Los Angeles County
Metropolitan Transportation Authority

SEPTEMBER 2011

Energy Conservation And Management Plan

Metro

Acknowledgement

This document was prepared by ICF International under contract through Metro's Sustainability Program administered by Metro's Environmental Compliance and Services Department. Technical input was provided by staff in the following Metro departments: Transit Project Delivery, Administration/Accounting, Maintenance Operations, Rail Wayside Systems Engineering, Bus/Rail Vehicle Maintenance, and Gateway Facility Operations.

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Acronymns

CAISO	California Independent System Operator
CARB	California Air Resources Board
CBECS	Commercial Building Energy Consumption Survey
CDD	cooling degree days
CH_4	methane
CNG	compressed natural gas
CO_2	carbon dioxide
CO_2e	CO2 equivalent
CPP	Critical Peak Pricing
CRIS	Climate Registry Information System
DWR	Department of Water Resources
ECMP	Energy Conservation and Management Plan
EMAP	Energy Management Action Plan
EMG	Energy Management Group
EMS	Environmental Management System
EPA	U.S. Environmental Protection Agency
FTA	Federal Transit Administration
GHG	greenhouse gas
GIS	Geographic Information System
HDD	heating degree days
HVAC	Heating-Ventilation-Air Conditioning
kWh	kilowatt hours
LADWP	Los Angeles Department of Water and Power
LAMC	Los Angeles Manufacturing Credit
LEED	Leadership in Energy and Environmental Design
Metro	Los Angeles County Metropolitan Transportation Authority
MSIP	Metro’s Sustainability Implementation Plan
MSSC	Metro Support Services Center
N_2O	nitrous oxide

NPV	net-present value
O&M	operations and maintenance
PPA	power purchase agreement
PV	photovoltaic
PWP	Pasadena Water and Power
RECs	renewable energy credits
REP	Renewable Energy Program (Policy)
REST	Renewable Energy Screening Tool
SCAQMD	South Coast Air Quality Management District
SCE	Southern California Edison
SEPTA	Southeastern Pennsylvania Transportation Authority
SSPP	System Safety Program Plan
TOU	time-of-use
USGBC	US Green Building Council’s

Executive Summary

This Energy Conservation and Management Plan (ECMP) is a strategic blueprint intended to proactively guide energy use for the Los Angeles County Metropolitan Transportation Authority (Metro) in a sustainable, cost-effective, and efficient manner. The ECMP complements Metro's Energy and Sustainability Policy*,* focusing on electricity for rail vehicle propulsion, electricity for rail and bus facility purposes, natural gas for rail and bus facility purposes, and the application of renewable energy (e.g., solar and wind). Natural gas for bus propulsion will be addressed in a separate, subsequent effort.

The ECMP addresses current and projected energy needs based on 2010 utility data and existing agency plans to meet increasing ridership through system expansion and new facility construction incorporating Measure R initiatives. The ECMP addresses both the supply and demand aspects of energy consumption at Metro. It provides an analysis of energy use profiles and the various procurement options, in terms of rate structures and supply contracts available to the agency.

The ECMP identifies opportunities to reduce energy consumption and realize cost savings through the implementation of low cost operational initiatives and cost effective capital retrofits. It also evaluates and recommends an optimal organizational structure and approach for the focused and effective implementation of an agency-wide Energy Management Program, largely based upon interviews with peer transit agencies and internal Metro staff.

Finally, the ECMP provides a set of implementation strategies for its successful execution. These strategies are based upon and organized around the "Plan-Do-Check- Act" model that has been successful in the launch of Metro's Environmental Management System (EMS) Program.

A summary of major findings and recommendations of this plan are presented in Appendix A, ECMP Recommendation Summary Matrix, and described below.

Energy Use and Demand

In delivering its services, Metro is a major energy consumer spending $31 million per year for electricity and natural gas. This amount includes electricity used for rail propulsion and facility operation as well as natural gas for facility operation. This amount does not include natural gas for bus propulsion. Electricity accounts for $30 million (97%) of those costs. Of this $30 million annual expenditure, $21 million is for propulsion power for the Metro Red Line and Metro's light rail lines, while $9 million is for operation of bus and rail maintenance facilities, layovers, terminals, and the headquarters building. Metro also expects that as the years progress these costs will rise along with periodic utility rate increases that are anticipated to occur in future years.

Energy intensity data for other major rail and bus systems is not publically available. Therefore, it is difficult to develop an accurate benchmark for Metro, as Metro's data cannot be compared to other organizations with similar functions, building uses, and energy needs. When compared to similar commercial buildings, Metro's electricity intensity appears to be on the higher end of the spectrum using benchmarks from the Commercial Building Energy Consumption Survey (CBECS) database.

The ECMP contains several recommendations, including the immediate implementation of improved and timelier collection of utility data and the sub-metering of buildings and propulsion injection points. The on-going monitoring and tracking of better utility data will assist in the identification and implementation of energy efficiency opportunities allowing Metro to measure its performance trends and compare these trends against industry peers. Sub-metering improvements will enable more accurate and granular data on resource use, particularly energy consumption at the building and rail line substation level, allowing Metro to more effectively control costs through rate optimization and strategic procurement practices.

Forecast

Energy use for rail propulsion is estimated to increase 90% by the year 2020 resulting from extensions to existing lines and construction of new lines to support projected increases in ridership. Over the same period of time, energy use in facilities is expected to increase by 10%, which reflects new construction plans, new technology, and weather impacts. This increase would be higher except that it will be offset by energy efficiencies achieved through new “green” construction policies.

Energy Supply and Rates

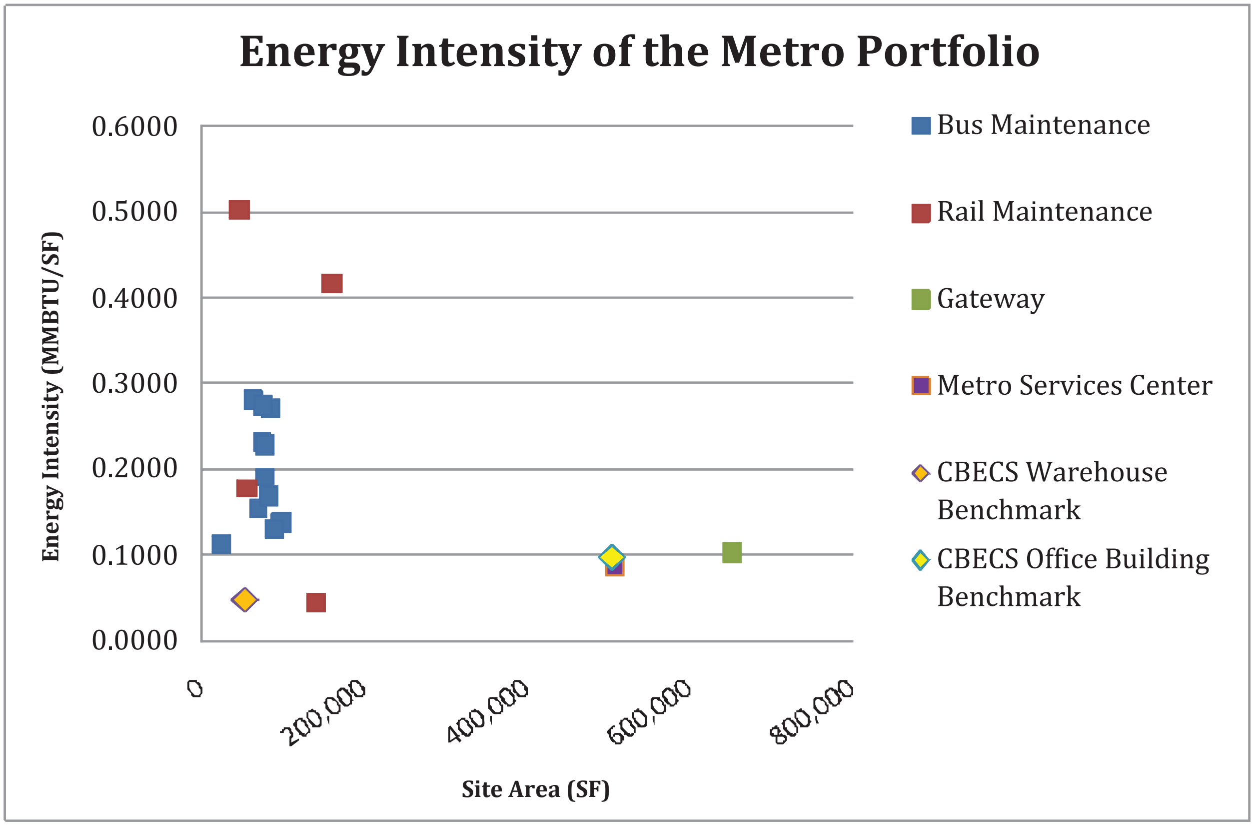
Energy supply arrangements and utility rates are highly complex on both the Los Angeles Department of Water and Power (LADWP) and Southern California Edison (SCE) utility systems, with many types of charges on the numerous monthly bills that Metro receives. These include a multitude of basic and “time-of-use” rates for electricity where there are charges for on-peak and off-peak demand and energy consumption. These rates also vary seasonally with separate summer and winter pricing structures. A dedicated resource is required to understand these rate structures and ensure that Metro is paying the lowest rates possible on each of its accounts. Also, better understanding the rate structures will assist Metro in accurately forecasting future electricity costs and the effect of energy efficiency and renewable energy investments.

In addition to regulated utility rates, there are limited direct access opportunities for competitive electricity procurement rates from SCE; there may or may not be similar opportunities in the future from LADWP. It is recommended that Metro not pursue any new electricity hedging and price risk management initiatives at this time, except those arising from renewable energy investments. If Metro wishes to stabilize its facility natural gas budget, it could easily add the relatively modest volume of facility natural gas to the existing compressed natural gas (CNG) financial hedging program in place for Metro’s bus fleet.

Energy Efficiency Opportunities

To date, Metro has made progress towards becoming a more energy-efficient organization, but there is still more we can do. This ECMP is intended to review and expand upon past work, and also provide a window into what remains to be done to improve our energy efficiency, and why.

More and more organizations are turning to a portfolio approach to energy efficiency, which focuses not on making one or two buildings highly efficient by investing large amounts of time and money into those few facilities, but rather looking at the whole portfolio of buildings and practices in order to find the best performing buildings, and replicate those practices across the portfolio. This approach combines a desktop review to compare building performance with a site-level investigation to determine what technologies and practices are in place at some of the stand-out sites found in the desktop review. Metro’s building portfolio scatter plot is below. Note that only buildings that provided both square footage and energy consumption data were available for inclusion in the scatter plot.



As is evident in this graph, facilities with similar purposes, such as rail and bus maintenance facilities, may be 10- or 100-fold different in terms of energy consumed per square foot. While this is surprising, this finding is not atypical of facility portfolios. Similarly, a building such as Gateway, which has had a substantial amount of investment in energy efficient technologies, is still not as efficient as similar buildings in the Los Angeles area, represented by the “CBECS Office Building Benchmark” above. The likely explanation for both of these disparities is a difference in building energy management, which tends to have a larger impact on the efficiency of a building than buying and implementing the latest energy saving technologies.

Hence, based on the scatter plot above, as well as visits and calls with facility managers and maintenance staff, our primary recommendation is to empower, systematize, and incentivize an energy management structure within Metro starting with the Energy Program Administrator. Specifically, with respect to energy efficiency, the Energy Program Administrator would be responsible for:

- Coordinating the dissemination of monthly utility data to the facility managers themselves, who do not have access to such information and thus cannot tell if they are making progress towards reducing energy expense and usage.
- Developing and implementing training and incentives so that facility managers will have the tools that they and their staff need to meet Metro’s energy management challenges.

With such an energy management structure in place, in concert with existing programs such as the $2 million fund for cost-effective sustainability measures, as well as seeking Leadership in Energy and Environmental Design (LEED) silver certification for all existing and new buildings, Metro can realize its energy efficiency goals across its building portfolio in a cost-effective and comprehensive manner, avoiding ad-hoc approaches that tend not to provide substantial cost savings.

Energy Management Structures

After analyzing several options, the ECMP recommends that Metro establish a focused, centralized organizational unit, dedicated to Energy Management. This approach would enhance Metro's ability to develop and implement an effective, cohesive, and dynamic Energy Management Program. To accomplish this, the ECMP recommends establishing an Energy Management Group (EMG) temporarily housed in the Transit Project Delivery Department, specifically contained within the Environmental Compliance and Services Unit; this organizational placement would be revisited within 5 years in light of any Metro organizational changes. The EMG would be led by an Energy Program Administrator. Initially, this role would be accomplished by the Environmental Compliance and Services Manager.

The primary advantage of placing the EMG in this department is the strong synergy that can be achieved through the integration of the Energy Management Program with the Environmental Management System, of which Energy Management is a key component.

In addition to implementing the optimal Energy Management structure, there are several critical factors that would greatly increase the likelihood of a successful program. It is imperative that the development of Metro's Energy Management Program focus on the following.

- A solid policy basis from the CEO and Board of Directors.
- A sustained organizational commitment.
- Realistic and affordable up-front and on-going program costs (with a multi-year budget commitment).
- A strong energy conservation/sustainability culture.
- Communicating a clear connection between Energy Management and Metro's agency core mission.
- Developing buy-in from all levels of the organization.
- CEO appointment of a Champion/Advocate at the executive level.
- Appointment of a technically and managerially experienced Energy Program Administrator, empowered to reach out across (and get response from) the entire agency.
- A collaborative program culture, with clear accountability established.
- Clearly defined roles, responsibilities, and expectations.
- Understandable and transparent systems.
- Development and implementation of an "Early Action Plan" with which to achieve early Energy Management successes to build upon and establish momentum.
- Creation of an atmosphere of innovation to inspire, capture, evaluate, and (as appropriate) implement ideas generated by all employees at all levels—managers, supervisors, and first line employees.

The ultimate success factor would be the EMG's strong collaboration and extensive communication with staff representing Bus and Rail Operations and Maintenance, Facilities Maintenance, Construction, Accounting , and other key departments in the planning, launch, and on-going execution of Metro's Energy Management Program.

ECMP Implementation Strategies

The ECMP implementation strategies are based upon and organized around the “Plan-Do-Check-Act” model. This model has been successfully implemented as part of Metro’s EMS Program. The recommended strategies are summarized below.

PLAN — Set Up the Energy Management Program and Action Plan

This step would start with the formation and launching of an Ad Hoc Energy Executive Team with the following mandate:

- Develop an Energy Management Program Charter
- Appoint an Interim Energy Program Administrator
- Identify an On-Going, Advisory Core Energy Management Team

Upon completion and approval of the initial assignments, the next step would be for the Energy Program Administrator to lead development of an Energy Management Action Plan (EMAP) in collaboration with an on-going Core Energy Management Team (a subset of the Ad Hoc Energy Executive Team). The EMAP would include:

- Immediate Fast Track Initiatives
- Short-Term Initiatives
- Long-Term Initiatives
- Resource Needs
- Financial Plan and Budget
- Initial Performance Metrics and Targets
- Approval Processes

DO — Implement the Energy Management Action Plan (EMAP)

Upon completion and approval of the EMAP, the Energy Program Administrator and Energy Management Team would be empowered to implement the EMAP. This would be accomplished following a process that would include:

- Project Development
- Pilot Project Initiation
- Performance Optimization and Verification
- Full Project Roll-Out
- Evaluation of Project Performance

CHECK — Conduct Annual Reviews

The annual review is a formal assessment of EMAP activities implemented during the evaluation period. It is intended to measure the effectiveness of the projects and programs that have been implemented. These results are compared against approved performance targets.

ACT — Adjust or Modify Program and Plan as Required

The results of the annual review should be used to update, adjust, or modify the EMAP and implementation processes; identify best practices; set new performance goals; and refine previously approved performance targets and benchmarks, as may be appropriate. The EMAP and its implementing programs should be sufficiently flexible to enable the use of Metro's on-going experience and lessons learned, while retaining the ability to adapt to the ever-changing operating environment. The documented results can be also used to inform stakeholders of the progress of the program and facilitate support of future initiatives.

The proposed timeline for implementing the initial phases of this ECMP is presented below:

Action	First 30 Days	30 to 60 Days	90-Days to 6 Months	6 to 12 Months	12 to 24 Months	24 Months and Longer
Form and Launch Ad Hoc Executive Energy Team	X					
Develop Charter		X				
Hire Energy Program Administrator		X				
Launch Core Energy Team		X				
Develop Energy Management Action Plan			X			
Implement Fast Track Projects				X		
Implement Short-Term Projects					X	
Implement Long-Term Projects						X
Conduct First Annual Program Evaluation					X	

Renewable Energy Program (REP) Development and Implementation

Metro is already a leader within the transit community in its renewable investments, having completed four large solar PV projects with a total installed capacity of about 2,000 DC kW that generate about 2,700,000 AC kWh annually (representing over $300,000 of displaced utility power each year). Metro is considering substantial growth to its existing renewable energy portfolio to increase its percentage of clean energy and to seek cost savings from these and other projects. A systematic, consistent approach would aid Metro in making strong decisions on which technologies to select, how large projects should be, where they should be located, and on other attributes.

Based on a February 17, 2011 Metro Operations Committee motion, Metro staff have been engaged in the development of a Renewable Energy Policy. The motion called for the consideration of a number of elements, including assessment of available technologies, lifecycle cost consideration, financing mechanisms, regulatory and industry guidelines, utility partnership opportunities, identification of pilot projects, and a plan of action.

This ECMP provides a generalized implementation blueprint (see Section 6) that Metro could follow to develop and ramp up a Renewable Energy Program (REP). This blueprint follows the same Plan-Do-Check-Act model identified in the ECMP, and includes a process to identify, evaluate, screen, and select renewable energy projects for potential inclusion in Metro's Capital Program and Budget and implementation. The REP could either be launched in conjunction with the ECMP implementation outlined in the previous section or as a standalone program. Either way, the REP is a critical step in shaping Metro's energy future.

In conclusion, Metro's ECMP provides the agency with a proactive, comprehensive, and dynamic blueprint with which to manage its current and future energy use in a sustainable, cost-effective, and efficient manner.

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1. Introduction

The vision of the Los Angeles County Metropolitan Transportation Authority (Metro) is “safe, clean, reliable, on-time, courteous service dedicated to providing Los Angeles County with a world class transportation system.” Metro’s mission is responsibility “for the continuous improvement of an efficient and effective transportation system for Los Angeles County.” In accomplishing its mission and striving toward its vision, Metro holds a set of values that guides its policies, services, programs, and projects. These are:

Safety: Metro commits to ensure that our employees’, passengers’, and the general public’s safety is always its first consideration.

Service Excellence: Metro commits to provide safe, clean, reliable, on-time, courteous service for our clients and customers.

Workforce Development: Metro commits to making this a learning organization that attracts, develops, motivates, and retains a world class workforce.

Fiscal Responsibility: Metro commits to manage every taxpayer and customer-generated dollar as if it were coming from our own pocket.

Innovation and Technology: Metro commits to actively participate in identifying best practices for continuous improvement.

Sustainability: Metro commits to reduce, re-use, and recycle all internal resources and reduce green house gas emissions. We also commit to focus on the continuous integration of decisions, infrastructure, and services that optimize the transportation system to maximize efficiency, access, safety, and performance while minimizing energy use and consumption; air, water, and noise pollution; and the generation of waste.

Integrity: Metro commits to rely on the professional ethics and honesty of every employee.

Teamwork: Metro commits to actively blend its individual talents to achieve world-class performance and service.

Metro’s core business goals are:

- Goal 1: Improve transit services
- Goal 2: Deliver quality capital projects on time and within budget
- Goal 3: Exercise fiscal responsibility
- Goal 4: Provide leadership for the region’s mobility agenda
- Goal 5: Develop an effective and efficient workforce
- Goal 6: Secure local, state and federal funding
- Goal 7: Maintain open lines of communication
- Goal 8: Enhance a safety-conscious culture with employees contractors and customers
- Goal 9: Sustain the environment with energy efficiency and reduce greenhouse gas emissions

(Source: Metro Web Site, last revised November 12, 2010; personal communication with Metro Staff)

1.1. Metro's Commitment to Sustainability and Energy Efficiency

Sustainability and energy efficiency is a central Metro focus and commitment, cutting across virtually all aspects of the agency's mission, vision, values, and core business goals. In June 2007, the Board of Directors adopted the Metro Energy and Sustainability Policy "to control energy consumption and embrace energy efficiency, energy conservation, and sustainability." This policy has been implemented in direct response to Metro's Core Business Goal 9: "Sustain the environment with energy efficiency and reduce greenhouse gas emissions," though the policy supports other Metro goals as well.

This policy has been implemented to:

- Avoid unnecessary expenditure.
- Help protect the environment.
- Improve cost-effectiveness, productivity, and working conditions.
- Prolong the useful life of fossil fuels by using resources more efficiently.

Metro's immediate stated energy efficiency objectives are to:

- Gain more control over energy consumption by aggressively pursuing renewable energy sources and implementing energy conservation measures where they are feasible and fiscally prudent.
- Construct new facilities and projects to achieve Leadership in Energy and Environmental Design (LEED), Silver certification, at minimum.

In the long-term, Metro's energy efficiency objectives are to:

- Reduce, whenever possible, Metro's use of fossil fuels through the use of ambient and renewable energy sources.
- Buy fuels and electricity at the most economic cost.
- Use fuels and electricity as efficiently as possible.
- Reduce the amount of emissions, especially carbon dioxide (C02), caused by required consumption.

The 2010 LACMTA Sustainability report shows progress towards achieving these energy efficiency goals through programs implemented in 2008 and 2009. The efficiency of the rail line when measured in kilowatt hours (KWH) per rail boarding improved 12% between 2005 and 2009. Metro facilities used 8% less electricity than in 2008 largely due to the installation of a 1 MW solar panel and other energy retrofits at the Metro Support Services Center. However this reduction in usage was offset by a substantial increase in electricity rates. Although overall electricity costs increased by 8%, this figure could have been significantly higher if the efficiency initiatives had not been implemented. In terms of new construction all new facilities are being designed to meet LEED Silver certification. Metro is also pursuing LEED EBOM for several of its existing facilities.

1.2. Background for this Energy Conservation Management Plan (ECMP)

This Energy Conservation and Management Plan (ECMP) complements Metro's Energy and Sustainability Policy, focusing on electricity, building facility natural gas[1], and renewable energy use throughout the current Metro system and supporting facilities relating to both the rail and bus systems, as

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[1] Natural gas for (bus) propulsion will be addressed in a separate future report or addendum, but is excluded from this report.

well as incorporating Measure R growth. The purpose of this ECMP is to provide a focused assessment of the Metro's energy demand and supply in order to develop short-term and long-term approaches to efficient management of energy use and costs.

The ECMP provides Metro with concrete information upon which to guide and oversee critical energy activities such as forecasting future system energy demand, identifying high-potential reductions in energy use, economizing on utility rates, selecting appropriate renewable energy investments, and coordinating the overall agency energy function. At its conclusion, this ECMP provides an implementation blueprint with which to develop an organizational focus on these and other key activities that build upon initiatives already completed and/or underway at Metro, and a path and schedule for charting Metro's path forward.

Metro spends approximately $31 million per year on utility costs for electricity and natural gas related to train propulsion and operation of facilities. This plan does not include transportation fuels for buses (chiefly natural gas) because the major focus is upon electricity, as recommended by the Inspector General (IG) Report. Fleet (transportation fuel) energy management issues are qualitatively different than electricity and are not easily integrated into a plan whose emphasis is electricity.

Electricity accounts for 97% of energy costs, at $30 million. Of this $30 million annual expenditure, $21 million is for propulsion power for the Metro Redline and other light rail lines, while $9 million is for operation of bus and rail maintenance facilities, layovers, terminals, and the headquarters building. As the years progress, Metro also expects that these costs will rise along with periodic utility rate increases that are anticipated to occur in future years. Staff believes that in this volatile and costly energy market, embracing sustainability, energy efficiency, conservation, and renewable energy sources is a primary pathway towards gaining control of, and reducing Metro's energy costs.

1.3. ECMP Document Organization

The ECMP is organized around four key areas:

- Energy Use and Demand (Section 2.0).
- Energy Supply and Rates (Section 3.0).
- Energy Management Structure (Section 4.0).
- Implementation Strategy (Section 5.0).

Within Energy Use and Demand (Section 2.0), the ECMP provides year-by-year forecasts of propulsion, facility, and total electricity use and facility natural gas consumption over the next 10 years. This section also characterizes baseline data on Metro's utility accounts and on Measure R growth and provides an assessment and investment process to guide energy efficiency and conservation efforts at the agency.

For Energy Supply and Rates (Section 3.0), the ECMP evaluates Metro's opportunities for electricity and natural gas utility rate and fee reductions while maintaining the same level of service reliability. This evaluation includes a review of electric rate structures at peer transit agencies and guidance on incorporating a regular process of propulsion and facility rate review into Metro's energy operations. In addition, there is an analysis of the pros and cons of energy hedging alternatives that may be available to Metro and a renewable energy project screening process that incorporates renewable technologies, including solar.

Regarding Energy Management Structures, Section 4.0 evaluates the pros and cons of various organizational alternatives and offers recommendations on how Metro can best accomplish its energy management goals and critical functionality such as consistent energy usage and rate monitoring, regular pursuit of energy use and rate reduction opportunities, effective coordination of utility billing and related matters, and the effective selection and deployment of energy projects. The Energy Management Structure recommendations draw upon interviews with key internal Metro staff and discussions with representatives from peer transit agencies involved in energy management. The recommendations also draw from successes and progress that Metro has already made in Energy Management and analogous programs such as the Environmental Management System (EMS) and the Corporate Safety areas.

Finally, the ECMP Implementation Strategies (Section 5.0) provide a road map with which Metro can proactively advance the development of its Energy Management Program, including detailed action planning and implementation—following the EMS Continuous Improvement Model of “Plan-Do-Check-Act.” This section organizes recommendations contained in other ECMP sections into a coordinated, phased approach for advancing the Energy Management Program at Metro. Although not analyzed in this ECMP, an examination of transportation propulsion fuels used by Metro’s fleet of buses and other support vehicles is identified as a recommended “Fast Track” follow-up item for consideration.

Taken together, the ECMP provides a base of information and actionable strategic guidance for better managing Metro’s significant energy draw, and the resulting emissions, in the daily fulfillment of our core purpose—delivering public transportation services to the public, now and into the future.

2. Energy Uses and Demand

2.1. Data Characterization and Methodology

Metro uses energy for two major applications – Propulsion and Facilities. Propulsion energy is used to propel trains along the tracks; facilities energy is used for offices, terminals, maintenance yards, and stations. The scope of this analysis does not include other non-electric transportation fuels, such as compressed natural gas (CNG). This section describes overall energy use while subsequent sections discuss these two applications in more detail.

The first step to understanding propulsion and facilities energy use is the preparation of a Utility Map, in the form of a table mapping utility accounts to specific facilities/assets. Metro's Utility Map is presented in Appendix B. The Utility Map was created using account information provided by LADWP, SCE, and The Gas Company, with a facility list provided by Metro. Electricity provided by Pasadena Water and Power (PWP) was not included in this analysis because it represents a negligibly small portion of overall electricity consumption. There were some difficulties in matching facilities to accounts because service addresses on utility bills did not always match addresses in the facility list. Additional information was requested and received from the utilities in an attempt to complete this mapping. Additional facility data such as square footage, building type, and occupancy also was collected and entered into the map.

Monthly energy cost and consumption data for each account was collected from the utilities for calendar years 2009 and 2010. Missing data was identified and requested from the utilities. For the purposes of this plan approximately 96% of the data was collected. It is possible that some of this data relates to outdated account numbers or closed accounts. This requires further investigation to resolve.

There are five accounts that were never matched to any type of facility. The service addresses appearing on the invoices do not place them anywhere near any of the facility addresses. Using Google Maps, it did not appear that these service addresses were close to any bus or train facilities. This is another area requiring further investigation because it is possible that these accounts do not belong to Metro, and hence we should not be paying for them.

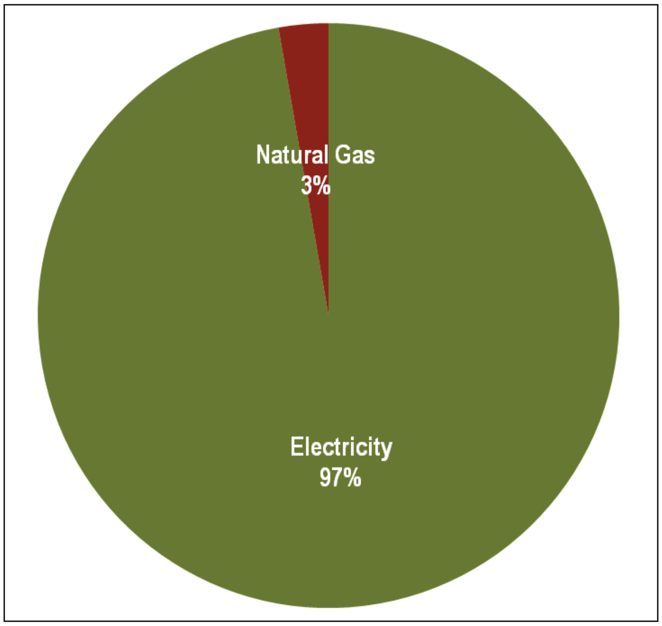
There are also several accounts listed as "Miscellaneous Gold Line" or "Miscellaneous Blue Line," etc. These accounts did not match up exactly to facility addresses, but, based on Google Maps, were near or along train or bus lines. For some of these accounts, data was received from Metro or from LADWP designating the line on which they are located, but the meters were not close enough to a station to be considered as part of that station. It is assumed that some of these may be power substations used for propulsion along train lines, but this should be verified.

Table 2-1 and Figures 2-1 and 2-2 provide an overview of Metro's energy consumption and cost data.

Table 2-1: Baseline Period Statistics

	Total Number of Locations	156
Electricity	Number of Locations	154
	Number of Meters	235
	Consumption (kWh)	242,092,915
	Consumption (MMBtu)	826,056
	Expenditure	$30,144,002
	Average Cost ($/kWh)	$0.12
	Average Cost ($/MMBtu)	$36.49
Natural Gas	Number of Locations	27
	Number of Meters	34
	Consumption (therms)	1,179,878
	Consumption (MMBtu)	117,964
	Expenditure	$857,265
	Average Cost ($/therm)	$0.73
	Average Cost ($/MMBtu)	$7.27
Total Energy Consumption (MMBtu)		944,020

Figure 2-1: Annual Metro Energy Expenditure[2]



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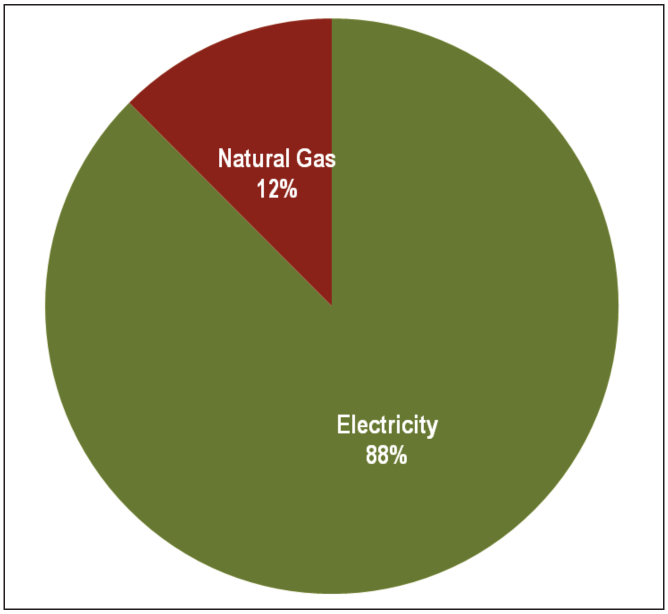
[2] For Facilities and train propulsion, measured in U.S. dollars.

Figure 2-2: Annual Metro Energy Consumption[3]



2.1.1. Propulsion Electricity

Introduction

This section presents an account of all energy usage for propulsion/traction accounts, in order to determine the baseline 2010 energy usage for the Metro traction systems. This baseline usage data will provide the basis for projection of usage and demand levels for the Metro Rail extension projects through the year of 2020.

Metro operates five Metro Rail lines in Los Angeles County, California: the Metro Red Line, the Metro Purple Line, the Metro Blue Line, the Metro Green Line, and the Metro Gold Line.

The Metro Red Line is a heavy rail subway line that connects Downtown Los Angeles to North Hollywood, passing through several neighborhoods in Hollywood and Mid-Wilshire. The Metro Purple Line is a heavy rail subway line running between Downtown Los Angeles and Koreatown/Mid-Wilshire. The Red and Purple Lines were opened in 1993 and currently have a combined daily ridership of 154,450. Train ridership or boarding units were not used within this exercise as it was anticipated that there would be little or no change to base year or projected usage. The Red Line has 16.4 miles of track and shares 6.4 miles of its track with the Purple Line.

The Metro Blue Line is a light rail line running between the Downtown Los Angeles Financial District and Downtown Long Beach. In between, the line serves several neighborhoods and cities in the county's south-central region, including Huntington Park, South Gate, Willowbrook, and Compton. The Blue Line, which opened in 1990, extends 22 miles and has a daily ridership of 82,840.

The Metro Green Line is a fully elevated light rail line running between Redondo Beach and Norwalk. In between, the line serves several neighborhoods and cities, including El Segundo, Hawthorne, and Lakewood. The Green Line opened in 1995. It has a current daily ridership of 40,344 and has 20 miles of track.

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[3] For facilities and train propulsion, relative value, measured in MMBtu.

The Metro Gold Line is a light rail line that runs between East Los Angeles and Pasadena, passing through Boyle Heights, Little Tokyo, Downtown Los Angeles, Highland Park, and South Pasadena. The Gold Line opened in 2003. It extends 19.7 miles and has a daily ridership of 34,285.

Methodology

Metro service characteristics were compared with those of other rail transit agency operations. Typically, this comparison would include a very detailed level of operating information (train consist, service frequencies, line losses, etc.), matching this data with a utility's usage and demand-level information. This method ensures that every factor associated with traction operations' electricity usage is in synch between the operations and the utility companies. There are a number of reasons for starting with this level of detail.

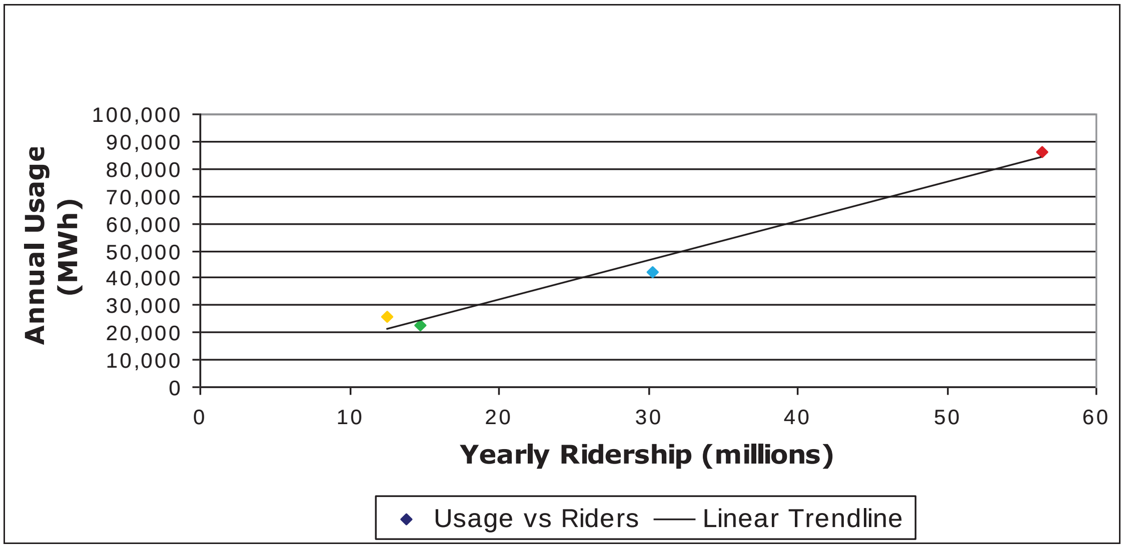
- Capturing data for different subsystems to assist in the management of traction operations.
- Providing guidance to mechanical operations on equipment standards and deviations reflecting maintenance or age differentials.
- Determining an energy strategy in conjunction with the organization's operations strategy.
- Gathering data that reflects options for hedging traction electricity supply. Examples of these criteria are: injection point usage and demand, equipment (types, uses, and base load information), traction infrastructure, consist (the nomenclature of each train's makeup) and frequency (number of trains) information, weekday vs. weekend service periods, conversion and distribution losses, and standby operations.

Unfortunately, during the data collection activities, much of the operations information was not available for this exercise. This is primarily due to a lack of submetering for non-propulsion activities and an interpretation and accumulation of system losses.

As a secondary approach, this model was based on utility company usage information in conjunction with available ridership information.

As shown in Table 2-2, a strong statistical correlation was found between annual usage and annual ridership, making this a suitable methodology for projecting future electricity usage.

Table 2-2: Electricity Usage vs. Ridership for Existing Lines



The correlation between annual usage and annual ridership was analyzed by plotting the data from the Blue, Green, Red, and Gold Lines (ridership data for the Purple Line was provided in combination with the Red Line, so the two were treated as one line; see discussion in "Results," below). A linear regression line was calculated for the plotted points, and a statistical analysis of the data showed a very strong correlation ($R^2 = 0.9808$) between annual usage and ridership. This correlation was used as the basis to project the annual usage of new lines and extensions where estimated ridership information was provided.

Propulsion accounts were identified based on rate class, total annual usage, service voltage, demand, and location. Measured propulsion accounts fit the following criteria.

- Rate Class
    - Class "A3A" for LADWP
    - Class "AL" or "AM" for PWP
    - Class "TOU" for SCE
- Annual Usage of over 500,000 kWh
- Service voltage of 12,000 kV
- Demand of over 100 kW
- Located adjacent to the Metro Rail system

The listing of propulsion accounts for the traction systems was compiled using tariff information and energy usage data from LADWP, SCE, and Pasadena Water & Power.[4] Excluded from consideration were auxiliary service lines into the traction substations or any possible submetering activities at the traction substations because there was no indication that these should be considered or specifically what these accounts or activities supported. Consideration was also given to the relatively small usage of these accounts, and it was determined that there is very little or no effect on the total baseline or projected usage. However, because of the value of these accounts to operations, it is suggested that these types of situations be scrutinized as a subject of further study. This consideration of traction-operations versus non-traction operations is addressed in Recommendation 2.1.1-4

As part of this analysis, a loss factor within the traction of approximately 2.25% (4M kWh in 2010 data) was included. This is clearly demonstrated within Table 2-2, where even with no ridership, the system would exhibit continued electricity usage. This percentage was compared to Amtrak's catenary traction system (different type of infrastructure and 1930s vintage) which has a loss factor of 9%. This percentage level was also discussed with traction system engineers and through those discussions. This is considered a reasonable estimate of the loss factors involved with the configuration of the Metro traction/propulsion system.

Results

Usage data was sorted by Metro Line and summed to establish a total usage baseline for each Metro Line for 2010. Daily ridership data for each of the lines was multiplied by 365 to convert levels to an annual ridership value. Since the analysis was performed based on the current annual electricity consumption, which would include all days regardless of weekday versus weekend, there would be no effect on the totals by breaking out ridership differently. Ridership data reported via the Metro website was used to estimate future usage. Ridership data for the Purple Line was provided in combination with

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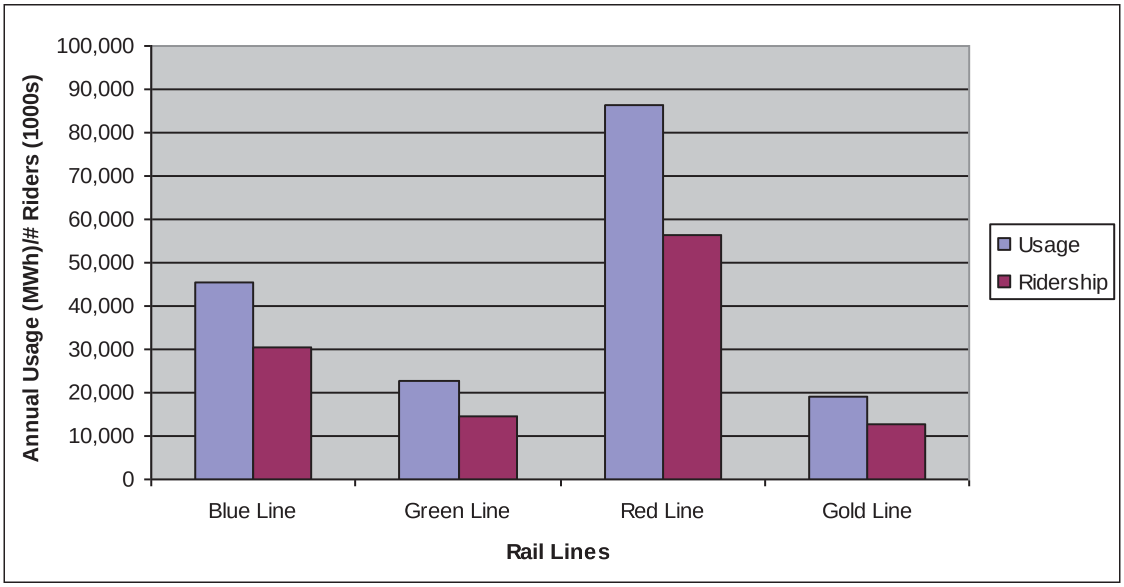
[4] These utility companies are all members of the California Independent System Operator (CA ISO)

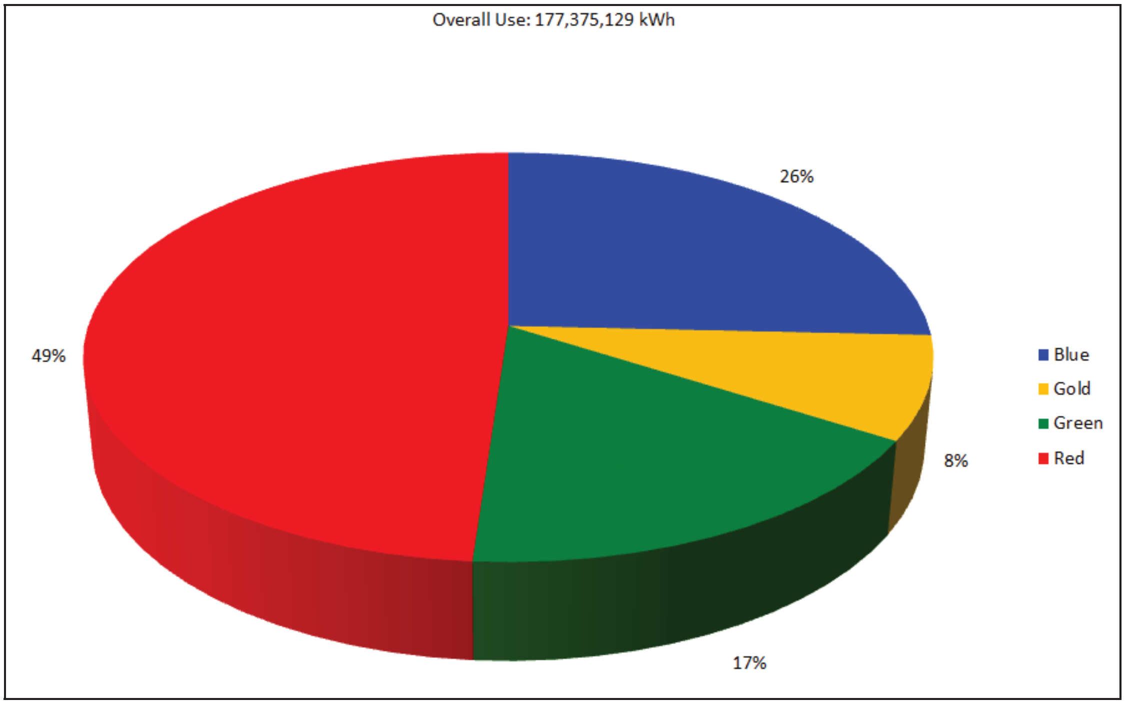
the Red Line, so the two were treated as one line in the calculations. This assumption was considered acceptable because the Purple Line shares six of its eight stops with the Red line. The relationship between annual electricity consumption and annual ridership is illustrated in Figure 2-3.

Figure 2-3: Annual Electricity Consumption (Usage) vs. Ridership



After compiling all of the data from the utility companies for each line, total electricity consumption was compiled. The following chart represents each line's current contribution to overall consumption, which totaled 177,375,129 kWh in 2010 (as shown in Figure 2-4).

Figure 2-4. 2010 Electricity Consumption by Line Use



Recommendations

In addition to compiling the data, segregating into lines, and providing the background information, the data was compared to that gathered for similar peer agencies to provide guidance on recommendations for consideration of an ongoing strategy for operations support. For example, Southeastern Pennsylvania Transportation Authority (SEPTA) and Amtrak exhibit similar usage patterns to those observed within the data, and similar lessons can be learned. Based on the final traction electricity usage projections for the system through 2020 (Section 2.2.1), the total amount of usage will be somewhat comparable. These traction system agencies learned through trial and error the need to integrate energy usage patterns with operating data, including ridership, to manage their traction systems. We are suggesting that similar tactics be incorporated.

Specific recommendations include the following:

Recommendation 2.1.1-1

Develop a policy of integrating operating staff into the energy strategy/management exercise. The creation of an energy management strategy committee may be crucial in establishing this integration, and in setting short- and long-term goals for strategic energy management. It is suggested that members of this committee should come from these business groups—finance, operations, strategic development, traction engineering, and energy management. (See Section 4, “Energy Management Structure.”)

Recommendation 2.1.1-2

Follow through and continue gathering and accumulating monthly utility information. Develop metrics for each portion of critical data and track the positions achieved. Specifically, Metro should gather and monitor usage, demand, distribution, and interval data and should merge operating statistics into a dynamic reporting environment. This operating data may include schedules and strategic scheduling, line losses for traction operations, and “what if” scenarios on future operations.

Recommendation 2.1.1-3

Develop and monitor all policies for the operation of trains. Be aware of notching (acceleration/deceleration) policies set up for each train. Know the limitations and attempt to develop the relationship between these two data points.

Recommendation 2.1.1-4

Determine the existence of submetering at the traction substations. If none exist, consider the establishment of a program to add these meters on any lines supporting non-traction activities. These meters should capture energy usage for these activities and be used to show the comparison of non-traction vs. traction usage. These levels should be monitored by the committee or the appropriate operations department. (See Section 4, “Energy Management Structure.”)

Recommendation 2.1.1-5

Develop a strategy and policy for standby operations. Currently, all trains are maintained, turned around, or are waiting for the next operational run within a maintenance facility, while maintaining contact with the traction power source. Although the tariff evaluation has shown that currently there is an economic advantage to having this policy, it may be beneficial to re-evaluate the circumstances after a complete tariff review has been completed.

Recommendation 2.1.1-6

Develop an integrated in-house monitoring system to accumulate all of the operational data along with energy usage information to better understand the correlation of these factors.

Recommendation 2.1.1-7

Consistently monitor all data (operational procedures and energy usage), question deviations, and create a dynamic approach to the reporting of energy characteristics.

2.1.2. Facility Electricity and Natural Gas

Electricity and natural gas consumption, demand, and cost data were collected for over 150 facilities across the Metro portfolio. Many facilities often contained multiple electricity and natural gas meters. The majority of information received and compiled also included monthly data for most meters. The notable exception was 86 accounts served by Southern California Edison (SCE), who was unable to provide the data despite repeated requests of the utility. When approximately 365 days of data were not available due to billing periods of irregular lengths, the data for a particular meter was normalized to the appropriate time period.

Within the facility electricity database, two types of accounts are identified. Many accounts pertain to a specific building, which is seen as the default classification. However, other accounts serve unknown purposes or are considered ancillary to rail operations. Such ancillary accounts were so classified if they were listed on internal Metro lists or external LADWP reports as rail accounts yet did not show the operating characteristics of a propulsion system as outlined previously. An extensive analytical and onsite assessment of the particular function that every electricity meter serves would be required for a comprehensive and finely detailed understanding of electricity consumption uses. This sophisticated survey would be aided with the use of a Geographic Information System (GIS) to identify exactly where each meter is located and what it serves. A GIS would also help clarify any remaining address discrepancies within the utility map by using more extensive and sophisticated mapping.

A database of collected energy consumption metrics is included with this report as Appendix B. Table 2-3 below summarizes the compiled data for the established baseline period of calendar year 2010.

Table 2-3: Facility Baseline Energy Statistics

	Baseline Period Statistics	
Electricity	Total Number of Facilities	112
	Number of Accounts	112
	Number of Meters	164
	Consumption (kWh)	74,783,188
	Consumption (MMBtu)	255,171
	Expenditure	$8,970,474
	Average Cost ($/kWh)	$0.12
	Average Cost ($/MMbtu)	$35.15
Natural Gas	Number of Accounts	27
	Number of Meters	34
	Consumption (therms)	1,179,878
	Consumption (MMBtu)	117,964
	Expenditure	$857,265
	Average Cost ($/therm)	$0.73
	Average Cost ($/MMBtu)	$7.27
Total Energy Consumption (MMBtu)		**373,135**

Figure 2-5 below illustrates the proportion of overall facility energy consumption for electricity and natural gas. Figure 2-6 illustrates the proportion of overall facility energy expenditures for electricity and natural gas. It is worth noting that natural gas expenditures are a significantly smaller share of overall expenditures than natural gas consumption. This is because the cost per unit of natural gas is just 25% of the cost per unit of electricity.

Figure 2-5: Facility Energy Consumption[5]

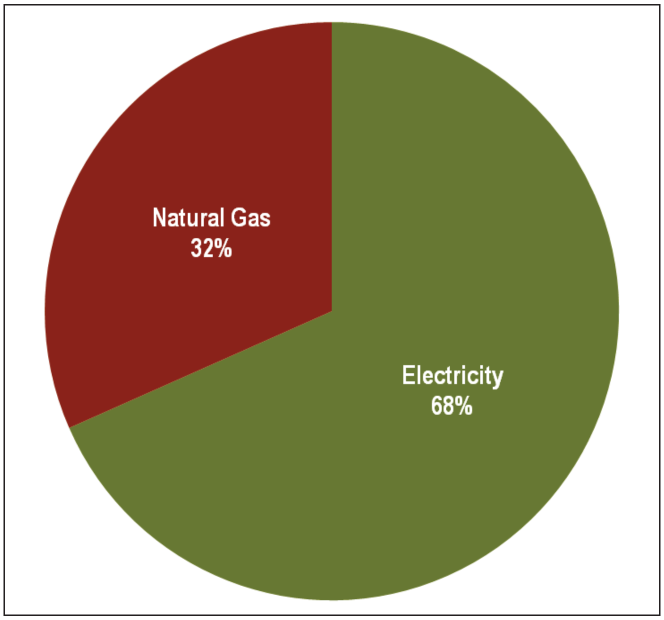
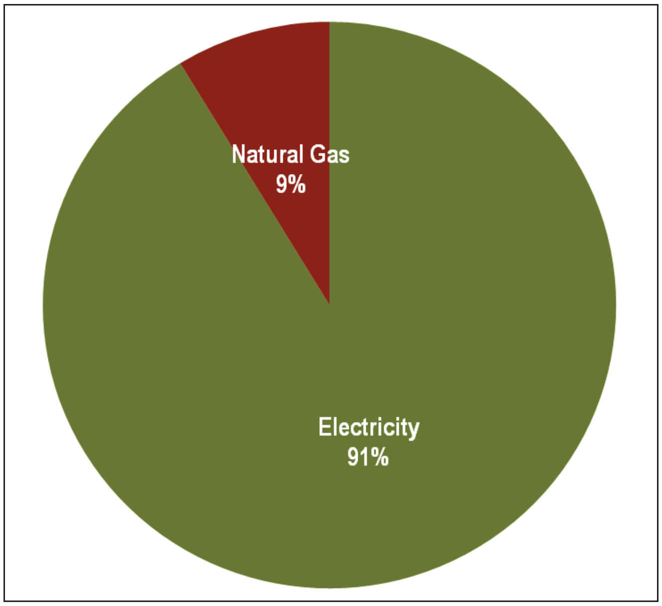


Figure 2-6: Facility Energy Expenditure[6]



2.1.3. Benchmarking

When analyzing Metro's facility energy consumption, it is illustrative to benchmark performance against similar organizations. This section provides a limited comparison of Metro's electricity intensity to that of other organizations, followed by a roadmap to help us collect and analyze more relevant data for future benchmarking.

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[5] Relative value, measured in MMBtu.

[6] Relative value, measured in U.S. dollars.

Benchmarking Analysis Methodology

Benchmarking is the evaluation of energy efficiency performance between and amongst similar facilities or operations. This technique uses an objective indicator of efficiency (a benchmark) to compare the facilities or operations to their industry standard or best practice. Benchmarking can help provide context for an organization’s electricity intensity estimates, and allows the organization to gauge whether its total electricity usage per square foot is above, below, or in line with other organizations of similar size and operational functions. Relevant external benchmarks and standards will encourage our agency to identify more specific and quantitative performance metrics and targets and to report how our performance standards measure up to these targets.

Internal benchmarking involves measuring an organization’s buildings against each other. This process provides additional insight into performance improvement opportunities by highlighting any performance gaps between the most and least efficient buildings in the organization’s portfolio. Internal benchmarking can help our agency to develop strategies to mitigate the biggest energy losses and environmental impacts, and to share best practices across our facilities or divisions. Internal energy efficiency comparisons for Metro will be discussed in Section 3.6, Energy Efficiency: Assessments and Investment Process. This section focuses on external benchmarks.

Results

We faced a number of challenges to developing effective benchmarks. For instance, few of the transit agencies that we spoke with said that they tracked data in a consistent and externally meaningful manner. Furthermore, Metro is a unique organization with unique energy use patterns that are not represented in published benchmarks, so it is difficult to find representative data. As a result, there are several key caveats to the following benchmarking analysis. Metro does not sub-meter its energy use by building, and propulsion energy for train lines often shares the same meter as facility electricity use. Therefore, it is difficult to identify the exact amount of energy that is providing electricity to Metro’s buildings. As mentioned, it is also challenging to identify and obtain data from other organizations with characteristics similar to Metro’s as energy intensity data for other major rail and bus systems is not publically available. It is also important to note that this analysis focuses on electricity consumption per square foot, which can vary significantly depending on factors such as climate, hours of operation, energy input mix, and infrastructure.

Nevertheless, benchmarking with existing data can provide Metro with a sense of where the agency stands relative to other organizations. Figure 2-7 compares Metro’s electricity consumption per square foot with that of three organizations: an average for state government buildings in California, Wal-Mart stores, and a benchmark from the Commercial Building Energy Consumption Survey (CBECS)[7] database. These benchmarks were selected because they represent as similar as possible building types to the Metro portfolio. The energy intensity data for Metro only includes energy use for the 23 sites from which we were able to aggregate square footage information. Based on this review, the agency appears to perform fairly well compared to these organizations, especially because many facilities in Metro’s portfolio use energy in a more industrial manner and over a 24/7 operating schedule. Although this analysis does not control for many factors, it is not surprising that Metro’s electricity intensity is higher than that of a major retail outlet and California state office buildings. The public assembly benchmark, which is intended for public buildings, is significantly higher than Metro’s but includes building types such as convention centers, assembly halls, stadiums, gymnasiums, and others.

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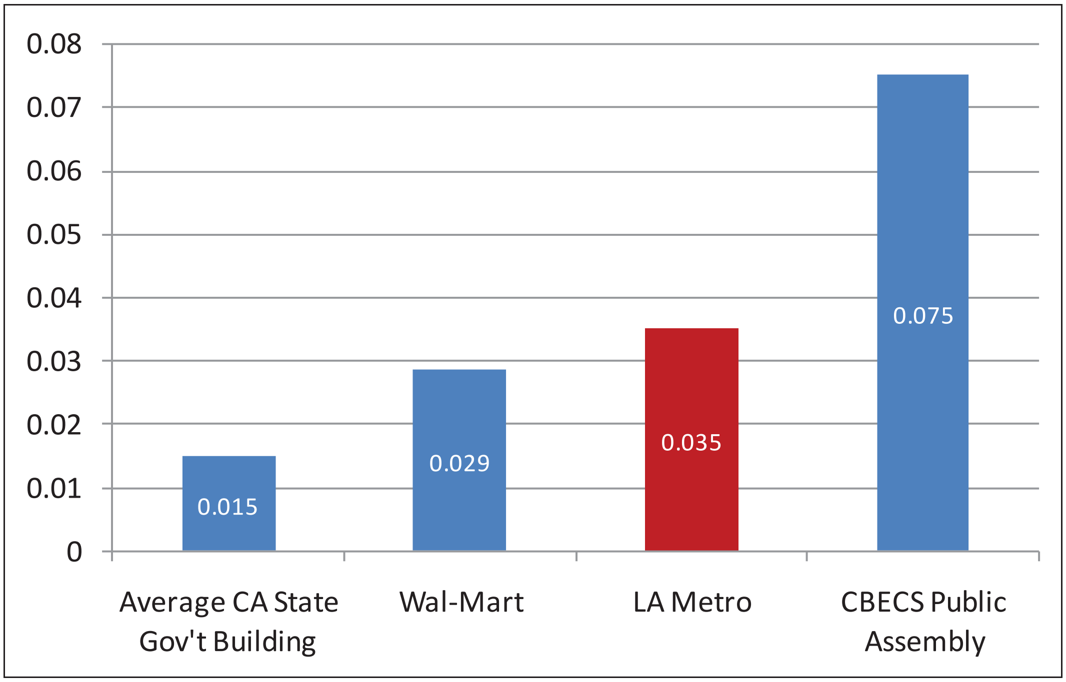
[7] CBECS data is available at www.eia.doe.gov/emeu/cbecs.

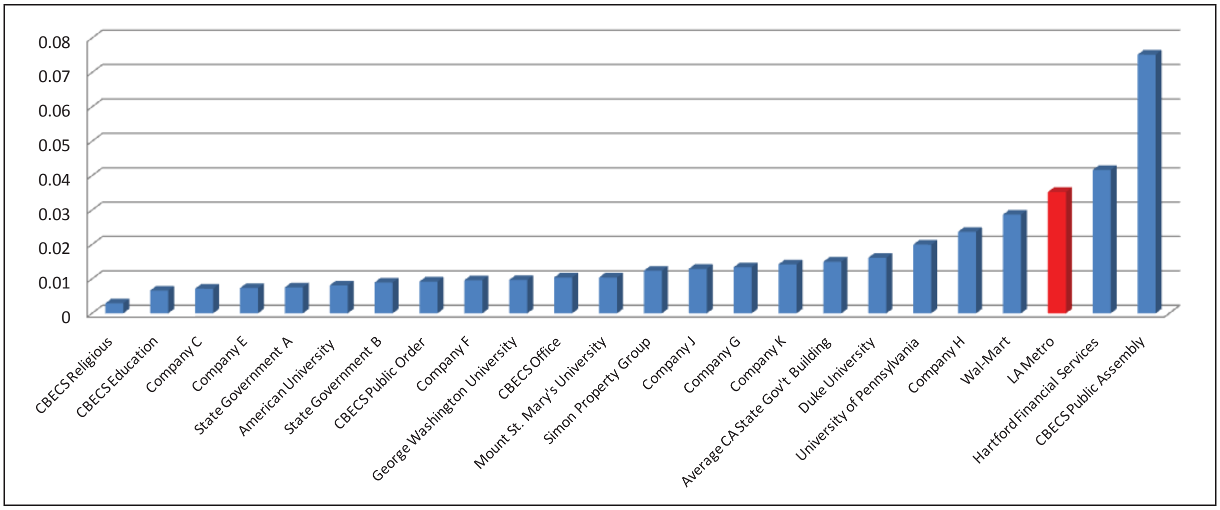
Figure 2-7: Electricity Intensity Benchmarks



Units indicated are MWh/sq. ft. Total electricity consumption is divided by total square footage for each portfolio.

Figure 2-8 compares Metro's electricity intensity against those of a variety of companies and agencies, as well as the average electricity consumption of specific building types, such as Office and Public Assembly, from the CBECS database. Metro's electricity intensity appears to be on the higher end of the spectrum; only two benchmarks use more electricity per site area than Metro.

Figure 2-8: Electricity Intensity of Selected Companies and Government Agencies



Units indicated are MWh/sq. ft.

Overall, Metro appears to use more energy per square foot than most other organizations. That being said, our agency utilizes the majority of its energy for propulsion purposes, rather than administration or institutional purposes. Therefore, it is difficult to truly compare our electricity usage to that of companies or universities that use energy in very different ways. Although the agency's energy intensity does appear on the higher side, when considering that Metro operates 24 hours per day and 7 days per week, its energy intensity per hour of operation is probably about on par with some other organizations. The Gateway Building more closely resembles a traditional office building, and we have performed some benchmarking analysis for that site in Section 3.6, Energy Efficiency: Assessment and Investment Process.

It is important to note that it may be difficult for the agency to change many operational aspects to reduce energy consumption. Aspects such as operating hours and the energy required for propulsion cannot be altered, because Metro is constrained by its need to maintain rail and bus operations 24 hours per day and 7 days per week. Unfortunately, we have not discussed these types of issues with peer transit agencies at this time. In the future, we should develop a process to compare our energy use and facilities data with other transit agencies with which we currently have relationships.

Recommendations

The following recommendations are intended to help Metro collect benchmarking data, identify points of comparison, and adjust for conflating factors.

Recommendation 2.1.3-1

Collect more Granular Data: Metro should begin sub-metering buildings as soon as possible. Collecting frequent, accurate, and granular data on resource use, particularly energy consumption at the building level, will allow Metro to analyze relative performance both internal and external to its own portfolio, identify problem buildings that are more resource-intensive than comparable buildings, and prioritize cost-effective improvements.

Recommendation 2.1.3-2

Identify Organizations Similar to Metro Against Which to Benchmark: Accurate benchmarking requires that the facilities being compared have few systematic differences that might affect the performance metrics in question. In particular, facilities chosen for comparison should have similar:

a. Facility functions and hours of operation

b. Energy input mix

c. Size of buildings

d. Employee, ridership, or miles of track

e. Climate (number of heating and cooling degree days)

Other domestic or international metro systems with similar operational characteristics may be effective benchmarks. Developing connections with these organizations might be an effective way to start benchmarking data and developing mitigation strategies.

Recommendation 2.1.3-3

Normalize Activity Data: While it is ideal to compare performance with facilities that have similar attributes, activity data should also be adjusted to account for differences. Data can be normalized in different ways to allow for different kinds of analysis. For example:

- Energy consumption is a function of both the number of people using energy and the size and the purpose of the buildings it serves. When benchmarking, it may be useful to consider energy per rider or energy per square foot for different building types.

- Climate affects both energy and water consumption. A useful method to control for climate is to divide consumption by heating/cooling degree days, a measure of the frequency and magnitude of a given climate's deviation from a set baseline.

2.2. Future Energy Use Projections

2.2.1. Propulsion Electricity

Introduction

Based upon the 2010 baseline established in Section 2.1.1, "Propulsion Electricity," this section presents an estimate of Metro's propulsion energy usage projected to 2020, encompassing the entire Metro system after a series of rail construction extension projects are completely constructed and put into service.

Methodology

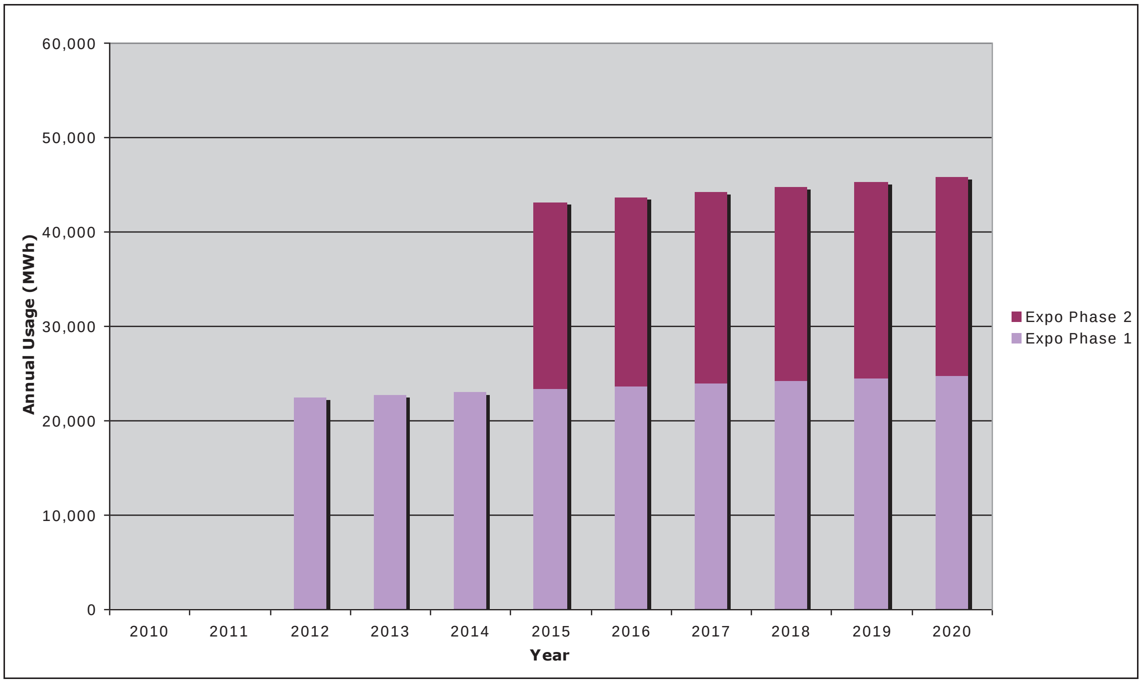
To accomplish this task and formulate a methodology, and before reviewing each of the extensions, a variety of assumptions were considered to estimate the electricity consumption levels for each year from 2010 through, and including, 2020.

- Operating policies for traction operations will remain the same for all of the years in question.
- There will be no changes in scheduling such as frequencies, changes in consist or equipment, or changes within the existing traction infrastructure.
- There will be no change in consist information, additional equipment, or energy efficiency change outs in existing transit cars.
- While specific operating data (system losses, performance evaluation, sub-metering, etc.) for energy usage was not available, system losses are estimated to be 2.25%, included in the base estimate along with each extension, as explained in Section 2.1.1, "Propulsion Electricity").
- Ridership on existing and finalized extensions will continue to increase annually. To determine the impact of increased ridership, we discussed possible factors with other agencies. We have found that other agencies have observed growth in energy use that can be anywhere from 1% to 1.5% annually based on ridership increases. For this exercise of energy use projections for the ECMP we used a conservative assumption of annual growth of 1.2%.
- There is a direct correlation between Metro's electricity consumption and passenger ridership (see Section 2.1.1, "Propulsion Electricity").
- Funding issues surrounding the completion of the extension projects were not considered. The assumption is that these concerns would be worked out within the financial planning process.

There are currently six extension projects scheduled to be completed by 2020. The first to be completed will be the Expo Phase 1 Extension, with an expected completion date in early 2012. The Expo Phase 1 Extension will run from 7th Street/Metro Center (Blue Line) to the Venice/Robertson Station, and will include 10 new stations covering a distance of 7.5 miles. The estimated new daily ridership for this extension is 43,000. The second is the Expo Phase 2 Extension, which is scheduled for completion in 2015. This extension will continue from the Venice/Robertson station of Expo Phase 1 and end at the 4th/Colorado Station in the City of Santa Monica. This project will add seven new stations and will cover

6.6 miles. There is also a new 45-car maintenance facility planned for this line. The annual projected usage growth based on the increased ridership is depicted in Figure 2-9 below.

Figure 2-9: Projected Expo Line Electricity Consumption, 2010–2020



For the three extensions where no estimated ridership data was available (Expo Phase 2, Foothill Phase 2A, and Foothill Phase 2B), alternate methods were used to estimate electrical consumption. No predicted ridership was provided for the Expo Phase 2 extension, but there was estimated ridership provided for the Expo Phase 1. Because the Expo Phase 2 project is considered an extension of the Expo Phase 1 project, for purposes of this analysis the Expo Phase 2 characteristics were assumed to be identical to the Expo Phase 1 characteristics. Based on that assumption, one could then estimate the electrical consumption for the Expo Phase 2 extension simply by multiplying the electrical consumption of the Expo Phase 1 Extension by the ratio of track miles of Expo Phase 2 to that of Expo Phase 1.

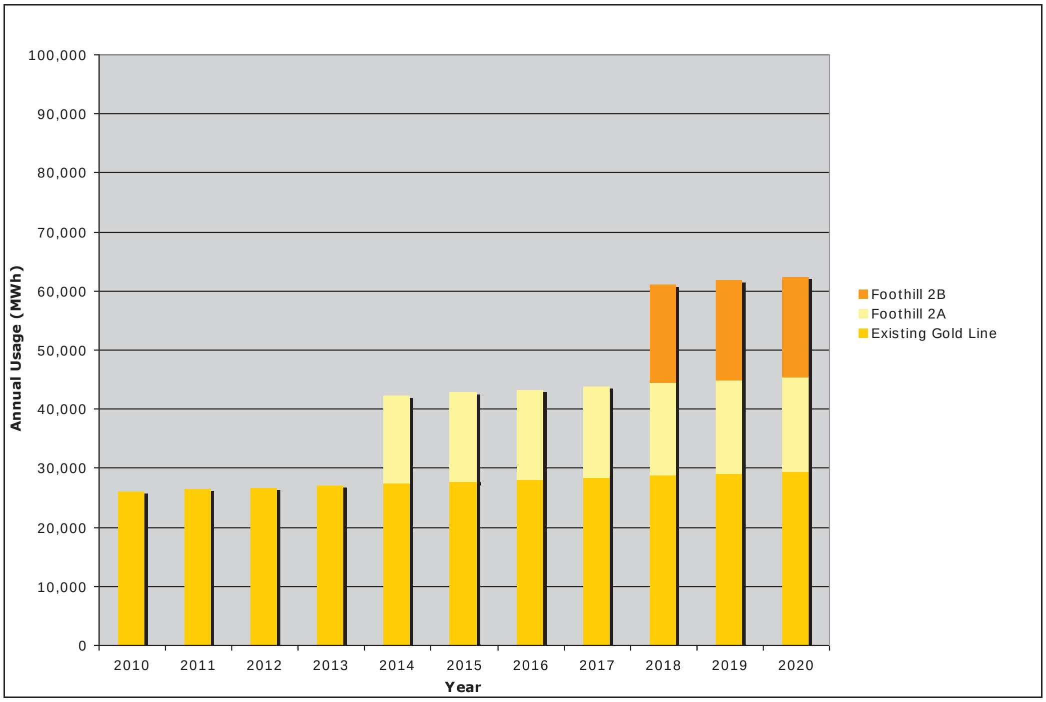
$$Usage_{ExpoPhase2} = Usage_{ExpoPhase1} \cdot \left(\frac{Miles_{ExpoPhase2}}{Miles_{ExpoPhase1}}\right)$$

Likewise, no information was available in regard to the expected ridership of either phase of the Gold Line Foothill extension. For purposes of the analysis, it was assumed that the Foothill Extension characteristics were similar to the Gold Line characteristics, such that the Foothill Extensions could be treated as an extension of the Metro Gold Line. Based on that assumption, the expected electrical consumption could then be calculated by extrapolating usage from the existing Gold line data. Predicted electrical consumption for the Gold Line Foothill Extension (both Phase 2A and 2B) was calculated using the current usage per mile of the Gold Line and multiplying that by the length of the extension.

$$Usage_{FoothillExtension} = \left(\frac{Usage}{TrackLength}\right)_{GoldLine} \cdot TrackLength_{Extension}$$

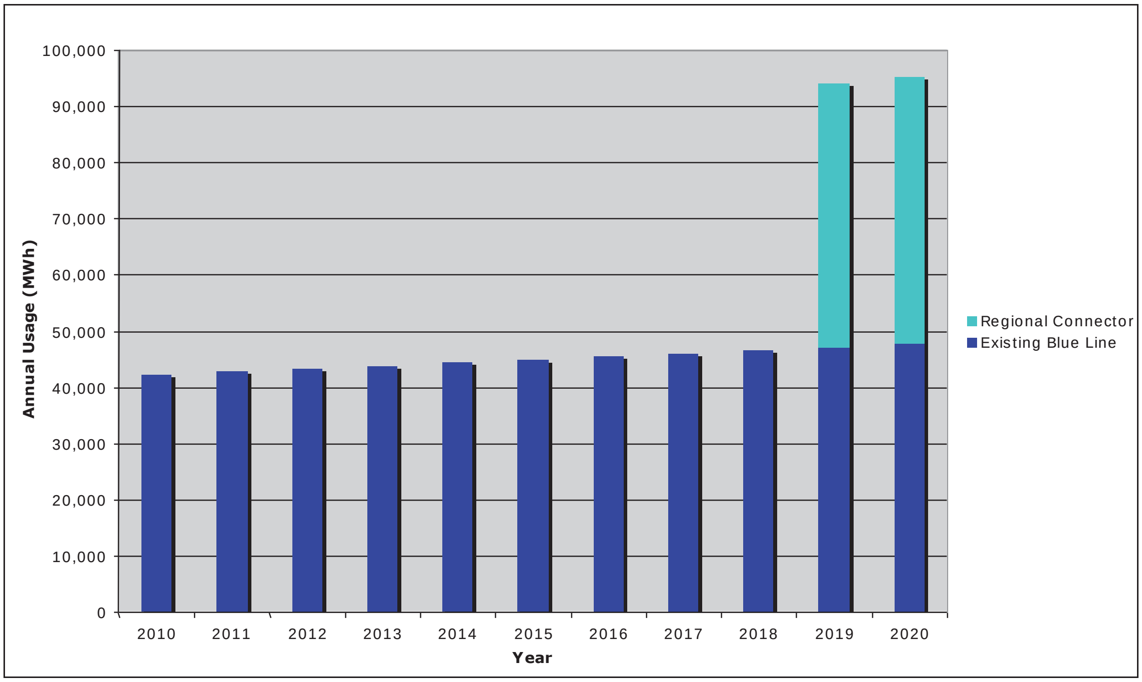
The next project to be completed will be the Gold Line Foothill Extension (Phase 2A) in 2014. This extension will run from the Sierra Madre Villa Station in Pasadena to the Azusa-Citrus Station, and will create six new stations and cover 11.3 miles. It will also include a new maintenance facility with a 104-car capacity. The Gold Line Foothill Extension (Phase 2B) is scheduled to be completed in the 2017 to 2019 timeframe. As mentioned above under assumptions, funding was not considered a deterrent to estimating electrical consumption as it was felt it would be approved at a later date. This project will continue on from the Azusa-Citrus Station of Phase 2A and end at the Montclair Station. The Phase 2B project will add six new stations and will extend 12.6 miles. No new daily ridership figures were provided for either of the Gold Line Foothill Extension projects or for the Expo Phase 2 Extension. See Figure 2-10 below.

Figure 2-10: Projected Gold Line Electricity Consumption, 2010–2020



The next project scheduled for construction is the Crenshaw Corridor, which is expected to open in 2018. The Crenshaw Corridor, which will run from the Expo/Crenshaw Station to the Imperial/Aviation Station, adds eight new stations and covers 8.5 miles. The estimated new daily ridership for the Crenshaw Corridor Extension is 21,300. The last of the projects to be completed will be the Regional Connector. This project will run from the Blue/Expo Lines to the Gold Line and Union Station; it will add four new stations and cover 4.5 miles. The Regional Connector is estimated to add 90,000 new daily riders. See Figure 2-11 below.

Figure 2-11: Projected Blue Line Electricity Consumption, 2010–2020



In addition to the added electrical consumption from the extensions, there will be added energy usage resulting from population growth and a subsequent increase in ridership. Based on previous experience with other rail systems$_1$, annual passenger growth is usually in the range of 1–1.5%. Future yearly usage was projected from 2010 to 2020 assuming a conservative annual passenger growth rate of 1.2% and that the extensions will begin running at full power on January 1 of their projected opening year. The following graphs (Figures 2-12 through 2-15 below) depict the growth in propulsion energy electrical consumption of the existing lines and the new Crenshaw Line.

Figure 2-12: Projected Green Line Electricity Consumption, 2010–2020

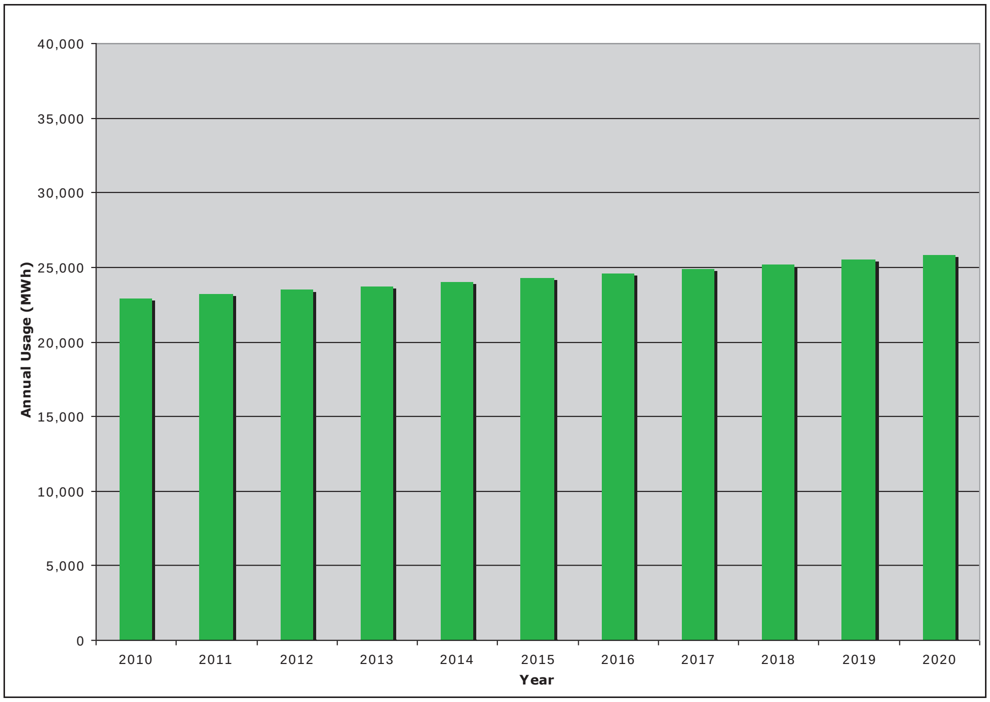


Figure 2-13: Projected Red Line Electricity Consumption, 2010–2020

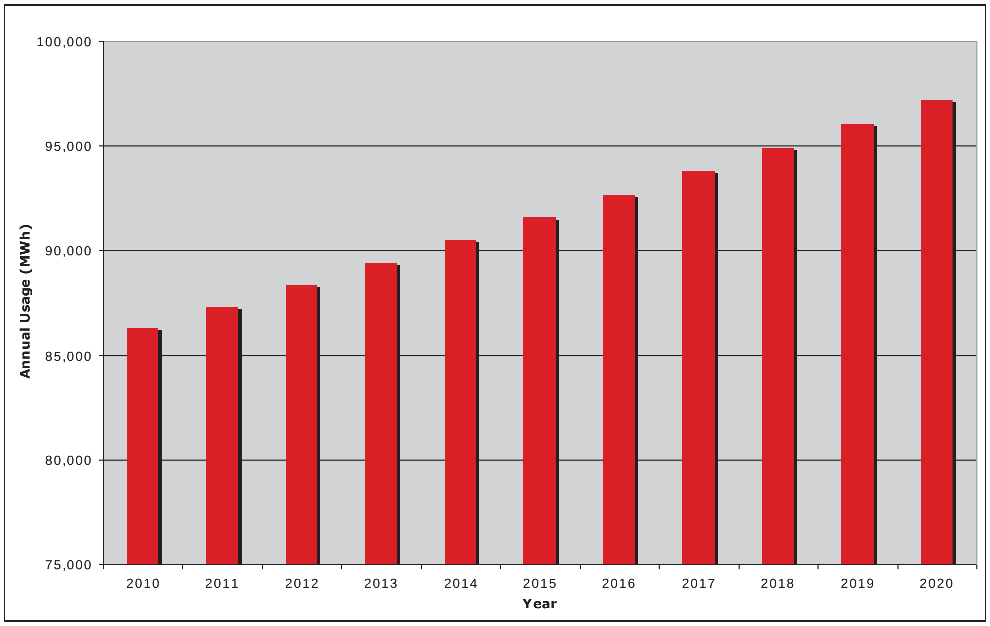


Figure 2-14: Projected Crenshaw Line Electricity Consumption, 2010–2020

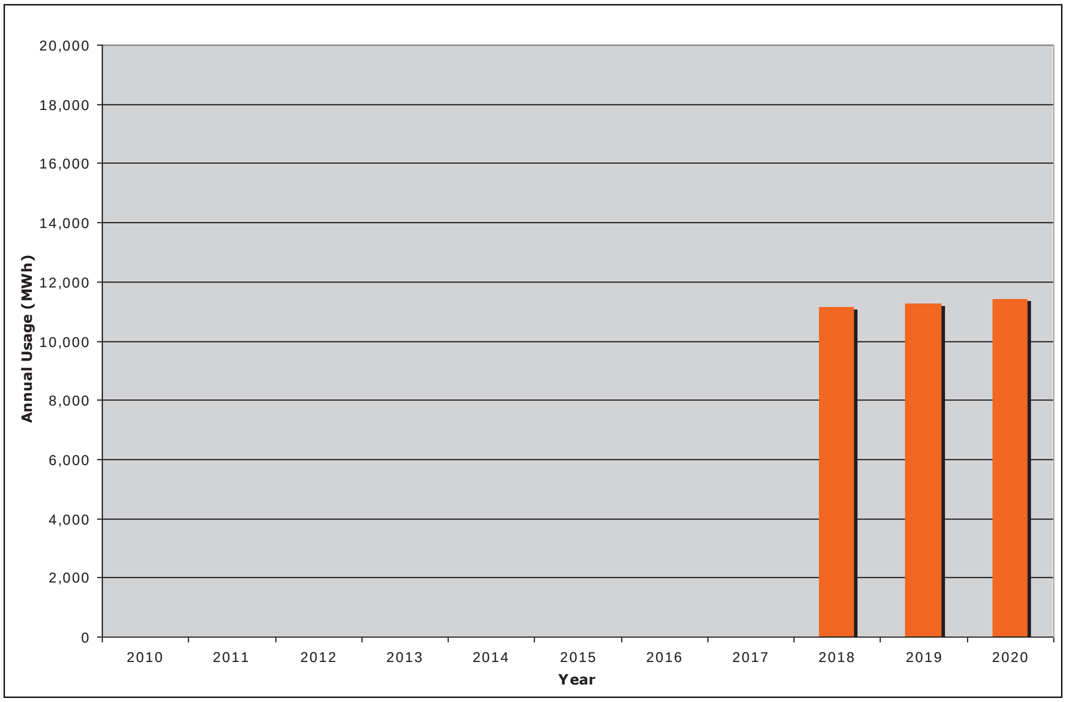


Figure 2-15 provides an overview of propulsion energy needs from 2010 to 2020 broken down by individual line.

Figure 2-15: Projected Overall System Electricity Consumption, 2010–2020

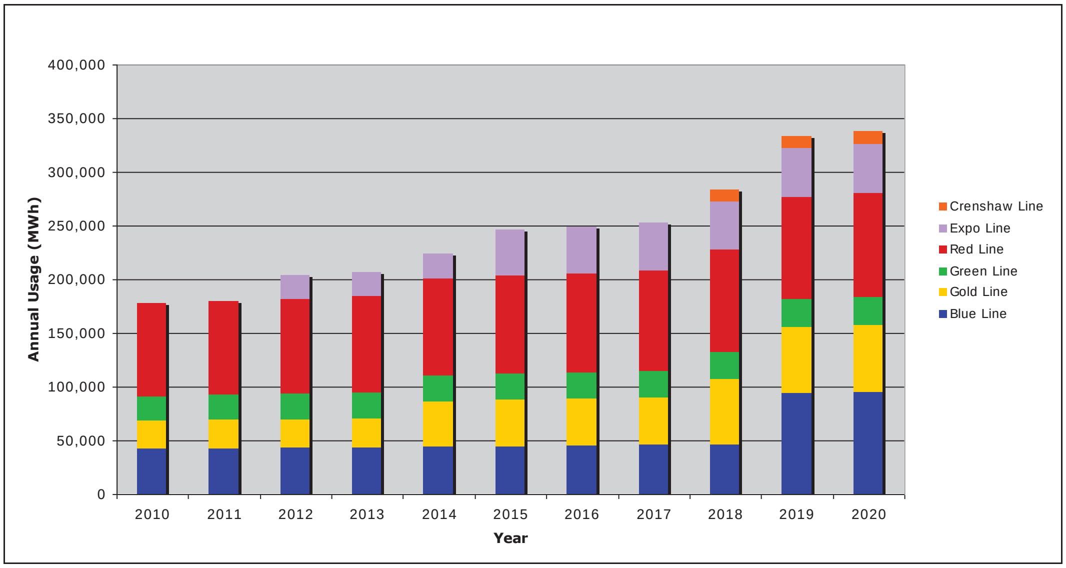


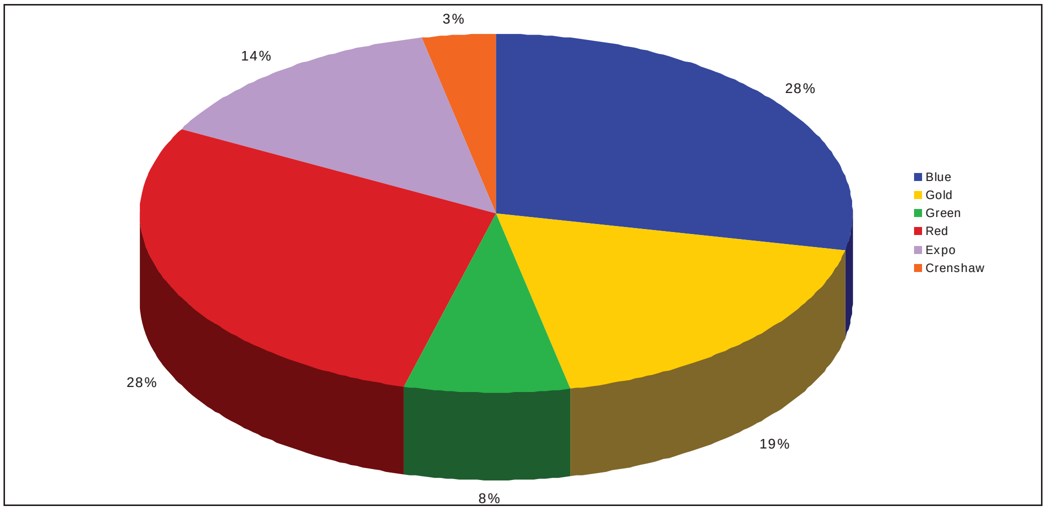
Table 2-4 and Figure 2-16 represent each line's projected contribution to overall consumption in 2020, which is projected to be 341,138,970 kWh, or an increase of 92% as compared to the 2010 base year. In terms of ridership, this would equate to an increase of 332,000 daily riders in 2010 to 638,748 daily riders in 2020.

Table 2-4: Metro Electricity Usage Projections (kWh)

Year	Total	Inc	Existing	Expo 1	Gold Line Foothill 2A	Expo 2	Gold Line Foothill 2B	Crenshaw	Regional C
2010	177,375,129	0%	177,375,129						
2011	179,503,631	1%	179,503,631						
2012	204,112,511	15%	181,657,674	22,454,837					
2013	206,561,861	16%	183,837,566	22,724,295					
2014	223,966,825	26%	186,043,617	22,996,986	14,926,222				
2015	246,414,683	39%	188,276,140	23,272,950	15,105,336	19,760,256			
2016	249,371,659	41%	190,535,454	23,552,225	15,286,600	19,997,379			
2017	252,364,119	42%	192,821,880	23,834,852	15,470,040	20,237,348			
2018	283,158,863	60%	195,135,742	24,120,870	15,655,680	20,480,196	16,643,398	11,122,977	
2019	333,555,264	88%	197,477,371	24,410,321	15,843,548	20,725,958	16,843,118	11,256,453	46,998,495
2020	337,557,927	90%	199,847,099	24,703,245	16,033,671	20,974,670	17,045,236	11,391,530	47,562,477

As shown in Table 2-4, the consumption of the existing lines is shown in the column labeled “Existing.” The projected energy use would grow a rate of 1.2% annually, as explained previously. The added consumption for each of the extensions, which are also assumed to grow at a 1.2% annual rate after being placed in service, is provided in the columns labeled according to the extension name. The total projected consumption, which reflects both the assumed annual growth and the contribution from each of the extensions, is shown in the column labeled “Total” for each year up to year 2020. The total percentage increase in year 2020 is 90% over the base year 2010. Figure 2-16 below indicates the projected relative energy use per train service line, as measured in kWh/year.

Figure 2-16: 2020 Service Line Electricity Use



2.2.2. Facility Electricity and Natural Gas

Over the next 10 years, based on Metro's projections, our facilities will increase their energy use by an estimated 11% compared to the 2010 baseline. This is an estimated increase of around 8.2 million kWh of electricity use and 100,000 therms of natural gas use. This increase is driven by several factors, including:

- New construction plans
- New green construction policies
- New installed technology
- Annual climactic data

Primarily, this increase is driven by the increase in the number of facilities in Metro's portfolio. Although energy use is increasing, the overall energy intensity of the portfolio is decreasing, a trend that is driven by new green construction policies mandated by internal Metro polices, California's Title 24 legislation, CALGreen Building Codes, and the Governor's Executive Order that all public buildings reduce energy use by 20% by 2015.

New Construction Plans

Over the next 10 years, Metro will significantly expand its operations. This increase in operations will require new facility construction across all of Metro's operations, including new passenger stations and maintenance yards. This increased facility footprint will lead to an overall increase in the amount of energy consumed by the agency's facilities. In 2010, Metro facilities consumed an estimated 68.6 million kWh of electricity and 0.95 million therms of natural gas. This equates to around 328,300 MMBTU of total energy used at Metro facilities.

Over the next 10 years, Metro intends to construct over 40 new rail facilities along four new lines. This expansion will include the Expo Light Rail, the Gold Line Foothill Extension, the Crenshaw Corridor, the Purple Line, the Regional Connector, and four new bus stations along the Orange Line. Many of the rail facilities will be subway or light rail stations, but three new maintenance yards are also slated for construction.

- A new maintenance yard will be constructed on the Expo Light Rail at Exposition and Stewart as part of the Expo Phase 1 expansion;
- A new 104-car maintenance yard is planned for construction along the Gold Line Foothill Extension;
- A new bus maintenance division (Division 13) will be constructed in the downtown area.

Metro identified datasets for 100 facilities; however, because the facility energy use baseline utility accounts and projections use data that is not sub-metered, there is a chance that some energy use data is also accounted for in the propulsion projections. We have cross-walked propulsion accounts with facility accounts and believe that the data used for facility and propulsion baselines are correct. However, as the agency continues to improve the data collection and reporting methodologies, the baseline assumptions and appropriate accounts should be updated as needed.

According to our 30/10 Plan and other Metro planning documents, we will construct approximately 45 new facilities. These expansions will be phased in over the next 10 years. Table 2-5 outlines Metro's facility expansion plans. Much of the expansion is focused on rail stations; however, in 2012 four new bus stations will be constructed, two rail maintenance facilities will be constructed in 2014and 2015, and one new bus maintenance division (Division 13) will be completed in 2013.

Table 2-5: Facility Expansion Plans for Metro

Line Expansion	Year of Completion	Number of new sites
Expo Light Rail Phase 1	2012	10 Stations
Expo Light Rail Phase 2	2015	7 Stations, 1 Maintenance Facility
Gold Line Foothills Phase 2A	2014	6 Stations, 1 Maintenance Facility
Gold Line Foothills Phase 2B	2017	6 Stations
Purple Crenshaw Corridor	2018	6-8 Stations (7 assumed for analysis)
Blue/ Expo Regional Connector	2018	4 Stations
Orange Line	2012	4 Bus Stations
Division 13	2013	1 Bus Maintenance Facility

If Metro built, operated, and maintained facilities without implementing any of the new building codes, the agency would increase its energy use by 15% over the next 10 years. This growth would stem entirely from the energy needed for the operations of new facilities. However, because we are constructing new sites and retrofitting old sites to achieve more efficient levels of energy use, Metro's portfolio should be significantly less energy-intensive in future years. The projected energy intensity takes into account the new CALGreen and LEED construction guidelines.

New Building Codes

All new construction, major retrofits, and existing buildings in the Metro portfolio will be constructed and operated in accordance to the US Green Building Council's (USGBC) LEED®-New Construction/ Existing Building Operations and Maintenance Silver certification requirements. This operational strategy aligns with California guidelines outlined in Title 24, CALGreen Building Codes, and the State Executive Order, which require all government facilities to decrease energy use by 20% (from a 2003 baseline) by 2015. The Executive Order also asks private and non-governmental institutions to follow these guidelines.

The LEED rating program is an internationally recognized green building certification system. LEED provides third-party verification that a building was designed and built using strategies intended to improve performance in metrics such as energy savings, water efficiency, CO_2 emissions reduction, improved indoor environmental quality, and stewardship of resources and sensitivity to their impacts. By requiring that all buildings be operated or constructed to LEED standards, Metro can ensure that new facilities reduce the overall negative environmental impacts that traditional buildings would create.

According to several studies by the New Buildings Institute,[8] LEED buildings consume around 20% less energy than traditional buildings. LEED buildings must also meet energy standards that are roughly 20% more efficient than the basic energy codes outlined in common international standards such as ANSI/ASHRAE/IESNA Standard 90.1-2007 or ASHRAE Standard 62.1-2007.[9] Furthermore, the CALGreen Building Guidelines state that all existing buildings should reduce energy use by 20% from the 2003 baseline by 2015. Therefore, for the purposes of these projections, it is assumed that the energy intensity at newly constructed Metro facilities will be 20% lower than the currently calculated energy intensity and that all Metro buildings will achieve a 20% reduction in energy use by 2015.

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[8] New Buildings Institute "Energy Performance of LEED® for New Construction Buildings, Final Report" Text Page 5 (PDF page 9) and New Buildings Institute "The Energy Performance of LEED® Buildings" Page 58.

[9] Based on the LEED requirements outlined on the USGBC website.

If Metro's portfolio of facilities increases according to the growth plans outlined above and achieves the assumed and projected 20% reduction in site energy use from the 2010 baseline, Metro will use roughly 8% less energy in 2020 than in 2010. This represents a 20% reduction from the business-as-usual scenario outlined in the section above. The assumed 20% reduction in facility energy use is based on the research behind the energy savings potential of LEED Silver certifications and the CALGreen buildings codes. The actual energy reduction may vary, but 20% is used to model the projected savings.

Technology Changes at Bus Divisions

Changes in technology will impact projected energy use at Metro facilities. Building mechanical systems such as lighting, HVAC systems, and pumps will become more efficient as we begin to invest in LEED certification strategies. These investments will be one of the main strategies used to achieve the assumed 20% reduction in energy use across Metro facilities.

However, there is one technological change that has the potential to adversely impact energy reduction initiatives. Based on new South Coast Air Quality Management District (SCAQMD) guidelines, all natural gas compressors at CNG facilities must be converted to electricity-driven natural gas compressors. Although the overall energy consumption at bus facilities with CNG stations might remain about equal because the sites will simply be switching from natural gas to electricity to power the compressors, this switch will cause the electricity use profile to change substantially. Furthermore, the scope of the ECPM does not cover fleet fuel use; therefore, the CNG used to drive the compressors has not been included in this baseline. The switch to electricity-driven compressors will be seen as a new energy demand for bus maintenance and operations yards.

Because Metro's growth plans call for one new bus maintenance facility (Division 13), the electricity use across all bus facilities would have increased by only that one site's consumption. However, because of new demand required by Division 13 and the electrification of the CNG compressor drives, electricity use will actually increase by 41% at bus maintenance and operations facilities and 30% as compared to the business-as-usual projections. According to our engineering staff, the electricity requirement for the compressors is roughly 2 million kWh per installed CNG facility, accounting for multiple CNG compressors. This demand accounts for multiple (between three and six) 600-HP drives running for around 10 hours per day during the bus refueling period. Currently, the electrified compressors have only been installed at Divisions 5 and 7. The new electricity demand at these sites is roughly 2 million kWh, which is how the estimation for future consumption is derived.

Weather Normalization

In order to project Metro's energy use within the context of annual climate variations, we reviewed the baseline year (2010) data against average climate data for Los Angeles. To do so, we analyzed 2010 data for heating degree days (HDD) and cooling degree days (CDD), and compared those results to the 5-year average. By comparing these degree-day values, ICF was able to estimate how climate variations might impact Metro's projected energy use.

Degree days are calculated based on outside air temperatures. HDD and CDD data are used extensively in calculations relating to building energy consumption. Because energy use in buildings is closely tied to heating and cooling demands of the space, HDD and CDD data is used to understand how climatic variations drive energy use. The HDD demonstrates how much lower the outside temperature is compared to a base temperature on a given day. Conversely, a CDD is the outside temperature's number of degrees above a base temperature on a given day. In general, the base temperature is 65^{o}F.

For example, if the outside air temperature on a given day is 60^{o}F; this temperature is 5^{o}F below the base temperature of 65^{o}F. The HDD can be calculated by multiplying the 5^{o}F difference by the 1 day (5 degree

* 1 day = 5 HDD). If the outside air temperature goes above the base temperature, a CDD is created, rather than a HDD. If the outside air temperature is 70°F, it is 5°F above the base temperature (65 °F) and the CDD can be calculated by multiplying the 5 degree difference by the 1 day (5 degree * 1 day = 5 CDD). This same logic holds true for multiple days. If the outside air temperature on a given week is 60°F, it is 5°F below the base temperature (65°F). The HDD can be calculated by multiplying the 5°F difference by the 7 days (5 degree * 7 days = 35 HDD).

Degree-day data can therefore be used to represent a single day's variation in temperature data compared to a baseline, or this data can be summed to represent the variations in climate data across a larger timescale (e.g., a week, a month, or a year).

Analysis

For this analysis, we reviewed climate data from 2010, as well as monthly 5-year average data, to understand how the HDD and CDD differ. The assumption is that some portion of facility energy consumption for each month is tied to climatic variations. In other words, for any month in 2010, if there are more CDDs in 2010 than the average CDDs, more energy will be used for cooling than in past years. In essence, if one day had a CDD of 2 and another day had a CDD of 4, the facility with a CDD of 4 would use around twice as much energy on cooling than the other site. Because we were able to review monthly HDD and CDD data, we were able to add the data to determine the total HDD and CDD for the year. This analysis represents the relevant variations in temperature for the entire 2010 baseline year.

Table 2-6: CDD and HDD Data for Los Angeles International Airport

	2010 DATA		AVERAGE		Ratios	
Month starting	*HDD*	*CDD*	*HDD*	*CDD*	*HDD*	*CDD*
January	230	33	264	34	0.87	0.97
February	221	18	236	27	0.94	0.67
March	194	39	226	27	0.86	1.44
April	202	12	177	35	1.14	0.34
May	138	19	97	40	1.42	0.48
June	44	35	36	77	1.22	0.45
July	38	66	13	159	2.92	0.42
August	45	74	15	156	3.00	0.47
September	52	111	24	133	2.17	0.83
October	50	72	66	109	0.76	0.66
November	182	81	140	67	1.30	1.21
December	230	24	277	19	0.83	1.26
Totals	**1,626**	**584**	**1,571**	**883**	**1.04**	**0.66**

Table 2-6, above, compares the 5-year average CDD and HDD data to the 2010 data from weather stations at LAX. In many instances, the average data aligns with the 2010 data. For example, in January 2010, there were 33 CDDs, while the average was 34. This means that in January the energy used for cooling in 2010 tracks closely with the average. However, there are months with significant differences between the average CDD and HDD data and the 2010 data. For instance, in July and August of 2010, the HDD data is three times as high as the average, which represents a significant difference. This means that during those 2 months, energy used to heat Metro facilities is around three times as high as the average (however, it is unlikely that any buildings are heated in July or August so this difference is just useful to review as an example for the differences in CDD and HDD data between the 2010 and average data).

Although the data in Table 2-6 is only from one weather station, Metro has reviewed several weather stations from around the Los Angeles metropolitan area to ensure that the data from LAX was typical of 2010 data. Based on this data, it appears that 2010 was a cool year for the Los Angeles metropolitan area, and, as a result, less mechanical cooling was required during the summer months. On average, the annual CDDs for 2010 were around 20% below average, while the HDDs were approximately 5% above average. This indicates that Metro spent about 20% less on cooling in 2010 than it would during an average year. In future years, it is likely that the energy needs for cooling Metro facilities will be higher than in the 2010 baseline year.

Based on benchmark data from the CBECS, the average energy needs for cooling are around 5-20% of the total energy needs of a building in Los Angeles. The variation in energy use for cooling stems from the differences in the energy use profiles of different building types. Because Metro facilities such as rail maintenance yards, bus maintenance yards, and train stations are not building types tracked in the CBECS database, there is no formal strategy for estimating how much energy use from facilities can be applied to cooling.

For this analysis, we assumed that approximately 10% of Metro's maintenance facility energy use is directed to cooling. Therefore, in maintenance and operations centers where cooling exists, we estimate that cooling needs will increase by 20% compared to the baseline and that the cooling load is 10% of the energy needs for these facilities. This means that energy use will increase by 2% (20% * 10%) at the Metro facilities where cooling loads exist.

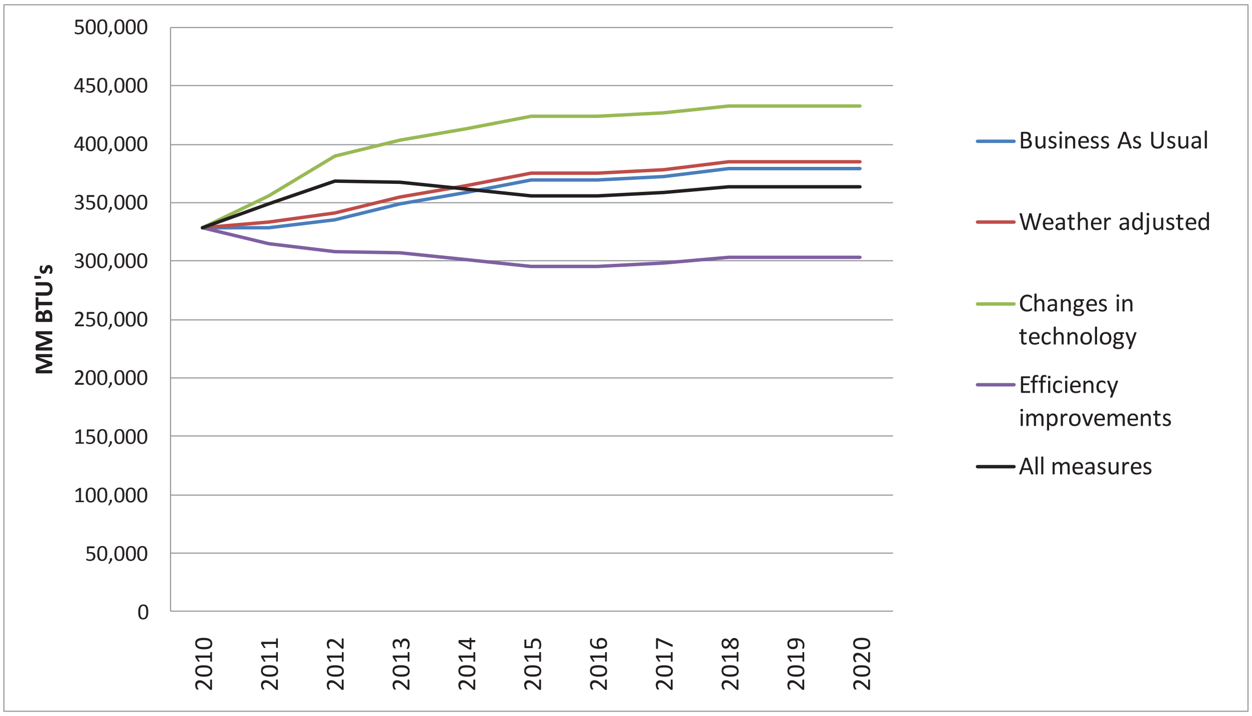
If Metro were not managing energy use across its portfolio, it would mean that, on average, Metro facilities would increase energy use by 2% or 7,500 MMBTU from the business-as-usual scenario outlined above.

Summary

Figure 2-17 depicts the agency's projected facility energy use from the 2010 baseline to 2020. Each line represents one scenario. Overall, if all metrics are accounted for, Metro will increase energy use by 11% from the 2010 baseline year. By 2018, it seems as though the energy use stabilizes. This is because, according to the projection's assumptions as laid out above, no new facilities are constructed after 2018, no new energy consuming technology is being installed, and all energy efficient upgrades have been completed.

- The "business as usual" line demonstrates facility energy use, assuming that 2010 is a typical year and that weather changes, technology changes, and new building codes do not impact Metro's overall energy use profile. This line does account for the projected growth in Metro facilities, such as the new bus stations and maintenance yards that will be constructed as Metro grows.
- The "weather adjusted" line accounts only for the change in energy use that would occur because of weather normalization compared to the business-as-usual approach. This accounts for an increase in energy use of roughly 2% due to the increase in cooling needs.
- The "changes in technology" line tracks the impact that switching to electrified CNG stations will have on Metro's portfolio. This line alters the business-as-usual baseline due to the increased electricity needs of bus divisions that will result from electrified CNG fueling stations and the construction of Division 13.

Figure 2-17: Projected Facility Energy Use



- The "efficiency improvements" line tracks the expected reduction in energy use across the portfolio that will occur as a result of the more efficient LEED and CALGreen guidelines that Metro has considered. These guidelines are projected to reduce energy use by up to 20% compared to the business-as-usual approach.
- Finally, the "all measures" line adjusts the business-as-usual data using 2010 as the baseline and integrating all of the above measures that impact Metro's overall energy use. Overall, Metro's facility energy use is projected to increase by 11% from the 2010 baseline. This increase is driven primarily by new facility construction but also by the installation of electrified CNG compressors.

3. Energy Rates and Supply

3.1. Utility Bill Audit

This section provides an overview of the utility rates applied to electricity and natural gas utility accounts and their impact on the delivered cost of energy. To illustrate the complex nature of energy charges, three monthly bills are summarized. Each bill was specifically selected because it represents a meter located at a facility assessed during site visits (as described in Section 3.6.3 and Table 3-14) and each refers to a different utility provider.

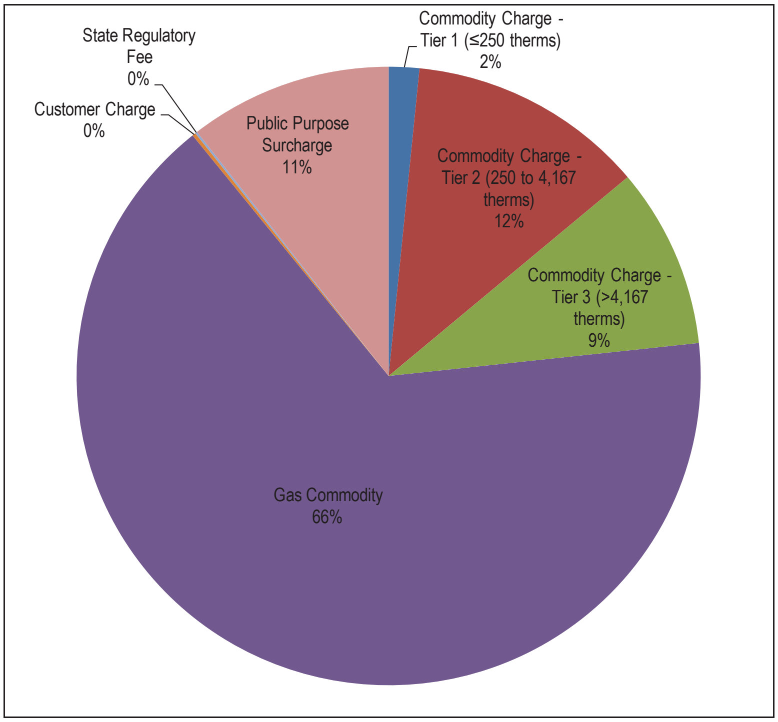
The Gas Company

As illustrated below in Table 3-1 and Figure 3-1, the monthly natural gas bill from The Gas Company (Southern California Gas Company) for the Metro Support Services Center (MSSC) facility is dominated by consumption-based charges. In particular, there are three tiered rates, plus an overall gas commodity charge applicable to consumption. The three tiered rates (applicable, respectively, to the first 250 therms of consumption, the next 3,917 therms, and any consumption over 4,167 therms each month) decline from $0.51487/therm for the first tier to $0.25616/therm and $0.08269/therm for the next two tiers, respectively. The utility's additional gas commodity charge varies based on its market procurement costs. The average cost per therm for the MSSC facility on this bill was $0.61. Since the MSSC facility is one of Metro's largest in natural gas consumption, its average unit gas costs tend to be lower than costs at Metro's smaller facilities because MSSC receives a high percentage of its natural gas supply at less-expensive price tiers from the utility.

Table 3-1: Sample Bill from The Gas Company

The Gas Company Metro Support Services Center (900 Lyon St.) Meter: 04754125 Dates: 09/30/10 - 10/29/10	
Procurement, Transmission, & Commodity Charges	
Commodity Charge - Tier 1 (≤250 therms)	$128.72
Commodity Charge - Tier 2 (250 to 4,167)	$1,003.38
Commodity Charge - Tier 3 (>4,167 therms)	$767.53
Gas Commodity	$5,371.81
Other Fees & Taxes	
Customer Charge	$14.30
State Regulatory Fee	$9.15
Public Purpose Surcharge	$858.05
Total	**$8,152.94**
Consumption (therms)	**13,449**
Natural Gas Unit Cost ($/therm)	**$0.61**

Figure 3-1: Sample Monthly Natural Gas Expenditure for Metro Support Services Center



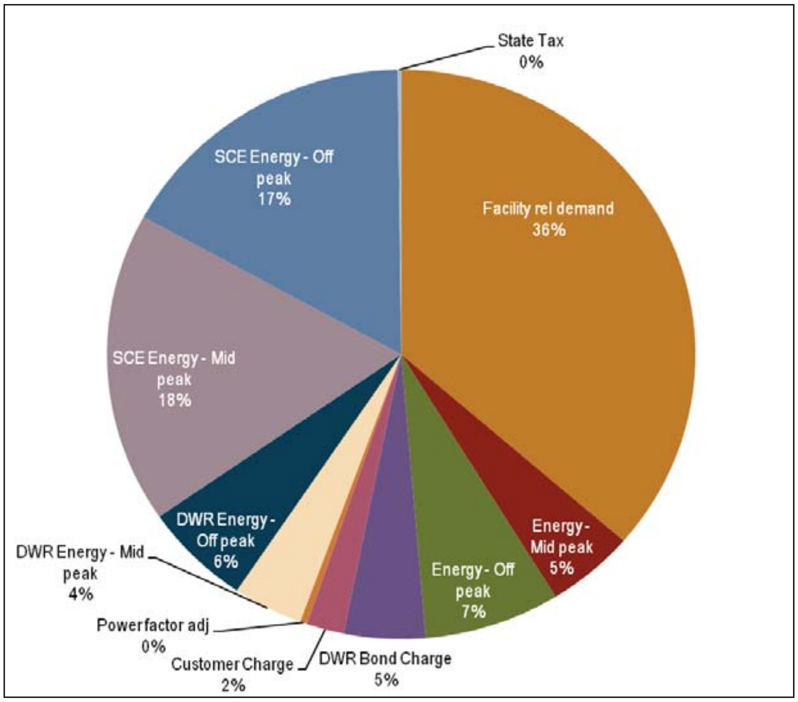
Southern California Edison (SCE)

Shown below in Table 3-2 and Figure 3-2, the Division 18 – Bus Yard facility is served by an SCE electricity meter (the larger consumer of two for the facility). The facility is charged for electricity consumption based upon a time-of-use (TOU) rate structure, in which rates vary throughout the day during three SCE-established time periods (two in winter) and two seasons (shown below in figure 3-2).

Table 3-2: Sample Bill from Southern California Edison

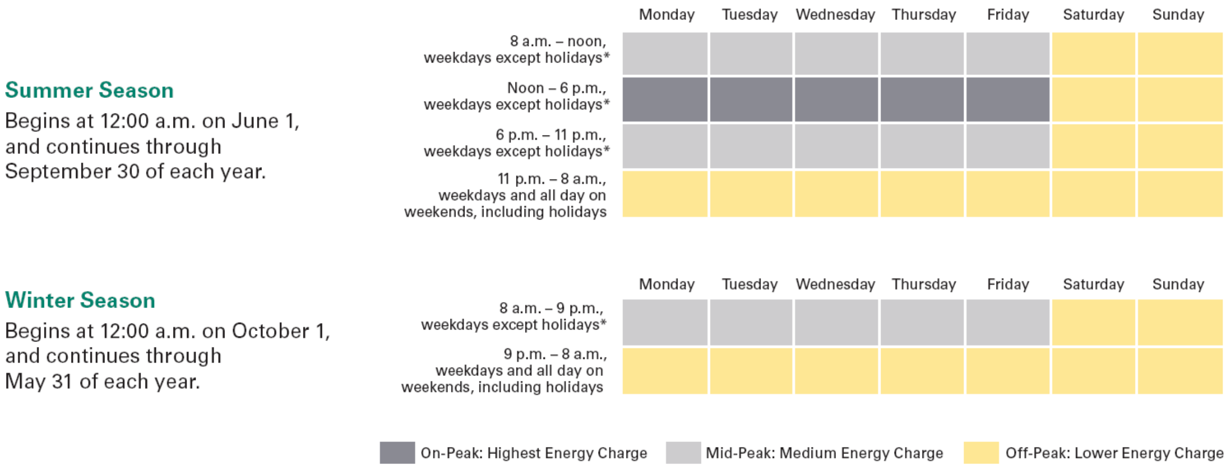
Southern California Edison (SCE) Division 18 – Bus Yard (450 W. Griffith St.) Meter: V349N-014204 Rate: TOU-8-CPP Dates: 10/18/10 - 11/17/10	
Delivery Charges	
Facility rel demand	$10,204.74
Energy - Mid peak	$1,359.66
Energy - Off peak	$2,093.75
DWR Bond Charge	$1,252.47
Customer Charge	$573.02
Power factor adj	$111.78
Generation Charges	
DWR Energy - Mid peak	$1,079.08
DWR Energy - Off peak	$1,661.70
SCE Energy - Mid peak	$4,959.53
SCE Energy - Off peak	$4,709.93
Taxes & Administration	
State Tax	$53.50
Total	**$28,059.16**
Consumption (kWh)	**243,198**
Electricity Unit Cost ($/kWh)	**$0.12**

Figure 3-2: Sample Monthly Electricity Expenditure for Division 18–Bus Yard



Rate assignment complexity requires an intricate utility bill consisting of many different delivery and generation charges. Figure 3-3 below shows the rate schedules as established by SCE.

Figure 3-3: SCE Time-of-Use Schedules



Summer Season

Begins at 12:00 a.m. on June 1, and continues through September 30 of each year.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8 a.m. – noon, weekdays except holidays*	░	░	░	░	░	🟨	🟨
Noon – 6 p.m., weekdays except holidays*	▓	▓	▓	▓	▓	🟨	🟨
6 p.m. – 11 p.m., weekdays except holidays*	░	░	░	░	░	🟨	🟨
11 p.m. – 8 a.m., weekdays and all day on weekends, including holidays	🟨	🟨	🟨	🟨	🟨	🟨	🟨

Winter Season

Begins at 12:00 a.m. on October 1, and continues through May 31 of each year.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8 a.m. – 9 p.m., weekdays except holidays*	░	░	░	░	░	🟨	🟨
9 p.m. – 8 a.m., weekdays and all day on weekends, including holidays	🟨	🟨	🟨	🟨	🟨	🟨	🟨

▓ On-Peak: Highest Energy Charge ░ Mid-Peak: Medium Energy Charge 🟨 Off-Peak: Lower Energy Charge

Source: http://asset.sce.com/Documents/Business%20-%20Rates/090202_Business_Rates_Summary.pdf

Additionally, though power is delivered solely by SCE, electricity is generated by both SCE-operated facilities and the Department of Water Resources (DWR), with a different generation rate corresponding to each share of generation.

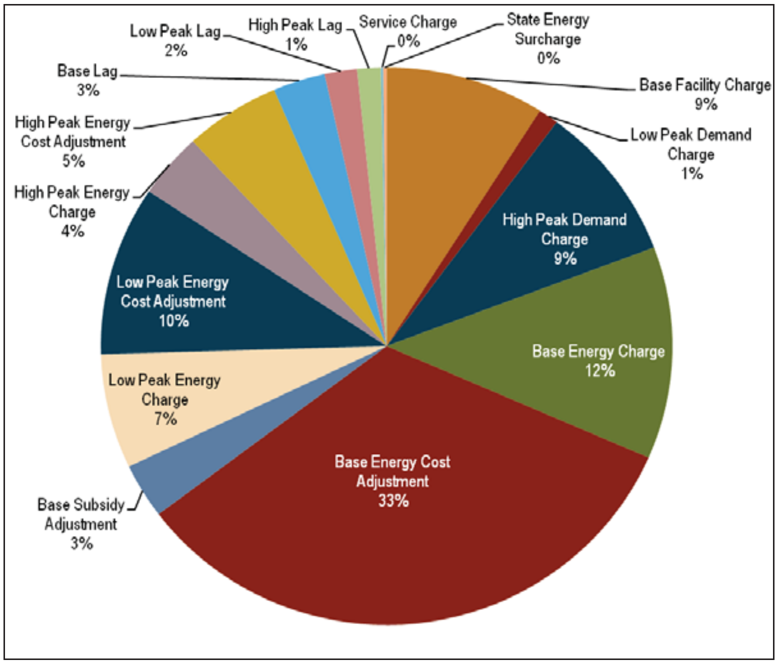
Los Angeles Department of Water and Power (LADWP)

As illustrated below in Table 3-3 and Figure 3-4, the electricity bill from Los Angeles Department of Water and Power (LADWP) for the Metro Support Services Center is even more complex than the bill from SCE discussed previously. Administrative fees and taxes are quite low, and consumption, demand, and load charges are dominant. Though only one generator (LADWP) provides the power, it utilizes a three-period rate during the current month. Despite differences in rate structures, billing terminology, and administrative costs, both SCE and LADWP charged approximately $0.12/kWh to the facilities examined during the periods shown.

Table 3-3: Sample Bill from LADWP

LADWP Location 30 – Metro Support Services Center (900 Lyon St.) Meter: ANPMYVL-2022-483 Rate: A3A Dates: 09/24/10 - 10/26/10	
Demand	
Base Facility Charge	$4,992.00
Low Peak Demand Charge	$630.00
High Peak Demand Charge	$5,056.00
Consumption	
Base Energy Charge	$6,832.45
Base Energy Cost Adjustment	$18,390.08
Base Subsidy Adjustment	$1,772.16
Low Peak Energy Charge	$3,690.24
Low Peak Energy Cost Adjustment	$5,462.40
High Peak Energy Charge	$2,091.94
High Peak Energy Cost Adjustment	$3,004.32
Kvarh	
Base Lag	$1,634.94
Low Peak Lag	$1,018.16
High Peak Lag	$739.20
Taxes & Administration	
Service Charge	$75.00
State Energy Surcharge	$103.84
Total	**$55,492.73**
Consumption (kWh)	**472,000**
Electricity Unit Cost ($/kWh)	**$0.12**

Figure 3-4: Sample Monthly Electricity Expenditure for Metro Support Services Center



As is seen in the above examples, an individual monthly utility bill may contain multiple meters, complicated time-of-day billing structures, seasonally adjusted rates and times, and a plethora of consumption, demand, and administrative fees. This complexity makes it difficult to track energy use and expenditure characteristics across a large profile and from one moment in time to another. A sophisticated system is needed to record, track, and analyze this vast amount of technical ever changing data if Metro wishes to further assess and analyze portfolio energy trends and behaviors.

3.2. Propulsion Power Rate Review

This section discusses the review of tariffs associated with propulsion power. In Sections 3.1.1 and 3.2.1, we have identified those accounts that had certain characteristics associated with traction operations. Those sections identified that propulsion accounts are covered by three electric distribution companies and seven different rate classes, as shown in Table 3-4 below. The demand and voltage ranges applicable to each tariff are provided in the following tables. Table 3-4 describes the characteristics of energy rate classes for Metro's various utility accounts. Table 3-5 shows the account and rate class for the different stations along each Metro Line and serves as the analytical basis for assessing the individual tariffs.

Table 3-4: Propulsion Rate Description

EDC	Rate Code	Demand (kW)	Voltage	Description
LADWP	A3A-87	>= 30		Sub-Transmission Service: 34.5kV system
PWP	AL2NP	>300	>17 k	Large Commercial and Industrial Service – Primary
PWP	AM1NP	30–300	<17 k	Medium Commercial and Industrial Service – Secondary
PWP	AM2NP	30–300	<17 k	Medium Commercial and Industrial Service – Primary
SCE	TOU-8-CPP	>500	2 to 50 kV	General Service - Large
SCE	TOU-GS3-CPP	200–500	2 to 50 kV	General Service - Demand Metered
SCE	GS-2-TOU-A	20-–200	2 to 50 kV	General Service – Medium to Large Commercial

Table 3-5: Propulsion Rate Class by Substation

Address	Station	Account	EDC	Rate Code
Blue Line				
660 S Figueroa Street	7th Street/Metro Center	1-63-34103-00660-00-9002-1-01	LADWP	A3A-87
1917 Stanford Avenue	San Pedro	1-43-80925-01917-00-0000-0-01	LADWP	A3A-87
1945 Long Beach Avenue	Washington	1-43-53447-01945-00-0000-1-01	LADWP	A3A-87
4415 Long Beach Avenue	Vernon	1-46-53447-04415-00-0000-3-01	LADWP	A3A-87
5865 Randolph Street	Slauson	3-010-1430-21	SCE	TOU-8-CPP
8616 Graham Avenue	Firestone	3-011-2069-83	SCE	TOU-8-CPP
1681 E 108 Street	103rd Street	1-54-93908-01681-00-0000-1-01	LADWP	A3A-87
11650 Willowbrook Avenue	Imperial/Wilmington	3-010-2270-33	SCE	TOU-8-CPP
13504 S Willowbrook Avenue	Compton	3-012-9196-94	SCE	TOU-8-CPP
507 N Willowbrook Avenue	Compton	3-010-2539-79	SCE	TOU-8-CPP
1810 S Acacia Avenue	Artesia	3-012-9197-04	SCE	TOU-8-CPP
20340 S Santa Fe Avenue	Del Amo	3-011-2088-80	SCE	TOU-8-CPP
3376 Pacific Place	Wardlow	3-012-8424-71	SCE	TOU-8-CPP
28th Street & W American	Willow	3-010-0982-78	SCE	TOU-8-CPP
333 E Esther Street	PCH	3-012-8442-79	SCE	TOU-8-CPP
150 Elm Avenue	5th St	3-013-1476-66	SCE	TOU-GS3-CPP
906 Pacific Avenue	Pacific	3-012-8424-68	SCE	TOU-GS3-CPP
2083 Santa Fe Avenue	Blue Line Main Yard	3-012-8424-67	SCE	TOU-8-CPP
1234 S Flower Street	7th Street/Metro Center	1-43-34746-01234-00-0000-101	LADWP	A3A-87
Green Line				
14724 Aviation Boulevard	Green Line Main Yard	3-013-1476-67	SCE	TOU-8-CPP
14721 Aviation Boulevard	Green Line Main Yard	3-012-8100-91	SCE	TOU-8-CPP
700 S Douglas Street	Douglas	3-008-6496-36	SCE	TOU-GS3-CPP
5380 Imperial Highway	Aviation/LAX	4-58-44749-05380-00-0000-0-01	LADWP	A3A-87
11230 S Acacia Avenue	Hawthorne	3-012-8100-92	SCE	TOU-8-CPP
3301 W 120th Street	Crenshaw	3-008-2587-49	SCE	TOU-8-CPP
11725 S Manhattan Place	Crenshaw	3-005-3807-14	SCE	TOU-GS3-CPP
11530 S New Hampshire Avenue	Vermont	3-005-3506-37	SCE	TOU-GS3-CPP

Address	Station	Account	EDC	Rate Code
11700 Belhaven Street	Avalon	1-57-08664-11700-00-0000-0-01	LADWP	A3A-87
2901 Fernwood Avenue	Imperial/Wilmington	3-005-0391-74	SCE	TOU-GS3-CPP
11500 Long Beach Avenue	Long Beach	3-005-4921-84	SCE	TOU-GS3-CPP
11750 Wright Road	Long Beach Freeway	3-005-8293-49	SCE	TOU-GS3-CPP
6170 Florence Avenue	Lakewood	3-005-7820-12	SCE	TOU-GS-3A
9733 Angell Street	Norwalk	3-013-1477-14	SCE	TOU-GS-3A
13026 Flatbush Avenue	Norwalk	3-013-1477-13	SCE	TOU-GS3-CPP
4160 Fernwood Avenue	Long Beach	3-005-6263-25	SCE	GS-2-TOU-A
12839 Lakewood Boulevard	Lakewood	3-013-1477-12	SCE	TOU-GS3-CPP
130 W 117th Street	Harbor Freeway	57-94124-00139-00-0000-001	LADWP	A3A-87
Red-Purple Line				
300 S Santa Fe Avenue	Red Line Main Yard	1-61-76752-00300-00-9006-4-01	LADWP	A3A-87
800 N Alameda Street	Union Station	1-61-00926-00800-00-9009-1-01	LADWP	A3A-87
100 N Hill Street	Civic Center	1-62-42932-00100-00-0000-1-01	LADWP	A3A-87
400 S Hill Street	Pershing Square	1-63-42933-00400-00-9001-1-01	LADWP	A3A-87
660 S Alvarado Street	Westlake/McArthur Park	1-47-02441-00660-00-0000-0-01	LADWP	A3A-87
3191 Wilshire Boulevard	Wilshire/Vermont	1-46-91800-03191-00-0000-0-01	LADWP	A3A-87
3510 Wilshire Boulevard	Wilshire/Normandie	1-62-91800-03510-00-9001-0-01	LADWP	A3A-87
3775 Wilshire Boulevard	Wilshire/Western	1-49-91800-03775-00-0000-0-01	LADWP	A3A-87
301 N Vermont Avenue	Vermont/Beverly	1-51-87724-00301-00-9002-0-01	LADWP	A3A-87
1015 N Vermont Avenue	Vermont/Santa Monica	1-57-87724-01015-00-0000-0-01	LADWP	A3A-87
1500 N Vermont Avenue	Vermont/Sunset	1-43-87724-01500-00-0000-0-01	LADWP	A3A-87
5450 Hollywood Boulevard	Hollywood/Western	1-45-43716-05450-00-0000-0-01	LADWP	A3A-87
6250 Hollywood Boulevard	Hollywood/Vine	1-56-43719-06250-00-9009-0-01	LADWP	A3A-87
6815 Hollywood Boulevard	Hollywood/Highland	1-58-43716-06815-00-9001-0-01	LADWP	A3A-87
3881 Lankershim Boulevard	Universal City	3-49-49931-03881-00-0000-0-01	LADWP	A3A-87
5420 Lankershim Boulevard	North Hollywood	3-52-49931-05420-00-9001-0-01	LADWP	A3A-87
Gold Line				
715 Fairview Avenue	Mission	3-028-1307-44	SCE	TOU-8-CPP
4970 Marmion Way	Highland Park	1-55-56992-04970-00-0000-1-01	LADWP	A3A-87
3541 Pasadena Avenue	Heritage Square	1-57-67563-03541-00-0000-1-01	LADWP	A3A-87
1802 Baker Street	Gold Line Main Yard	1-61-06809-01802-00-0000-1-01	LADWP	A3A-87
1561-1/2 N Broadway	Chinatown	1-63-12933-01561-50-9001-4-01	LADWP	A3A-87
401 Bauchet Street	Union Station	1-61-07938-00401-00-0000-1-01	LADWP	A3A-87
4025 E 3rd Street	Maravilla	3-032-8696-84	SCE	TOU-8-CPP
322 S Arizona Avenue	Maravilla	3-032-7014-29	SCE	TOU-GS3-CPP
5100 Pomona Boulevard	Atlantic	3-032-5969-45	SCE	TOU-GS3-CPP
300 Monterey Road	Highland Park	3-022-5709-02	SCE	TOU-8-CPP
57 E State Street	Fillmore	268765-5	PWP	AM2NP
3055 E Walnut	Sierra Madre Villa	272372-4	PWP	AL2NP
2152 E Maple	Allen	272648-7	PWP	AL2NP
240 S Raymond Avenue	Del Mar	297195-0	PWP	AM1NP
240 S Raymond Avenue	Del Mar	297209-9	PWP	AM1NP

Address	Station	Account	EDC	Rate Code
HSE				
167 E Walnut	Memorial Park	300459-5	PWP	AL2NP
149 N Halstead Street	Sierra Madre Villa	309165-9	PWP	AM1
309 N Michigan Avenue	Lake	288133-2	PWP	AL2NP
2310 E 1st Street	Soto	1-59-93716-02310-00-9001-0	LADWP	A3A-87
1722 E 1st Street	Mariachi	1-59-93716-01722-00-9001-0	LADWP	A3A-87

Because some rate classification information from the different utilities was unavailable, for this review and evaluation we concentrated our analysis on the demand and energy performance metrics within the known rate classifications. After evaluating the pricing aspects of the individual tariffs, we found that an in-depth analysis was appropriate for the summer months as opposed to the winter months, because energy demands are higher during the summer months in the Los Angeles region. The energy and demand prices for each tariff are provided below for both the summer and winter periods, and were gathered from the approved 2010 tariffs.

Table 3-6: Energy Prices–Summer and Winter 2010

			Summer		Winter	
EDC	Rate Code	Period	$/kWh	$/kW	$/kWh	$/kW
LADWP	A3A-87	High Peak	0.04390	9.00	0.03863	4.00
		Low Peak	0.03764	3.00	0.03863	-
		Base	0.01755	-	0.02197	-
PWP	AL2NP	On-Peak	0.08867	-	0.08867	-
		Off-Peak	0.07879	-	0.07879	-
PWP	AM1NP	All	0.08463	-	0.08463	-
PWP	AM2NP	All	0.08371	-	0.08371	-
SCE	TOU-8-CPP	On-Peak	0.09658	22.08	N/A	0.00
		Mid-Peak	0.07645	6.19	0.07175	0.00
		Off-Peak	0.04798	-	0.04314	-
SCE	TOU-GS3-CPP	On-Peak	0.11918	14.67	N/A	0.00
		Mid-Peak	0.08113	3.49	0.05736	0.00
		Off-Peak	0.05234	-	0.03954	-
SCE	GS2-TOU-A	On-Peak	0.41035	12.25	0.41035	0.00
		Mid-Peak	0.14486	-	0.07430	-
		Off-Peak	0.04543	-	0.04543	-

Using the information made available through the individual utility's tariff, it was difficult to evaluate the individual pricing points because they are based on the individual utility company's cost of service, which is approved by the state regulators. In the future it may prove beneficial for Metro to request these cost of service documents to review the makeup of the energy and demand pricing. Also, consideration should be given to an evaluation of the distribution costs associated with the delivery of the electric supply.

Included within our evaluation of the tariffs is a "sanity check" on the invoice billing associated with each of the tariff components dealing with generation supply. In comparing energy prices per utility, LADWP prices are consistently lower than their counterparts. LADWP is a local municipal authority and, as such, is not subject to the normal pricing aspects of the CAISO, while the other utilities come under those pricing points.

In reviewing the usage and demand pricing aspects of the individual tariffs, we were limited to the information provided within the published and approved tariffs of the utility companies. A review of each classification's cost of service would be required to determine if these published prices are accurate. Due to time constraints, and the difficulty of obtaining these documents without a more detailed discussion with the respective utilities, this level of in-depth review was not completed. However, we recommend that this issue along with the following point be investigated further in the future, as discussed below.

3.2.1. Conjunctive Billing

We found that one important aspect of the review deals with each utility company billing demand for each substation for the metered level recorded for that injection point. This is highly irregular for train/transit operations – it is well documented that transit/traction operations are much better served through *conjunctive* demand billing.

Utility companies typically treat transit service providers the same as regular industrial or commercial services. However, they are not the same. For example, for a power source connected directly to a commercial facility, demand is accumulated with the highest peak level recorded, and the prices reflected to the end user at that stagnant location. In the case of transit operations (electrified rail), the train moves and remains in motion while passing through all of the substation injection points along the line. This should reflect the demand/capacity level remaining the same no matter how far the train travels. For example, if it is assumed that although one train peaks at 1 MW of demand and moves through eight injection points, it does not create 8 MW of demand. Rather, it takes 1 MW of capacity to make the total run. Based on this example, Metro bills reflect 8 MW of demand, and this is precisely the way that supplier utilities currently charge Metro. Although this is a very rudimentary example, this scenario can be discussed with the utilities. We have investigated these possibilities and found that there are other agencies that have experience with this particular issue and have worked through this with their respective utility companies.

3.2.2. Recommendations

Based on the preceding discussion, there are three basic actions that Metro can take:

Recommendation 3.2-1

Initiate a dialog with each of the utility companies to delve further into the aspect of tariff review. There needs to be a cooperative effort between Metro and the utilities to maintain low energy costs for transit and support the growth of the operation at minimal energy pricing. Metro should request from each utility an examination of their cost of service documents to determine transparency, adequacy of pricing definition, suitability for rail transit operations, and negotiation possibilities.

Recommendation 3.2-2

Operationally determine the actual demand level by individual train or locomotive car. With this as a starting point, a conjunction level of demand can be determined, and with that determination a two-step approach should be made:

(a) discuss these levels with the CAISO to determine how they are interpreting the ways individual demand levels are determined (and should be determined) by the individual utilities, and

(b) approach the individual utility companies to get their view on demand calculations.

Recommendation 3.2-3

Initiate a dialog with each of the utility companies to deliver all interval data and metered demand and usage information electronically in a format that can be used to integrate with operations data into a traction/propulsion energy management reporting system.

3.3. Facility Electricity Rate Review

This section examines the rates of Metro's facility electricity meters in SCE and LADWP utility territories in order to identify potential areas of savings and to suggest a regular process of electric rate review that Metro can implement for its facility accounts. Rates for PWP were not included in this analysis as the share of electricity consumed by Metro from PWP was low compared to the other utilities. The analysis is being conducted at the macro and the micro level, but it is not a comprehensive review/audit.

SCE

Metro accounts with SCE fall into eight different rate schedules as reported by the utility. Of those eight, four particular rate classes account for the significant majority (43) of the accounts. The remaining accounts are primarily served by different classifications of lighting-only schedules. The four rates most commonly used are summarized below.

Table 3-7: SCE Rate Classes – Four Most Commonly Used

	SCE Rate Classes			
Rate	**GS-1**	**GS-2**	**TGS3-CPP (TOU-GS-3-CPP)**	**TOU-8-CPP**
Number of Meters	28	8	2	5
Average Energy Rate	$0.163/kWh	$0.120/kWh	$0.101/kWh	$0.137/kWh
Description	General Service Non-Demand	General Service Demand	Time-of-Use - General Service - Large	Time-of-Use - General Service - Large
Demand Eligibility	20 kW and less	Between 20 and 200 kW	Between 200 and 500 kW; Bundled Service Customers	500 kW and greater; Bundled Service Customers
Rate Type	Seasonal	Seasonal	Seasonal	Seasonal
Customer Charge	Charge per meter, per month	Charge per meter, per month	Charge per meter, per month	Charge per meter, per month
Demand Charge	None	Facilities-related	Facilities related; On-peak & mid-peak demand charges	Facilities related; On-peak & mid-peak demand charges
Energy Charge	Lower in winter, higher in summer	Lower in winter, higher in summer	On-peak, mid-peak, and off-peak energy charges that are lower in winter and higher in summer; during CPP events, on-peak energy charges are significantly higher.	On-peak, mid-peak, and off-peak energy charges that are lower in winter and higher in summer; during CPP events, on-peak energy charges are significantly higher.
Other Options			Power factor adjustment per kVar; CPP: 9-15 events per summer, each from 2 p.m. to 6 p.m.	Power factor adjustment per kVar; CPP: 9-15 events per summer, each from 2 p.m. to 6 p.m.

The most common schedule is GS-1, which serves low demand meters and offers the least complicated billing process. The average energy cost is well above the overall SCE and Metro averages.

Accounts currently on a GS-1 schedule have the option of TOU metering that provides reduced rates during times of low system demand and higher rates during peak hours. An interval meter that tracks consumption by time-of-day must be installed and is subject to availability. The differences in the two rates are outlined below.

Table 3-8: SCE Rate Classes – Current and Alternative for GS-1

	SCE Rate Classes	
Rate	**Current: GS-1**	**Alternative: TOU-GS-1**
Description	General Service Non-Demand	General Service Non-Demand
Demand Eligibility	20 kW and less	20 kW and less
Rate Type	Seasonal	Seasonal; Optional for GS-1
Customer Charge	Charge per meter, per month	Charge per meter, per month
Demand Charge	None	None
Energy Charge	Lower in winter, higher in summer	Time-of-Use: On-peak, mid-peak, and off-peak energy charges are lower in winter, higher in summer.
Other Options		Interval meter required (subject to availability)

Another popular rate is the GS-2 schedule, which features facilities with slightly higher demand than GS-1 and that are now charged an additional fee based upon monthly demand characteristics. Unlike the GS-1 rate, the average GS-2 energy cost is around the SCE and Metro average. Also, as is the case with the GS-1 schedule, GS-2 facilities may choose to participate in TOU billing with the installation of an interval meter. The GS-2 and alternative TOU rate are compared below.

Table 3-9: SCE Rate Classes – Current and Alternative for GS-2

	SCE Rate Classes	
Rate	**Current: GS-2**	**Alternative: GS-2-TOU**
Description	General Service Demand	General Service Non-Demand
Demand Eligibility	Between 20 and 200 kW	Between 20 and 200 kW
Rate Type	Seasonal	Seasonal; Optional for GS-2
Customer Charge	Charge per meter, per month	Charge per meter, per month
Demand Charge	Facilities-related	Facilities-related; On-peak & mid-peak demand charges
Energy Charge	Lower in winter, higher is summer	Time-of-Use: On-peak, mid-peak, and off-peak energy charges are lower in winter, higher in summer.
Other Options		Interval meter required (subject to availability)

Because no Metro accounts are currently under the TOU-GS-1 and GS-2-TOU schedules, it is difficult to assess potential savings by comparing current GS-1 and GS-2 facilities against their rate class, demand, and consumption peers. Existing TOU account information for comparable facilities would provide the necessary granular data for a more thorough analysis and predictive model. TOU rates may lead to cost savings if the facilities operate on an extended day or 24-hour schedule where a significant portion of electricity consumption occurs during mid- and off-peak times that have corresponding lower rates.

However, it is possible that a TOU rate may result in higher electricity costs for a facility, though this cannot be determined without more data about the operations of the portfolio as a whole and the unique operating characteristics of each individual facility. Metro may consider converting a few GS-1 and GS-2 facilities to a TOU rate to assess what billing savings may occur based upon the trial data.

For medium-sized commercial and industrial accounts, the TGS-3-CPP (also known as TOU-GS-3-CPP) applies. At this demand level, TOU pricing is mandatory for all customers and is thus the default for Metro facilities with demand between 200 and 500 kWh. Without the option to convert to a different rate, savings are largely realized by optional programs offered by SCE. In the case of the SCE accounts, the Critical Peak Pricing (CPP) option has been elected. Under the CPP program, SCE offers a lower monthly on-peak demand charge during the summer in exchange for flexibility in reducing demand during specified critical periods. SCE will contact Metro by 3:00 PM on the day prior to a scheduled CPP event, which occur 9 to 15 times each summer. A number of scenarios lead to the anticipation of a CPP event on the following day, often triggered by production issues or forecasted high temperatures. When SCE anticipates these events, the customer is given prior notice and asked to reduce demand during the upcoming specified time period. During the CPP event, energy charges increase significantly, in an attempt to affect consumer behavior and reduce demand. As long as a CPP program participant successfully reduces demand during the CPP event period, they will avoid significantly increased energy charges while benefiting from lower demand rates during non-CPP event times. SCE also offers bill protection, assuring that a customer will not see an increased bill of comparable demand and consumption under the CPP plan for the first 12 months. This allows for a trial period to develop policy and required actions to reduce demand when needed.

Five meters are also on the TOU-8-CPP rate schedule, which is identical to the TOU-GS-3-CPP schedule except it includes facilities with demand greater than 500 kW. The TOU-8-CPP rate schedule results in Metro energy rates that are lower than the overall SCE and Metro accounts, while the TOU-GS-3-CPP rate schedule is higher. Without more information about the particular facilities that are serviced by these rates, it is difficult to determine what may lead to this situation. It is possible that some facilities lack the ability to reduce demand significantly during CPP event periods and are thus penalized under the significantly higher energy charges. A more thorough analysis would be required to determine if all accounts should remain in the CPP option or if operational policy and procedural changes at some facilities are needed to take advantage of this unique program.

LADWP

Metro accounts with LADWP fall into six different rate schedules as reported by the utility. Of those six, two particular rate classes account for the significant majority (50) of the accounts. The two rates most commonly used are summarized below.

Table 3-10: LADWP Rate Classes – Most Commonly Used

	LADWP Rate Classes	
Rate	**A-1A**	**A-3A**
Number of Meters	55	14
Average Energy Rate	$0.115/kWh	$0.125/kWh
Description	General Service Demand	General Service Demand
Demand Eligibility	30 kW and less	30 kW and greater
Rate Type	Seasonal	Seasonal
Customer Charge	Charge per meter, per month	Charge per meter, per month

	LADWP Rate Classes	
Rate	**A-1A**	**A-3A**
Demand Charge	Facilities-related	Facilities related; High-peak & low-peak demand charges
Energy Charge	Lower in winter, higher in summer	High-peak, low-peak, and base energy charges that vary by season
Other Options		An additional Reactive Energy Charge is assessed if demand exceeds 250 kW

The most common schedule is A-1A, which serves low demand meters and offers the least complicated billing process. The average energy cost is on par with the overall LADWP and Metro averages.

Accounts currently on an A-1A schedule have the option of TOU metering that provides reduced rates during time of low system demand and higher rates during peak hours. The differences in the two rates are outlined below.

Table 3-11: LADWP Rate Classes – Current and Alternative Rates for A-1

	LADWP Rate Classes	
Rate	**Current: A-1A**	**Alternative: A-1B**
Description	General Service Demand	General Service Demand
Demand Eligibility	30 kW and less	30 kW and less
Rate Type	Seasonal	Seasonal; Optional for A-1
Customer Charge	Charge per meter, per month	Charge per meter, per month
Demand Charge	Facilities-related	Facilities-related
Energy Charge	Lower in winter, higher in summer	High-peak, low-peak, and base energy charges that vary by season

Because only a handful of Metro accounts are currently under the alternative A-1B schedule, it is difficult to assess potential savings by comparing current A-1A facilities against their rate class, demand, and consumption peers. As was discussed prior in regards to optional TOU rates for SCE accounts, Metro may consider converting a few A-1A facilities to a TOU rate to assess what billing savings may occur based upon the trial data and the handful of existing A-1B accounts.

Another popular rate is the A-3A schedule, which features facilities with slightly higher demand than A-1A and that are now charged based upon a TOU seasonal structure. Similar to the A-1A rate, the average A-3A energy cost is around the LADWP and Metro average. Although an alternative non-TOU rate, A-3B, was previously available to customers with demand of 30 kW or greater, the deadline of January 1, 2011, has since passed where all A-3 accounts are phased into the now mandatory TOU schedule. The one account with LADWP that was on the A-3B schedule as shown in the utility map is likely to have already been transferred to A-3A after January 1.

The descriptions above of SCE's and LADWP's rates for Metro's facility electricity meters should provide direction to Metro for its budgeting of electricity costs, as well as for its review of energy efficiency and renewable energy investments. On the latter point, when Metro gets to the point of assessing individual efficiency and renewable projects, it is very useful to calculate their savings against particular utility rate structures (demand charges, time-of-use, etc.) as opposed to against a simple average electricity price.

3.3.1. Connection to Earlier TriStem Reports on Metro Electricity Rates

Metro hired an outside firm, TriStem, to conduct reviews of the agency's electricity rate billings on certain individual accounts between 2008 and 2010.[10] Many of TriStem's initial findings were related to potential utility over-billings on PWP and potential rate improvements or irregularities in LADWP and SCE utility account billings. TriStem identified some billings that were corrected to Metro's benefit, and found most of the accounts flagged for further review were on the appropriate rate schedules with the given utility. Metro has already taken steps to address any unresolved items within TriStem's review. The electricity rate review in this section is less an audit of accounts, which was the intent of the TriStem work, than a description of electricity rate structures for Metro and how the agency can manage and plan costs within those rate structures now and as an ongoing process into the future. Additionally, this section's rate review focuses only on those accounts clearly identified as facility (non-propulsion) accounts. Propulsion electricity accounts are reviewed in Section 3.2.

3.3.2. Competitive Market Supply under Southern California Edison Direct Access Program

California expanded competitive electricity supply within the territories of the state's large investor-owned utilities, including SCE, which serves approximately 30% of Metro's load. This expansion of the competitive electric market (called "Direct Access") was authorized under Senate Bill 695 signed into law on October 11, 2009, and allows a capped percentage of non-residential customers to have the choice of taking the generation portion of their service from a competitive (non-utility) supplier. The utility's distribution and reliability service obligations to customers do not change under Direct Access. The difference is that competitive suppliers, rather than SCE itself, would be responsible for arranging electricity delivery to the edge of SCE's distribution system for their Direct Access customers and would arrange pricing and other contract terms with the customers for the non-distribution portions of the electric rates. Direct Access customers still pay SCE for distribution and associated services at appropriate published utility rates.

The Direct Access program re-opened in April 2010, and has an annual cap on the volume of Direct Access customers that can participate. That annual participation cap, which was quickly reached for the current year, rises each year for 4 years. The cap was instituted to assist SCE in managing load migration and to protect state businesses from the potential volatility of a fully competitive marketplace.

Metro has, to date, either elected not to participate in the SCE Direct Access program and/or been shut out of participation by the caps. For Metro at this time, if it could even achieve participation in the program, the benefits of SCE Direct Access would likely be limited. This is because:

- Only roughly 30% of Metro's load is on SCE.
- Only a limited percentage of SCE load is allowed to participate under the caps.
- The caps have, to date, been reached very quickly.

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[10] See TriStem, "Utility Bill Audit for Los Angeles County Metropolitan Transportation Authority: Audit Overview," December 31, 2008; TriStem, ""Report to Los Angeles Metropolitan Transport *(sic)* Regarding Billing for Electricity by City of Pasadena," December 14, 2009; and TriStem, "Utility Bill Audit for Los Angeles County Metropolitan Transportation Authority: Final Report," May 31, 2010. These were the substantive summary TriStem reports provided to the authors of this ECMP.

- One of the principal benefits of the Direct Access program is the ability to hedge (e.g., via fixed-price contracts) generation costs, and hedging a small slice of agency electricity costs (e.g., 1% to 10%) for a year or two would have minimal effects.[11]

With little chance of a sizable share of Metro's total, agency-side electricity load being in the Direct Access program within the next couple of years, pursuing this program as a way to manage the level or volatility of electricity costs is not recommended as a high priority for the Energy Management function. If SCE expands its rate caps in the future to allow ready and predictable entry into the program, and/or LADWP's market opens considerably to competitive supply through a program like Direct Access, it may be worthwhile for Metro to devote resources to studying the pros and cons of such programs in greater depth.

3.3.3. Micro-Level Review of Selected Metro Facility Electricity Accounts

This subsection describes the review process conducted for a few of Metro's largest accounts, including its Gateway facility and the Metro Support Services Center (MSSC). The purpose of this micro-level account review is to provide a more detailed snapshot of rate issues on selected accounts.

In the process of reviewing rates at the MSSC, one sizable potential irregularity was identified. In late August 2010, MSSC's usage and demand shifted between its two LADWP meters. The previously more heavily used meter became much more lightly used, and vice versa. Specifically, a meter that had not registered a peak demand of more than 384 kW in the prior year shot up to peak demands of 500 kW to over 1,100 kW beginning in late August 2010, when the second meter's demand dropped to zero for a time before going back to levels of roughly 50 to 100 kW.

This pattern is important because one of LADWP's billing charges (its Facilities Charge) is based on trailing 12-month peak demand (i.e., the highest peak 15-minute demand of each meter over the past 12 months). So, both MSSC meters will be paying a large meter Facilities Charge for about 11 months after the load shifted between the meters. The total economic effect of this extra charge on the now smaller meter is estimated to be about $40,000 to the detriment of Metro.[12] Depending on the circumstances of the load shifting between the meters, Metro may wish to further explore this issue.

No noteworthy circumstances have been identified to date on the two primary Gateway electricity meters on the LADWP system.

Turning to SCE, another example of the usefulness of interval data is demonstrated by Figure 3-5 below for one of Metro's Division 7 Bus Yard meters.

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[11] Section 3.4 on Electricity Hedging and Price Risk Management describes the pros and cons of hedging through the SCE Direct Access program at greater length.

[12] The Schedule A-3A rate that LADWP applies to the Metro Support Service Center (MSSC) has a monthly Facilities Charge of $4 per kW that "shall be based on the highest demand recorded in the last 12 months, but not less than 30 kW." Los Angeles Department of Water & Power, Electric Rates, Schedule A-3 Subtransmission Service, http://www.ladwp.com/ladwp/cms/ladwp001753.jsp (rate schedule accessed March 2011). The total effect of this load shift between the two MSSC meters could be an additional almost 900 to 1,000 kW/month for 11 months on the meter with now-smaller demand at $4/kW, which sums to approximately $40,000.

Figure 3-5: Electricity Interval Data for one of Division 7 Bus Yard's Meters

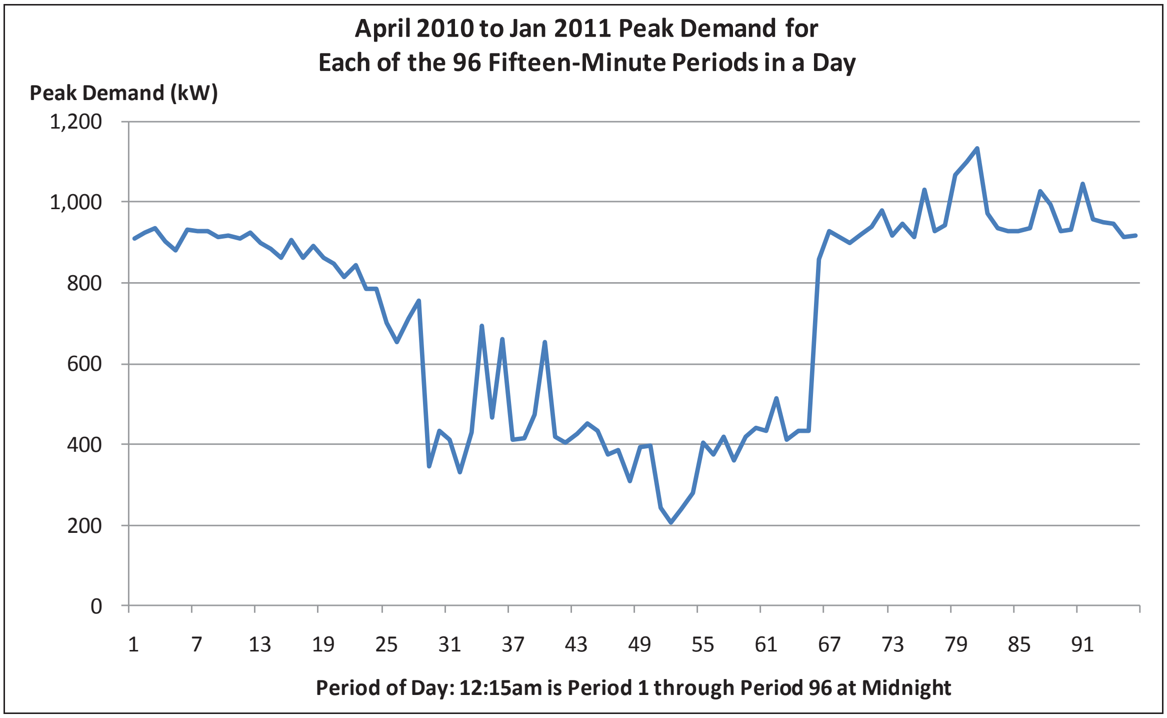

Figure 3-5 above shows the peak demand over a recent 10-month period for each 15-minute interval during the day.[13] From a rate review perspective, the most relevant part of the graph is probably the limited number of periods when demand peaks above 1,000 kW. To the extent that Metro could reduce its peak demand, even by 5%, it could realize substantial savings. This is because a large portion of Metro's TOU-8-CPP utility rate for this meter and others like it is based on peak demand, irrespective of electricity consumption.

These issues at MSSC on the LADWP system and at the Division 7 Bus Yard on the SCE system are demonstrations of the basic usefulness of "interval data"—usage, demand, and other data collected every 15 minutes by the utility on certain accounts, and/or by Metro's own sub-meters on its side of the utility meters. In these cases, the interval data helped pinpoint the dramatic change in MSSC facility activity between its two meters and the times of maximum demand at the Division 7 Bus Yard. Metro's sub-metering initiative, already underway well before this ECMP, will be very supportive of more widespread energy analyses using interval data.

3.3.4. Process Flow Chart for Ongoing Review of Facility Electricity Rates

In order to manage facility electricity rates, a sample review process that Metro can follow or modify on an annual or bi-annual basis is described in Figure 3-6 below. Because Metro's larger facility electricity meters such as Gateway and the MSSC represent a sizable share of the agency's annual facility usage and because Metro's electricity rates tend to be complex, Metro may wish to simplify any review process

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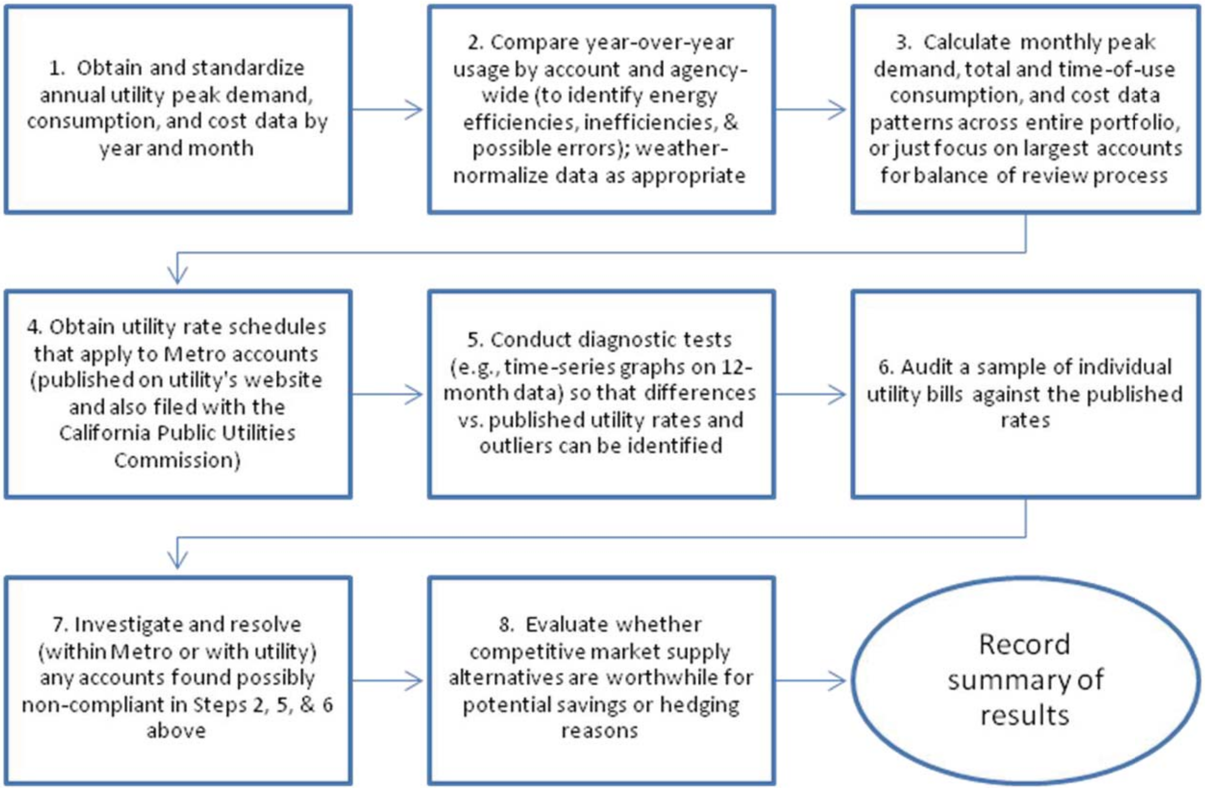
[13] In other words, the graph displays the highest electricity demand recorded during the 1pm interval over the entire 10 months from April 1, 2010, through January 31, 2011; the highest recorded for the 1:15pm interval during those months; the highest for the 1:30pm interval; and so forth for the 96 intervals of 15 minutes in a day.

by initially focusing on a subset of its largest accounts.[14] After that initial work, Metro can determine if follow-up on a larger set of facilities is warranted.

Figure 3-6: Facility Electricity Gas Rate Review Process



3.3.5. Recommendations

Metro’s facility electricity rates are quite complex on both the LADWP and SCE utility systems, with many types of charges on each month’s bill, such as different summer vs. winter rates, different rates depending on the time of day, power factor charges, and demand charges (sometimes for a year at a time) determined by 15-minute peak demand. In light of that complexity, the principal recommendations of this section are:

Recommendation 3.3-1

Consider TOU pricing for SCE accounts currently under the GS-1 and GS-2 rate schedules and LADWP accounts under the A-1A and A-3A rate schedules. Analyze individual facilities to see if significant operations occur during off-peak hours in order to take advantage of lower energy costs. Convert a select number of facilities to TOU pricing to determine if cost savings may be realized across the portfolio using this experimental data.

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[14] This recommended process is similar to the one suggested for Metro’s Facility Natural Gas accounts in Section 3.5.5, though the natural gas rate review should be much easier to conduct than the electricity review due to the fact that Metro has significant electricity load on two electric utilities (LADWP and SCE) but only one natural gas utility, Metro’s electricity rates for large accounts have many more billing components than its natural gas rates, and facility electricity costs are many times larger than Metro’s facility natural gas costs.

Recommendation 3.3-2

Thoroughly analyze operations at SCE CPP rate schedule facilities to determine if this unique rate structure with mandatory demand shaving is optimal for each facility's unique function.

Recommendation 3.3-3

Metro's Energy Management function should understand its electricity rate structures—especially the large billing components—in order to accurately forecast future electric costs and to assess the effect of energy efficiency and renewable energy investments in a thorough and precise manner.

Recommendation 3.3-4

There is no need to complicate Metro's management of facility electric rates by pursuing SCE's Direct Access (competitive supply) market at this time. This is because Metro has only roughly 30% of its electricity load on the SCE system, and there is currently a fully subscribed cap on participation in the competitive program. The chances of Metro being able to hedge or otherwise manage a sizable share of its overall electricity costs through the SCE Direct Access program at this time are very low. If the SCE program expands significantly and matures, it may be more worthwhile for Metro to pursue it.

Recommendation 3.3-5

Metro should continue to emphasize its sub-metering efforts already underway, which are an excellent extension of the meter-level interval data (showing Metro's electricity demand and usage every 15 minutes) already available from LADWP and SCE.

Recommendation 3.3-6

On an annual or bi-annual basis, Metro may wish to conduct a structured review process on its facility electricity rates along the lines described in the prior subsection. The initial focus of such a review should be the largest facility meters.

3.4. Electricity Hedging and Price Risk Management

Electricity costs amount to approximately $30 million annually for the agency. Since hedging and price risk management (hedging) techniques are tools for potentially stabilizing and adding predictability to Metro's electricity costs, this section evaluates their pros and cons in light of the new Energy Management function described in Section 4. Such hedging evaluations are common elements of energy plans for large governmental agencies.

3.4.1. Descriptions of Physical, Financial, and Renewable Energy Hedge Transactions

Hedging and price risk management refers to practices whereby Metro would stabilize a portion of its electricity costs through physical supply transactions with competitive electric suppliers; through purely financial transactions with energy trading companies, banks, or insurers; and/or through renewable energy investments on its property.

A 1-year fixed-price transaction with a competitive, third-party electricity supplier for Metro's load on the SCE utility system would be an example of a physical hedge. The 1-year fixed price (which would apply to the generation portions of Metro's costs only) could replace SCE's various monthly generation charges. Under such a physical supply arrangement, the third-party supplier would essentially drop off the appropriate amount of power for Metro's needs at the edge of the SCE distribution system, and SCE would then accept that power and deliver it for Metro's needs. Such a physical supply transaction would not change SCE's service reliability obligations to Metro, and the power would still move through SCE's distribution system to reach Metro's propulsion and facility meters. Metro and the competitive supplier would be free to arrange the price, contract duration, and other terms subject to relevant laws and regulations.

Eligibility to participate in such competitive market physical supply transactions (called Direct Access in SCE territory) is capped, and that cap for the current period has already been reached. As a practical matter, competitive, physical supply is not currently available on the LADWP system, where Metro has the majority of its electricity load. The present restrictions on competitive electricity supply in California markets reflect, in part, a desire to avoid the disruptions caused by the California electricity crisis of a decade ago, when the state's electricity market was significantly deregulated and competitive.

While Metro's practical ability to enter into physical electricity supply hedges is restricted, the agency could more freely pursue purely financial hedges. Financial transactions, such as a swap of a known generation fixed price for a floating (daily or monthly) generation price index could potentially be completed with large banks, insurers, or energy trading companies. Metro previously entered into similar swaps covering approximately 95% of its annual exposure to natural gas costs (principally for its CNG bus fleet)[15]. Beyond simple fixed for floating swaps, there may also be opportunities for Metro to buy call options that would establish maximum prices on its generation costs, collars that would establish a price range for the generation portion of its electricity costs, and several other hedging products. Such financial products would likely be available across Metro's SCE, LADWP, and/or PWP load.

Renewable energy installations can offer a known average, or levelized, price for electricity over their useful lives if owned outright, or a known annual price for many years into the future if contracted under a long-term lease or power purchase agreement. Leases or power purchase agreements typically have scheduled starting (Year 1) prices and annual percentage price escalations that are established for up to 25 years at contract signing. Renewable energy investments, whether solar photovoltaic (PV), geothermal, wind, or other technologies, can fix costs for approximately the percentage of Metro's total electricity load that they represent.[16]

Table 3-12 below portrays the pros and cons of three electricity hedging approaches and is followed by narrative sections separately describing the benefits (Section 3.4.2) and the limitations and drawbacks (Section 3.4.3) of electricity hedging programs.

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[15] See Los Angeles County Metropolitan Transportation Authority (Metro), Comprehensive Annual Financial Report for the Fiscal Year Ended June 30, 2009, Notes to the Financial Statements. http://www.metro.net/about_us/finance/images/cafr_2009.pdf, pages 93-94; and "Metro, Compressed Natural Gas Hedging Program" adopted March 2007, http://www.metro.net/about_us/library/images/Compressed%20Natural%20Gas%20Hedging%20Program.pdf.

[16] Renewable energy projects are discussed in greater length in Section 3.7. Solar water heating, as opposed to solar PV and other renewable technologies that generate electricity, often displaces and hedges whatever energy source is used to heat water (e.g., natural gas).

Table 3-12: Overview of Pros and Cons of Three Electricity Hedging Approaches

Electricity Hedging Approach	Potentially Positive Factors	Potentially Negative Factors
Physical, Competitive Market Supply (with fixed pricing)	• SCE Direct Access program overseen by CA Public Utility Commission • May have desirable terms & conditions in addition to providing price stability	• Limits on participation in SCE • Not practical yet in LADWP • Overhang of CA electric crisis & risk of changing regulation • Counterparty risk • Uncertainty in Metro load forecasting • Added duty/distraction to Energy Management function
Financial Product (e.g., fixed-price for index-price swaps)	• Flexibility to stabilize prices for various periods • Selection of hedging products • Scalable for high % of Metro load	• Tracking error (basis risk) • Counterparty risk • Possible Metro balance sheet obligations • Uncertainty in Metro load forecasting • Potential for additional fees •
Renewable Energy Investment	• Known electric prices for 20+ years • Purchase, lease, or PPA options • GHG reduction & other environmental benefits • Displaces distribution, as well as generation costs • Can generate cost savings	• Metro capital required for purchase/ counterparty required for lease or power purchase agreement (PPA) • Uncertainty in Metro load forecasting • Procurement and possible O&M effort required • Limits on viable sites/scale

3.4.2. Potential Benefits of a Metro Electricity Hedging Program

The primary benefit of an electricity hedging program is that it could provide much greater year-over-year budget certainty to Metro regarding its electricity costs. Electricity hedging, especially a financial hedging approach that applied to Metro's SCE, LADWP, and PWP load, could fix or establish a ceiling price for much of the agency's generation costs. Generation—the cost of actually generating the electricity—would typically be the largest electricity cost element and the one with the most price variability.[17] The variability, or volatility, of generation costs is, in turn, driven by the volatility of costs for the marginal fuels (e.g., natural gas) used by generators in Metro's region.

An effective hedging program would attempt to stabilize a percentage (up to 100%) of Metro's generation costs for a period of months or years. Combining (a) that generation hedge, (b) reasonable estimates of distribution and other utility rates, and (c) estimates of Metro's future electricity consumption and demand, could meaningfully increase the precision of Metro's electricity budget forecasts. That budget precision could, in turn, contribute to greater rate certainty for Metro's riders and greater overall energy planning certainty for Metro's Energy Management function.

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[17] While Metro could conceivably financially hedge the other main elements of its electricity costs—including distribution of power within the utility's system—doing so would be unusual, challenging in finding the appropriate underlying index, and likely expensive relative to the benefits. Distribution costs are not typically volatile from month-to-month or year-to-year.

While a deregulated physical supply or financial hedging program could stabilize costs, it would not be deployed in order to reduce costs. Aiming for cost reductions in tandem with long-term cost predictability implies that Metro could outguess the electricity market on average.[18]

Metro could also improve its electricity budget predictability through further investments in renewable energy projects. Metro is a leader within the transit community with several sizable solar installations amounting to about 2,000 kW in peak capacity, and these PV installations already provide known future costs for their electricity output along with their considerable environmental benefits. In addition to stabilizing costs, the solar installations generate cost savings to Metro when compared to conventional utility supply.

3.4.3. Limitations and Drawbacks of a Metro Electricity Hedging Program

The analysis of electricity hedging programs points to several possible limitations or drawbacks of such programs that should be considered in the context of Metro's ECMP. Several of these negative factors are particular to the electricity commodity itself and to the legacy of California's experience with electricity deregulation 10 years ago; these negative factors would not apply equally to natural gas hedging programs at the agency.

The potentially negative factors discussed below should be weighed against the price stability benefits of an electricity hedging program.

1. **Tracking Error of Financial Hedges (also called Basis Risk)** results when a hedge does not closely track or match its intended target and, therefore, does not eliminate the price volatility it intends to eliminate. Because Metro's electricity generation charges variously consist of usage (around-the-clock on certain rate schedules and at different times of day on other rate schedules) and of peak demand charges, there will be difficulty finding simple electricity indices against which to benchmark and financially hedge Metro's electricity costs.[19]
2. **Regulatory Risk** exists for physical electricity supply contracts in the competitive market. While physical supply contracts can overcome the tracking error limitation for generation costs, such contracts are not practically available in LADWP territory at this time, and the current cap on competitive market participation has been reached in SCE territory. Because the California electricity market has cautiously re-opened to competitive supply, there is more regulatory risk of changing market rules than may exist in states with more mature and stable deregulated electric markets. Additionally, hedges of any sort do not typically apply to the local distribution, fixed-fee, and other portions of electricity costs (up to roughly 50% of total electricity costs).
3. **Counterparty Risk** would occur because Metro would be contracting with one or more additional companies (beyond its electric utilities SCE, LADWP, and PWP) if it entered into financial or physical hedges for its electricity supply. Metro would need to do an initial credit evaluation of the financial health of its new counterparty and monitor that financial health to ensure that the counterparty stays solvent so it can deliver on its contractual price commitments to Metro. For

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[18] Sections 3.2, 3.3, 3.5, and 3.6 on, Propulsion Electricity Rate Reviews, Facility Electricity Rate Reviews, Facility Natural Gas Rate Reviews, and Energy Efficiency (respectively) describe available methods for managing Metro's electricity costs without taking on additional market price risk.

[19] This limitation is largely absent in natural gas hedging programs, since the commodity portion of gas bills are often strictly usage-based. This is one of the reasons that Metro's existing compressed natural gas (CNG) financial hedging program for its bus fleet could readily be expanded to incorporate Metro's facility natural gas volumes (see Section 3.5.5).

renewable energy projects that Metro leases or off-takes through a power purchase agreement, it would also have a long-term counterparty.

4. **Balance Sheet Obligations** by Metro could occur implicitly or explicitly with a financial electricity hedge or a renewable energy investment. In the case of a financial hedge, Metro may be required to post collateral or a letter of credit to the extent that its hedges are out-of-the-money (worth less than zero as stand-alone contracts) at any point. (Metro's counterparty may be required to do likewise to the extent that the hedges are in-the-money). Such collateral may be surrendered to the other party in the event of a financial transaction termination due to solvency or other legal events. In the case of renewable energy project purchases, Metro equity capital and/or debt would likely be required.
5. **Uncertainty of Electricity Load Forecasting** at Metro would impede the relevance of hedges. Measure R growth will make future electricity usage at Metro somewhat difficult to predict during the next several years. Effective hedges depend on having known electricity volumes because a hedge usually involves a certain volume over a certain time at a certain price or price range.
6. **Fees** can be associated with financial hedges that would be additional to fees embedded in utility or competitive supplier physical supply. These fees usually increase with the complexity of hedging tactics selected.
7. **Distraction of Metro's Energy Management Function** could arise as individuals charged with implementing this ECMP and other agency initiatives direct attention to developing a strategy for electricity hedging, contracting for the hedges, monitoring the electricity hedges, and managing the procurement and maintenance of renewable energy installations.
8. **Scale Limitations** would likely exist on the percentage of Metro's electricity consumption that could be offset through viable renewable energy sites.

3.4.4. Recommendations

Based on the preceding discussion, the three recommendations are:

Recommendation 3.4-1

Metro should not pursue any new electricity hedging and price risk management initiatives at this time, except those arising from renewable energy investments.[20] There are several potentially significant limitations and drawbacks to implementing an electricity hedging program within Metro through deregulated physical supply or financial transactions. The negative factors associated with electricity hedging, including distracting the Energy Management function within Metro from more important cost- and GHG-reduction actions, far outweigh the principal hedging benefits of greater stability and predictability for Metro's energy budget.

Recommendation 3.4-2

For renewable energy installations owned or leased long-term by Metro, the attendant price predictability (through known capital costs or lease payments) adds to the value of the renewable projects, and it is recommended that it be considered as an explicit screening factor by the

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[20] These recommendations are based on information provided on Metro's electricity costs and the authors' knowledge and research into relevant hedging instruments in the context of Metro's overall energy approach. Based on requests made within Metro, it appears that no other Metro electricity hedging or related policy documents are available.

Energy Management function. Section 3.7 describes a renewable energy project screening and selection approach for Metro implementation that explicitly includes a hedging benefit.

Recommendation 3.4-3

In the event that the competitive electricity supply (Direct Access) market in SCE territory matures and expands in the future and the LADWP market opens effectively to competition for generation supply, it may be worthwhile for Metro to re-assess the benefits and drawbacks of introducing additional electricity hedging to its cost management program. Several of the negative factors discussed in this section are particular to electricity hedging, and may not apply to natural gas hedging activities related to Metro's CNG bus fleet.

3.5. Facility Natural Gas Rate Review

This section reviews the nature and suitability of the rates currently assessed on Metro's facility natural gas consumption and describes an ongoing process of rate review that can assist the agency in tightly managing its natural gas costs going forward. On an agency-wide basis, Metro consumes approximately 1,200,000 therms of natural gas at its facilities annually, at a cost of just under $900,000 over the past year.[21] These facility natural gas costs are modest relative to Metro's $9 million in annual facility electricity costs, but still sufficient to warrant a periodic check to make sure that Metro's financial resources are being prudently overseen. This natural gas rate analysis parallels the ECMP rate analyses in Sections 3.2 and 3.3 conducted for Metro's electricity meters. This facility-focused rate review does not address Metro's use of compressed natural gas (CNG) for its bus fleet.

3.5.1. Goals of Facility Natural Gas Rate Analysis

At a broad level, the goals of this analysis are to provide a useful starting point and an ongoing review process that Metro's Energy Management function can deploy to manage its facility gas costs. To meet those goals, this review covers five specific areas:

- Summarizing the agency's rate structures.
- Screening through diagnostic tests for potential errors in Metro's gas volumes and prices.
- Evaluating competitive market physical supply opportunities.
- Evaluating extension of Metro's existing compressed natural gas (CNG) financial hedging program for its bus fleet to its facilities
- Illustrating a simplified ongoing rate review process.

This gas rate analysis concludes with a set of recommendations.

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[21] The considerable volume of natural gas that Metro utilizes in its bus fleet is not included in this Energy Conservation and Management Plan (ECMP) because the ECMP does not address transportation fuel issues.

3.5.2. Summary of Metro's Facility Natural Gas Usage and Costs

Table 3-13: Summary Data on Metro Facility Natural Gas Usage and Costs (Data from 2010, standardized for 365-day year)

# of Facility Natural Gas Meters (Accounts)	33	# of Gas Accounts with Usage over 10,000 Therms Annually	19
Annual Usage for All Facility Natural Gas Accounts	1,179,878 therms	% of Annual Gas Usage Represented by Largest 19 Accounts	97%
Annual Natural Gas Costs for All Facility Natural Gas Accounts	$857,265	% of Annual Gas Costs Represented by Largest 19 Accounts	96%
Average Unit Cost for All Facility Natural Gas Accounts	$.73/therm	Average Unit Cost for Facility Natural Gas for Largest 19 Accounts Only	$.72/therm
Average Unit Cost for Facility Natural Gas for Smallest 14 Accounts Only	$.98/therm	Average Unit Cost for Two Largest Facility Natural Gas Accounts (Metro Support Services Center and Gateway Facility)	$.65/therm

A number of the data points in the table above are applied throughout the balance of this section. From a rate perspective, Metro's facility natural gas accounts are served on rate schedule GN-10 with Southern California Gas. Based on the data provided by Metro, including individual bills for each meter, it does not appear that any of these facility accounts have competitive market commodity supply contracts.[22]

3.5.3. Diagnostic Tests of Natural Gas Volumes and Prices

As Table 3-13 above demonstrates, just over half (19 of 33) of Metro's facility natural gas meters account for 97% of the agency's annual facility natural gas consumption and 96% of such costs. Those largest-consuming 19 accounts were selected as the basis for diagnostic testing.

Two types of diagnostic tests were completed on the largest 19 accounts—one test for volume (consumption) patterns and one test for price patterns. The tests were meant to surface potential outliers or errors versus gas utility rates and versus other Metro facilities.

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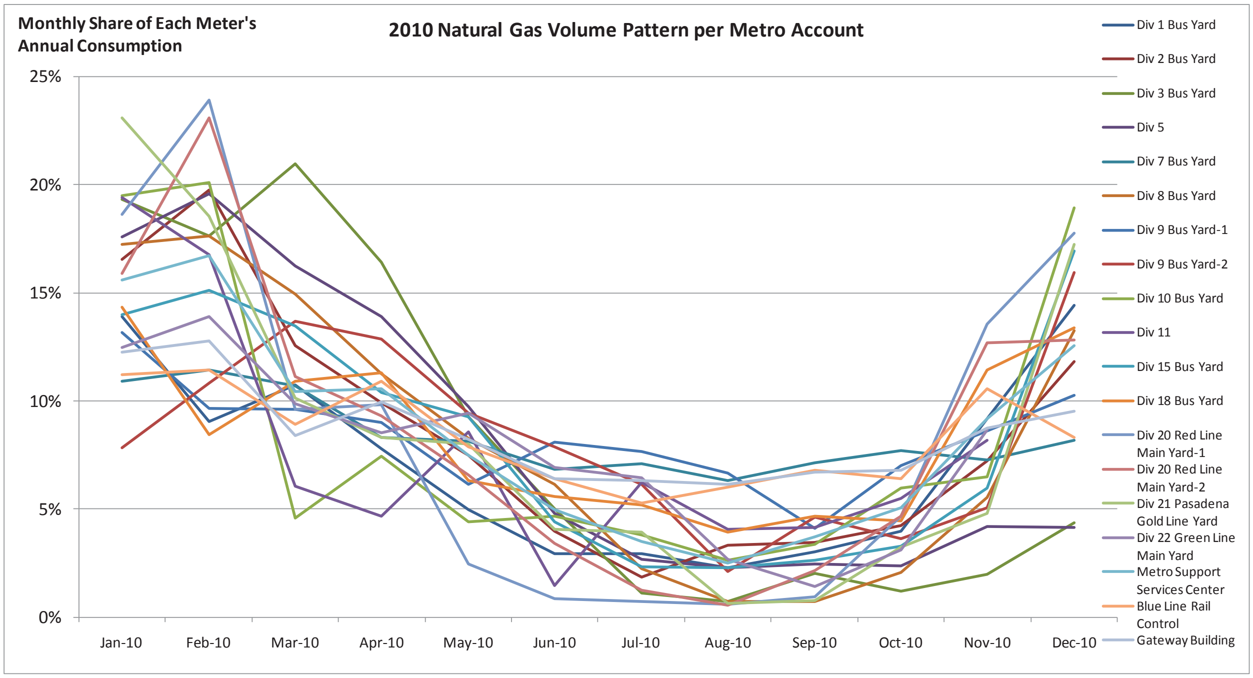
[22] In general, Metro's facility natural gas accounts do not have the range of utility rate choices (e.g., time-of-use rates) to consider that Metro's electricity accounts have (see Sections 3.2 and 3.3 on electricity rate reviews).

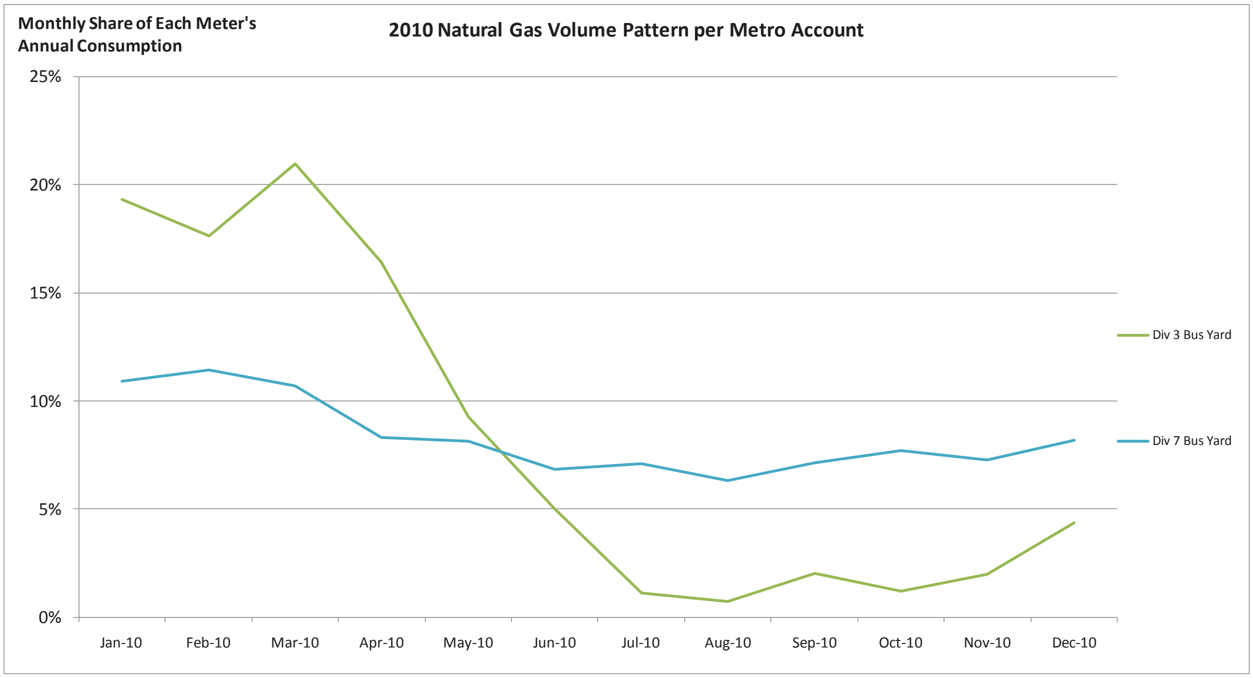
Figure 3-7: Diagnostic Test of Natural Gas Volumes for 19 Largest Accounts



To compare meters of different gas consumption or usage levels (e.g., the Metro Support Services Center meter, with the agency's highest consumption, versus the smaller Division 7 Bus Yard meter), each meter's monthly volume was analyzed as a percentage of its annual consumption. This way, one can see the monthly pattern of gas usage across Metro's entire portfolio of larger-consuming meters.

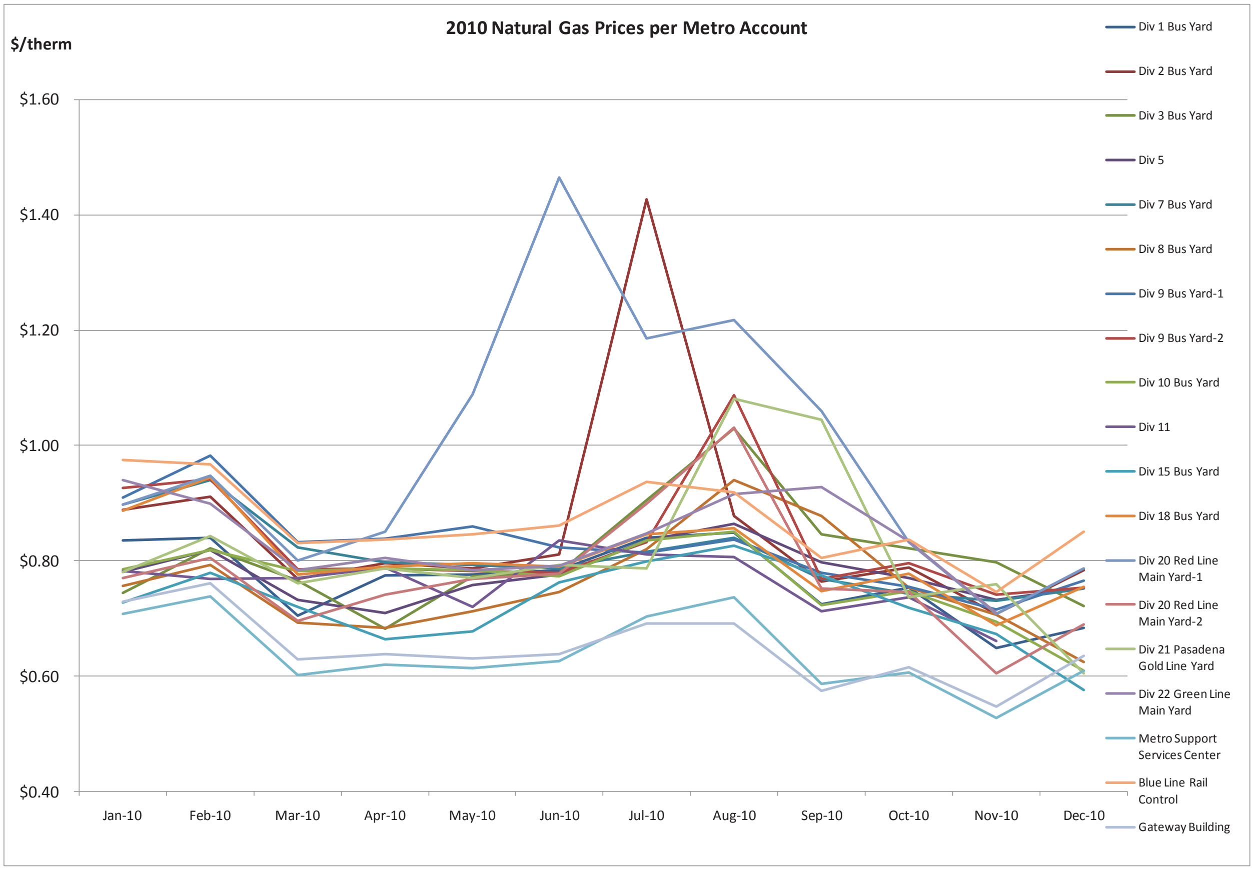
The graph above depicts an expected and relatively tight pattern of consumption. All but three of the meters follow a predictable curve that parallels temperature, i.e., using a low amount of gas in the summer, ramping up in the fall, peaking in the winter, and declining again in the spring.

Figure 3-8: Diagnostic Test of Natural Gas Volumes Spotlighting Two Accounts with Atypical Patterns



This test is meant to flag meters, such as the Division 3 Bus Yard and the Division 7 Bus Yard (both spotlighted in Figure 3-8 above), that do not follow the pattern. The Division 3 Bus Yard usage does not follow the usual seasonal pattern of increasing late in the year, and the Division 7 Bus Yard has much flatter monthly usage than is typical for Metro’s accounts. Additional review is warranted of those outliers to ascertain why they do not conform to the predicted pattern—whether it may be due to entirely explainable operating conditions or whether operational problems or billing errors may be occurring. Full sets of annual bills for these two meters have been requested for further analysis.

Figure 3-9: Diagnostic Test of Natural Gas Prices for Largest 19 Accounts



The prices above reflect the full billing charges to Metro for each account. Southern California Gas' published rates for Metro's accounts[23] consist of:

(a) a fixed monthly charge;

(b) a tiered gas transportation component that applies a set rate for the first 250 therms of gas consumed monthly, a second lower rate for the next 3,917 therms, and the lowest rate for all additional gas consumed beyond 4,167 therms;

(c) a "gas commodity" component that is based on monthly fluctuations in the market price of gas that the utility procures for its customers and that is applied to all monthly volumes; and

(d) two taxes and fees applied to all monthly volumes.

The pattern of monthly price movements across Metro's largest gas accounts is consistent with the monthly fluctuation in Southern California Gas' published gas rates. The utility's gas rates declined by about 40% within the course of the year as the national and regional gas markets declined in price.[24]

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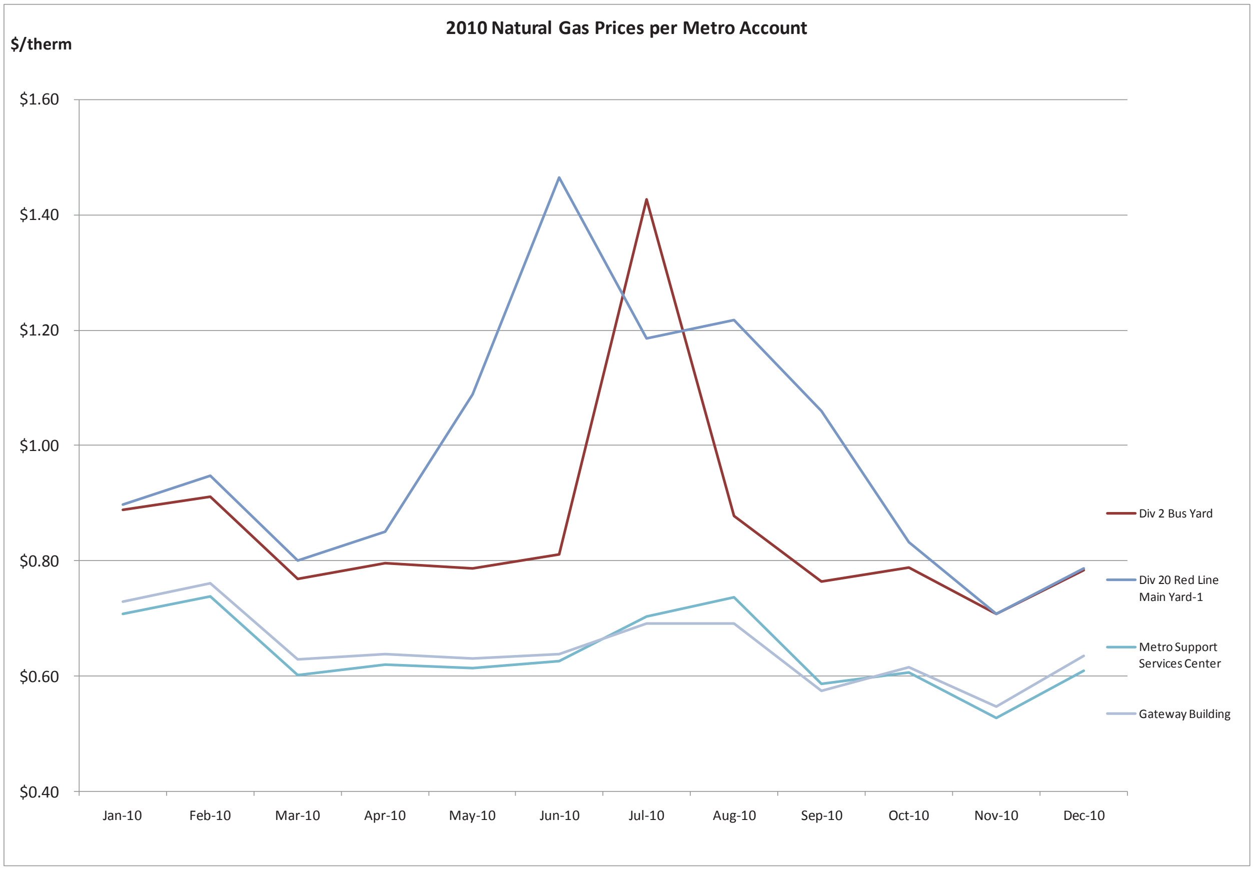
[23] These Metro accounts are on the "GN-10" rate with Southern California Gas. See Southern California Gas Company, Rate Schedules, Schedule No. G-10 Core Commercial and Industrial Service, http://www.socalgas.com/regulatory/tariffs/tm2/pdf/G-10.pdf (rate schedules accessed in February 2011).

[24] Between January and December 2010, Southern California Gas' core procurement (commodity) gas price ranged from $.57867/therm in January and $.59331/therm in February down by over 40% to an annual low of $.34044 in November before concluding the year in December at $.43851/therm.

Figure 3-10: Diagnostic Test of Natural Gas Prices Spotlighting Four Accounts with Atypical Patterns



As to outliers in Figures 3-9 and 3-10, two Metro accounts—the MSSC and the Gateway facility represented by the two lowest lines in the figure above—have less expensive monthly gas prices than others because they are the largest accounts on a volume basis. The MSSC and Gateway accounts spread the fixed and tiered elements of the utility's rate structure over a much larger volume of gas, thereby lowering those accounts' average monthly rates.

Beyond MSSC and Gateway, two other accounts stand out—on Figure 3-9, the Division 2 Bus Yard, and on Figure 3-10, one of the two Division 20 Red Line Main Yard gas meters. Their average gas cost spikes in summer months of up to $0.40/therm above peer accounts raised the need for investigation. In both cases, the price spikes were at least partially caused by extremely low usage volumes during the months of June through September. Essentially, the utility's fixed monthly charges and higher tiered transport charges for low usage were spread over few total units of gas during the summer months at these particular accounts, resulting in higher average bills.[25] However, a portion of the Division 2 Bus Yard's July 2010 bill remains unexplained, and a copy of that bill has been requested from the utility for further analysis.

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[25] For example, the Division 20 Red Line Main Yard account consumed only 84 therms of gas in August, and had a total bill of only $102 that month. Its fixed charges were about $15 that month and all of its transport costs were charged at the utility's highest tiered rate, so the account shows a very high per unit gas rate for the month.

The volume and price tests described above were based upon the utility's monthly billing data from 2010, standardized from intra-month billing periods into calendar months and standardized into 365-day billing years.[26]

3.5.4. Assessing Opportunities for Alternative Rates: Competitive Market Supply

Commercial and industrial customers of the Southern California Gas utility generally have the option of obtaining the commodity portion of their gas supply from a competitive market natural gas firm, as an alternative to taking fully bundled (commodity procurement and distribution) supply from the utility. Currently, Metro takes the fully bundled service from the utility.

Under the competitive supply alternative, the utility would still deliver the natural gas to the customer through its local distribution system and would have the same local service and reliability obligations. What would be different with the competitive option is that (a) the competitive supplier or marketer, rather than the utility, would have the obligation for procuring the actual natural gas supply and moving it to the edge of the regulated utility distribution system, and (b) the portion of Metro's costs associated with commodity gas procurement would be set by a private contract between Metro and the competitive supplier, as opposed to by Southern California Gas' published rate schedule. [27]

There are three potential benefits of competitive supply alternatives that commercial and industrial customers consider:

- Price stability
- Potential price reductions
- Attractive, flexible contract terms other than price

Each of these potential benefits will be briefly described.

First, competitive supply contracts frequently offer price stability via long-term (e.g., 1 year or longer) fixed prices. These fixed prices contrast with the existing utility rate schedule in which gas procurement costs vary monthly and introduce customer budget uncertainty because they are not posted for future months or years. It is not possible to know in advance whether a long-term, fixed-price competitive supply will be less or more expensive than the standard utility rates. Rather, *fixed-price* contracts are usually selected to improve energy budget certainty and/or to beat some known historical or current benchmark rate. Figure 3-11 below illustrates the historical variability of natural gas commodity costs.

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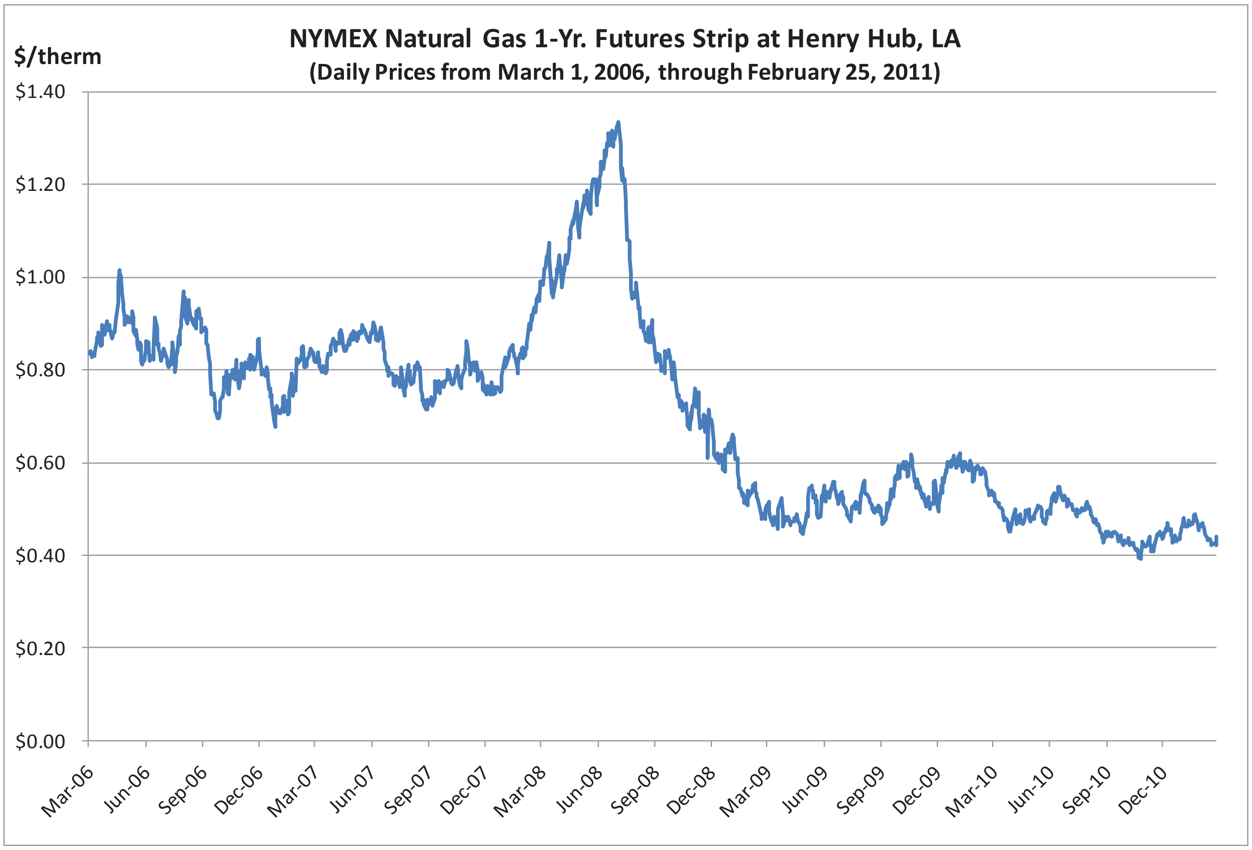
[26] In addition to applying the volume and price tests to the portfolio of Metro's largest accounts that represents 97% of Metro's annual facility gas consumption, individual bills for 12 of the largest accounts from a sample month in 2010 were examined for pricing and appeared accurate.

[27] Even in the competitive market option, portions of Metro's natural gas costs (fixed customer charges, distribution or "transmission" charges, and taxes/fees) would be set by Southern California Gas' published rate schedule.

Figure 3-11: Futures Price of 1-Year Strip of Natural Gas Supply (Commodity Costs Only) at Standard National Pricing Point



Second, many competitive gas suppliers offer monthly "floating rate" or "index" pricing plans that parallel the utility's floating monthly rate practice. Competitive suppliers may be able to show that their indices have been historically less expensive than the utility's rates, but rarely do experienced suppliers guarantee meaningful future savings against utility rates. The reluctance to make a guarantee is borne of caution—future utility gas procurement costs in the market are unknown, so it would be difficult to guarantee beating an unknown benchmark. A commercial or industrial customer may sign a floating rate or index contract with a competitive supplier with a reasonable hope of price savings, but without total certainty.

The third category of potential benefits from competitive supply contracts is that they can offer non-price terms (e.g., longer payment, customized billing) that may be attractive. There is also the possibility that competitive contract terms would be less attractive to the customer than normal utility contract terms.

When organizations consider competitive gas supply, they weigh the potential benefits described above against the price risks, other risks (e.g., supplier contract and credit), and administrative time and distraction of introducing a new vendor.

In this case, the relatively small size of Metro's facility natural gas costs (about 3% of the total costs and 10% of the facility-related costs considered in this ECMP) does not warrant the administrative time and distraction of evaluating competitive options for physical supply. Even a long-term, fixed-price natural gas physical supply contract would be likely to remove only up to a few hundred thousand dollars of annual budget uncertainty, and could end up costing Metro more or less money at contract end.

3.5.5. Extension of Existing Metro Financial Hedging Program for Bus Fleet Natural Gas to Facility Natural Gas

Metro has a well-established compressed natural gas (CNG) hedging program that it has applied to the approximately $40 million of natural gas used annually in its bus fleet.[28] The CNG hedging program for the bus fleet (effectively substituting fixed, longer-term natural gas costs for the utility's variable monthly natural gas costs) aids the agency in stabilizing its CNG costs that otherwise could introduce great uncertainty in Metro's annual budget planning. If Metro wants to introduce price stability into its facility natural gas budget, slightly expanding the existing $40 million CNG hedging program to include the commodity portion of the under $1 million in total annual facility natural gas costs would be much easier than pursuing the competitive physical supply alternatives described in the prior section.

The reasons that Metro's CNG hedging program could be readily extended to facility natural gas include: (a) the utility for the bus fleet CNG (Southern California Gas) is the same utility that supplies Metro's facilities with natural gas, (b) the Southern California Border basis location and first-of-month index price used as the variable rate proxy for the CNG hedging program should be equally appropriate as the proxy for facility natural gas hedging, and (c) there should be little to no additional administrative cost or time required by Metro to financially hedge a slightly higher volume of natural gas. Rolling the facility natural gas volumes into the CNG hedging program would not involve the new counterparty contract and credit burdens of the competitive physical supply alternatives discussed in the prior section. In addition, pairing the facility natural gas costs with the many times larger CNG bus fleet costs at Metro could likely offer the facility's gas budget a wider range of hedging product choices than if a hedging approach (through the physical or financial markets) was applied exclusively to the much smaller facilities-only budget.

Metro's new Energy Management function will consult with Metro's Treasury Department in 2011 and will jointly decide if and how to include the facilities natural gas volumes for 2012 or thereafter in the much larger CNG hedging program that the Treasury Department assists in administering.

3.5.6. Process Flow Chart for Ongoing Review of Facility Natural Gas Rates

In order to manage natural gas rates, a sample review process that Metro can follow on an annual or bi-annual basis is described in Figure 3-12. Because slightly more than half of Metro's 33 facility gas meters represent 97% of the agency's annual facility usage, Metro may wish to simplify any review process by focusing on some subset of its largest accounts.

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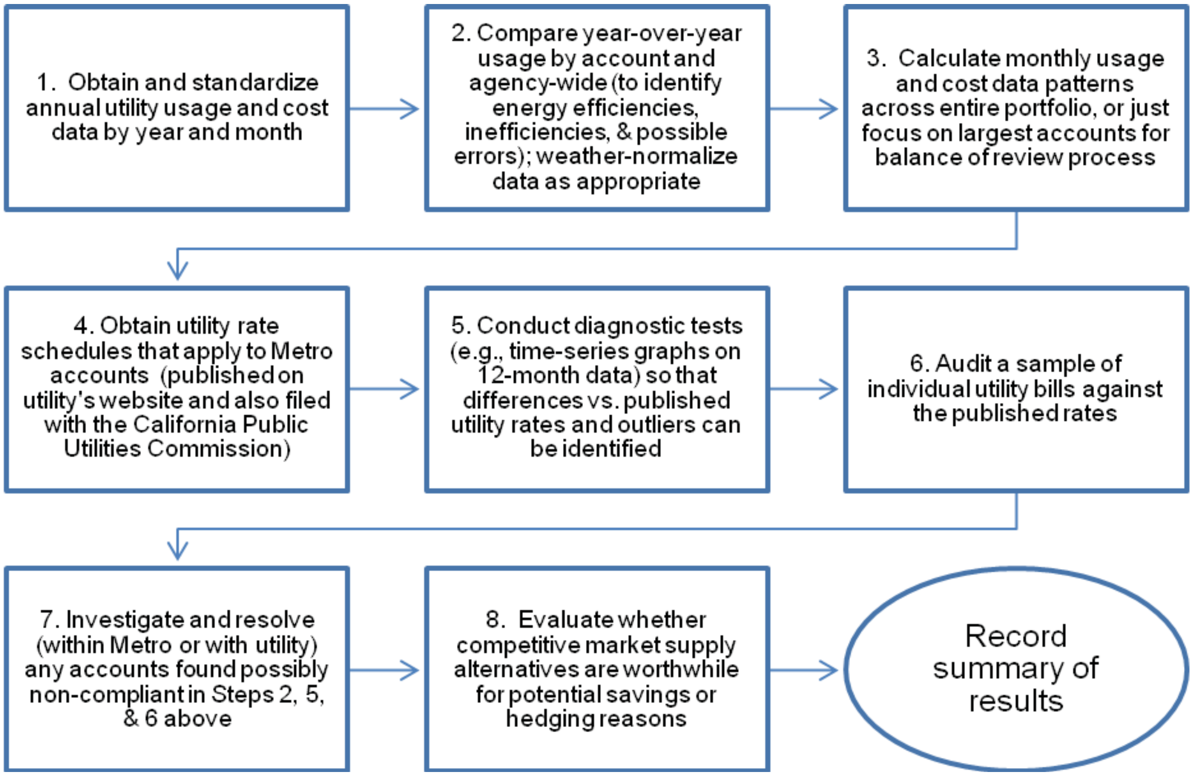
[28] See Los Angeles County Metropolitan Transportation Authority (Metro), Comprehensive Annual Financial Report for the Fiscal Year Ended June 30, 2009, Notes to the Financial Statements, http://www.metro.net/about_us/finance/images/cafr_2009.pdf, pages 93-94; and "Metro, Compressed Natural Gas Hedging Program" adopted March 2007, http://www.metro.net/about_us/library/images/Compressed%20Natural%20Gas%20Hedging%20Program.pdf.

Figure 3-12: Facility Natural Gas Rate Review Process



3.5.7. Recommendations

Based on the preceding discussion, Metro will pursue these recommendations related to its facility natural gas rates:

Recommendation 3.5-1

Because facility natural gas costs represent a modest share (about 3% of the total costs and 10% of the facility-based costs) considered in this ECMP and their billing appears to be accurate, Metro intends that managing facility gas rates not be an area of emphasis for the Energy Management function.

Recommendation 3.5-2

For the purposes of general planning and account review, Metro intends to use the facility natural gas account summary table contained here to assist in budgeting and the process flow chart in Figure 3-12 for conducting streamlined annual or bi-annual reviews of natural gas volumes and prices.

Recommendation 3.5-3

Metro will not pursue competitive natural gas supply for its facilities at this point. Due to the relatively small size of Metro's facility natural gas budget, the potential hedging and/or rate benefits of pursuing competitive market alternatives to standard utility rates do not warrant the administrative time and effort that would be involved. However, Metro will strongly consider extending the existing natural gas financial hedging program in place for Metro's compressed natural gas (CNG) bus fleet to Metro's much smaller facility natural gas costs in order to stabilize annual fluctuations in facility natural gas budgets.

3.6. Energy Efficiency: Assessment and Investment Process

3.6.1. Introduction

A key component of this Energy Conservation and Management Plan (ECMP) is leveraging energy data from our agency to identify and prioritize energy efficiency investment opportunities across our facilities. To identify and prioritize the most cost-effective energy efficiency investments, we have employed a portfolio-wide approach to energy efficiency to support Metro in its energy management planning process. Our portfolio-level process consisted of the following.

- Benchmarking Metro against other organizations (Section 3.1.3).
- Benchmarking Metro's own buildings against each other.
- Performing site calls and site visits.
- Sharing best practices found both inside and outside of Metro's operations.

Through benchmarking, site calls and visits, and identifying best practices across Metro's building portfolio, we identified key strategies that will help cost-effectively improve energy efficiency. These strategies focus on opportunities to make low and no-cost investments that will improve energy performance immediately, before making any major capital investments in new building technology.

- **Implement no-cost and low-cost opportunities.** A combination of simple no-cost and low-cost measures could reduce Metro's annual energy use without requiring substantial investments. We have limited resources to devote to energy efficiency projects, and achieving immediate savings from minimal capital expenditures is an important first step for building agency-wide confidence in sustainability efforts and illustrating the potential success of these types of initiatives. These measures include utilizing energy checklists, improving maintenance and operations, training employees in energy awareness, and implementing inexpensive equipment such as programmable thermostats and photocells.
- **Promote management commitment and culture change.** Often organizations can achieve substantial efficiency gains by focusing on facility management and staff operations. A program that recognizes staff for energy efficiency and energy savings helps build commitment and awareness. An effective management program is one that includes training for all staff levels in the importance of energy management and offers incentives and recognition for staff that produce energy savings. Supporting and promoting a strong organization-wide commitment to energy efficiency has the potential to produce more savings than capital upgrades in heating, cooling, lighting systems, and other technology projects. The benefits of a program of this kind have already been realized at the Division 20, Red Line Yard, which has implemented an Environmental Management System (EMS) under the ISO 14001 framework.
- **Track and analyze energy use.** Metro should understand its energy usage and current trends. It is important to identify the end-use of building energy consumption and the reasons for varying levels of energy consumption in different facilities. Often greater energy savings can be achieved through installing smaller investment-grade energy efficiency equipment across the building portfolio rather than investing in a major renovation to a single facility.
- **Invest cost savings from energy efficiency into development of a culture of continuous efficiency improvement.** If no-cost and low-cost efficiency improvements are made portfolio-

wide, we could conservatively see annual savings of well over $400,000 (5% of the total) in avoided facility electricity costs. This money could be re-invested in broadening and strengthening “culture-change” efficiency training and incentive programs, which would allow Metro to capitalize on the initial program success and support continued success. Also, as the agency invests in achieving LEED for Existing Buildings (EB) Certifications, the facilities will be able to realize closer to 20% savings over current consumption levels.

3.6.2. Methodology

Methods for Portfolio Assessment

To understand the different mitigation opportunities available, we have both performed a portfolio benchmarking assessment to identify best and worst performers in our building portfolio, and made calls and visits to facilities to assist in more specific energy saving opportunities.

With the information gained from reviewing data and speaking with facility staff, we have developed a process for evaluation and prioritization of energy management improvements to maximize the impact of energy efficiency and conservation measures across the portfolio. For each facility in Metro’s portfolio, we have examined many of the factors that drive energy consumption. This information includes hours of operation, use of the building space, and other operating characteristics. We have grouped buildings based on building use type (bus maintenance, train maintenance, etc.) and analyzed and organized the portfolio into opportunities based on energy use intensity of the buildings that provided both energy and site area data. With this data in hand, we can prioritize which buildings are the most energy intensive and thus would benefit the most from investments in energy efficiency projects.

Conducting the Portfolio Analysis

It is Metro’s understanding that reviewing energy data reveals critical patterns of performance within a portfolio. After this initial review, we find our agency’s portfolio is no different. However, because we only have site area information for a small proportion of the portfolio, we were only able to build an energy intensity scatter plot for a subset of Metro facilities. As discussed below, a good step to take in the portfolio analysis would be to gather additional site data to develop a deeper understanding of how and why performance varies across the portfolio.

In order to build the portfolio performance assessment, we analyzed existing building site and energy data, with the goal of understanding the range of performance between the very best and worst performers in the portfolio. In a portfolio with homogeneous subsets (i.e., facility types) such as Metro, where buildings have similar types of equipment and usage profiles, this performance spread can be used to target facilities that will yield best and worst management practices.

It is important to note that Metro has performed site audits at many of its facilities already. However, not all of the data from these site audits are tracked, shared across the organization, organized into a comprehensive plan, or acted upon. We have only been able to use a portfolio approach to review 23 sites that had both energy consumption and square footage information, which is the bare minimum of data for the portfolio assessment. In the future, as we start to collect and manage site and energy use data more effectively, this type of review should be performed regularly.

Benchmarking and Data Estimation Approach

Metro data was used to build the scatter plot and benchmark review. In order to provide some industry benchmarks, we reviewed the portfolio and identified a similar “average” building consumption using the

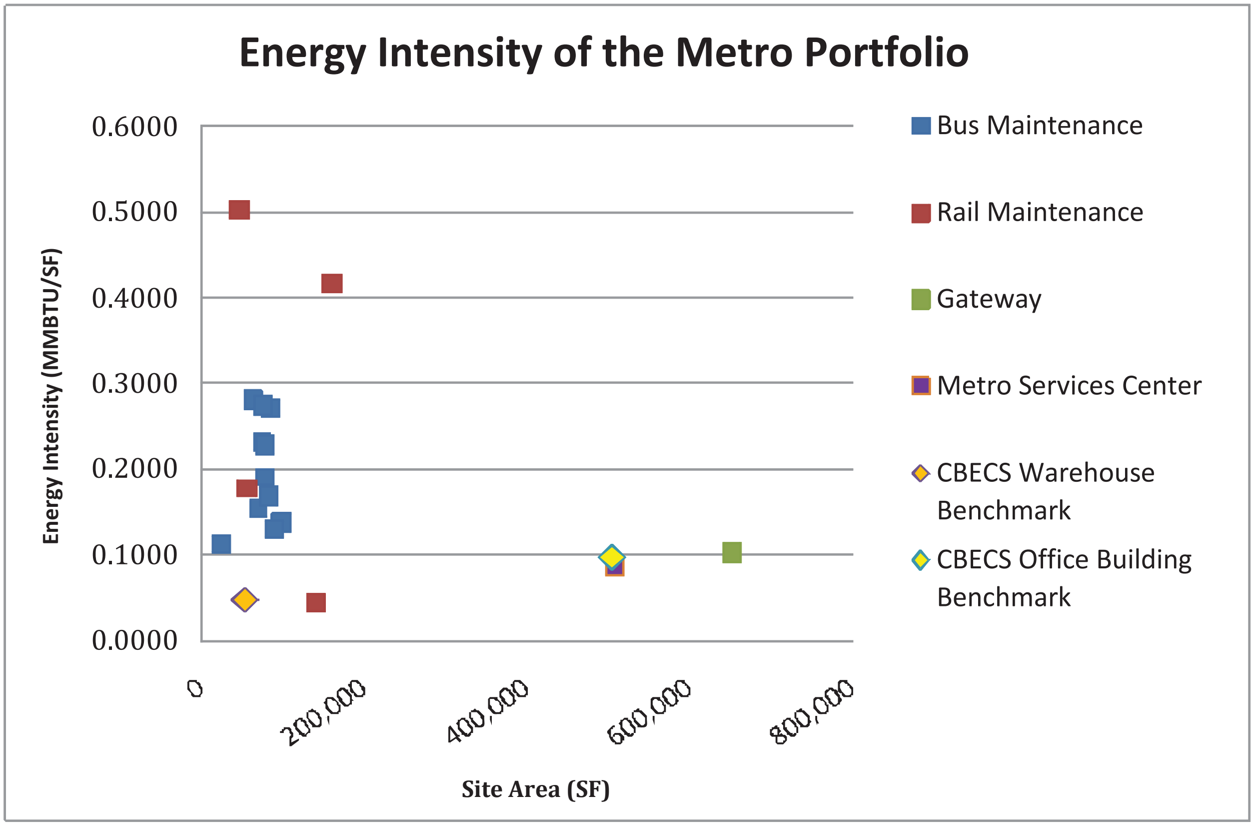
Commercial Building Energy Consumption Survey (CBECS) data.[29] This allowed us to compare energy use across Metro facilities with the energy use of similar buildings external to the Metro portfolio. However, because many of Metro's facilities are unique, the industry benchmarks are used only for comparison and do not necessarily tell the entire story about Metro's facility energy use.

3.6.3. Preliminary Results

Results of Portfolio Assessment

Figure 3-13 illustrates the energy intensity spread of Metro's portfolio. There is a significant spread in energy use across much of the portfolio, which is expected (or understandable) because many of the buildings have unique operating profiles. However, where building types are similar, it is surprising, but not atypical, to see such a large spread.

Figure 3-13: Energy Intensity of Metro Portfolio



Although each Metro facility is unique, many perform similar functions or contain similar technologies, which can help identify appropriate strategies for the entire building portfolio. Metro facilities that have provided site area data have been grouped into four basic functional classes based on staff recommendations. Figure 3-13 shows the buildings organized by class (in the case of the Metro Support Services Center (MSSC) and Gateway, they are unique buildings in the portfolio and cannot be bundled)

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[29] See CBECS http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html

and plots them based on their energy intensity[30]. Where each building class has more than one site, there is a substantial variation among buildings, and this range represents an opportunity for energy savings**.** We can realize substantial energy savings by implementing best practices to bring all buildings in the same class closer to the leading performers (those with the lowest energy use per square foot).

Bus Maintenance – For bus divisions or maintenance/ operations centers, there is a significant spread in energy intensity. The most energy-efficient division uses 0.11 million British thermal units per square foot (MMBTU/SF) while the most energy-intensive division uses almost three times as much energy per square foot, at 0.28 MMBTU/SF. Because (generally) bus divisions are relatively similar in terms of their operations, it is of note that there is nearly a 300% spread between the best and worst performers. However, by organizing and reviewing the spread in a scatter plot format, we were able to crosswalk the scatter with information we have about the sites. The best performing site is actually Division 6, which has a modified schedule and is not operating 24/7 like the other bus divisions. Therefore, it makes sense that the site uses less energy than the other bus divisions. If the energy intensity at Division 6 was normalized to a 24/7 operating schedule, the energy intensity at Division 6 becomes 0.19 MMBTU/SF, which is very close to the average energy intensity of Metro’s bus divisions.

In essence, the scatter plot graph provides a framework for our agency to review site data in order to help benchmark and focus energy management efforts on closing the gap between the best and worst performers. However, it is important to identify any key operating characteristics that may be driving energy performance up or down using other site information, such as operating hours or onsite data centers, to ensure that the most efficient or most intensive sites’ energy use is directly comparable and not skewed by an irregularity in its operations. For bus divisions, there exists a significant spread, and, by targeting retrofits across the portfolio and at the least efficient sites, Metro can define energy use targets and internal benchmarks.

Rail Maintenance – For the three rail divisions, a similar data review process was employed as described for bus maintenance above. As can be seen in Figure 3-13, there is an even larger spread between the best and worst rail maintenance and operations centers. The most efficient rail division has an energy intensity of 0.18 MMBTU/SF while the most intensive has an energy intensity of 0.50 MMBTU/SF. Once again, this spread tells an interesting story. The most efficient site and most intensive site seem to be very similar; they have similar operating characteristics, number of employees, and site area. However, the most efficient site uses around twice as much natural gas and about one-third as much electricity as the most intensive site. The spread shows that there could be best practices at the most efficient site that should be reviewed, internalized, and spread to other rail divisions. The spread between the most and least efficient is roughly 300%. By reviewing each site and understanding the differences in operations between most efficient and most intensive rail sites, the agency should be able to more effectively target technology upgrades and operational strategies that will prove to be effective at rail divisions.

Gateway Building – Unlike rail and bus divisions, the Gateway building is a unique structure in the Metro portfolio. Because it is more of a typical office building, the Gateway building can be benchmarked against external sources. The CBECS database provides energy use data about “average” common commercial buildings, including traditional office buildings. The average data point represents a building that uses the median amount of energy per square foot for all buildings of that type. As can be seen from Figure 3-13, the Gateway building is slightly more energy intense than an average office building in the Los Angeles area. This is surprising because Gateway has performed many different efficiency upgrades intended to reduce the energy use of the site. We understand that the site has also submetered the two data centers (both the larger 24/7, agency-wide data center on the 2nd floor and the smaller ATMS data center on the 6th floor) and the full service cafeteria on site, all of which should decrease the energy

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[30] This is a normalized measure of energy use per square foot of building area.

consumption for the main meter. We recommend continuing to investigate the building's energy use to determine if it is underperforming. One way to start to address this performance gap is to implement all of the energy efficiency measures that we are suggesting across the entire Metro portfolio. There is nearly always room for improvement and energy cost savings. Similar to other sites, the facility managers at the Gateway building need to continuously review and follow operations and maintenance plans in order to work towards incremental improvements in energy reductions.

Metro Support Services Center – Like the Gateway building, the MSSC is a unique structure in our portfolio. Because it is a large centralized campus that maintains buses, houses staff, and contains several different building types, it is difficult to benchmark it against any external sources. However, when reviewing Figure 3-13, one can see that the MSSC is one of the least energy intense sites in the portfolio. This is partly because it seems as though the MSSC is not fully utilized at present and much of the square footage is dedicated to storage as opposed to maintenance or other high energy using space types. But, the MSSC (working with an energy savings performance contract) has invested heavily in energy efficiency upgrades. The building has installed solar panels, retrofitted the HVAC systems, installed more efficient air compressor systems, and upgraded lighting. These types of energy management projects have proved effective at the MSSC and are a useful lesson for other sites within Metro's portfolio. However, even in a building with considerable energy efficiency technology, it is possible to identify opportunities for improvement. In the case of the MSCC, improving the use of the Building Automation System (BAS) would lead to even greater energy efficiency in the facility.

Results of Site Calls and Visits

We have performed site assessments and made calls to our facility and line managers. By speaking with staff, we have been able to learn what types of mechanical systems are currently in place, what types of retrofits have been successful in the past, and how the retrofit process is currently managed. This understanding of building management and operations helped to provide some insight into the performance spread of the agency's facilities, but cannot explain all of the variation between the most energy-intensive versus most energy-efficient buildings in the portfolio. By understanding current strategies and future opportunities, we can tailor the recommendations to align with Metro's needs and current management structure.

Division Calls

A key component of the ECMP included information obtained through a series of calls to facility managers from various divisions. We spoke with five facility and line managers representing ten different sites, and found that despite differences between each division, many of the trends in facility management techniques remained consistent.

These conversations helped us gain perspective on our historical challenges and successes. The calls also provided insight into the reasons for the variations in Metro's energy use that were identified through the scatter plot analysis. The calls reinforced that each Metro division has both more efficient and less efficient sites. Understanding how each division is managed helps to explain why there can be such a range in energy use across the portfolio.

Below is a list of common themes that were expressed by Metro facility managers during the phone calls. Facility managers:

- Generally do not have sufficient knowledge to exercise control over facility BAS and rely on one team for maintenance and troubleshooting across the whole portfolio of similar systems, such as the small HVAC team.

- Are not clear on organizational energy management policies.
- Do not have guidance about energy management nor do they receive regular energy use data.
- Have limited resources (money, people, and time) to invest in energy efficiency upgrades.
- Want to collaborate on energy management issues.
- Report their facilities are more focused on keeping buses and trains working than building energy management.

It appears that there is limited collaboration between the Metro central management and the onsite facilities staff. A majority of the site managers feels that they receive little direction from management about energy use. This forces each facility to either develop its own separate goals and strategies or not consider energy management in the least. Furthermore, the central HVAC support staff, although given good marks and responsive to the facilities, lacks resources and does not necessarily communicate with each facility about how each site's HVAC is operating or the repairs that need to be budgeted.

Most likely, due to this lack of communication between Metro groups, many facility managers are uncertain of the energy policies within the organization. Each site is more focused on keeping buses and trains maintained and not on energy management initiatives. Because of this, there has been some inconsistency related to the upgrading energy systems. This strategic diversity among facilities may be helpful, but information sharing is necessary to ensure that each division is taking advantage of all best practices and bulk install and purchasing opportunities.

Another important theme is that not enough data is reviewed on site, which makes it difficult for site managers to develop energy performance improvement strategies. Without developing a metric or tracking data, there is no way for facility managers to set goals or measure improvement. If energy management is important to Metro management, the organization needs to clarify facility goals and support each facility in the development of metrics and emphasize the importance of tracking building energy performance over time.

Additionally, our facility managers seemed unaware of the resources available to invest in energy efficiency upgrades. Many facility managers mentioned that they would have to invest their own resources for capital improvements, while others mentioned that there is a $2 million earmark to invest in sustainability projects and initiatives that can demonstrate significant cost savings, including energy efficiency projects. Typically, each facility makes the facility budget at one point during the year, and if that budget does not include the additional costs for efficiency improvements, then the upgrades cannot be made that year. Many facility managers also said that they lack the time, manpower, and/or knowledge needed to improve certain technologies and processes.

In general, information obtained from these calls suggested that we have the will to work towards improving facility energy performance, but there is inconsistent support and resources available to achieve energy efficiency and reduction goals. There are a number of divisions that have been investigating ways to both reduce water use and improve energy efficiency, including Division 20 and the MSSC. These facility managers are interested in working with others to develop energy reducing solutions. However, the facilities lack a central repository for energy management policies and do not have the necessary communication lines to share and leverage best practices.

Site Visits

As a key component of the ECMP project, we gathered additional energy management data through select site visits, focusing on individual facilities and not divisions, which were covered above in the site calls. Site visits illustrate how energy management is practiced within different types of facilities, as well as the specific energy equipment, management systems, and energy efficiency efforts of facilities across Metro's building portfolio. For these site visits, our consultants, who are energy efficiency experts, met with Metro facility staff to learn more about how facility managers, maintenance staff, and employees approached energy management, efficiency programs, and equipment maintenance and upgrades.

A detailed assessment checklist was prepared, which included questions on all major building equipment, facility maintenance, energy management, and employee participation in energy management programs[31]. Checklists also included a "successes and challenges" section, with open-ended questions about the successes and failures of past energy management projects, the type of support and direction facility managers feel they receive concerning energy management, and some of the barriers managers face when implementing more comprehensive energy reduction programs. These questions were provided to site managers in advance of the visits and calls, and the majority of each visit and call was spent reviewing these checklists. We also reviewed past energy audits but generally focused more on management approach than on counting specific technologies and systems so that our approach was complementary to past work, instead of redundant.

We visited five facilities ranging from bus maintenance sites to the MSSC and rail maintenance centers. Sites were collaboratively selected so that all basic building types and uses were represented. We arranged site visits at locations where site data was available, and, in general, the sites selected for visits were the largest energy users within the portfolio. By conducting a combination of thorough, 1–2 hour site visits and 30-minute calls, we were able to investigate a broad variety of sites.

Table 3-14: Sites Visited

Facility Name	Site Contact	Type of Site
Division 7	Audie Alexandre	Bus Yard
Division 18	Donell Harris	Bus Maintenance Yard
Division 20	Fred Kan	Train Maintenance Yard
Location 60 – Blue Line Central Controls	Christopher Limon	Central Rail Controls
Metro Support Services Center	Kevin Sechler	Bus Maintenance and Operations Center

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[31] Checklists are included in Appendix C.

Best Practices and Areas for Improvement

Below are the most common energy management practices we observed during the site visits. Although these observations only cover a select section of Metro's sizeable building portfolio, they help to explain the significant variation in energy use from one facility to another, even if energy use is normalized for facility type and size. Implementing best practices across the portfolio and eliminating inefficiencies could produce substantial energy savings.

"Hall of Fame"
Efficiency Actions

T8s take over: At most facilities, T8 lights are replacing their T12 and Metal Halide predecessors – saving 25–75% on energy use.

Motion sensors moving in: At newly renovated facilities, motion sensors are now in some offices, bathrooms, and storage closets. They should continue to be rolled out where appropriate.

Testing energy management strategies: Some sites have started to focus on energy management and there are good stories from around the portfolio including the MSSC, Gateway, and Division 20. The best energy savings strategies from these sites should be noted and promoted throughout Metro.

HVAC maintenance: The Metro Central HVAC team is responsible for over 1,000 air conditioning units across Metro's portfolio. Although they maintain and operate many different types of units, the team has developed quarterly and annual operations plans to ensure that system life remains high and that it operates efficiently.

"Opportunities for Improvement"
Inefficiencies Identified On Site

24 hour lighting: At many facilities, lights are left on constantly. This is partially because of safety requirements and the fact that the space is used 24/7; however, there are strategies to reduce lighting levels while complying with safety concerns.

Bay doors always kept open: Although heating and cooling is supplied to most of the maintenance areas, many of the buildings always kept the bay doors open. By doing this, Metro facilities lose significant amounts of energy through conditioned air escaping.

Old technology: There were several sites that referenced the desire to replace older, less efficient technology with newer, more efficient systems. However, because the budget does not allow for any uncritical repairs, getting the new systems is often a time consuming and ineffective process.

Who's got the bill? Most facilities were not actively tracking monthly utility bills, and they are handled centrally at the Gateway building. Because facilities are not regularly reviewing their energy use, variations in costs are likely going unnoticed.

Some of the major takeaways from the visits and calls include the following:

- Three facilities (MSSC, Division 20, and Gateway) have developed comprehensive energy management plans that included goals, strategies, and tactics; however, most facilities have some energy saving equipment in place but lack energy management training efforts.
- We have not thoroughly informed facilities about specific energy efficiency best practices or goals. As a consequence, comprehensive energy efficiency efforts have only been initiated at a few facilities.
- Facility managers have some awareness of and interest in energy management, but few have communicated this because it is often seen as something that is outside of their responsibilities.
- There is little energy management communication within facilities or across facilities.
- Some innovative environmental programs have been pursued in order to reduce cost, for example, the energy services contract at the MSCC.
- Facility managers had ideas for efficiency upgrades, but most had insufficient financial resources and staff to undertake them.

3.6.4. Implications

There are a number of reasons that many of these energy management challenges occur. Some of the top reasons include the following.

- Insufficient finances for efficiency upgrades.
- Insufficient time and/or staff to continuously monitor energy use or make key energy efficiency maintenance improvements.
- Insufficient direction at the corporate level as to goals, strategies, and tactics for energy efficiency at the facility level.
- Lack of clear goals and incentives, and general lack of motivation for implementing environmental programs instead of maintaining trains/buses and addressing safety concerns.

A number of reasons were given for the current energy management challenges, but most commonly noted were lack of time to implement energy efficiency efforts and a lack of resources. In the following sections, the no-cost and low-cost efficiency measures address both of these concerns, providing solutions that often take minimal effort on the part of facility managers or other energy management staff, but can yield significant results.

While time and money remain the key barriers to efficiency efforts, it is also clear that for some managers, there is a lack of motivation. Managers are not provided with clear steps to reduce energy consumption, and most managers continue to focus on other priorities—namely, preventing accidents, preventing bus/train breakdowns, and keeping the staff comfortable. When asked what they needed to make energy use reduction a priority, all said that extra staff and extra budget would help, but many also said that a clear plan on a dedicated energy manager at Metro corporate would also help them to target and potentially begin implementing energy efficiency improvements.

Conclusion: Site visits show that portfolio-wide management and employee trainings, and low-cost equipment upgrades have significant energy savings potential.

Through conversations with managers at approximately 10 facilities, and approximately 25 Metro facility staff, we found that beyond the energy consumption data there are examples of *leadership, creativity, and innovation, and also challenges that lead to inattentive energy management, lack of energy efficiency training, and a reluctance to launch any major energy efficiency initiatives.*

Where energy efficiency efforts are lacking, facility managers point to lack of funds for capital expenditures, lack of time or staff to implement efficiency improvements, and lack of data to monitor the reduction efforts. However, most facility managers are open to new approaches and hopeful that if given clear detailed checklists for energy management, provided with inexpensive technology to reduce energy consumption, and given adequate staff time and training materials, they could achieve significant energy efficiency gains.

3.6.5. Energy Efficiency Priorities: Next Steps

As Metro begins developing a program to reduce its energy use and environmental impact across its operations, there are steps that can be taken immediately. These steps usually involve a very small up-front cost, providing a quick and significant return on investment (ROI). Low-cost mitigation strategies will include the following.

- Small equipment upgrades such as lighting sensors and programmable thermostats.

- Enhanced facilities management with better control of operating hours, temperature, and ventilation.
- Stakeholder education and engagement including energy and environmental education, a “turn it off” campaign, and other incentive programs for improved performance.

Using the information contained in the site audits and benchmarking sections above, Metro should be able to more thoroughly evaluate investment-grade projects and ultimately invest in projects that may have longer payback periods but (through a combination of energy savings and government rebates) will yield a significant ROI over their lifetime. Furthermore, there is a $2 million revolving loan budget for sustainability projects and initiatives that can demonstrate significant cost savings, including energy upgrades. Through site visits and conversations with Metro staff, we identified indoor and outdoor lighting upgrades, submetering buildings, and more modern thermostats and automated light switches as three key, short-term, lower-cost upgrades that would set Metro on a path to greater understanding and control of its energy costs.

As a longer-term strategy, Metro will need to identify ways to integrate energy management and sustainability into its long-term budgeting and planning process. Our primary recommendation in this area is to assign one individual with the responsibility of saving energy throughout the Metro system. This person will be responsible for documenting and replicating a broad set of best practices, including ensuring that all new construction and renovation adheres to LEED Silver certification (either using the new construction [NC] or EB standards as appropriate), setting up management structures and processes that engage facilities maintenance and other staff directly in energy savings efforts, and developing a system that allows managers to track energy consumption in real-time (or at least on a monthly basis) at the site level and take corrective action if there are spikes in consumption. Metro might be addressing this in part by expanding the Environmental Management System (EMS), but such an expansion will have limited effect without a person in this broad energy management supervisory role. Although the EMS is only being piloted at a couple of sites, this program has the potential to help Metro track, improve, report, and reevaluate its goals and mitigation opportunities, particularly in concert with a more formalized management structure. Metro should ensure that before any major redevelopment or new energy use system is approved, someone knowledgeable with the EMS program reviews the designs and outlines possible opportunities to improve efficiencies.

Low-Cost Equipment Upgrades

A key part of any mitigation program is to first identify the “low-hanging fruit”—the low-cost opportunities to reduce energy consumption and environmental impacts. Key low-cost equipment upgrades are described below. All of these upgrades would likely cost less than a total of $10,000 per facility for the Metro portfolio, and most would pay for themselves in energy savings in less than 2 years.[32]

Automated Lighting Controls

Regardless of how efficient a lighting system is, leaving lights on unnecessarily wastes energy and wears out both bulbs and lighting equipment. A variety of options exist to control lighting, some of which are dependent on existing conditions. These include occupancy sensors, manual switches, timers and scheduled controls, and photocell switches and dimmers.

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[32] These costs and benefits are estimates based on the cost of electricity and heat at Metro in 2010. Water and waste-saving mitigation strategies may not meet these thresholds (as waste is relatively inexpensive and water is free), but mitigation strategies suggested in this section and subsequent sections are very inexpensive and will have a significant environmental impact.

During the site visit, there were many instances at Metro where lights were unnecessarily on while occupants were gone or while daylight levels were sufficient. It is recommended that Metro investigate the following control options in the order listed for any variably occupied space where lights are left on when occupants are absent.

- Occupancy sensors in spaces where technology is appropriate to dimensions, interior layout, and occupancy patterns (good candidates would include conference rooms, storage closets, some recreation rooms and common areas, and bathrooms).
- Local manual switching where none exists and the logistics for adding switches are reasonable. These switches should be controlled by building management and cleaning staff.
- Where it makes sense, integrating lights into existing BAS that have the capacity for additional controls (to automate and make sure lights are not left on all night).

This prioritization places the simplest and most effective option first, with subsequent options becoming more costly, complicated, and unreliable. In each case, wattage control and utility rate schedule can be used to estimate the annual savings, which then can be used to assess simple payback. Note that all of these switching options can be considered in conjunction with a shift from sodium vapor and metal halide lighting to T8 fluorescent lighting, as well as a shift from T12 to T8.

From the sites visited, it appears that Metro is using photocells or timers for all external lighting. It is recommended that at some point, Metro staff confirm that all exterior lights are controlled by photocell switching at the circuit level. This will ensure that these lighting systems are not unnecessarily left on.

At several sites, daylight seemed to be sufficient in some indoor areas, but lights were still on. For interior spaces where daylight provides more than enough light during most of the occupied period, photocell switching should be considered. For interior spaces where daylighting significantly contributes to light levels during the occupied day, photocell dimming should be considered. Integrating photocell dimming and switching can be effective tools for energy savings.

Although results are highly variable based on existing conditions and electric rates, improved control of lighting systems will typically save more than 5% of the total electricity spend at a facility and provide a payback period of under 18 months.

Efficient Fluorescent Lights

A fairly simple, low-cost start to using more efficient fluorescent lighting is to upgrade all incandescent bulbs to compact fluorescent (CFL), all 32-watt T8 bulbs to 28 or 25-watt T8 bulbs, and to replace any remaining T12 bulbs. Upgrades from incandescent to CFL will reduce energy consumption by 40–75%/bulb and save on average $40/bulb over the bulb's lifetime. An upgrade in T8 bulbs will save on average 15–20% over traditional T8, resulting in a savings of nearly $20 over the bulb's lifetime.[33] Furthermore, a GHG Cost Effectiveness report written for Metro in 2010[34] also indicated that facility lighting upgrades have both a substantial carbon reduction potential and is cost-effective. The specific recommendation in that report was to upgrade current bulbs to more efficient bulbs, and the energy savings would be about 14 million kWh or around $1.7 million.

Although there may be some instances where it is not possible or desirable to replace bulbs, from an energy perspective it is cost-effective to replace all incandescent and less-efficient T8 bulbs with more efficient bulbs as soon as possible (and not wait for current bulbs to burn out). Depending on the type of

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[33] www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=LB

[34] Los Angeles County Metropolitan Transportation Authority, 2011. Greenhouse Gas Emission Cost Effectiveness Study.

High Intensity Discharge (HID) bulbs Metro currently uses in fixtures, there may be opportunities with these bulbs as well, either by replacing bulbs with high-output CFL or simply using more efficient traditional HIDs.

Metro should consider developing specific bulb replacement strategies to ensure that the most efficient light bulbs for every system are being used, and that the most cost-effective bulbs are determined by the lifetime cost of the bulb. To encourage the use of CFLs in employee task lighting, Metro should consider giving away and installing one CFL per employee, and providing energy and environmental awareness information with this upgrade.

Programmable Digital Thermostats

Digital thermostats are an important tool in maximizing the energy savings of any HVAC system. Even if a facility does not have a BAS, digital thermostats will allow facility managers to program temperature “set points” and “set backs,” which will reduce unnecessary HVAC operation. While the largest buildings use digital thermostats, this option has not been considered and implemented universally, leaving more savings available with this low-cost upgrade. Many Metro sites did have digital thermostats, but at some sites they were not fully enabled, there were no defined set-back temperatures, or employees were allowed to change temperatures in their areas through automatic controls.

In areas where digital thermostats are lacking, Metro should install them to ensure that HVAC systems deliver no more air conditioning than is needed and are shut off when air conditioning is not necessary. Opportunities that we encountered included areas of Division 20 and Location 60. The payback for digital thermostats is under 18 months and generally provides annual savings of 1–5% off the utility bill of a building (results may be higher in facilities operating 24/7).

Closed Bay Doors While Space Heating and Cooling is Enabled

Because of Los Angeles’ temperate climate, oftentimes bay doors are left open. This is not a problem and should be encouraged to provide natural and free ventilation as long as the space is, at the time; not being mechanically heated or cooled.

Keeping bay doors open while heating or cooling systems are enabled allows heating and cooling to escape the building. Heating and cooling buildings is expensive and can account for anywhere from 5–30% of a building’s energy use. Therefore, to reduce losses due to open doors, facility managers and staff should be aware of this and should consider closing the bay doors while air-conditioning and heating are operating, or alternatively, turn off heating and cooling whenever possible to let employees take advantage of fresh air when temperatures are between 65 and 75.

If the space does have heating units or cooling systems enabled then the facility should close the bay doors. If staff feels like having the bay doors open is necessary while heating or cooling systems are enabled, the staff should close the door that opens to the prevailing wind; this will limit the amount of conditioned air that is pushed out of the buildings. We should also consider simply disabling heating and cooling in well-ventilated facilities when the ambient air temperature is between 65 and 75.

Table 3-15 outlines the most important no- and low-cost energy management strategies along with potential cost and energy savings.

Table 3-15: Most important No- and Low-Cost Energy Management Strategies

Low-Cost/No-Cost Improvements			
Measure	**Relevance to Metro?**	**Potential Energy Savings**	**Potential Cost Savings**
Install occupancy sensors for lights in offices, bathrooms, closets, break rooms, etc.	High – many offices, conference rooms, and storage rooms are empty for large portions of the day	Results are highly variable based on existing conditions and electric rates, but improved control of lighting systems will typically save more than 5% of the total electricity spend at a facility	Generally provide a payback period of under 18 months
Install photo-sensors for lights in parking lots, outdoor lighting, and well-lit maintenance bays	High – several parking structures keep their lights on 24/7; mechanical lighting is unnecessary during the day in the bus maintenance facilities with high levels of natural light	Results are highly variable based on existing conditions and electric rates, but improved control of lighting systems will typically save more than 5% of the total electricity spend at a facility	Generally provide a payback period of under 18 months
Upgrade current light bulbs to efficient T8, HID, and CFLs	High – some facilities have done so already	Upgrades from incandescent to CFL will reduce energy consumption by 40–75%/bulb; an upgrade to T8 bulbs will save on average 15–20% over more commonly used T12s; also, T12s are being phased out by the federal government and will be harder to find in the coming years	Upgrades from incandescent to CFL save on average $40/bulb over the bulb's lifetime; an upgrade in T8 bulbs results in a savings of nearly $30over the bulb's lifetime
Use light meters to eliminate over lit conditions	High – Large discrepancies in lighting levels within each facility	High	High
Close doors when heat/AC is on	High – maintenance shops keep bay doors open even when heat is on; bus facilities do so for ventilation, but should close the doors facing the wind	High	High
Install automated digital thermostats with programmable automatic setback temperatures	High – Division 20 reports that the HVAC is badly balanced/controlled – it is difficult to maintain the proper temperature; the administrative staff uses space heaters, which they want to discourage	Generally provides annual savings of 1–5% off the utility bill of a building; results may be higher in facilities operating 24/7	Typical paybacks for installing digital thermostats are under 18 months
Install sink aerators in all bathrooms and kitchens	High – some facilities report using aerators, but many said they have taken them off	Reduces water use and the energy needed to heat water	Payback in a matter of months based on the energy savings associated with heating and cooling water
Weather stripping on doors and caulk windows	High	Prevents heat loss associated with poorly sealed windows and doors	Costs less than $10 per treatment and have a payback of 3 months or less

Low-Cost/No-Cost Improvements			
Measure	**Relevance to Metro?**	**Potential Energy Savings**	**Potential Cost Savings**
Install CO_2 sensors and manually check CO_2 levels	Medium – Most facilities report already measuring CO_2 levels	In spaces where CO_2 levels are too high, added sensors and controls will not save energy but will improve staff comfort and productivity	Paybacks in spaces where too much air is brought into the building can be less than 6 months

Investment Grade Opportunities

In today's economic climate with little funding for major efficiency investments, it is natural for organizations to prefer energy use reduction projects with fast paybacks. Our initial recommendations are to implement no- and low-cost improvement projects that pay back quickly if not immediately. These projects focus on lighting or basic automation, which generate savings with a relatively high ROI. Eventually, if we wish to make significant reductions in energy consumption, we will have to invest in some resource-intensive projects that can achieve significant efficiency gains but have longer payback periods. Some of these projects are attractive because they have a significant ROI, while others are mandated or strongly recommended by policies at the state, local, or national level (such as integrating renewable energy into the power mix).

A simple example of a valuable investment-grade efficiency improvement is the replacement of aging chillers, hot water heaters, or boiler equipment. After 10–20 years in continuous operation, many of these systems surpass their useful lives, require frequent repair, and may be operating at only 50–60% of their original efficiency. Although replacing these systems is very expensive, including efficiencies as well as government and utility rebates and other incentives in evaluating these projects can help introduce the concept of cost savings over time. Understanding which projects are the most cost effective is very site- and building-dependent, but attention to performance data and successes with no- and low-cost recommendations puts us in a position to make more informed prioritization decisions.

By increasing efficiency and providing long-term savings potential, investment-grade projects exhibit to both employees and stakeholders that the agency is serious about both the environment and innovation. As we have already experienced, an investment in solar PV installation symbolizes our efforts in environmental programs and in achieving energy independence. By taking aggressive steps on investment-grade technologies, paybacks sometimes take many years, but positive image enhancements occur immediately.

The following initiatives cost more than $15,000 to implement or have an estimated payback longer than 3 years, and therefore are not included on our initial recommendations checklist. In some cases, significant investments will be needed to achieve further energy efficiency gains. In addition, each of these investments should be refined through further research and a competitive bidding process with a number of potential equipment manufacturers or service providers. However, we strongly recommend considering these projects as potential energy efficiency upgrades for expected capital projects and/or equipment replacement projects on a site-by-site basis.

These investment-grade approaches are more time consuming, more expensive, and uncover more building-specific options than the portfolio-wide approach. Metro should consider carefully selecting a few buildings to recommission in order to assess what this more extensive approach can provide in terms of site-specific savings. LEED EB Operations and Maintenance guidelines require recommissioning, so additional commissioning activities would help achieve compliance with such guidelines.

Table 3-16 presents selected recommendations for investment-grade projects to consider.

Table 3-16: Potential Investment-Grade Opportunities[35]

Measure	Relevance to Metro?
Convert T12 and indoor HID lights to T8 or T5	High – The lighting staff have already started this process for some facilities. The savings potential is between 10 and 40% of the lighting energy use, depending on the type of lights being replaced. Paybacks are generally short and can easily be estimated on a per job basis. The more inefficient the original system and the higher the burn hours, the higher the savings and the faster the payback will be in installing more efficient lighting.
Upgrade outdoor lighting – replace older HID lights with more efficient ones	High – Some facilities have already started doing this. One facility (Division 20) has 70–foot outdoor lights in the parking lot that are unnecessarily high and require expensive equipment to maintain.
Install windows on maintenance bay walls to reduce the need for mechanical lighting during the day	High – Maintenance shops could use windows rather than sheet metal walls to reduce the need for mechanical lighting or keeping doors open.
Look at opportunities to upgrade older HVAC and boiler equipment	High
Consider retro-commissioning of select sites	High – Could select several sites to recommission in order to assess what this more extensive approach can provide in terms of site-specific savings.
Submeter electricity use of every building	High – It would be particularly useful to distinguish propulsion from facility power, but probably cost prohibitive.
Hire a systems engineer to provide support and training on BAS	High – Many facilities report issues with BAS systems but inability to fix them.
Install and optimize BAS for all buildings	High – Some buildings already have BAS, but they are not functioning properly.

Improved Data Collection and Tracking

As a first step in developing a mitigation strategy, Metro should investigate opportunities to track energy performance more aggressively. Some key steps to improving energy and environmental tracking include the following:

Developing an Enhanced Building Equipment Inventory

Metro has an inventory of appliances and lighting at each of its divisions – “Facility List and Descriptions,” dated December 2010. However, this inventory has limited data on power consumption and efficiency of equipment, and does not include key energy-consuming equipment like HVAC, water heaters, and servers.

We should expand our facilities equipment list to include the age and power consumption of major heating, cooling, refrigeration, ventilation, and lighting equipment. On a regular basis (annually or every other year), these systems should be tested to ensure that they are performing at their rated capacity and

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[35] Note that energy and cost savings potentials are not included here because we did not get a sense of how prevalent these technologies are across the portfolio. Metro is in the middle of a lighting upgrade program, so T12s and other inefficient fixtures may have largely been eliminated as of March 2011.

efficiency, and major equipment and systems should be evaluated to determine what upgrades would be cost-effective. Identifying which equipment and systems could benefit the most from an upgrade will allow us to better estimate payback on investment and prioritize equipment upgrades that will drive efficiency at the lowest cost.

Metering Each Building's Electricity Consumption

Without electricity meters on each building, it is difficult to benchmark performance and identify the buildings and the energy uses that are contributing the most to Metro's energy consumption. Moreover, given reports of Metro paying for electricity being consumed by non-Metro entities, submetering and regular bill review is essential to cost savings as well. Submetering has already begun as a part of the LEED EB Operations and Maintenance effort, and thus this recommendation would ready more buildings to be LEED certified.

Because submeters have become substantially less expensive over the past several years, Metro could consider installing submeters at every major building, and even every major service area (warehouse, maintenance shop, office) within each major facility system-wide. This will not only provide facility managers with a better understanding of site-specific energy use, but will also provide more detailed energy use data that can be helpful in determining poorly functioning equipment. Where available, Metro should take advantage of utility programs that provide rebates or free installation of submeters and, depending on the findings of these meters, should consider participating in a demand-side management program with the local utility.

Tracking Energy and Environmental Performance on a More Regular Basis

Metro currently tracks energy consumption, but this information is not shared across departments or actively used to identify reduction opportunities.

Metro should at minimum share this information at the site level with the responsible parties charged with day-to-day facilities management. Although out of the scope of this particular plan, similar systems should be set up to track water and waste.

At most high-performing facilities, it is ultimately the responsibility of the facility manager to track energy management. This ensures that the facility is making progress in energy reduction, that the facility is paying attention to the rate structure of the local utility to inform their energy consumption, and that any major energy "leaks" in the system can be immediately identified and corrected. At a minimum, it is recommended that building managers obtain electricity consumption, peak demand, and electricity cost information from their utility bills and track this information (in a table or graph format) every month. This will allow building managers to do the following:

- Develop a thorough understanding of their buildings' energy usage and cost characteristics.
- Set a baseline for energy performance and track performance against this baseline over time.
- Set targets for energy reduction and a plan of steps to take to achieve energy reduction goals, including using a cost-benefit analysis to determine if the net present value is positive and the payback is fast enough for our needs.
- Measure energy and cost savings associated with energy-saving measures.
- Identify performance problems early so that they can be resolved before wasting money or causing employee discomfort.
- Communicate energy performance improvements to division managers, engineers, Environmental Health and Safety (EH&S) staff, and employees.

- As the program builds momentum, recognize achievements in energy performance improvement at the employee level and at the facility level.

Currently, our managers may receive energy consumption information but may sign off on utility bills without studying consumption patterns over time, looking for trouble spots in energy use, or sharing this information with employees as part of their energy reduction efforts. Utility cost and consumption information is not currently shared with the contractors who perform maintenance on the buildings on a daily basis.

Metro should hold periodic building engineering and maintenance staff meetings to discuss energy use analysis. This regular meeting should highlight accomplishments and savings and encourage staff to continue with energy efficiency best practices.

A common best practice for this type of meeting is to use a whiteboard to notify engineers and staff of energy trends and fluctuations. The examples below (Tables 3-17 through 3-19) would allow discussion of daily changes in consumption.

Table 3-17: Simple Energy Data Tracking for Facility Managers

Timeframe	Electricity Usage (kWh)	Natural Gas Usage (therm)	Peak Electricity Use (kWh)	Time of Peak Electricity Use	Maximum Outside Temp	Minimum Outside Temp	Day of Minimum Temp
This month							
Last month							
This month last year							

Table 3-18: Foundational Facility Management Practices

Facility Management	
Measure	**Relevance to Metro?**
Develop an enhanced building equipment inventory	High
Track energy and environmental performance on a regular basis	High
Share monthly energy consumption and cost data with facility managers	High – several facilities managers suggested that this would be beneficial.
Implement active temperature controls with off-hour setbacks for thermostats	High
Create efficient equipment standards	High
Set portfolio-wide reduction goals	High

Table 3-19: Facility Management Energy Cost Reduction Strategies

Facility Management			
Measure	Relevance to Metro?	Potential Energy Savings	Potential Cost Savings
Standardize BAS	High – Systems are currently malfunctioning and in some cases cannot be fixed by current staff. Because Metro has many different BAS, there is confusion about how they operate. We should either have a contract with someone to manage these or install one type of system across the portfolio so the HVAC crew knows how to use them effectively.	The savings potential for night pre-cooling can be as high as 20% of the HVAC energy. Savings are highly dependent on location, HVAC configuration, building usage patterns, and mass.	The payback for this measure can be anywhere from under 6 months to under 2 years.
Reset chiller coil temperatures	Medium – where appropriate as Metro seems to be doing this regularly.	The savings from resetting coil temperatures can be between 10 and 30% of chiller energy.	Payback is short if controls or manual approaches can be implemented without outside assistance.
Reset hot water heater temperature settings	Medium	A 10 degree reduction in water temperature at the boiler level will save 3–5% on water heating costs.	
Ensure hot water heaters are properly insulated	Medium – we saw one boiler that was not insulated, but there may be more.		Thermal jackets cost $20–$50 and pay for themselves in energy savings within 6 months.
Expand the availability of the revolving loan fund of $2 million for sustainability projects and initiatives that can demonstrate significant cost savings by streamlining the budget cycle, which can take as long as 2 years at present, and consider increasing payback period for efficiency projects	High – several facilities management staff emphasized that it is difficult to get funding for improvements.	Reinvest savings into energy projects.	Reinvest savings into energy projects.

Educating and Engaging Employees

Our site visits indicated that Metro's facility managers are thinking about energy use, but only as a secondary issue to keeping buses and trains well maintained. For instance, at a bus division, employees knew that the vacuums were extremely inefficient and that dryers for paint application were wasting energy. Overall, our experience at the site level demonstrated that the people who worked in each facility knew what the energy efficient technologies were and had suggestions for ways they could improve efficiency.

To turn the corner as an organization, Metro should incentivize all of employees to save energy. This would apply particularly to facilities and maintenance specialists, but would involve using tools such as increased information and training, and competition, as described below. Informing employees of the financial and environmental benefits of energy-saving measures (i.e., shutting computers down or turning lights off) is a simple method of reinforcing the importance of employee participation. These programs could include installation of an energy-saving computer program where employees can track their energy consumption and make pledges to reduce it,[36] developing signage in office hallways on energy savings, or developing a visible building checklist to ensure that all equipment is turned off at appropriate times by security and cleaning staff. If such a policy is included, then it should be clear that security and cleaning staff will not touch individual computers/work stations.

Engaging Employees through Information, Competition, and Recognition

A formal awareness program should be developed to involve employees in Metro's energy conservation and environmental impact reduction efforts. This program would be based on consistent and frequent messaging, such as signage, newsletters, or monthly or quarterly emails, to assist employees in saving energy and reducing their energy costs. As this program gains momentum, Metro can expand the program to cover more activities, and include education, data tracking, and incentives to boost participation. Elements of this program would include the following.

- **Periodic Communication to Employees**: Letters and/or e-mails can be sent to employees to explain the continued commitment to improving energy performance and suggest specific ways that employees can contribute to this goal. These communications should reference specific data on the facility's overall energy performance and, when possible, each employee's energy management performance.
- **Computer Energy Management Software**: Certain free, simple software tools can enable power management on computer monitors in seconds. These tools can save approximately 200 kWh of energy annually per computer. The EPA's EZ Wizard is available for download at http://www.epa.gov/eebuildings/ezenglish.html. This tool can be distributed by the IT department or emailed to employees for self-installation.
- **Create Incentives and Recognition Programs to Reward Performance**: Building recognition and incentives into the energy performance improvement efforts can help encourage active participation. Employees who follow all recommended energy actions should receive recognition on performance evaluations, and exemplary participation should be publicly recognized with awards. Similarly, best practices at the facility level should be recognized through bonuses, awards, and bringing environmental leaders to present to their peers. A recognition program could also leverage competition to drive energy conservation norms across the building portfolio.
- **Develop Air Compressor Checklists**. Because air compressors operate at most Metro facilities, it is important that Metro develop an effective energy management strategy to ensure that these systems are running efficiently and not loosing energy. A five question checklist that has proved effective in the past should be employed at least once a year for all compressors:

9. Are main areas of use capable of being isolated and compressors switched off during periods of no use? It is important to check to ensure that there are suitable means of isolating main compressed air discharge points.
10. Are pressure settings on air compressors adjusted to the minimum pressure requirement to complete the task? Air compressors are an important tool, and it is important for staff to be able to

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[36] We have developed and customized programs for employee engagement and would be happy to provide demonstrations of the tool.

access compressed air when they need it. All compressed air discharge points should have the "approved operating pressure" noted and the main air compressor should only have to be set 5-10% higher.

11. Do operating procedures ensure that compressed air is only used where necessary in order to minimize extraneous blowing or use of pressure reducing valves? To achieve this, one strategy is to survey all compressed air users to get a sense of where blow-off lines occur. And, where possible, make sure that a static line pressure of no more than 30 pounds per square inch (psi) exists.
12. Are regular inspections of compressed air lines undertaken to detect pressure drops and line losses? The air compressor maintenance plan should include quarterly line inspections to ensure that lines do not have holes. Also, hose line setup should be reviewed regularly. The longer the line is from the air compressor the higher the pressure drop. On average, a 6 millimeter air line will lose 30 psi over 30 feet.
13. Are compressed air units maintained and serviced according to manufacturer's instructions? Effective maintenance plans are extremely important to efficient operations. To check if the current maintenance plan is effective, Metro can check for pressure drops across inline filters and additional heat from the compressor's coolers.

Training Cleaning and Security Staff

After-hours work and varied occupancy schedules can result in lights being left on and the HVAC system remaining in use after primary occupants are no longer in the building. Invariably, there will also be lights, computers, and other electronic equipment left on by employees who forget to shut down their workspace or rooms. Both security and cleaning staff can play an integral role in energy management by assisting in overall building or space shutdowns. They can contact the facility managers if any unusual or redundant energy uses throughout the building are occurring, or they can ensure that the lights and other equipment are turned off after hours. Examples of items that should be turned off are computer monitors, task lights, office and hall lights, coffee machines, and printers.[37]

Cleaning and security staff needs to be included in the 24-hour energy management strategy of a facility. One important way to engage after-hours or late shift staff in energy management is to provide a checklist that provides clear instructions on what equipment should be turned on or off when they arrive, and what should be turned off when they leave. This approach is critical in that cleaning and security teams often have high turnover rates or shifts that may work at different times during the week. One suggestion if security is not patrolling is to have security report to facility staff when lights are left on during the night when staff are not using the space.

With lighting, labeling with simple colored stickers to demarcate whether lights can be turned on or left off has proved effective. Including these items in the contract language for contracted security and cleaning services is an effective way to establish accountability and show that energy management practices are taken seriously.

For cleaning crews that work several hours later than most staff, consider options other than extending the conventional conditioning and lighting schedule. It may be that letting interior temperature "float" through the cleaning schedule or using 100% outdoor air will keep temperatures in the comfort zone for this activity.

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[37] Caution should be used to ensure that security and cleaning staff do not shut off equipment that was intentionally left to run all night or may have a sensitive shut-down procedure, such as a laptop computer used for a critical function.

Table 3-20: Employee Engagement Measures

Measure	Relevance to Metro?
Develop a formal awareness program	High – several facility staff expressed the need for such a program
Expand employee training to include energy efficiency and energy use management	High – several staff members suggested that energy training could be effective if implemented similarly to their current mandatory safety trainings
Engage employees through information, incentives, competition, and recognition	High – currently there are no incentives to save energy; make energy use reduction part of employee performance metrics including recognition and incentives for efficiency improvements
Develop checklists for employees at all levels to ensure energy use is a core part of performance tracking	High – currently there is little to no employee engagement
Create a culture of continuous improvement	High
Train cleaning and security staff	High
Develop a “Turn it Off” campaign and consider adding a web-based tracking system and/or incentives	High – currently there are no programs enforcing the need to turn off lights, etc.
Develop and enforce end-of-day shut down procedures	High – currently there are no programs regarding end-of-day procedures, turning off computers, etc.

3.6.6. Recommendations

Key Steps to Cost-Effective Immediate Reductions in Energy Consumption

This section lays out a potential strategy for Metro to reduce energy use. This plan should be seen as a first step in developing a program that helps identify, approve, and drive mitigation strategies and investments to help cost-effectively reduce energy consumption and environmental impact.

“5 + 5 + 5 + 5 Recommendations” for an Immediate Impact on Metro’s Energy Consumption

The sections above contain numerous recommendations that will help Metro reduce energy consumption and create a culture of continuous improvement for energy management. Based on both a qualitative and quantitative analysis of Metro’s current energy consumption and management practices, the following grouped recommendations represent a strong starting point in reducing Metro’s energy and environmental impact, both in the short- and long-term.

Recommendation 3.6-1

5 Key Equipment Upgrades

- Install occupancy sensors and/or photo sensors in areas with limited employee traffic (bathrooms, conference rooms, meeting rooms, and closets) and on outdoor lighting.
- Replace all metal halide, high pressure sodium, and T12 fluorescent lights with T8 or T5 fluorescent lights, and all incandescent bulbs with compact fluorescent (CFL) bulbs, where possible. Furthermore, as LED technology becomes more reliable, consider its use around the portfolio.
- Submeter electricity use of every building in operation. It is especially important to submeter energy used for propulsion verses energy use for facility operations. Identify opportunities to submeter water consumption where economically feasible.

- Install automated digital thermostats that can be programmed with automatic setback temperatures.
- Install sink aerators in all bathrooms to reduce water flow from 2 gallons per minute to 1 or 0.5 gallon per minute, reducing the energy use associated with water usage.

Recommendation 3.6-2

5 Critical Facility Management Strategies

- Create an overarching management structure for energy management, including a process for sharing energy consumption and cost data with facility management on a monthly basis, and a manager who takes primary responsibility for reducing energy consumption and cost Metro-wide.
- Implement active temperature control with off-hour setbacks for thermostats and temperatures set at seasonal thresholds.
- Develop strategies to reduce lighting loads in an OSHA-compliant manner in spaces that go unoccupied for long periods of time.
- Develop checklists for employees at all levels to ensure energy use is a core part of performance tracking.
- Develop strategies to ensure that bay doors are kept closed while heating and cooling systems are in use.

Recommendation 3.6-3

5 Stakeholder Engagement Efforts

- Expand employee environmental and safety training to include energy efficiency and energy management.
- Develop a campaign or contest to get similar Metro sites to compete against one another for energy savings, and consider developing a web-based tracking system and/or incentives to support the energy reduction contest (and the future program).
- Make energy reduction part of employee performance metrics, including recognition and incentives for efficiency improvements.
- Expand funding for efficiency and energy management projects, and consider developing a streamlined budgeting process for efficiency projects.
- Expand and systematize training and technical support for Building Automation Systems.

Recommendation 3.6-4

5 Powerful Sustainability and Investment-Grade Opportunities to Explore

- Look at opportunities to upgrade older HVAC and boiler equipment.
- Hire a systems engineer to integrate existing Building Automation Systems, as well as provide training and coherency to the myriad Building Automation Systems currently in place.
- Consider multi-day retro-commissioning of select sites, particularly to comply with the LEED Existing Buildings Operations and Maintenance standard.
- Look at the potential for onsite power generation (solar, wind, geothermal, etc.).

- Ensure that Metro prioritizes energy efficiency points in LEED projects.

These 5+5+5+5 strategies could lay the groundwork for effective energy and environmental management, easy low-cost opportunities to begin saving energy and water, and more time- and cost-intensive opportunities to improve sustainability on Metro's campus that have a reasonable ROI and payback period.

3.7. Renewable Energy

Renewable Energy can be defined as that coming from any naturally occurring, and theoretically inexhaustible, source of energy that is not derived from fossil or nuclear fuel. Common examples are solar, wind, biomass, wave, tidal, and hydro power. Metro is already a leader within the transit community in its renewable investments, having completed four large solar PV projects with a total installed capacity of about 2,000 DC kW that generate about 2,700,000 AC kWh annually (representing over $300,000 of displaced utility power each year). Metro used available incentives to substantially reduce system costs in each instance. In addition to their environmental and other benefits, the renewable energy projects provide electricity hedging benefits to Metro (known, fixed costs for the portion of its electricity supply represented by renewable output). The four completed Metro projects are summarized below.[38]

Table 3-21: Metro Solar PV Installations in Service

Metro Facility Name	City	Year of Installation	Installed Capacity (DC kW)	Actual Year 1 Output (AC kWh)
Division 8	Chatsworth	2005	213	318,895
Division 15	Sun Valley	2005	213	327,414
Division 18	Gardena	2007	417	645,000
MSSC	Los Angeles	2009	1,200	1,467,234

Metro is considering substantial growth to its existing renewable energy portfolio to increase its percentage of clean energy and to seek cost savings from these and other projects. A systematic, consistent approach would aid Metro in making strong decisions on which technologies to select, how large projects should be, where they should be located, and on other attributes.

Section 6 of this document defines an approach for Metro to build upon its current experience with renewable energy and affirmatively develop a systematic, structured program for selecting, implementing, and evaluating additional projects for implementation. These projects would be part of a well-defined Metro Renewable Energy Program, directed by clear Board policy guidance.

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[38] Section 3.4 discusses the electricity hedging and price risk management effects of renewable projects at greater length.

4. Energy Management Structure

Metro has a tremendous opportunity to build upon its accomplishments as an internationally recognized sustainability leader among transit agencies by developing a focused and effective Energy Management Program. The foundation of this program is a new structure that centralizes the management, coordination, and focus of the Energy Management functions and activities of the agency. Based on the existing line structure, this central focus can temporarily be housed as an integrated element of Metro's Environmental Compliance and Services Unit in the Transit Project Delivery Department. However, this approach should be revisited at least once every 5 years, or more often as Metro's organizational structure requires (see Recommendation 4-1, below). This section provides the methodology and background information that led to this recommendation and other elements that are critical to a successful implementation.

4.1. Methodology

Four peer agencies were interviewed to ascertain their experiences in the Energy Management realm: NY MTA (New York), CTA (Chicago, IL), TriMet (Portland, OR), and King County Metro (Seattle, WA). The interview questionnaire developed for the peer agency interviews is contained in Appendix E.

Table 4-1 provides a list of the agencies contacted, key reasons for selecting these agencies, and contact names and titles.

Table 4-1: Peer Agency Interview List

Agency	Selection Rationale	Contact Name	Title
NY MTA (New York, NY)	• Recognized as sustainability leader • Large umbrella organization • Includes rail and bus operations	Projjal Dutta	Director of Sustainability
CTA (Chicago, IL)	• Recognized as sustainability leader • Large agency • Includes rail and bus operations	Karl Peet	Project Manager, Planning & Development
Tri Met (Portland, OR)	• Recognized as sustainability leader • Former General Manager (Fred Hansen) was Chair of APTA's sustainability task force • Have a designated staff person (in the Office of the General Manager) to address climate change/GHG • Includes rail and bus operations	Judy Munro Elizabeth Papadopoulos	Capital Projects Manager Facilities Manager
King County Metro (Seattle, WA)	• Recognized as sustainability leader • Has designated staff to address climate change/GHG in the Director's Office and in the Divisions • Operates diesel and hybrid buses; electric trolley buses; and rail (LRT is under contract to Sound Transit)	Jerry Rutledge	Manager of Power and Facilities

In addition to the external perspectives provided by the peer agencies, seven Metro staff members were interviewed to better understand the internal challenges, opportunities, critical functionality, and other key elements needed to successfully manage energy at Metro. The questionnaire developed for the Metro staff interviews is contained in Appendix E. Table 4-2 identifies the contact names and functional areas of the Metro participants. Personnel selected for interviews included a cross-section of managers and executives in key business units involved in Energy Management program efforts.

Table 4-2: Metro Staff Interview List

Functional Area	Contact
Transit Project Delivery	KN Murthy, Executive Director, Transit Project Delivery
Administration/Accounting	Jesse Soto, Director of Accounting
Operations	Mike Stange, Interim Deputy Executive Officer of Operations
Division Managers	Frank Lonyai- Maintenance Operations Manager (Bus Division, San Fernando Valley)
Rail Wayside	Michael Harris-Gifford, Executive Officer—Rail Wayside Systems
Bus/Rail Vehicle Maintenance	John Roberts, Executive Officer Transportation
Gateway	Paul Gomez, Facilities Maintenance Supervisor/Gateway (HQ)

In addition, separate discussions were conducted with Metro staff involved in two other key Metro programs that cut across departmental and business unit lines: the Corporate Safety and EMS programs. The purpose of the discussions was to assess the potential transferability of various aspects of these cross-cutting programs for consideration in developing a Metro Energy Management structure.

Following are summaries of interviews and discussions.

4.2. Benchmarking Peer Strategies

The peer agency interviews provided valuable information from agencies considered to have pertinent experience with Energy Management programs. Following are some of the key themes that emerged from the peer interviews.

- Each peer agency interviewed had various policies and practices that specifically focused on Energy Management – some under the “Sustainability” umbrella.
- Sustainability groups typically consist of a manager and 1–2 support staff.
- *None* of the peer agencies interviewed had a specifically defined, formally adopted Energy Management program with dedicated staff.
- Some agencies have negotiated specific agreements with their main energy providers, receive special rates, and are able to resell unused energy to other customers at a higher rate.
- Some agencies have started to systematically report their annual performance related to the amount of energy purchased and GHG emissions by facility through CRIS (Climate Registry Information System). Emissions management and measurement is done though a centralized structure dedicated to the Sustainability program. The information is in the public domain. Measuring and reporting is perceived as a first and critical step toward energy conservation improvements.
- Third-party audits to monitor energy usage at the facility level and identify individual meter problems are common practice and very effective.
- Monitoring energy consumption requires that meters are installed at appropriate locations. A frequent issue is that a particular meter may cover multiple buildings and, in some cases, propulsion power for vehicles, making it difficult to relate the consumption pattern to a specific load. Modifying the metering system, through submetering changes, can be a very costly

undertaking – one in which the utility companies would look to the transit agency to cover the costs incurred.

- Energy usage is tracked by some agencies using a proprietary software package called Utility Manager. Specific energy bills are reviewed in various fashions, though the focus appears to be exception-based or aberration-based. For example, a bill may only be further scrutinized if it reflects a spike in usage when compared to the previous month's bill or the bill for the same time period in the previous year.
- Voluntary programs are in place to encourage all employees to contribute ideas related to sustainability and energy conservation. These efforts are typically not tied to formalized incentive programs.
- Obtaining funding for energy efficiency programs is challenging for all, and typically there is no budget specifically allocated to energy improvements. The idea that energy saved on projects could be used to finance future energy-saving projects is often mentioned but not actually implemented.

4.3. Assessment of Existing Energy Management Practices at Metro

The internal Metro staff interviews provided a wealth of information from a wide range of personnel involved in Energy Management and conservation efforts. Through the interviews, a set of key issues and opportunities associated with current practices at Metro were identified.

4.3.1. Issues

The interviews helped describe what could be improved at Metro from an organizational perspective, the main challenges associated with current practices, and items that should be addressed in the Energy Management program.

Some of the key issues and challenges identified during the interviews include the following.

- No one individual or department within Metro is currently responsible for monitoring and evaluating energy consumption to ensure that the agency is using energy efficiently.
- No one individual or department within Metro is currently responsible for coordinating with utility companies to ensure that the agency is paying the lowest rates.
- A single Metro person or department, with the responsibility to coordinate with the utility company account manager on all billing matters, could add value.
- There is a lack of cohesion (re: Energy Management) due to a separate set of responsibilities among many different departments.
- Metro is a very large organization (9,500 employees, 2,500 buses, 250 rail cars) and its bureaucracy can be a challenge when trying to effect change.
- The organizational chart seems to be a moving target with frequent reorganizations. As an example, an Energy Manager position existed at some point, but the position was eliminated after about a year.
- Operations/Facilities Managers do not receive reports on energy consumption so they cannot compare usage, costs, etc. from year to year or month to month.
- Metro does not track energy usage and bills through a specific accounting software tool; such a tool could help assess how the various facilities compare in energy performance and where

opportunities for savings exist, and ensure that only accurate bills get paid in a timely and efficient manner.

- There are limited financial resources to fund projects and strategies (such as replacing old equipment or installing more solar panels).
- Balancing the agency's priority of providing service to the public with a focus on energy conservation is a challenge in terms of time and available financial resources.
- An Energy Management group should have representatives from the different divisions (Rail, Bus, Facilities/Maintenance); this could be accomplished through an advisory committee.
- An Energy Management structure should be an integrated, supportive organization rather than a prescriptive, directive one (some responded negatively to the term "Energy Czar").
- Increasing energy efficiency should not adversely affect the goal of the organization, which is moving people efficiently.
- Metro needs to design and implement an infrastructure for gathering and disseminating information.
- There is a lack of adequate submetering; because some of Metro's current utility meters monitor several buildings within a division (for example), it is often difficult to accurately identify the source of increasing or decreasing energy usage within a specific division.
- There could be some resistance to the introduction of an Energy Management program with specific goals; it is up to the executive level to clearly explain the benefits of the program: cost savings, energy conservation, reduced carbon footprint, etc.

4.3.2. Opportunities

The interviews also helped describe what has already been accomplished at Metro in the area of Energy Management or, more generally, on Sustainability. These accomplishments can be positively leveraged in the process of developing organizational changes related to Energy Management efforts. Specific opportunity examples include the following.

- Energy Management and conservation efforts are directly connected to Metro's adopted Sustainability and Energy Policy.
- Metro's Sustainability Implementation Plan (MSIP) specifically includes Energy Management as a key element.
- There is a strong commitment from the executive level to implement an ambitious Sustainability program, and to be a national leader in this area.
- Metro is committed to learning from other transit agencies in the area of Energy Management.
- Some training on energy conservation has already been done through the Sustainability program.
- Metro has recently completed energy audits at several facilities and divisions.
- A major energy retrofit was conducted at the Metro Support Services Center.
- In developing its Energy Management program and related organizational structure, Metro can draw from and incorporate elements of other cross-cutting programs already in place, such as Corporate Safety, Labor Relations, and the EMS.

- The Corporate Safety program was successfully implemented as an agency-wide, cross-departmental system. This Corporate Safety Department developed specific policies and now works with other departments to implement these policies.
- Another example of a system-wide implementation group is the Labor Relations Department. They provide first-level support to decision-makers, and provide information and feedback.
- Several interview participants observed that an organizational mechanism similar to the Environmental Management System (already in place) tailored to Energy Management could be very effective. Through the EMS, Metro has been identifying environmental issues of significant concern, proactively addressing those issues, implementing specific solutions to those issues as those solutions are developed, and continuously engaging management to ensure continuous improvement.

4.4. Other Cross-Cutting Programs at Metro

Follow-on discussions were conducted with Metro staff involved in other cross-departmental/business unit (or cross-cutting) programs, with the objective of gathering information that could be useful in developing recommendations about organizational structures for Energy Management. Both the Corporate Safety program and the EMS were reviewed and are discussed below.

4.4.1. Corporate Safety Program

The Corporate Safety program has been in place for over 10 years. Its direction comes from a Department that operates under the CEO Business Unit. Its Director reports directly to the Deputy CEO. It currently has a dedicated staff of 27 employees.

Corporate technical staff members are responsible for overseeing the day-to-day safety program, evaluating trends, and examining whether training is needed at a particular division, etc. Technical staff members covering different functions are assigned by mode or discipline: bus, rail, bus and rail, training, ergonomics, industrial hygiene, etc. Corporate Safety technical specialists cover Metro’s nine bus divisions and its four rail operating divisions.

The program is an agency-wide effort that has been successful at providing all operating divisions with common policies and procedures. The department has also been helpful in providing safety specialists to go out to divisions to get feedback on what is working at the ground level.

The Corporate Safety Department is viewed as a resource and a collaborating partner. When regulating agencies such as EPA or OSHA do reviews, Corporate Safety Department staff serve as a liaison and support the divisions. When an unsafe working condition is identified in a division, Corporate Safety staff members help that division evaluate the situation, complete the paperwork, identify solutions, and make appropriate changes. The divisions understand that the Safety Department is not there to do the work for them, but rather is there as a knowledgeable resource to assist in continuously improving their safety practices.

Part of the Corporate Safety program’s effectiveness is due to its direct reporting and open door to the CEO and Deputy CEO. The CEO and Deputy CEO have been very supportive of the Corporate Safety Program and its efforts. The program’s effectiveness is critically linked to support from not only the CEO and Deputy CEO, but also from Metro’s Executive Team, managers, superintendents, and supervisors, etc.

Metro's safety efforts must be advanced at all levels, across all departments and divisions. The Corporate Safety Department helps by keeping the focus needed to fully implement the program and by paying attention to detail.

Each division has safety performance metrics and targets and the Safety Department conducts an annual divisional assessment. For example, the annual assessment includes measures and performance targets for collision rates. In the assessment, the Corporate Safety Department not only examines the division's performance compared to its goals and targets but, in addition to evaluating the numbers, also reviews the efforts the division is making to reduce collisions (also employee injuries). A division would not be taken to task for not meeting its target unless it is not making sufficient (documented) efforts toward reducing its collision and injury rates.

The Corporate Safety Department conducts two major annual assessments, one for rail operations and one for bus operations. Based on these assessments, the department ranks the divisions and issues "rewards" to the highest ranking divisions in the form of funding for implementing safety or wellness programs of their choice. In addition to the annual assessments, for rail operations there is an annual review/audit required by state and federal law. There is also an external review every 3 years by the Federal Transit Administration (FTA) to ensure that the agency is following its System Safety Program Plan (SSPP).

The results of the annual assessments and audits are communicated to the appropriate Executive Officers, Directors, and Division Managers for any corrective action that may need to be taken. While the Corporate Safety Department's assessments provide a mechanism for accountability, the Safety Department itself does not administer corrective action or discipline.

In summary, the Corporate Safety program is a central agency function that is focused on a very high corporate priority. The Corporate Safety Department provides technical support to the operating departments and divisions in their efforts to continuously improve the safety of Metro services, and meet all regulatory requirements. The department also provides an independent, organizationally consistent internal review of the various operating divisions and departments – to assess progress toward meeting performance goals and to help identify internal and external best practices for implementation throughout Metro.

4.4.2. Environmental Management System

Metro's EMS is one of the three main components of Metro's Sustainability Program, the other two being Energy Management and climate change management. The EMS is overseen by the Metro's Environmental Compliance & Services Department Manager and his staff.

EMS is a tool to ensure environmental compliance and is guided by the Board-adopted Environmental Policy. The EMS process is based upon the continuous improvement, quality management approach of "Plan-Do-Check-Act." At this point, the program has been implemented at the Red Line yard and is beginning to be implemented at Division 10. The goal is to extend it agency wide in 2012.

The EMS program has strong commitment and buy-in from top Metro leadership, from the CEO on down. By 2010, the organization will be structured around a central "EMS Administrator" (housed within the Transit Project Delivery Business Unit) to take care of EMS-related administration, a "Core Team" to develop the procedures and monitor their implementation, and a team of "local" EMS coordinators to carry out implementation at the facility level.

The Core Team is an ad-hoc, cross-cutting committee of about 20 individuals representing different business units, departments, and divisions including: Environmental Compliance & Services; Legal Counsel; Operations; Procurement; Corporate Safety; Red Line Yard; Division 10; Communications; Rail;

Document Control; Project Control; and Local Division Representatives. This core team initially met almost weekly during the early phase of the program, which involved building the procedures to obtain certifications. During the implementation phase, the core team has been reduced to a configuration of 7–8 core members, drawing in other team members as needed for specialized expertise or focus.

Building momentum on the successes of the program will be critical. Although starting as a “top-down” initiative, its continued success will be dependent upon the continued buy-in and enthusiasm of staff throughout the Metro organization. These are the people who are instrumental in making the EMS a viable program. To this end, the EMS program also conducts staff training, which serves as a constant reminder of the program, its purpose, and various technical aspects.

EMS as a concept is known agency-wide because people have talked about the principles. The principles are also incorporated into everyday tools, such as boilerplate contracts. In other words, there is one EMS program, but all of its elements are being used agency-wide. It is a vehicle to reinforce what the agency is doing already, and encourages staff to continuously improve and adopt new best practices.

4.5. Evaluation of Potential Approaches and Recommended Metro Energy Management Structure

Based upon the insights and information gathered in the peer agency benchmarking interviews, the Metro staff interviews, and other industry experience, a set of potential Energy Management organizational options have been developed for evaluation. The Energy Management functionality that any organizational approach should achieve is delineated below, followed by a discussion of potential organizational alternatives for Metro. A summary of each alternative’s pros and cons is provided followed by recommendations on the optimal Metro structure with which to effectively implement an Energy Management program.

4.5.1. Functionality Objectives

Based upon the work described in the previous sections of this Plan and the input received from the peer and internal Metro interviews, the following are some of the key functionality objectives that would need to be addressed under any Energy Management organizational approach.

- Energy Management Program Leadership: To provide sustained, consistent program direction, coordination, and facilitation within Metro toward achieving agency and program goals and objectives.
- Utility Bill Payment: To provide for the efficient and timely payment of electricity and natural gas utility bills on a regular and predicable basis.
- Billing Review and Expenditure Trend Analysis: To provide timely billing review for accurate and proper payments, and to analyze expenditure data and trends for effective budgeting.
- Database and Information System Establishment: To develop and implement a utility database and information system that enables efficient data input, robust analyses, useful and flexible report generation, and precise query capabilities.
- Energy Consumption Monitoring and Analysis: To monitor and analyze electricity and natural gas consumption data and trends, at the system, mode, division, and location level, using the utility database and information system described above,

- Energy Rate Monitoring, Analysis, and Strategy Development: To regularly monitor electric and natural gas rates by user group, consumption levels, and time of day; and analyze that data to develop strategies for engaging utility companies in rate negotiations.
- Negotiation and Liaison with Utility Companies: To designate specific staff to represent Metro in negotiations and other discussions with utility companies for the purposes of rate changes, conservation campaigns, third-party energy audits, etc.
- Utility Coordination on Billing Matters: To establish designated representatives at Metro who communicate with the specific utility departments on billing matters, and an effective internal coordination system within Metro to provide timely and accurate information for the Metro utility representatives.
- Energy Assessments and Audits: To conduct regular assessments and audits of both facility and propulsion energy use to identify excessive energy consumption levels, best practices at Metro for potential expanded application, and opportunities for promising investment and/or changes in practice.
- Evaluation of Potential Energy Management Investments: To assess, evaluate, and prioritize potential Energy Management projects, programs, and activities for potential Metro investment – including the capacity to estimate the lifecycle costs and benefits of alternative investments and initiatives, and their payback periods); these projects would include renewable energy investments as well as those that would enhance electricity or natural gas efficiencies/conservation efforts.
- Implementation of Selected Strategies and Projects: To implement the investments selected in a timely and cost-effective manner, whether capital projects or operating practices.
- Post-Implementation Evaluation: To evaluate the effectiveness, actual costs, and associated benefits of each significant Energy Management project implemented to inform decision-making on future investments (an appropriate assessment period would need to be established for each project).
- Energy Management and Conservation Training: To educate and raise the awareness of staff throughout the agency, toward generating buy-in and excitement, while encouraging and enabling active participation and innovation.
- Performance Management: To establish Energy Management performance goals, objectives, metrics, benchmarks, and targets; and the ongoing capability to monitor and assess progress at relevant levels of the agency – in the context of Metro's agency-wide performance management system.

The key is combining these various functions of Energy Management into an integrated, cohesive structure that has the clear direction, sufficient technical capacity, adequate financial resources, and sustained focus and support.

4.5.2. Potential Organizational Approaches

There are two fundamental organizational structure paths for implementation of an Energy Management program: (1) a Decentralized structure, or (2) a Centralized structure.

In the decentralized approach, the various critical functions related to Energy Management would reside in multiple business units throughout the agency, which would be united in common purpose through an agency-wide Energy Management policy. While there could be a coordinating committee, there is no single, empowered department or group vested with the responsibility for planning, executing, and evaluating Energy Management programs and initiatives.

Under a centralized organizational approach, Energy Management would be implemented through a central, defined group or department expressly dedicated to the following.

- Leading and guiding Energy Management programs and initiatives.
- Accomplishing many of the key Energy Management functions previously mentioned.
- Coordinating with departments outside of the central group that perform the remaining key functions.
- Working with the relevant line departments and divisions that consume energy.

Although there are multiple, conceivable variations within each approach (Decentralized and Centralized), the research performed in this task, as described above, led to the identification of the following four organizational options for evaluation.

- Alternative A: (Decentralized) – Under this alternative, each department would handle its own Energy Management issues independently. The various key Energy Management functions would be performed by multiple departments without a dedicated, central focal point. Although decentralized, this alternative would include a cross-departmental coordinating committee to share information and, where feasible, align activities between departments. Given its decentralized construct (i.e., no specific Energy Management focal point), there is no schematic diagram shown for Alternative A.
- Alternative B (Centralized): Under this alternative, a new central Energy Management Group (EMG) would be created within the CEO Business Unit as a new department (see Figure 4-1). A new position, “Energy Program Administrator,” would be created to lead the EMG. The EMG would provide focus, leadership, and technical support in Energy Management to the line operating departments of energy consumers. Other agency administrative and support departments would be drawn from as well to perform key functions. To augment the Energy Program Administrator and the EMG, a cross-departmental Core Energy Management Team would function as a steering group to involve and engage the full spectrum of departments and divisions in planning and executing the Energy Management Program.
- Alternative C (Centralized): Under Alternative C, a new, central, Energy Management Group would be created; however, it would be contained within the Transit Project Delivery Business Unit, specifically within the Environmental Compliance & Services Department (see Figure 4-2). From there, Alternative C shares a similar structure to Alternative B. The new position of Energy Program Administrator would be created to lead the EMG, with the EMG providing focus, leadership, and technical support in Energy Management to the line operating departments of energy consumers. In addition, other agency administrative and support departments would be tapped to perform key Energy Management functions. The Energy Program Administrator and the EMG would be augmented by a cross-departmental Core Energy Management Team. As with Alternative B, the team would function as a steering group to involve, engage, and integrate the range of departments and divisions in the planning and execution of the program.
- Alternative D (Centralized): Under Alternative D, a new, central, Energy Management Group would be created within the Operations Business Unit, specifically within the Operations Administration Department (see Figure 4-3). As with Alternatives B and C, Alternative D would create a new Energy Program Administrator position to lead the EMG. The roles of the EMG, the

Energy Program Administrator, support departments, and cross-departmental Core Energy Management Team would mirror those roles described above under Alternatives B and C.

Figure 4-1 –Schematic Diagram, Alternative B (Centralized)

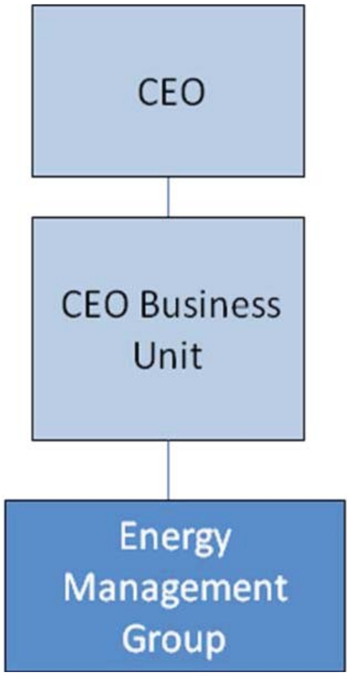

Figure 4-2 –Schematic Diagram, Alternative C (Centralized)

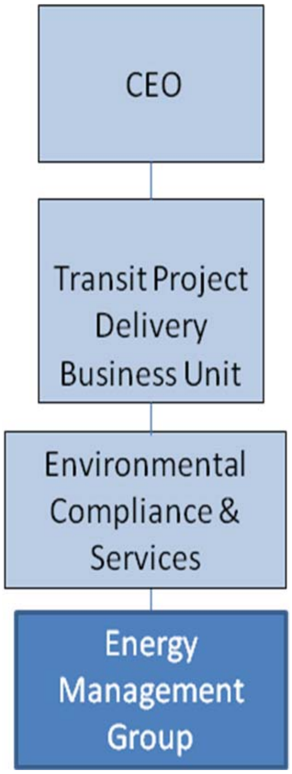

Figure 4-3 –Schematic Diagram, Alternative D (Centralized)

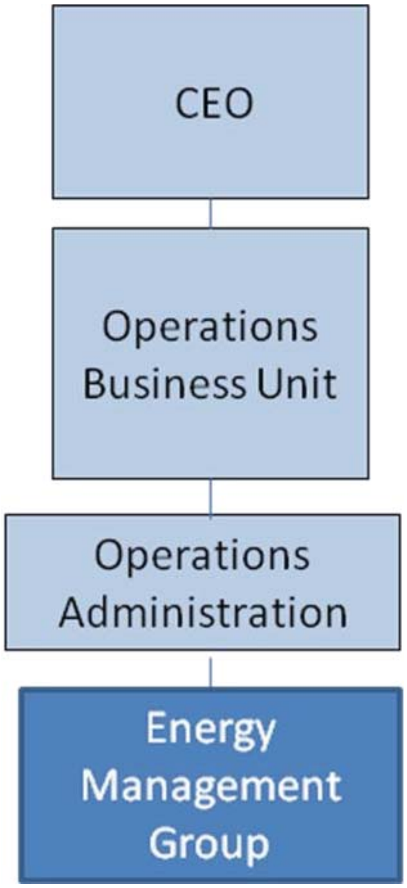

Table 4-3 summarizes each alternative in terms of how the critical Energy Management functional objectives could be accomplished under that alternative.

Table 4-3: Overview of Potential Energy Management Organization Options

Energy Management Function	Accomplished Through			
	Alternative A DECENTRALIZED	Alternative B CENTRALIZED Energy Management Group within CEO Business Unit	Alternative C CENTRALIZED Energy Management Group within Transit Project Delivery Business Unit	Alternative D CENTRALIZED Energy Management Group within Operations Business Unit
Energy Management Program Leadership	No designated individual charged with leading the program. A cross-departmental coordinating committee is established with a designated committee Chair or Co-Chairs appointed by the CEO or Deputy CEO.	Energy Program Administrator and EMG staff, augmented by Core, Cross-Departmental Steering Team (Chaired by the Energy Program Administrator)		
Utility Bill Payment	Financial Services Business Unit (Accounts Payable).	Financial Services Business Unit (Accounts Payable)		
Billing Review and Expenditure Trend Analysis	Individual energy consumer departments, with support from Financial Services.	EMG, with support from user department staff and Financial Services		
Database Design and Information System Establishment	Individual energy consumer departments with IT support, as may be coordinated through Committee.	EMG, with support from consumer department/division staff, Financial Services staff, IT staff, and others as appropriate		
Energy Consumption Monitoring and Analysis	Individual energy consumer departments.	EMG, in coordination with the energy consumer departments		
Energy Rate Monitoring, Analysis, and Strategy Development	Individual energy consumer departments, in coordination with Financial Services.	EMG, in coordination with the energy consumer departments, and Financial Services		
Negotiation and Liaison with Utility Companies	Individual energy consumer departments, in coordination with designated department within Financial Services,	EMG, with support from and coordination with designated Department within Financial Services, Operations, and/or Transit Project Delivery/ Environmental Compliance		

Energy Management Function	Accomplished Through			
	Alternative A DECENTRALIZED	Alternative B CENTRALIZED Energy Management Group within CEO Business Unit	Alternative C CENTRALIZED Energy Management Group within Transit Project Delivery Business Unit	Alternative D CENTRALIZED Energy Management Group within Operations Business Unit
	Operations, and/or Transit Project Delivery/Environmental Compliance			
Utility Coordination on Billing Matters	Financial Services (Accounts Payable), in coordination with Individual energy consumer departments	Financial Services (Accounts Payable) in coordination with EMG and user departments		
Energy Assessments and Audits	Individual energy consumer departments, with support from Environmental Group	EMG with support from Environmental Group		
Evaluation of Potential Energy Management Investments	Individual energy consumer departments through budgeting process, or tasking coordinating committee with project selection-- with support from Financial Services, Transit Project Delivery, and Operations Business Units	EMG and Cross-Departmental Core Team, with support from Financial Services, Transit Project Delivery, and Operations Business Units		
Implementation of selected strategies and projects.	Appropriate Unit/Dept., depending upon whether it is an operating practice, capital project, etc.	Appropriate Unit/Dept., depending upon whether it is an operating practice, capital project, etc.		
Post-implementation Evaluation	Individual energy consumer departments	EMG, with support from appropriate user department		
Energy Management and Conservation Training	Individual energy consumer departments	EMG, with support from user departments (could evaluate a “train the trainer” program to get entire agency involved)		
Performance Management	Individual energy consumer departments.	EMG, through annual assessments and reporting to CEO, Department CEO, and other Senior Leadership.		

Table 4-4 (A–D) summarizes some of the pros and cons related to each of the four alternatives.

Table 4-4A: Alternative A –- Pros and Cons

Alternative A: Decentralized Each department handles its own Energy Management issues independently, with no distinct, dedicated Energy Management Group	
Pros	**Cons**
Avoids additional one-time and on-going cost required with the creation of a new, central EMG	Level of focus and effort dependent upon the discretion and interest of individual department or division – without any independent review
Operating departments are closest to opportunities for energy conservation and savings	Lack of cohesive, consistent corporate focus
A cross-departmental coordinating committee could be a positive vehicle for Energy Management information sharing and the coordination of efforts across the Agency	Even with a cross-departmental coordinating committee, there is a lack of ownership and accountability that could result in inability to galvanize in a common and consistent direction; and maintain sustained energy and forward progress
	May be lack of technical expertise in a specific department/division with which to identify and evaluate energy efficiency initiatives

Table 4-4B: Alternative B – Pros and Cons

Alternative B: Centralized Establishment of a distinct, dedicated EMG within the CEO Business Unit	
Pros	**Cons**
High organizational stature of the CEO Department sends strong message that Energy Management is a high corporate priority	Requires creation of a new department within the CEO Business Unit, and its attendant one-time and on-going costs
Provides a strong, common organizational focus on Energy Management, along with the staff resources and technical support needed to implement a robust and collaborative program	Energy Management is separated departmentally from the Sustainability Program, and its EMS and Climate Change components – both of which are housed in the Transit Project Delivery Business Unit (within Environmental Compliance and Services)
Provides technical and analytical resources to energy consuming departments to assist them in identifying and implementing best practices	Unless managed well, could create a disconnect between the central EMG and the primary energy users (i.e., Rail and Bus Operations and Maintenance)
Provides an independent perspective in addition to that of the departments/divisions within the Operations Business Unit	

Table 4-4C: Alternative C – Pros and Cons

Alternative C: Centralized Establishment of a distinct, dedicated EMG within the Transit Project Delivery Business Unit	
Pros	**Cons**
Energy Management can be integrated departmentally with the Sustainability Program, and its EMS and Climate Change components – both of which are housed in the Transit Project Delivery Business Unit (within the Environmental Compliance and Services Department)	Requires creation of a new group, within the Environmental Compliance and Services Department, and its attendant one-time and on-going costs
Provides a strong, common organizational focus on Energy Management, along with the staff resources and technical support needed to implement a robust and effective program	Lacks the higher organizational stature of containment within the CEO Business Unit
Provides technical and analytical resources to energy consuming departments to assist them in identifying and implementing best practices	Unless managed well, could create a disconnect between the central EMG and the primary energy users (i.e., Rail and Bus Operations and Maintenance
Provides an independent perspective in addition to that of the departments/divisions within the Operations Business Unit	

Table 4-4D: Alternative D – Pros and Cons

Alternative D: Centralized Establishment of a distinct, dedicated EMG within the Operations Business Unit	
Pros	**Cons**
Placing the EMG within the Operations Business Unit provides the opportunity for direct integration with Rail and Bus Operations and Maintenance (including facilities and wayside power) – the largest internal consumers of electricity and natural gas in the agency	Requires creation of a new group, within the Operations Administration Department, and its attendant one-time and on-going costs
Provides a strong, common organizational focus on Energy Management, along with the staff resources and technical support needed to implement a robust and effective program	Lacks the higher organizational stature of containment within the CEO Business Unit
Provides technical and analytical resources to energy consuming departments to assist them in identifying and implementing best practices.	The primary focus on day-to-day service delivery challenges may preempt or divert needed focus on Energy Management
	Does not allow for an independent energy perspective in addition to that of the Operations Business Unit

4.6. Recommendations

Upon evaluation of the pros and cons, it is recommended that Metro establish a focused, Centralized organizational unit, dedicated to Energy Management. Establishing an EMG through any of the Centralized structure alternatives (B, C, or D) would greatly enhance Metro's ability to develop and implement an effective, cohesive, and dynamic Energy Management Program.

> **Recommendation 4-1**
>
> In light of the previously discussed research, the recommended option is to temporarily establish a new EMG in the Transit Project Delivery Department, specifically contained within the Environmental Compliance and Services Unit. This group would be led by an Energy Program Administrator position. The Administrator role may be accomplished by the Environmental Compliance and Services Unit Manager, or until such time that Metro is able to establish a new Energy Program Administrator position. The primary advantage of placing the EMG here is the strong synergy that can be achieved through the integration of the Energy Management Program with the Environmental Management System, of which Energy Management is a key component.

Drawing program elements and attributes from Metro's Environmental Management System and the Corporate Safety Program, a new Centralized EMG in this structure could work collaboratively across the various divisions/departments involved in energy use and related issues – particularly Rail and Bus Operations and Maintenance – and provide technical resources and a formalized structure with which to "plan, do, check, and act;" the cornerstone of the Environmental Management System.

The divisions/departments would be closely involved in the development of specific goals, program elements, and benchmark performance targets – and would then be accountable for their progress and continuous improvement toward meeting established targets – with the support and expertise provided by the Energy Management staff.

In addition to implementing the optimal Energy Management structure, there are several critical factors that would greatly increase the chances for a successful program. It is imperative that the development of any Metro Energy Management program focus on the following.

- A solid policy basis from the CEO and Board of Directors.
- A sustained organizational commitment.
- Realistic and affordable up-front and on-going program costs (with a multi-year budget commitment).
- A strong energy conservation/sustainability culture.
- Communicating a clear connection between Energy Management and Metro's agency core mission.
- Developing buy-in from all levels of the organization.
- CEO anointment of a Champion/Advocate at the Executive level.
- Appointment of a technically and managerially experienced Energy Program Administrator, empowered to reach out across (and get response from) the entire agency.
- A collaborative program culture, with clear accountability established.
- Clearly defined roles, responsibilities, and expectations.

- Understandable and transparent systems.
- Development and implementation of an "Early Action Plan" with which to achieve early Energy Management successes to build upon and establish momentum.
- Creation of an atmosphere of innovation to inspire, capture, evaluate, and (as appropriate) implement ideas generated by all employees at all levels – managers, supervisors, and first line employees.

The ultimate success factor will be the EMG's strong collaboration and extensive communication with staff representing Bus and Rail Operations and Maintenance, Facilities Maintenance, Construction, Accounting , and other key departments in the planning, launch, and on-going execution of Metro's Energy Management Program.

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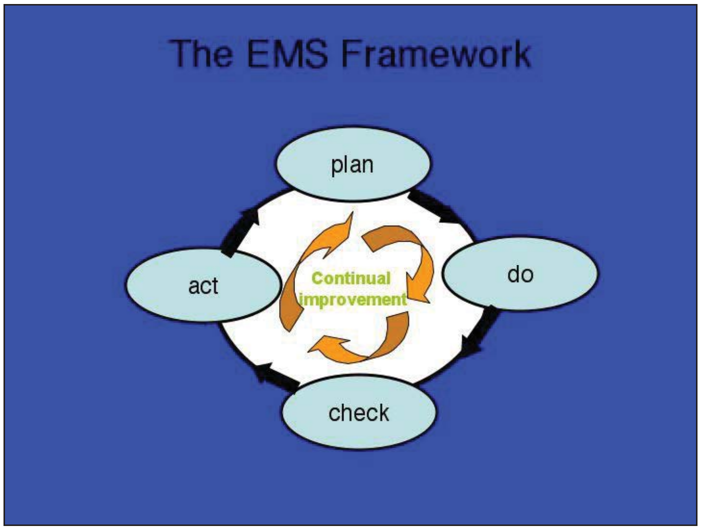
5. ECMP Implementation Strategies

This section provides a set of Energy Management Implementation Strategies designed to capture and build upon the organizational momentum and excitement created through Metro's Sustainability Program, including its EMS. The implementation strategies presented here follow the Plan-Do-Check-Act model employed by Metro in its EMS (see Figure 5-1). This is also similar to the continuous improvement approach recommended by the EPA Energy Star program in their Guidelines for Energy Management.

Figure 5-1: Plan-Do-Check-Act Model



Source: University of Massachusetts, Lowell.

5.1. PLAN—Set Up the Energy Management Program and Action Plan

This first step would form the foundation for a new Energy Management Program at Metro. Metro has created a policy for Sustainability and Energy Efficiency that is consistent with our mission for the continuous improvement of an *efficient* and effective transportation system for Los Angeles County. Metro has also been pursuing many energy efficiency initiatives over the past years. In addition, the Inspector General's report recommended the development of a comprehensive electricity conservation and management plan with centralized management promoting an agency-wide conservation effort. The following steps are intended to continue and expand upon Metro's commitment to energy management in a proactive and collaborative manner.

5.1.1. Form and Launch an Ad Hoc Energy Executive Team

Following endorsement of the ECMP, a cross-departmental steering committee would be formed immediately as the implementation arm of Metro's Energy Management Program. The committee, the Ad Hoc Energy Executive Team, would be composed of select Metro staff representing various aspects of Bus and Rail Operations, Bus and Rail Fleet and Facility Maintenance, Finance; Environmental Compliance, Construction, and other key agency functions. Team members would be designated, appointed, and empowered by the CEO. The Team Chair would also be designated by the CEO and would be a visible champion/advocate of the new program. The Ad Hoc Energy Executive Team's charge would include:

- Development of an Energy Management Program Charter.

- Development and assistance in filling the Energy Program Administrator position (when a new position may be created by Metro).
- Selection of an on-going, advisory Core Energy Management Team (as defined in the charter to be developed).

Develop an Energy Management Program Charter

Drawing upon the ECMP and other internal expertise, the Ad Hoc Energy Executive Team would develop the proposed Energy Management Program Charter and present its recommendations to the Executive Office for approval and (as may be appropriate) to the Board for endorsement. Approval of the charter would include a commitment for the resources required to initiate the program. The Energy Management Program Charter would establish the program, including the following terms of reference and some potential elements.

1. Mission and Vision Statement of the Energy Management Program
2. Scope of Program
    a. Energy forms to be managed (i.e., electricity, natural gas, petroleum fuels, renewable energy, etc.); relevant energy uses (i.e., propulsion, facilities, etc.); and the Metro energy budget associated with the forms and uses (currently estimated at approximately $30 million)
    b. Stages of supply to be managed (e.g., procurement and accounting)
    c. Stages of demand to be managed (e.g., operational and maintenance procedures, equipment/system performance related to energy use/efficiency)
3. Program Goals/Targets
    a. Absolute energy reduction
    b. Intensity based energy reduction
    c. Renewable energy
    d. Greenhouse gas emissions
    e. Employee awareness
    f. General public awareness
    g. External stakeholder awareness and (as appropriate) involvement (e.g., City of Los Angeles and other cities, Los Angeles County, California Air Resources Board [CARB] and other state agencies, FTA, etc.)
4. Funding Processes
    a. Development of a financial plan, and operating and capital budgets
    b. Financial parameters and criteria for project and program investment
    c. Processes for project approval
    d. Processes for project tracking and evaluation
5. Organization Structure Detail
    a. Executive commitment and oversight

   b. Energy Program Administrator and EMG staff roles and responsibilities
   c. EMG staffing needs and other resources
   d. Defining an on-going, cross-functional Core Energy Management Team and its roles and responsibilities
   e. Regular team meeting frequency and schedule
6. Governance
   a. Mechanism for on-going program advice and oversight
   b. Appointment of the Core Energy Management Team
   c. Energy Management Action Plan preparation and approval process
   d. Periodic (quarterly) executive meetings (project/program review and approvals)
   e. Annual review by the Executive Office and Board

Completion and approval of the charter would be an early endorsement and demonstration of the Metro's commitment to energy management.

Develop and Assist in Filling the Energy Program Administrator Position

As part of its charter development process, the Ad Hoc Energy Executive Team would work with Metro's Human Resources Department in preparing the job description for the position of Energy Program Administrator. The Administrator role may be accomplished by the Environmental Compliance and Services Unit Manager, or until such time that Metro is able to establish a new Energy Program Administrator position. The Energy Program Administrator will chair the EMG, which will consist of representatives from affected business units.

Following the formula of the EMS, the Energy Program Administrator will convene local Energy Representatives in divisions and business units to develop the Energy Management Action Plan outlined below. The Energy Program Administrator's role and position within Metro should be revisited within 5 years, or as required, in response to changes in the program or implementation of any reorganization plans.

Identify an On-Going, Advisory Core Energy Management Team

Rounding out its charge, the Ad Hoc Energy Executive Team would identify a subset of its membership (that may be augmented from outside the group as needed) for appointment to an on-going team to advise and assist the Energy Program Administrator in further developing and advancing Metro's Energy Management Program. This group, the Core Energy Management Team, would:

- Help ensure timely continuity of the work of the Ad Hoc Energy Executive Team.
- Represent the variety of cross-departmental, cross-functional perspectives in energy management.
- Be chaired by the Energy Program Administrator.
- Meet regularly to focus on its first primary assignment—the development of the Energy Management Action Plan (EMAP).

5.1.2. Develop the Energy Management Action Plan (EMAP)

The previous sections of the ECMP provide an assessment of Metro's current status with respect to energy management. This assessment includes recommendations and identifies opportunities for improvements. With an established charter, a dedicated Energy Program Administrator, and an established Core Energy Management Team, the next stage of implementation would be the development of a workable EMAP. The EMAP would include immediate, short-term, and long-term initiatives; a supporting financial plan and budget; program performance metrics and targets; and approval processes.

Immediate Fast Track Initiatives

The previous sections of this ECMP document contain recommendations that could be implemented immediately (within the first 6 months to 1 year). These measures would provide an opportunity to rapidly demonstrate the value of the Energy Management Program and establish momentum. These Fast Track Initiatives (i.e., projects, activities, etc.) would be identified and developed by the Core Energy Team as part of, and in parallel with, EMAP development. The goal would be to launch these initiatives as early as possible, without necessarily waiting for the completion and approval of the entire Energy Management Action Plan. In the event that the Energy Program Administrator has not yet been appointed or hired, these Fast Track Initiatives could be coordinated and managed by designated Transit Project Delivery Managers.

In response to some of the issues identified in the ECMP, some of the immediate Fast Track Initiatives could include:

- Improvements in Utility Bill Tracking and Monitoring.
- Initial Efforts toward Utility Rate Re-Negotiation.
- Examination of Bus/Support Vehicle Transportation Propulsion Fuels (e.g., compressed and liquid natural gas) including the development of strategies for improved propulsion fuel management.
- Development of a Renewable Energy Policy and Identification of Promising Potential Project Opportunities (see Section 6).
- Improvements in Energy Procurement.

Short-Term Initiatives

The previous sections of this ECMP document have identified recommendations that could be implemented in the first 1 to 2 years of the program. These Short Term Initiatives (programs, projects, and activities) would be fleshed out in more detail in the EMAP in terms of their scope, cost (initial and on-going), benefits, and timeline for implementation. Some Short-Term Initiatives could include:

- Increasing Staff Energy Awareness.
- Development of an Energy Management Training Program.
- Improvements in the Energy and Equipment Procurement Process.
- Development of Design Standards for New Construction and Renovations.
- Operational Equipment Improvements/Recommissioning/Upgrades.

- Expansion of Existing Renewable Energy Systems (e.g., installation of additional solar panels at Metro facilities).
- Implementation of Changes in Operating Practices and Procedures.
- Implementation of the lighting retrofit program (already developed).
- Initiating a structured review process on facility electricity consumption and rates, with the initial focus on the largest facility meters.
- Batching renewable investment decisions together semi-annually or annually for feasibility studies, review, and procurement so that (1) a broader view of their comparative benefits can be made, and (2) administrative efficiencies can be achieved.
- Development of a Sub-Metering Plan to identify high priority needs for more granular data collection (and the associated cost of implementation).

Long-Term Initiatives

This ECMP document has also identified recommendations that are longer term in nature. These would be identified for implementation beyond the second year of the program. These Long-Term Initiatives (programs, projects, and activities) would also be further developed in the EMAP in terms of their scope, cost, benefits, and timeline for implementation. Some Long-Term Initiatives could include:

- Retrofit Programs for Motors, Controls, Heating-Ventilation-Air Conditioning (HVAC) Systems, etc.
- Development and Implementation of new Renewable and Alternative Energy Projects.
- Implementation of Approved Direction from Sub-Metering Plan.

Resource Needs

The EMAP would identify the resources required to support the initiatives and other facets of the program including:

- Staffing (both within the EMG and in other Metro departments)
- Consultant services
- Office space and other facility needs
- Special tools and equipment
- Support goods and services
- Other miscellaneous support needs

Financial Plan and Budget

Key to an implementable EMAP is an accurate and affordable financial plan and budget. The financial plan component would include a multi-year program of projects, identifying both estimated expenditures (one-time and recurring) and projected financial resources available by year. A more detailed and precise annual Energy Management Program budget for the first full year would also be developed. This element would be designed to complement and inform Metro’s agency-wide budget development process.

Initial Performance Metrics and Targets

The EMAP would also include the development of initial performance objectives, measures, benchmarks, and targets. This would enable evaluation of the on-going progress of the Energy Management Program system-wide and within its key components, including regular assessments of energy performance by division, facility, and other management units. These efforts would be integrated with the Metro's agency-wide performance management system.

As described earlier in the ECMP, collecting frequent, accurate, and granular data on resource consumption at the building level would allow Metro to analyze relative performance, identify "problem" buildings that are more resource-intensive than comparable buildings, and prioritize cost-effective improvements.

Approval Processes

The EMAP would also identify the various internal and external approval processes required for its implementation, including timelines, decision-makers, level of information required, etc. These processes would include:

- Approval of the Energy Management Action Plan itself.
- On-going updates of the EMAP.
- Efficient evaluation and selection of prospective energy projects, initiatives, and programs, including use of the renewable energy screening process and evaluation tool discussed earlier in the ECMP.
- External requirements and timelines for various energy-related grant programs.

5.2. DO—Implement the Energy Management Action Plan

The actual implementation of the Energy Management Action Plan has its own variation of the Plan-Do-Check-Act model. Plan implementation would include project refinement and development, pilot program initiation, performance optimization and verification, full project roll-out, and the evaluation of project performance

5.2.1. Project Development

The first step for implementation of the projects/programs identified in the Energy Management Action Plan is project development. Upon approval of the measures and actions identified for implementation, this step involves:

- Developing a scope of work for identified projects, which would include preliminary design and requests for budget level proposals/quotes. As required, this may be out-sourced to an approved engineering company or consultant or performed in-house where necessary resources and expertise exist.
- Completing a cost-benefit analysis with information from proposals/quotes. The cost-benefit analysis (preferable life cycle) should use the financial parameters and investment criteria as established in the charter.
- Identifying and applying for applicable government grants and utility incentives.
- Preparing the business case for project approval, including scope of work, implementation schedule, cost-benefit analysis, return on investment, and financing package.

- Obtaining approval to proceed to pilot project initiation phase.

5.2.2. Pilot Project Initiation

In many cases it is recommended to start with a pilot project. A pilot project can provide a cost-effective opportunity to gauge potential success (and identify critical needs) before the investment is made in a full-scale project roll-out. The steps would include:

- Identifying where a pilot or demonstration project may be applicable and beneficial. Where a pilot project is not applicable, the initiative may proceed directly to preparation of the final business case for presentation to senior management for approval.
- Selecting a small sample of facilities or areas that would be representative of a larger project. The selection could be based on scoping audits and baseline analyses completed in the Energy Management Action Plan phase.
- Collecting detailed information from the sample sites in order to prepare a scope of work for the pilot projects. This may require hiring a qualified consultant to review this and other information and prepare a scope of work. It is sometimes advantageous to gather information from potential contractors (through an RFI or Request for Information)—particularly contractors that Metro would likely invite to bid. They can provide valuable input for the scope of work.
- Preparing a scope of work in sufficient detail so that the costs and benefits can be accurately estimated.
- Issuing the solicitation for the pilot project following agency procurement policies and processes. At the pilot stage, it may be worthwhile to select more than one contractor to be able to evaluate and consider performance prior to procuring goods and/or services for a full project roll-out.
- Tracking performance during pilot project start-up and assisting in its optimization during early stages of operation.

5.2.3. Performance Optimization and Verification

Once the pilot project is complete, it is necessary to verify performance using recognized monitoring and verification protocols. The results of the pilot will be useful in selecting suitable sites, estimating costs and benefits, and preparing the schedule for a roll-out of the initiative. All of this analysis goes into the preparation of the final business case. This business case would then be presented to senior management for authorization to proceed with the full-scale project.

5.2.4. Full Project Roll-Out

In general, the steps to full project roll-out include:

- Select a project manager and, where appropriate, a general contractor. Detailed engineering and solicitation of the project will be responsibility of project manager/general contractor.
- Refine cost estimates and project scope based upon experience gained in the pilot project (if applicable).
- Re-run cost-benefit analysis after bids/proposals are received for the project.
- Obtain final approval to proceed, through the Executive and (where applicable) Board processes.

- Re-run cost benefit analysis if scope of project changes significantly, or upon completion, using actual costs and actual performance specifications for equipment installed.
- Ensure that equipment is commissioned properly.

5.2.5. Evaluation of Project Performance

At a minimum, a systematic evaluation of project performance should include:

- Ensuring that sufficient monitoring systems are in place so that costs, benefits, and other performance aspects can be accurately measured.
- Allowing adequate time before and after the project is launched to collect sufficient monitoring data.
- Verifying performance on a year-by-year basis, taking seasonal variations into account.
- Calculating energy and cost savings for repayment of financing or settlement of incentive funding.
- Compiling lessons-learned at each phase of the project from planning and development, through implementation and operation.
- Identifying needed changes that may benefit the outcomes of future energy management projects.

5.3. CHECK—Conduct Annual Reviews

The annual review is a formal assessment of EMAP activities implemented during the evaluation period. It is intended to measure the effectiveness of the projects and programs that have been implemented. These results are compared against approved performance targets. Positive results can be used to recognize and potentially reward the efforts of those directly involved in the Energy Management Program in general and high-value projects in particular.

5.4. ACT—Adjust or Modify Program and Plan as Required

The information and data gathered throughout the previously described approach will assist in making informed decisions concerning the Energy Management Program, the Energy Management Action Plan, and their key elements. This information should be used to update, adjust, or modify the Energy Management Action Plan and implementation processes; identify best practices; set new performance goals; and refine previously approved performance targets and benchmarks, as may be appropriate. The EMAP and its implementing programs should be sufficiently flexible to enable the use of Metro's on-going experience and lessons learned, while retaining the ability to adapt to the ever-changing operating environment. The documented results can be also used to inform stakeholders of the progress of the program and facilitate support of future initiatives.

5.5. Suggested Time Line

Table 5-1 contains a suggested summary time frame for the steps and activities described above.

Table 5-1: Summary Time Line

Action	First 30 Days	30-60 Days	90-Days to 6 months	6 to 12 months	12 -24 months	24 months plus
Form and Launch Ad Hoc Executive Energy Team	X					
Develop Charter		X				
Hire Energy Program Administrator		X				
Launch Core Energy Team		X				
Develop Energy Management Action Plan			X			
Implement Fast Track Projects				X		
Implement Short-Term Projects					X	
Implement Long-Term Projects						X
Conduct First Annual Program Evaluation					X	

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6. Renewable Energy Program (REP) Development and Implementation

On February 17, 2011, the Metro Operations Committee passed a motion to establish a "Metro Renewable Energy Policy". The Committee recognized that under Measure R and America Fast Forward, the projected expansion of the Metro system, including approximately 70 miles of light and heavy rails lines, will have substantial effects upon the projected cost of energy required in order to operate the Metro system.

The motion called for a review of a number of elements, including:

- An assessment of technical feasibility for off-track and on-track renewable power.
- Exploration of creative renewable energy solutions.
- Life-cycle financial considerations.
- Use of creative financing mechanisms.
- Inclusion of life-cycle cost analyses for renewable energy use in awarding construction contracts.
- Existing industry and government guidelines for evaluating renewable energy and energy efficiency.
- Retrofitting existing rail and bus rapid transit corridors for solar and other renewable power systems.
- Opportunities to partner with local power utilities.

The motion also called for a proposed agency policy statement, plan of action, and identification of specific opportunities for incorporating renewable energy (solar and other renewable power systems) and energy efficiency measures into existing and new transit projects. The policy and plan should include the installation of a demonstration renewable energy system (preferably but not limited to solar panels) on at least one existing station as a demonstration project.

A Renewable Energy Policy Study is under development to address a number of these and other issues, while building on the research and analyses contained in this Energy Conservation and Management Plan (ECMP). The purpose of the Study is to conduct a broad analysis of renewable energy technologies, potential applications and project siting, screening methodologies, financial mechanisms, life-cycle costs and management, stakeholder relationships (both internal and external to Metro), and a survey of relevant peer transit agencies. This will provide a sound basis for a Renewable Energy Policy statement that will be submitted to the Metro Board for approval, and a program with which to implement the adopted policy.

Building upon Metro's current initiatives and in response to the Metro Operations Committee motion, this section of the ECMP provides a generalized implementation blueprint that Metro could follow to develop and ramp up an Renewable Energy Program (REP). The REP could either be launched in conjunction with the ECMP implementation outlined in the previous section or as a standalone program. Either way, the REP is a critical step in shaping Metro's energy future.

Just as the Plan-Do-Check-Act model is applicable to the overall implementation of the ECMP, this model is also well-suited to guide the focused parallel and complementary ramping up of an REP at Metro. The REP programmatic ramp-up reflects most of the same actions and approaches as the Energy Management Implementation Strategies outlined in Section 5 above, with a specific focus. Following are some of the key steps that Metro will need to take to enable scale-up of its Renewable Energy Program.

6.1. PLAN—Set Up the Renewable Energy Program

The following "PLAN" steps are needed to form the foundation for a new, focused Renewable Energy Program (REP) at Metro, either standing alone or as part of the Energy Management Program referenced above. These steps and activities are intended to rapidly ramp-up a program that reflects Metro's commitment to renewable energy, again, encompassing many of the actions identified in Section 5.1 above for the development of the REP.

6.1.1. Define Policy Direction

A draft Renewable Energy Policy has been developed by Metro staff. This draft Policy would undergo further refinement and, upon completion, recommended to the Metro Board for approval. The Board-adopted Policy would form the foundation of the Renewable Energy Program at Metro.

6.1.2. Establish Program Structure

Based upon the policy direction received, an REP structure would be established within the Metro organizational framework. Consistent with the Energy Management Program, it is recommended that the Renewable Energy Program be temporarily housed within the Transit Project Delivery Department, and contained within the Environmental Compliance and Services Unit. It is further recommended that a Renewable Energy Program Lead be appointed from within the Department to coordinate and facilitate the REP. Initially, this would not necessarily require a new position. Workload levels could be assessed as the program evolves, and the staff support adjusted accordingly.

A cross-departmental Renewable Energy Task Team (RETT) would be appointed to provide oversight, guidance, and advice. The RETT could be the same group or a subset of the Core Energy Team identified in Section 5 above.

The initial charge to the Renewable Energy Program Lead and the RETT would be to focus on the identification, selection, and development of pilot projects and other immediate action initiatives.

6.1.3. Establish Renewable Energy Project Screening Process

A renewable energy project screening and decision making process was developed as part of the ECMP to enable Metro to compare and screen potential renewable energy projects in a consistent and standardized manner as Metro builds its renewable energy portfolio. The recommended process can compare prospective renewable projects at different sites and of different sizes, technologies, and basic ownership structures across Metro's three electric utility territories based on user-defined inputs.

An Excel-based tool has been constructed for Metro to support the screening process, providing a summary of outputs and a "score" for each potential project, allowing easy comparisons between candidate renewable projects. The Renewable Energy Screening Tool (REST) is designed to be easy to use and should not require specialized renewable energy expertise.

Following is an overview of the REST and screening process. When evaluating potential renewable energy projects, there are a number of factors that will likely influence Metro's decision of whether or not to install a particular system. While cost is often a primary consideration, employing a decision process that takes into account other factors provides a more robust analysis and illuminates potentially overlooked benefits. The REST uses six separate categories for evaluating potential renewable energy projects (with their relative starting weights listed in parentheses):

- Cost (40 of 100 points)[39]
- Environmental benefit (20 of 100 points)
- Land-use efficiency (10 of 100 points)
- Peak shaving benefit (10 of 100 points)
- Hedging benefit (10 of 100 points)
- Local content use (10 of 100 points)

In the REST, each of these six categories is evaluated across one or more metrics that indicate how each project would perform relative to baseline utility electricity (for renewable electricity projects) or natural gas (for solar water heating projects that displace natural gas). The outcomes (e.g., cost savings or emissions reductions) for each screening factor are assigned point values to make the results comparable across each of the categories. The number of points assigned to each outcome reflects the system's performance relative to a chosen maximum and minimum performance level. Finally, a weighting was applied to each category's score based on the assumed importance of that category. The starting category weights are based on the collected experience of large renewable project hosts such as Metro. Metro can adjust these values to reflect its current and future renewable program priorities. A renewable project's weighted scores for each category are added, giving a final total score. The total score provides a measure of the project's performance relative to an assumed maximum. An example REST summary for a renewable project is provided below.

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[39] It is important to note that the cost category uses utility-specific average retail electricity prices and does not account for time-of-use rates. Instead, the benefits of avoiding costly peak-usage electricity rates are captured through the peak shaving benefit category.

Table 6-1: Example Renewable Project Output from Renewable Energy Screening Tool (REST)

Score			
Category	Points		
Cost	40	out of	40
Environmental Benefit	2	out of	20
Land-Use Efficiency	8	out of	10
Peak Shaving	10	out of	10
Hedging Benefit	4	out of	10
Local Content	10	out of	10
Total	74	out of	100
Project Information: Inputted by User			
Project Name		Project 1	
Technology		Solar PV	
Utility		SoCal Edison	
Installed Capacity		450	kW
Year One Estimated Output (kWh)		650,000	kWh
Useful Life of Asset		20	Years
Square Footage of Installation		60,000	sq ft
Purchase by Metro or Power Purchase Agreement (PPA)?		Outright Purchase	
Installed Cost (Pre-Incentives)		$ 2,500,000	
Annual O&M Costs ($/kWh)		$0.003	/ kWh
System from a California Supplier?		Yes	
System Manufactured in Los Angeles County?		Yes	
Calculated Summary Values for Project			
Percent Difference in NPV		-57%	
20-Year Electricity Output		12,382,500	AC kWh
Average GHG Emissions Avoided Per Year		118.80	MTCO2e
Installed Land-Use Efficiency		3.06	Acres / MW
Peak Shaving Credit		100%	

While the screening process and supporting Excel tool provides a structure and useful underlying metrics for each renewable energy evaluation category, it is designed to be flexible. Metro can adjust the scoring scales and relative weights of each category to reflect future changes in the its renewable energy policy; in renewable energy technology costs and performance; or in state and utility incentive payments. Three parts of Appendix E provide more detailed information on REST. A more detailed discussion of the methodology and assumptions associated with each of the six scoring criteria in is contained in Appendix E-1. Appendix E-2 contains an overview of how to screen renewable energy projects in REST, and Appendix E-3 contains computer screenshots of the tool.

Recommendations

The development of this screening process and the accompanying evaluation tool has revealed several conclusions and recommendations that should be useful to Metro's Energy Management function. They include:

Recommendation 6.1.3-1

It is important to measure and consider many renewable energy system benefits. In addition to cost, the recommended process here explicitly weights environmental benefits, land-use efficiency, peak shaving benefits, hedging benefits, and the use of California and Los Angeles County content. By combining these factors in its analysis, Metro should be able to smartly build on its reputation as a renewable energy leader among transit agencies.

Recommendation 6.1.3-2

Direct agency ownership options should be compared to available power purchase agreement (PPA) structures.

Recommendation 6.1.3-3

To the extent practical, Metro should follow a best practice among renewable energy purchasers and hosts in batching renewable investment decisions together semi-annually or annually for feasibility studies, review, and procurement so that (i) a broader view of their comparative benefits can be made and (ii) administrative efficiencies can be achieved. The renewable screening process described here supports such batch consideration of project options.

Recommendation 6.1.3-4

Beyond the evaluation of pilot project opportunities underway in mid-2011, Metro should continue to use the Renewable Energy Screening Tool to help it assess potential projects as it scales up its Renewable Energy Program.

Recommendation 6.1.3-5

As Metro continues to plan and develop its renewable energy projects, it should at least annually (a) update the assumptions in the Renewable Energy Screening Tool to match current market conditions (electric prices, incentive levels, technology costs, etc.), and (b) modify the score category weights as it sees fit to meet its larger energy and climate goals. Such updates to the tool can be made by Metro personnel.

6.1.4. Establish Renewable Energy Development Strategy Framework

Projects that flow through the Renewable Energy Screening Tool described above must also be further evaluated in the context of a Renewable Energy Development Strategy Framework. This enables candidate projects to be further refined and evaluated for the greatest potential success and consistency with Metro's intended direction. Below are some of the steps that are recommended as part of Framework.

Step 1: External Policy and Demand Considerations

During this stage, decision makers consider the scope and scale of a candidate project, including type of project (e.g., retrofits vs. new construction), energy production goals and geographic area identification and the regulatory framework in which these decisions must be made. The following links provide additional information:

- "Solar Technologies Overview" in Appendix A of the *Procuring Solar Energy: A Guide for Federal Facility Decision Makers* (http://www1.eere.energy.gov/solar/pdfs/47854.pdf).

- The "Solar Water Heating" section of the National Institutes of Building Sciences' Whole Building Design Guide (WBDG) online (http://www.wbdg.org/resources/swheating.php) is a resource for designing solar water heating projects.
- The "Solar Screening Evaluation Checklist" in *Procuring Solar Energy: A Guide for Federal Facility Decision Makers"* (http://www1.eere.energy.gov/solar/pdfs/47854.pdf) can be used for reviewing Building Integrated Solar for a rooftop system or a ground mounted system.
- NREL's National Wind Technology center's presentation "Technology Overview- Fundamentals of Wind Energy" provides an overview of the technologies. (http://www.nrel.gov/docs/fy05osti/38095.pdf)
- More information about wind energy can also be found on EERE's Wind and Water Program page. See http://www1.eere.energy.gov/windandhydro/wind_how.html for more information.

Identification of energy production goals includes gathering baseline data, potentially from an energy audit, on the consumption and demand portfolio. Information on potential greenhouse gas offset metrics may also provide good data sources by which to evaluate a project's viability.

Federal, state and local policies and/or regulations must be evaluated for potential applicability at the outset of project development. Such policies and/or regulations may include renewable energy portfolio and interconnection standards, zoning and land use ordinances, and applicable building codes. It is important to identify applicable regulations and permitting requirements at an early stage to avoid complications of regulatory difficulties in later project phases.

The Database of State Incentives for Renewable Energy (DSIRE) provides summary and detailed information for federal and state rules, regulations, and policies. California rules and regulations can be found at http://www.dsireusa.org. The following links provide additional information to some of the key policies and regulations for consideration:

- California Renewables Portfolio Standard http://www.cpuc.ca.gov/PUC/energy/Renewables/index.htm
- California Interconnection Standards http://www.cpuc.ca.gov/PUC/energy/DistGen/rule21.htm
- California Net Metering Standards http://www.cpuc.ca.gov/PUC/energy/DistGen/netmetering.htm
- LA Solar/Wind Access Policy http://www.dsireusa.org/documents/Incentives/CA04R.htm

Step 2: Assessment of Resource Requirements

Next, the strength of potentially viable renewable energy resources (e.g., sufficient intensity and availability of sunlight or wind exposure) must be assessed for all alternative locations to identify viable locations for project development. A key element is the assessment of the resource strength and potential generation estimates for various venues. Depending on the project objectives, some locations may not be viable based on estimated energy production or the distance between the points of energy generation and usage (unless suitable energy storage can be accommodated as part of the project) . The following links provide starting points for solar and wind resource assessment.

Solar

- Solar Maps for Photovoltaic and Concentrating Solar Power technologies can be found at http://www.nrel.gov/gis/solar.html.
- "Self-Guided Solar Screening" in *Procuring Solar Energy: A Guide for Federal Facility Decision Makers* (http://www1.eere.energy.gov/solar/pdfs/47854.pdf). The Summary of Preliminary Solar

Energy Site Screening for Photovoltaics Checklist can be used to make a “Go or No-Go Decision” on building integrated solar.

- Site specific solar assessments estimate production based on shading, tilt, and orientation of the PV panels. The Solar Screening tool will develop more detailed estimates (PVWATTS version 1 or 2at www.nrel.gov/rredc/pvwatts/).

Wind

- Wind Site Screening: Federal Wind Siting Information Center provides tools to assist in the preliminary screening of wind sites, and helps a user in reviewing wind turbine potential impacts to federal mission areas, such as radar and wildlife. See http://www1.eere.energy.gov/windandhydro/federalwindsiting/ for more information.
- Commercial wind 80-Meter Wind Maps and Wind Resource Potential are accessible via an interactive US map with more detailed information for each state. See http://www.windpoweringamerica.gov/wind_maps.asp for more information.
- Small Wind Electric Systems Consumer's Guides for many of the states in the US and a Small wind electric Model can be found at http://www.windpoweringamerica.gov/small_wind.asp.
- The Community Wind Tool Kit provides information on project planning and wind resource assessment at http://www.windustry.org/CommunityWindToolbox.
- The NREL “Wind Resource Assessment Handbook” provides fundamentals for conducting wind resource monitoring programs. See http://www.nrel.gov/wind/pdfs/22223.pdf for more information.

Site suitability and availability must also be assessed. Ownership and management, site conditions (e.g., topography, construction access, environment and habitat, etc.) existing infrastructure and/or retrofit potential should be considered. Feasibility of grid interconnection and right of way access to existing grid infrastructure are also key aspects in resource site assessment. The Institute of Electrical and Electronics Engineers (IEEE) 1547 series of interconnection standards Standard for Interconnecting Distributed Resources with Electric Power Systems outlines interconnection agreements, rules, and standards, on a national, regional, and state level. It provides requirements relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection. See http://ieee.org/groups/scc21/1547/1547_index.html for more information.

Step 3: Environmental Impact and Stakeholder Identification

Each Renewable Energy Project may have environmental impacts that must be assessed in accordance with Federal, State, and local Environmental laws and regulations. Significant environmental impacts will likely require mitigation. An early assessment of each project is recommended to determine its potential environmental review and permitting requirements. Following are links to information concerning:

- The National Environmental Policy Act (NEPA) http://www.epa.gov/compliance/nepa/
- The California Environmental Quality Act (CEQA) http://www.ceres.ca.gov/ceqa/

Stakeholder identification for potentially viable locations for project development includes individuals and/or groups with an interest in environmental, economic and social impacts of project development.

NREL’s Stakeholder Analysis Methodologies Resource Book discusses the principles underlying a systematic stakeholder analysis, and goes on to discuss the steps comprising the subsequent phases of analysis. See http://frames.nbii.gov/documents/hdfss/babiuch_farhar_1994.pdf for more information.

Green LA Coalition (more information at http://greenlacoalition.org/) and Move LA (more information at http://www.movela.org/organizations.html) are two groups comprised of many local groups and businesses and provide extensive lists of potentially interested stakeholders interested in Metro's renewable energy development. The Coalition for Clean Air (http://www.coalitionforcleanair.org), Center for Energy Efficiency and Renewable Technologies (http://www.ceert.org/) are additional groups with stakeholder interest who may be consulted.

Additionally, the REST tool includes points for local content use and land-use efficiency, which would be important to know when discussing projects with stakeholders.

Step 4: Financing Approaches and Partnership Opportunities

The project financing step includes the identification of potentially available sources of funding (public and private) and the opportunities for incentives and partnerships. This information is essential in determining the financial viability of a candidate project for further development. On the cost side, it is essential to understand each candidate project's life-cycle cost estimate, including its upfront capital and operational costs, and its recurring, on-going operational and maintenance costs.

The Database of State Incentives for Renewable Energy (DSIRE) provides summary and detailed information for state and federal incentives organized by state which can be accessed at www.dsireusa.org.

The Renewable Energy Screen Tool (REST) includes default incentives (listed on the Inputs sheet of the tool) and allows the user to add additional incentives when screening projects. The life-cycle cost section of the REST allows project developers to track and consider the life-cycle costs of their projects, which is essential to maximize the efficiency of project financing. The Wind Energy Finance Calculator is a tool for financial analysis of potential wind farm projects developed by NREL. See http://analysis.nrel.gov/windfinance/login.asp for more information.

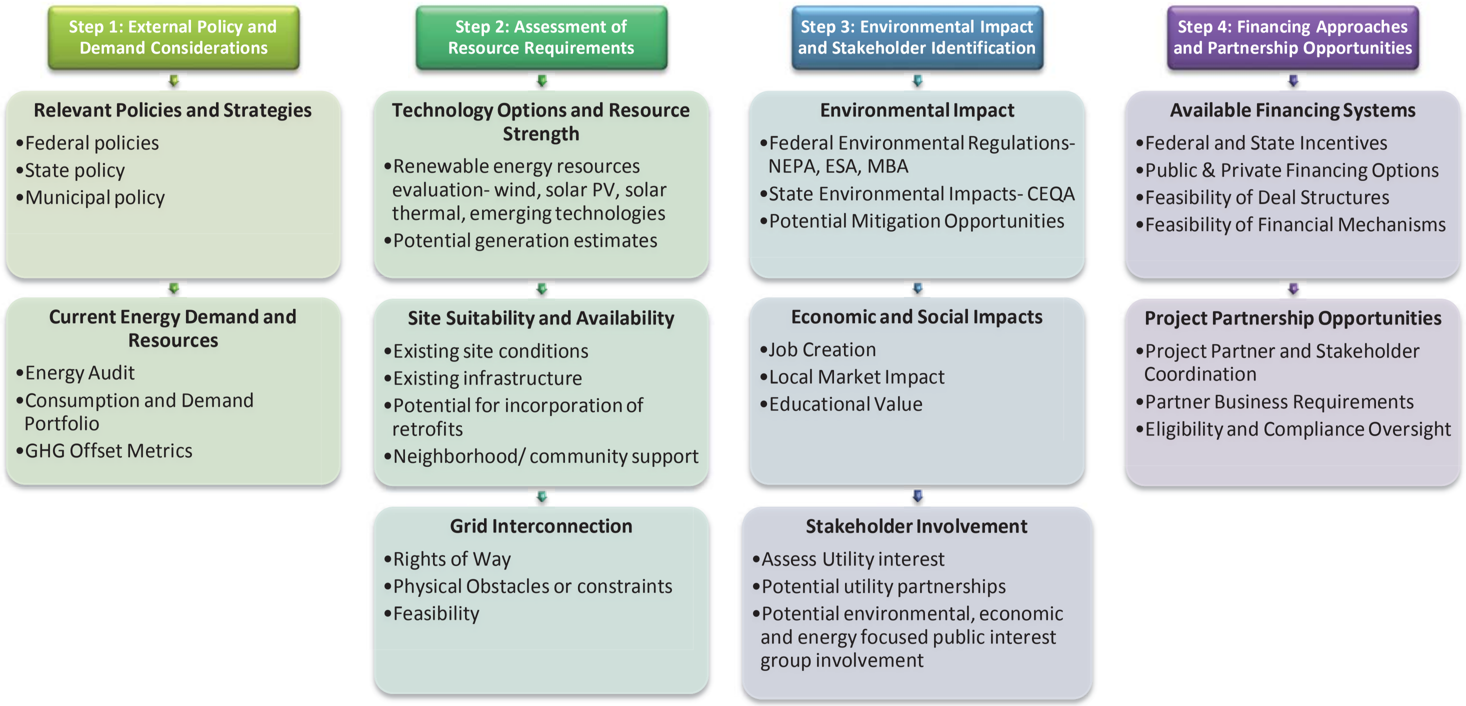
As part of a potential project's financial viability, it is important to review available federal and state incentives and consider the feasibility of various deal structures and alternative financial mechanisms. Additional information on project financing considerations, key program elements, PPA agreements, and other types of financing programs can be found at EERE's Solution Center page "Financing for Energy Efficiency and Renewable Energy". Refer to http://www1.eere.energy.gov/wip/solutioncenter/financialproducts/default.html for more information.

EERE's Federal Energy Management Program (FEMP) provides more information on PPAs, "Quick Guide: Power Purchase Agreements". The guide covers PPA basics, FEMP services in PPAs, how to get started, as well as providing links to additional resources. See http://www1.eere.energy.gov/femp/pdfs/ppa_guide.pdf for more information.

Additionally, Requests for Proposals (RFPs) from utilities entering into PPAs for renewable energy systems can be found on the Green Power Network as references for project administration and finance options development. See http://apps3.eere.energy.gov/greenpower/financial/archives.shtm for more information.

Figure 6-1 provides a graphic depiction of the Framework described above.

Figure 6-1: Renewable Energy Development Strategy Framework



Step 1: External Policy and Demand Considerations

Relevant Policies and Strategies
- Federal policies
- State policy
- Municipal policy

Current Energy Demand and Resources
- Energy Audit
- Consumption and Demand Portfolio
- GHG Offset Metrics

Step 2: Assessment of Resource Requirements

Technology Options and Resource Strength
- Renewable energy resources evaluation- wind, solar PV, solar thermal, emerging technologies
- Potential generation estimates

Site Suitability and Availability
- Existing site conditions
- Existing infrastructure
- Potential for incorporation of retrofits
- Neighborhood/ community support

Grid Interconnection
- Rights of Way
- Physical Obstacles or constraints
- Feasibility

Step 3: Environmental Impact and Stakeholder Identification

Environmental Impact
- Federal Environmental Regulations- NEPA, ESA, MBA
- State Environmental Impacts- CEQA
- Potential Mitigation Opportunities

Economic and Social Impacts
- Job Creation
- Local Market Impact
- Educational Value

Stakeholder Involvement
- Assess Utility interest
- Potential utility partnerships
- Potential environmental, economic and energy focused public interest group involvement

Step 4: Financing Approaches and Partnership Opportunities

Available Financing Systems
- Federal and State Incentives
- Public & Private Financing Options
- Feasibility of Deal Structures
- Feasibility of Financial Mechanisms

Project Partnership Opportunities
- Project Partner and Stakeholder Coordination
- Partner Business Requirements
- Eligibility and Compliance Oversight

6.1.5. Establish Project Programming and Budgeting Process

The next step in the process is Project Programming and Budgeting. This entails the initial development of the pool of candidate projects; project evaluation and screening; and the selection of Renewable Energy Projects for approval and inclusion in Metro's Capital Program and Annual Budget. An annual Renewable Energy Project programming cycle is recommended, one that is established with a set timeline synchronized with the annual Metro Budget process.

The pool of candidate projects would be drawn from two sources. A formal call for projects would be used to solicit ideas internally from Metro departments and externally from public agencies. In addition, a Request for Information and Qualifications (RFIQ) issuance would also be employed to gather ideas and proposals externally from private and public ventures. An RFIQ is currently being developed to assist Metro in the conceptualization and implementation of potential renewable energy technology applications.

Once a pool of candidate projects and supporting documentation has been assembled, the evaluation and screening process would begin. The required analytical staff resources, coordinated by the Renewable Energy Program Lead, would be marshaled to apply the Renewable Energy Screening Tool and Strategy Framework (described above) to each candidate project. A common format would be developed to enable each project to be consistently compared and contrasted for use by the Renewable Energy Task Team (RETT).

The RETT, with augmented membership as needed to ensure sufficient breadth and depth of expertise, would be tasked with reviewing the candidate projects and making recommendations to Metro's Budgeting Team as part of the annual capital budget development process.

In order to optimize staff time and resources, it is recommended that a preliminary screening phase be employed by the Renewable Energy Program Lead to identify "fatal flaws" or clearly infeasible projects. For full transparency, any projects removed from further consideration would be communicated to the RETT along with the rationale for its removal.

It is further recommended that for the initial project evaluation cycle, that the list of candidate projects be limited to a manageable number. As more experience is gained in subsequent evaluation and screening process cycles, a greater number of projects may be considered.

It is critical that the structured project programming process described above, with clearly communicated deadlines, is seamlessly integrated with Metro's annual Capital Program and Annual Budget development process.

There are a number of renewable energy pilot or demonstration projects that Metro is currently considering, or are currently underway, including the following:

- **Wind Tunnel Energy – Subway Lines** (*projected to be installed along Red Line*):
  Metro staff has conducted tests to understand the feasibility of wind tunnel renewable energy generation at in the Red Line subway tunnel. Results indicate the potential of the technology. Metro staff have recently completed a Transit Investment for Greenhouse Gas and Energy Reduction (TIGGER) grant application for use in a pilot scale demonstration. A related procurement will be carried out to implement the pilot project when TIGGER funds are secured.
- **Solar Panels – Buildings** (*project selected at El Monte Station on Silver Line*):
  Solar panels will be deployed at the new facility being constructed at the El Monte Station on the Silver Line and procurement will soon be advertised. This project will be used to demonstrate how solar panels are installed on new transit infrastructures.

- **Renewable Energy Project – Transit Facilities / Large Scale** (*project not yet selected*): Following adoption of the proposed policy, Metro will begin the evaluation of one or more large-scale demonstration projects. The relatively large size and type of these projects will most likely require the approval of the procurement by the Metro Board in advance of issuing a solicitation document. While a potential scope of work has been considered, Metro will need further consultation with the agency's procurement team to better understand the types of proposals that may be feasible for such a comprehensive and large scale renewable energy project. Examples of the types of parcels where this can be implemented include, but are not limited to: linear right of way corridors; vacant or excess land not currently in use; park and ride lots; and similar types of parcels.
- **Solar Panels – Transit Facilities/Small Scale** (*project selected along the Blue Line*): Pico Station has been suggested as the initial location for this pilot. This project will illustrate implementation of solar installations at relatively small scale structures. However, there is likelihood that the Pico Station would be modified when the proposed football stadium plans are finalized. As this policy will already be in place at that time; along with a requirement to rebuild the Pico Station, there should be a consideration of a much larger cost-neutral renewable energy source at the location. Other locations will be considered for possible implementation of this type of pilot project.

6.1.6. Clarify Project Management, Conceptual Development Processes, and Project Approvals

At such time that a project successfully advances through the screening process and is included within the adopted Metro Capital Program and Budget, a Project Manager (PM) is assigned. Once assigned, it is advisable to review, clarify as necessary, and affirm the PM’s role on the project, including the scope of decision-making authority. At this time, a Project team may be assembled. The PM would function in accordance with the project management principles, practices, and requirements established by Metro for its Capital Program agency-wide. It is recommended that the PM prepare a Project Management Plan with which to guide his/her project.

While a particular renewable energy project may be programmed and budgeted, it may require further engineering and design in order to advance to specification development and procurement. In that case, the PM would be charged with leading any further project concept development required and obtaining the necessary project approvals required to advance into specification development and procurement.

Once the project scope is sufficiently well-defined, a baseline scope, schedule, and budget would be established by the PM, with appropriate Metro management approvals. As well, the PM would develop the standards and criteria against which project performance is to be measured upon completion and implementation.

6.2. DO—Implement Renewable Energy Program and Selected Projects

The implementation of approved Renewable Energy Projects have their own variation of the Plan-Do-Check-Act model. A few key project “DO” steps are highlighted below. Please also refer to Sections 5.2.1 through 5.2.5 for the “DO” steps of the Energy Management Action Plan. These sections provide useful, applicable guidance to implementing Renewable Energy Projects as well

6.2.1. Specification Development and Procurement

The Project Manager is responsible for working closely with the Metro Procurement Department to develop a suitable specification for a Request for Proposals (RFP), Request for Qualifications (RFQ), or Invitation to Bid (IFB). The Procurement Department may also provide guidance as to the most suitable procurement type to use and any specific requirements called for under applicable grant funding programs. The Project Manager may rely upon other technical resources within Metro or, as the project may entail, securing external expertise with which to prepare the specification.

The PM will continue to work with the Procurement Department throughout the RFP, RFQ, or IFB process, including the issuance of the solicitation documents, evaluation of proposals (or bid opening), and recommendations for needed Executive and Board approvals.

6.2.2. Project Execution

Once required approvals are obtained, the PM initiates the execution of the project. Project execution entails numerous critical activities including, but not limited to, the assertive mobilization of the project team; regular communication with internal and external project sponsors and stakeholders; and diligent management of the approved scope, schedule and budget—throughout the course of the project. Project execution also includes the timely Notice to Proceed (NTP) to and on-going management of project contractors, in accordance with the awarded contracts.

6.2.3. Project Completion

As well, project completion encompasses multiple critical activities, milestones, and steps. These include Metro's assurance that it has obtained all deliverables and work products from the contractor(s), or, where applicable, in-house providers. Such deliverables and products are likely to include, at a minimum:

- Required certification and testing that the installation, product, and/or service, is in full working order in accordance with contract specifications.
- Required project documentation, including plans, as-built drawings, manuals, etc.
- Completed staff training, in accordance with the contracts, to enable internal operation and use of the new project (depending upon the complexity of the project, an internal trainer may be designated and trained by the contractor to enable on-going continuity of knowledge transfer).
- Warranty information, and maintenance standards that must be performed to ensure continued warranty coverage.

Other critical project completion activities include project commissioning and a clean and thorough transition to Metro staff charged with the on-going operation and maintenance of the newly commissioned renewable energy project and/or system. Once the project has been placed into service, the closeout process can begin in accordance with Metro policies and procedures.

6.3. CHECK—Conduct Regular Monitoring and Reviews

The "CHECK" step description contained in Section 5.3 for the Energy Management Program is also applicable for Renewable Energy Program (REP). It is recommended that regular monitoring and reviews be performed of the implemented projects. Once operational, actual project performance is compared against approved performance targets and monitored and analyzed over time. This step is crucial in identifying and clearly documenting *lessons learned* that can be used in the development of future Renewable Energy Projects.

6.4. ACT—Adjust or Modify the Program and Future Projects as Required

The "ACT" step description contained in Section 5.4 for the Energy Management Program is also applicable for Renewable Energy Program (REP) and its projects. The information and data gathered throughout the previously described approach will assist in making informed decisions concerning the REP. This information should be used to update, adjust, or modify the REP processes; identify best practices; set new performance goals; and refine previously approved performance targets and benchmarks, as may be appropriate. The REP should be sufficiently flexible to enable the use of Metro's on-going experience and the *lessons learned* from each project , while retaining the ability to adapt to the ever-changing operating environment. The documented results can be also used to inform stakeholders of the progress of the program and facilitate support of future initiatives.

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Appendix A: ECMP Recommendation Summary Matrix

Section 2.1.1: Propulsion Electricity	
Number	**Recommendation**
2.1.1-1	Develop a policy of integrating operating staff into the energy strategy/management exercise. The creation of an energy management strategy committee may be crucial in establishing this integration, and in setting short- and long-term goals for strategic energy management. It is suggested that members of this committee should come from these business groups—finance, operations, strategic development, traction engineering, and energy management. (See Section 4, "Energy Management Structure.")
2.1.1-2	Follow through and continue gathering and accumulating monthly utility information. Develop metrics for each portion of critical data and track the positions achieved. Specifically, Metro should gather and monitor usage, demand, distribution, and interval data and should merge operating statistics into a dynamic reporting environment. This operating data may include schedules and strategic scheduling, line losses for traction operations, and "what if" scenarios on future operations.
2.1.1-3	Develop and monitor all policies for the operation of trains. Be aware of notching (acceleration/deceleration) policies set up for each train. Know the limitations and attempt to develop the relationship between these two data points.
2.1.1-4	Determine the existence of submetering at the traction substations. If none exist, consider the establishment of a program to add these meters on any lines supporting non-traction activities. These meters should capture energy usage for these activities and be used to show the comparison of non-traction vs. traction usage. These levels should be monitored by the committee or the appropriate operations department. (See Section 4, "Energy Management Structure.")
2.1.1-5	Develop a strategy and policy for standby operations. Currently, all trains are maintained, turned around, or are waiting for the next operational run within a maintenance facility, while maintaining contact with the traction power source. Although the tariff evaluation has shown that currently there is an economic advantage to having this policy, it may be beneficial to re-evaluate the circumstances after a complete tariff review has been completed.
2.1.1-6	Develop an integrated in-house monitoring system to accumulate all of the operational data along with energy usage information to better understand the correlation of these factors.
2.1.1-7	Consistently monitor all data (operational and energy), question deviations, and create a dynamic approach to the reporting of energy characteristics.

Section 2.1.3: Benchmarking	
Number	**Recommendation**
2.1.3-1	*Collect more Granular Data:* Metro should begin sub-metering buildings as soon as possible. Collecting frequent, accurate, and granular data on resource use, particularly energy consumption at the building level, will allow Metro to analyze relative performance both internal and external to its own portfolio, identify problem buildings that are more resource-intensive than comparable buildings, and prioritize cost-effective improvements.
2.1.3-2	*Identify Organizations Similar to Metro Against Which to Benchmark:* Accurate benchmarking requires that the facilities being compared have few systematic differences that might affect the performance metrics in question. In particular, facilities chosen for comparison should have similar: f. Facility functions and hours of operation g. Energy input mix h. Size of buildings i. Employee, ridership, or miles of track j. Climate (number of heating and cooling degree days) Other domestic or international metro systems with similar operational characteristics may be effective benchmarks. Developing connections with these organizations might be an effective way to start benchmarking data and developing mitigation strategies.

2.1.3-3	*Normalize Activity Data:* While it is ideal to compare performance with facilities that have similar attributes, activity data should also be adjusted to account for differences. Data can be normalized in different ways to allow for different kinds of analysis. For example: • Energy consumption is a function of both the number of people using energy and the size and the purpose of the buildings it serves. When benchmarking, it may be useful to consider energy per rider or energy per square foot for different building types. • Climate affects both energy and water consumption. A useful method to control for climate is to divide consumption by heating/cooling degree days, a measure of the frequency and magnitude of a given climate's deviation from a set baseline.
Section 3.2: Propulsion Electricity Rate Review	
Number	**Recommendation**
3.2-1	Initiate a dialog with each of the utility companies to delve further into the aspect of tariff review. There needs to be a cooperative effort between Metro and the utilities to maintain low energy costs for transit and support the growth of the operation at minimal energy pricing. Metro should request from each utility an examination of their cost of service documents to determine transparency, adequacy of pricing definition, suitability for rail transit operations, and negotiation possibilities.
3.2-2	Operationally determine the actual demand level by individual train or locomotive car. With this as a starting point, a conjunction level of demand can be determined, and with that determination a two-step approach should be made: (a) discuss these levels with the CAISO to determine how they are interpreting the ways individual demand levels are determined (and should be determined) by the individual utilities, and (b) approach the individual utility companies to get their view on demand calculations.
3.2-3	Initiate a dialog with each of the utility companies to deliver all interval data and metered demand and usage information electronically in a format that can be used to integrate with operations data into a traction/propulsion energy management reporting system.
Section 3.3: Facility Electricity Rate Review	
Number	**Recommendation**
3.3-1	Consider TOU pricing for SCE accounts currently under the GS-1 and GS-2 rate schedules and LADWP accounts under the A-1A and A-3A rate schedules. Analyze individual facilities to see if significant operations occur during off-peak hours in order to take advantage of lower energy costs. Convert a select number of facilities to TOU pricing to determine if cost savings may be realized across the portfolio using this experimental data.
3.3-2	Thoroughly analyze operations at SCE CPP rate schedule facilities to determine if this unique rate structure with mandatory demand shaving is optimal for each facility's unique function.
3.3-3	Metro's Energy Management function should understand its electricity rate structures—especially the large billing components—in order to accurately forecast future electric costs and to assess the effect of energy efficiency and renewable energy investments in a thorough and precise manner.
3.3-4	There is no need to complicate Metro's management of facility electric rates by pursuing SCE's Direct Access (competitive supply) market at this time. This is because Metro has only roughly 30% of its electricity load on the SCE system, and there is currently a fully subscribed cap on participation in the competitive program. The chances of Metro being able to hedge or otherwise manage a sizable share of its overall electricity costs through the SCE Direct Access program at this time are very low. If the SCE program expands significantly and matures, it may be more worthwhile for Metro to pursue it.
3.3-5	Metro should continue to emphasize its sub-metering efforts already underway, which are an excellent extension of the meter-level interval data (showing Metro's electricity demand and usage every 15 minutes) already available from LADWP and SCE.
3.3-6	On an annual or bi-annual basis, Metro may wish to conduct a structured review process on its facility electricity rates along the lines described in the prior subsection. The initial focus of such a review should be the largest facility meters.

Section 3.4: Electricity Hedging and Price Risk Management

Number	Recommendation
3.4-1	Metro should not pursue any new electricity hedging and price risk management initiatives at this time, except those arising from renewable energy investments.[40] There are several potentially significant limitations and drawbacks to implementing an electricity hedging program within Metro through deregulated physical supply or financial transactions. The negative factors associated with electricity hedging, including distracting the Energy Management function within Metro from more important cost- and GHG-reduction actions, far outweigh the principal hedging benefits of greater stability and predictability for Metro's energy budget.
3.4-2	For renewable energy installations owned or leased long-term by Metro, the attendant price predictability (through known capital costs or lease payments) adds to the value of the renewable projects, and it is recommended that it be considered as an explicit screening factor by the Energy Management function. Section 3.7 describes a renewable energy project screening and selection approach for Metro implementation that explicitly includes a hedging benefit.
3.4-3	In the event that the competitive electricity supply (Direct Access) market in SCE territory matures and expands in the future and the LADWP market opens effectively to competition for generation supply, it may be worthwhile for Metro to re-assess the benefits and drawbacks of introducing additional electricity hedging to its cost management program. Several of the negative factors discussed in this section are particular to electricity hedging, and may not apply to natural gas hedging activities related to Metro's CNG bus fleet.

Section 3.5: Facility Natural Gas Rate Review

Number	Recommendation
3.5-1	Because facility natural gas costs represent a modest share (about 3% of the total costs and 10% of the facility-based costs) considered in this ECMP and their billing appears to be accurate, Metro intends that managing facility gas rates not be an area of emphasis for the Energy Management function.
3.5-2	For the purposes of general planning and account review, Metro intends to use the facility natural gas account summary table contained here to assist in budgeting and the process flow chart in Figure 3-13 for conducting streamlined annual or bi-annual reviews of natural gas volumes and prices.
3.5-3	Metro will not pursue competitive natural gas supply for its facilities at this point. Due to the relatively small size of Metro's facility natural gas budget, the potential hedging and/or rate benefits of pursuing competitive market alternatives to standard utility rates do not warrant the administrative time and effort that would be involved. However, Metro will strongly consider extending the existing natural gas financial hedging program in place for Metro's compressed natural gas (CNG) bus fleet to Metro's much smaller facility natural gas costs in order to stabilize annual fluctuations in facility natural gas budgets.

Section 3.6: Energy Efficiency Assessment and Investment Process

Number	Recommendation
3.6-1	*5 Key Equipment Upgrades* • Install occupancy sensors and/or photo sensors in areas with limited employee traffic (bathrooms, conference rooms, meeting rooms, and closets) and on outdoor lighting. • Replace all metal halide, high pressure sodium, and T12 fluorescent lights with T8 or T5 fluorescent lights, and all incandescent bulbs with compact fluorescent (CFL) bulbs, where possible. Furthermore, as LED technology becomes more reliable, consider its use around the portfolio. • Submeter electricity use of every building in operation. It is especially important to submeter energy used for propulsion verses energy use for facility operations. Identify opportunities to submeter water consumption where economically feasible. • Install automated digital thermostats that can be programmed with automatic setback temperatures. • Install sink aerators in all bathrooms to reduce water flow from 2 gallons per minute to 1 or 0.5 gallon per minute, reducing the energy use associated with water usage.

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[40] These recommendations are based on information provided on Metro's electricity costs and the authors' knowledge and research into relevant hedging instruments in the context of Metro's overall energy approach. Based on requests made within Metro, it appears that no other Metro electricity hedging or related policy documents are available.

3.6-2	*5 Critical Facility Management Strategies* • Create an overarching management structure for energy management, including a process for sharing energy consumption and cost data with facility management on a monthly basis, and a manager who takes primary responsibility for reducing energy consumption and cost Metro-wide. • Implement active temperature control with off-hour setbacks for thermostats and temperatures set at seasonal thresholds. • Develop strategies to reduce lighting loads in an OSHA-compliant manner in spaces that go unoccupied for long periods of time. • Develop checklists for employees at all levels to ensure energy use is a core part of performance tracking. • Develop strategies to ensure that bay doors are kept closed while heating and cooling systems are in use.
3.6-3	*5 Stakeholder Engagement Efforts* • Expand employee environmental and safety training to include energy efficiency and energy management. • Develop a campaign or contest to get similar Metro sites to compete against one another for energy savings, and consider developing a web-based tracking system and/or incentives to support the energy reduction contest (and the future program). • Make energy reduction part of employee performance metrics, including recognition and incentives for efficiency improvements. • Expand funding for efficiency and energy management projects, and consider developing a streamlined budgeting process for efficiency projects. • Expand and systematize training and technical support for Building Automation Systems.
3.6-4	*5 Powerful Sustainability and Investment-Grade Opportunities to Explore* • Look at opportunities to upgrade older HVAC and boiler equipment. • Hire a systems engineer to integrate existing Building Automation Systems, as well as provide training and coherency to the myriad Building Automation Systems currently in place. • Consider multi-day retro-commissioning of select sites, particularly to comply with the LEED Existing Buildings Operations and Maintenance standard. • Look at the potential for onsite power generation (solar, wind, geothermal, etc.). • Ensure that Metro prioritizes energy efficiency points in LEED projects.
Section 4: Energy Management Structure	
Number	**Recommendation**
4-1	In light of the previously discussed research, the recommended option is to temporarily establish a new EMG in the Transit Project Delivery Department, specifically contained within the Environmental Compliance and Services Unit. This group would be led by an Energy Program Administrator position. The Administrator role may be accomplished by the Environmental Compliance and Services Unit Manager, or until such time that Metro is able to establish a new Energy Program Administrator position. The primary advantage of placing the EMG here is the strong synergy that can be achieved through the integration of the Energy Management Program with the Environmental Management System, of which Energy Management is a key component.
Section 5: ECMP Implementation Strategies	
Number	**Recommendation**
	This section provides a set of Energy Management Implementation Strategies designed to capture and build upon the organizational momentum and excitement created through Metro's Sustainability Program, including its EMS. The implementation strategies presented in Section 5 follow the Plan-Do-Check-Act model employed by Metro in its EMS. It is recommended that the entire Section be carefully reviewed, and considered as an integrated set of recommendations.
Section 6: Renewable Energy Program (REP) Development and Implementation	
Number	**Recommendation**
	This section provides an implementation blueprint that Metro could follow to develop and ramp up a

	Renewable Energy Program (REP), following the same Plan-Do-Check-Act model employed in Section 5, and utilized by Metro in its EMS. It is recommended that the entire Section be carefully reviewed, and considered as an integrated set of recommendations. In addition, the following recommendations are also provided for consideration by Metro:
6.1.3-1	It is important to measure and consider many renewable energy system benefits. In addition to cost, the recommended process here explicitly weights environmental benefits, land-use efficiency, peak shaving benefits, hedging benefits, and the use of California and Los Angeles County content. By combining these factors in its analysis, Metro should be able to smartly build on its reputation as a renewable energy leader among transit agencies.
6.1.3-2	Direct agency ownership options should be compared to available power purchase agreement (PPA) structures.
6.1.3-3	To the extent practical, Metro should follow a best practice among renewable energy purchasers and hosts in batching renewable investment decisions together semi-annually or annually for feasibility studies, review, and procurement so that (i) a broader view of their comparative benefits can be made and (ii) administrative efficiencies can be achieved. The renewable screening process described here supports such batch consideration of project options.
6.1.3-4	Beyond the evaluation of pilot project opportunities underway in mid-2011, Metro should continue to use the Renewable Energy Screening Tool to help it assess potential projects as it scales up its Renewable Energy Program.
6.1.3-5	As Metro continues to plan and develop its renewable energy projects, it should at least annually (a) update the assumptions in the Renewable Energy Screening Tool to match current market conditions (electric prices, incentive levels, technology costs, etc.), and (b) modify the score category weights as it sees fit to meet its larger energy and climate goals. Such updates to the tool can be made by Metro personnel.

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Appendix B: “Utility Map” of LA Metro’s Facilities, Service Addresses, and Electricty and Gas Accounts

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
Division 1 Bus Yard (1130 E. 6th St, Los Angeles, CA 90021)					
	1130 E. 6th St, Los Angeles, CA 90021	LADWP	Electric	1-4497183-01130-00-9001-0	APMYV-226-8331
	1016 E. 6th St, Los Angeles, CA 90021	The Gas Company	Natural Gas	109-700-0800-8	03588499
	1130 E. 6th St, Los Angeles, CA 90021	The Gas Company	Natural Gas	111-800-0800-2	02535918
Division 2 Bus Yard (720 E. 15th St, Los Angeles, CA 90021)					
	720 E. 15th St, Los Angeles, CA 90021	LADWP	Electric	1-44-94734-00720-00-0000-3	APMD-2019-325
	720 E. 15th St, Los Angeles, CA 90021	LADWP	Electric	1-44-94734-00720-00-9001-0	PMYD-219-18930
	720 E. 15th St, Los Angeles, CA 90021	The Gas Company	Natural Gas	129-700-2400-1	11414395
	720 E. 15th St, Los Angeles, CA 90021	The Gas Company	Natural Gas	138-100-2400-3	10717942
Division 3 Bus Yard (630 W. Avenue 28, Los Angeles, CA 90065)					
	630 W. Avenue 28, Los Angeles, CA 90065	LADWP	Electric	1-56-05756-00630-00-9002-0	APMYV-227-6285
	630 W. Avenue 28, Los Angeles, CA 90065	The Gas Company	Natural Gas	124-320-5800-1	10575667
	2716 Pepper Ave, Los Angeles, CA 90065	LADWP	Electric	1-56-68383-02716-00-0000-0	APMYD-226-4418
Division 4 Non Revenue Vehicle (7878 Telegraph Rd, Downey, CA 90240)					
	7878 Telegraph Rd, Downey, CA 90240	SCE	Electric	53-47-118-1001-03	P379-002011
	7878 Telegraph Rd, Downey, CA 90240	The Gas Company	Natural Gas	071-306-9000-6	11056634
Division 5 Bus Yard (5425 Van Ness Ave, Los Angeles, CA 90062)					
	5425 Van Ness Ave, Los Angeles, CA 90062	LADWP	Electric	1-47-86990-05425-00-9002-0	APMYD-226-8384
	5425 S. Van Ness Ave, Los Angeles, CA 90062	The Gas Company	Natural Gas	059-705-9500-4	12692072
	2300 W. 54th St, Los Angeles, CA 90062	The Gas Company	Natural Gas	123-306-6200-3	11006314
Division 6 Bus Yard (100 Sunset Ave, Venice, CA 90291)					
	100 Sunset Ave, Venice, CA 90291	LADWP	Electric	4-53-82621-00100-00-0000-0	PMY-222-7399
	100 Sunset Ave, Venice, CA 90291	The Gas Company	Natural Gas	078-203-5200-8	12774339
Division 7 Bus Yard (8800 Santa Monica Blvd, West Hollywood, CA 90069)					
	8800 Santa Monica Blvd, West Hollywood, CA 90069	SCE	Electric	63-42-999-1951-91	V349N-008776
	8800 Santa Monica Blvd, West Hollywood, CA 90069	SCE	Electric	00-00-000-0000-00	308Z-192270

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
	8800 Santa Monica Blvd, West Hollywood, CA 90069	SCE	Electric	00-00-000-0000-00	V349N-016145
	8800 Santa Monica Blvd, West Hollywood, CA 90069	The Gas Company	Natural Gas	180-001-9700-6	11967104
Division 8 Bus Yard (9201 Canoga Ave, Chatsworth, CA 91311)					
	9201 Canoga Ave, Chatsworth, CA 91311	LADWP	Electric	3-53-15455-09201-00-0000-3	NPMYD-277-5587
	9201 Canoga Ave, Chatsworth, CA 91311	LADWP	Electric	3-53-15455-09201-00-9001-0	1APMYV-226-8112
	9201 Canoga Ave, Chatsworth, CA 91311	The Gas Company	Natural Gas	082-611-6900-0	02344952
Division 9 Bus Yard (3449 Santa Anita Ave, El Monte, CA 91731)					
	3449 Santa Anita Ave, El Monte, CA 91731	SCE	Electric	63-22-999-0298-91	V349N-005042
	3449 Santa Anita Ave Unit B, El Monte, CA 91731	The Gas Company	Natural Gas	010-155-9597-6	12453858
	3449 Santa Anita Ave Apt A, El Monte, CA 91731	The Gas Company	Natural Gas	140-317-3900-7	11087125
	3333 Santa Anita Ave, El Monte, CA 91731	SCE	Electric	00-00-000-0000-00	308Z-263890
	3369 Santa Anita Ave, El Monte, CA 91731	The Gas Company	Natural Gas	089-917-3957-7	12509868
Division 10 Bus Yard (742 N. Mission Rd, Los Angeles, CA 90033)					
	742 N. Mission Rd, Los Angeles, CA 90033	LADWP	Electric	1-61-60555-00742-00-0000-0	APMYD-219-21995
	742 N. Mission Rd, Los Angeles, CA 90033	LADWP	Electric	1-61-60555-00742-00-0000-3	APMYD-277-2931
	742 N. Mission Rd, Los Angeles, CA 90033	LADWP	Electric	1-61-60555-00742-00-9001-1	1APMYV-229-3224
	742 N. Mission Rd, Los Angeles, CA 90033	The Gas Company	Natural Gas	088-019-4100-9	01334379
Division 11 Blue Line Main Yard (4350 E. 208th St, Long Beach, CA 90810)					
	1005 W. Carson St, Long Beach, CA 90810	The Gas Company	Natural Gas	008-601-3200-0	12317903
Division 15 Bus Yard (11900 Branford St, Sun Valley, CA 91352)					
	11900 Branford St, Sun Valley, CA 91352	LADWP	Electric	3-45-12230-11900-00-9003-0	1NPMYV-277-5570
	11900 Branford St, Sun Valley, CA 91352	The Gas Company	Natural Gas	007-120-3700-1	10279340
Terminal 17 Maple Lot (632 Maple Ave, Los Angeles, CA 90014)					
	636 Maple Ave, Los Angeles, CA 90014	LADWP	Electric	1-62-56192-00636-00-9001-0	PMYD-209-47349
	636 Maple Ave, Los Angeles, CA 90014	LADWP	Electric	1-62-56192-00636-00-9003-0	PMYD-209-44013
Division 18 Bus Yard (450 W. Griffith St, Gardena, CA 90248)					
	450 W. Griffith St, Gardena, CA 90248	SCE	Electric	62-32-574-0716-01	V349N-014204
	450 W. Griffith St, Gardena, CA 90248	SCE	Electric	63-32-999-0714-91	V349N-009472
	450 W. Griffith St, Gardena, CA 90248	The Gas Company	Natural Gas	121-501-4300-1	10139316

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
Terminal 19 - El Monte Station (3501 Santa Anita Ave, El Monte, CA 91731)					
	3501 Santa Anita Ave, El Monte, CA 91731	SCE	Electric	57-22-801-0295-01	349-018869
	3501 Santa Anita Ave, El Monte, CA 91731	SCE	Electric	00-00-000-0000-00	3416-073239
Division 20 Red Line Main Yard (320 S. Santa Fe Avenue, Los Angeles, CA, 90013)					
	300 S. Santa Fe Avenue, Los Angeles, CA, 90013	LADWP	Electric	1-61-76752-00300-00-0000-0	APMV-30021-19
	300 S. Santa Fe Avenue, Los Angeles, CA, 90013	LADWP	Electric	1-61-76752-00300-00-9004-0	APMV-30011-81
	320 S. Santa Fe Avenue, Los Angeles, CA, 90013	The Gas Company	Natural Gas	079-000-1931-1	10582599
	320 S. Santa Fe Avenue, Los Angeles, CA, 90013	The Gas Company	Natural Gas	081-100-1900-0	05303208
Division 21 Pasadena Gold Line Yard (Midway) (1800 Baker St, Los Angeles, CA 90012)					
	1800 Baker St, Los Angeles, CA 90012	LADWP	Electric	1-61-06809-01800-00-0000-0	PMYD-222-8623
	1802 Baker St, Los Angeles, CA 90012	LADWP	Electric	1-61-06809-01802-00-0000-1	APMV-30015-102
	1800 Baker St, Los Angeles, CA 90012	The Gas Company	Natural Gas	027-165-1769-9	07800406
Division 22 Green Line Main Yard (14724 Aviation Blvd, Lawndale, CA 90260)					
	14724 Aviation Blvd, Hawthorne, CA 90250	SCE	Electric	59-44-135-1029-02	PO376-000935
	14724 Aviation Blvd, Hawthorne, CA 90250	SCE	Electric	63-44-999-1026-91	V345N-000647
	14724 Aviation Blvd, Hawthorne, CA 90250	SCE	Electric	63-44-999-1021-91	V345N-000876
	14724 Aviation Blvd, Lawndale, CA 90260	The Gas Company	Natural Gas	106-003-8600-6	10278943
Location 23 - Gold Line Eastside Extension Office (2420 E. Cesar Chavez Ave, Los Angeles, CA 90033)					
	No relevant service addresses were found for this facility.				
Terminal 24 - Ex Bus Yard (14557 Sherman Way, Van Nuys, CA 91405)					
	No relevant service addresses were found for this facility.				
Terminal 25 - Toberman Lot (1831 Toberman St, Los Angeles, CA 90015)					
	No relevant service addresses were found for this facility.				
Terminal 26 - West LA Transit Center					
	5702 Apple St., LA, 90016	LADWP	Electric	1-54-03711-05702-00-0000-0	M-9-942802
Terminal 27 - LAX Transit Center					
	6111 W. 96th St., LA, 90045	LADWP	Electric	4-59-97974-06111-00-9002-0	APMY-209-47913
Terminal 28 - 18th Street Bus Layover					
	111 W. 18th St., LA, 90015	LADWP	Electric	1-43-95166-00111-00-0000-3	M-9-795798

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
Location 30 - Metro Support Services Center (900 Lyon St, Los Angeles, CA 90012)					
	900 Lyon St, Los Angeles, CA 90012	LADWP	Electric	1-61-55028-00900-00-9001-0	ANPMYVL-2022-482
	900 Lyon St, Los Angeles, CA 90012	LADWP	Electric	1-61-55028-00900-00-9002-0	ANPMYVL-2022-483
	900 Lyon St, Los Angeles, CA 90012	The Gas Company	Natural Gas	155-219-4200-1	04754125
Terminal 31 - Vignes Bus Layover (938 N. Vignes St, Los Angeles, CA 90012)					
	No relevant service addresses were found for this account				
Location 33 - OCI (900 Lyon St, Los Angeles, CA 90012)					
	This facility has the same address as Locations 30, 35, and 88. All accounts are included with Location 30.				
Location 34 - Vernon Yards (4462 Pacific Blvd, Los Angeles, CA 90058)					
	4462 Pacific Blvd, Los Angeles, CA 90058	The Gas Company	Natural Gas	114-800-3300-7	11468518
Location 35 - Facilities Maintenance (900 Lyon St, Los Angeles, CA 90012)					
	This facility has the same address as Locations 30, 33, and 88. All accounts are included with Location 30.				
Fox Hills Mall, Culver City,					
	No relevant service addresses were found for this facility.				
Terminal 37 - Palm Place Loop Bus Layover (8145 Seville Ave, South Gate, CA 90280)					
	8145 Seville Ave, South Gate, CA 90280	SCE	Electric	Serv #:1336554 , Cust #: 39070966	8508080
Terminal 38 - 85th & Central Bus Layover (8500 S. Central Ave, Los Angeles, CA 90001)					
	8500 S. Central Ave, Los Angeles, CA 90001	SCE	Electric	Serv #: 1573366 , Cust #: 39070966	AE208412640
Terminal 39 - Jefferson Loop Bus Layover (3012 W. Jefferson Blvd, Los Angeles, CA 90018)					
	3012 W. Jefferson Blvd, Los Angeles, CA 90018	LADWP	Electric	1-58-45784-03012-00-0000-3	9-782927
Terminal 40 - Pico Rimpau Loop Bus Layover (W. Pico Blvd, Los Angeles, CA 90019)					
	4600 W. Pico Blvd, Los Angeles, CA 90019	LADWP	Electric	1-57-68812-04600-00-9002-1	MPY-209-47053
Terminal 41 - 6th & Wilton Bus Layover (530 S. Wilton Pl, Los Angeles, CA 90020)					
	530 S. Wilton Pl, Los Angeles, CA 90020	LADWP	Electric	1-53-91838-00530-00-0000-0	FM-106-161147
Terminal 42 - Echo Park & Donaldson Bus Layover (2200 Echo Park Ave, Los Angeles, CA 90026)					
	2200 Echo Park Ave, Los Angeles, CA 90026	LADWP	Electric	1-45-29781-02200-00-9001-0	FM-9-1130618
Terminal 43 - Whittier & Brannick Terminal (4302 Whittier Blvd, Los Angeles, CA 90023)					
	4302 Whittier Blvd, Los Angeles, CA 90023	SCE	Electric	Serv #: 1336553 , Cust #: 39070966	222010128000
Terminal 44 - Dozier & Rowan Layover (427 N. Rowan Ave, Los Angeles, CA 90063)					

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
	427 N. Rowan Ave, Los Angeles, CA 90063	SCE	Electric	Serv #: 33434012 , Cust #: 39070966	222010128000
Terminal 45 - Rose Hills Station Layover (4592 N. Huntington Dr, Los Angeles, CA 90032)					
	4630 N. Huntington Dr, Los Angeles, CA 90032	LADWP	Electric	1-55-44399-04630-00-0000-3	M-9-991472
Terminal 46 - Red Line Bus Terminal (Argyle St. Hollywood/Vine, LA, 90032)					
	No relevant service addresses were found for this facility.				
Terminal 47 - USC Medical Center Busway Station (1930 Pomeroy Ave, Los Angeles, CA 90012)					
	1930 Pomeroy Ave, Los Angeles, CA 90012	LADWP	Electric	1-58-69469-01930-00-0000-0	PM-419-3551
Terminal 48 - Cal State Busway Station (5150 State St, Los Angeles, CA 90015)					
	No relevant service addresses were found for this facility.				
Terminal 49 - Mountain & Brand Terminal (1340 N. Brand Ave, Glendale, CA 91202)					
	No relevant service addresses were found for this facility.				
Terminal 50 - M.L. King Transit Center (Compton) (305-7 N. Tamarind Ave, Compton, CA 90220)					
	No relevant service addresses were found for this facility.				
Terminal 52 - South Bay Galleria Transit Center (1850 Kingsdale Ave, Redondo Beach, CA 90278)					
	No relevant service addresses were found for this facility.				
Terminal 53 - 117th St/ Figueroa Bus Layover					
	No relevant service addresses were found for this facility.				
Terminal 54 - Shatto Place					
	No relevant service addresses were found for this facility.				
Location 60 - Blue Line Rail Central Control Facility (2000 Imperial Hwy, Compton, CA 90059)					
	2034 E. Imperial Hwy TPP, Compton, CA 90059	SCE	Electric	54-32-026-4802-03	Y278-003045
	2000 Imperial Hwy, Compton, CA 90059	The Gas Company	Natural Gas	186-700-9400-4	02536331
Location 61 - Red Line Maintenance Of Way (284 S. Santa Fe Ave, Los Angeles, CA 90012)					
	No relevant service addresses were found for this facility.				
Location 66 - Blue Line Maintenance Of Way (1680 Imperial Hwy, Compton, CA 90559)					
	1680 E. Imperial Hwy, Los Angeles, CA 90059-2524	SCE	Electric	Serv #: 17773503 , Cust #: 4702346	249000420
	1680 E. Imperial Hwy, Los Angeles, CA 90059-2524	The Gas Company	Natural Gas	127-928-1689-9	10958519
Location 70 - 37th Street - Harbor Transitway Station (421 1/2 W. 37th St, Los Angeles, CA 90007)					
	421 W. 37th St, Los Angeles, CA 90007	LADWP	Electric	1-52-96704-00421-00-0000-1	PMYD-219-16242

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
Location 71 - Slauson Ave - Harbor Transitway Station (350 1/2 Slauson Ave, Los Angeles, CA 90003)					
	No relevant service addresses were found for this facility.				
Location 72 - Manchester Ave - Harbor Transitway Station (452 1/2 Manchester Ave, Los Angeles, CA 90003)					
	No relevant service addresses were found for this facility.				
Location 74 - Rosecrans Ave - Harbor Transitway Station (622 W. Rosecrans Ave, Los Angeles, CA 90248)					
	No relevant service addresses were found for this facility.				
Location 75 - Artesia Transit Center (731 W. 182nd St, Los Angeles, CA 90248)					
	No relevant service addresses were found for this facility.				
Location 76 - Carson St - Harbor Transitway Station (599 1/2 W. Carson St, Carson, CA 90745)					
	601 W. Carson St, Carson, CA 90745	SCE	Electric	Serv #: 17584915 , Cust #: 4702346	PO826011671
	901 E. Carson St, Carson, CA 90745	SCE	Electric	Serv #: 22598188 , Cust #: 4702346	3416012210
Location 77 - PCH - Harbor Transitway Station (1435 1/4 N. Figueroa St, Wilmington, CA 90744)					
	1440 1/2 Figueroa St, Los Angeles, CA 90744	LADWP	Electric	2-50-34102-01440-50-0000-1	PMY-219-14987
	333 E. Esther St, Long Beach, CA 90813	SCE	Electric	Serv #: 12844279 , Cust #: 4702346	V345N000022
Location 80 - Materials Warehouse (628 Aliso St, Los Angeles, CA 90012)					
	622 Aliso St, Los Angeles, CA 90012	LADWP	Electric	1-61-01612-00622-00-9001-8	9-4141
	622 Aliso St, Los Angeles, CA 90012	LADWP	Electric	1-61-01612-00622-00-9002-3	PM-209-1135
Location 81 - Surplus Office Space (6th Floor) (818 W. 7th St, Los Angeles, CA 90017)					
	E. 7th St, Los Angeles, CA 90021	LADWP	Electric	741724-315597	1335-1339
Location 82 - Office Space (Floors 23,24,27,28,29, & 37) (707 Wilshire Blvd, Los Angeles, CA 90017)					
	No relevant service addresses were found for this facility.				
Location 83 - Office/Warehouse Building (3730 Monterey Rd, El Monte, CA 91731)					
	3730 Monterey Rd, El Monte, CA 91731	SCE	Electric	Serv #: 18095287 , Cust #: 4702346	885007380
	3730 Monterey Rd, El Monte, CA 91731	The Gas Company	Natural Gas	016-317-2290-5	03450338
Location 84 - San Fernando Valley Service Sector (9760 Topanga Canyon Blvd, Chatsworth, CA 91311)					
	9760 Topanga Canyon Blvd A, Chatsworth, CA 91311	LADWP	Electric	3-53-84834-09760-00-0001-0	PMYD-209-57208
	9760 Topanga Canyon Blvd B, Chatsworth, CA 91311	LADWP	Electric	3-53-84834-09760-00-0002-5	PMYD-209-38468
	9760 Topanga Canyon Blvd C, Chatsworth, CA	LADWP	Electric	3-53-84834-09760-00-0003-2	PMYD-209-38470

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
	91311				
	9760 Topanga Canyon Blvd, Chatsworth, CA 91311	The Gas Company	Natural Gas	018-526-3574-5	10866821
Location 85 - San Gabriel Valley Service Sector (3449 Santa Anita Ave, El Monte, CA 91731)					
	This facility has the same address as Division 9 Busyard. All accounts are included with Division 9.				
Location 86 - South Bay Service Sector (680 Knox St., Suite 150, Torrance, CA 90502)					
	No relevant service addresses were found for this facility.				
Location 87 - Gateway Cities Service Sector (7878 Telegraph Rd, Downey, CA 90240)					
	This facility has the same address as Division 4 Non Revenue Vehicle. All accounts are included with Division 4.				
Location 88 - Westside-Central Service Sector (900 Lyon St, Los Angeles, CA 90012)					
	This facility has the same address as Locations 30, 33, and 35. All accounts are included with Location 30.				
Location 89 - Reserved for Sector Office					
	No relevant service addresses were found for this facility.				
Location 91 - First Transit Inc. (14011 S. Central Ave, Los Angeles, CA 90059)					
	659 S. Central Ave, Los Angeles, CA 90059	LADWP	Electric	1-44-17616-00659-00-0000-0	MD-9-850703
	585 S. Central Ave, Los Angeles, CA 90059	LADWP	Electric	1-62-17616-00585-00-0000-0	FM-9-1173898
Location 99/109 - LACMTA Headquarters Bldg. (One Gateway Plaza/729 N. Vignes St, Los Angeles, CA 90012)					
	785 N. Vignes St, Los Angeles, CA 90012	LADWP	Electric	1-61-88449-00785-00-0000-0	1APMYVL-232-917
	785 N. Vignes St, Los Angeles, CA 90012	LADWP	Electric	1-61-88449-00785-00-0000-0	None
	785 N. Vignes St, Los Angeles, CA 90012	LADWP	Electric	1-61-88449-00785-00-9001-1	1APMYVL-232-952
	785 N. Vignes St, Los Angeles, CA 90012	LADWP	Electric	1-61-88449-00785-00-9001-1	None
	801 N. Vignes St, Los Angeles, CA 90012	The Gas Company	Natural Gas	102-719-4200-4	10509785
Location 105 - Baldwin Hills Customer Service Center (3650 M.L. King Jr. Blvd, Los Angeles, CA 90005)					
	3650 M.L. King Jr. Blvd, Los Angeles, CA 90005	LADWP	Electric	1-55-55082-03650-02-0101-0	APMY-209-48558
Location 106 - Wilshire Customer Service Center (5301 Wilshire Blvd, Los Angeles, CA 90036)					
	5301 Wilshire Blvd, Los Angeles, CA 90036	LADWP	Electric	1-49-91800-05301-00-9001-3	PMSD-219-18224
	5301 Wilshire Blvd, Los Angeles, CA 90036	The Gas Company	Natural Gas	106-302-3500-9	12982482
Location 110 - East L.A. Customer Service Center (4501 Whittier Blvd B, Los Angeles, CA 90022)					
	4501 E. Whittier Blvd B, Los Angeles, CA 90022	SCE	Electric	Serv #: 16447 , Cust #: 39070966	D724005167
	4501 E. Whittier Blvd B, Los Angeles, CA 90022	The Gas Company	Natural Gas	082-900-2500-9	11276480

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
Terminal 200 - Line 402 Pasadena P&R (Pasadena & Carson)					
	No relevant service addresses were found for this facility.				
Terminal 201 - Line 418 Northridge P&R (Shirley Ave & Plummer St)					
	No relevant service addresses were found for this facility.				
Terminal 202 - Line 424/ 425 Studio City P&R (Ventura Blvd & Lankershim Blvd)					
	10729 1/2 Ventura Blvd	LADWP	Electric	3-49-87476-10729-50-0000-0	FM-9-1170466
Terminal 203 - Line 427 Canoga Park P&R (Vanowen St & Platt Ave)					
	No relevant service addresses were found for this facility.				
Terminal 204 - Line 445 San Pedro P&R (Battery St & Gaffey St)					
	No relevant service addresses were found for this facility.				
Terminal 205 - Line 445 Torrance P&R (Hamilton Ave & Torrance Blvd)					
	No relevant service addresses were found for this facility.				
Terminal 206 - Line 457 Long Beach P&R (Marina Dr & Studebaker Rd)					
	No relevant service addresses were found for this facility.				
Terminal 207 - Line 459 Huntington Beach P&R (Huntington Center)					
	No relevant service addresses were found for this facility.				
Terminal 208 - Line 459 Los Alamitos P&R (Southwest Regional Laboratories)					
	No relevant service addresses were found for this facility.				
Terminal 209 - Line 464 Fullerton P&R (Orangethorpe Ave & Magnolia Ave)					
	No relevant service addresses were found for this facility.				
Terminal 210 - Line 466 La Mirade P&R (La Mirada Blvd & Ocaso Ave)					
	No relevant service addresses were found for this facility.				
Terminal 211 - Line 495 Diamond Bar P&R (Diamond Bar Blvd & Cal Trans P&R Lot)					
	No relevant service addresses were found for this facility.				
Terminal 212 - Line 495 Industry P&R (Albatross Rd & Castleton St)					
	No relevant service addresses were found for this facility.				
Terminal 213 - Line 497 Montclair P&R (Monte Vista Ave & Moreno St)					
	No relevant service addresses were found for this facility.				
Terminal 214 - Line 497 Pomona R&R (McKinley Ave & Garey Ave)					

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
	No relevant service addresses were found for this facility.				
Terminal 215 - Line 497 Pomona P&R (McKinley Ave & Cannon Way)					
	No relevant service addresses were found for this facility.				
Terminal 216 - Line 498 Azusa P&R (Citrus Ave & Foothill Blvd)					
	No relevant service addresses were found for this facility.				
Terminal 217 - Line 498 West Covina P&R (Barranca Ave & Eastland Center Dr)					
	No relevant service addresses were found for this facility.				
Terminal 218 - Long Beach P&R					
	No relevant service addresses were found for this facility.				
Terminal 219 - Parking Structure Adjacent to B732 (200 W. 27th St, Long Beach, CA, 90806)					
	200 E. 27th St, Long Beach, CA, 90806	SCE	Electric	Serv #: 15077155 , Cust #: 4702346	PO826010987
Terminal 220 - Parking Structure Sierra Madre Gold line Station (149 N. Halstead St, Pasadena, CA, 91107)					
	No relevant service addresses were found for this facility.				
Station 300 - Mt. Washington Radio Station (4990 Glenalbyn Dr, Los Angeles, CA 90065)					
	No relevant service addresses were found for this facility.				
Station 301 - Verdugo Peak Radio Station (5 miles south of La Tuna Canyon Rd & Foothill Fwy, Glendale, CA)					
	No relevant service addresses were found for this facility.				
Station 302 - San Pedro Hill Radio Station (3900 West Crest Road, Rancho Palos Verdes, CA, 90274)					
	No relevant service addresses were found for this facility.				
Station 303 - Beverly Glen Radio Station (3137 1/2 Beverly Glen Blvd, Los Angeles, CA 90077)					
	No relevant service addresses were found for this facility.				
Station 304 - Rio Hondo Radio Station (Puente Hills Dr, near Rio Hondo College, Whittier, CA)					
	3600 Workman Mill Rd, Whittier, CA 90601	SCE	Electric	Serv #: 1336556 , Cust #: 39070966	8970889
Station 305 - Sierra Peak Radio Station (West of Corona, CA)					
	No relevant service addresses were found for this facility.				
Station 306 - First Interstate Bank (707 Wilshire Blvd, Los Angeles, CA, 90017)					
	No relevant service addresses were found for this facility.				
Station 308 - Mt. Lukens Radio Station #2 (5 Mount Lukens Rd, Tujunga, CA, 91042)					
	No relevant service addresses were found for this facility.				

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
Station 309 - Mt. Lukens Radio Station #1 (Angeles Crest National Forest, La Crescenta, CA)					
	No relevant service addresses were found for this facility.				
Station 311 - Baldwin Hills Radio Station (4400 La Cienega Blvd, LA, CA, 90008)					
	No relevant service addresses were found for this facility.				
Station 313 - Oat Mountain Radio Station (Orcutt Ranch, Chatsworth, CA 91311)					
	No relevant service addresses were found for this facility.				
Station 314 - Hauser Peak Radio Station (Red Rover Mine Rd, Palmdale, CA)					
	No relevant service addresses were found for this facility.				
ORANG E LINE					
Orange Line Station 001 - Warner Center Station (6120 Owensouth Ave, Los Angeles, CA 91367)					
	6120 Owensouth Ave, Los Angeles, CA 91367	LADWP	Electric	3-50-66323-06150-00-0000-0	M-9-1031660
Orange Line Station 002 - Canoga Station (6552 Canoga Ave, Los Angeles, CA 91303)					
	6550 1/2 Canoga Ave, Los Angeles, CA 91303	LADWP	Electric	3-51-15455-06550-50-0000-0	M-19-22941
	6550 1/2 Canoga Ave, Los Angeles, CA 91303	LADWP	Electric	3-51-15455-06552-50-0000-0	M-1922956
Orange Line Station 003 - De Soto Station (W/B 20901 Victory Blvd, Los Angeles CA, 91367, E/B 20851 Victory Blvd, Los Angeles, CA 91367)					
	20851 Victory Blvd, Los Angeles CA, 91367	LADWP	Electric	3-51-88337-20851-00-0000-0	M-9-1046806
Orange Line Station 004 - Winnetka Station (W/B 6425 Winnetka Ave, Los Angeles, CA 91367, E/B 6424 Winnetka Ave, Los Angeles, CA 91367)					
	6425 Winnetka Ave, Los Angeles, CA 91367	LADWP	Electric	3-52-92039-06425-00-0000-3	M-19-22868
Orange Line Station 005 - Tampa Station (W/B 6101 Tampa Ave, Los Angeles, CA 91335, E/B 6100 Tampa Ave, Los Angeles, CA 91335)					
	6100 Tampa Ave, Los Angeles, CA 91335	LADWP	Electric	3-57-83378-06100-00-0000-0	M-9-1031698
Orange Line Station 006 - Reseda Station (W/B 6065 Reseda Blvd, Los Angeles, CA 91335, E/B 6064 Reseda Blvd, Los Angeles, CA 91335)					
	6065 Reseda Blvd, Los Angeles, CA 91335	LADWP	Electric	3-56-72147-06065-00-0000-0	M-19-22896
Orange Line Station 007 - Balboa Station (W/B 6340 N. Balboa Blvd, Los Angeles, CA 91316, E/B 6338 N. Balboa Blvd, Los Angeles, CA 91316)					
	6340 Balboa Blvd, Los Angeles, CA 91316	LADWP	Electric	3-52-06830-06340-00-9003-0	M-19-22873
Orange Line Station 008 - Woodley Station (W/B 6381 N. Woodley Ave, Los Angeles, CA 91406, E/B 6380 N. Woodley Ave, Los Angeles, CA 91406)					
	6380 N. Woodley Ave, Los Angeles, CA 91406	LADWP	Electric	3-52-92625-06380-00-0000-0	M-9-943217
Orange Line Station 009 - Sepulveda Station (W/B 15430 W. Erwin St, Van Nuys, CA 91411, E/B 15432 W. Erwin St, Van Nuys, CA 91411)					

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
	15430 W. Erwin St, Van Nuys, CA 91411	LADWP	Electric	3-55-32201-15430-00-9001-0	M-19-22897
Orange Line Station 010 - Van Nuys Station (W/B 6062 Van Nuys Blvd, Van Nuys, CA 91411, E/B 6060 Van Nuys Blvd, Van Nuys, CA 91411)					
	6060 Van Nuys Blvd, Van Nuys, CA 91411	LADWP	Electric	3-56-87016-06060-00-9001-0	M-19-22832
Orange Line Station 011 - Woodman Station (W/B 13620 W. Oxnard St, Van Nuys, CA 91401, E/B 13622 W. Oxnard St, Van Nuys, CA 91401)					
	13622 W. Oxnard St, Van Nuys, CA 91401	LADWP	Electric	3-59-66352-13622-00-0000-3	M-9-1032350
Orange Line Station 012 - Valley College Station (W/B 5621 N. Fulton Ave, Van Nuys, CA 91401, E/B 13420 W. Burbank Blvd, Van Nuys, CA 91401)					
	13420 W. Burbank Blvd., Van Nuys, CA, 91401	LADWP	Electric	3-59-13811-13240-00-9001-0	M-9-1030727
Orange Line Station 013 - Laurel Canyon Station (W/B 5371 Laurel Cyn. Blvd., LA, CA, 91607, E/B 5370 Laurel Cyn. Blvd., LA, CA 91607)					
	5370 Laurel Cyn. Blvd., LA, CA, 91607	LADWP	Electric	3-46-50606-05370-00-0000-0	M-9-1032238
Orange Line Station 014 - North Hollywood Station (5373 N. Lankershim Blvd, Los Angeles, CA 91601)					
	5373 N. Lankershim Blvd, Los Angeles, CA 91601	LADWP	Electric	3-52-49931-05373-00-9001-0	M-9-1032342
	11305 1/2 Chandler Blvd, Los Angeles, CA 91601	LADWP	Electric	3-52-18040-11305-50-0000-0	M-9-936272
	5300 Bakman Ave, Los Angeles, CA 91601	LADWP	Electric	3-52-06816-05300-00-0000-0	APMYD-122-3339
Miscellaneous Orange Line					
	6100 1/2 White Oak Ave, Los Angeles, CA 91316	LADWP	Electric	3-46-91111-06100-50-0000-3	M-9-942516
RED LINE					
Red Line Station 0602 - Union Station (801 Vignes St, Los Angeles, CA 90012)					
	800 N Alameda St, Los Angeles, CA 90012	LADWP	Electric	1-61-00926-00800-00-9009-1	AMPV-30015-107
Red Line Station 0604 - Civic Center Station (101 S. Hill St, Los Angeles, CA 90013)					
	100 N Hill St, Los Angeles, CA, 90013	LADWP	Electric	1-62-42932-00100-00-0000-1	APMV-30015-108
Red Line Station 0606 - Pershing Square Station (500 S. Hill St, Los Angeles, CA 90017)					
	400 S. Hill St, Los Angeles, CA 90017	LADWP	Electric	1-63-42933-00400-00-9001-1	PMVL-30015-103
Red Line Station 0608 - 7th & Metro Center Station (696 W. 7th St, Los Angeles, CA 90017)					
	660 S. Figueroa St, Los Angeles, CA 90017	LADWP	Electric	1-63-34103-00660-00-9002-1	APMV-30019-27
Red Line Station 0610 - Westlake - MacArthur Park Station (660 S. Alvarado, Los Angeles, CA 90057)					
	660 S. Alvarado, Los Angeles, CA, 90057	LADWP	Electric	1-47-02441-00660-00-0000-0	PMVL-30015-105
Red Line Station 0612 - Wilshire - Vermont Station (3191 Wilshire Blvd, Los Angeles, CA 90005)					

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
	3191 Wilshire Blvd, Los Angeles, CA 90005	LADWP	Electric	1-46-91800-03191-00-0000-0	APMV-30015-112
Red Line Station 0614 - Wilshire - Normandie Station (3510 Wilshire Blvd, Los Angeles, CA 90005)					
	3510 Wilshire Blvd, Los Angeles, CA 90005	LADWP	Electric	1-62-91300-03510-00-9001-0	APMV-30015-109
Red Line Station 0616 - Wilshire - Western Station (3775 Wilshire Blvd, Los Angeles, CA 90005)					
	3775 Wilshire Blvd, Los Angeles, CA 90005	LADWP	Electric	1-49-91800-03775-00-0000-0	APMV-30011-72
Red Line Station 0618 - Vermont - Beverly Station (301 N. Vermont Ave, Los Angeles, CA 90004)					
	301 N. Vermont Ave, Los Angeles, CA 90004	LADWP	Electric	1-51-87724-00301-00-9002-0	AMPV-30015-106
Red Line Station 0620 - Vermont - Santa Monica Station (1015 N. Vermont Ave, Los Angeles, CA 90029)					
	1015 N. Vermont Ave, Los Angeles, CA 90029	LADWP	Electric	1-57-87724-01015-00-0000-0	APMV-30011-77
Red Line Station 0622 - Vermont - Sunset Station (1500 N. Vermont Ave, Los Angeles, CA 90028)					
	1500 N. Vermont Ave, Los Angeles, CA 90028	LADWP	Electric	1-43-87724-01500-00-0000-0	APMV-30011-73
	1500 N. Vermont Ave, Los Angeles, CA 90028	LADWP	Electric	1-43-87724-01500-00-0000-0	APMV-30011-78
Red Line Station 0624 - Hollywood - Western Station (5450 Hollywood Blvd, Los Angeles, CA 90028)					
	5450 Hollywood Blvd, Los Angeles , CA 90028	LADWP	Electric	1-45-43716-05450-00-0000-0-01	PMV-30015-92
Red Line Station 0626 - Hollywood - Vine Station (6250 Hollywood Blvd, Los Angeles, CA 90038)					
	6250 Hollywood Blvd, Los Angeles, CA 90038	LADWP	Electric	1-56-43716-06250-00-0000-0	APMV-30011-74
Red Line Station 0628 - Hollywood - Highland Station (6815 Hollywood Blvd, Hollywood, CA 90028)					
	6815 Hollywood Blvd, Hollywood, CA, 90028	LADWP	Electric	1-58-43716-06815-00-9001-0	PMV-30015-48
Red Line Station 0632 - Universal City Station (3881 Lankershim Blvd, Studio City, CA 91604)					
	3881 Lankershim Blvd, Studio City, CA 91604	LADWP	Electric	3-49-49931-03881-00-0000-0	APMV-30011-76
	10781 1/2 Bluffside Dr, Studio City, CA 91604	LADWP	Electric	3-49-10975-10781-50-0000-0	M-9-913904
Red Line Station 0636 - North Hollywood Station (5350 Lankershim Blvd, North Hollywood, CA 91601)					
	5420 Lankershim Blvd, North Hollywood, CA 91601	LADWP	Electric	3-52-49931-05420-00-9001-0	APMV-30011-75
BLUE LINE					
Blue Line Station 0702 - 7th & Flower Station (660 S. Figueroa St, Los Angeles, CA 90017)					
	505 S. Flower St C-8, Los Angeles, CA 90017	LADWP	Electric	1-63-34746-00505-03-0008-6	PMY-209-24405
Blue Line Station 0704 - Pico Station (1236 S. Figueroa St, Los Angeles, CA 90015)					

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
	1234 S. Flower St, Los Angeles, CA 90015	LADWP	Electric	1-43-34746-01234-00-0000-1	APMV-30011-54
Blue Line Station 0706 - Grand Station (331 1/2 W. Washington Blvd, Los Angeles, CA 90015)					
	331 1/2 W. Washington Blvd, Los Angeles, CA 90015	LADWP	Electric	1-43-89725-00331-50-0000-1	M-9-801724
Blue Line Station 0708 - San Pedro Station (767 E. Washington Blvd, Los Angeles, CA 90021)					
	1917 Stanford Ave, Los Angeles, CA 90021	LADWP	Electric	1-43-80925-01917-00-0000-0	APMV-30011-86
Blue Line Station 0710 - Washington Station (1945 Long Beach Ave, Los Angeles, CA 90021)					
	1945 Long Beach Ave, Los Angeles, CA 90021	LADWP	Electric	1-43-53447-01945-00-0000-1	APMV-30011-53
Blue Line Station 0712 - Vernon Station (4421 Long Beach Ave, Los Angeles, CA 90021)					
	4415 Long Beach Ave, Los Angeles, CA 90021	LADWP	Electric	1-46-53447-04415-00-0000-3	APMV-30011-84
Blue Line Station 0714 - Slauson Station (5585 Randolph St, Los Angeles, CA 90001)					
	5865 Randolph St, Huntington Park, CA 90001	SCE	Electric	Serv #: 10143021 , Cust #: 4702346	V345N000559
Blue Line Station 0716 - Florence Station (7225 Graham Ave, Los Angeles, CA 90002)					
	7501 Graham Ave, Los Angeles, CA 90001	SCE	Electric	Serv #: 12969215 , Cust #: 4702346	V345N001201
Blue Line Station 0718 - Firestone Station (8615 Graham Ave, Los Angeles, CA 90002)					
	8616 Graham Ave, Los Angeles, CA 90002	SCE	Electric	Serv #: 11206983 , Cust #: 4702346	V345N000558
	8616 Graham Ave, Los Angeles, CA 90002	SCE	Electric	Serv #: 16147721 , Cust #: 4702346	V345N000558
Blue Line Station 0720 - 103rd Station (10100 Grandee Ave, Los Angeles, CA 90002)					
	1681 E. 108th St, Los Angeles, CA 90002	LADWP	Electric	1-54-93908-01681-00-0000-1	APMVL-30011-80
Blue Line Station 0722 - Rosa Parks Imperial Station (11611 Willowbrook Ave, Los Angeles, CA 90059)					
	11422 1/2 Willowbrook Ave, Los Angeles, CA 90059	LADWP	Electric	1-55-91701-11422-50-0000-0	M-9-935379
	11650 E. Willowbrook Ave, Los Angeles, CA 90059	SCE	Electric	Serv #: 10227033 , Cust #: 4702346	V345P000059
	13504 S. Willowbrook Ave, Los Angeles, CA 90059	SCE	Electric	Serv #: 12919694 , Cust #: 4702346	V345N001751
	13504 S. Willowbrook Ave, Los Angeles, CA 90059	SCE	Electric	Serv #: 16081195 , Cust #: 4702346	V345N001751
	11670 Willowbrook Ave, Los Angeles, CA 90059	SCE	Electric	Serv #: 4712554 , Cust #: 4702346	PO376002188
Blue Line Station 0724 - Compton Station (275 Willowbrook Ave, Compton, CA 90220)					
	507 N. Willowbrook Ave, Compton, CA 90220	SCE	Electric	Serv #: 10253979 , Cust #: 4702346	V345N000940
	507 N. Willowbrook Ave, Compton, CA 90220	SCE	Electric	Serv #: 15760081 , Cust #: 4702346	V345N000940
Blue Line Station 0726 - Artesia Station (1920 1/2 Acacia Ave, Compton, CA 90220)					
	1810 S. Acacia Ave, Compton, CA 90220	SCE	Electric	Serv #: 8833167 , Cust #: 327848966	22201052726

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
	Acacia North of Imperial, Inglewood, CA 90304	SCE	Electric	Serv #: 12919704 , Cust #: 4702346	V345N000525
Blue Line Station 0728 - Del Amo Station (20220 Santa Fe Ave, Los Angeles, CA 90220)					
	18919 S. Santa Fe Ave, Los Angeles, CA 90221	SCE	Electric	Serv #: 12969214 , Cust #: 4702346	V345N000879
	20340 S. Santa Fe Ave, Los Angeles, CA 90221	SCE	Electric	Serv #: 11208880 , Cust #: 4702346	V345N001451
	2083 Santa Fe Ave, Los Angeles, CA 90221	SCE	Electric	Serv #: 10142099 , Cust #: 4702346	V345N000924
	2083 Santa Fe Ave, Los Angeles, CA 90221	SCE	Electric	Serv #: 12842467 , Cust #: 4702346	V345N000154
Blue Line Station 0730 - Wardlow Station (3420 N. Pacific Ave, Long Beach, CA 90802)					
	3376 Pacific Ave, Long Beach, CA 90806	SCE	Electric	Serv #: 12842471 , Cust #: 4702346	V345N000118
	3380 Pacific Ave, Long Beach, CA 90806	SCE	Electric	Serv #: 31874750 , Cust #: 4702346	2.22012E+11
	3711 Del Mar Ave, Long Beach, CA 90807	SCE	Electric	Serv #: 8270536 , Cust #: 4702346	222011641538
Blue Line Station 0732 - Willow Station (2750 W. American Ave, Long Beach, CA 90806)					
	4300 E. 208th St TPP, Long Beach, CA 90810	SCE	Electric	69-46-622-7400-01	208-512417
	28th St & W. American St, Long Beach, CA 90805	SCE	Electric	Serv #: 10098278 , Cust #: 4702346	V345N000527
Blue Line Station 0734 - Pacific Coast Highway Station (1798 N. Long Beach Blvd, Long Beach, CA 90813)					
	2401 Long Beach Ave, Long Beach, CA 90813	LADWP	Electric	1-43-53447-02401-00-0000-0	FM-9-1097314
Blue Line Station 0736 - Anaheim Station (1290 N. Long Beach Blvd, Long Beach, CA 90813)					
	Long Beach/Anaheim, Long Beach, CA	SCE	Electric	Serv #: 541852 , Cust #: 4702346	N105023706
Blue Line Station 0738 - 5th Street Station (598 N. Long Beach Bl., Long Beach, CA, 90802)					
	598 Long Beach Bl., Long Beach, CA, 90802	SCE	Electric	Serv #: 595980 , Cust #: 4702346	N105003077
Blue Line Station 0740 - 1st Street Station (108 N. Long Beach Blvd, Long Beach, CA 90802)					
	2310 E. 1st St, Long Beach, CA 90803	LADWP	Electric	1-59-93716-02310-00-9001-0	APMV-30011-85
	150 Elm Ave, Long Beach, CA 90802	SCE	Electric	Serv #: 13147666 , Cust #: 4702346	V345R000029
Blue Line Station 0742 - Transit Mall Station (128 W. 1st St, Long Beach, CA 90802)					
	128 W. 1st St, Long Beach, CA 90802	SCE	Electric	Serv #: 1342385 , Cust #: 4702346	N105003070
Blue Line Station 0744 - Pacific Station (498 Pacific Ave, Long Beach, CA 90802)					
	906 Pacific Ave TPSS, Long Beach, CA 90802	SCE	Electric	Serv #: 12842468 , Cust #: 4702346	V345N001288
Miscellaneous Blue Line					
	1005 W Carson St Pump, Long Beach, CA 90810	SCE	Electric	69-46-622-1123-01	V349-000979
	1011 W Carson St, Long Beach, CA 90810	SCE	Electric	00-00-000-0000-00	234010-052643

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
GREEN LINE					
Green Line Station 0802 - Marine Station North (2406 S. Marine Ave, Redondo Beach, CA 90278)					
	2406 Marine Ave, Redondo Beach, CA 90278	SCE	Electric	Serv #: 8217743 , Cust #: 4702346	PO726011435
Green Line Station 0802b - Marine Station South (5301 Marine Av., Redondo Beach, CA, 90278)					
	No relevant service addresses were found for this facility.				
Green Line Station 0804 - Douglas Station (700 S. Douglas St., El Segundo, CA, 90245)					
	700 S. Douglas St., El Segundo, CA, 90245	SCE	Electric	Serv #: 8649636 , Cust #: 4702346	V345N001855
Green Line Station 0806 - El Segundo Station (2226 E. El Segundo Blvd, El Segundo, CA 90245)					
	2226 E. El Segundo Blvd, El Segundo, CA 90245	SCE	Electric	Serv #: 5637232 , Cust #: 44702346	PO726011117
Green Line Station 0808 - Mariposa Station (555 N. Nash St, El Segundo, CA, 90245)					
	2090 E. Mariposa Ave, El Segundo, CA 90245	SCE	Electric	Serv #: 5540054 , Cust #: 4702346	PO726011036
	2090 E. Mariposa Ave, El Segundo, CA 90245	SCE	Electric	Serv #: 8285639 , Cust #: 327848966	Y278003820
	810 N. Nash St, El Segundo, CA, 90245	SCE	Electric	Serv #: 8180082 , Cust #: 4702346	222011160266
	151 N. Nash St, El Segundo, CA, 90245	SCE	Electric	Serv #: 13147711 , Cust #: 4702346	V345N001799
	2212 E. Imperial Hwy, El Segundo, CA 90245	SCE	Electric	Serv #: 5276246 , Cust #: 4702346	Y278003403
Green Line Station 0810 - Del Norte Station (951 N. Douglas St, El Segundo, CA 90245)					
	941 S. Douglas St, El Segundo, CA 90245	SCE	Electric	Serv #: 5540053 , Cust #: 4702346	3416048674
Green Line Station 0812 - Aviation Station (11500 Aviation Blvd, Los Angeles, CA 90048)					
	11500 Aviation Blvd, Los Angeles, CA 90048	LADWP	Electric	4-58-06307-11500-00-0000-0	APMY-210-22254
	11400-1/4 Aviation Blvd, Los Angeles, CA 90048	LADWP	Electric	4-58-06307-11400-25-0000-0	FM-9-1131678
	5380 W Imperial Hwy, Los Angeles, CA 90045	LADWP	Electric	4-58-44749-05380-00-0000-0	APMV-30015-62
Green Line Station 0814 - Hawthorne Station (11230 S. Acacia Ave, Inglewood, CA, 90304)					
	11230 S. Acacia Ave, Inglewood, CA, 90304	SCE	Electric	Serv #: 12810092 , Cust #: 4702346	V345N001571
	11230 S. Acacia Ave, Inglewood, CA, 90304	SCE	Electric	Serv #: 16081209 , Cust #: 4702346	V345N001571
	111th St & Burin Ave, Inglewood, CA 90304	SCE	Electric	Serv #: 8833171 , Cust #: 327848966	AE85422785
	111th St and Larch Ave, Inglewood, CA 90304	SCE	Electric	Serv #: 8833168 , Cust #: 327848966	22201115653
	Burin Ave, North of 111th St, Inglewood, CA 90304	SCE	Electric	Serv #: 8274828 , Cust #: 16509010	E302073208

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
Green Line Station 0816 - Crenshaw Station (11901 S. Crenshaw Blvd, Hawthorne, CA 90303)					
	11801 Crenshaw Blvd, Hawthorne, CA 90303	SCE	Electric	Serv #: 5328794 , Cust #: 4702346	PO376003167
	3301 W. 120th St, Hawthorne, CA 90303	SCE	Electric	Serv #: 8258749 , Cust #: 4702346	V345N001853
Green Line Station 0818 - Vermont Station (11603 S. Vermont Ave, Los Angeles, CA 90048)					
	11530 New Hampshire Ave, Inglewood, CA 90044	SCE	Electric	Serv #: 5350637 , Cust #: 4702346	V345N000088
	11530 New Hampshire Ave, Inglewood, CA 90044	SCE	Electric	Serv #: 15626054 , Cust #: 4702346	V345N000088
Green Line Station 0820 - Harbor Freeway I-105 Station (11500 S. Figueroa St, Los Angeles, CA 90048)					
	11600 S. Figueroa St, Los Angeles, CA 90048	LADWP	Electric	1-59-34103-11600-00-0000-0	APMYV-222-22865
Green Line Station 0822 - Avalon Station (11667 S. Avalon Blvd, Los Angeles, CA 90067)					
	11711 1/2 Avalon Blvd, Los Angeles, CA 90067	LADWP	Electric	1-57-05428-11711-50-0000-0	APMYD-222-11891
Green Line Station 0824 - Wilmington Station - Rosa Parks (11651 Wilmington Ave, Los Angeles, CA 90001)					
	11601 Wilmington Ave, Los Angeles, CA 90001	SCE	Electric	Serv #: 5270633 , Cust #: 4702346	708027208
Green Line Station 0826 - Long Beach Station (11508 Long Beach Blvd, Lynwood, CA 90262)					
	11500 Long Beach Blvd, Lynwood, CA 90262	SCE	Electric	Serv #: 5492184 , Cust #: 4702346	3-005-4921-84
Green Line Station 0828 - Long Beach Freeway (Future) (11750 Wright Road, Lynwood, CA 90262)					
	11750 Wright Road, Lynwood, CA 90262	SCE	Electric	Serv #: 5829349 , Cust #: 4702346	V345N000318
Green Line Station 0830 - Paramount Station (13706 Paramount Blvd, Southgate, CA 90280)					
	13706 Paramount Blvd, Southgate, CA 90280	SCE	Electric	Serv #: 5178064 , Cust #: 4702346	O378002434
	6170 Florence Ave, Southgate, CA 90280	SCE	Electric	Serv #: 5782012 , Cust #: 4702346	V345E000260
	6170 Florence Ave, Southgate, CA 90280	SCE	Electric	Serv #: 15621675 , Cust #: 4702346	V345E000260
Green Line Station 0832 - Lakewood Station (12801 Lakewood Ave, Downey, CA 90241)					
	12939 Lakewood Ave, Downey, CA 90242	SCE	Electric	Serv #: 13147712 , Cust #: 4702346	V345N000113
Green Line Station 0834 - I-605- I-105 Station (Norwalk) (12901 Hoxie Ave, Norwalk, CA 90650)					
	13026 Flatbush Ave, Norwalk, CA 90650	SCE	Electric	Serv #: 13147713 , Cust #: 4702346	V345N000518
Miscellaneous Green Line					
	2901 Fernwood Ave, Lynwood, CA 90262	SCE	Electric	Serv #: 5039174 , Cust #: 4702346	V345E000641
	4160 Fernwood Ave, Lynwood, CA 90262	SCE	Electric	Serv #: 5626325 , Cust #: 4702346	V345N000123
	11725 S. Manhattan Pl, Los Angeles, CA 90047	SCE	Electric	Serv #: 5380714 , Cust #: 4702346	V345N001046
	11725 S. Manhattan Pl, Los Angeles, CA 90047	SCE	Electric	Serv #: 15621670 , Cust #: 4702346	V345N001046

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
	9733 Angell St, Downey, CA 90242	SCE	Electric	Serv #: 13147714 , Cust #: 4702346	V345N001484
	139 W 117th St, Los Angeles, CA 90061	LADWP	Electric	1-57-94124-00139-00-0000-0	APMV-30011-59
	11700 Belhaven Ave, Los Angeles, CA 90059	LADWP	Electric	1-57-08664-11700-00-0000-0	APMV-30011-83
GOLD LINE					
Gold Line - Atlantic Station (5150 E. Pomona Blvd, Los Angeles, CA 90022)					
	5100 E. Pomona Blvd, Los Angeles, CA 90022	SCE	Electric	Serv #: 32596945 , Cust #: 4702346	V345N000124
	255 S. Atlantic Ave, Los Angeles, CA 90022	SCE	Electric	Serv #: 34605636 , Cust #: 4702346	349028373
Gold Line - East LA Civic Center Station (4780 E. 3rd St, Los Angeles 90022)					
	3rd & Mednick St, Los Angeles, CA 90033	SCE	Electric	Serv #: 34294979 , Cust #: 4702346	
	4803 3rd St, Los Angeles, CA 90022	SCE	Electric	Serv #: 31154636 , Cust #: 4702346	3416060301
Gold Line - Maravilla Station (4520 E. 3rd St, Los Angeles 90022)					
	4025 E. 3rd St, Los Angeles 90022	SCE	Electric	Serv #: 32869684 , Cust #: 4702346	V345N001441
	4498 E. 3rd St, Los Angeles 90022	SCE	Electric	Serv #: 31145359 , Cust #: 4702346	3416059590
	3rd St- Woods to Atlantic Ave, Los Angeles, CA 90033	SCE	Electric	Serv #: 34294981 , Cust #: 4702346	
Gold Line - Indiana Station (210 S. Indiana St, Los Angeles 90063)					
	1101 1/2 Indiana Ave, S. Pasadena, CA	SCE	Electric	Serv #: 22570882 , Cust #: 4702346	222010338759
	201 S. Indiana St, Los Angeles, CA 90063	LADWP	Electric	1-48448-42002-1000-00-0-00	PSMD-209-40078
	303 S. Ditman Ave, Los Angeles, CA 90063	SCE	Electric	Serv #: 32419660 , Cust #: 4702346	3416065462
	322 S. Arizona Ave, Los Angeles, CA 90022	SCE	Electric	Serv #: 32701429 , Cust #: 4702346	V345N001131
Gold Line - Soto Station (2330 E. 1st St, Los Angeles 90033)					
	No relevant service addresses were found for this facility.				
Gold Line Mariachi Plaza Station (1831 E. 1st St, Los Angeles, CA 90033)					
	1722 E. 1st St, Los Angeles, CA 90033	LADWP	Electric	1-59-93716-01722-00-9001-0	APMV30011-79
Gold Line Aliso/Pico Station (1311 E. 1st St, Los Angeles 90033)					
	1311 E. 1st St, Los Angeles 90033	LADWP	Electric	1-59-93716-01311-00-0000-0	PMSD-209-56875
Gold Line Little Tokyo / Arts District Station (200 N. Alameda St, Los Angeles, CA 90012)					
	200 N. Alameda St, Los Angeles, CA 90012	LADWP	Electric	1-61-00926-00200-00-0000-0	PMSD-209-56953

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
Gold Line Station 0901 - Union Station (810 N. Vignes St, Los Angeles, CA 90012)					
	401 Bauchet St, Los Angeles, CA 90012	LADWP	Electric	1-61-07938-00401-00-0000-1	APMVL-30011-69
	Bauchet Warehouse	The Gas Company	Natural Gas	03940117009-1210-1	
Gold Line Station 0903 - Chinatown Station (901 N. Spring St, Los Angeles, CA, 90012)					
	1241 1/2 N. Spring St, Los Angeles, CA, 90012	LADWP	Electric	1-61-80489-01241-50-0000-0	PMYD-222-8639
Gold Line Station 0905 - Lincoln/Cypress Station (370 W. Avenue 26, Los Angeles, CA, 90031)					
	370 W. Avenue 26, Los Angeles, CA, 90031	LADWP	Electric	1-57-05732-00370-00-0000-4	PMY-209-44687
Gold Line Station 0907 - Heritage Square (3545 Pasadena Ave, Los Angeles, CA 90031)					
	3541 Pasadena Ave, Los Angeles, CA 90031	LADWP	Electric	1-57-67563-03541-00-0000-1	AMPV-30011-70
	404 1/2 W Avenue 33, Los Angeles, CA 90031	LADWP	Electric	1-57-05816-00404-50-0000-1	M-9-962730
	3536 Marmion Way, Los Angeles, CA 90065	LADWP	Electric	1-57-56992-03536-00-0000-0	PMY-209-44014
	3556 Marmion Way, Los Angeles, CA 90065	LADWP	Electric	1-57-56992-03556-00-0000-0	M-9-963000
	3571 Pasadena Ave, Los Angeles, CA 90031	The Gas Company	Natural Gas	166-320-6506-2	12147997
Gold Line Station 0909 - Southwest Museum Station (4600 Marmion Way, Los Angeles, CA 90065)					
	4600 Marmion Way, Los Angeles, CA 90065	LADWP	Electric	1-55-56992-04600-00-0000-0	PMY-209-44676
	4526 Marmion Way, Los Angeles, CA 90065	LADWP	Electric	1-55-56992-04526-00-0000-0	9-970961
	4970 Marmion Way, Los Angeles, CA 90065	LADWP	Electric	1-55-56992-04970-00-0000-1	APMV-30015-100
	6233 Marmion Way, Los Angeles, CA 90065	LADWP	Electric	1-58-56992-06233-00-0000-1	M-9-962965
	4729 Woodside Dr, Los Angeles, CA 90065	LADWP	Electric	1-55-92732-04729-00-0000-1-01	M-9-962004
Gold Line Station 0911 - Highland Park Station (151 N. Avenue 57, Los Angeles, CA 90042)					
	151 N. Avenue 57, Los Angeles, CA 90042	LADWP	Electric	1-58-06087-00151-00-0000-0	PMY-209-47000
	5816 Marmion Way, Los Angeles, CA 90065	LADWP	Electric	1-58-56992-05816-00-0000-4	M-9-962024
	5400 Marmion Way, Los Angeles, CA 90065	LADWP	Electric	1-58-56992-05400-00-0000-1	M-9-984336
	145 1/2 N Avenue 50, Los Angeles, CA 90042	LADWP	Electric	1-58-06010-00145-50-0000-1	M-9-962773
	145 1/2 N Avenue 51, Los Angeles, CA 90042	LADWP	Electric	1-58-06010-00145-50-0000-1	M-9-962046
	133 1/2 N Avenue 60, Los Angeles, CA 90042	LADWP	Electric	1-58-06120-00133-50-0000-0	M-9-962727
	121 1/2 N Avenue 61, Los Angeles, CA 90042	LADWP	Electric	1-58-06131-00121-50-0000-1	M-9-962775
Gold Line Station 0913 - Mission Street Station (905 Meridian Ave, South Pasadena, CA, 91030)					
	905 Meridian Ave, South Pasadena, CA, 91030	SCE	Electric	Serv #: 22570887 , Cust #: 4702346	342000567

Facility Name	Service Address	Vendor Name	Account Type	Account #	Meter #
	1001 1/2 Mission St, South Pasadena, CA 91030	SCE	Electric	Serv #: 22570847 , Cust #: 4702346	222010343095
Miscellaneous Gold Line					
	114 N. Loara St, Anaheim, CA 92801	LADWP	Electric	1-48-53724-00114-00-0000-3	APMV30011-82
	596 Fremont Ave, South Pasadena, CA 91030	SCE	Electric	Serv #: 22570797 , Cust #: 4702346	222010341642
	899 1/2 El Centro St, South Pasadena, CA 91030	SCE	Electric	Serv #: 22570832 , Cust #: 4702346	222010341602
	1052 Arroyo Verde Rd, South Pasadena, CA 91030	SCE	Electric	Serv #: 22570842 , Cust #: 4702346	222010126608
	1028 Hope St, South Pasadena, CA 91030	SCE	Electric	Serv #: 22570924 , Cust #: 4702346	222010341561
	1101 Orange Grove Ave, South Pasadena, CA 91030	SCE	Electric	Serv #: 22570930 , Cust #: 4702346	222010338757
	715 Fairview Ave, South Pasadena, CA 91030	SCE	Electric	Serv #: 28130744 , Cust #: 4702346	V345N000225
	300 1/2 Monterey Rd, South Pasadena, CA 91030	SCE	Electric	Serv #: 22570911 , Cust #: 4702346	222010338919
	300 Monterey Rd, South Pasadena, CA 91030	SCE	Electric	Serv #: 22570902 , Cust #: 4702346	V345N001731
	1561 1/2 N Broadway, Los Angeles, CA 90012	LADWP	Electric	1-63-12933-01561-50-9001-4	APMV-30015-101
	3810 N. Figueroa St, Los Angeles, CA 90065	LADWP	Electric	1-57-34102-03810-00-0000-0	PMY-209-44635
Unknown Facilities - Unmatched Service Addresses					
	4200 Wilshire Blvd, Los Angeles, CA 90036	LADWP	Electric	1-59-91800-04200-00-9001-4	9-568049
	413 Ducommun St, Los Angeles, CA 90012	LADWP	Electric	1-61-28713-00413-00-0000-0	FM-9-1184833
	675 S Alameda St, Los Angeles, CA 90012	LADWP	Electric	1-44-00927-00675-00-0000-0	PMYD-209-46241
	1010 E 16th St, Los Angeles, CA 90012	LADWP	Electric	1-44-94884-01010-00-9001-0	MD-9-850825
	14314 Mulholland Dr, Los Angeles, CA 91403	LADWP	Electric	4-57-62188-14314-00-0000-0	FM-9-1086691

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Appendix C: Outline for Site Visits, Checklist

Site Visit Instructions

Face-to-Face Qualitative Conversation/ Questionnaire

A general qualitative conversation is had at the site with the facility manager/engineer who has the most intimate knowledge of how the site's mechanicals are run. If he or she is unavailable to do the introductory talk in person, a basic questionnaire can be sent ahead of time to coerce the necessary information from the site's facility manager. (Below is list of important questions to ask.)

Site Walk Through

Walk through site as an observer. Take in as much information as you can while letting the facility and contract engineer discuss the specifics of the mechanicals. It is important to stay focused so that you can recount what was discussed in the site report. Furthermore, you must realize that you are there to help spread best-practices not try and tell the facility manager that you can operate the site more efficiently than he or she can. So, do not seem like a know-it-all consultant who is pushing strategies at the facility manger, when in reality he knows how to operate the site infinitely better than you.

Site Report

Site reports will be different for each client. Some may want detailed site reports, others will be simply a quick summary of finding and description of the no/low cost energy efficiency strategy. These site reports may be given to the facility managers or may be kept in confidence until the final summary report is developed.

General Mannerisms

It is important to seem intelligent but not demanding. It is important to reiterate that you are there to spread best-practices, not to tell the facility manager how to run his/her job or define the best and worst managed sites.

Questions for Overall Facilities Manager

General Operations

1. Which buildings are in operation? Which buildings are currently non-operative? Which buildings are scheduled for demolition or major renovation in the next 2 years?
2. What are the operating hours of different buildings? Are all facilities 24/7/365 or are some only occupied during work hours? Do the 24-hour facilities have sections that shut down after work hours? If so, how large are these sections and how are they shut down (i.e. manually, automatically, remotely)?
3. Are there major parts of buildings that are not going to be in use for a long time? (for example, a large conference space?)
4. How many facility management staff are there, what are their hours, who do they report to, and what are their primary roles?
5. How are technology upgrades managed? Does every facility have an operations and maintenance plan?
6. What role does the facility staff have in facility operations?
7. Are there “wish lists” for different or new technologies in different sites? For train stations? For offices?
8. Is energy use across the portfolio tracked and reviewed regularly? If so, by who?
9. Are there particular challenges associated with energy management?
10. Are there any incentives to excite employees about managing energy use at every facility?
11. How are utility bills managed? Are they paid centrally or are the sent to each site and paid onsite?
12. Do you work with the utility regularly to perform site assessments or determine potential rebate opportunities?
13. For buildings occupied only during office hours (8-10 hours/day, 5 days/week), do you have a standard approach to operations? (e.g., setback temperatures, economizer mode (night-cooling), lighting shut down, reduced plug load).
14. Are indoor CO2 levels ever measured?

Questions for Site Manager

Electricity Rates

First establish how much the Site Manager or person responsible for site operations knows about electricity and gas. If he or she is knowledgeable about these issues, ask the following:

1. Do you see utility bills each month? If not, is it sent to a central bill-paying system?
    a. What is your average cost per kilowatt-hour?
    b. Do you pay peak rates on some days? If so, what is the increased price during peak demand hours? Approximately how many days out of the year are you paying peak rates?

   c. Did you negotiate an electricity rate directly with the power company? If so, when does this rate expire?
   d. Do you participate in a demand-side management or peak-load pricing program (where the power company can interrupt your power with notice during the most energy-intensive days of the year)?
   e. Do you get contacted by the utility company or vendors who are interested in selling you technologies to reduce energy use?

HVAC and Temperature

1. Are your buildings heated, cooled, or both? Are there any buildings that are heated but not cooled or vice versa? (Look to determine which buildings are not heated and cooled)
2. Are any unused facilities heated or cooled? If so which ones, and for how much of the year?
3. What types of HVAC/temperature controls are in place?
   a. Is the HVAC manually set? Can it be adjusted by users other than the facility manager in some buildings?
   b. Are train stations heated/ cooled mechanically?
   c. Are office buildings' HVAC systems controlled by a facility manager or an EMS?
4. What are the temperature settings? Are they consistent across facilities?
5. What year was your HVAC installed in major buildings? Any of them more than 20 years old? If yes, what is the cooling capacity?
6. Are there any energy management systems installed at some or all of the sites?
7. Are indoor CO_2 levels ever measured?

Lighting

1. Please indicate the types of lighting used in the building, and the percent of the building that each type of bulb covers:
   a. Compact fluorescent (CFL)
   b. Incandescent bulbs
   c. T-5 fluorescent
   d. T-8 Flourescent
   e. T-12 flourescent
   f. Metal Halide
   g. High pressure sodium
   h. Other 1 (please list)
   i. Other 2 (please list)
2. Have the lighting levels ever been measured in your facility? If so, did you find that most spaces were underlit, overlit, or properly lit? Were recommended lighting levels achieved?
3. Please provide information on major outdoor lighting systems:

   a. Number of lamps (approximate)
   b. Type of bulbs
   c. Controls (photocell, timer, manual)

Insulation

1. What is the primary material that the building is composed of? (Concrete, brick, wood, aluminum/steel?)
2. Is the building insulated?
3. If the building is insulated, what type and thickness of insulation are used?

Windows and Roof

1. What type of roof does the building have?
2. What color is the roof?
3. What is the primary type of window used in the building?
   a. What year were the windows installed?
   b. What is the type of window frame (aluminum, steel, vinyl)?
   c. What is the window manufacturing company?
   d. What is the NFRC rating (if known)?
   e. Are windows ENERGYSTAR certified?

On-Site Power

1. Do you have any onsite generators that you use on a regular basis?
2. Do you have any renewable energy sources onsite?

Start Up and Shut Down

1. Do you have a building shut-down and start-up procedure in place? If so, who is involved in the process and what do they do? Or, is it automated?
2. During what hours is the site occupied? If it is not 24/7/365, do you:
   a. Use setback temperatures?
   b. Use pre/free/night cooling?
   c. Shut off all lighting?
   d. Reduce plug load?

Optional Questions

1. Have you made any energy performance improvements? If so, what have you done? Have you measured how successfully the improvements have reduced energy use?

2. Have you identified any energy performance improvements you would like to make in your facility? If so, what are they? If you have completed any analysis of cost and potential payback time, please include this as well.

Site Visit Questionnaire

General Building Information		
1.	Date of original construction completion	
2.	Building data	Gross square feet = Total number of floors (above & below grade) = Total number of floors below grade =
3.	Approx Percentage Space Usage	Office _____% Data Center _____% Operations Center _____% Retail _____% Food Service _____% Unoccupied (Mech, Elec, Corridor, etc.) _____% Other (define) _____%

Staffing and Operations & Maintenance (O&M) Schedule		
1.	Who is the Chief Operating Engineer for the building? Include contact information for site visit coordination.	Name: Office Phone: Cell Phone: Email:
2.	How many O&M staff are assigned to this building?	
3.	What is the typical working schedule for O&M staff?	
4.	What types of training and/or certifications have the O&M staff received?	

Use of Outside Contractors	
1.	What outside contractors are used for O&M?
2.	What are the services that these contractors offer and when was the last time one was used in the building?

Heading, Ventilating & Air Conditioning (HVAC) System		
1.	What space temperatures are maintained in occupied spaces?	Summer = Winter =
2.	Is there active humidification?	Yes/No? Minimum relative humidity levels = Type of humidification?
3.	Is there active dehumidification?	Yes/No? Maximum relative humidity levels = Type of dehumidification?
4.	What is the main source of building cooling? Chilled Water Plant in Building? Central Chilled Water? DX Cooling? Other?	Quantities? Make & Manufacturer?
5.	What is the main source of building heat? • Steam Boiler Plant in Building? • Central Steam? • Hot Water Boiler Plant in Building? • Central Hot Water? • Electric Heat? • Gas-Fired Furnaces? • Other?	Quantities? Make & Manufacturer?
6.	Is this a two-pipe building or a four-pipe building?	
7.	What is the main source of space heating/cooling? • VAV/reheat air handling system? • Constant volume/reheat air handling system? • Fan-coil units? • Heat pumps? • Single zone air handlers? • Other?	Quantities?
8.	What is the main source of outside air ventilation? • Central mixed air handling units? • Central 100% makeup air units? • Through-the-wall terminal units? • Exhaust fans only (relying on negative pressure infiltration? • Other?	Quantities? Make & Manufacturer?

	Heating, Ventilating & Air Conditioning (HVAC) System	
9.	• Are there variable speed drives on the following equipment? • All fans? • All large fans? • Some fans? • All pumps? • All large pumps? • Some pumps? • Cooling tower fans? • Other?	
10.	Is there year-round cooling? HVAC? Specialized equipment/cooling loop? Other?	
11.	Is there any special energy conservation equipment? • Air-to-air heat exchangers (energy wheels, plate heat exchangers, etc.)? • Run-around hydronic heat recovery loop? • Heat recovery chiller? • Solar heating? • Other?	Quantities?

	Building Pressurization
1.	Does this building maintain a positive or negative pressure balance? Is this controlled, either manually or through the BAS system?

	Parking Garage Ventilation & Smoke Evacuation Systems
1.	Is there a parking garage?
2.	What percent of total garage space is typically filled during the work day?
3.	Does the garage have carbon monoxide (CO) sensors? Are CO levels routinely measured and monitored? If so, how?
4.	Is there a time of day schedule for operating garage exhaust fans? If so, what is it?
5.	How many fans and of are used to ventilate the garage? Are these fans multi-speed?
6.	Are there separate smoke evacuation fans (including atrium exhaust fans)? If so, how many?
7.	Are any of the garage or smoke exhaust fans operated manually?

	Building Automation System (BAS)	
1.	What type of HVAC control system does the building have? • Direct digital control (DDC) • Pneumatic • Electric • Mix (explain) • Other?	
2.	If DDC	What Brand? What Model or Year Last Updated?

Building Automation System (BAS)

		Does it produce graphical trend logs? Central operator's workstation? Terminal units controlled by DDC?
3.	Who is responsible for the O&M of the HVAC control system?	
4.	What is the normal operating schedule for the HVAC system, that is, when is the system typically turned on in the morning and turned off at night? If this schedule varies during the year, please explain.	
5.	Are any of the following control strategies used? • Unoccupied setback temperature setpoints? • Air-side economizer/free cooling? • Water-side economizer/free cooling? • CO2 based outside air ventilation? • Occupancy sensors to control terminal unit modes of operation? • Static pressure reset on VAV air handling systems? • Discharge air temperature reset on supply air handling systems?	

Temperature Control

1.	If you have a chilled water system, what temperature supply chilled water is delivered to the HVAC equipment? Is it constant or does it vary based on load requirements or outdoor air conditions?
2.	If you have a heating hot water system, what temperature supply hot water is delivered to the HVAC equipment? Is it constant or does it vary based on load requirements or outdoor air conditions?
3.	If you have central air handling units, what temperature supply air is delivered to the terminal units? Is it constant or does it vary based on load requirements or outdoor air conditions?
4.	Are supply temperature changes made automatically by the BAS system or manually?

Plumbing

1.	Domestic hot water source? • Central gas water heaters? • Central electric water heaters? • Point-of-use electric water heaters? • Other?
2.	Does the domestic hot water system have a recirculation pump? Does it run continuously?

Lighting

1.	What are the primary light fixture types? • T-12? • T-8? • T-5? • Incandescent? • Metal Halide? • Other?	

2.	Have lighting levels ever been measured in this building? Have these been compared to recommended levels?	
3.	What percent of occupants/tenants sit in front of a computer most of the day to do their work?	
4.	Are there lights that are used after hours to create a visual effect? What type of lights are these and how are these lights controlled?	
5.	Is there a lighting controls system? If yes…	Occupancy sensors? Photocells? Integration with HVAC Controls? Exterior lighting controls? Time-of-Day Scheduling?
6.	Who is responsible for the O&M of the lighting control system?	
7.	What is the normal operating schedule for the lighting? Include details for the common areas and the tenant areas. If this schedule(s) varies during the year, please explain.	

Electrical Power

1.	Is there a backup generator? If so, what is it intended to serve? • Life safety systems? • Elevators? • Mission critical process loads? • Entire building? Other?
2.	Do you load shed upon request from your electric utility?

Occupancy, Business Hours, and Occupant/Tenant Interaction

1.	What is the normal occupancy schedule for this building? For example, when do most occupants/tenants arrive in the morning and leave in the evening?
2.	Are lighting and HVAC provided after hours?
3.	Are lighting and HVAC provided during the weekend?
4.	How are weekend and after hours lighting and HVAC needs determined? Are there occupancy override switches in the building?
5.	What are typical after-hours and weekend HVAC and lighting schedules?
6.	Has the O&M team worked with the occupants/tenants to teach or initiate any energy saving practices?
7.	Describe any energy saving practices undertaken with the occupants/tenants.

Coil and Filter Cleaning, Damper Operation

1.	When were the HVAC coils last cleaned?	Central air handling equipment? Terminal units?
2.	Is there a schedule for this cleaning? What is this schedule?	
3.	Is there a schedule for cleaning or replacing air filters? If so, what is the schedule?	Central air handling equipment? Terminal units?
4.	When were outside air dampers and bird screens last cleaned? When was proper operation of outside air dampers last verified?	
5.	Is there a schedule for cleaning and checking operation of dampers and bird screens? What is it?	

	Cleaning
1.	Is this building cleaned by in-house staff or contractors?
2.	What is the normal daily cleaning schedule? Does this schedule vary throughout the year? Please explain.

	Documentation
1.	Do you have HVAC controls documentation for this building such as controls schematics, sequences of operation, points lists, device cutsheets, etc.?
2.	Do you have lighting controls documentation for this building such as controls schematics, sequences of operation, points lists, device cutsheets, etc.?
3.	Do you have HVAC equipment O&M manuals for this building?
4.	Do you have light fixture O&M manuals for this building?
5.	Do you have mechanical and/or electrical system drawings available? Original and any renovations? As built drawings?
6.	Do you have air and water balancing reports for the HVAC systems?

	Data Collection and Display
1.	What energy use and environmental data is collected at this building, and are they collected manually or by the control system? • Energy cost • Electricity use • Gas use • Oil or other fuel use • Interior temperature • Interior relative humidity • Interior CO_2
2.	Are these data organized, plotted, and watched over time to identify changes? Are any of these data posted routinely so that the team can observe performance changes over time? If so, who is responsible for this?
3.	Please attach examples of each type of tabulated or graphed data report.

	Energy Efficiency Practices
1.	Please attach a list of energy efficiency measures implemented in the building over the past 3 years. Provide as much detail as possible regarding any changes over time in the manner in which these measures were managed or in perceived or measured contributions to energy savings.
2.	Please attach a list of any energy efficiency measures that the building operators would like to implement in the building.

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Appendix D: Questionnaires for Energy Management Structure

Peer Agency Questionnaire

1. Has your organization developed and formally adopted an energy management program?

   If so, how long has the energy management program been in effect?

   What does the Program encompass?

2. Below is a list of functions related to energy usage and conservation. In your organization, who is currently responsible for each of these functions:

   Specify groups or individuals involved and their level of involvement – lead, advisory, support role reporting structure.

   - Monitoring electricity usage
   - Reviewing utility bills
   - Paying utility bills (paid centrally vs. paid by each facility)
   - Coordinating with utility companies on billing matters (billing errors, rates, discounts)
   - Conducting energy assessments of divisions and facilities
   - Developing energy efficiency policies, programs and projects
   - Implementing energy efficiency solutions and strategies

3. Has your organization proactively engaged utility companies in developing energy conservation strategies? Negotiating rates that encourage conservation? What are the challenges/benefits that have come up (if any) as a result of these negotiations or re-negotiation of rates? (e.g., less energy security, fluctuation in month to month usage and cost, greater awareness of energy usage and cost, etc.)

4. Within your organization, is there an individual or a group clearly identified as being in charge of energy management?

   If yes, please indicate:

   - Individual title or group name;
   - Is all staff housed at the corporate level?
   - Staff education/experience;
   - Overall budget/resources allocated;
   - Do department directors report to the energy director?

   If yes or no, please indicate:

   - Are there local or departmental energy managers?
   - What is the reporting structure?

5. Does your organization conduct regular energy assessments of operations and major facilities? If so, please explain.

6. What procedures are in place to encourage all employees to contribute to energy savings?

(e.g., awareness, training, incentive program for energy savings ideas…)

7. Are there any mechanisms in place to ensure accountability for participation and/or compliance throughout the organization? Is there individual accountability for meeting specific performance goals or objectives related to energy management (e.g., through the performance evaluation process, etc?)
8. How is the Program's performance (and "success") monitored, measured, and managed?
9. What are the benefits of your current organizational structure for energy management?
10. What organizational challenges does your organization face in energy management efforts?
11. What internal organizational changes would you recommend to better support energy conservation goals?
12. Does your energy management program have a corporate/executive sponsor or internal champion? What level of authority does this individual have in the Program's implementation and operation? How involved is your executive management in resource allocation (budget, staffing) related to energy management?
13. What have been the results or outcomes of your energy management program to date? Are these published anywhere?
14. Is there anything else regarding energy management at your organization that you would like to share?

Metro Staff Questionnaire

1. Where has Metro made progress in the areas of energy management, efficiency, and conservation? Where, in your view, are there other opportunities to build upon that progress and make improvements?
2. What are the main challenges associated with current energy management practices at Metro from an internal organization perspective?

   Cite 2-3 main challenges
3. Below is a list of functions related to energy usage and conservation. In your opinion, who (or which position (s)) in the organization should be responsible for each of these functions?
   - Monitoring electricity usage
   - Reviewing utility bills
   - Paying utility bills
   - Coordinating with utility companies on billing matters
   - Conducting energy assessments of divisions and facilities
   - Developing energy efficiency policies, programs and projects
   - Implementing energy efficiency solutions and strategies
4. The IG report on Electricity Management (July 2010) recommended a more centralized energy management approach. In your opinion, would Metro's energy management program generally benefit from a more centralized organization?

   Yes/No/Maybe/Don't know

5. What are the main reasons why Metro’s energy management program would (or would not) benefit from a more centralized organization?

   Cite 2-3 potential benefits/opportunities

6. If Metro were to move towards a more centralized energy management structure, what would you consider to be the optimal organization?

   Alternative solutions to consider may include:

   - Centralized structure with an individual or a group housed at the Executive Staff level identified as being in charge of energy management
   - Hybrid approach with corporate energy management personnel embedded (or “matrixed”) in various divisions and/or departments
   - Advisory committee or subcommittee
   - Executive Committee made up of Executive sponsors and an Operating Committee made up of an Energy Manager and Energy Champions representing the various divisions
   - Others.

7. Should agency and departmental energy management performance goals be established and performance monitored toward meeting those goals? What are your ideas as to how this might this be accomplished?

8. Should Facility Managers/Division Managers be provided with information on monthly energy usage? Why and why not?

9. Should Facility Managers/Division Managers be responsible for more efficient energy usage and conservation? What kind of accountability is needed (e.g., through departmental and/or individual performance objectives)?

10. Can you think of other cross-departmental or “cross-cutting” programs that are already managed through a centralized structure at Metro?

    Cite 1 or 2 cross-cutting programs (such as Environmental Management System, or Health & Safety). For each cross-cutting program, indicate: how it works; is it generally successful; why; how could it be improved?

11. In your opinion, do Metro’s culture and history make the agency well suited for implementing a more centralized energy management structure? Why?

12. What potential conflicts/sources of resistance would you anticipate if Metro were to move towards a more centralized energy management structure?

    Cite 2-3 factors

13. In your opinion, what are the key requirements to ensure a successful implementation of a more centralized energy management structure?

    Cite 2-3 requirements

14. What should the major goals of an energy management program be?

    Indicate top 3 goals among list below:

    - Cost Reduction (x%)

- GHG Reduction (x%)
- Energy Price Protection
- Reputation Benefits
- Corporate Citizenship
- Competitive Fitness
- Sustainability
- Compliance -Risk Aversion
- Increased Corporate Value
- Industry Recognition
- Others

15. Who (or what position) would be the appropriate Executive Sponsor (or internal champion) or "Energy Czar" of a cross-functional energy management program? Should an existing position take on this role or should a new position be created?
16. Do you have any other ideas or insights to share on energy management at Metro that haven't been covered?

Appendix E: Renewable Energy Screening Tool (REST)

Appendix E-1: Detailed Descriptions of the Six Renewable Energy Screening Tool (REST) Criteria

This Appendix provides specific descriptions for each of the six scoring criteria applied in the renewable screening process and tool. This material should be useful in understanding the major evaluation factors that underlie renewable investment decisions and how they are scored in the Excel-based Renewable Energy Screening Tool (REST). This Appendix also provides background and logic that should be helpful to Metro as it decides if and how to adjust this screening process to its particular needs (e.g., to change the scoring system or criteria weights).

Category 1: Cost

The proposed renewable energy screening process evaluates the cost of a renewable energy system relative to baseline utility electricity based on each system's net-present value[41] (NPV) to Metro. The NPV calculation accommodates system purchase by Metro or system access by Metro through a power purchase agreement (PPA) with an outside system owner. The NPV for each proposed renewable energy system and for the baseline utility electricity is based on user inputs and values already programmed into the Excel tool.

To calculate the proposed renewable energy system's NPV, the following inputs are needed:

- Renewable energy technology[42] used in the system.
    - If the chosen technology is fuel cell, whether or not the system uses renewable energy feedstocks.
    - If the chosen technology is solar water heat, whether the system will replace electricity or natural gas consumption.
- Useful life of the system; in this screening process, the useful life is assumed to be 20 years.
- Utility territory.
- Cost of the renewable energy system:
    - If Metro is purchasing the system, the installed cost; or
    - If Metro is entering a PPA for the system, the beginning PPA rate and annual escalation rate.
- Annual operations and maintenance (O&M) cost of the system (for purchased systems only).

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[41] Net present value (NPV) is a common financial analysis mechanism for converting long-term investment cash flows, like those for a renewable project, into a single value in today's dollars. NPV was used here as the scoring basis because it allows comparisons between the two main renewable financing options – (1) purchase by Metro, or (2) power purchase agreement (PPA) with Metro paying for the electricity from a renewable system owned by an outside party on Metro's roofs or other land. PPAs can be thought of as a form of lease.

[42] There are five technologies considered in the underlying Excel model – solar photovoltaic (PV), wind, fuel cell, geothermal, and solar water heat. All but geothermal are designed in the model for distributed (behind-the-meter) applications, while geothermal is designed for central station applications (i.e., not directly connected to Metro electricity load).

- Installed capacity of the system, in DC kW for solar PV projects, kW_{th} for solar water heat systems that displace natural gas, and AC kW for all other projects.
- Annual expected power output from the system, based on:
  - Expected power output of the system in the first year, in therms for solar water heat systems that displace natural gas and kilowatt-hours (kWh) for all other systems; and
  - Assumed annual output degradation rate, as a percent.

In addition to the project-specific inputs described above, the Excel model contains values for discount rate (assumed to be 5% here), revenue from the sale of renewable energy credits (RECs) as applicable, average utility retail rates, wholesale power prices (for electricity that does not qualify under relevant net metering policies), average facility delivered natural gas prices (for solar water heat projects that displace natural gas), and certain of the major renewable incentives and discounts available and associated with Metro system purchase.

The revenue and incentive payments for a proposed system are added together for each year. This total revenue and incentive value can then be subtracted from the cost of the system for each year of useful life to get the net cash flow from the renewable energy system for every year it would be in operation.[43]

When rating the renewable energy system's cost relative to the utility cost baseline, this screening process assigns the maximum weighting (i.e., best-case scenario) to the renewable energy systems with an NPV percent difference of -50% or less. In other words, the best cost score is achieved by those renewable energy systems that have a NPV equal to or less than half of the baseline utility electricity rate. For renewable energy systems with a NPV higher than the baseline NPV, the cost score decreases depending on the percent difference between the two NPVs. A system with a 50% difference – whereby the renewable energy project's NPV is 50% higher than the NPV of baseline utility power – would achieve one-third of the maximum weighting for the cost category. A system with a 100% or greater difference between the baseline and renewable energy system would be assigned the minimum weighting (i.e., worst-case scenario). Table E1 below illustrates the cost "scores" associated with various NPV differences of renewable projects compared to average utility electric power prices.

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[43] The NPV is calculated using the following equation:

$$NPV = \sum_{t=0}^{T} \frac{C_t}{(1+r)^t}$$

Where:

T = useful life of the system; this value is fixed at 20 years for this screening process

t = year

C_t = the net cash flow for year t

r = assumed discount rate; this value is set at 5% for this screening process

Table E1: Example Percent Differences in NPV and Resulting Cost Scores

Percent Difference in NPV	Resulting REST Score
-50% or lower	40
-25%	33
0%	27
25%	20
50%	13
75%	7
100% or higher	0

In this screening process, the cost category is assigned a maximum of 40 points out of 100 total points for the evaluation. This is based on the assumption that the cost of the renewable energy system is the most important factor in determining whether or not to proceed with a proposed renewable energy project. That relative weight, as well as weights for the other five categories beyond cost, can be changed at Metro's discretion.

This cost category does not consider the hedging (providing electric price certainty) benefits of renewable investments, which are reflected in their own category below.

Category 2: Environmental Benefit

By generating electricity through renewable energy sources instead of the largely carbon-based sources used to generate baseline grid electricity, the greenhouse gases (GHG) associated with the baseline grid electricity are avoided. The proposed renewable energy screening process evaluates the environmental benefit of a renewable energy system relative to the baseline utility electricity (or natural gas, for solar water heating systems that displace natural gas) based on GHG emissions that would be avoided. To calculate the GHG emissions avoided by a proposed renewable energy system, the following values are used:

- Expected power output of the system over 20 years of its useful life, in kWh (or therms for solar water heat systems that displace natural gas).
- Electric (or natural gas) utility.
- Emission rate of three primary GHGs (carbon dioxide, methane, and nitrous oxide) for the electricity generated by the utility (or natural gas for solar water heat systems that displace natural gas).

Electric utilities are required to report the GHGs emitted per unit of electricity they generate. This screening process uses the GHG emission rates from the U.S. Environmental Protection Agency's (EPA's) eGRID 2010 database. eGRID provides the emission rate for individual utilities (e.g., Southern California Edison (SCE), Los Angeles Department of Water and Power (LADWP), and Pasadena Water & Power (PWP)), in units of pounds of gas per megawatt-hour of power for the three relevant gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). However, some GHGs have a greater ability to trap heat in the atmosphere per pound of gas, so the eGRID emission factor uses the weighted unit of pounds of carbon dioxide equivalent per megawatt-hour (lb CO_2e/MWh)[44].

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[44] As explained in a recent draft U.S. EPA report, "the Intergovernmental Panel on Climate Change (IPCC) developed the Global Warming Potential (GWP) concept to compare the ability of each greenhouse gas to trap

The eGRID emission factors for each utility are based on the average GHG emissions for each unit of electric power the utility generates with its current mix of fuel sources and generation technologies. For example, a utility that derives most of its electricity from coal (a relatively carbon-intensive fuel) and a small percentage of its electricity from hydropower (a source that generates little-to-no GHG emissions) would have a higher GHG emission rate per megawatt-hour[45] than a utility that uses less coal and more hydropower. Because of this, a renewable energy project modeled in REST that offsets the grid electricity from a utility with a higher GHG emissions rate will have higher environmental benefits than an otherwise identical project that offsets the grid electricity from a utility with a lower GHG emissions rate. The GHG emissions rates for the three electric utilities modeled in REST are expected to decrease in the coming years as the utilities invest in more low- and zero-carbon energy sources. Therefore, Metro may wish to modify the number of points awarded in REST for each unit of GHG emissions avoided (as described below) depending on how much the utility GHG emissions rates change in the future.

For solar water heat projects that displace natural gas consumption, REST must use a different method for estimating the GHG emissions avoided because the solar project is replacing natural gas itself, not utility electricity with a certain emissions rate. The natural gas emissions avoided by a given solar water heating project are calculated by taking the natural gas consumption that would have occurred and multiplying it by the fuel-specific energy content and carbon content. It is assumed that the energy content value of 0.106 gigajoules (GJ) per therm is appropriate for natural gas[46]. The avoided GHG emissions rates for North American natural gas delivered to California[47] include the following components:

- **Natural gas recovery** – 3.5 g CO_2e/MJ
- **Natural gas processing** – 3.7 g CO_2e/MJ
- **Transport and distribution** – 0.97 g CO_2e/MJ
- **Carbon in fuel** – 55.2 g CO_2e/MJ

Adding these four components together, using the energy content assumed above, and converting units, a final avoided GHG emissions rate for natural gas of 0.505 lb CO_2e per kWh of natural gas offset was calculated.

When rating the renewable energy system's environmental impact relative to the baseline, this screening process assigns the maximum weighting (i.e., best-case scenario) to renewable energy systems that

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heat in the atmosphere relative to another gas." U.S. Environmental Protection Agency (EPA), Draft Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 2009 (February 2011), EPA 430-R-11-005. http://www.epa.gov/climatechange/emissions/usinventoryreport.html. The IPCC currently estimates that CO_2 has a GWP of 1, while CH_4 and N_2O have GWPs of 25 and 298, respectively. In this screening process and many other analyses dealing with GHG emissions, the reference gas used is CO_2, and therefore GWP-weighted emissions are measured in units of CO_2 equivalent (CO_2e). The GHG emission rate per unit of power for each utility is calculated by multiplying CH_4 and N_2O emission rates by their respective GWPs, adding the CO_2 emissions rates, and putting all emission rates in common units of pounds of CO_2e per MWh.

[45] 1 Megawatt-hour (MWh) is equal to 1,000 kilowatt-hours (kWh).

[46] For this value, we've used the higher heating value (HHV) of natural gas, as opposed to the lower heating value (LHV). HHV was chosen because it is frequently used for gas-fired boilers used for water heating.

[47] These values were provided by the California Air Resource Board's "Detailed California-Modified GREET Pathway for Compressed Natural Gas (CNG) from North American Natural Gas." For the Renewable Energy Screening Tool, it is assumed that natural gas is not compressed and, thus, that component of the GHG emission factor is not included.

avoid 1,000 $MTCO_2e$ (CO_2 equivalent) or more on average annually[48]. For renewable energy systems that avoid less than 1,000 $MTCO_2e$, the environmental benefit score decreases depending on the quantity of GHGs avoided. For every 50 fewer $MTCO_2e$ avoided annually, the renewable energy system's environmental weighting goes down by 5 percent. Therefore, a system that avoids 500 $MTCO_2e$ annually would achieve half of the maximum weighting available for the environmental benefit factor. A system that avoids 0 $MTCO_2e$ would be assigned the minimum weighting (i.e., worst-case scenario).

In this screening process, the environmental benefit factor is assigned a maximum of 20 points out of 100 total points for the evaluation. This is based on the assumption that the GHG benefits of the renewable energy system is the second most important factor, behind cost, in determining whether or not to proceed with a proposed renewable energy project.

Category 3: Land-Use Efficiency

All potential renewable energy projects using this screening process would likely be located in Los Angeles County, a densely populated county where space is an important commodity. Additionally, the land occupied by Metro's facilities for renewable energy systems, whether on the ground, parking lots, building roofs, or elsewhere is limited. Because of this, it is important to consider the land-use efficiency for renewable technology systems. That is, it is helpful to know how much area a renewable energy system occupies for each unit of power it generates. Every square foot occupied by renewable energy systems may be unable to be used for other purposes, including future renewable energy and other sustainability applications.

This screening process evaluates land-use efficiency for a renewable energy system, summed to acres per megawatt of installed capacity, a measure commonly used in land-use efficiency evaluations. Two user-provided inputs are required to calculate a renewable energy system's land-use efficiency:

- Installed capacity of the system, in kW (or kW_{th} for solar water heat systems that displace natural gas).
- Area occupied by the system, in square feet.

The land-use efficiency is calculated by dividing the area occupied by the system by the installed capacity of the system, then converting the value to units of acres per MW or MWth. For solar water heat systems that offset natural gas, the system capacity is converted from units of kWth to MWth to aid in the comparison with other technology systems. When rating the renewable energy system's land-use efficiency, this screening process assigns the maximum weighting (i.e., best-case scenario) to renewable energy systems that occupy 1 acre or less for every megawatt or thermal megawatt of capacity. For every acre beyond the first one occupied per MW or MWth, the renewable energy system's land-use efficiency weighting goes down by 7.14 percent. Therefore, a system that occupies 8 acres per MW would achieve 50 percent of the maximum weighting available for the land-use efficiency factor. A system that occupies 15 or more acres per MW would be assigned the minimum weighting (i.e., worst-case scenario).

In this screening process, the land use efficiency factor is assigned a maximum of 10 points out of 100 total points for the evaluation. This is based on the assumption that the land-use efficiency of the renewable energy system is less important than cost and (environmental) GHG emissions avoided in determining whether or not to proceed with a proposed renewable energy project.

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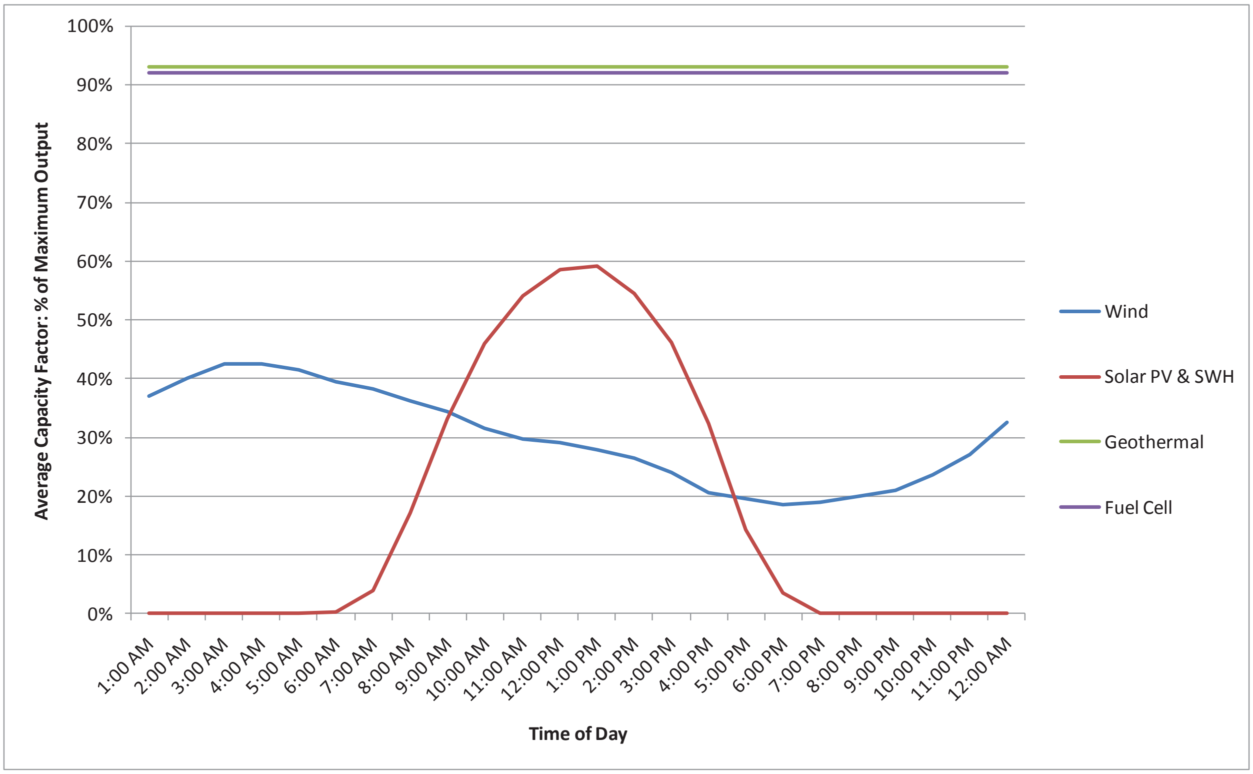
[48] To place this value in context, 1,000 MTCO2e is roughly equivalent to the annual GHG emissions from 196 passenger vehicles according to the U.S. EPA Greenhouse Gas Equivalencies Calculator.

Category 4: Peak-Shaving Benefit

In general, electricity demand is assumed to peak in the early and late afternoon. SCE, LADWP, and PWP all place a premium cost on retail electricity consumed during peak hours. If an energy user like Metro can reduce its electricity demand during peak hours, this practice is often called “peak-shaving.”

The proposed renewable energy technologies considered in this screening analysis produce electricity at different rates depending on the time of day. General example hourly load profiles for each of the technologies considered in this screening process are shown in Figure E1 below. Power output from solar PV and water heat systems increases as direct sunlight increases, and it decreases to zero at night. Wind energy system output tends to be highest late at night and in the morning, decreasing during the afternoon and evening. Power output from geothermal and fuel cell systems, on the other hand, are generally steady, with little-to-no fluctuation in output during the day.

Figure E1 : Indicative Power Output for Renewable Energy Technologies as a Percent of Total Potential Output per Hour



Because of these differences, the choice of technology will have a significant impact on the amount of peak-time electricity Metro can offset or even sell back to the utility. Rather than attempt to track the precise additional revenue from peak-shaving for each technology (as a percentage of the total revenue from that technology), this screening process applied a simple weighting to each technology to reflect the relative benefit the technology will receive from peak shaving. The model can be easily updated to assign a different value for peak-shaving benefits.

This screening process assigns the maximum weighting (i.e., best-case scenario) to solar PV and solar water heat systems because their output peaks when electricity demand also tend to peak (mid-day). The middle weighting is assigned to geothermal and fuel cell systems because their output remains high and constant during peak demand hours. The minimum weighting (i.e., worst-case scenario) is assigned to wind energy systems because their output is at or near its lowest during peak hours. Zero points are assigned to solar water heating projects that displace natural gas because natural gas rates do not vary with time-of-use.

In this screening process, the peak shaving factor is assigned a maximum of 10 points out of 100 total points for the evaluation. This is based on the assumption that the potential benefits from peak shaving are less important than the overall cost of the system and the GHG benefits. A solar PV or solar water heat system would achieve 10 points, a geothermal or fuel cell system would achieve 6 points, and a wind energy system would achieve 2 points.

Category 5: Hedging Benefit

One of the attributes of renewable energy investments or leases is that they provide price certainty to the buyer or user of physical electricity generated. This is a valuable attribute, and renewable energy transactions are the sole hedging technique currently recommended in Section 3.4 of the ECMP on Electricity Hedging and Price Risk Management.

For example, a solar PV installation owner like Metro could be expected to receive electricity from a solar PV installation for at least 20 years,[49] and the cost of that electricity would be known upfront either through (a) the lease rate in a power purchase agreement, or (b) by amortizing (“levelizing”) the 20-year cost of the solar PV plant if Metro owned it. Having a known, upfront cost of renewable electricity provides a “hedge” against electricity price uncertainty and allows Metro to budget with confidence against the unit price of electricity coming from its renewable energy investments. This is the “hedging benefit” described in this section and contrasts with the normal situation Metro encounters whereby its electricity prices from the utility are unknown even over the next year, much less over the 20-year useful life of a renewable energy investment.

Hedging benefits are directly proportional to the 20-year electricity output of the renewable system. Every kilowatt-hour of electricity produced by a renewable system introduces a known price into Metro’s electricity budget. Metro’s current roster of approximately 2 MW of solar projects produces about 2,700,000 kWh annually, or about 1.2% of the agency’s total electricity output every year. Over 20 years, these solar projects would hedge about 50,000,000 kWh of Metro’s electricity costs. The renewable energy screening process uses that 20-year electricity output metric (which includes annual performance degradation) uniformly across Metro’s utilities to assess the hedging benefit of renewable projects.

The screening process assigns a maximum weight (i.e., best-case scenario) of 10 points to renewable projects that are estimated to generate 30,000,000 kWh or more over 20 years.[50] The remainder of the scale is proportional with one point assigned for every 3,000,000 kWh of lifetime (20-year) electricity output. For solar water heat systems that offset natural gas, the estimated 20-year output of the system is converted from therms to kWh for comparison purposes.

The weighting of 10 points for the hedging benefit reflects a belief that this factor is less important than the overall cost or the environmental benefits of a renewable system. The weighting of the hedging factor, as with all other factors, can be easily adjusted by Metro.

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[49] Solar PV installations typically have a useful life of over 20 years, and their primary components (panels) are generally under warranty for 20 to 25 years. Other renewable energy investments have somewhat different predicted life cycles, but 20 years can be taken as a proxy of their useful lives for the purposes of estimating their electricity output and associated hedging benefits.

[50] This electricity output level represents about 2% of Metro’s current, agency-wide electricity load.

Category 6: Local Content Use

The benefits of installing renewable energy systems that utilize locally manufactured equipment are threefold. First, locally manufactured systems allow Metro to reinvest in California- and Los Angeles-based business, encouraging local jobs and bolstering the local economy. Second, using locally manufactured products avoids GHG emissions associated with transporting equipment over longer distances. Third, the main utilities addressed in this screening process offer additional financial incentives for certain systems manufactured in California or in Los Angeles. Rather than requiring the user to estimate the percentage of locally manufactured equipment in a proposed renewable energy system, this screening process evaluates local content use based on two inputs:

- Whether the system comes from a California supplier.
- Whether the system was manufactured in Los Angeles County.

The definition of a California supplier used in this screening process is analogous to that used by the California State Self-Generating Incentive Program.[51] For purposes of qualifying as a California supplier, a distribution or sales management office or facility does not qualify as a manufacturer.[52]

The definition of a Los Angeles manufacturer used in this screening process is comparable to that used by the LADWP Solar Incentive Program for the Los Angeles Manufacturing Credit (LAMC). LADWP awards the LAMC for equipment PV modules and solar power equipment "manufactured within the limits of the City of Los Angeles." [53] While the LAMC applies only to solar PV systems within the City of Los Angeles, in this screening process the same local manufacturing benefits will be applied for all technologies, within the broader geographic boundaries of the County of Los Angeles.

This screening process assigns the maximum weighting (i.e., best-case scenario) to systems manufactured within Los Angeles County. The middle or 50 percent weighting is assigned to systems from California suppliers, but not manufactured in Los Angeles County. The minimum weighting (i.e.,

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[51] The Self-Generating Incentive Program defines as California supplier as "any sole proprietorship, partnership, joint venture, corporation, or other business entity that manufactures eligible distributed generation technologies in California and that meets either of the following criteria:

1. The owners or policymaking officers are domiciled in California and the permanent principal office, or place of business from which the supplier's trade is directed or managed, is located in California. Or,
2. A business or corporation, including those owned by, or under common control of, a corporation, that meets all of the following criteria continuously during the five years prior to providing eligible distributed generation technologies to an SGIP recipient:
    a. Owns and operates a manufacturing facility located in California that builds or manufactures eligible distributed generation technologies.
    b. Is licensed by the state to conduct business within the state.
    c. Employs California residents for work within the state."

[52] California Public Utilities Commission. 2010. "Self-Generation Incentive Program Handbook." http://www.cpuc.ca.gov/NR/rdonlyres/F47DC448-2AEB-473F-98D8-CC0CC463194D/0/2010_SGIP_Handbookr4100506.pdf

[53] To qualify for the LAMC and be considered locally manufactured, a minimum of 50% of the components of the finished PV modules or qualifying equipment must have been manufactured and/or assembled within the City of Los Angeles. Alternatively, LAMC status may be obtained through the submission of and acceptance of the manufacturer's local business plan by LADWP. Such local business plan should clearly demonstrate and document the use of local workforce, locally-manufactured components, or other local economic resources such that 50% or more of the manufactured product's wholesale value is derived from the aforementioned local resources." Los Angeles Department of Water and Power. 2011. "Solar Photovoltaic Incentive Program Guidelines." http://www.ladwp.com/ladwp/cms/ladwp009742.pdf

worst-case scenario) is assigned to systems that are not manufactured in Los Angeles County or from California suppliers.

In this screening process, the local content use factor is assigned a maximum of 10 points out of 100 total points for the evaluation. This is based on the assumption that the potential benefits from local content use are lower than the overall cost of the system and the GHG benefits. Therefore, a system manufactured in Los Angeles County would achieve 10 points; a system from a California supplier, but not manufactured within Los Angeles County, would achieve 5 points; and a system that meets neither of those requirements would achieve 0 points.

Appendix E-2: Screening Projects using the Renewable Energy Screening Tool (REST)

The Excel evaluation tool developed to support this screening process, REST, allows the user to compare the system performance metrics and weighted scores for up to 4 potential renewable energy projects side-by- side simultaneously. By running multiple iterations of REST, unlimited numbers of renewable projects can be compared against one another. The tool has been designed to run in Excel 2003, but will also work in newer versions of Excel. User instructions are included within REST, and the tool does not assume that users have any specific renewable energy expertise.

The main features of the tool are the Inputs sheet, the Project Score sheets for each of the 4 projects, and the Score Summary sheet (showing up to 4 projects side-by-side). The end of this Appendix showsfor example screenshots of these sheets for hypothetical renewable projects. The Inputs sheet includes fields where users enter data specific to each project, with each project's inputs arranged in a column. The following is a list of the categories and the individual inputs that must be entered for each project.

- Basic Project Information:
  - Project Name.
  - Technology – Chosen from a drop-down list.
  - If fuel cell, does it use renewable energy (as opposed to natural gas)? – Chosen from a dropdown list; "NA" for any technologies other than fuel cells.
  - If solar water heat, does it displace electricity or natural gas? – Chosen from a dropdown list; "NA" for any technologies other than solar water heat.
  - Utility – Chosen from a drop-down list.
- Project Scale:
  - Installed capacity (kW, except for solar water heat projects that displace natural gas, which use units of kW_{th}).
  - Year one estimated output (kWh, except for solar water heat projects that displace natural gas, which use units of therms).
  - Annual output degradation (straight line %) – User input or default, depending on the response to the next question.
  - Use default degradation? – "Yes" or "No" response, chosen from a drop-down list. If "Yes," the annual output degradation field is automatically populated.

  - Useful life of asset (years) – This value is fixed at 20 years, but is included on the Inputs sheet for demonstrative purposes.
- Project Logistics:
  - Square footage of installation.
  - System from California supplier? – “Yes” or “No” response, chosen from a drop-down list.
  - System manufactured in Los Angeles County? – “Yes” or “No” response, chosen from a dropdown list.
- Ownership and Costs:
  - Purchase by Metro or PPA lease? – Chosen from a drop-down list.
  - Installed cost (pre-incentive) – User input, unless user selects “PPA Lease” in the input above, in which case the field is grayed-out and populated with “NA.”
  - PPA lease rate ($ / kWh) – User input, unless user selects “Outright Purchase” in the input above, in which case the field is grayed-out and populated with “NA.” For solar water heat systems that displace natural gas, this input will be in units of $ / therm.
  - Annual (lease) escalation rate (%) – User input, unless user selects “Outright Purchase” in the input above, in which case the field is grayed-out and populated with “NA.”
  - Annual O&M costs ($ / kWh) – User input, unless user selects “PPA Lease” in the input above, in which case the field is grayed-out and populated with “NA.” For solar water heat systems that displace natural gas, this input will be in units of $ / therm.
- Incentives:
  - For Metro-purchased systems only, an input area is provided for each year of the system’s useful life for the user to indicate any incentives in addition to the incentives built into the tool.

Based on the information added by the user on the Inputs sheet, the spreadsheet calculates the metrics and scores for each factor, as described above. The results from the screening process are then output on the Project Score sheet specific to each of the four projects that can be printed or stored. The Project Score sheet results are arranged in three boxes: Project Information, Discrete Scoring Values, and Score.

The Project Information box includes many of the selections, data, and information entered on the Inputs sheet.

The Discrete Scoring Values box contains the results from the screening analysis for each evaluation factor before they have been converted to scores and includes the following values:

- Percent difference in NPV.
- Average GHG emissions avoided per year, in units of MTCO2e.
- Installed land-use efficiency, in units of acres per MW or MW_{th}.
- Peak shaving credit, as a percentage.
- Hedging benefit, as a percentage of total Metro electricity load.
- System from California supplier?
- System manufactured in Los Angeles County?

The Score box contains the score for each of the six factors followed by the total score available for that factor. At the bottom of the score box, the scores are totaled and presented relative to the maximum total score of 100. There is also a Score Summary sheet that provides side-by-side scores, by category, for up to four projects.

It should be noted that the tool includes fixed values for certain assumptions that are not included on the Inputs sheet, such as discount rate, retail electricity rates, incentive pay-outs, GHG emission rates, and weightings. The tool is designed for these assumptions to be easily changed by Metro on the calculation sheets should the new data become available or if Metro would like to adjust the weighting assumptions.

Appendix E-3: Renewable Energy Screening Tool (REST) Screenshots: For Hypothetical Projects

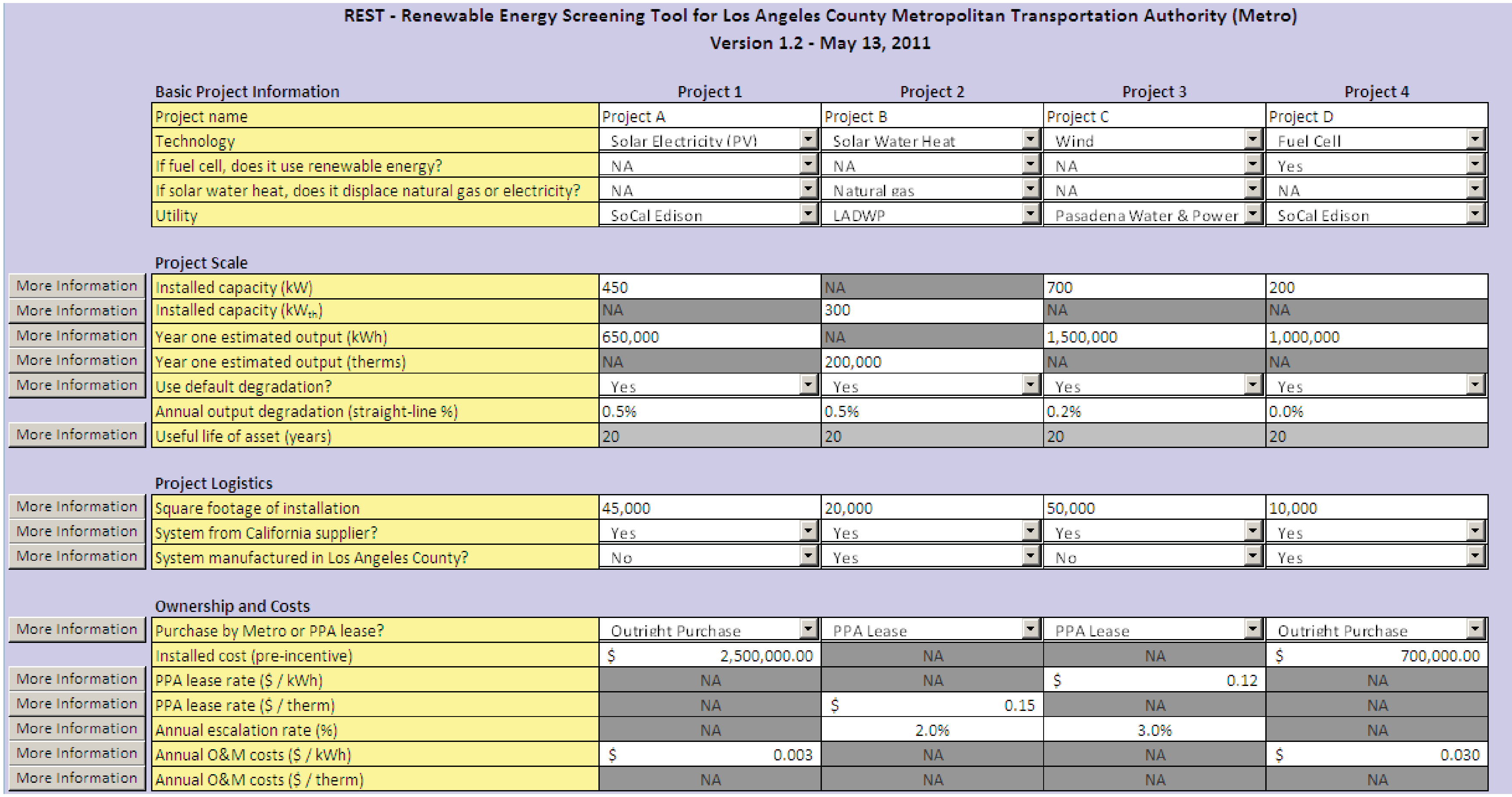


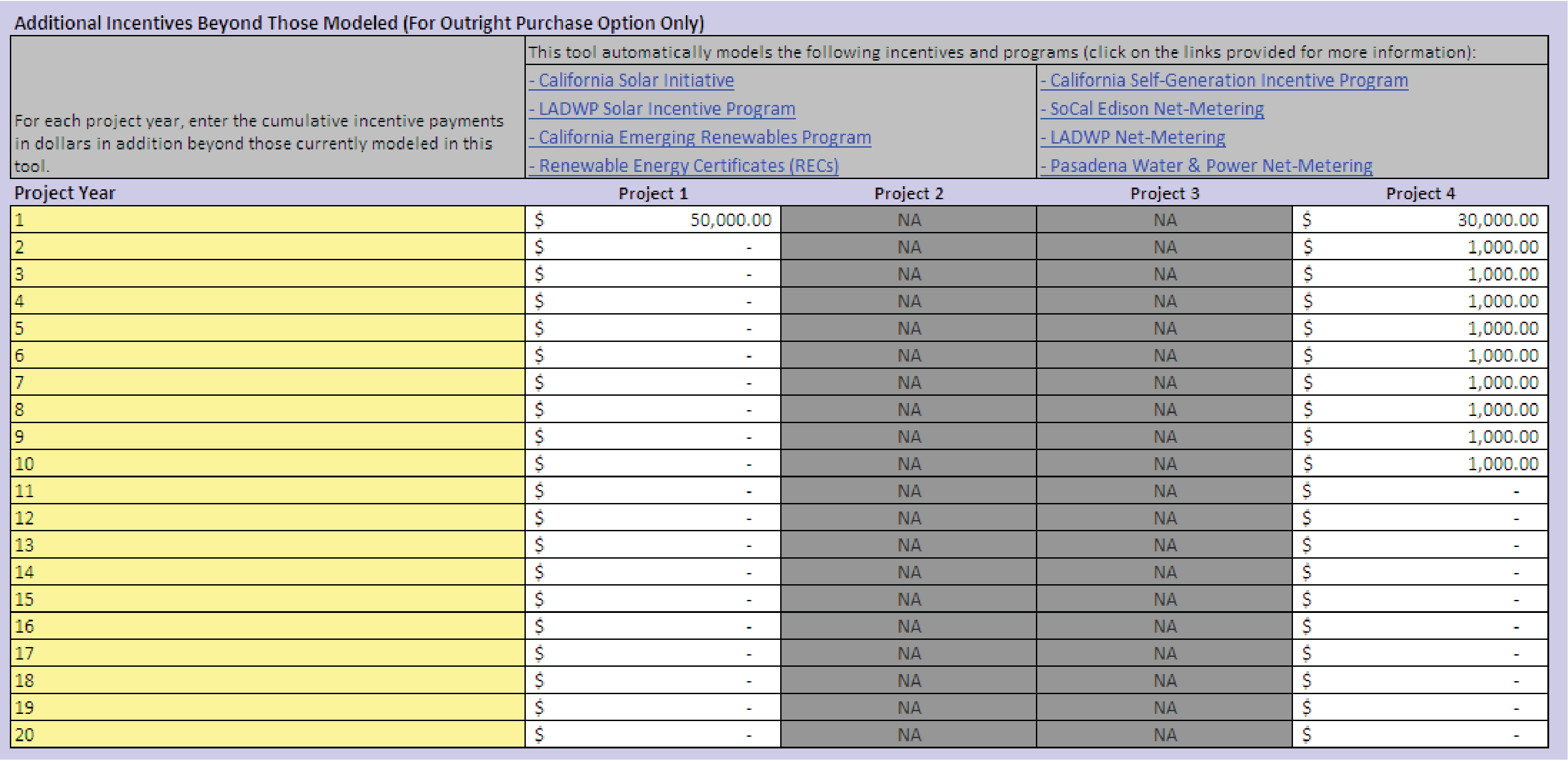
Figure E2: Renewable Energy Screening Tool (REST) Inputs Sheet – Main Inputs

REST - Renewable Energy Screening Tool for Los Angeles County Metropolitan Transportation Authority (Metro)

Version 1.2 - May 13, 2011

	Basic Project Information	Project 1	Project 2	Project 3	Project 4
	Project name	Project A	Project B	Project C	Project D
	Technology	Solar Electricity (PV)	Solar Water Heat	Wind	Fuel Cell
	If fuel cell, does it use renewable energy?	NA	NA	NA	Yes
	If solar water heat, does it displace natural gas or electricity?	NA	Natural gas	NA	NA
	Utility	SoCal Edison	LADWP	Pasadena Water & Power	SoCal Edison
	Project Scale				
More Information	Installed capacity (kW)	450	NA	700	200
More Information	Installed capacity (kW_{th})	NA	300	NA	NA
More Information	Year one estimated output (kWh)	650,000	NA	1,500,000	1,000,000
More Information	Year one estimated output (therms)	NA	200,000	NA	NA
More Information	Use default degradation?	Yes	Yes	Yes	Yes
	Annual output degradation (straight-line %)	0.5%	0.5%	0.2%	0.0%
More Information	Useful life of asset (years)	20	20	20	20
	Project Logistics				
More Information	Square footage of installation	45,000	20,000	50,000	10,000
More Information	System from California supplier?	Yes	Yes	Yes	Yes
More Information	System manufactured in Los Angeles County?	No	Yes	No	Yes
	Ownership and Costs				
More Information	Purchase by Metro or PPA lease?	Outright Purchase	PPA Lease	PPA Lease	Outright Purchase
	Installed cost (pre-incentive)	$ 2,500,000.00	NA	NA	$ 700,000.00
More Information	PPA lease rate ($ / kWh)	NA	NA	$ 0.12	NA
More Information	PPA lease rate ($ / therm)	NA	$ 0.15	NA	NA
More Information	Annual escalation rate (%)	NA	2.0%	3.0%	NA
More Information	Annual O&M costs ($ / kWh)	$ 0.003	NA	NA	$ 0.030
More Information	Annual O&M costs ($ / therm)	NA	NA	NA	NA

Figure E3: Renewable Energy Screening Tool (REST) Inputs Sheet – Additional Incentives



Additional Incentives Beyond Those Modeled (For Outright Purchase Option Only)

For each project year, enter the cumulative incentive payments in dollars in addition beyond those currently modeled in this tool.

This tool automatically models the following incentives and programs (click on the links provided for more information):

- California Solar Initiative
- LADWP Solar Incentive Program
- California Emerging Renewables Program
- Renewable Energy Certificates (RECs)
- California Self-Generation Incentive Program
- SoCal Edison Net-Metering
- LADWP Net-Metering
- Pasadena Water & Power Net-Metering

Project Year	Project 1	Project 2	Project 3	Project 4
1	$ 50,000.00	NA	NA	$ 30,000.00
2	$ -	NA	NA	$ 1,000.00
3	$ -	NA	NA	$ 1,000.00
4	$ -	NA	NA	$ 1,000.00
5	$ -	NA	NA	$ 1,000.00
6	$ -	NA	NA	$ 1,000.00
7	$ -	NA	NA	$ 1,000.00
8	$ -	NA	NA	$ 1,000.00
9	$ -	NA	NA	$ 1,000.00
10	$ -	NA	NA	$ 1,000.00
11	$ -	NA	NA	$ -
12	$ -	NA	NA	$ -
13	$ -	NA	NA	$ -
14	$ -	NA	NA	$ -
15	$ -	NA	NA	$ -
16	$ -	NA	NA	$ -
17	$ -	NA	NA	$ -
18	$ -	NA	NA	$ -
19	$ -	NA	NA	$ -
20	$ -	NA	NA	$ -

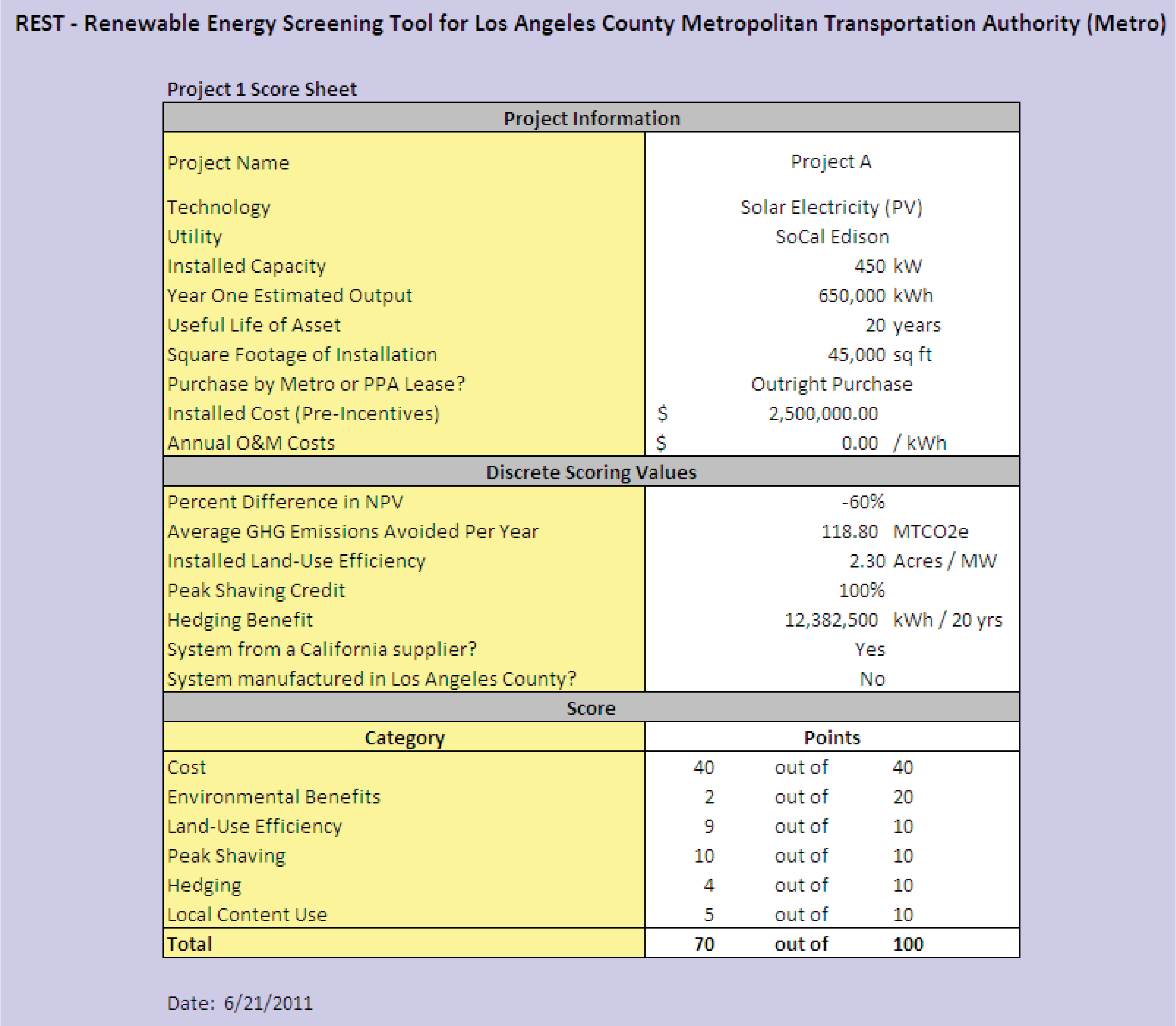
Figure E4: Renewable Energy Screening Tool (REST) Score Summary Sheet

REST - Renewable Energy Screening Tool for Los Angeles County Metropolitan Transportation Authority (Metro)

Multi-Project Score Summary	Project 1	Project 2	Project 3	Project 4
Project Name	Project A	Project B	Project C	Project D
Technology	Solar Electricity (PV)	Solar Water Heat (displaces natural gas)	Wind	Fuel Cell
Installed Capacity	450 kW	300 kWth	700 kW	200 kW
Cost Score (out of 40 points)	40	23	18	40
Environmental Benefits Score (out of 20 points)	2	0	16	4
Land-Use Efficiency Score (out of 10 points)	9	9	9	10
Peak Shaving Score (out of 10 points)	10	0	2	6
Hedging Score (out of 10 points)	4	10	10	7
Local Content Use Score (out of 10 points)	5	10	5	10
Total Score (out of 100 points)	**70**	**52**	**60**	**77**

Date: 6/21/2011

Figure E5: Renewable Energy Screening Tool (REST) Project Score Sheet



REST - Renewable Energy Screening Tool for Los Angeles County Metropolitan Transportation Authority (Metro)

Project 1 Score Sheet

Project Information	
Project Name	Project A
Technology	Solar Electricity (PV)
Utility	SoCal Edison
Installed Capacity	450 kW
Year One Estimated Output	650,000 kWh
Useful Life of Asset	20 years
Square Footage of Installation	45,000 sq ft
Purchase by Metro or PPA Lease?	Outright Purchase
Installed Cost (Pre-Incentives)	$ 2,500,000.00
Annual O&M Costs	$ 0.00 / kWh
Discrete Scoring Values	
Percent Difference in NPV	-60%
Average GHG Emissions Avoided Per Year	118.80 MTCO2e
Installed Land-Use Efficiency	2.30 Acres / MW
Peak Shaving Credit	100%
Hedging Benefit	12,382,500 kWh / 20 yrs
System from a California supplier?	Yes
System manufactured in Los Angeles County?	No

Score			
Category	**Points**		
Cost	40	out of	40
Environmental Benefits	2	out of	20
Land-Use Efficiency	9	out of	10
Peak Shaving	10	out of	10
Hedging	4	out of	10
Local Content Use	5	out of	10
Total	**70**	**out of**	**100**

Date: 6/21/2011

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