

Prepared for:
California State University System



Emission Inventory for CO₂ for 2006 for the California State University System

ENSR Corporation
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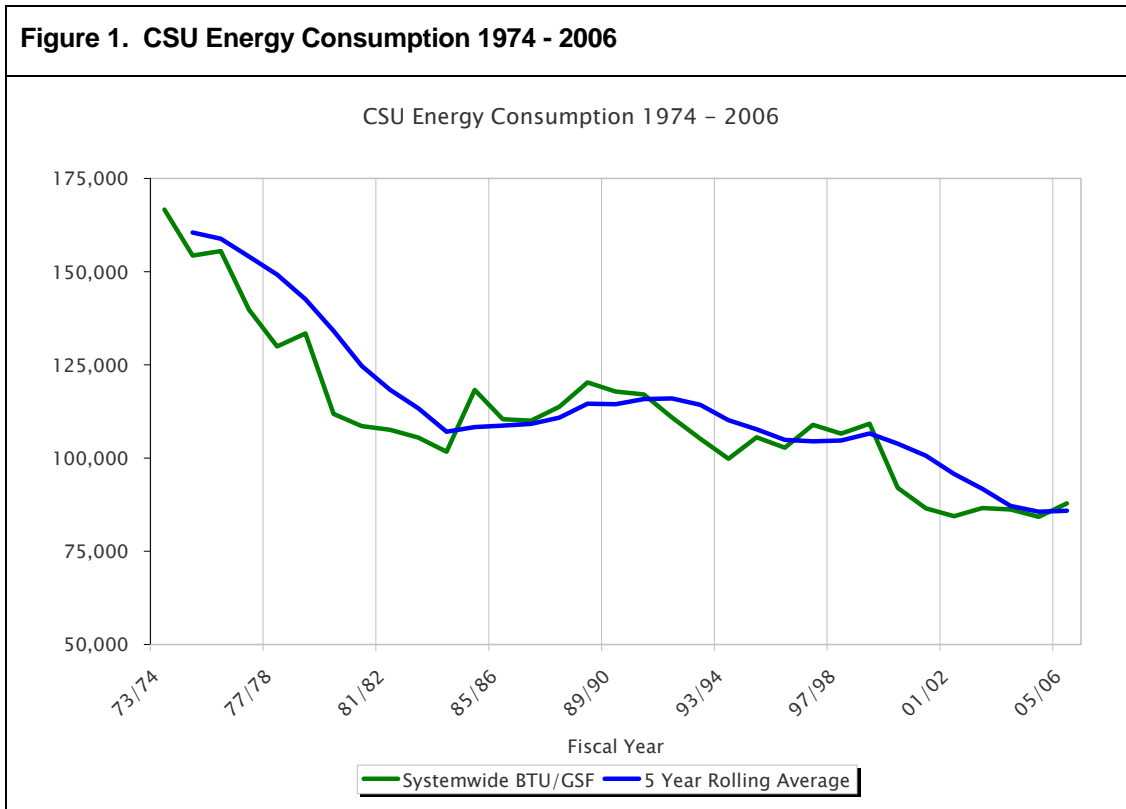
1.0 Introduction

The California State University (CSU) joined the California Climate Action Registry (CCAR) in 2006. CSU's goals in joining the registry are to reduce risks to CSU associated with its GHG emissions, understand its carbon footprint to better participate in the regulatory development process under AB32, and to establish a starting point from which to improve the efficiency of CSU's operations. Membership in the CCAR requires a system-wide inventory of direct and indirect GHG emissions using guidance provided by CCAR, certification through a State and Registry approved certifier, and the reporting of the total emissions through the Climate Action Registry Reporting Online Tool (CARROT). CSU is reporting its CO₂ emissions for 2006 under management control. Management control is the likely reporting criteria to be used under AB32.

1.1 Background

CSU has a long standing record of exemplary stewardship of state assets beginning in 1978, whereby CSU's policies and procedures for developing, building, operating, maintaining and renewing campus facilities and infrastructure embraced the 'cradle to cradle' concept which is the underlining principle of sustainability and LEED (Leadership in Energy and Environmental Design). Over the past 30 years we have reduced energy use intensity (EUI) in units of British Thermal Units per gross square footage by 50% (fifty percent), as shown in the Table 1.

Figure 1. CSU Energy Consumption 1974 - 2006



CSU's policy was updated in 1988 to mandate recharging non-state funded entities for utilities consumed and to institute Monthly Energy Reports. The policy is stated in both in the State University Administrative Manual (SUAM) as well as Executive Order 987 (EO 987).

The CSU State University Administration Manual 9170.02 (18) can be obtained at the following URL: <http://www.calstate.edu/CPDC/SUAM/SUAM9170.pdf> , a portion of which is extracted below:

...(9) The CSU will monitor energy usage on all campuses and the chancellor's office monthly, and prepare a systemwide annual report on energy utilization. The chancellor's office will maintain a systemwide energy database in which monthly campus data will be compiled to produce systemwide energy reporting. Campuses will provide the chancellor's office the necessary energy and utility data for the systemwide database in a timely manner...

...(18) All CSU campuses will implement a utilities chargeback system to recover costs of utilities provided to self-support and external organizations...

The CSU Executive Order 987 can be obtained at the following URL: <http://www.calstate.edu/EO/EO-987.html> , a portion of which is extracted below:

...8. The CSU will monitor energy usage monthly on all campuses and the Chancellor's Office, and will prepare a systemwide annual report on energy utilization. The Chancellor's Office will maintain a systemwide energy database in which monthly campus data will be compiled to produce systemwide energy reporting. Campuses will provide the Chancellor's Office the necessary energy and utility data for the systemwide database in a timely manner. **(78-; 88- Adopt; 01-Revise; 04-No Change)**...

...18. All CSU campuses will implement a utilities charge back system to recover costs of utilities provided to self-supporting and external organizations. **(78-; 88-Adopt; 01-No Change; 04-No Change)**...

These policies adopted in 1988 have created the foundation for CSU's greenhouse gas report. Campuses have delegated authority to implement a utilities charge back system. Campuses have taken 3 approaches to implement the charge back system that consist of:

1. Sub-metering of self-supporting & external organizations;
2. Performed engineering calculations to calculate the utilities recharge amounts; and
3. Created full-service lease rates that include utilities

These recharge bills are netted out from the main campus metered utility consumption to determine the amount of general funds expended to provide utilities. We have defined general fund paid for utilities as meeting the criteria of management control. Organizations that are recharged for utility use include but are not limited to the organizations and entities listed in **Table 1-1. Auxiliary Organizations and Entities Subject to Utility Recharge**.

Notwithstanding the charge-back policy discussed above, CSU is using total metered utility consumption on campus (i.e., Campus Total usage) as the boundary for the inventory. The General Fund usage that incorporates the charge backs is a subset set of the Campus Total utility consumption.

Table 1-1. Auxiliary Organizations and Entities Subject to Utility Recharge

Auxiliary organizations	A listing can be found at http://www.calstate.edu/FT/AuxOrg/AuxOrgList.shtml
Normal recharge accounts	Parking Housing Food Service Vendors (Carl's Jr, Burger King, etc.) Bookstore Student Union Student Recreation Center Health Services Foundation(s) Childcare Research activities

1.2 Boundaries of Inventory

Reporting to the CCAR can be either on the basis of equity control or management control. CSU is reporting emissions to the CCAR for GHG emissions sources contained within the CSU system that are under management control.

1.3 CSU System Description

CSU consists of 23 campuses plus Moss Landing Marine Lab, seven off-campus centers and other miscellaneous off-campus space. **Table 1-2. Gross Square Footage of Campus and Off-Campus Space** presents a list of the campuses that comprise the CSU system. **Table 1-3. Off-Campus Locations Included in the Emissions Inventory** presents the Off-Campus locations included in the inventory.

The information on campus and off-campus space usage is contained in the Space & Facilities Database Facility Reports for 2006, which can be found at the following URL:

http://www.calstate.edu/cpdc/Facilities_Planning/Space_Mgmt/Reports/Campus_Fac/2006/

CSU has the statutory requirement to purchase and report fleet vehicle inventories to California Department of General Services. The fleet inventory for 2006 is given below in **Table 1-4. CSU System Vehicle Fleet Inventory for 2006**. The fuel consumed by these vessels is reported through fuel invoices or the Voyager Gas Card online reporting system.

CSU's Marine Labs include the following ships & boats listed in **Table 1-5. CSU Campuses with Marine Vessels**. The fuel consumed by these vessels is reported through fuel invoices or the Voyager Gas Card online reporting system.

Table 1-2. Gross Square Footage of Campus and Off-Campus Space

Campus	Gross Square Feet (GSF)	Off-campus Space	Gross Square Feet (GSF)
Bakersfield	1,683,709	Antelope Valley	41,147
Channel Islands	584,277	None	
Chico	2,871,206	Leased	42,278
Dominguez Hills	1,676,313	None	
East Bay	1,738,905	Concord Center	235,898
Fresno	3,293,126	None	
Fullerton	4,361,604	Irvine/El Toro	46,510
Humboldt	2,107,586	None	
Long Beach	4,920,963	None	
Los Angeles	3,940,129	None	
Maritime Academy	367,850	Training Ship Golden Bear	200,000
Monterey Bay	1,377,982	None	
Northridge	6,288,187	North Campus	111,845
Pomona	3,457,459	None	
Sacramento	3,769,222	None	
San Bernardino	2,167,971	Palm Desert Campus	101,225
San Diego	8,079,514	Imperial Valley Campus	80,748
San Francisco	5,887,730	Downtown	None reported
San Jose	6,027,202	Moss Landing Marine Lab (See Table 3)	60,610 (See Table 3)
San Luis Obispo	4,004,382	(See Table 3)	(See Table 3)
San Marcos	1,153,504	None	
Sonoma	1,977,752	(See Table 3)	(See Table 3)
Stanislaus	1,266,331	Stockton	418,281
Chancellor's Office	165,000	Chancellor's Residence	5,000
Totals:	73,167,904		1,282,932

Table 1-3. Off-Campus Locations Included in the Emissions Inventory		
Campus	Space	GFS
Chico	Leased off campus	42,278
Northridge	North Campus	111,845
San Diego	Mt. Laguna	16,000
San Diego	Santa Margarita	7,880
San Jose	Art Foundry	6,844
San Jose	Leased Space	48,536
San Jose	San Jose Municipal Airport	42,000
San Jose	South Campus	129,157
San Luis Obispo	Marine Science/Research	3,322
San Luis Obispo	President's House	4,416
San Marcos	Leased Off-Campus	33,836
Sonoma	Osborn/Fairfield Preserve	2,810
Sonoma	Ukiah Center	2,880

Table 1-4. CSU System Vehicle Fleet Inventory for 2006

	1	2	3	4	5	6	7		
CAMPUS	Pass-enger Vehicles (Including Buses & Vans)	Trucks	Scooters	Street Sweepers	Fork Lifts	Tractors	Riding Mowers	Total Equip Listed in Columns 1-7	Number of Vehicles Operated Off-Road*
Bakersfield	26	25	34	2	2	6	6	101	0
CMA	6	12	11	1	3	1	3	37	0
Chancellor's Office	3	0	0	0	0	0	0	3	0
Channel Island	15	17	62		1	5	5	105	11
Chico	62	89	0	0	7	37	6	201	44
Dominquez Hills	22	18	71	1	4	3	3	122	6
Fresno	27	87	85	1	12	34	19	265	150
Fullerton	32	65	56	0	4	11	0	168	62
Hayward	51	21	26	3	11	10	8	130	
Humboldt	8	61	7	1	3	5	3	88	9
Long Beach	11	56	147	4	8	3	8	237	170
Los Angeles	36	24	86	0	7	7	4	164	10
Monterey Bay	39	21	0	0	3	0	0	63	
Northridge	164	47	5	3	7	5	8	239	18
Cal Poly Pomona	52	87	34	2	4	5	16	200	
Sacramento	48	45	101	5	6	4	10	219	14
San Bernardino	36	60	68	3	6	2	9	184	27
San Diego	80	111	45	2	6	7	8	266	23
San Francisco	24	20	70	1	10	4	4	133	89
San Jose	36	41	103	6	5	3	7	201	120
San Luis Obispo	99	140	70	5	26	84	7	442	291
San Marcos	36	11	10	0	3	0	0	60	
Sonoma	16	17	76	1	6	2	8	126	94
Stanislaus	47	27	34	0	3	6	9	126	88
Total	976	1,102	1,201	41	147	244	151	3,880	1,226

* Show in this column the number of off-road vehicles that were included in the figures for columns 1-7 (and therefore, in the Total Equipment Column).

NOTE: Not all mowers, forklifts, tractors, scooters, etc., are operated exclusively off-road.

Table 1-5. CSU Campuses with Marine Vessels

Campus	Vessel / Description
Humboldt State University / Telonicher Marine Lab	RV Coral Sea
San Jose State University / Moss Landing Marine Laboratory	RV John Martin & RV Point Sur
California Marine Academy	TSGB & Tug
San Francisco State University	Romberg Tiburon Center
CSU Long Beach	Marine Lab
San Diego State University	Coastal & Marine Institute

1.4 Emission Sources Included in the Inventory

Emission sources at the CSU campuses include Campus Total direct and indirect emissions.

- Direct sources consist of:
 - Natural gas (NG) combustion associated with space and water heating, cogeneration (COGEN) units at five campuses that produce electricity and/or steam for heating, and for laboratory research and instructional purposes;
 - Stationary sources consisting of diesel-fueled and/or Natural Gas emergency generators;
 - Mobile sources consist of:
 - Diesel and gasoline fueled on- and off-road vehicles, and landscaping and gardening equipment; and
 - Propane and CNG fueled on-road vehicles; and
 - Marine vessels
- Indirect electrical power and steam purchased from off-campus sources.

This inventory for direct and indirect sources was prepared following guidance in the CCAR General Reporting Protocol, Version 2.2 (GRP 2.2) and the Power and Utility Reporting Protocols (PUP). These documents can be obtained at the following URLs:

<http://www.climateregistry.org/PROTOCOLS/GRCP/>,

<http://www.climateregistry.org/PROTOCOLS/PUP/> .

2.0 Emissions Reporting

The CSU emission reporting was organized in accordance with the California Climate Action Registry (CCAR) General Reporting Protocol (GRP) to facilitate the verification of the emissions calculations by the Certifier. To this end, the emissions calculations were first divided by direct and indirect emissions, and the direct emissions were further divided into stationary and mobile emission source categories. The emissions sources in each of these three emission source categories, Direct Stationary Sources, Direct Mobile Sources, and Indirect Sources were inventoried by fuel type (e.g., gasoline, diesel, propane, etc.). For each fuel type within each of the emission source categories, the following information was provided:

- Oxidation fraction (stationary sources only);
- Emission factor;
- Emission factor source; and
- The calculated CO₂ emission value.

2.1 Direct Emissions

Direct emissions of CO₂ were calculated and reported for each of the emission source by emission source category for each campus, and as an aggregate of all of the campuses plus the Office of the Chancellor. The following sources were inventoried.

- Stationary source emissions:
 - Diesel & Natural Gas fueled emergency generators;
 - COGEN and boilers fueled by natural gas;
 - Natural gas fueled emergency generators;
 - Natural gas fueled space and water heaters used in offices, classroom, in-door athletic facilities, and laboratories; and
 - Natural gas used for experimental and instructional purposes in laboratories.
- Mobile source emissions:
 - On-road gasoline fueled vehicles;
 - Off-road gasoline fueled vehicles;
 - On-road diesel fueled vehicles;
 - Off-road diesel fueled vehicles;
 - Propane fueled warehouse equipment; and
 - Compressed natural gas (CNG) fueled on-road vehicles.

- Marine gas oil and related distillate fuels

The data used in the emissions calculations were presented in separate tables for the stationary and mobile sources. These tables list each emission source with the corresponding oxidation fractions (for stationary emissions only), emission factors, and resulting emissions.

2.2 Indirect Emissions

The indirect emissions for purchased electricity, purchased COGEN electricity, and purchased COGEN steam includes the units purchased, emission factors, and corresponding emissions for each campus, and the aggregate emissions of all the campuses plus the Office of the Chancellor. For the purchased COGEN electricity and steam, the emissions were calculated from the natural gas used to produce the purchased electricity and steam. The Channel Islands campus is the only campus that purchases steam and electricity from an external cogeneration facility. As all steam is produced using waste heat from the combustion turbine, there is no supplemental fuel used to produce the steam and the purchased steam can be ignored because all the CO₂ emissions are accounted for in the electrical purchase.

2.3 *De Minimis* Emissions

The GRP allows small sources to be classified as *de minimis* and these sources do not have to be quantified to the same level of detail as other sources. The *de minimis* threshold is defined as an emission total from small source, when summed together, represent less than 5% of the entity's total emissions for the reporting year. *De minimis* can be defined separately for each GHG pollutant emitted by the entity. The GRP allows bounding calculations can be used to demonstrate that a given source or source type is *de minimis*.

The sources examined and found to be *de minimis* consist of the following:

- Oxy-acetylene welding;
- Butane combustion;
- Dry ice usage; and
- Specialty gas use.

3.0 Emission Methodology – Direct and Indirect Emissions

3.1 Direct Emissions

3.1.1 Stationary Combustion

The stationary source emissions were inventoried by fuel type (see **Table 3-1. Stationary Source Emissions by Source and Fuel Type**), and the highest priority emission computation methodology was selected to calculate the emissions of each source based on information availability (see **Table 3-2. Emission Computation Methodology Priority for Stationary Sources**). In this case, priority 2 was used because of the availability of fuel consumption data, and use of emission factors supplied by the CCAR GRP. The default emission factors are given in **Table 3-3. 2006 Default Combustion Emission Factors**.

Table 3-1. Stationary Source Emissions by Source and Fuel Type

Source Type	Fuels	CO ₂
Emergency Generators	Diesel	X
COGEN & Boilers	Natural Gas	X
Emergency Generators	Natural Gas	X
Space and Water Heating	Natural Gas	X
Laboratory Experimental and Instructional Uses	Natural Gas	X

Table 3-2. Emission Computation Methodology Priority for Stationary Sources

Priority (High to Low)	Emission Method
1	Fuel consumption and manufacturer guarantee emission factor.
2	Fuel consumption, carbon content of fuel, and oxidation fraction.
3	Fuel consumption and carbon content of fuel.
4	Fuel consumption and default emission factors.

Diesel fuel used by the emergency generators and similar equipment are drawn from the same sources as the diesel fuel used by the mobile diesel fueled equipment and vehicles. CSU has no records of direct diesel usage in emergency generators and fire equipment. The emissions from diesel use in stationary sources are included in the emission estimates for on-campus diesel fuel combustion in motor vehicles. However, the emission factors for on-road equipment and stationary sources differ. The GRP emission factors for CO₂ for diesel mobile combustion is 9.96 kg/gal (GRP, Table C.3, CA Low Sulfur Diesel) and for stationary combustion it is 10.05 kg/gal (GRP, Table C.5, Distillate Fuel). The difference is 0.9%, well below the uncertainty in the total fuel usage for the CSU system.

Table 3-3. 2006 Default Combustion Emission Factors

Source	Oxidation Fraction (%)	Unadjusted Emission Factor	Adjusted Emission Factor	Units
Diesel Combustion GRP Table C.5	0.990	10.15	10.05	Kg-CO ₂ /Gallon
Non-Cogen Natural Gas Combustion GRP Table C.5	0.995	53.05	52.78	Kg-CO ₂ /MMBtu
Cogen Natural Gas Combustion PUP Table 5.1 ¹	0.995	53.05	52.78	Kg-CO ₂ /MMBtu
¹ The emission factors are derived from the Registry General Reporting Protocol 2.2 (GRP2.2) and the Power/Utility Protocol (PUP). The PUP Natural Gas factor has been converted to Kg CO ₂ from Kg C by multiplication by the ratio of the molecular weights (44/12).				

For the natural gas fueled stationary emissions, ENSR calculated the CO₂ emissions as follows:

1. Determine natural gas usage based on utility company invoices for each campus;
2. Apply a Heat Content factor to convert fuel use from physical units to energy units;
3. Select the appropriate emission factor;
4. Calculate CO₂ emissions and convert to metric tons (tonnes);and
5. Sum the CO₂ emissions for each campus, and the Chancellor’s Office Complex.

Stationary source emissions are summarized in **Table 3-4. 2006 Stationary Source CO₂ Emissions.**

Table 3-4. 2006 Stationary Source CO₂ Emissions					
Source	Fuel	Oxidation Fraction (%)	CO₂ Emission Factors	Units	CO₂ (Tonnes)
Cogen Natural Gas (MMBtu)	1,659,025	0.995	53.05	Kg/MMBtu	87,571
Non-Cogen Natural Gas (MMBtu)	1,844,025	0.995	53.05	Kg/MMBtu	97,337
Diesel (Gallons)	--- ¹	0.990	10.15	Kg/Gal	--- ¹
Total Stationary Source CO₂ Emissions:					184,908
<p>¹ There is no separate accounting of diesel used in stationary sources from that used in mobile sources using on-campus fueling. Diesel usage in stationary sources is very small compared to that in mobile sources. Therefore, all diesel combustion is included in the mobile source inventory. See discussion in Section 3.1.1.</p> <p>² Channel Islands Campus only. No supplemental fuel used to generate steam. CO₂ emissions already accounted for in OLS indirect Cogeneration Purchased Power.</p>					

3.1.2 Mobile Source Emissions

Mobile sources in use on the CSU Campuses in 2006 included:

- On-road and off-road gasoline and diesel fueled vehicles;
- Gasoline fueled landscaping and gardening equipment;
- Marine gas oil in ocean going vessels;
- Propane fueled warehouse equipment; and
- CNG fueled on-road vehicles.

Gasoline and diesel fuel were either purchased and dispensed from fueling stations located on most CSU campus, or were purchased from commercial service stations using a credit card system provided and administered by Voyager Fleet Systems, Inc. of Houston, Texas. Marine gas oil was delivered to Maritime Academy and Moss Landing by local fuel contractors; Propane was delivered to the campuses in cylinders by local contractors; and CNG fuel was purchased for and dispensed from the Channel Islands and Pomona campus fueling stations.

The mobile sources calculations were carried out as follows:

1. Determine gasoline, diesel, marine gas oil, propane, and CNG use based on on-campus fuel station purchases of gasoline and diesel, off-campus purchases of gasoline and diesel using the Voyager credit cards, and contractor invoices for propane and CNG purchases;

2. Select the appropriate mobile source emission factors for California Reformulated gasoline, 5.7% ethanol, California Low Sulfur Diesel, propane, and CNG (per gasoline gallon equivalent);
3. Calculate CO₂ emissions, and convert to metric tons (tonnes); and
4. Sum the CO₂ emissions for each campus, and the Chancellor's Office Complex.

The emission factors were provided by GRP 2.2 in Table C.3 for transport CO₂ emissions. The emission factors were: 8.55 kg-CO₂ per gallon for California reformulated gasoline; 9.96 kg-CO₂ per gallon for California low sulfur diesel fuel and marine gas oil, 5.67 kg-CO₂ per gallon for propane; and 6.86 Kg-CO₂ per gallon for CNG. The equation used to convert kg/gallons to tonnes/year is:

$$\text{Tonnes/year} = \text{emission factor (kg/gallons)} \times \text{gallons used times } 1 \text{ tonne}/1,000 \text{ kg.}$$

Mobile source emissions are presented in **Table 3-5. 2006 Mobile Source CO₂ Emissions.**

Table 3-5. 2006 Mobile Source CO₂ Emissions

Source	Fuel (gallons)	CO ₂ Emission Factor* (kg-CO ₂ /gal)	CO ₂ (Tonnes)
Voyager Gasoline	286,650	8.55	2,451
Voyager Diesel	28,310	9.96	282
Voyager CNG	2,156	6.86	12
Gasoline Dispensed On-Campus	588,951	8.55	5,036
Diesel Dispensed On-Campus	186,868	9.96	1,861
CNG Dispensed On-Campus	3,840	6.86	26
Marine Gas Oil (Diesel No. 2 equiv)	711,182	10.05	7,147
Propane	17,277	5.67	98
Total Mobile Source CO₂ Emissions:			16,913
* GRP 2.2, Table C.3: Carbon Dioxide Emission Factors for Transport Fuels (Kg-CO ₂ /Gallon)			

To evaluate the uncertainty in the motor vehicle emission factors for use in years prior to 2006, an estimate of the gasoline and diesel CO₂ emission factors were computed using the California Air Resources Board EMFAC2007 emission factor model. Emission factors were computed for each year from 1990 to 2006 assuming a model year distribution of 1980-2006 vehicles (both diesel and gasoline). A weighted average CO₂ emission factor for 2006 of 10.1 kg/gal was computed for diesel vehicles assuming LDT1, LDT2, and MDV diesel truck classes and the default EMFAC2007 vehicle miles traveled data and speed distributions. This value is very close to the GRP 2.2 Table C.3 value of 9.6 kg/gal for CA Low Sulfur Diesel. Likewise, a weighted average CO₂ emission factor for 2006 for gasoline of 11.8 kg/gal was computed using the gasoline vehicle classes LDA-CAT, LDT1-CAT, and LDT2-CAT. This emission factor is approximately 30 percent greater than the GRP 2.2 Table C.3 value of 8.55 kg/gal. Given the close agreement of the diesel emission factors for 2006, the relative comparability of the gasoline emission factors, and the little year-to-year variation in EMFAC2007 computed factors, the GRP 2.2 C.3 emission factors were used to estimate on-road motor vehicle emissions from diesel and gasoline vehicles.

3.2 Indirect Emissions

Indirect emissions consist of purchased electricity for a facilities' own consumption. These are the emissions associated with the generation of purchased electricity, and emissions associated with steam/heating/cooling that are consumed in equipment or operations owned or controlled by the facility.

Emissions from electricity use were calculated as follows:

1. Determine annual electricity purchase from utility bills. The monthly totals for the CSU system were obtained from the Monthly Energy Report. These reports are prepared to meet the requirements of the State University Administrative Manual (SUAM) as well as Executive Order 987 (EO 987). The energy usage values used to compute the indirect emissions are those in the Monthly Energy Report reported as general fund purchases, consisting of campus totals (i.e., amount on utility bills) less recharges for nonstate entities.
2. Select appropriate electricity emission factors that apply to the electricity used. The GRP Table C.1 emission factor for the WECC California eGRID subregion (804.54 pounds per megawatt hour [lb/MWh]) was used. This factor is representative of all electrical generation in California, which the EPA refers to as the "CALI eGRID Subregion" or the "WECC California eGRID Subregion." ;
3. Determine total annual emissions in metric tons;
4. If applicable, convert from non-CO₂ gases to carbon dioxide equivalent (CO₂e). This was performed by multiplying the non-CO₂ GHG emissions in units of mass by its Global Warming Potential (GWP) obtained from GRP Appendix C (SAR, 1996); and
5. Total the sum of all CO₂ and CO₂e gases emitted from electricity use.

The equation for tonnes of any of the three gases is as follows:

$$\text{Tonnes/year} = \text{emission factor (lbs/MWH)} \times \text{MWH used} / 2000 \text{ lbs/ton} \times 0.9071 \text{ tonnes/ton.}$$

COGEN steam and electricity is purchased from OLS Energy Camarillo by CSU Channel Islands. The steam is generated using the exhaust heat of the combustion turbine and no additional natural gas is consumed during steam generation. In 2006 CSUCI purchased 7,487,770 KWh of COGEN electricity, an energy equivalent of 65,072 MMBtu. In addition, they purchased 112,350 MMBtu of steam. The overlap, if any, between steam purchases and electricity purchases, is not known. The natural gas heat rate for 2006 is known: 8690.41 British Thermal Units per Kilowatt hour (Btu/KWh). The thermal efficiency for heat transfer from the turbine exhaust heat exchanger is unknown but an internet search identified boiler efficiencies of 70-90%. Assuming a mid-range efficiency of 80%, the natural gas heat rate required to generate the purchased steam can be estimated as the heat output divided by efficiency. This computation results in an estimated 140,400 MMBtu of heat input required for steam generation, slightly more than double the energy content of the purchased electricity.

If the steam and electricity purchases did not overlap in time, the total heat input would be the sum of the two values. However, this is an unlikely scenario. Most like, some of the electrical purchase overlapped the steam purchase, but the fraction of overlap is unknown. For this analysis, an arbitrary 50% overlap was assumed (i.e., 50% of the electrical generation is coincident with steam purchases). To avoid double counting of emissions, the natural gas heat input rate for half the electrical generation is therefore not used to estimate CO₂ emissions from purchased COGEN electricity while the entire estimated heat input for steam generation is used to compute CO₂ emissions from natural gas COGEN combustion.

The emission factor for industrial natural gas combustion was obtained from the PUP Tables 5.1 while the carbon oxidation fraction was obtained from the PUP Table 5.2. These emissions factors are identical to those

in the GRP 2.2, Table C.5. The CO₂ emissions associated with the 2006 purchase of steam and electricity from OLS Energy Camarillo is 1,717 Tonnes-CO₂ from purchased COGEN electricity and 7,412 Tonnes-CO₂ from purchased COGEN steam. The amount of CO₂ attributable to COGEN steam and electrical purchases at CSUCI in 2006 is therefore 9,129 Tonnes CO₂, a value that is only 2% of the total systemwide emissions and could qualify as a *de minimis* quantity. A more rigorous accounting of emissions from the COGEN purchases at CSUCI is not warranted, given the minor nature of the estimated emissions.

Indirect source emissions are presented in **Table 3-6. Indirect Source CO₂ Emissions** and **Table 3-7. Indirect CO₂ Emissions from COGEN Power Purchase at CSU Channel Islands Purchase.**

Table 3-6. Indirect Source CO₂ Emissions from Grid Power Purchase

Purchased Power (MWH)	Emission Factor (lbs/MWH)	CO ₂ Emissions (tons)
601,595	804.54	219,544
Emission factor from GRP, Table C1 for WECC California eGRID subregion		

Table 3-7. Indirect CO₂ Emissions from COGEN Power Purchase at CSU Channel Islands

Source	Fuel Use (MMBtu Input)	Oxidation Fraction ¹ (%)	CO ₂ Emission Factors ²	Units	CO ₂ (Tonnes)
Purchased Power from OLS Cogen (assumed 50% of total – see text)	32,536	0.995	53.05	Kg/MMBtu	1,717
Purchased Steam from OLS Cogen (equivalent MMBtu Input), estimated assuming 80% thermal efficiency (see text)	140,437	0.995	53.05	Kg/MMBtu	7,412
Total Indirect Stationary Source CO₂ Emissions:					9,129
¹ Oxidation fraction from PUP 1.0, Table 5.2.					
² Emission factor from PUP 1.0, Table 5.1					

3.3 Emissions of Other Greenhouse Gases

For 2006, CSU is reporting only CO₂ emissions, as allowed by the CCAR. Other potential sources of GHG emissions that must be considered in future year reporting by CSU include:

- Sulfur hexafluoride (SF₆) emissions from circuit breakers;
- Hydrofluorocarbons (HFCs) due to leakage or maintenance on refrigeration systems and air conditioners;
- Perfluorocarbons (PFCs) from use or maintenance on fire extinguishers containing Halon gas; and
- Others that may include:
 - Biogenic CO₂ from bio matter produced by animals on ranches and dairies; and
 - Anthropogenic methane from the decomposition of organic matter or composting.

Both methane and N₂O from combustion sources were computed for 2006. However, since methane from agricultural and landscape maintenance activities were not inventoried in 2006, the methane cannot be reported since the CCAR GRP does not allow the reporting of a partial inventory for a given pollutant. Therefore, neither the methane nor the N₂O emissions are being reported for 2006.

3.4 Sources That Can Be Classified as De Minimis Emission Sources

The GRP allows small sources to be classified as *de minimis* and that do not have to be quantified to the same level of detail as other sources. The *de minimis* threshold is defined as an emission equal to 5% of the entity's total emissions for the reporting year. As allowed for by the GRP, bounding calculations can be used to demonstrate that a given source or source type is *de minimis*. For the CSU GHG Inventory, the *de minimis* threshold of 5% of the total GHG emissions equates to CO₂ emissions of 18,754 tonnes.

For the California State University (CSU) System, identifying, quantifying, and reporting all of its Greenhouse Gas (GHG) emissions would be unduly burdensome and not cost-effective. The CSU System conducts hundreds of small activities where the known emissions are a small fraction of larger emissions sources from electricity purchases, fuel and natural gas combustion, and motor vehicles and vessels. These *de minimis* source areas lie within the CSU Colleges and Academic Departments such as: College of Arts and Letters; College of Professional Studies and Fine Arts (Departments of Design Theatre, etc.); College of Engineering (Aerospace Engineering, Mechanical Engineering, etc.); College of Sciences (Biology, Chemistry, etc.); Campus Facilities Planning and Management and Vehicle Maintenance.

For these insignificant sources, rough upper-bounds were estimated to determine the amount of emissions that could be defined as *de minimis*. The sources examined and found to be *de minimis* consist of the following:

- Oxy-acetylene welding;
- Butane combustion (jewelry making, plumbing using, cutting torches, etc);
- Dry ice usage; and
- Specialty gas use.

It is noted that electric arc welding is captured in the electrical usage and that the *de minimis* emission estimation for oxy-acetylene (and arc welding) do not address the potential oxidation of fluxes or other carbonaceous material on the surfaces being welded. This component of welding emissions is small and non-quantifiable at this time.

The fuel combusted in all campus small internal combustion engines such as landscape maintenance equipment, portable generators, small non-road utility vehicles, and outboard motors, is captured in the fuel use summary for each campus. Therefore, these small sources are not separately accounted for to prevent double counting of emissions.

Direct emissions of specialty gases such as methane and CO₂ used directly in campus chemistry and other laboratories was not quantified due to the lack of adequate records. Based on the results for acetylene and butane usage, it is assumed that the use of these other specialty gases on campus will result in emissions well below the *de minimis* emission level.

3.4.1 Selecting a Rough Upper-Bound

Purchase records for acetylene, butane, dry ice, and specialty gases are not available. Therefore, rough upper bound calculations were performed for the first three sources (acetylene, butane, and dry ice). Specialty gas use is highly speculative (both in amount and type of gas) and GHG emissions from the use of small quantities of these gases will be on the same order as that for acetylene or butane. Therefore, emissions bounding computations for specialty gases were not performed.

The methodology for estimating the upper bound limit for a given source type consisted of the following steps:

1. Estimate usage for a large campus which would be expected to have one of the highest rates of usage of the given *de minimis* sources.
2. Compute emissions of GHGs for that usage at one campus.
3. Extrapolate from one campus to 23 campuses by assuming the same rate for all campuses.
4. Compare the estimated value of GHG emissions against the *de minimis* threshold.

The CSU Long Beach campus was chosen to represent an upper-bound emission value from *de minimis* sources. CSU Long Beach is has one of the largest campuses in the CSU system, with over 4.9 million gross square feet of building space. In addition, CSU Long Beach has a large number academic departments, it is assumed that 17 of them could possibly utilize oxy-acetylene welding, butane, and dry ice and 2 non-academic departments (Campus Facilities Planning & Management and Vehicle Maintenance) could utilize oxy-acetylene welding and butane materials.

3.4.2 De Minimis Calculations

3.4.2.1 Acetylene

The following equation was used to calculate the CO₂ emissions for the complete combustion of a standard acetylene cylinder containing 92 standard cubic feet of acetylene:

$$92 \text{ ft}^3 \text{ cylinder} \times \frac{28.32 \text{ L}}{\text{ft}^3} \times \frac{2 \text{ g} - \text{molC}}{\text{g} - \text{molHCCH}} \times \frac{\text{g} - \text{molCO}_2}{\text{g} - \text{molC}} \times \frac{\text{g} - \text{molHCCH}}{23.7 \text{ L}} \times \frac{\text{Kg}}{10^3 \text{ g}} = 9.7 \text{ Kg} - \text{CO}_2$$

The equivalent CO₂ emissions from the oxidation of a single standard acetylene cylinder containing 92 cubic feet are 9.7 kg-CO₂. Using CSU Long as a rough upper-bound, it is assumed a total of 17 of its departments (academic and staff based) would possibly perform oxy-acetylene welding activities. It is then assumed that the maximum number of acetylene cylinders utilized by each of the 17 departments is two standard cylinders each, plus six per year at Campus Facilities Planning & Management and Vehicle Maintenance departments,

resulting in a total of 40 cylinders. This results in a per campus acetylene usage of 0.39 tonnes CO₂ (9.7 kg/cylinder x 40 cylinders / 1000 kg/tonne). If all campuses used the same amount, the system-wide acetylene CO₂ emissions from 23 campuses (total of 920 cylinders) would be 9 tonnes CO₂.

As a check of the bounding calculation, it would take combustion of over 1,000 cylinders to equal 5% (10,000 tonnes) of the CO₂ emissions from indirect electrical purchases alone (approximately 200,000 tonnes), and a much larger number to reach the entity *de minimis* level. Oxy-acetylene welding is clearly a *de minimis* source.

3.4.2.2 Butane

Butane is used in plumbing, as a cutting torch, and in jewelry making. Most butane used for these purposes will be contained in small hand-held cylinders. However, to estimate an upper bound value, the butane is assumed to come in 11.5 kg (25 lb) cylinders. The following equation is the resulting CO₂ emissions for the complete combustion of an of butane.

The GRP Table C.5 emission factor for butane is 6.49 kg CO₂/gallon, assuming an oxidation fraction of 99.5%.

$$11.5 \text{ kg cylinder} \times \frac{1\text{L}}{0.58 \text{ kg}} \times \frac{1\text{gal}}{3.78 \text{ L}} \times \frac{6.49 \text{ kg} - \text{CO}_2}{\text{gal}} = 34.0 \text{ kg} - \text{CO}_2$$

The equivalent CO₂ emissions from the oxidation of an entire 11.5 kg cylinder of butane is 34 kg of CO₂. Since butane used in hand-held torches is used more for artistic and design applications such as jewelry making and using CSULB as a rough upper-bound model, it is assumed a total of 8 of its departments (academic and staff based) plus the two non-academic departments would possibly utilize butane. It is further assumed that the maximum amount of butane tanks utilized by the eight academic departments is 2 per year (16 total) plus an additional 2 each at Campus Facilities Planning & Management and Vehicle Maintenance departments for a total of 20 tanks per year. This results in a per campus acetylene usage of 0.68 tonnes CO₂ (34.0 kg/cylinder x 20 cylinders / 1000 kg/tonne). If all campuses used the same amount, the system-wide acetylene CO₂ emissions from 23 campuses (460 total cylinders) would be 16 tonnes CO₂.

As a check of the bounding calculation, it would take combustion of over 600 large butane cylinders to equal 5% of the CO₂ emissions from indirect electrical purchases alone, and a much larger number to reach the entity *de minimis* level. Butane usage is clearly a *de minimis* source.

The butane specifications above refer to a PRO TORCH PT-200 and are obtained from the following references:

<http://cableorganizer.com/solder-it/pro-torch200.htm>

http://www.sievert.se/us/lp_gas_information.htm

3.4.2.3 Dry Ice

A given quantity of solid CO₂ (dry ice) sublimates completely into CO₂ as a gas. Using CSU Long Beach as a rough upper-bound model, it is assumed a total of 17 of its academic departments could use dry ice for experiments. Dry ice is not used in vehicle or building maintenance and should not be used by the Campus Facilities Planning & Management and Vehicle Maintenance departments. If the assumed maximum amount of dry ice utilized by each of the 17 academic departments at CSU Long Beach is 100 kg per year, the total usage for the model campus is for a total of 1.7 tonnes per year of CO₂ (100 kg/yr x 17 departments). Assuming similar usage on all campuses, the annual system-wide CO₂ emissions from dry ice would be 39 tonnes of CO₂.

As a check of the bounding calculation, each campus would have to consume over 425 tonnes of dry ice per year to equal 5% of the CO2 emissions from indirect electrical purchases alone, and a much larger amount to reach the entity *de minimis* level. Dry ice usage is clearly a *de minimis* source.

. The CSU system-wide *de minimis* sources are presented in **Table 3-8. De Minimis Emissions Summary**.

Table 3-8. Emissions Summary for Sources with Emissions Less than the <i>De Minimis</i> Limit					
Source	Source Quantities	Units	CO₂ Emission Factor	Emission Factor Units	CO₂ (Tonnes)
Acetylene	920	Gas Cylinder (92CF)	9.7	kg-CO ₂ /Cylinder	9
Butane	414	Gas Cylinder (11.5 kg)	34.3	kg-CO ₂ /Cylinder	16
Dry Ice	19,600	kg	1.0	kg-CO ₂ / kg	39
Specialty Gases	¹ NA				
Total					64
De Minimis Threshold (5% of Entity Total Emissions)					21,525
¹ Not Available. Purchase records for specialty gases are not available. Using methodology similar to that for butane and acetylene will produce similar results demonstrating that specialty gas usage produces emissions below the <i>de minimis</i> threshold.					

*

4.0 Results

The 2006 total annual emissions for the CSU System are presented in **Table 4-1. CSU System 2006 CO₂ Emissions**. The total CSU 2006 CO₂ emissions were determined to be 430,495 tonnes. Direct emissions accounted for 47% of the emissions, and indirect emissions accounted for 53%.

Table 4-1. CSU 2006 CO₂ Emissions

CO₂ Emission Sources	CO₂ Emissions (Tonnes)	Percent of Total
Direct Emissions		
Stationary Combustion Sources	184,908	43 %
Mobile Sources	16,913	4 %
Indirect Emissions		
Purchased Power and Steam	288,675	53 %
Total Emissions:	430,495	100 %
Note: Emission values do not sum to total due to rounding.		

APPENDIX A

CSU ACTIVITY DATA SUMMARY

Activity Checklist			
Sources	Activity Amount	Units	Information Source
Direct Sources			
Diesel: Dispensed On-Campus	186,868	Gallons	Fuel Records
Gasoline: Dispensed On-Campus	588,951	Gallons	Fuel Records
CNG: Dispensed On-Campus	3,840	Gasoline Equivalent Gallons	Fuel Records
Propane: Dispensed On-Campus	17,277	Gallons	Fuel Records
Diesel: Voyager	28,310	Gallons	Voyager Card
Gasoline: Voyager	286,650	Gallons	Voyager Card
CNG: Voyager	1,671	Gasoline Equivalent Gallons	Voyager Card
Marine Gas Oil and Related	711,182	Gallons	Fuel Records
Cogen Natural Gas	16,590,247	Therms	Natural Gas Records
Non-Cogen Natural Gas	18,440,248	Therms	Natural Gas Records
Purchased Electrical Power	601,595,292	KWh	Power Records
Purchased COGEN Power	7,487,770	KWh	Power Records
Purchased COGEN Steam	1,123,495	Therms	Power Records

APPENDIX B

CSU MONTHLY ENERGY REPORT SUMMARIES

See PDF Data Files

APPENDIX C

VOYAGER DATA SUMMARY

**See Spreadsheet
VOYAGER 2005-2006 110107.xls**

APPENDIX D

CSU 2006 CARROT REPORT

Total Emissions Summary Report

Report Date: 11/02/2007 01:04 pm PT



California State University System

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Contact: A. Klemm
 Industry Type: Education - University
 NAIC Code: 6113-Colleges, Universities, and Professional Schools
 SIC Code: 8221-Colleges, Universities, and Professional Schools
 Description: CSU is the State University system for California. CSU consists of 23 campuses plus Moss Landing Marine Lab, seven off-campus centers and other miscellaneous off-campus space. The CSU is a leader in high-quality, accessible, student-focused higher education. With 23 campuses, 417,000 students, and 46,000 faculty and staff, we are the largest, the most diverse, and one of the most affordable university systems in the country. We offer unlimited opportunities to help students achieve their goals. We prepare graduates who go on to make a difference in the workforce. We engage in research and creative activities leading to scientific, technical, artistic and social advances. And we play a vital role in the growth and development of California's communities and economy.

Legend

Blue = required

Orange = optional

Primary Calculation
 Methodologies:

CERTIFIED EMISSIONS INFORMATION

Reporting Year: 2006
 Reporting Scope: CA
 Reporting Protocol: General Reporting Protocol, Version 2.2 (March 2007)
 Direct Baseline Year
 Indirect Baseline Year

Direct Emissions	CO2e	CO2	CH4	N2O	HFCs*	PFCs*	SF6	Unit
Mobile Combustion	16,912.74	16,912.74	0.00	0.00	0.00	0.00	0.00	metric ton
Stationary Combustion	184,908.47	184,908.47	0.00	0.00	0.00	0.00	0.00	metric ton
Process Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
Fugitive Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
TOTAL DIRECT	201,821.21	201,821.21	0.00	0.00	0.00	0.00	0.00	metric ton

* HFCs and PFCs are classes of greenhouse gases that include many compounds. These columns may reflect the total emissions of multiple HFC and PFC compounds, each of which has a unique Global Warming Potential (GWP). Emissions of each gas are first multiplied by their respective GWP and then summed in the total CO2-equivalent column.

Indirect Emissions	CO2e	CO2	CH4	N2O	Unit
Purchased Electricity	221,263.19	221,263.19	0.00	0.00	metric ton
Purchased Steam	7,412.90	7,412.90	0.00	0.00	metric ton
Purchased Heating and Cooling	0.00	0.00	0.00	0.00	-
TOTAL INDIRECT	228,676.09	228,676.09	0.00	0.00	metric ton

CERTIFICATION INFORMATION

Certification Company:
 Certifier Name:
 Lead Certifier Name:
 Basis of Certification Opinion:

Total Emissions Summary Report

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California State University System

Certifier Comments:

OPTIONAL INFORMATION

Information in this section is voluntarily provided by the participant for public information, but is not required and thus, not certified under Registry protocols.

Deminimis Emissions	CO2e	CO2	CH4	N2O	HFCs*	PFCs*	SF6	Unit
Butane combustion	16.00	16.00	0.00	0.00	0.00	0.00	0.00	metric ton
Dry Ice usage	39.00	39.00	0.00	0.00	0.00	0.00	0.00	metric ton
Oxy-Acetylene welding	9.00	9.00	0.00	0.00	0.00	0.00	0.00	metric ton
TOTAL DEMINIMIS	64.00	64.00	0.00	0.00	0.00	0.00	0.00	-

Optional Emissions	CO2e	CO2	CH4	N2O	HFCs*	PFCs*	SF6	Unit
Other Indirect Emissions	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-
TOTAL OPTIONAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-

* HFCs and PFCs are classes of greenhouse gases that include many compounds. These columns may reflect the total emissions of multiple HFC and PFC compounds, each of which has a unique Global Warming Potential (GWP). Emissions of each gas are first multiplied by their respective GWP and then summed in the total CO2-equivalent column.

Movement Report

Factor	Details	Amount (CO2e)	Unit
Emissions Efficiency metric:	1.06 tonnes CO2 / full time equivalent (FTE) student		
Emissions Management Programs:			
Emissions Reduction Projects:			
Emissions Reduction Goals:			

Total Emissions Summary Report

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California State University System

Source	Emission Category	Calc Method	Fuel/ Mileage	Emission Factor	Fract. Oxid.	GHG	Amount	Unit	Methodol./ Source	General Info
Butane combustion	Stationary Combustion	Pre-Calc				CO2	16.00	metric ton		
CA Diesel - Dispensed on Campus	Mobile Combustion	CARROT	186868 gallon	9.96 kg/gallon	100	CO2	1,861.21	metric ton		
CA Diesel - Voyager Records	Mobile Combustion	CARROT	28310 gallon	9.96 kg/gallon	100	CO2	281.97	metric ton		
CA Gasoline - Dispensed on Campus	Mobile Combustion	CARROT	588951 gallon	8.55 kg/gallon	100	CO2	5,035.53	metric ton		
CA Gasoline - Voyager Records	Mobile Combustion	CARROT	286650 gallon	8.55 kg/gallon	100	CO2	2,450.86	metric ton		
Campus Total Purchased Electricity	Purchased Electricity	CARROT	601595292 KWh	0.80 lb/KWh		CO2	219,545.79	metric ton	GRP, Ver 2.2, Mar 2007, Table C.1	CARROT uses rounded factor of 0.805. Enter full digits to match non-rounded GRP factor used in emission computation spreadsheet
CNG - Dispensed on Campus	Mobile Combustion	CARROT	3840 gallon	6.86 kg/gallon	100	CO2	26.34	metric ton	GRP 2.2, Table C.3. Natural Gas (CNG) per gasoline gallon equivalent	Could not find CNG in CARROT pull-down menu
CNG - Voyager Records	Mobile Combustion	CARROT	1671 gallon	6.86 kg/gallon	100	CO2	11.46	metric ton	GRP 2.2 Table C.3. Natural Gas (CNG) per gasoline gallon equivalent	Did not find emission factor in CARROT pull-down menu
Cogeneration Natural Gas	Stationary Combustion	CARROT	16590247 therm	5.28 kg/therm	100	CO2	87,571.62	metric ton		
CSUCI purchased electricity from OLS Energy	Purchased Electricity	Pre-Calc				CO2	1,717.40	metric ton	Assume half of electrical purchase coincides with purchase of steam from COGEN. Therefore, only half of the electrical purchase counts against the CO2 emission burden since no supplemental heat is used.	The CSUCI COGEN purchase of electricity plus steam could be a de minimis source.
CSUCI Purchased Steam from OLS Energy Camarillo	Purchased Steam	Pre-Calc				CO2	7,412.90	metric ton	Take Steam purchased (1,404,300 therms), divide by 10 to convert to MMBtu, divide by assumed thermal efficiency of 0.8, multiply by the GRP 2.2 Table C.5 (Natural Gas) emission factor of 52.78, and divide by 1000 to convert to tonnes.	The CSUCI COGEN purchase of electricity plus steam could be a de minimis source.
Dry Ice usage	Stationary Combustion	Pre-Calc				CO2	39.00	metric ton		
Marine Gas Oil - Ocean going vessels	Mobile Combustion	CARROT	711182 gallon	10.05 kg/gallon	100	CO2	7,147.38	metric ton		
Non-Cogeneration Natural Gas Combustion	Stationary Combustion	CARROT	18440248 therm	5.28 kg/therm	100	CO2	97,336.85	metric ton		
Oxy-Acetylene welding	Stationary Combustion	Pre-Calc				CO2	9.00	metric ton		
Propane	Mobile Combustion	CARROT	17277 gallon	5.67 kg/gallon	100	CO2	98.00	metric ton		

Total Emissions Summary Report

Report Date: 11/02/2007 01:04 pm PT



California State University System

REFERENCE DOCUMENTS

Title	Author	Publish Date
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