230	43,148				
CO_{2e} Emission [d]					946	429	459	438.02
N_2O Emission [b,c] **as CO_{2e}**					141.71	28.91	30.94	29.52
CH_4 Emission [b,c] **as CO_{2e}**					70.12	10.15	10.86	10.36
100% Biodiesel, gallons	0	10,564	11,307	10,787				
CO_{2e} Emission [e]					0	100	107	102
General Fleet CNG Consumption, GGE	0	36,000	64,909	61,274				
CO_{2e} Emission [f]					0	218	393	371
N_2O Emission, as CO_{2e}					0.00	7.26	13.09	12.36
CH_4 Emission, as CO_{2e}					0.00	6.58	11.87	11.21
Subtotal General Fleet	259,758	252,599	242,601	209,700	2,696	2,173	2,009	1,722
SFO Shuttle Fleet Biodiesel Fuel Usage:								
Diesel Fuel[g]**, gallons**	203,413	92,173	102,702	98,714				
CO_{2e} Emission					2,065	936	1,043	1,002
N_2O Emission as CO_{2e}, gm/mile		483,730	586,837	547,191	1.59	0.72	0.87	0.81
CH_4 Emission as CO_{2e}, gm/mile		483,730	586,837	653,414	0.11	0.05	0.06	0.07
100% Biodiesel, Gallons	0	23,043	25,676	24,678				
CO_{2e} Emission					0	218	243	234
SFO Shuttle Fleet CNG Usage, GGE	0	182,285	190,236	191,066				
CO_{2e} Emission					0	1,103	1,151	1,156
N2O Emission as CO_{2e}		665,520	668,843	547,191	0.00	36.10	36.28	29.69
CH_4 Emission as CO_{2e}		665,520	668,843	653,414	0.00	27.48	27.61	26.98
Subtotal Shuttle Fleet	203,413	297,501	318,614	314,458	2,067	2,103	2,259	2,216

Table 2-3. GHG Emissions from Consumption of Various Fuels at SFO (Continued)

Standby Generators Diesel Fuel Consumption, gallons	13,660	19,633	16,366	15,727				
CO_2 Emission[h]					139	199	166	160
N_2O Emission as CO_{2e}					0.33	0.47	0.39	0.38
CH_4 Emission as CO_{2e}					0.11	0.16	0.13	0.13
Subtotal Standby Generators					139	200	167	160
General Fleet Propane Usage, gallons	5,176							
CO_{2e} Emission[i]					30	0	0	0
N_2O Emission as CO_{2e}					1.29	0	0	0
CH_4 Emission as CO_{2e}					0.05	0	0	0
Subtotal Propane Use					31	0	0	0
Fuel Consumption by General Vehicular Travel on SFO Controlled Roads[j,k] GGE	896,698	1,117,044	1,155,769	1,163,869				
CO_{2e} Emission					7,899	9,840	10,181	10,252
N_2O Emission as CO_{2e}					419.05	240.84	249.19	250.93
CH_4 Emission as CO_{2e}					30.89	12.59	13.03	13.12
Subtotal Vehicular Travel on SFO Roads					8,349	10,093	10,443	10,516
SFO Employees' Commute Fuel Consumption, GGE	210,849	280,854	281,435	281,435				
CO_{2e} Emission					1,857	2,474	2,479	2,548
N_2O Emission[m] as CO_{2e}					98.54	69.86	70.00	0.00
CH_4 Emission[m] as CO_{2e}					7.26	3.99	4.00	0.00
Subtotal SFO Employee Commute					1,963	2,548	2,553	2,548
Grand Total	**1,589,554**	**1,967,631**	**2,014,785**	**1,775,489**	**15,246**	**17,117**	**17,431**	**17,168**
Total Biogenic GHG Emissions[n]	0	33,607	36,983	35,465	0	318	350	336

All emission factors in this table were obtained from: "Direct Emissions from Mobile Combustion Sources, US EPA, EPA430-K-08-004, May 2008"

[a] Based on an emission factor of 19.42 lbs of CO_2 per gallon of gasoline

[b] CH_4 and N_2O emissions for FY 2009 were calculated on the basis of the total annual mileage logged by each vehicle, vehicle model; the type of fuel consumed by the vehicle or equipment , as applicable; using the emission factors provided in the U.S. EPA May 2008 publication cited above. Related emissions for other reporting periods were estimated by extrapolating the FY 2009-10 data on the basis of consumed fuel volumes in each fiscal year. Details of the FY 2009 emission calculations are shown in the Table 15, Sheet 3 of Master Spreadsheet in Appendix A.

[c] The ratios of CH_4 and N_2O unit emission factors for 1984 -1993 vehicle models to the average of these factors for 1994-2005 (3.1345 and 2.2234, respectively) were used to estimate the corresponding 1990 emission values for these gases

[d] Based on an emission factor of 22.38 lbs of CO_2 per gallon of diesel fuel

[e] Based on an emission factor of 20.86 lbs of CO_2 per gallon of 100% biodiesel

[f] Based on the conversion of 1.00 GGE to 1.14 therms and using a unit GHG emission factor of 11.70 lbs CO_2 per therm

[g] Estimated diesel fuel use in 1990 is based on available data for the average usage in 1998-1999 period. See Table 10 in Sheet 2 of Master Spreadsheet in Appendix A for details of GHG emission calculations for FY 2009. CH_4 and N_2O emission factor are expressed per mile of driving. For other reporting periods the N_2O and CH_4 emissions were estimated on the basis of fuel use ratios to FY 2009.

[h] Based on an emission factor of 22.38 lbs CO_2 per gallon of diesel fuel (Direct Emissions from Stationary Combustion Sources, US EPA , EPA430-K-08-003, May 2008). N_2O and CH_4 emission of 0.6 and 3.0 grams/MMBTU were also used from the same publication http://www.epa.gov/climateleaders/documents/resources/stationarycombustionguidance.pdf. An energy density level of 128,700 BTU per gallon of diesel fuel was used for CH4 and N2O emission calculation.

[i] Based on an emission factor of 12.65 lbs CO_2 per gallon of liquid propane. A 12 mile per gallon fuel efficiency was assumed for CH_4 and N_2O emission calculations

[j] Based on data developed from annual traffic surveys performed by the SFO Traffic Engineering Group. For FY 2008-2010 an average fuel efficiency of 23.9 miles per gallon (mpg) of GGE, and average N_2O and CH_4 emission factors of 0.0079 and 0.0147 g/mile, respectively, were used based on the corresponding emission factors for the model year 2005. For 1990 an average fuel efficiency of 23.3 mpg and average N_2O and CH_4 emission factors for 1984-1993 model years of 0.0647 and 0.0704 g/mile, respectively, were used. (See Table 12, Sheet 3 of Master Spreadsheet in Appendix A for FY 2010 survey data)

[k] The 1990 travelled miles was estimated by using the ratio of 1990 to 2007 total passenger traffic at SFO.

[l] The details of 2007-08 GHG emission calculations for SFO employees' commute are shown in Table 4, Sheet 2 of Master Spreadsheet in Appendix A. The 2008-09 values were prorated from the 2007-08 survey data on the basis of total number of employees for the respective years. GHG emissions for employee vehicular commute were estimated by using an SFO employee count of 1,091 for 1990, 1,739 for 2007-08, 1,789 for 2008-09, and 1,849 for 2009-10 FY. Other relevant details for FY 2010 are shown in Table 26 of Sheet 3, Master Spreadsheet in Appendix A

[m] GHG emissions for employee commute were estimated on the basis of equivalent gasoline gallons combusted using data on vehicular commute travel miles derived from automobile, carpool, and bus transport modes as shown in Table 16 Sheet 3 of Master Spreadsheet in Appendix A. A gasoline fuel efficiency of 23.3 mpg in 1990 and 23.9 mpg for recent years and a diesel fuel efficiency of 4.5 mpg for buses were used for calculating the CO_2 emission. N_2O and $CH_{4\ \text{average}}$ emissions for 1994 through 2005 model years were used for the corresponding emission factors.

[n] Biogenic GHG emissions were generated by the use of biofuel in fleet vehicles and SFO shuttle buses and are excluded from the grand total GHG emissions for fuel use

Solid Waste Disposal

Various solid waste disposal practices result in the generation of greenhouse gases. At SFO solid waste has been historically transported to, and disposed of in, landfills. In recent years, however, due to the mandates of State laws and City ordinances, a progressively higher percentage of the solid waste has either been source separated at the Airport or has been sorted at the offsite facilities of the waste haulers and has been recycled. In FY 2010 and FY 2011 approximately 71% and 75% of the general solid waste generated at SFO was recycled. In addition about 94% of all construction and demolition waste is generally recycled by construction contractors in the years in which such waste is generated. Solid waste generation data and the estimated greenhouse gas emission associated with solid waste disposal / recycling operations for 1990 and FY 2009 through FY 2011 are shown in Table 2-4. Solid waste generation rate and waste composition for 1990 were estimated by applying the respective FY 2008 per passenger unit generation rates to the 1990 annual passenger traffic data.

Data shown in Table 2-4 indicate that baseline GHG emission associated with solid waste disposal in landfills was 2,596 tons in 1990. These emissions were reduced to 1,065 tons in FY 2009, 820 tons in FY 2010, and 788 tons in FY 2011. The decline in solid waste disposal GHG emissions from FY 2009 to FY 2011 is attributable to the increased rates of solid waste recycling and composting, and a corresponding decrease in landfilling of solid waste, in the latter years. The GHG emission offset associated with the recycling of general solid waste at SFO are estimated at 2,749 tons in FY 2009, 2,205 tons in FY 2010, and 2,619 tons in FY 2011. The variation in the GHG emission offset from recycling operations for general solid waste from FY 2009 to FY 2011 were in part due to the initiation of large scale composting for SFO solid waste, involving 3,661 tons of the generated waste in FY 2011. Composting operations yield a lower GHG emission offset value than other solid waste recycling activities. However, recycling operations in FY 2010 and FY 2011 were more representative of the actual composition of SFO solid waste and the corresponding GHG emission offset values are more representative of the actual offset achieved by SFO for these operations.

Recycling of construction and demolition waste contributed significant GHG emission offsets for FY 2009 and FY2010 (13,096 tons in FY 2009 and 4,545 tons in FY 2010). No appreciable construction & demolition waste was generated at SFO in FY 2011. Due to the extreme fluctuation in the rate of generation and recycling of construction & demolition waste these operations could create significant fluctuations in the carbon footprint of SFO, if it were to be counted as an emission offset. Accordingly we have chosen to treat the GHG emission reductions associated with Construction & Demolition activities as emission mitigation rather than emission offset in our footprint calculations.

Table 2-4. Estimated GHG Emissions from Solid Waste Disposal and Recycling Operations

Activity Type	Solid Waste Generation (Tons)				GHG Emission (Tonnes)			
	1990[e]	FY 2009	FY 2010	FY 2011	1990	FY 2009	FY 2010	FY 2011
Landfilled Solid Waste:								
General Waste[a]	6,000	2,823	2,621	2,348	2,246	785	785	753
Construction/Demolition[b]	5,000	4,000	500	500	350	280	35	35
Subtotal Disposal GHG Emission					2,596	1,065	820	788
Recycled Solid Waste:								
General Recycling[c]	0	3,129	3,053	3,300	0	-2,178	-1,440	-1,821
Composting[d]	0	2,619	3,507	3,661	0	-571	-765	-798
Subtotal Regular Recycling						-2,749	-2,205	-2,619
Construction & Demolition[c]		7,708	13,041	0		-13,096	-4,545	0
Subtotal Recycling GHG Emission		13,456	19,601	6,961	0	-15,845	-6,750	-2,619
Total	11,000	20,279	22,722	9,309	2,596	-14,780	-5,930	-1,831

[a] Methane emissions from landfilled solid waste were estimated by using Equation 9.1 of the publication: Local Government Operations Protocol Version 1.1, November 2010, California Air Resources Board, et al for a landfill equipped with comprehensive methane collection facilitiies (See Table 16 and 17, Sheet 3 of Master Spreadsheet)

[b] Annual quantities of landfilled construction and demolition waste are based on reports filed by SFO contractors. The corresponding value for 1990 is an estimated quantity. . (See Tables 21, 22, and 25, Sheet 3 of Master Spreadsheet).

[c] The Scope 3 Spreadsheet developed by ICF Intl for US EPA was used for estimating emission offsets from solid waste recycling. (See Table 18, Sheet 3, of Master Spreadsheet in Appendix A)

[d] GHG emission mitigation factor of -0.218 tons/ton for composting operations and an emission factor of 0.07 tons / ton of landfilled construction and demolition (C&D) waste were obtained from the U.S. EPA's Waste Reduction Model (WARM) Version 11 released in November 2010. The C&D landfilling factor is the average of the related factors for concrete, asphalt shingle, and drywall materials http://www.epa.gov/climatechange/wycd/waste/calculators/Warm_home.html

[e] Solid waste generation rates for 1990 were estimated on the basis of 2007 generation rate of 0.87 lbs per enplaned passenger at SFO. It was also assumed that no solid waste

recycling was carried out in 1990 and construction/demolition waste generation was assumed at an estimated 5,000 tonnes for that year

Fugitive Refrigerant Gas Emissions

SFO uses a central plant for providing preconditioned air to all terminal buildings. The central plant is currently equipped with two 3,000 ton and two 6,000 ton capacity chillers. SFO also uses various packaged air conditioning units in other airport buildings and facilities. In 1990 SFO used two 3,000 ton chillers in the central plant with a refrigerant charge of 8,800 lbs of R-12 each. The two 3,000 ton chillers were converted from R-12 to R134A in 2001. In FY 2008 the older of the 6,000 ton chillers was converted from R-500, an ozone depleting gas, to R-134A refrigerant, an ozone safe gas with a lower global warming potential (R-500 refrigerant gas is a blend of 73.8 wt. % R-12 and 26.2 wt. % of R-152A with a global warming potential (GWP) of 6,014). The newest 6,000 ton chiller was installed in 1999 with R-134A refrigerant gas. Currently Chiller No. 2 is offline pending a major overhaul in 2011.

A portion of the refrigerant gases stored in the central plant chillers and in the packaged air conditioning units is lost each year due to leakage through the shutdown seals. In June 2010 and June 2011 the refrigerant gas load in each chiller was measured by SFO staff and is shown in Table 2-5. The rate of loss of refrigerant gases due to leakage through the seals was estimated from the above data and is also shown in Table 2-5. For 1990 an estimated loss rate equal to 5% of the capacity of chiller units was assumed based on the measured historical leakage rates at SFO. The loss rate for the packaged air conditioning units in the respective fiscal years is based on the quantity of make-up gases purchased during each year. A similar make-up rate was assumed for the packaged air conditioning units in 1990, but in proportion to the estimated number of such units in that year. Data for the capacity of air conditioning units in Fleet vehicles and SFO shuttle buses was used to estimate the corresponding refrigerant gas make up rates and GHG emissions for these equipment.

A summary of the capacities, estimated annual leakage rates, and GHG emissions from the various air conditioning units at SFO is provided in Table 2-5. These data indicate that fugitive refrigerant gases were the source of an estimated 4,874 tons of equivalent carbon dioxide gas emissions at SFO in 1990. The corresponding figures for FY 2010 and FY 2011 were about 3,512 and 740 tons, respectively. The reduction in GHG emissions from 2010 to 2011 is due to more accurate measurement of fugitive gas emissions. The indicated reduction in the GHG emissions from fugitive refrigerant gases after 1990 is part due to the replacement of Dichlorodifluoromethane (R-12) with a GWP of 8,100 with 1,1,1,2-Tetrafluoroethane (R-134A) and Chlorodifluoromethane (R-22) which have a lower GWP of 1,300 and 1,810, respectively. It should also be noted that Kyoto Treaty only requires the inclusion of fugitive refrigerant gases of hydrofluorocarbons and perfluorocarbons types in the carbon footprint of an enterprise. Releases of fugitive refrigerant gas R-134A were included in the final accounting of SFO's carbon footprint because the inclusion is recommended by Air Resources Board in the publication entitled Local Government Operations Protocol as cited in the footnotes to Table 2-5.

Table 2-5. Estimated GHG Emissions from Refrigerant Gas Losses at SFO

Year	1990		FY 2009	FY 2010				FY 2011[f]			
Chiller Units	1	2	1-4	1	2	3	4	1	2	3	4
Chiller Size, Tonnes	3,000	3,000	42,000	3,000	3,000	18,000	18,000	3,000	3,000	18,000	18,000
Estimated Refrigerant Gas in Storage, lbs	8,800	8,800	39,815	4,600	0	13,000	10,200	4,600	0	16,000	15,000
Refrigerant Gas Type[a]	R-12	R-12	R-134A	R-134A	R-134A	R-134A	R-134A	R-134A	R-134A	R-134A	R-134A
Estimated Annual Gas Loss Rate[b,c], lbs	440	440	4,522	420	0	2,900	782	116	0	327	257
Combined Annual Gas Loss Rate[e], lbs/year	880		4,522	4,102				700			
Packaged Air Conditioning Units Make up, lbs/year	375		791	1,170	25	25	75	330	0	20	0
Refrigerant Gas Type[a]	R-12		R-134A	R-22	R-134A	R-407C	R-410A	R-22	R-134A	R-407C	R-410A
Vehicular Air Conditioning Units Make up, lbs/year											
SFO Fleet[d]	34.8		34.8	34.8				34.8			
SFO Shuttle Fleet[d]	36.8		36.8	36.8				36.8			
Estimated Total Refrigerant Gas Loss, lbs/year	1,327		5,385	5,469				1,122			
Estimated Total GHG Emission[e], Tonnes/Year	4,874		3,175	3,512				740			

[a] R-12 = Dichlorodifluoromethane, R-134A = 1,1,1,2-Tetrafluoroethane, R-410A = Mixture of Difluromethane, and Pentaflurethane, R-410C = Mixture of Difluromethane, Pentaflurethane, and 1,1,1,2 Tetrafluroethane, and R22=Chlorodifluoromethane

[b] Chillers No. 1 and 2 were last replenished in 2001 when the refrigerant gas was changed from R-12 to R-134. The refrigerant gas was replenished in Chiller No. 3 FY 2008 when the chiller was filled with R-134A gas. A measurement made in June 2010 indicated a loss of 420 lbs per year for chillers No. 1 and 2 and a loss of 2,900 lbs per year for chiller No. 3 . The gas loss rate for Chiller No. 4 was estimated at 8,600 lbs from 1999 through 2010 or 782 lbs per year.

[c] In June 2011 the Chillers 1, 3, and 4 were rechaged to 4,600 lbs, 16,000, and 15,000 lbs. Chiller No. 2 remained inactive as in prior years. Based on the total purchase of 12,000 lbs of R134-A refrigerant gas and the balnce of 3,500 lbs stored in the onsite storage tank it was estimated that the actual refrigerant gas losses were at 700 lbs during FY 2011

[d] R-22

[e] Global Warming Potential (GWP) for R-12 = 8,100, for R-152A=120, for R-134a = 1,300, for R-22=1,810, for R-407C = 1,526, and for R-410A = 1,725

Source of GWP factors: Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories, California Air Resources Board, et al, September 2008, and US EPA web site at the following address:
http://www.epa.gov/climatechange/emissions/downloads/ghg_gwp.pdf

[f]All fugitive refrigerant gas losses for FY 2011 were based on the actual gas make up for the same period.

The Fire Department at SFO maintains the various fire extinguishers deployed at the terminals and other buildings and facilities. Fire Department replenishes these extinguishers annually with about 36 lbs of Halon 1211 and 60 lbs of multi-purpose ABC dry chemical extinguishers (consisting of ammonium phosphate and mono-ammonium phosphate). No data is available for the 1990 replenishment rate for the fire extinguishers but it can be assumed that Halon 1211 was used predominantly in 1990 for this purpose. U.S. EPA provides a direct global warming potential of 1,300 for Halon 1211. This gas also manifests a negative GWP ranging from (3,600) to (24,000) because Halon depletes the Ozone in the atmosphere and Ozone is a more potent greenhouse gas than Halon. For this reason no GHG emission values are assigned to fugitive Halon emissions from individual fire extinguishers at SFO. Currently the Fire Department is phasing out the use of Halon 1211 in fire extinguishers due to its harmful effect on the earth's Ozone layer.

Wastewater Treatment Process and Receiving Water Emissions

SFO operates both a Sanitary Wastewater Treatment Plant (SWTP) and an Industrial Wastewater Treatment Plant (IWTP). The SWTP employs a state-of-the-art biological-batch-reactor treatment process with a design capacity of 2.2 million gallons per day (mgd). The average daily discharge from the SWTP was 0.54 mgd in FY 2009 and FY 2010 and 0.63 mgd in FY 2011. The SWTP processes do not include nitrification/de-nitrification treatment. The IWTP treats wastewater generated at the various vehicular and aircraft maintenance facilities and the first flush of storm water runoff generated in the terminal and industrial areas of the Airport. The dry weather capacity of the IWTP is 1.2 mgd. The average annual discharge from the IWTP was 0.61, 0.613 and 0.65 mgd, in the respective three fiscal years. The influent to and effluent from the IWTP does not contain nitrogen compounds to any appreciable extent, and is therefore not considered as a source of GHG emissions. Treated effluent from the two plants is discharged into San Francisco Bay through an offshore outfall. The sludge generated at the two treatment plants is treated by the anaerobic digestion process and the treated and dewatered sludge is used as daily cover at a landfill. Methane and carbon dioxide gases generated in the sludge treatment reactor are collected and flared at the treatment plant. GHG emissions from treatment processes, the biogas flaring operations, and the receiving water where the effluent is discharged are summarized in Table 2-6 and indicate total GHG emissions of 288, 282, and 373 tons per year for FY 2009 through FY 2011, respectively; excluding the biogenic carbon dioxide portion of the digester gas flaring operations.

Table 2-6. Estimated GHG Emissions from SFO Wastewater Treatment Plants[a]

	Generation Rates				GH Emissions			
	1990	FY 2009	FY 2010	FY 2011	1990	FY 2008	FY 2009	FY 2011
Sanitary Plant Average Annual Flow[b], mgd	0.44	0.54	0.54	0.63				
Treatment Process N_2O Emission[c], tonnes / year	0.06	0.07	0.07	0.08	18	22	22	25
Average Annual Ammonia Nitrogen in the Discharged Sanitary Effluent , mg/l	64	64	64	64				
Receiving Water N_2O Emission, Tonnes/Year	0.19	0.24	0.24	0.28	61	75	75	87
Digester Gas Flaring Operations [d,e]								
Methane Gas, ft^3	2,156,936	2,646,397	2,567,313	3,621,825	156	191	185	261
Total					**235**	**288**	**282**	**373**

[a] The following Reference was used for all emission calculations shown in this Table:
Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories, Version1.1, May 2010, Developed in Partnership by California Air Resources Board, et al.

[b] The 1990 flow rate was prorated from the 2008-09 flow rate in proportion to the total number of passengers for the respective years

[c] Calculated by using formula No. 10-9 from the reference above for N_2O emission from Wastewater Treatment Plant without nitrification/de-nitrification and assuming a per capita sanitary wastewater generation rate of 25 gallons per day and a nitrous oxide generation of 3.2 grams per capita per day

[d] Reported FY 2009 annual digester gas generation at SFO's Wastewater Treatment Plants was extrapolated to 1990 on the basis of passenger traffic data (29,939,835 in 1990 versus 36,733,910 in FY 2009). Density values of 0.662 kg/m^3 and 1.842 kg/m^3, at 20° C and atmospheric pressure, were used for CH_4 and CO_2 gases, respectively. Approximately 99% of the flared methane gas was assumed to be converted to CO_2 and H_2O and a conversion factor of 44/12=3.67 was used for oxidation of CH_4 to CO_2 in the flaring process.

[e]Methane gas constitutes 65% of the total gases generated by the digesters and the balance consists mainly of biogenic carbon dioxide.

GHG Emission Reduction, Offset, and Mitigation (ROM) Measures Implemented at SFO

SFO has successfully implemented a number of measures in recent years to reduce, offset, and mitigate the GHG emissions at local and regional levels. The emission reduction measures generally refer to actions that directly reduce the GHG emissions from SFO controlled operations, such as: increasing the fuel efficiency of fleet vehicles, reducing electric energy and natural gas consumption, using biodiesel in SFO fleet vehicles and SFO shuttle buses, etc. Emission reduction measures have been taken into account in the baseline emission values shown in tables 2-2 through 2-6. Emission offset measures, consisting of solid waste recycling and carbon dioxide sequestration by tree plantings at SFO, reduce the category 1 carbon footprint of SFO. Several mitigation measures have also been implemented at SFO to reduce the GHG emissions from sources that are not directly related to SFO controlled operations, such as: providing Preconditioned Air and 400 Hz power to aircrafts at the gates, providing partial funding for the extension of Bay Area Rapid Transit (BART) to SFO, constructing the AirTrain to eliminate the need for rental car shuttle buses, and implementing the Green Car Rental Incentive Program. Each of the above elements is described briefly in the following paragraphs.

Implemented GHG Emission Reduction Measures

These measures directly reduced the GHG emissions from day-to-day operations of the Airport. In FY 2011 these measures reduced the GHG emissions at SFO by 19,632 tons, as itemized below:

- General reduction in the GHG emission factor for electricity supplied by SFPUC to SFO in FY 2011, and implementation of electric energy efficiency measures resulted in a GHG emission reduction of 12,716 tons in comparison with the corresponding 1990 emission level
- GHG emission from SFO Fleet decline by 974 tons from the 1990 level due to improved fuel efficiency of the fleet vehicles and the use of alternate fuels which compensated for the rise in the number of vehicles
- Reducing the quantity of landfilled solid waste from 6,000 tons in 1990 to 2,348 tons in FY 2011 reduced the GHG emissions for landfilling operations by 1,808 tons
- Reducing the emission of fugitive refrigerant gases and using more climate friendly refrigerant gases resulted in an emission reduction of 4,134 tons compared to 1990 emission level.

The above emission reductions were balanced by growth induced increases in consumption of energy and various fuels resulting in a net GHG emission reduction of 8,148 tons from 1990 to FY 2011 or a reduction of 15.6%.

Implemented GHG Emission Offset Measures

These measures relate to Airport operations or actions that yield a direct reduction in the GHG emissions to the atmosphere. In FY 2011 the following offsets were achieved by SFO:

- SFO recycled about 75% of the general solid waste collected at the Airport yielding an emission offset of 2,619 tons.
- SFO has planted 2,020 trees of various species around the Airport which sequester about 121 tons of carbon dioxide from the air per year.

As the result of the above offset measures SFO's Category 1 carbon footprint was reduced by an additional 2,740 tons in FY 2011, thereby yielding an additional 5.2% reduction from the 1990 emission level.

The combined emission reduction and offset measures implemented at SFO yielded a net GHG emission of 41,331 tons for FY 2011, indicating 20.8% reduction from the 1990 emission level.

Implemented Voluntary GHG Emission Mitigation Measures

The following voluntary GHG emission mitigation measures have been implemented at SFO in recent years:

- Installation of preconditioned air supply (PC Air) and 400 Hz power supply equipment at the new International Terminals A and G, and Boarding Areas C, E, and F which have reduced the need for the use of Auxiliary Power Units (APUs) aboard the aircraft, while the aircraft is deplaning and enplaning passengers. SFO regulation 11.4 (B) requires the use of PC Air and 400 Hz power as described below:

"Operators are encouraged to use ground power and air sources whenever practicable. APU's may be used when aircraft are being towed.

(1) At domestic terminals, the use of APU's is prohibited between the hours of 2200 - 0600 except 30 minutes prior to departure, when passengers are aboard, or it is needed to test other aircraft equipment.

(2) At the International Terminal, the following procedures apply:

(a) Aircraft scheduled to be at a gate in Boarding Areas A and G for more than 45 minutes between the hours of 0700 – 2200, are required to use 400Hz ground power and pre-conditioned air, where available. APU's are not authorized without prior permission from Airport Operations, during the use of ground power and pre-conditioned air until 30 minutes prior to push-back.

(b) All aircraft scheduled to be at a gate between 2200 – 0700 hours are required to use 400Hz ground power and pre-conditioned air, where available, regardless of the duration at the gate. APU's are not authorized without prior permission from Airport Operations, during the use of ground power and pre-conditioned air until 30 minutes prior to push-back."

In FY 2011, the PC Air system mitigated the GHG emissions at SFO by 48,295 tons. The significant increase in the PC Air emission mitigation from FY 2010 to FY 2011 was due to the installation of dedicated PC Air units at 12 jet bridges in Boarding Areas C and F and the utilization of these units by airlines for the entire FY 2011. SFO has also installed 14 PC Air units at jet bridges in the renovated Terminal 2 which became operational in April 2011. Boarding Area E is currently undergoing renovation and all gates at the renovated Boarding Area will be equipped with PC Air units.

- The GHG emission mitigation associated with construction & demolition (C&D) waste recycling operations at SFO were estimated at 462 tons in FY 2008, 13,096 tons in FY 2009, and 4,545 tons in FY 2010. No major C&D waste recycling was carried out in FY 2011. The variations in the magnitude of these mitigations are associated with the composition of recycled waste and variations in the quantity of construction and demolition waste. SFO utilized the Scope 3

Solid Waste GHG Emission Model developed by ICF Intl. for the U.S. EPA to estimate the mitigation values for recycled solid waste. SFO also used an emission mitigation factor of 0.218 ton per ton of composted waste from the US EPA Waste Reduction Model.

- In 2009 SFO initiated a three year Green Car Rental Incentive Program (GCRIP) in conjunction with the rental car companies operating at the Airport. This program provided financial incentives to the rental car companies to increase the number of fuel efficient cars with an EPA score of 17 or higher to 15% of their rental vehicle inventory. The program also provided a $15 discount to the customers who rent a Green Car. In FY 2011 the net emission mitigation from the GCRIP was estimated at 9,946 tons.

- SFO provided partial funding for BART extension to SFO which in FY 2011 resulted in a reduction of about 72 million miles of travel by airline passengers based on monthly passenger data provided by BART to SFO staff. SFO shares approximately 9.1% of this mitigation based on the SFO contribution of 200 million dollars to the capital cost for extending BART from Colma to SFO and Millbrae. In FY 2011, it is estimated that BART extension mitigated SFO's GHG emissions by 2,180 tons.

- In 2003 SFO completed the construction of AirtTrain which has eliminated the need for the use of shuttle buses by all on-Airport Rental Car Agencies. In FY 2011, the AirTrain system mitigated SFO's GHG emissions by 1,960 tons.

The measures listed above yielded a total GHG emission mitigation of 62,381 tons in FY 2011 at SFO, as shown in Table 2-7.

APU jet fuel usage was calculated for each reporting period on the basis of actual SFO flight operations during a representative 24-hour period in the peak travel month which was then extrapolated to the entire year by using an adjustment factor of 0.82 for converting the peak month-average day passenger traffic to annual-average day passenger traffic. The duration of APU use for each flight on the Design Day was calculated on the basis of reported turn- around-times (TAT) for these flights. In general for all flights with a TAT less than 60 minutes no preconditioned air usage was assumed. For flights with TATs between 60 and 120 minutes it was assumed that PC Air and ground power was used for all but 30 minutes of the TAT. For flights with TATs exceeding two hours it was estimated that the PC Air and ground power would be used for a total of 90 minutes. The figures for PC Air usage were estimated from the results of a survey of international and domestic carriers at SFO. APU fuel use in 1990 was calculated on the basis of the reported aircraft types, the number of average-day flight operations (Master Plan Program Final Environmental Impact Report, May 1992), and the published APU fuel use levels for the respective aircraft types. For FY 2011 avoided APU emissions at the International Terminals A and G, where the PC Air and 400 Hz power equipment were installed and are maintained by SFO, were included as mitigation for the Category 1 GHG emissions. In addition PC Air and 400 Hz power was supplied at a number of gates in Boarding Areas C and F and at all gates in Terminal 2 by SFO in FY 2011. Emission mitigation was estimated for the use of these facilities as detailed in tables 1, 2, and 3 in Sheet 3 of the Master Spreadsheet in Appendix A.

Table 2-7. Summary of Implemented GHG Emission Mitigation and Offset Measures at SFO

Type of mitigation Measure	Resources Saved in FY2009	Resources Saved in FY 2010	Resources Saved in FY 2011	GHG Emission Mitigation or Offset (tonnes per year) FY 2009	FY 2010	FY 2011
GHG Emission Mitigation Measures						
PC Air and 400 Hz Power Supply Installation at International and Domestic Terminals[a]	1,445,979	2,226,413	4,912,280	-14,216	-21,889	-48,295
Green Car Rental Incentive Program[b]	862,033	1,224,329	1,118,473	-8,055	-11,442	-9,946
Construction & Demolition Waste Recycling	7,708	13,041	0	-13,096	-4,545	0
SFO's Share of GHG Mitigation for BART Extension to SFO[c]	249,063	229,753	241,262	-2,250	-2,076	-2,180
AirTrain Facility[d]	176,654	183,856	193,281	-1,791	-1,864	-1,960
Subtotal Emission Mitigation				-39,409	-41,816	-62,381
GHG Emission Offset Measures						
Solid Waste Recycling[e]**, tons**	13,556	19,601		-2,749	-2,205	-2,619
Tree Planting Operations[f]	2020	2020		-121	-121	-121
Total GHG Emission Offset				-2,870	-2,326	-2,740

[a] Volume of jet fuel saved by providing PC Air and 400 Hz power supply to aircraft; at all International Terminal A and G gates, at 5 gates in Boarding Area C starting in January 2010, and at 6 gates in Boarding Area F starting in March 2010, was estimated by assuming a maximum use of Auxiliary Power Units for any gate stay exceeding 60 minutes during deplaning and enplaning operations. (See Tables 1, 2, and 3 in Sheet 3 of Master Spreadsheet in Appendix A)

[b] Gasoline savings resulting from the implementation of the Green Car Rental Incentive Program (See Tables 10 and 11 in Sheet 3 of Master Spreadsheet in Appendix A)

[c] Gallons of gasoline saved by passengers using BART service to SFO. An estimated one-way average travel distance of 19 miles per BART passenger was estimated based on 2006 Metropolitan Transportation Commission Survey of SFO and Oakland Airport passengers. The average vehicle fuel efficiency was assumed at 23.9 mpg per US EPA, and a BART per passenger per mile fuel use at 12% of the passenger vehicle per mile was obtained from BART staff. The share of SFO was estimated at 9.1% of the total GHG emission offset. (See Table 4 in Sheet 3 of Master Spreadsheet in Appendix A)

[d] Gallons of diesel fuel saved by eliminating the need for 800,000 miles of travel by Car Rental Agency shuttle buses in 2007-08. Avoided miles for subsequent years were estimated on the basis of the ratio of total SFO passengers for the respective years to FY 2008. A fuel efficiency of 4.5 mpg was assumed for the shuttle buses. (See Table 5 in Sheet 3 of Master Spreadsheet in Appendix A)

[e] Impact of general and construction/demolition solid waste recycling at SFO (See Tables 16 through 23 of Sheet 3, Master Spreadsheet for details of calculations)

[f] The impact of carbon sequestration by 2,020 trees planted throughout the Airport as a part of the SFO landscaping program (see Table 9, Sheet 3 of Master Spreadsheet in Appendix A)

Summary of Category 1 SFO Controlled GHG Emissions

Estimated Category 1 GHG emissions at SFO for 1990 and FY 2009 through FY 2011 are summarized in Table 2-8. These data show that SFO controlled operations generated 52,219 tons of GHG emissions in 1990 and 42,140 tons in FY 2009. For FY 2010 SFO had a net GHG emission of 42,197 tons which was decreased to a net emission of 41,337 tons in FY 2011. These emission levels included an annual offset of 2,870 tons, 2,326 tons, and 2,740 for FY 2009 through FY 2011, respectively. GHG emission mitigation levels at SFO increased from 39,409 tons in FY 2009 to 62,382 tons in FY 2011. The significant increase in GHG emission mitigation level in FY 2011 was, mainly, attributable to expanded PC Air and ground power service to aircraft at additional Boarding Areas in this fiscal year, as described previously.

Table 2-8 - Summary of Historical and Current Category 1 GHG Emission and GHG Emission Offset and Mitigation Levels at SFO

Activity	Category 1 SFO Controlled GHG Emissions (tonnes per year)			
	1990	FY 2009	FY 2010	FY 2011
GHG Emission Levels				
Electric Energy and Natural Gas Consumption	29,267	23,363	22,478	25,008
Fuel Consumption	15,246	17,118	17,430	17,168
Fugitive Refrigerant Gas Emissions	4,875	3,176	3,513	740
Solid Waste Disposal	2,596	1,065	820	788
Wastewater Treatment	235	288	282	373
Total Gross Baseline Category 1 GHG Emission	52,219	45,010	44,523	44,077
GHG Emission Offset Levels				
Solid Waste Recycling Offset	0	-2,749	-2,205	-2,619
Tree Sequestration Offset	0	-121	-121	-121
Total GHG Emission Offsets	0	-2,870	-2,326	-2,740
Net Category 1 GHG Emission	**52,219**	**42,140**	**42,197**	**41,337**
GHG Emission Mitigation Level				
Total GHG Emission Mitigation	**0**	**-39,409**	**-41,817**	**-62,382**

Summary of Planned GHG Emission Reduction, Offset, and Mitigation Measures at SFO

A number of additional GHG emission reduction, offset, and mitigation measures are currently being implemented or are being planned at SFO as follows:

Planned GHG Emission Reduction Measures

- Additional energy efficiency measures with a potential for reducing Category 1 GHG emissions by up to 473 tons per year (See tables 3-2 and 3-5 in Section 3). Also, projected reductions in natural gas consumption could mitigate the GHG emissions by 5,219 tons per year.
- Implementing planned Fleet Vehicle replacement program including 234 of the existing aged vehicles over a six year period mostly with CNG powered vehicles, where available. This program is expected to mitigate the category 1 GHG emissions by 528 tons per year upon completion (See Table 4-3 in Section 4)

Planned GHG Emission Offset Measures

- Increasing the solid waste recycling rate to 85% by 2017 from the FY 2011 recycling rate of 75%. This measure is expected to yield an additional GHG emission mitigation of about 2,000 tons per year.

Planned Voluntary GHG Emission Mitigation Measures

- Full year operation of PC Air units at Boarding Areas E in FY 2014. These systems are expected to yield a GHG emission mitigation of 5,136 tons per year

The planned Category 1 GHG emission ROM measures at SFO are summarized in Table 2-9 and indicate that GHG emissions at SFO could be further rebalanced by the combined impact of planned reduction and offset measures by 8,047 tons per year. A number of these measures which are associated with the Terminal 2 Renovation Project and PC Air installation at Boarding Areas C and F have already been implemented and are operational. Other measures such as PC Air units in Boarding Area E will become operational at the completion of ongoing renovations in this terminal. Also enhanced solid waste recycling and the fleet efficiency program are currently being implemented.

Table 2-9. Summary of Planned GHG Emission Reduction, Offset, and Mitigation Measures at SFO

Activity	Planned GHG Emission Reduction/Offset /Mitigation Measures, tonnes per year
GHG Emission Reduction Measures	
Natural Gas Use Reduction [a]	5,219
Fleet Vehicle Replacement [b]	354
Electric Energy Efficiency Measures [c]	473
Subtotal Emission Reductions	**6,047**
GHG Emission Offset Measures	
Enhanced Solid Waste Recycling [d]	2,000
Subtotal Mitigation Measures	**2,000**
GHG Emission Mitigation Measures	
PC Air and 400 Hz Power Supply System at B/A E[e]	5,136
Subtotal Mitigation Measures	**5,136**
Grand total	**13,183**

[a] Based on the Energy Audit Report recommendations

[b] Based on scheduled fleet vehicle replacement

[c] Based on the Energy Audit Report's electric energy saving recommendations (31,688 mWh of electricity per year) and a funded lighting efficiency project (392 mWh/year) and using a CO_2e emission factor of 32.52 lbs per mega Watt hour for SFPUC electric supply in 2010.

[d] Based on increasing the recycling rate from 75% to 80%

[e] Expected offset generated by PC Air and 400 Hz power supply system at Reactivated Boarding Area E.

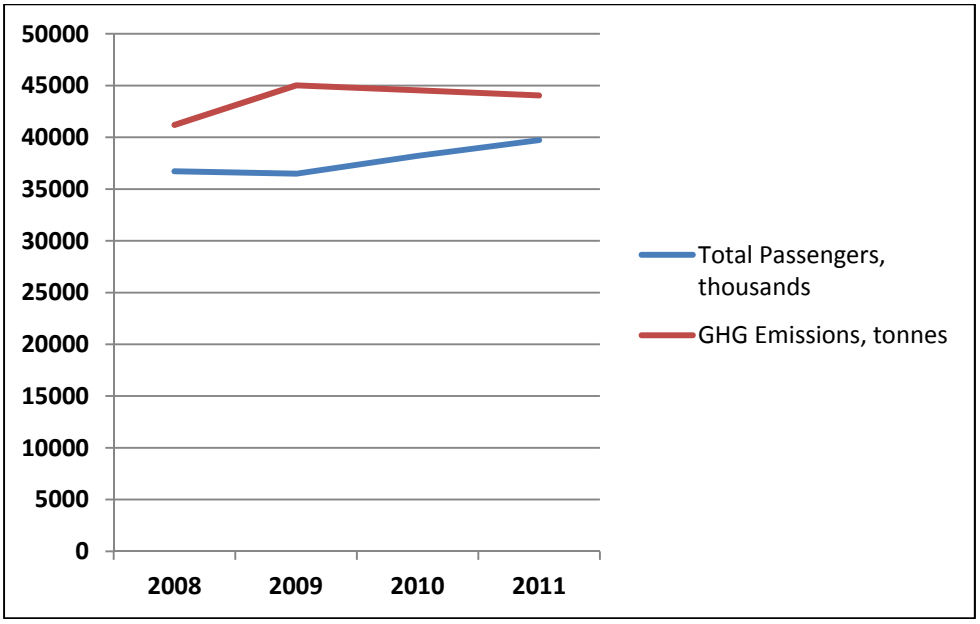
Category 1 GHG Emission Projections

Ordinance No. 81-08 requires a reduction in GHG emissions to 25% below 1990 emission levels by 2017 and 40% below 1990 emission levels by 2025. Therefore, it is necessary to establish baseline estimates for SFO's expected carbon footprint in 2017 and 2025 to assess the magnitude of compliance requirements.

Basis for GHG Projections

A review of Baseline GHG emissions for fiscal years 2008 through 2011 indicates a potential correlation between the rate of increase in GHG emissions and the number of enplaned passengers at SFO, as shown in Figure 2-1. Data for this period was selected because it represents the operating conditions at SFO following the completion of the Master Plan Program. The observed correlation reflects the impact of increased passenger traffic on electric energy use for the operation of baggage handling systems, escalators, elevators, and moving walkways. The increased passenger loads could also increase the load on the central air conditioning system during the summer months, coinciding with the peak passenger traffic period at the Airport. Other parameters such as the number of flight operations, impacting PC Air and 400 Hz power supply or APU usage, and solid waste loadings are also directly related to the passenger traffic level at SFO. Accordingly, it appears reasonable to conservatively assume that the future baseline GHG emissions at SFO would increase in proportion to the total annual number of enplaned passengers.

Figure 2-1. Plot of Historical Data for Enplaned Passengers, and Baseline GHG Emissions at SFO



Passenger Projection Levels. Passenger growth scenarios for SFO have been analyzed by the Planning Division and consolidated projections for the number of enplaned passengers have been developed based on FAA and SFO Finance Department growth estimates. The results of these projections are summarized in Table 2-10 and indicate passenger traffic growth of 14.54% by 2017 and 33.62 % by 2025.

Table 2-10. Projected Passenger Traffic Levels at SFO

Growth Scenario	FY 2011	2017	2025
Enplaned Passengers	20,383,634	23,347,414	27,236,612
% Growth form 2011		**14.54%**	**33.62%**

Projected Gross GHG Emissions. Projected 2017 and 2025 gross GHG emission levels were estimated by assuming that GHG emissions would increase in the future in proportion to the rate of growth in the number of enplaned passenger. The projected estimates for Business as Usual (BAU) GHG emissions are summarized in Table 2-11. The FY 2011 BAU baseline emission level shown in Table 2-11 does not include the impact of operational and non-operational offset measures. These offset measures are accounted for when assessing the overall emission balance, as shown in Table 2-12. However, SFO expects to generate additional GHG emission reduction and mitigation level of 8,047 tons over the same period for a combined mitigation level of 57,081 tons which would exceed the expected 2025 Category 1 baseline GHG emission level by 5,905 tons.

Table 2-11. Projected 2017 and 2025 Category 1 Gross GHG Emission Levels at SFO (Tons per Year)

Growth Scenario	FY 2011[a]	2017	2025
Consolidated Growth Projection	44,071	50,479	58,888
% Increase from FY 2011		14.54%	33.62%

[a] For Business as usual conditions excluding tree sequestration and solid waste recycling offsets and including fugitive refrigerant gas emissions and biofuel use GHG emissions

Estimates of the GHG emission reduction levels to be achieved to meet the mandates of Ordinance No. 81-08 were developed by comparing the projected GHG emission data shown in Table 2-11 with the mandated target emission levels for 2017 and 2025. The results of these calculations are summarized in Table 2-12 and indicate that if the GHG emission levels in 2017 and 2025 increase to the levels shown in Table 2-11, SFO would require additional emission reduction/offset of 527 tons in 2017 and 16,769 tons in 2025 to comply with the requirements of Ordinance 81-08.

Table 2-12. Projected Category 1 GHG Emission and Emission Offset and Mitigation Levels at SFO (Tons per Year)

Item	FY 2011	2017	2025
Allowable GHG Emission Level (Ordinance 81-08) Based on the 1990 GHG Emission of 52,219 tons		39,165	31,332
FY 2010 and Projected Net GHG Emissions	44,077	50,479	58,888
Implemented Emission Offset Measures	-2,326	-2,740	-2,740
Planned Emission Reduction / Offset Measures		-8,047	-8,047
Total Potential GHG Emission Levels	41,751	39,692	48,101
Required GHG Emission Reduction / Offset Level under Ordinance 81-08		527	16,769
Implemented GHG Emission Mitigation Measures	-62,382	-62,382	-62,382
Planned GHG Emission Mitigation Measures		-5,136	-5,136
Total Potential GHG Emission Mitigation Levels	-62,382	-67,518	-67,518

Estimated Category 2 GHG Emissions at SFO

Category 2 GHG emissions are defined to include the various emissions from airlines, airline support services, and concessionaires as well as governmental operations such as the U.S. Post Office's vehicle fleet at SFO, etc. A partial list of the emissions included under this category is as follows:

- Natural gas consumption by airlines, Ground Services Operations, and concessionaires which are not delivered under SFO accounts

- Gasoline, diesel, biodiesel, and CNG consumption by fleet vehicles for airlines, concessionaires, and airline support services
- Jet fuel consumption for aircraft landing and takeoff (LTO) cycles.
- Jet fuel consumption for aircraft Auxiliary Power Units (APU)
- Fuel consumption by construction contractors working at SFO for Airport, airlines, and other tenants
- Fuel consumption for vehicular commute by employees of airlines, concessionaires, and airline support services
- Fuel consumption by U.S. Post Office's fleet vehicles
- Fuel consumption by trucks delivering supplies to tenants, concessionaires, airlines, and airline support services

Because the focus of the SFO Climate Action Plan is on activities managed and controlled by the Airport Commission, information on some of Category 2 carbon footprint elements was not available for inclusion in this report. The missing emission data will be collected and will be included in future updates of the Airport CAP. Available data on the carbon footprint of these activities is summarized in Table 2-13 and indicate a reduction in Category 2 GHG emissions from 839,000 tons in 1990 to 749,398 tons in FY 2011. The estimated decline is mainly due to the reduction in LTO cycle and auxiliary power unit emissions from the estimated 1990 level. The 1990 estimates, however, could probably be refined by performing a more rigorous analysis. Some of the aircraft flight emission data included for FY 2008 in this table was developed by Wyle Aviation Services, et al in conjunction with SFO staff, by using FAA's EDMS model. The related emissions for 1990 and for subsequent years were extrapolated from FY 2008 data based on the number of flight operations for the respective years.

The GHG emission data shown in Table 2-13 for such elements as solid waste handling and fugitive refrigerant gas emissions are specific to tenant operations and have not been included under Category 1 emissions.

Table 2-13. Estimated Category 2 GHG Emissions from Airlines, Airline Support Services, and Concessionaire Operations*

Activity Type	Consumption/Quantity				GHG Emission, Tonnes			
	1990	FY 2009	FY 2010	FY 2011	1990	FY 2009	FY 2010	FY 2011
Commercial Passenger Aircraft LTO Cycle Jet Fuel Use[a] (million gallons)	67.26	54.29	56.87	59.13	658,688	531,716	556,911	579,105
Cargo Aircraft LTO Cycle Jet Fuel Use[b] , million gallons	3.24	2.08	2.18	2.26	31,730	20,338	21,302	22,151
Aircraft Auxiliary Power Unit Jet Fuel Use[c], gallons	7.75	5.81	6.09	6.33	75,897	56,928	59,625	62,002
Employee Commute Fuel Consumption[d] (GGEx106)	2.52	3.27	3.42	3.56	22,210	28,813	30,178	31,381
Tenants Independent Natural Gas Use (Therms)	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Ground Services Equipment Fuel Use[e] (GGEx106)	4.40	3.54	3.71	3.85	38,779	31,177	32,655	37,731
Tenants' Fleet Vehicles Fuel Use[f] (GGEx106)	0.64	0.73	0.76	0.79	5,641	6,393	6,696	7,737
Landfilled and Recycled Solid Waste[g] (tonnes)	8,325	10,256	10,742	11,170	5,016	7,370	7,719	8,027
Fugitive Refrigerant Gas Emissions[h] (lbs)	TBD	TBD	TBD	TBD	456	520	544	566
Tenants and Concessionaires Fuel Use for Supply Deliveries[i] (GGEx106)	64,026	72,856	76,355	79,298	564	642	673	699
Total					**838,980**	**683,897**	**716,303**	**749,398**

*Some of the data presented in this table were developed by Wyle Aviation Services, Synergy Consultants, and ESA Airports under a contract with SFO in conjunction with input from the SFO staff

[a] Landing and Takeoff Cycle Emissions for FY 2008 were calculated by using the FAA's Emission and Dispersion Modeling System, Version 5.1.1 and the annual flight data base provided by the SFO Noise

Monitoring Office. 1990 flight data were obtained from three sources: Landed Fee Reports, SFO Master Plan EIR, and the Official Airline Guide Schedule Data. The LTO cycle emissions for FY 2009 were estimated by multiplying the FY 2008 and FY 2010 fuel use values by the ratio of annual number of flight operations for the respective years (390,830 versus 379,200 and 383,457 flight operations, respectively).
[b] Data for the number of cargo aircraft flights and aircraft types were also obtained from the sources listed above as well as Aircraft Activity Data System and Landed Fee Reports.

[c] APU fuel use levels for various aircraft types were derived from the following sources:

a. The report entitled: Emission Estimation Technique Manual for Airports Version 1.1, Environment Australia, 17 May 2001

http://www.unitar.org/cwm/publications/cbl/prtr/pdf/cat5/Australia_airports.pdf

b. EDMS Data base, and

c. AIDS etc

APU fuel use for FY 2008 was calculated by SFO staff using actual flight operations data for August 24, 2007 at all terminals and extrapolating the data to the entire year. Avoided APU fuel use was calculated for flight operations at the gates where PC Air and ground power was available by assuming a maximum combined APU use of 60 minutes, or the duration of gate stay if less than 60 minutes. It was also assumed that PC Air and ground power was used for the balance of the of the gate stay up to a total maximum limit of 132 minutes. The same maximum time limit was used for gates without PC Air and ground power facilities. Data for 2008-09 was extrapolated from the FY 2008 values by applying a factor based on the ratio of total flight operations for the respective years. APU fuel use in 1990 was calculated on the basis of reported aircraft types and the number of average day flight operations (SFO Master Plan Final EIR, 1991). No PC Air or ground power was assumed to have been available in 1990. EDMS simulations were also carried out by Wyle Aviation for APU use at SFO, however, these data were not include in the table because the indirect method yielded more conservative emission values for the actual and business as usual scenarios

[d] FY 2008 Tenant employee commute was estimated on the basis of total number of badged and un-badged employees at SFO, excluding the Commission employees. The commute distance was calculated based on the zip code data for each employee home location. The on-Airport travel distance was subtracted from this number because this portion of the commute is included under Category 1 emissions for Airport Controlled Roads. Fuel use and GHG emission for the subsequent years were estimated by applying the respective ratio of flight operations to FY 2008 data.

[e] Approximate fuel use for GSE equipment was estimated indirectly from EDMS model output supplemented by emission data for OFFROAD vehicles published by California Air Resources Board. The FY 2008 emission was estimated on the basis of total flight operations for that year. Fuel use and GHG emission for the subsequent years were estimated by applying the respective ratio of flight operations to FY 2008 data.
[f] Tenant fleet vehicle emissions were calculated on the basis of the survey data obtained by SFO Environmental Services staff in 2009. These data represent the results of the returns with usable data but are deemed to include the majority of the tenant fleet vehicles at SFO. The on-Airport portion of the tenant fleet vehicle travel was excluded from these values because these emissions are accounted for under Category 1, as described in the preceding sections.

[g] The solid waste disposal and recycling data for SFO tenants was developed from the survey data. The data may not represent the total quantities of the respective items and is subject to revision as additional data becomes available. The FY 2008 data was extrapolated to 1990, FY 2009 and FY 2010 by SFO staff using the ratios of enplaned passengers for the respective years.
[h] Tenant fugitive refrigerant gas emissions were developed from data obtained in the FY 2008survey and was extrapolated to other reporting periods by using the ratio of enplaned passengers for the respective years.

Estimated Category 3 GHG Emissions at SFO

The Category 3 carbon footprint at SFO includes the GHG emissions generated beyond the defined boundary of SFO but which are related to enterprise activities at SFO. Examples of these emission sources for SFO are as follows:

- Jet fuel consumption at cruising altitude by passenger and cargo aircraft flying from SFO to their immediate departure destination. These emissions are included under Category 3 to indicate that they occur outside the geographical boundary of SFO.
- Vehicular and public transit travel by airline passengers to and from SFO
- Emissions from cargo service trucks and from trucks delivering supplies or providing services to SFO and to Airport enterprises
- Emissions from Car Rental Fleets. These emissions pertain to the actual operation of the rental fleets, including the green car fleets. SFO claims mitigation only for the saved fuel in the green car fleets under the Green Car Rental Incentive Program, as described in a previous section.

Available data for Category 3 GHG emissions are summarized in Table 2-14. Portions of the data included, or referred to, in this table were also developed by Wyle Aviation Services, et al in conjunction with the SFO staff for FY 2008. Estimated cruising altitude emissions were developed by using data on total number of flight operations in 1990 and subsequent reporting periods and applying the results of FAA's EDMS software simulation for FY 2008. Data for LTO Cycle were also developed by using the EDMS output. APU fuel consumption was estimated by using actual ground operation data at SFO for the selected 24 hour period along with published fuel consumption levels for the various APU types. The combination of the aircraft fuel consumption for the three elements of the flight cycle were then compared to the actual fuel volumes dispensed to all airlines at SFO and the cruise altitude values were adjusted to reconcile the two respective numbers. The GHG emissions for these activities for FY 2009 through FY 2011 were estimated by applying a factor based on the ratio of flight operations for the respective years to FY 2008 data. Other Category 3 GHG emission values were developed on the basis of responses received from the airlines, airline support services, and concessionaires to a questionnaire distributed by SFO staff in 2009, data developed by SFO's Traffic Engineering Group for SFO controlled roads, and the tonnage of cargo shipments at SFO. Table 2-14 shows that Category 3 GHG emissions at SFO ranged from seven million tons in 1990 to over eight million tons in FY 2011.

Table 2-14. Estimated Category 3 GHG Emissions at SFO

Activity	Consumption				GHG Emission, Tonnes			
	1990	FY 2009	FY 2010	FY 2011	1990	FY 2009	FY 2010	FY 2011
Jet Fuel Consumption for Commercial Aircraft Flying to the Departure Destination [a], (million gallons)	646.94	740.34	752.37	788.98	6,335,565	7,278,599	7,396,862	7,756,817
Jet Fuel Consumption for Cargo Aircraft Flying to the Departure Destination [b], million gallons	41.31	27.54	28.28	26.77	404,513	270,758	278,002	263,229
Fuel Consumption by Multimodal Passenger Travel [c], (millions GGE)	31.61	35.55	37.23	40.55	278,459	316,431	331,422	347,123
Fuel Consumption for Cargo and US Mail Shipment Delivery/Pickup at SFO [d], (gallons)	173,774	131,025	102,813	74,400	1,763	1,739	1,365	1,071
Emissions from Construction Contractors' On and Off-Road Equipment	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
Emission from Rental Car Fleets [e]	12,343,605	12,175,002	12,098,689	14,363,056	107,243	103,186	100,598	119,426
Total					7,127,543	7,970,713	8,108,249	8,487,665

[a] Estimated cruising altitude emissions for FY 2008 were calculated by using the FAA's Emission and Dispersion Modeling System, Version 5.1.1 and the annual flight data base provided by SFO Noise Monitoring Office. 1990 flight data were obtained from three sources: Landed Fee Reports, SFO Master Plan EIR, and the Official Airline Guide Schedule Data. The model output for cruising emissions in FY 2007, and calculated emissions for 1990 and FY 2008 were adjusted on the basis of the total dispensed jet fuel of 766,500,000 and 828,601,173, and 870,634,084 gallons, respectively, and by accounting for the estimated LTO Cycle and APU emissions. The cruise emissions for FY 2009 and FY 2010 were estimated by multiplying the FY 2008 fuel use value by the ratio of annual number of flight operations for the respective years.

[b] Data for the number of cargo aircraft flights and aircraft types were also obtained from the sources listed above as well as Aircraft Activity Data System and Landed Fee Reports for FY 2008. Emission data for FY 2008 and other reported years were derived by the approach described for cruising altitude emissions.

[c] Based on data developed in 2006 by the Metropolitan Transportation Commission. Estimates for 1990 and other reported years were developed by extrapolating the MTC data on the basis of passenger counts for the respective years (See Table 8-1 for details of MTC data)

[d] Estimated by using the reported annual cargo and US Mail shipments at SFO for the respective years and assuming an average roundtrip distance of 25 miles for cargo delivery / pickup in trucks holding 15 tons of cargo with a diesel fuel efficiency of 5.9 miles per gallon.

[e] Estimated on the basis of the reported rental transaction for regular, EPA rated 17+ and EPA 18 rated vehicles. An estimated travel distance of 221 miles per transaction and vehicle fuel efficiencies of 20, 30, and 40 miles per gallon, respectively, were used for the regular and two categories of high efficiency vehicles. 1990 transactions were estimated by multiplying the 2009 transaction level by the ratio of total passenger traffic for the respective years. Also, an average gas efficiency of 17.5 miles per gallon and a trip length of 221 miles were used for estimating the 1990 GHG emission level. (See Table 10 in Sheet 3 of the Master spreadsheet)

3. SFO Energy Use

Summary

SFO is the San Francisco Public Utility Commission's (SFPUC) largest purchaser of electric energy and in FY 2011 purchased 327 gWh, or nearly 35% of SFPUC's total electric power supply. The electric energy is used for lighting and for powering equipment (such as people movers) operating in public spaces; and heating, ventilation, and air conditioning (HVAC) equipment at the terminals, boarding areas, and other SFO facilities. SFO supplies all electric energy needs of airlines, concessionaires, and other Airport tenants; and in FY 2011 their electric consumption accounted for 51% of the electricity purchased from SFPUC.

SFO is also the second-largest purchaser of natural gas from the SFPUC, and in FY 2011 purchased 3.1 million therms of natural gas for use by Airport operations and for meeting the needs of most of the tenants. The local utility also supplied an additional 709,000 therms of natural gas to SFO. The summary of implemented and planned energy saving measures and the greenhouse gas (GHG) emission reductions associated with these measures is shown in Tables 3-1. These data indicate that implemented efficiency measures have yielded energy savings of 9,552 mWh / year and a GHG emission reduction of 140 tons per year. Ongoing projects will yield an additional energy saving of 2,115 mWh / year and a GHG emission offset of 31 tons per year. The results of the SF PUC's Investment Grade Audit at SFO indicate the potential for additional savings 31,688 mWh of electric energy and 981,000 therms of natural gas per year at an estimated capital cost of $34,000,000. These measures are estimated to provide annual cost savings of $5.3 million and would reduce the direct GHG emissions from consumption of natural gas by 5,200 tons and provide an additional emission reduction of 467 tons per year for the electric energy savings.

Table 3-1. Summary of Implemented, Ongoing, and Planned Electric Energy Efficiency Projects at SFO

Project Title	Electric Energy Savings mWh/year	GHG Emission Offset Tons/year
40 Implemented Electric Energy Efficiency Projects	9,552	160
Planned and Funded Electric Energy Saving Projects	2,115	31
Total	11,667	191

Potential Energy Efficiency Measures at SFO

In November 2005, the San Francisco Public Utilities Commission (SFPUC) Power Enterprise approached SFO to participate in its *Clean Energy Clean Air Program* to reduce operating costs and improve efficiency at the airport. SFO has had an ongoing effort to reduce the airport's energy costs, and in support of the Mayor's Executive Directive on Energy Efficiency, is participating in the *Clean Energy Clean Air Program* to advance the Airport Commission's energy conservation goals. As a part of this program, the SFPUC engaged their energy consultants, HDR and Cogent Energy, to complete a Preliminary Energy Audit of the SFO Airport in December of 2006. The results of the preliminary audit were presented to SFO senior management in May 2007. The Airport Director then instructed SFO staff to work with the SFPUC to develop an implementation plan to move forward with further evaluation and implementation of energy

efficiency improvements. As a next step, the SFPUC and Cogent Energy worked with SFO engineering and maintenance staff to complete an investment grade energy audit of the mechanical and Heating, Ventilating and Air Conditioning (HVAC) systems of the airport's main terminal complex. The following material is extracted from the executive summary of the Investment Grade Audit (IGA) Report for SFO, prepared by Cogent Energy for SF PUC Power Enterprise, dated April 2009.

The IGA report describes a package of recommended energy efficiency measures estimated to reduce SFO's energy costs by $6.1 Million per year. The capital investment required to achieve these savings is estimated to cost $34 Million providing a simple payback of 6.0 years.

In addition to reducing annual energy costs, implementation of energy efficiency measures will provide the opportunity to upgrade outdated equipment, enhance the airport environment and comfort, reduce operations and maintenance costs, reduce electric demand and provide more efficient operation of the airport's heating and cooling systems. As a further benefit, these measures will support SFO's sustainability program and will aid SFO in achieving the goal of carbon neutrality.

The SFPUC's *Clean Energy Clean Air* program was established to help SFO and other large City departments identify the most cost-effective energy efficiency opportunities, and to provide the sustained technical support necessary for their successful implementation. SFO, with an annual energy bill of over $35 million, is SFPUC's single largest electricity customer. SFO accounts for approximately 35% of the City's municipal electricity usage. Over the years, SFO engineering and maintenance personnel have worked steadily to reduce energy costs, installing, for example, upgraded lighting systems, saving SFO over $650,000 per year.

The Investment Grade Audit (IGA) studied the mechanical and Heating, Ventilating and Air Conditioning (HVAC) systems of the airport's main terminal complex, focusing on the public areas of the domestic and international terminals, boarding areas, the central plant, the parking garages and the car rental center, altogether representing over 9 million square feet. SFO engineering is pursuing lighting and other energy efficiency opportunities that were identified in the Preliminary Energy Audit independent from the SFPUC. The objective of the IGA study was to assess the economic feasibility of the HVAC energy-efficiency measures identified in the Preliminary Energy Audit by providing more accurate energy savings and project cost information. The IGA evaluated HVAC energy efficiency improvement measures with the potential to achieve approximately 31,700,000 kWh/yr in electricity saving and 981,000 therms/yr in natural gas saving. This represents approximately a 16% reduction in total energy costs (electricity and natural gas) for the entire airport and a 53% reduction in central plant and HVAC energy costs for the targeted areas. The economic analysis presented in the IGA report uses a life cycle cost approach to evaluate the financial viability of the identified measures. Estimates of greenhouse gas emissions that could be reduced due to implementation of Energy Efficiency Measures (EEM) are also provided.

IGA's Recommended Energy Efficiency Measures

The current energy cost to operate SFO's HVAC systems, including the central plant, is estimated at $10.5 million per year. The IGA Report recommended the following modifications:

- Upgrade and standardize the existing controls system.
- Optimize the new control systems at the International Terminal and Rental Car Center

- Convert constant volume dual duct air handlers in Terminal 3 to dual duct variable air volume (VAV).
- Replace two of the boilers in the central plant.
- Upgrade components of the cooling tower and install variable frequency drives on the cooling tower fans.
- Optimize the chilled water and heating hot water distribution systems and convert them to variable flow systems.
- Install a thermal energy storage system at the central plant to generate and store chilled water at night.
- Optimize the pre-conditioned air plant equipment.
- Reset zone temperature set-points.
- Replace two of the older chillers in the central plant with three new high efficiency units.

The results of the energy and economic analysis of recommended EEMs are summarized in Table 3-2. The IGA Report assumes that the recommended energy efficiency measures will be implemented as a series of projects through SFO's Design and Construction Division. The IGA Report also presents a preliminary implementation plan for the recommended projects.

Table 3-2. Recommended Energy Efficiency Measures for SFO Terminals Complex

Group	Proposed Energy Efficiency Measure	Annual Electricity Savings mWh/yr	Annual Gas Savings Thousand Therms/yr	Estimated Project Cost Thousand dollars	Simple Payback Period yrs	Avoided Electricity GHG Emission CO_{2e} tons	Avoided Gas GHG Emission CO_{2e} tons
1	**Measures to be Completed FY 08-09: EEM 4: Central Plant Cooling Towers- Apply VFDs on the Cooling Tower Fans**	245	0.0	175	3.2	4	0.00
	EEM 7a: Boiler Replacement (50% complete by FY 08-09)	-29	106.7	2,521	18.8	-0.4	568
	EEM 31a: Controls – System Optimization (IT/RAC- New Front End, Honeywell Integration, Optimize Sequences; 25% complete by FY 08-09)	704	15.1	377.4	4.0	10	80
	EEM 32a: Controls - Upgrade (Corrective Actions by SFIA)	43	12.2	41	2.1	1	64.71
	EEM 33a: Controls - Install Zone Level DDC Controls (Corrective Actions by SFIA)	50	2.0	25.6	3.3	1	10.82
	EEM 36: Shut down boiler plant during summer months	10	55.5	0	0.0	0.2	295.30
	EEM 40: Air Handlers - Change Zone Setpoints	1,033	184.6	5	0.0	3	982.26
	EEM 42: Chiller Plant Shut-down during Winter Nights	849	0.0	0	0.0	13	0.00
	Group 1 Total:	2,905	376.1	3,145	3.8	43	2,001.52
2	**EEM 7b: Boiler Replacement (remaining 50%)**	-29	106.7	2,521	18.8	-0.4	567.89
	Group 2 Total:	-29	106.7	2,521	18.8	-0.4	567.89
3	**EEM 31b: Controls - System Optimization (Implementation Phase of Optimization Project; remaining 75%)**	2,113	45.4	1,132	4.0	31	241.59
	Group 3 Total:	2,113	45.4	1,132	4.0	31	241.59
4	**EEM 32b: Controls - Upgrade Pneumatic Controllers to DDC**	2,116	595.8	4,070	4.3	31	3,170.82
	Group 4 Total:	2,116	595.8	4,070	4.3	31	3,170.82
5	**EEM 10: Chilled Water Distribution System - Remove or Modify De-couplers in Terminals to Increase System Temperature Differential**	805	0.0	164	1.7	12	0.00
	EEM 11: Chilled Water Distribution System - Convert Constant Volume Tertiary Pumps to Variable Flow to Lower Pump Speed during Part-Load Operation	591	0.0	946	13.2	9	0.00
	EEM 12: Chilled Water Distribution System - Replace Three-way Air Handler Chilled Water Valves with Two-Way Valves; Clean Cooling Coils to Increase System Temperature Differential	322	0.0	406	10.4	5	0.00

Table 3-2 (Continued). Recommended Energy Efficiency Measures for SFO Terminals Complex

Group	Proposed Energy Efficiency Measure	Annual Electricity Savings mWh/yr	Annual Gas Savings Thousand Therms/yr	Estimated Project Cost Thousand dollars	Simple Payback Period yrs	Avoided Electricity GHG Emission CO_{2e} tons	Avoided Gas GHG Emission CO_{2e} tons
	EEM 13: Chilled Water Distribution System - Implement Chilled Water Differential Pressure Reset Control or Relocate Differential Pressure Sensors to Optimize Pump Speed Control	232	0.0	134.5	4.7	3	0.00
	EEM 14: Hot Water Distribution System - Convert Constant Volume Tertiary Pumps to Variable Flow; Balance the Speed of Parallel Pumps to Lower Pump Speed during Part-Load Operation	592	-21.0	768	19.4	9	-111.91
	EEM 15: Hot Water Distribution System - Implement Hot Water Differential Pressure Reset Control or Relocate Differential Pressure Sensors to Optimize Pump Speed Control	51	-1.3	134.5	31.7	1	-6.76
	Group 5 Total:	2,593	-22.3	2,553.5	9.1	38	-118.67
6	**EEM 35: Chilled Water Distribution System - Convert Constant Volume Secondary Pumps to Variable Flow to Lower Pump Speed during Part-Load Operation**	1,341	0.0	454.7	2.8	20	0.00
	EEM 8: Chilled Water Distribution System - Install Check Valve in Central Plant Bypass (De-coupler) Line to Improve Chilled Water Distribution Low Temperature Differential	161	0.0	84	4.3	2	0.00
	EEM 41: Replace Chillers 1 and 2 with three 1,500 ton Chillers and Tower-Free Cooling	3,795	0.0	6,645	11.8	56	0.00
	Group 6 Total:	5,297	0.0	7,184	9.6	78	0.00
7	**EEM 33b: Controls - Install Zone Level DDC Controls (Cascaded from EEM 32)**	2,447	99.6	2,530.5	6.8	36	530.28
	EEM 26: Terminal 3 Main Terminal Building - Convert to Dual Duct VAV to Increase Efficiency	17,054	155.6	8,054.8	4.0	251	828.09
	Group 7 Total:	19,501	255.3	10,585	4.5	287	1,358.37
8	**EEM 2a: Central Chiller Plant - Install a Thermal Energy Storage System at the Central Plant to Generate and Store Chilled Water at Night (CHW TES)**	-94	0.0	5,561	10.8	-1	0.00
	Group 8 Total:	-94	0.0	5,561	10.8	-1	0.00
9	**EEM 16: PCA System - Optimize the Ice Storage System Operation**	63	0.0	15	2.3	1	0.00
	EEM 17: PCA System - Improve PCA System Pumping	73	0.0	75	10.0	1	0.00
	Group 9 Total:	137	0.0	90	6.4	2	0.00
10	**EEM 24a: Terminal 1- Remove Pre-Filters to Reduce Fan Energy**	55	-0.2	6	0.8	1	-0.80

Table 3-2 (Continued). Recommended Energy Efficiency Measures for SFO Terminals Complex

Group	Proposed Energy Efficiency Measure	Annual Electricity Savings mWh/yr	Annual Gas Savings Thousand Therms/yr	Estimated Project Cost Thousand dollars	Simple Payback Period yrs	Avoided Electricity GHG Emission CO_{2e} tons	Avoided Natural Gas GHG Emission CO_{2e} tons
	Group 10 Total:	55	-0.2	6	0.8	1	-0.80
	Total (All Measures):	34,593	1,356.9	36,849	6.0	508	7,220.73
	Total Measures in Construction:	2,905	376.1	3,145	3.8	43	2,001.52
	Total Remaining Measures	31,688	980.8	33,704	6.4	456	5,219.21

* EEMs designated "New Measures" are measures added to the IGA analysis that were not analyzed during the Preliminary Energy Audit.
Note: The following factors were used to calculate CO_2 reductions:
SF Community factor 2010 (used to estimate "global system effect" of savings): 32.4 lbs eCO_2/MWh
Source: derived by SFPUC, includes all sources (PG&E, local generation, direct access, Hetch Hetchy hydro, purchased power)
Natural Gas Savings factor: 11.732 lbs eCO_2/therm
Source: CARROT (CCAR software) default factor

Implemented, Ongoing, and Planned Energy Efficiency Projects at SFO

SFO's Facility Division has implemented 40 energy efficiency enhancement projects since 1998. These projects have yielded electric energy savings of 9,553 mWh and a GHG emission reduction of 141 metric tons per year (Table 3-3). Currently Design and Construction is implementing seven additional enhancement projects that are estimated to yield energy savings of 2,115 mWh per year and a GHG emission reduction of 31 metric tons per year (Table 3-4).

Table 3-3. Energy Efficiency Projects Implemented by SFO Facilities Division

Task No.	Project Location	Date Completed	No. of Old Fixtures	Old Load (kW)	No. of New Fixtures	New Load (kW)	Yearly Energy Reduction (kWhr)
1	**T3 Mezzanine Level- 8" Downlights**	Jun-04	500	103.5	500	18.0	748,980
2	**ITB Ticket Counters**	Oct-04	1,728	72.6	144	39.6	288,870
3	**West Underpass - Roadway**	Jun-03	58	12.0	30	6.2	25,386
4	**ITB - Elevator Cab Lighting**	Jun-02	26	31.2	26	3.9	239,148

Table 3-3. Energy Efficiency Projects Implemented by SFO Facilities Division (Continued)

Task No.	Project Location	Date Completed	No. of Old Fixtures	Old Load (kW)	No. of New Fixtures	New Load (kW)	Yearly Energy Reduction (kWhr)
5	ITB - 3rd Floor Above Escalators	Mar-03	72	8.4	72	4.2	36,372
6	FOM Engineering Building	Sep-01	250	60.0	Linear	28.0	210,240
7	ITB - 2nd Floor South Bridge Art Display	Jun-02	48	12.0	12	0.7	98,603
8	T3 Mezzanine Level - Uplights Pre/Post Security	Mar-05	820	49.2	820	34.4	129,298
9	Traffic Signal Conversion to LED	Jun-00	16	1.0	16	0.1	5,782
10	Domestic Terminal - Central Garage Parking	Jun-98	15,440	849.2	15440	648.5	1,758,307
11	Domestic Terminal F&B - Host Decommissioning	Mar-05	-	120.0	-	45.0	657,000
12	T1 - Departures Canopy	Sep-05	500	50.0	500	31.0	166,440
13	T3 - Arrival/Departure Level- 8" Down lights (FOM)	Jun-06	811	167.9	500	16.0	1,330,443
14	Domestic Terminal - Viaduct Lighting (#3560A)	Dec-06	600	124.2	600	64.8	520,344
15	T3 - Baggage Claim Area (#4200R2)	Dec-06	1,993	199.3	1993	123.6	663,430
16	T3 - Level 2 Pre-Security (#4200R2)	Dec-06	163	16.3	163	10.1	54,259
17	B/A F Connector Fluorescent (#4200R2)	Jun-07	234	23.4	234	14.5	77,894
18	T3 - High Level Ceiling Fluorescent (#4200R2)	Jun-07	1,128	112.8	1128	69.9	375,489
19	T3 - High Level Ceiling 8" Downlights (#4200R2)	Oct-07	116	30.7	116	12.5	159,537
20	T3 - High Level Ceiling 10" Down Lights (#4200R2)	Mar-08	18	7.5	18	1.9	48,408
21	T3 - Boarding Area 'E' Fluorescent (#4200R2)	Mar-08	558	55.8	556	34.5	186,833
22	T3 - Boarding Area 'E' 8" Downlights (#4200R2)	Mar-08	29	6.0	29	1.0	43,441
23	Central Garage Parking - LED Exit Signs (FOM)	Jun-08	135	8.1	135	0.7	65,043
24	ITB B/A G HVAC Penthouses (FOM)	Jun-08	70	3.9	70	2.6	11,038

Table 3-3. Energy Efficiency Projects Implemented by SFO Facilities Division (Continued)

Task No.	Project Location	Date Completed	No. of Old Fixtures	Old Load (kW)	No. of New Fixtures	New Load (kW)	Yearly Energy Reduction (kWhr)
25	**AirTrain Maintenance - LED Exterior Lights (FOM)**	Dec-08	11	3.1	11	1.5	7,082
26	**Facilities - Fuel Station Canopy**	Jun-09	16	6.9	10	0.6	27,822
27	**Central Plant - High Bay Flourescent (#8592)**	Dec-09	36	30.5	36	12.6	156,419
28	**North Access Road - LED Roadway Fixtures (#8592)**	Dec-09	28	7.9	28	4.8	13,490
29	**North Access Road - LED Roadway Fixtures (#8592)**	Dec-09	54	15.2	54	6.2	39,735
30	**North McDonnell Road - LED Roadway Fixtures (#8592)**	Mar-10	55	15.5	45	7.7	34,033
31	**North McDonnell Road - LED Roadway Fixtures (#8592)**	Mar-10	43	12.1	43	4.9	31,641
32	**West Field Road - LED Roadway Fixtures (#8592)**	Mar-10	5	1.4	5	0.9	2,409
33	**West Field Road - LED Roadway Fixtures (#8592)**	Mar-10	23	6.5	23	2.6	16,924
34	**South Checkpoint - LED Roadway Fixtures (#8592)**	Mar-10	14	3.9	10	1.9	8,839
35	**Domestic Garage - Fluorescent Core F/G, F & E (#8771)**	Jun-10	773	73.1	773	47.2	227,322
36	**Domestic Garage - Fluorescent Core F & E (#8771)**	Sep-10	24	2.4	24	1.5	8,234
37	**T3 - Boarding Area 'F' Ramp Wall Pack (#8771)**	Dec-10	157	44.3	157	24.6	171,915
38	**T3 - Boarding Area 'F' Flourescent Departures Ceiling(#8771)**	Dec-10	1,546	154.6	1,546	95.9	514,632
39	**T3 - Boarding Area 'F' Ramp Level Low Bays (#8771)**	Dec-10	254	69.9	275	25.9	385,440
40	**Central Plant - Main Floor Flourscent (#8592)**	Dec-10	14	2.3	14	1.5	6,328
						Total Annual Electrical Energy Saved	**9,552,849**

Table 3-4. Ongoing and Planned Energy Efficiency Projects

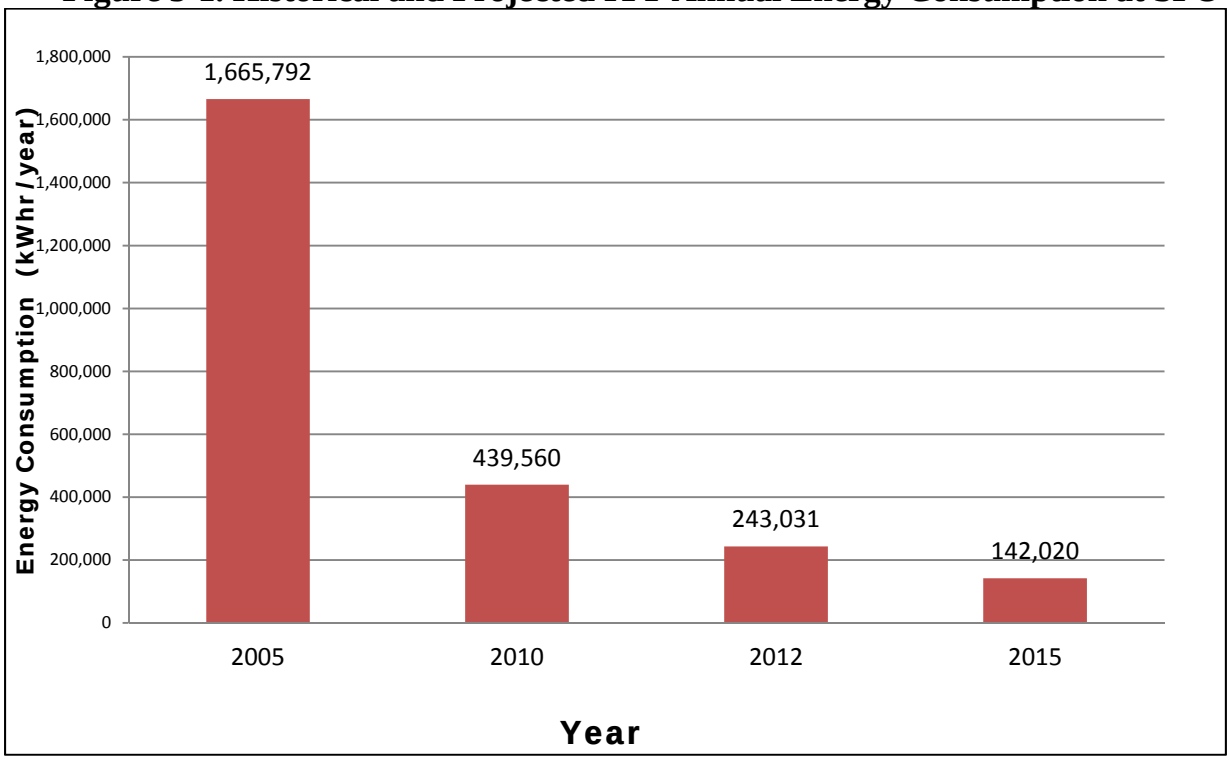
Task No.	Project Location	Date Completed	No. of Old Fixtures	Old Load (kW)	No. of New Fixtures	New Load (kW)	Yearly Energy Reduction (kWhr)
	Ongoing Projects						
1	T3 - Boarding Area 'E' 8" Downlights (#8771)	Dec-10	390	51.5	390	14.0	327,974
2	T3 - Boarding Area 'F' 9" Downlights (#8771)	Dec-10	65	8.6	65	2.3	54,662
3	T3 - Boarding Area 'F' Hub 12" Downlights (#8771)	Dec-10	95	26.8	95	10.2	145,635
4	T3 - Boarding Area 'F' Hub 12" CFL (#8771)	Dec-10	60	12.4	60	2.2	89,878
5	T3 - Boarding Area 'F' Level 1 (#8771)	Dec-10	275	118.8	275	43.2	662,475
6	N. McDonnell Road - LED Roadway Fictures (#8592)	Jun-11	67	18.9	67	14.5	38,150
7	S. McDonnell Road - LED Roadway Fictures (#8592)	Jun-11	50	14.1	50	8.3	50,808
8	Domestic Garage - Stairwells Flourescent (#8592)	Mar-11	100	5.5	100	3.7	15,768
9	AirTrain Domestic Stations - CFL Wattage (FOM)	Mar-11					TBD
	Planned Projects						
1	T1 - Baggage Claim Area (#8599)	Jun-11	1,600	144.0	1600	99.2	392,448
2	T1 - Boarding Areas (#8599)	Jun-11					TBD
3	Domestic Garage - Core A/B, B & C (#8599)	Dec-10	1,012	101.2	1,012	62.7	336,875
						Total Electric Energy Savings	**2,114,673**

Information Technology Transfer Section's Energy Saving Measures

For the past six years, SFO ITT has embarked on a carbon footprint reduction program to reduce energy consumption by computers and monitors. ITT has eliminated the use of Cathode Ray Tube (CRT) monitors

and has replaced these monitors with Liquid Crystal Displays (LCDs) which require two-thirds less energy than CRTs. Additionally ITT is gradually converting desktop computers with laptops which consume a much lower electric energy. Also, ITT procures and deploys Energy Star - rated computers that typically consume 50% less energy. ITT has also established a PC Power Management Program that turns off all inactive desktop computers at 7:00 PM each night. The overall ITT energy efficiency program has yielded a reduction of 74% in energy consumption from 2005 consumption level. A further 42% reduction from current electric energy consumption at ITT are expected by the year 2015 (Figure 3-1).

Figure 3-1. Historical and Projected ITT Annual Energy Consumption at SFO



In the Data Centers at SFO, IBM Blade Servers, a rack-based system utilizing common power supplies and network interfaces, have been used for server consolidation and virtualization and replacing older server hardware, while improving CPU utilization and energy consumption. Transferring documents electronically and standardizing the default double-sided printing mode on all printers has reduced paper consumption at SFO by fifty percent.

Further energy consumption reductions could be realized by implementing the following PC Power Management strategies:

1. Creating, communicating and enforcing a common policy for power management across the enterprise, including educating and training the user.
2. Establishing sleep or hibernation rules as the default settings when new computers and monitors are commissioned.
3. Training and educating the user base to configure the sleep and hibernation settings on their computers to conform to their work patterns.

Further optimization of paper reduction and printer use could be achieved by converting traditional, paper-based business processes into electronic processes. Any process that requires a paper form to be printed and submitted could be converted to an online form submission. Also an electronic signature could replace the wet ink signature, if approved by Legal Department. Copies of paperwork could also be scanned and stored electronically for archiving and retrieval.

Other carbon footprint reduction initiatives could include:

1. Reduction in Business travel through the use of Internet Protocol (IP) videoconferencing for meetings and other communications.
2. Transitioning the use of desktop computers to more efficient laptops.
3. Decommissioning unused and obsolete equipment in the Data Centers

4. Fleet Vehicles

Summary

SFO's fleet contains 354 light duty vehicles that are licensed for the road and are under 18,000 pounds gross vehicle weight. The fleet includes 38 CNG powered, 18 diesel powered, and 298 gasoline powered vehicles (including 11 hybrid gas / electric vehicles). SFO also operates 28 Neighborhood Electric Vehicles. In FY 2011 SFO's fleet consumed 94,491 gallons of gasoline, 53,935 gallons of biodiesel fuel, and 61,274 gasoline gallons equivalent of compressed natural gas. The combined GHG emission of the fleet was 1,722 metric tons for this period, showing an 14% reduction from FY 2010 emission level. SFO is in the process of replacing up to 234 of the least efficient vehicles with new and more efficient, and mostly CNG powered vehicles 2015. The total cost of this program is estimated at about 10 million dollars and would reduce the fleet's carbon dioxide emission by about 528 tons per year when it is fully implemented.

SFO Fleet Composition

SFO's fleet contains 354 light duty vehicles that are licensed for the road and are under 18,000 pounds gross vehicle weight. In addition SFO operates 47 heavy duty trucks, fire trucks, and buses; 54 off road construction equipment, 18 portable light vehicles, five lifts, four trailer mounted generators, six boats, and nine heavy duty portable generators. The fleet includes 112 CNG powered, 137 diesel powered, and 327 gasoline powered vehicles and equipment (including 11 hybrid gas / electric vehicles). SFO also operates 28 Neighborhood Electric Vehicles. Data for fuel consumption and GHG emissions for the fleet vehicles by fuel type are shown in Section 2. The fleet vehicles consumed a total of 209,700 gallons of various fossil fuels in FY 2011 and generated 1,722 tons of GHG emissions.

Table 4-1. Summary of SFO Fleet Vehicles for 2011 Fiscal Year

Fuel Type	Number of Vehicles
Gasoline	327
Biodiesel	137
CNG	112
Total	576

Fleet Vehicles Replacement Program

SFO is in the process of replacing 234 of the fleet vehicles with the highest odometer readings. Of these, 220 vehicles are gasoline powered, 13 use diesel fuel and one is a CNG powered vehicle. Information for the fleet vehicles replacement program and amount of fuel consumed by the vehicles is summarized in Table 4-2. The calculated annual greenhouse gas emissions from the vehicles slated for replacement is also shown in this table. The vehicles slated for replacement generated a combined total of 1,020 tons of GHG emissions in FY 2008. Currently 16 gasoline, 34 CNG, 8 diesel, and 2 electric powered vehicles are on order by the Airport.

Table 4-2. Summary Data for SFO Fleet Vehicles Replacement Program

Fiscal Year	Number of Vehicles to be Replaced			FY 2008 Fuel Consumption (Gallons)			FY 2008 Greenhouse Gas Emission[b] (Tons)		
	Gasoline	Diesel	CNG	Gasoline	Biodiesel	CNG[a]	Gasoline	Biodiesel	CNG
2011-13	77	2	1	51,156	2,045	258	451	19	1.6
2013-15	77	1	0	35,578	66.3	0	313	0.63	0
2015-17	66	10	0	21,527	4,660	0	190	44	0
Total	220	13	1	108,261	6,771.3	258	954	64	1.6

[a] Gasoline gallon equivalent, [b] Unit emission factors are shown in Section 2 of the report

GHG Emission Reduction Impact of the Proposed Vehicle Replacement Program

The proposed fleet vehicles replacement program would substitute more efficient CNG powered vehicles for the existing gasoline and diesel powered trucks. The impact of the six-year replacement program on reducing the GHG emissions from the SFO fleet is summarized in Table 4-3. Assuming that the new vehicles would achieve a fuel efficiency of 16 miles per gallon, the same as the current CNG powered vehicles, then the GHG emissions from the fleet would be reduced by about 528 tons per year or a 31% percent reduction from the current level of total fleet GHG emission and over 48% reduction from the current emission level from the vehicles that are to be replaced. The cost of the six year replacement program is estimated at $10,158,300.

Table 4-3. Summary of Fleet Vehicle Replacement Costs and GHG Emission Reduction Levels

Fiscal Year	Number of Vehicles to be Replaced	Planned Capital Funding, Millions	Estimated Annual Mileage	Estimated CNG Consumption (GGE/Yr)[a]	Estimated Future Annual GHG Emission (Tons/Yr)[b]	Current Annual GHG Emission (Tons)	Annual GHG Emission Reduction (Tons)
2011-13	80	$3.5	634,969	39,686	247	472	225
2013-15	78	$3.37	361,733	22,608	141	314	173
2015-17	76	$3.31	268,094	16,756	104	234	130
Total	234	$10.16	1,264,796	79,050	492	1,020	528

[a] Based on the current efficiency of 16 MPG for CNG vehicles in the SFO fleet

[b] Based on the estimated carbon dioxide emission of 11.70 lbs per Therm of CNG and a conversion factor of 1.15 therms per gasoline gallon equivalent

A comparison of the data shown in tables 4-2 and 4-3 shows that the new CNG powered vehicles would require approximately 36,240 fewer gallons of fuel per year than the existing vehicles for the same number of miles of usage.

Other Implemented or Planned Emission Reduction / Offset Measures for Fleet Vehicles

The following additional emission reduction / offset measures are planned for SFO's fleet vehicles:

- All diesel powered vehicles that are fuelled at the Airport Auto Shop's fuel island have been converted to Bio-Diesel (B20) fuel
- 50% of "on-road diesel" vehicles have been equipped with a Diesel Particulate Filter (DPF) to reduce 95% of exhaust particulate emissions.
- 40% of "off- road diesel" construction equipment have been equipped with a DPF to reduce 95% of exhaust particulate emissions.
- Any vehicle requiring air-conditioning repair and which uses the R-12 refrigerant, an ozone depleting gas, will be retro-fitted to use the R-134A, an ozone-safe refrigerant gas with a lower global warming potential.
- Neighborhood Electric Vehicles will be purchased for use at SFO whenever possible.
- Administrative and educational measures will be taken to inform all SFO staff to avoid running the fleet vehicle engines in the idle mode, to the maximum extent possible. Unnecessary idling of the vehicle engines is wasteful of fuel and would result in poor mileage efficiency for all vehicles.

SFO is continuing to upgrade the fleet vehicles and replacing the aging vehicles with fuel efficient cars including hybrids and electric vehicles. The budget for fleet replacement program has been included in the Capital Improvement Program and is expected to be completed over the next four years. The following is a summary of planned vehicle replacement and other related energy efficiency measures:

- Continue to purchase alternative fuel vehicles. (Additional cost for CNG conversion to base vehicle price is $10,500 for a Ford Crown Victoria, $18,000 for a pickup truck)
- Purchase more NEV (neighborhood electric vehicles)
- Purchase 100% electric powered vehicles. A new breed of electric vehicles is expected to be available in the near future.
- Install DPF's (diesel particulate filter) with N_2O (nitrous oxide) reduction. (Cost $18,00.00 to $32,000.00)
- Install DPF's on non-emergency generators to be used in construction.
- Replace towable diesel powered light plants with hydrogen power. Auto Shop is currently working with Sandia Laboratories on this project and hopes to have a prototype in service at SFO late this year when the hydrogen fuel station is expected to open at the south end of the airport.

Fleet Vehicles

- Purchase hybrid service trucks. Example: Bucket truck in which the diesel engine can be shut off and the Bucket (or accessories) can be used while powered by on board batteries.
- Reduce vehicle idle time.
- When traffic lanes need to be closed for work, use more solar powered traffic signs. Use battery operated illuminated traffic cones.
- Install a car pool (vehicle sharing) system. Auto Shop is currently working on this program for three locations on SFO property
- Determine if an employee van pool would work from outlying areas. For example employee commuting from South Bay, East Bay, or North Bay could potentially benefit from a car pool van.
- Telecommute from home one day a week, when feasible.

Overall the fleet vehicle replacement program could reduce fuel consumption at SFO and reduce the SFO carbon footprint by 528 tons per year.

5. Zero Waste Plan

Summary

Solid waste is generated at Airport operated facilities, aboard incoming aircraft, and by various Airport tenants. SFO provides solid waste collection facilities and disposal services in the public areas of all terminals. The Airport also provides solid waste disposal services at the terminals to various concessionaires and to most airlines. Some airlines and concessionaires at SFO maintain independent solid waste handling operations. Most recyclable materials such as cardboard, glass, aluminum, plastic bottles, etc. are collected separately at the Airport and are recycled by the contractor providing solid waste transport and disposal services to the Airport. The mixed solid waste materials collected from the Airport are sorted by the contractor at their offsite facilities where additional recyclable materials are removed from this stream. In FY 2011 SFO collected 9,309 tons of solid waste at the terminals and at other facilities. A total of 6,961 tons of this waste was recycled by the Airport contractor. On-site source separation contributed 1,413 tons (15.2%) of the recycled waste and the remainder was separated at off-site facilities of South San Francisco Scavenger Company (SSFSC). The solid waste reduction and recycling programs offset the GHG emissions at SFO by 2,619 tons in FY 2011. SFO is continuing to enhance the source separation operations having achieved the City's recycling goal of 75% in the in fiscal year 2011 and aiming for the goal of 85% recycling by 2017 and 100% recycling by 2020. In FY 2011 SFO composted 3,661 tons or 39.3%of the generated solid waste.

Waste Profile

In FY 2011 about 9,309 tons of general solid waste was generated at SFO of which 6,961 tons or 74.8 percent was recycled. No additional recycling from construction/demolition waste was recorded as no significant construction activity occurred during this period. Detailed information on the composition of the solid waste and the quantities of recycled wastes is provided in Table 5-1. These data indicate fairly consistent recycling rates during 2010 and 2011. As shown in Table 5-2 the SSFSC's quarterly offsite recycling rates, as a percentage of the total waste generated at the Airport, varied from 56.71 % to 61.78 % with an average annual recycling rate of about 59.60%. The quarterly recycling rates for the Airport's source separation operations ranged from 14.57 % to 15.72%, as a percentage of total waste, with an annual average rate of 15.18%.

Graphical representations of quarterly solid waste generation and recycling rates for calendar year 2009 are shown in Figures 5-1 and 5-2.

Table 5-1. FY 2011 Solid Waste Generation and Recycling Rates at SFO by Waste Type

Solid Waste Type	Quantity (Tons) 1st	2nd	3rd	4th	Total Quantity Recycled (Tons)
Cardboard	357	305	294	320	1,276
Wood	19	20	25	21	85
Mixed Recyclables (alluminum, glass, plastics)	65	57	46	52	220
Mixed Paper	33	21	19	21	94
Composted Waste	959	936	833	933	3,661
Newspaper	111	92	101	114	418
Magazines	82	89	97	110	378
Waste Paper	58	123	134	152	467
Glass	29	36	40	45	150
Alluminum	9	14	16	18	57
Plastics	9	4	5	5	23
Scrap Metal	10	10	10	10	40
Clippings	0	0	0	0	0
Wastewater Treatment Sludge	23	23	23	23	92
Total Recycled	1,764	1,730	1,643	1,824	6,961
Mixed Waste (landfilled)	696	567	520	565	2,348
Grand Total	2,460	2,297	2,163	2,389	9,309

Table 5-2. Quarterly Solid Waste Generation and Recycling Rates at SFO in FY 2011 (Tons)

Period	Solid Waste Generation, Tons			Offsite Recycling Rate[a]	Onsite Source Separation Rate[a]	Combined Recycling Rate[a]
	Mixed	Source Separated	Total Combined			
Third Quarter 2010	2,091	369	2,460	1,395 56.71%	369 15.00%	1,764 71.71%
Fourth Quarter 2010	1,936	361	2,297	1,369 59.60%	361 15.72%	1,730 75.32%
First Quarter 2011	1,828	335	2,163	1,308 60.47%	335 15.49%	1,643 75.96%
Second Quarter 2011	2,041	348	2,389	1,476 61.78%	348 14.57%	1,824 76.35%
Total FY 2011	7,896	1,413	9,309	5,548 59.60%	1,413 15.18%	6,961 74.78%

[a] Based on the combined tonnage of general solid waste generated at the Airport

Figure 5-1. FY 2011 Solid Waste Generation and Recycling Rates at SFO

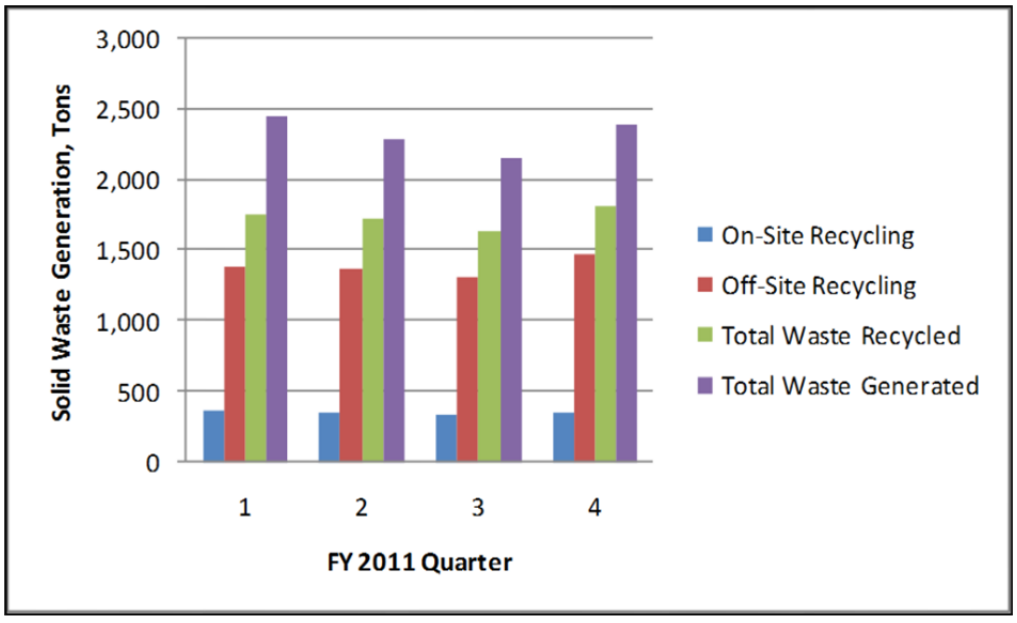
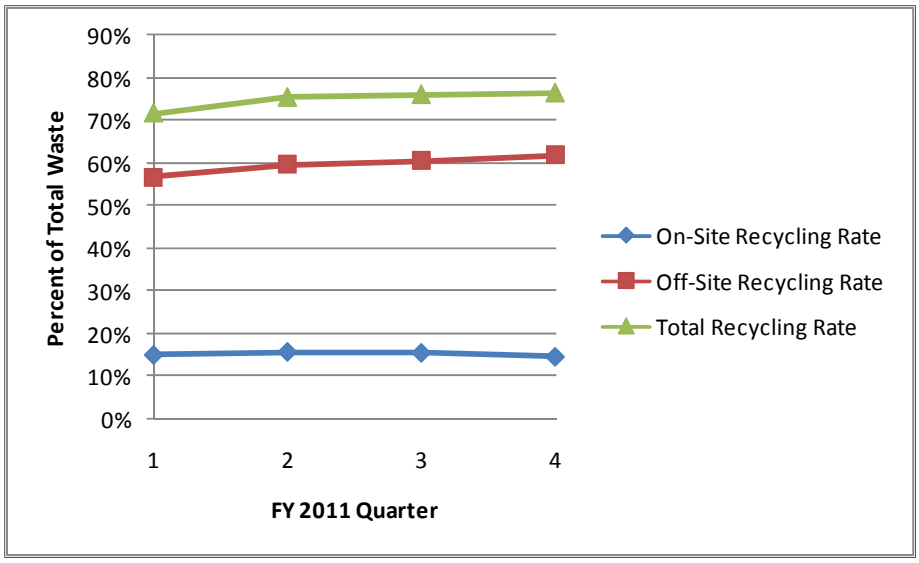


Figure 5-2. FY 2011 Quarterly Solid Waste Recycling Rates at SFO as a Percent of Total Waste



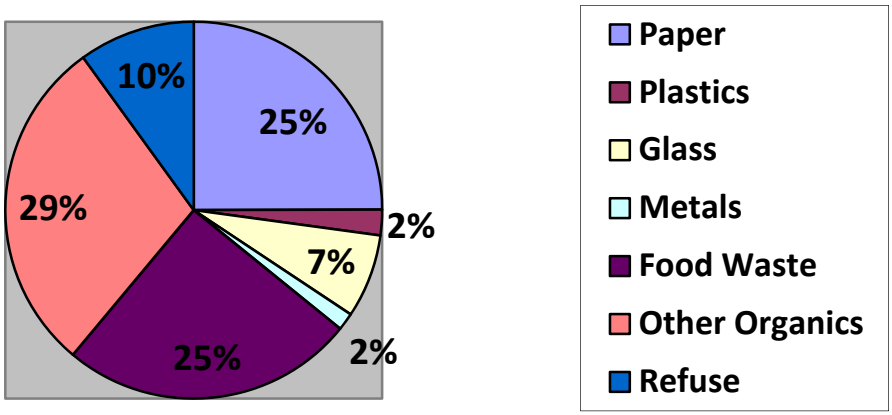
The estimated recycled tonnages for the sorting operations performed by SSFSC at their offsite facilities are based on SSFSC's service area characteristics and do not necessarily reflect the composition of the waste materials hauled off from the Airport. In August 2008 SFO performed a waste characterization study in which the contents of all 19 solid waste compactors deployed at various locations around the terminals, and at other Airport facilities, were individually examined at SSFSC recycling facilities during a one week period. In this investigation the net weight of the waste material in each compactor was obtained by weighing the trucks before and after dumping the compactor contents. The waste was then spread evenly on the ground and the volume and weight of the various components of the waste were estimated in up to three representative samples that were isolated from each compactor load. The results of this analysis are summarized in Table 5-3 and are shown graphically in Figure 5-3. These results indicate that food waste and other compostable materials comprise 55% of the waste material transported to SSFSC's recycling facilities from SFO. The non-recyclable refuse constitutes about 9.4% of the waste and the balance of 35.6% consists of recyclable materials. The contents of several compactors, however, were composed of up to 99% biodegradable materials. Based on the results of this study SSFSC increased the rate of composting of SFO solid waste from about 30 tons per quarter to over 800 tons per quarter starting in the fourth quarter of 2008. In FY 2011 SSF SC transported an average of 915 tons of SFO solid waste per quarter to a composting facility.

Table 5-3. Composition of Representative Samples of Solid Waste Hauled off from SFO[a]

Waste Component	Weight (lbs)	Percentage
Paper	41,060	25
Plastic	3,590	2.2
Glass	11,800	7.2
Metal	2,380	1.5
Food Wastes	41,420	25.3
Other Compostable Waste Materials	47,560	29
Refuse (Non-recyclable)	15,930	10
Total	163,740	100

[a] Based on visual examination of the contents of all 19 compactors deployed at SFO and transported from SFO to South San Francisco Scavenger Company's recycling facilities in a 2008 study

Figure 5-3. Estimated Composition of Solid Waste Hauled off from SFO[a]



Solid Waste Reduction Measures

SFO has undertaken a comprehensive waste reduction program including resource conservation, source separation, and composting. The objective of these reduction measures is to achieve a recycling rate of 85% by 2017 and 100% by 2020.

The goal of the resource conservation program is to educate, encourage, and persuade the Airport staff, tenants, and the general public to generate less waste in the course of their daily activities at or travel through the Airport.

This program includes the following elements:

- Paper Use Reduction. SFO staff has developed a paper use reduction program, pursuant to the Mayor's Executive Directive, by assigning a paper allocation to each Division at 80% of the previous year's consumption and requiring the submittal of a special request if the assigned allocation is prematurely exhausted.
- Double Sided Printing and Copying. All SFO printers and copiers have been programmed to produce double sided prints or copies. Signs have also been posted at all copying machines exhorting the users to save paper and avoid un-needed copying.
- Electronic Document Transfer. SFO is encouraging all staff to transmit various documents electronically.
- Paper Towel Use Reduction. SFO has experimented with the use of electric hand dryers in the Airport terminal restrooms. The results of the pilot program have been promising and plans are being made for widespread use of these hand dryers throughout the Airport. The use of electricity by the dryers is mitigated by the benefits derived from saving paper towels.
- Composting Program. In 2007 SFO initiated a program for separate collection of food waste from food vendors at the terminals. The food waste along with landscaping trimmings and wastewater treatment sludge is transported to offsite composting facilities. In 2011, SFO implemented an enhanced composting program for the waste generated in the Terminal 2 food court. SFO requires food vendors in Terminal 2 to supply biodegradable tableware, plates and containers, allowing the composting of 100% of the generated waste. SFO plans phase in this program at other terminals in the future.

Enhanced Source Separation

SFO Actions

In FY 2011 approximately 15.2 % of the solid waste generated at the Airport was separated at the source for recycling and was transported directly to the recycling facilities. Also up to 94% percent of construction demolition materials is generally sorted at the Airport and is transported to recyclers. In order to maximize the rate of source separation for the general waste SFO has deployed solid waste containers, in sets of three, throughout the Airport for depositing:

- Paper,
- Bottles & Cans, and
- General Trash

Dedicated bins have also been deployed for temporary storage of the different waste types.

Airline Actions

SFO has engaged the various airline staffs to encourage source separation of solid waste generated aboard the incoming aircrafts. The response of most airlines has been positive. Further consultation with airlines will be carried out to improve the rate of source separation aboard the aircraft.

Improved Off-Site Separation

In FY 2011 SFO's contractor achieved a recycling rate of 59.6% for mixed solid waste transported off the Airport. This value represents the average rate of recycling for the combined operation of South San Francisco Scavenger Company (SSFSC) including the offsite composting operations. In FY 2010 SSFSC completed the installation of additional mechanical equipment to improve the efficiency of solid waste sorting at their facilities. These improvements are reflected in the higher rate of recycling of the waste processed at SSFSC facilities.

Potential Additional Solid Waste Management Measures

SFO intends to increase the rate of solid waste recycling from the current level of about 74.8 % to the target level of 80% by 2015 and 85% by 2017. Using the data supplied by SFO on the composition of our waste, SSFSC has been hauling up to 959 tons per quarter of SFO's waste directly to a composting facility. SFO believes that use of biodegradable plastic tableware, cups, and containers by all food vendors would reduce the generation of non-biodegradable waste from the Terminal food courts and further enhance our solid waste composting rates. SFO has also encouraged additional source separation of waste materials at the terminals by deploying separate containers for different waste types throughout the terminals. Finally regular training and education of custodial staffs needs to be carried out to ensure that the staff would not comingle the separated wastes during the course of collecting and transporting the waste to compactors or designated bins. The potential additional solid waste management measures that are under consideration at SFO are summarized below.

Source Separation / Waste Reduction Measures

1. Use of Clear Liner Bags: Black plastic liner bags are still in use in some sections of the Airport. Black plastic bags filled with recyclable materials are likely to be dumped into the garbage compactors since custodial staff would not be able to visually identify the contents of these bags. Eliminating the use of black plastic bags and replacing them with clear bags will reduce the amount of source separated recyclables that would be sent to the offsite sorting facilities. Additionally, if compostable clear bags are used by all food vendors, then the bags of food scraps could be composted along with their contents.

2. Preventing the Dumping of Recyclables in the Compactors: Significant quantities of recyclables have been found in some of the Airport's compactor loads. Much of the observed recyclable materials had been clearly separated for recycling and then had been inappropriately placed in the compactors. Requiring SFO and tenants custodial staffs to use clear plastic bags would help alleviate this problem. Also intensive training and education of Airport and tenants custodial staffs should be carried out to ensure that the staffs are cognizant of the need and the

requirement for keeping sorted materials separate and depositing these materials in the appropriate designated bins.

3. Excessive Use of Plastic Bags: Examination of waste deposited in compactors has indicated many plastic bags that were placed in other plastic bags, with very little waste in any of the bags. It appears that empty bags are being changed out even when they do not need to be replaced. This issue should be addressed in the employee training program. Also vendors should be encouraged to keep clean film plastic wrap and other plastic packaging separate from other wastes, by bagging the film in clear plastic bags.

4. Employee Training: All custodial staffs and other employees responsible for collecting and transporting waste materials and recyclables to the appropriate bins should receive additional training on what happens to the materials once it leaves the Airport, and how to properly manage garbage and the recyclable materials.

5. Plastic Serve-Ware: Plastic serve-ware from food service vendors is a significant component of the wastes deposited in the compactors. Replacing disposable plastic serve-ware with compostable serve-ware would greatly reduce the amount of waste that has to be disposed of in a landfill. In addition to the food serve-ware provided to customers, the vendors should be required to use reusable or compostable service trays, food containers, cups, plates, etc. to enable composting of 100% of the waste generated by such vendors.

6. Discarded Ice: During visual observation of several of the waste samples from various compactors Airport consultants observed excessive amounts of water on the tipping floor. It is believed that this condition resulted from food vendors' practice of depositing surplus ice in the compactors. Providing a location where the vendors could properly dispose of the ice would reduce the weight of the waste in the compactors and eliminate the distortion introduced by water weight in the recycling calculations.

Site Specific Source Separation / Waste Reduction Measures

The following measures could be taken to reduce waste generation at specific operational areas within the airport.

1. Materials Taken off Aircrafts at SFO
Some flight crews are collecting recyclables in separate bags on board the airplanes. The sorted materials, however, are then discarded with the trash by custodial contractors. Airlines should be required to train their ground crews to keep the sorted recyclables separate from the remaining trash.
Airlines should be encouraged to discontinue or limit the offering of disposable travel kits and other giveaways (such as eye shades, sleeping socks and toothbrushes) that end up being discarded at the end of the flight without having been used.

2. Materials Collected at Security Checkpoints: SFO has started providing containers at the security checkpoints for emptying water bottles and depositing other bottles that could not be brought into the secure areas.

3. Surplus Food Items: Surplus food items are currently deposited by food vendors into the compactors. Airport could encourage the vendors to donate such food items to a food pantry. HDPE cooking oil containers inside cardboard boxes are also being discarded in the compactors. The feasibility of recycling these containers without removing them from the boxes should be explored.

4. Retail Vendors: "SFO Good to Go" plastic bags handed out by retail vendors to their customers are often discarded by passengers and end up in the compactor loads. These bags should be replaced by paper bags that could be recycled or composted when discarded.

5. Abandoned Textile and Leather Goods: Textile and leather goods constitute up to 10% of the contents of SFO compactors by weight. Most of these items appeared to be clothing, baggage, and other accessories that may have been discarded by passengers to avoid paying excess luggage charges or for other reasons. Separate collection of these items for donation to a non-profit thrift organization could reduce the quantity of waste produced at the Airport and prevent the waste of a resource.

6. Battery Recycling Containers: Some discarded batteries were observed in the compactor loads. Placing 'battery recycling' containers throughout the terminals (including in public access, private, and secure areas) should aid in recovering discarded batteries for proper disposal.

6. *Employee Commute Program*

Summary

Since 1993 SFO has implemented a trip reduction program by adopting a Transit First Policy. This policy is intended to promote the use of public transport by SFO employees and by air passengers; and by the employees of airlines, airline support services, and concessionaires. Under this program biennial surveys of employees are carried out to assess the modes of transit used by SFO employees and develop appropriate measures to encourage the use of public transit by a greater number of employees. In the past two years the staff of the Department of Environment in conjunction with SFO staff has conducted an annual survey of the employee commute modes. The results of the latest employee survey carried out in January 2011 indicated the following:

- 79.8% of the 900 respondents drive alone to work
- 10.5% use carpool and vanpool
- 8.1% use public transit (BART, Samtrans, and Caltrain)
- 1.6% use other modes (motorcycle, bicycle, walking, etc.)

The GHG emissions from all modes of commute, by SFO's 1,843 employees, were estimated to be about 2,529 tons in FY 2011. Several incentive programs are currently offered to SFO employees to encourage the use of public transit. A BART fare discount has been put in place, and new programs to develop bus service, link to a new ferry terminal, and encourage bicycle travel are under consideration or being implemented.

Transit First Program

The goal of SFO's Transit First Policy is to promote public and private high occupancy vehicle (HOV) access to the Airport. Implementation of this policy increases the use of shared-ride modes over driving alone, thereby reducing emissions.

In the 1990s, SFO added a "*Trip Reduction Rule*" to the Airport's official Rules and Regulations, and implemented a Commuter Benefits Program for City staff. The Trip Reduction Rule reduces the impact of Airport operations on local and regional air quality and complies with a development agreement between SFO and the surrounding communities. In 2009, a tenant Commuter Benefits Regulation was added.

SFO's Trip Reduction and Commuter Benefits programs include the following elements:

- Employers must provide a pre-tax payroll deduction benefit for employee transit or vanpool expenses, a monthly payment for these expenses, or a shuttle service. Employees are surveyed periodically to collect data on their commuting habits
- A Ground Transportation Information Program includes information booths in the terminals, periodic public information media campaigns, and orientation sessions for new employees that provide information on commute alternatives.

Employee Survey Results

In January 2011 SFO conducted a survey of employee modes of travel to and from work. A total of 900 employees responded to this survey. The results of the survey are summarized below:

- 79.79% of employees drive alone to work
- 10.53% use carpool
- 8.1% take transit
- 1.6% use other modes (motor cycles 0.58%, bikes, etc. 0.65%)
- The average one-way commute time is 34 minutes
- Travel time and convenience are the most important factors in determining the commute mode.

GHG Emissions for Employee Commute in FY 2011

Estimates for GHG emissions from various modes of commute by SFO employees were developed on the basis of information obtained from the January 2011 employee commute survey. The GHG emission impact of the commute travel by SFO employees is summarized in Table 6-1.

Table 6-1. FY 2011 Annual GHG Emissions from Commute Travel by SFO Employees

Commute Mode	Percent of Employees	Miles Travelled	GHG Emission, Tonnes/Year
Drive Alone[a,b]	79.79	6,621,795	2,396
Carpool[b,c]	10.53	309,732	112
BART/Bus[d]	8.1	672,221	29
Shuttle/Taxi/Limousine[e]	0.18	14,938	2
Motorcycle/Scooter[f]	0.58	48,291	9
Telecommute[g]	0.13	0	0
Bicycle	0.52	0	0
Total	**100**		**2,548**
Emission Reduction for Compressed Work Week Program[g]	5.37		-23
Net GHG Emission			**2,526**

[a] Based on a total employee count of 1,843, an average roundtrip commute distance of 19 miles, and 237 work days per year

[b] Based on an average commute distance of 19 miles, a fuel efficiency of 25 miles per gallon, and a GHG emission of 19.42 lbs per gallon of gasoline

[c] Based on an assumed number of 3 passengers per car pool and 252 work days per year

[d] Based on the BART emission factor equivalent to 12 percent of the personal auto emission rate

[e] Based on an average fuel efficiency of 4.5 miles per gallon of diesel fuel and an average round trip commute distance of 19 miles, and a GHG emission of 22.37 lbs per gallon of diesel fuel

[f] Based on an estimated fuel efficiency of 40 miles per gallon of gasoline

[g] Based on the participation of 36 employees in the 9/80 Compressed Work Week Program (CWWP) and 63 employees in the 4/40 CWWP in FY 2011 and using an Airport-wide average GHG emission reduction of 12.86 lbs per employee per avoided commute day

Data shown in Table 6-1 indicate a regional GHG emission contribution of about 2,526 tons in FY 2011 by SFO employees commuting to work.

Implementation of GHG Emission Reduction / Offset *Measures*

Measures taken by SFO for reducing the GHG emissions from employee commute activities are described below:

1. Commuter Benefits Program

The City's Commuter Benefit Program is administered by the Department of the Environment. All Airport Commission employees who meet the program requirements qualify to participate. The program is regulated by provisions in the Federal tax code and allows employees to use pre-tax dollars (with potential savings of up to 40%) to purchase monthly public transportation passes or vouchers that can be used either for public transit passes, Airporter bus fares or vanpool fees for commuting to and from work. The cost of the passes or vouchers is deducted from employee paychecks and the passes are mailed to employees' home address each month. Information for this program is included in the materials provided by Human Resources to all new employees and is also introduced at New Employee Orientations. Information is also available on the City's website and on www.SFOConnect.com.

2. Bicycle Fleet Program

The Airport has marked new bike lanes on McDonnell Road and has installed bike racks at 4 locations that can be used by employees or the general public. Information on locations and rules for using the bike racks are provided in the New Employee Orientations and are also available on the Airport's website: www.flysfo.com. SFO is developing a bicycle sharing program that may debut in late 2012.

3. Rideshare Programs

The Airport partners with the Peninsula Commute Alliance and 511.org to provide incentives for Airport Commission employees to share their ride to work. Through these programs a variety of financial incentives for starting new carpools and vanpools or adding additional members to

existing ones are available to Airport Commission employees. The 511 Rideshare Program also provides free Bay-Area-Wide ride matching services that support the initiation of new pools or addition of new members to existing carpools and vanpools. These programs are promoted during New Employee Orientations. Information can also be found on the 511.org website and a link is available from SFO Connect through the Landside page.

4. Compressed Work Week Program (CWWP)

Certain SFO employees may choose to work a compressed schedule of 80 hours over 9 days in each two-week period (9/80 option) or 40 hours in four days per week (4/40 option). Currently [update] a total of 36 SFO employees participated in the 9/80 CWWP and 63 employees participated in the 4/40 CWWP. A unit GHG emission factor of 12.86 lbs per employee per commute day was developed on the basis of the estimated FY 2011 GHG emission of 2,548 tons for commute by 1,843 employees, in the absence of a CWWP. The total GHG emission reduction for the CWWP at SFO was, therefore, estimated at 23 tons per year in FY 2011.

5. Emergency Ride Home Program

The City's Emergency Ride Home Program is also administered by the Department of the Environment. All Airport Commission employees who meet the program requirements qualify to participate. The program allows employees who use alternative transportation to get to work to take public transportation, hire a taxi, or rent a car to deal with an emergency (personal or family illness, bike/vanpool problems, etc.), up to a maximum of four times per year, and be reimbursed by the City for the incurred cost.

6. Additional Measures

SFO will explore additional initiatives which could motivate auto commuters to use other forms of commute transportation.

7. Other Measures

Summary

This section covers the miscellaneous sustainability activities undertaken at SFO as follows:

- SFO has a policy of securing LEED Gold certification for all new building construction and remodeling projects. In 2011, SFO obtained LEED Gold certification for Terminal 2 Renovation and for Building 575 remodeling project. SFO is currently seeking LEED Gold certification for the new FAA Air Traffic Control Tower and Boarding Area E Renovation Project.
- The PC Air and 400 Hz power supply systems have been installed at the International Terminal A and G gates, 5 gates in Boarding Area C, 6 gates in Boarding Area F, and all gates at Terminal 2. Installation of PC Air and 400 Hz power supply facilities at all 14 gates at Terminal 2 eliminates the need for the use of Auxiliary Power Units (APU) on board the aircraft parked at the gates and is expected to save about 523,000 gallons of jet fuel and reduce the GHG emissions by about 5,140 tons per year..
- In 2009 SFO initiated a Green Car Rental Incentive Program in conjunction with the rental car companies operating at the Airport. This program provides financial incentives to the rental car companies to increase the number of fuel efficient cars in their rental vehicle inventory. The program also provided a discount to the customers who rented a Green Car for the first three years. In FY 2011 car rental agencies at SFO increased the number of transactions for EPA SmartWay rated vehicles to 17% of the total transactions and the rental of EPA SmartWay Elite rated cars was increased to 2.8% of the total transactions. These transactions resulted in saving 1,118,474 gallons of gasoline and in reducing the GHG emissions by 9,947 metric tons. The total cost of this program to SFO in FY 2011 was $1,431,360 or about $144 per ton of GHG emission mitigation.
- Water conservation has been practiced by SFO over many years. All Terminal complex toilets, urinals, and bathroom sinks are equipped with low flow fixtures and a dual plumbing system has been installed in the renovated Terminal 2 to enable the use of treated wastewater for toilet and urinal flushing purposes.
- SFO complies with Precautionary Purchasing Ordinance and Executive Order 08-02 by purchasing the required items from the SF Approved Catalogue to the maximum extent possible. The SFO purchasing staff is currently consulting with the DOE staff to further improve the Green Purchasing Program at the Airport.

LEED Gold Construction Program

Terminal 2

In 2011, SFO completed the renovation program for Terminal 2 at a cost of 383 million dollars. This project added 14 new gates for use by domestic airlines and created 640,000 square feet of terminal space for use by airlines, concessionaires, SFO, and the general public. Terminal 2 is projected to serve 5.2 million passengers per year. SFO received a Gold certification for this terminal under US Green Building Council's Leadership in Energy and Environmental Design (LEED) certification program. The LEED Green Building Rating System for New Construction and Major Renovation provides a set of performance standards for certifying the design and construction of commercial and institutional buildings. The intent of LEED ranking is to assist in the creation of high performance, healthful, durable, affordable and environmentally sound buildings. The ranking system addresses the following project elements:

- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials & Resources
- Indoor Environmental Quality
- Innovation in Design

Terminal 2 Renovation has been designed and constructed by following the LEED guidelines to optimize all of the above elements to the maximum extent practicable. The renovation project made use of the existing terminal structure to the maximum extent possible and added new structures only where needed to meet the requirements of a modern airport terminal.

The renovated Terminal 2 will achieve an overall energy efficiency of 2.3% below the baseline design rating 67,079 MBtu per year. The majority of these savings are achieved by reducing the electric energy consumption by 19.6%. Also water consumption at Terminal 2 is expected to be reduced from the baseline rate of about 17 million gallons per year to 9.2 million gallons per year by installing efficient fixtures in all bathrooms. Additionally SFO has installed a dual plumbing system in the building to enable the use of treated wastewater for grey water uses when a supply line is constructed in the future. This system would reduce the fresh water consumption by an additional 8 million gallons for an overall reduction of 93.7% below the baseline consumption level.

Building 575 – SFO Business Center

SFO achieved LEED Gold Certification, under the Commercial Interiors rating system, for the recently completed remodeling of Building 575 at the Airport. The scope of the remodeling included efficiency upgrades to the existing HVAC system and comprehensive lighting retrofits, resulting in over 20% lighting power reduction from 48,300 watts baseline allowance under the code to 38,330 watts. All installed lighting within 10 feet of windows is equipped with day-lighting controls capable of dimming the lights when sufficient outdoor light is available. To further reduce energy consumption in the building, Energy-Star rated appliances were procured for over 90% of the office equipment and computers. A comprehensive metering system was put in place to monitor the electricity usage in the space after occupancy. To encourage the production of off-site renewable energy sources, SFO agreed to offset 100% of the building's annual energy consumption with Green-e certified renewable energy certificates over a two-year period. Low-flow

plumbing fixture used in the bathrooms and break rooms are 40% more water efficient than regular fixtures, and would result in conserving over 153,000 gallons of water per year.

During construction of Building 575 building materials made with recycled content and products that are salvaged or manufactured locally were utilized to the maximum extent possible. The majority of the furnishings in the Building 575 space were either refurbished or reused from existing SFO offices. To promote a healthy indoor environment for the occupants, all of the finishes and materials used on the project were either low-emitting or contained zero-VOCs. Outdoor air monitors installed on the air handling units, ensure that air quality inside the space is free of pollutants and that sufficient fresh air is introduced into the building. Prior to occupancy, the space underwent a full building flush-out to remove any contaminants that may have been generated in the space during construction.

Air Traffic Control Tower and Integrated Facility

SFO has embarked on a project to replace the existing structurally deficient tower and build a new Air Traffic Control Tower (ATCT) in Courtyard 2, between Terminals 1 and 2 and to improve other Airport Facilities in the project area. The existing tower will be demolished once the new ATCT is commissioned and is operational. The new ATCT will be an approximately 35,000 square foot facility designed to receive LEED Gold under the LEED Green Building Rating System for New Construction and Major Renovation. The scope of the project includes the following:

- The Replacement of Airport Traffic Control Tower and Integrated Facility: Construct a Federal Aviation Administration (FAA) Airport Traffic Control Tower including a new Integrated Facility base building. The Integrated Facility will house FAA and Airport support spaces (including new public restrooms) as well as Secure and Non Secure Spaces Corridors connecting Terminals 1 and 2.
- Terminal 1 / Boarding Area C Entrance Area Improvements: Reconfigure a portion of the existing terminal to provide access to the new public restrooms and Secure and Non Secure Corridors of the Integrated Facility, optimize concessions, respond to increased security and modernize the facility.
- Boarding Area C Airline Club: Construct a new club on Level 3 of Boarding Area C within the existing west mechanical room shell structure. The new club will occupy approximately half of the existing mechanical room floor area, and will be served by new elevators, new emergency egress stairs and a new rooftop mechanical room.
- The Secure Connector between the Integrated Facility and Terminal 2: Provide an airside secure link on Level 2 from Terminal 1 / Boarding Area C, through the Integrated Facility, to Terminal 2 / Boarding Area D, allowing passengers and employees to travel between terminals without leaving the secure area.

This project is currently in the preliminary design phase and is expected to start construction in May 2012.

Boarding Area E Renovation Project

SFO is currently undertaking the Boarding Area E (BAE) Improvement Project to renovate and enhance the existing 100,000 square-foot boarding area. The two main objectives of this project are: 1) to enhance the

functionality of the boarding area so that it meets both passenger needs as well as the SFO standard of customer care, and 2) to replace or upgrade components and systems that are obsolete or at the end of their useful life. This project will pursue LEED Gold certification under the LEED Green Building Rating System for New Construction and Major Renovation. Sustainable features include 400Hz aircraft ground power; pre-conditioned air system, minor fuel system modifications, clerestory windows throughout the terminal, and improved HVAC systems.

The BAE Project includes a building expansion and remodel that will increase the concourse floor area by approximately 18,000 square feet. The additional space will be used to expand hold rooms; add concession space for food and retail; add room for passenger amenities, including a children's play area and a recomposure area; and provide sufficient space for relocating and expanding the airline clubroom. The E Tunnel from the Baggage Claim Area to the Garage will also be remodeled as part of this project. The security of the terminal will also be improved by enhancing the access control, paging, fire protection and fire alarm systems, and IP-based CCTV systems.

A significant portion of the project is making improvements to many terminal systems and building components that have reached the end of their useful life. Specifically, the following critical scope of work items will be renovated or replaced:

- Building structural upgrades
- Aircraft apron paving repairs
- Utilities relocations and renovations, including plumbing
- Passenger boarding bridge improvements or replacement
- Baggage handling systems modifications, including a systems tie-in between BAE and BAF
- Basement ventilation system modifications
- HVAC system replacement
- Enhanced fire protection and fire alarm upgrades
- New tenant wiring closets
- New fiber optic backbone cabling
- New Airport Wi-Fi infrastructure
- Common use Flight Information Display Systems (FIDS)
- Tenant leasehold electric metering
- New lighting

This project is currently in the schematic design phase. Construction is expected to be completed February 2014.

Preconditioned Air and 400 Hz Power Supply System Installation Program

SFO currently provides preconditioned air and 400 Hz power to aircrafts at all International Terminal gates, Terminal 2 and at selected gates in Terminals 1 and 3. A survey of the various gates indicated that 10 Airport owned and 29 tenant-owned jet bridges are not currently equipped with PC Air and 400 Hz power

supply units. In FY 2011, the PC Air system offset GHG emissions by 48,295 tons. The PC Air facilities at Boarding Areas C and F are partially owned and controlled by the tenant airlines and no credit has been taken for the portion of these facilities that are owned by the airlines.

Green Car Rental Incentive Program

In 2009 SFO implemented the nation's first Green Car Rental Incentive Program that rewards customers for renting "green" alternative-fueled vehicles. Customers renting cars with a combined EPA Greenhouse Gas and Air Pollution Ranking of 17 or higher (also known as EPA SmartWay and EPA Ultimate SmartWay), such as the Honda Civic Hybrid, Nissan Altima Hybrid and Toyota Prius, would receive a $15 discount at the counter.

Likewise, airport rental car companies would qualify for additional incentives when they increase the rentals of high-mileage and alternative-fueled vehicles. Rental car companies that maintain a fleet containing 15 percent or more vehicles with a combined EPA Greenhouse Gas and Air Pollution Ranking of 17 or higher would qualify for a 20 percent reduction of their airport rental fees.

In FY 2011 car rental agencies at SFO increased the number of transactions for EPA SmartWay rated vehicles to 17% of the total transactions and the rental of EPA Ultimate SmartWay rated cars was increased to 2.8% of the total transactions. These transactions resulted in saving 1,118,474 gallons of gasoline and in reducing the GHG emissions by 9,947 metric tons. The total cost of this program to SFO in FY 2011 was $1,431,360 or about $144 per ton of GHG emission offset claimed by SFO.

The estimated reduction in GHG emissions of 9,946 tons in 2011 represents approximately 8.3% of the total GHG emission of 119,420 tons from all rental cars in that year.

Summary information for the green car rental incentive program is shown in Table 7-1.

Table 7-1. Estimated Greenhouse Gas Emission Reductions Generated by the SFO Green Vehicle Rental Incentive Program

	EPA SmartWay		EPA Ultimate SmartWay	
	FY 2010	FY 2011	FY 2010	FY 2011
Number of Transactions	263,583	243,943	46,096	39,810
Miles Driven	58,178,913	53,911,414	10,187,213	8,897,994
Gasoline Saved, gallons	969,649	898,524	254,680	219,950
Reduction in Greenhouse Gas Emission [a], metric tons	9,101	7,996	2,341	1,951
Estimated Program Cost	$1,598,421	$1,230,543	$691,440	$200,817
Cost of Gross GHG Emission Reduction $/ton	$176	$154	$295	$103

[a] The reductions in GHG emission was estimated by using an average fuel efficiency of 20 mpg for regular rental vehicles, 30 mpg for EPA SmartWay rated vehicles, and 40 mpg for EPA Ultimate SmartWay rated vehicles; and a unit GHG emission rate of 19.42 lbs per gallon of gasoline.

Carbon Sequestration Program

Over the past ten years SFO has developed approximately 50 acres of landscaping around the Airport containing 2,020 trees of different species, excluding the older trees in the undeveloped areas to the west of Highway 101, as shown in Table 7-2. Each tree sequesters carbon dioxide in its biomass over the life span of the tree. The U.S. Forest Service has developed a Carbon Sequestration Model[1] for estimating the annual rate of carbon sequestration for various tree species. SFO staff calculated an estimated sequestration rate of 121 tons per year for the 2020 trees planted at SFO. The sequestered carbon dioxide would not be released back into the environment because the trees are expected to be sustained for a long time at SFO and the wood would be salvaged when a tree is removed.

Table 7-2. Carbon Sequestration by Landscaping Tree Species Planted at SFO

Tree Species	Number Planted	2011 CO2 Sequestration, tons/year	Tree Species	Number Planted	2011 CO2 Sequestration, tons/year
Sequoia	694	73.88	Cypress	22	1.63
Podocarpus (conifer)	458	2.97	Vine Maple	20	0.11
Cercis Tendentis	253	2.79	Eucalyptus	16	5.49
Polar	76	9.05	Incense Cedar	15	0.76
Sycamore	66	4.33	Miscellaneous species	162	9.19
Arbutus	55	2.52	Total	2,020	120.70
Alder	54	3.32			
Prunus	42	1.14			
Buckeye	30	0.37			
Olive	30	1.38			
Melaleuca	27	1.77			

[1] Center for Urban Forest Research, Tree Carbon Calculator, Developed by the Center for Urban Forest Research, Pacific Southwest Research Station, US Forest Service, in partnership with the California Department of Forestry and fire Protection, 2009

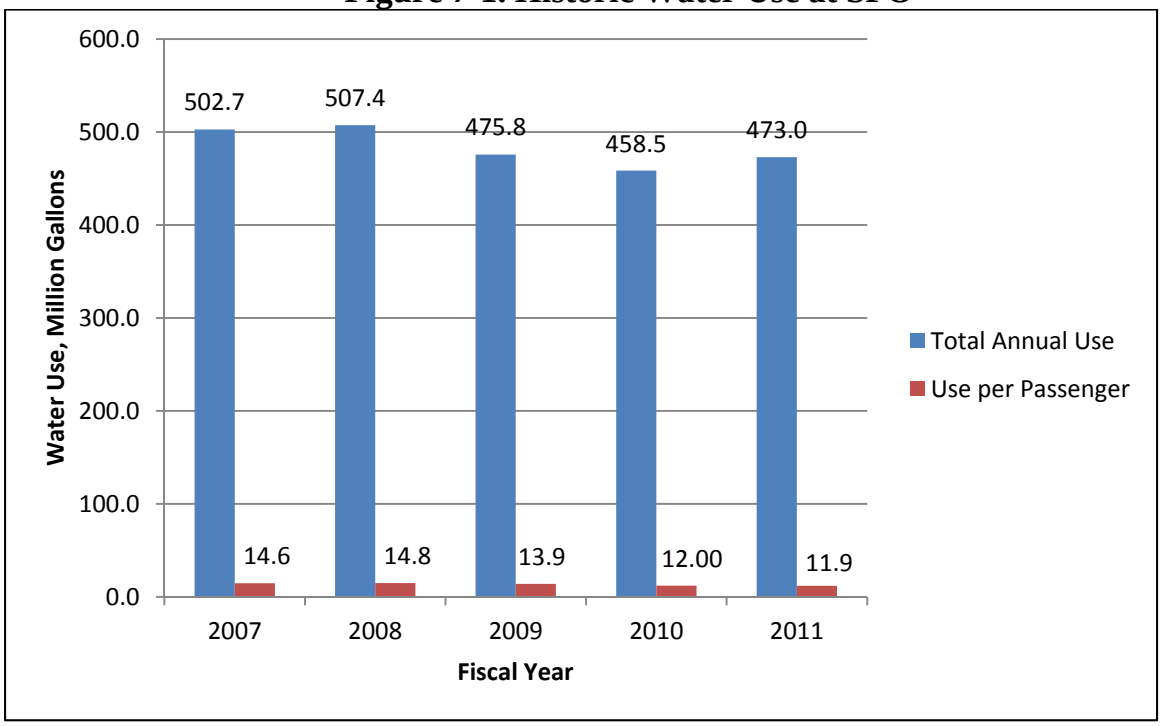
Water Conservation Practices

Historic water use data at SFO is shown in Figure 7-1 and indicates a total water use ranging from 502.7 million gallons in FY 2007 to 473 million gallons in FY 2011. Most of the year to year variation in water use at SFO is impacted by the total number of passengers passing through the Airport. Therefore, the per passenger water consumption is a more effective gauge for measuring water efficiency levels at SFO. The annual per passenger water consumption levels in the past five years at SFO indicate a gradual decline in water use from 14.8 to 11.9 gallons per passenger from FY 2008 to FY 2011.

A portion of the total increase in water consumption from FY 2010 to FY 2011 could be attributed to the activation of Terminal 2 in April 2011. However, Terminal 2 was designed to achieve the following water savings from the Baseline design requirements:

- Baseline Annual Water Consumption: 16,814,345 gallons/year
- Design Annual Water Consumption : 9,182,128 gallons/year
- Total Water Savings: 45.4%

Figure 7-1. Historic Water Use at SFO



In the future, when the planned reclaimed water system is connected to the terminals for toilet and urinal flushing at Terminal 2 total fresh water usage will be further reduced to 8,119,363 gallons/year resulting in an additional fresh water use reduction of 1,062,765 gallons per year in comparison with the standard Building Code requirements.

7 Other Measures

SFO has installed automatic water conserving toilets, urinals and faucets in all Terminal bathrooms and in most of the other Airport buildings. A count of these facilities and the rate of savings for each fixture are shown below:

- Water Closets: 1,450
    - Water use per flush: 1.5 gallons
    - Water savings per flush: 1.5 gallons
- Urinals: 560
    - Water use per flush: 1 gallon
    - Water savings per flush: 1 gallon
- Faucets: 1,170
    - Flow rate 0.5 to 1.5 Gallons per minute
    - Water savings per minute: 20 to 30%

Green Purchasing

SFO complies with Precautionary Purchasing Ordinance and Executive Order 08-02 by purchasing the required items from the SF Approved Catalogue to the maximum extent possible. The SFO purchasing staff is currently consulting with the DOE staff to further improve the Green Purchasing Program at the Airport

8. Community-Wide Impacts

Summary

SFO's operations contribute to the global warming impact of the nine-county San Francisco Bay Area in proportion to the GHG emissions generated by Airport activities. In a more direct sense travel by SFO employees, air passengers, taxis, shuttle buses, delivery trucks, BART, Samtrans, etc. to the Airport from all parts of the Bay Area impacts the regional and local air quality and contributes to the regional emissions of greenhouse gases. Regulation and control of air quality impacts of the various modes of travel to SFO fall under the jurisdiction of Bay Area Air Quality Management District and are not directly addressed in the Climate Action Plan. However, any reductions in the emission of global warming gases would also aid in reducing the emission of other air pollutants. The global warming impact of Airport operations has been addressed in Chapter 2 of this Plan and the regional impact of these operations is recapped in this Chapter.

SFO Employees Commute Impact

SFO employee count was 1,843 in FY 2011. These employees commute to and from work by various means including personal vehicles, BART, Samtrans, Caltrain, car pools, etc. Information obtained from a recent employee commute survey is summarized in Section 6. The GHG emission impact of the commute travel by SFO employees is described in Section 6, Table 6-1. These data indicate a regional GHG emission contribution of about 2,548 tons per year from the commute travel by SFO employees. Potential future SFO employee public transit incentive programs, which are also described in Section 6, could significantly reduce the impact of vehicular emissions from the SFO employee commute activities.

Air Passengers Ground Travel Impact

The results of a bi-annual survey conducted by the Metropolitan Transportation Commission In 2006 are summarized in Table 8-1. These results indicate that air passengers travelled a combined total of 825 million miles to and from SFO in 2006. Travel by private vehicle drop off / pick up and private vehicles parked at the Airport accounted for about 63% of the total mileage, and travel by rental cars accounted for 14% of the total mileage. BART accounted for 6% of the total miles traveled in 2006 or about 53 million miles per year. Taxis, limousines, vans, and Airport bus service accounted for a combined 13% of the annual mileage; and hotel vans, public buses, Caltrain and chartered buses accounted for 2.2% of the total miles travelled.

Table 8-1. Summary of Air Passenger Travel Modes to SFO in 2006

Mode of Travel	All regions				GHG Emission, Tons/Year
	Miles Traveled to SFO	Milles Traveled from SFO	Total Mileage	% of Total Mileage	
Private Vehicle Drop offs	225,350,620	224,892,507	450,243,127	54.5	151,664 [a]
Private Vehicle Parked for Trip	34,248,614	34,178,990	68,427,604	8.3	22,989 [a]
Private Vehicle Disposition Not Stated	1,917,493	1,913,595	3,831,088	0.5	1,290 [a]
Rental Car	59,546,922	59,425,870	118,972,792	14.4	40,076 [a]
Taxi	17,059,919	17,025,238	34,085,156	4.1	20,016 [b]
Limousine	9,341,086	9,322,097	18,663,183	2.2	10,960 [b]
Shared-Ride Van	16,654,258	16,620,402	33,274,660	4.0	19,541 [b]
Scheduled Airport Buses	12,657,704	12,631,972	25,289,676	3.1	17,150 [c]
BART	26,711,117	26,656,817	53,367,934	6.5	2,157 [d]
Caltrain	1,464,332	1,461,355	2,925,687	0.4	118 [d]
Public Transit Bus	1,333,959	1,331,247	2,665,207	0.3	6,010 [e]
Hotel/Motel Courtesy Shuttle	5,012,322	5,002,133	10,014,454	1.2	5,881 [b]
Chartered Bus or Van	1,920,972	1,917,067	3,838,038	0.5	8,655 [e]
Total	413,219,317	412,379,289	825,598,606	100	306,507

[a] Based on an assumed fuel efficiency of 23.9 miles per gallon and a GHG emission factor of 19.42 lbs per gallon of gasoline

[b] Based on an assumed fuel efficiency of 15 miles per gallon and a GHG emission factor of 19.42 lbs per gallon of gasoline

[c] Based on an assumed fuel efficiency of 9 miles per GGE and a GHG emission factor of 13.46 lbs per GGE

[d] Based on the estimated BART GHG emission rate at 12 percent of personal vehicle travel

[e] Based on an assumed fuel efficiency of 4.5 miles per gallon and a GHG emission factor of 22.37 lbs per gallon of diesel fuel

Data shown in Table 8-1 indicate a contribution of about 306,507 tons of GHG emissions per year in the nine-county San Francisco Bay Area by SFO passengers travelling to and from the Airport in 2006. The GHG emissions from this source could have increased to 309,143 tons in 2007 and to 387,969 tons in FY 2011, assuming a direct correlation between these emissions and the total number of passengers at SFO for the respective years.

Impact of Service and Trade Deliveries

Various types of service and trade deliveries are made to SFO on a daily basis. Some of the examples of these types of travel to SFO are shown below:

1. Cargo pick up from and deliveries to various cargo carriers such as Federal Express, DHL, etc.
2. U.S. Post Office mail and package pick up and deliveries
3. Deliveries of fuels and supplies to Airport, airlines, and concessionaires
4. Deliveries of various materials and equipment to various contractors working at SFO
5. Hauling of solid waste, construction demolition waste, and other waste materials from SFO
6. Other deliveries
7. Travel by car rental customers
8. Commute travel by employees of airlines, airline support service companies, and concessionaires

Estimated GHG emission for these activities is shown under Category 3 GHG emissions in Chapter 2 of this Plan.

9. Measuring Progress

Summary

As described in the preceding sections greenhouse gases generated at SFO can be classified in three distinct categories depending on the ownership and control of the operations that emit such gases.

- Category 1 – SFO Controlled GHG emissions from facilities and operations under the direct control of the Airport Commission
- Category 2 – GHG emissions by all other enterprises operating at SFO
- Category 3 – Optional GHG emissions or emissions that are consequential to the operations at SFO, such as GHG emissions from cruising aircrafts or emissions from passenger commute to and from SFO

Ordinance No. 81-08 calls for the identification and recommendation of GHG emission reduction / offset measures for: "private sector greenhouse gas emission sources regulated by the department". Although SFO does not directly regulate any air pollutants or GHG emissions from the facilities of the enterprises operating at the Airport, nevertheless in the context of Ordinance No. 81-08 SFO staff has worked with the tenants to develop an estimate of the various GHG emissions from all such enterprises. To this effect SFO staff initially distributed a comprehensive questionnaire to all airlines and other enterprises at the Airport to collect data on the various GHG emitting operations of these enterprises. The results of these surveys were updated for Category 2 GHG emissions based on the total number of flights or passengers, as appropriate, for the past three fiscal years..

The required steps for measuring progress in mitigating the GHG emissions for each of the above categories are described in this section.

Measuring Progress for SFO Operations

SFO will continue to monitor the rate of GHG emissions from all Airport facilities and operations and the GHG emission reduction, offset, and mitigation generated by existing and planned emission reduction measures. Specifically the following parameters will be monitored and quantified:

GHG Emission Sources

1. Electric energy consumption
2. Natural gas consumption
3. Fossil fuel consumption
4. Refrigerant gas makeup rate
5. Solid waste generation
6. SFO employees commute to and from work

GHG Emission Reduction/Offset/Mitigation Measures

1. Electric energy efficiency measures
2. Natural gas efficiency measures
3. Solid waste reduction and recycling measures
4. Employee green commute measures
5. Resource use reduction measures

6. Green purchasing program
7. LEED certification measures
8. Educational and other measures

Data for GHG emissions and for emission reduction/offset/mitigation levels for each of the above parameters will be collected and compiled regularly. These data will be analyzed for assessing the Airport's progress in reducing the Category 1 GHG emissions and the results of the analysis will be included in future revisions of the Departmental Climate Action Plan.

Measuring Progress for Category 2 and 3 Operations

The airlines, airline support services, concessionaires, and other entities operating at SFO generate GHG emissions both within and outsides the physical boundaries of SFO. GHG emissions from these sources are generated by the following broad activities:

1. Electric energy and natural gas consumption
2. Fossil fuel consumption for vehicle fleets, ground services equipment, etc.
3. Jet fuel consumption for landing and take-off cycles and by cruising aircrafts
4. Fugitive refrigerant gas releases
5. Passenger commute to and from SFO
6. Enterprise employee commute to and from SFO
7. Solid waste generation and recycling
8. GHG emission by materials, supplies, and services deliveries
9. Other miscellaneous sources

SFO has developed fairly accurate information for GHG emission from electric energy and natural gas consumption for Category 2 operations based on available internal billing records. Estimates of GHG emissions for LTO cycles and for cruising aircrafts have also been developed by indirect approximation of jet fuel consumption for these operations. SFO has also collected data from the airlines and other enterprises for the remaining items on the list and these data as supplemented by EDMS Modeling and other methods as summarized under Category 3 emissions in Chapter 2 of this Plan.

In future years SFO, in cooperation with all stakeholders, plans to refine and supplement GHG emission estimates for Category 2 and Category 3 activities at the Airport. Recommendations for applicable GHG emission reduction / offset / mitigation measures will also be developed cooperatively for these operations

CLIMATE ACTION PLAN STAFF CONTACT

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