STATE ENERGY MANAGEMENT PLAN

For State Facilities in Florida

Prepared by:

The Florida Department of Management Services

Division of Real Estate Development & Management

Building Construction & Facilities Management

February 2010

Executive Summary

Purpose: The State Energy Management Plan (SEMP) was developed pursuant to Section 255.257, Florida Statutes (F.S.). The purpose of this plan is to develop a comprehensive system to manage and reduce the consumption and costs of non-renewable energy in large state-owned and metered state-leased facilities.

Governmental Entities Subject to the Plan: This plan applies to each executive branch department or agency created by Chapter 20, F.S. The Florida Public Service Commission, the Department of Military Affairs, the judicial branch, and other state government entities are encouraged to participate in the reporting, sub-metering and training requirements as well.

Government Buildings Subject to the Plan: This plan only applies to the following:

- Facilities 5,000 net square feet and larger that are owned by an agency.
- Facilities 5,000 net square feet and larger that an agency leases and is contractually obligated to pay for utility consumption based on the utility provider's monthly statement or the building owner's sub-meter. *Note: The plan does not apply to leased facilities where the agency is contractually obligated to reimburse the property owner only if utility consumption exceeds expectations.*

The Florida Department of Management Services (DMS) will be responsible for complying with the plan for all DMS-managed facilities. Therefore, this plan does not impose any obligations on agencies that only occupy space in DMS-managed facilities.

Elements of the Plan: The basic elements of the SEMP are:

1. Data Gathering Requirements / Sub-Metering Requirements: [See Chapter 3]. This plan establishes the following two categories of energy data gathering requirements:

    - Utility bill data – consumption, peak demand, and cost data via monthly bill statements from the utility provider.
    - Sub-metered data – consumption and real-time demand data from metering devices ("smart meters" in most cases) deployed by the agency.

    In order to fulfill the sub-metered data reporting requirements, agencies will be required to install sub-meters for total building electrical consumption and demand at all state-owned and metered state-leased facilities larger than 5,000 net square feet. Where a building has particularly large energy consuming systems such as Heating, Ventilation & Air Conditioning (HVAC) or water heaters, additional sub-metering requirements may apply. This plan also outlines acceptable sub-metering schemes for all types of energy-consuming systems found in state buildings.

2. Reporting System: [See Chapter 4]. This plan introduces a utility reporting system that has been designed to accomplish the following goals simultaneously:

- Provide accurate utility records for the agency.
- Meet the reporting requirements of this plan.
- Meet the previous two goals while only requiring energy consumption and cost data to be entered once.
- Utilize a generic and common format (Microsoft Excel®).

Annual submission to DMS of the reporting forms presented in the plan is required. The reporting system consolidates energy consumption and cost data in a single format that automatically generates the reporting forms required in this plan. The reporting system has been developed to simultaneously meet the utility recordkeeping and energy management goals of state agencies.

The reporting system will require some initial setup. Some basic/intermediate Microsoft Excel® training may be required. The result of such setup and training procedures will ultimately be a more thorough, yet necessary, understanding of the mechanics involved in effective energy management.

3. Uniform Data Analysis Procedures: [See Chapter 5]. This plan summarizes basic data analysis procedures for energy consumption data and, more importantly, energy demand data. The energy demand data required in the plan will be used identify energy-related behaviors such as equipment schedules (start/stop times), occupancy schedules, and peak load occurrences so that energy usage can be managed optimally and very likely reduced.

4. Building Energy Audit Procedures: [See Chapter 6]. This plan provides recommended procedures for conducting a thorough energy audit in a state building. Energy audits are a vital part of an effective energy management strategy.

5. Employee Energy Education Program Measures: These measures will be developed in the future based on input from agency energy management coordinators.

6. Techniques to Reduce Energy Consumption: [See Chapter 7]. The energy reduction techniques presented in this plan go beyond day-to-day strategies to control energy consumption and costs. The techniques presented pertain to operations and renovations in existing buildings. Agencies in the position of replacing energy-consuming equipment through either fixed capital outlay or performance contracting methods should consult these techniques. Many of the techniques presented address the urgency of considering the true relationship between energy efficiency and long-term costs when energy-related decisions are at hand.

7. Training Requirements: [See Chapter 8]. The training requirements of this plan center around the long-term goal of developing "certified energy managers"

(CEM®) by the Association of Energy Engineers. Qualified energy managers are essential to the goal of effectively reducing energy consumption and costs.

8. Guidelines for Building Managers: [See Chapter 9]. The guidelines presented in this plan are general in nature and are intended to provide an account of the daily and weekly activities that can reduce building energy consumption. Building managers are encouraged to take an active role in energy conservation and the agencies should include them in all such efforts.

Agency Assistance: DMS intends to organize a joint agency energy management committee (committee) to set the energy reduction goals pertaining to the SEMP. This committee shall be comprised of agency energy management coordinators and/or engineers as applicable from each state agency. In addition to setting the energy reduction goals of the SEMP, the committee shall also:

- Produce a timeline for implementing the sub-metering ("smart metering") requirements of this plan.
- Produce employee energy education program measures.
- Develop recommendations and requirements for reducing consumption of gasoline and other nonrenewable energy sources by agencies in the area of transportation.
- Consider storing all agency energy data in a central computer server.
- Discuss the possibility of developing a formal database for storing, reporting, and analyzing agency energy consumption data.
- Address related agency concerns.

Timeline for Compliance: Although much of this plan consists of recommendations, best practices, and instructional material, agencies are required to comply with the following items:

- Sub-meter ("smart meter") installations for total building electrical usage and other large end-uses as required in Chapter 3 shall begin no later than July 1, 2011 and be completed by the date agreed upon by the joint agency energy management committee.
- The energy reporting system (Chapter 4) presented in this plan shall be fully implemented and in use no later than July 1, 2011.
- Annual Data Reports, as described in Section 4.5, are due beginning September 1, 2012 (covering Fiscal Year 2011-12).
- Training for Energy Management Coordinators, as described in Chapter 8, shall begin no later than July 1, 2011.

Implementation Costs: Addendum 1 of the SEMP includes an analysis of estimated implementation costs.

Conclusion: Development of the SEMP provides an opportunity to better manage and reduce the consumption and costs of non-renewable energy in state-owned and metered state-leased facilities. The procedures presented in this plan provide agencies accurate energy consumption information and, more importantly, insight into how and why energy is consumed. The SEMP also provides the tools necessary for agencies to, on their own behalf, measure and verify "guaranteed energy, water, and wastewater performance savings" projects as defined in Section 489.145, F.S.

Reducing energy consumption today is crucial. It is essential to look deeper than monthly utility bill statements and identify energy-related behaviors at the building level. Implementing this plan represents a focused effort on behalf of state government to achieve a sustainable future for all Floridians.

CONTENTS

CHAPTER 1 – INTRODUCTION

1.1 Intent of Energy Plan

The State Energy Management Plan (SEMP) is intended to serve as a reference guide for agency energy management coordinators and planners as well as vendors who assist the agencies with the implementation of energy management measures. This document is also intended to provide a comprehensive overview and strategy of energy management for agency energy management coordinators.

The SEMP was designed to provide a comprehensive system to manage and, more importantly, reduce energy consumption. Utility rate (pricing) structures have not been addressed in this plan because changing to a new rate classification does not affect energy consumption. However, DMS encourages the agencies to explore all avenues to reducing energy costs.

1.2 Scope of Energy Plan

The scope of this plan includes detailed energy and cost data gathering procedures, reporting procedures, uniform data analysis procedures, techniques to reduce energy consumption, and guidelines for building managers and staff. The data gathering requirements of this plan include sub-metering total building electrical usage as well as major energy end-uses. This plan is intended as a guide for managing all energy consumption and costs that are associated with the operation of state-owned and leased buildings.

The requirements of this plan are specifically intended to organize the efforts of the state towards managing building energy consumption and costs at the building level. This plan focuses in particular on managing the major energy end-uses within each building as well as developing effective decision-making procedures regarding energy consumption.

1.3 Electrical Use in Commercial Buildings

For most commercial buildings, HVAC systems consume more energy than any other end-use. Lighting systems usually follow as the next largest end-use, but exceptions can occur where lighting is the largest end-use in a building. In typical office buildings, lighting systems can consume up to one quarter of the total electricity used. Office equipment is another major source of energy use in commercial buildings, particularly due to the increasing number of personal computers in recent years.

The average breakdown of energy end-uses in commercial buildings is summarized in Table 1. The SEMP focuses in large part on the largest energy loads identified in Table 1.

Table 1: End-Use Electrical Consumption in Commercial Buildings

End -Use	Consumption (billion kWh)	Percent of Total Electrical Consumption
Space heating	45	5.0
Space cooling	232	25.6
Ventilation	66	7.3
Water Heating	11	1.2
Refrigeration	78	8.6
Cooking	19	2.1
Lighting	210	23.1
Office Equipment	163	17.9
Other	84	9.2
Total	908	100

Source: Energy Information Administration, Commercial Building Energy Consumption Survey, 1999

1.4 Utility Bill Limitations

The energy consumption data provided in monthly billing statements is important, but it only tells building owners the amount of energy that was consumed during the monthly billing period. In contrast, sub-metered energy data, particularly the historical demand trends generated from such data, tells building owners when, what time of day, and to what degree energy-consuming systems actually operated during the billing period.

Demand load data opens the door to more sophisticated and meaningful energy analysis, which is discussed in greater detail in Chapter 5. Energy meters that offer such capabilities are often referred to as “smart” or “intelligent” meters. Such meters have existed for many years, but the development and adoption of digital technology in recent years have made their implementation commonplace.

Sub-metered consumption and demand data will allow building owners to isolate more quickly the cause of excessive energy consumption when it occurs; and, it will occur. Commercial buildings are complicated systems due to the number of complex electrical and mechanical systems that have to be maintained and controlled, but also because they are occupied by human beings who have changing needs, schedules, and behaviors. Smart metering ultimately represents the ability for building owners to respond to a changing environment and verify that energy-related decisions are based on fact instead of perception.

1.5 Implementation & Goals

One of the initial steps involved in reducing energy consumption is to set a goal. It would be very reasonable for an agency to set a goal to reduce energy consumption or costs by 20 percent over five years. The goal in and of itself is ultimately less important than the effort engineered to achieve it.

DMS recommends that the agencies form a joint committee to set the energy reduction goals pertaining to the SEMP. This committee should be comprised of agency energy management coordinators and/or engineers from each state agency.

In addition to setting the energy reduction goals of the SEMP, the committee should also:

- Produce a timeline for implementing the sub-metering ("smart metering") requirements of this plan.
- Produce employee energy education program measures.
- Develop recommendations and requirements for reducing consumption of gasoline and other nonrenewable energy sources by agencies in the area of transportation.
- Consider storing all agency energy data in a central computer server.
- Discuss the possibility of developing a formal database for storing, reporting, and analyzing agency energy consumption data.
- Address related agency concerns.

CHAPTER 2 – DEFINITIONS

- **ASHRAE:** refers to the American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc.
- **ASHRAE 62.1:** refers to the *ANSI/ASHRAE Standard 62.1 Ventilation for Acceptable Indoor Air Quality*.
- **ASHRAE 90.1:** refers to the *ANSI/ASHRAE/IESNA Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings*.
- **BTUH:** (British thermal units per hour) BTUH refers to any instantaneous heat transfer load. One ton of air-conditioning is the equivalent of 12,000 BTUH.
- **BTU-Hours:** represents the total cumulative heat transfer without regard to any instantaneous BTU load that occurred during the measurement interval.
- **BTU Meter:** refers to one water flow meter and two water temperature sensors.
- **Cubic Foot:** refers to the basic unit of measure for natural gas.
- **CCF:** refers to 100 cubic feet (typically used for natural gas).
- **COP:** (coefficient of performance) refers to the efficiency rating for refrigeration equipment.
- **CUI:** refers to cost utilization index (utility cost/sqft/yr).
- **DX HVAC System:** refers to HVAC systems that utilize refrigerant to directly cool or heat air.
- **ECM:** refers to energy conservation measure.
- **EER:** refers to energy efficiency rating.
- **EMCS:** refers to energy management & control system.
- **EPI:** refers to energy performance index (kBTU/sqft/yr).
- **HVAC:** refers to heating, ventilation, and air conditioning.
- **IESNA:** refers to the Illuminating Engineering Society of North America.
- **IPLV:** refers to integrated part load value; efficiency rating for refrigeration equipment that is derived from efficiency characteristics at various loads.

- **kW:** (kilowatt-demand) represents any instantaneous electrical load, but is typically used to represent the maximum (peak) instantaneous load that occurred during the billing period.
- **kWh:** (kilowatt-hours) represents the total cumulative electrical consumption for the billing period without regard to any instantaneous load (kW) that occurred during the billing period. One kWh represents one kW being consumed for a period of one hour.
- **Life-Cycle Cost:** refers to the sum of all costs associated with owning an asset. For energy-consuming equipment, this includes first costs, operating costs (energy costs), maintenance costs, and replacement costs throughout a pre-determined analysis period.
- **Life-Cycle Cost Analysis:** refers to a comparative analysis of total life-cycle costs for more than one potential alternative design.
- **Major End-Use:** refers to any single energy use that accounts for more than 10 percent of a building's total energy consumption.
- **Meter:** refers to any utility meter used by the utility provider for billing purposes.
- **Metered State-Leased Building:** refers to any facility leased by a state agency where the agency is contractually obligated to pay for the consumption of utilities based on the utility provider's billing statement or the building owner's sub-meter.
- **Power Factor:** refers to the ratio of real power to apparent power (kVA). Power factor represents the amount of supplied power being used to perform work.
- **Reporting System:** refers to the Microsoft Excel® energy and cost data recordkeeping system presented in Chapter 4 and various appendices of this plan.
- **SCADA:** refers to supervisory control & data acquisition.
- **SEER:** refers to seasonal energy efficiency rating.
- **Smart Meter:** refers to an energy or utility meter and associated hardware or software that has the capability to collect and store instantaneous load (demand) data in addition to cumulative (consumption) data.
- **Sub-Meter:** refers to an electronic meter that is installed by the agency to measure the energy consumption and/or demand of a particular system or end-use within a building. All sub-meters that are required by this plan to collect demand data shall also be considered "smart meters".
- **Therms:** refers to the unit of measure typically used for natural gas. One therm is equivalent to one hundred cubic feet (CCF).
- **Tons:** refers to refrigeration capacity (HVAC). Tons represent instantaneous refrigeration capacity. One ton is equivalent to 12,000 BTUH.
- **Ton-Hours:** represents total cumulative refrigeration capacity without regard to any instantaneous load that occurred during the measurement interval.
- **Unitary HVAC Equipment:** any self-contained HVAC unit – typical used for residential and light commercial construction.

CHAPTER 3 – ENERGY DATA COLLECTION REQUIREMENTS

3.1 General

3.1.1 Scope of Energy Data Collection

These energy data collection requirements shall apply to all state-owned and metered state-leased buildings larger than 5,000 net square feet. These collection requirements represent a combination of utility bill data and specific sub-metering procedures designed to provide agencies with a more comprehensive view of how state buildings consume energy. The intent of these requirements is to provide a general structure for collecting information that is suitable to support effective energy-related decision making in public buildings.

The sub-metering requirements are intended to produce energy consumption data for the major energy end-uses within state buildings, but only where such sub-metering is practical. For example, due to the number of individual sub-meters required, sub-metering HVAC heating loads may not be practical for multiple duct-mounted electric reheat units scattered throughout a building, but would be practical for a centralized boiler system where energy consumption can be measured with one sub-meter device. Refer to Appendix A for further guidance regarding sub-metering procedures.

Lighting systems have been excluded from these requirements due to the number of separate sub-meters that would typically be required to measure lighting loads. Lighting loads can be approximated by subtracting other major end-uses from total building electrical consumption. Nevertheless, lighting systems often represent the largest single end-use in commercial buildings and proper control of these systems is an important component of an effective energy management strategy.

Domestic water heating systems have been included, but sub-metering is only expected for high-use facilities such as, or functionally similar to, dormitories, laboratories, and health care facilities (not office buildings).

3.1.2 Sub-Metered Data Sources

Collecting sub-metered energy data is a common function of the Energy Management & Control Systems (EMCS) found in most large commercial buildings today. EMCS typically control building HVAC systems but have evolved over time to include numerous energy management capabilities. EMCS typically trend total building electrical loads as well as major end-uses such as HVAC loads.

Implementing sub-metering schemes in buildings that have no EMCS requires a meter device, power source, internet connection, communication field panel, and possibly front-end software (assuming the building owner is not already using an internet-based EMCS software application in another facility or no such system at all).

EMCS vendors common to the HVAC industry are not the only providers of such energy monitoring capabilities, but they do provide software interface capabilities that are common to most large commercial buildings and building operators. Nevertheless, data acquisition such as this is available in what is generically referred to as SCADA (Supervisory Control & Data Acquisition) systems. The sub-metering and data collection capabilities referred to here are common across many industries.

The hardware required for collecting sub-metered consumption data such as electrical demand meters (split-core current transformers), flow meters, and temperature sensors often exist in large commercial buildings. Components such as these are often required to implement normal building automation schemes. The task of implementing a data collection program can be more administrative than technical in nature depending on the existing EMCS and its capabilities.

For fuels that are delivered in bulk such as fuel oil, diesel fuel, and propane, EMCS/SCADA (electronic) sub-meters are unnecessary. In these cases, conventional consumption meters such as those that are likely to already exist shall be considered appropriate.

3.2 Minimum Energy Data Collection Requirements

3.2.1 Buildings Larger Than 5,000 Net Square Feet

The following energy consumption data shall be sub-metered and trended:

- building electrical consumption and demand (main building feed)
- HVAC cooling consumption and demand for buildings with a total cooling system capacity of 50 tons or greater
- HVAC heating consumption and demand for buildings with a total heating system input capacity of 500,000 BTUH or greater
- domestic water heating consumption for buildings with a total water heating system input capacity of 300,000 BTUH or greater

Note: The minimum system capacity requirements for sub-metering listed above may be lowered in subsequent revisions to this plan. The initial system capacity requirements are intended to capture energy data on what is generally considered to be large commercial equipment. This plan will *most likely require more expansive equipment sub-metering as the agencies develop these skills and procedures.*

HVAC cooling and heating loads may not be practical to sub-meter for certain types of systems (refer to Energy Data Collection Schemes in Appendix A for further guidance). In general, sub-metering any single energy end-use shall be considered impractical when it requires more than four separate sub-meters to collect the required energy data.

In addition to the sub-meter data collection previously mentioned, monthly billing information and/or conventional consumption meters shall be utilized to collect the following energy consumption data (as applicable):

- building electrical consumption and peak demand
- domestic water consumption
- irrigation water consumption
- ground water consumption
- reuse water consumption
- natural gas consumption
- propane consumption
- diesel fuel consumption
- fuel oil consumption
- trash & recyclables generation

3.2.2 Buildings Smaller Than 5,000 Net Square Feet

The energy data collection and reporting requirements in this plan are not required for buildings smaller than 5,000 net square feet, but many of the procedures and recommendations outlined in this plan are applicable to smaller buildings. In particular, the reporting system presented in this plan can be utilized for buildings of all sizes even if no sub-metering is performed. The agencies should consider utilizing the reporting system to account for monthly billing statements.

3.3 Energy Data Collection Schemes

The technical requirements for setting up sub-metering schemes are located in Appendix A. Appendix A contains detailed information regarding how sub-metering should be approached as well as what type of energy data should be collected. Appendix A is intended to be reference material for engineers, energy managers, and vendors.

3.4 Campus Sub-Metering

When a group of buildings is served by a consolidated utility distribution system, sub-metering is required for the distribution system in addition to each individual building. This applies specifically to main electrical distributions and HVAC production plants. Consolidated consumption data will not be considered an acceptable alternative to individual building sub-meters. Refer to 4.3 for information regarding campus energy reporting.

3.5 Sub-Meter Accuracy

The following information shall serve as a general guideline for meter accuracy:

a. Electrical sub-meters (energy monitors): ±1% accuracy
b. Flow meters (water):
   - ±0.5% of reading at calibrated velocity
   - ±1% of reading from 3 to 30 feet per second (10:1 range)
   - ±2% of reading from 0.4 to 20 feet per second (50:1 range)
c. Flow meters (steam, gas, and other fluids): ±2% of reading at rate

3.6 Data Trends

Data trends for end-uses that require EMCS/SCADA sub-metering such as total building electrical consumption and HVAC loads shall incorporate a sampling frequency of 15 minutes. In other words, sub-meters shall collect energy consumption data points every 15 minutes in order to allow for meaningful demand load trends to be produced.

It is recommended that energy data trends be supplied to the agency-designated person(s) in Microsoft Excel® format for easy manipulation, analysis, and comparison to other demand loads; however, the agencies may utilize whatever format and/or software package they choose. The agencies will be responsible to develop energy data trends of sufficient quality to allow for adequate data analysis.

When considering potential software packages for EMCS/SCADA systems, some of the important features to be considered are:

- the ability to export trend data in Microsoft Excel® format
- the ability to generate graphs such as demand load profiles
- automated e-mail transmission of trend load data to energy managers
- dedicated computer storage capacity for historical data

CHAPTER 4 – DATA REPORTING FORMAT

4.1 Intent of Reporting Format

The reporting requirements presented in this chapter shall apply to state-owned and metered state-leased buildings larger than 5,000 net square feet. The reporting system and submission requirements discussed in Chapter 4 merely represent the format prescribed by the Department of Management Services (DMS), but these requirements shall not be misconstrued as data analysis procedures. Data analysis, as discussed in Chapter 5, will be the responsibility of the agencies.

The reporting system presented here will assist the agencies in determining energy consumption trends, but only to the extent of helping the agencies and DMS determine the effectiveness of the agency's energy management efforts. The minimum reporting requirements of this plan are outlined in the Annual Submission section (4.5) of this chapter.

The reporting system presented here was developed in order to replace the agency's recordkeeping procedures for utility consumption and cost data. The general intent of this reporting system is to provide a comprehensive reporting system that simultaneously achieves the following goals:

- Provide accurate utility records for the agency.
- Meet the reporting requirements of this plan.
- Meet the previous two goals while only requiring energy consumption and cost data to be entered once.
- Utilize a generic and common format (Microsoft Excel®).

4.2 Building Energy Report

4.2.1 General

The Building Energy Report (see Appendix B) lists the major energy end-uses typically found in large buildings. Agencies shall disregard end-uses that do not exist in their respective building(s) and report all consumption and peak load data for major end-uses in accordance with the Minimum Energy Data Collection Requirements (3.2). The Building Energy Report will be supplied by DMS in Microsoft Excel® format. See Appendix C for detailed instructions regarding the Building Energy Report.

For stand-alone buildings, the agencies will create one separate Microsoft Excel® file for each building and utilize the Utility Worksheets as described in this chapter to generate automatically the required Building Energy Reports. The Utility Worksheets are where all energy consumption and costs data will be recorded. The Utility Worksheets are included in the Building Energy Report file. For groups of buildings served by a common utility system, refer to Campus Energy Report (4.3).

The agency shall report utility bill data for the following end-uses:

- electrical consumption and cost
- water, sewer, storm water, & fire service consumption and cost
- reuse water consumption and cost

- natural gas consumption and cost
- other fuels (propane, diesel fuel, & fuel oil) consumption and cost
- trash generation and cost
- recyclables generation and cost

The agency shall also report sub-metered HVAC cooling, HVAC heating, and domestic water heating consumption data on the Building Energy Report when such energy data collection is required (see 3.2.1).

4.2.2 Utility Worksheets

The Utility Worksheets provided in the Building Energy Report file are where the agencies will record utility bill information as well as sub-metered consumption data. There are 11 separate Utility Worksheets (see Appendix B) provided with the Building Energy Report. The Utility Worksheets are labeled as follows:

- Electric Meters
- Domestic Water Meters
- Irrigation Water Meters
- Reuse Water Meters
- Natural Gas Meters
- Propane Consumption
- Diesel Fuel Consumption
- Fuel Oil Consumption
- Trash Collection
- Recyclables Collection
- Sub-Meters (electrical, HVAC, domestic water heating, etc.)

Each Utility Worksheet contains a summary table that will maintain a running total of each energy end-use (consumption and cost) for the building. The Building Energy Report references the consumption and cost data located in the Utility Worksheet summary tables.

The Utility Worksheets are provided as separate Microsoft Excel® worksheets within the Building Energy Report file. The Utility Worksheets provided by DMS will contain spaces for up to 20 separate meters of each type. The extra meter spaces will rarely be needed although it is possible for a single building to have more than one electric, gas, or water meter. The extra meter spaces provided in the Utility Worksheets were developed to account for consolidated utility distribution systems that serve more than one building (see 4.3 for further information). The Utility Worksheets are intended to be used for all scenarios. The Utility Worksheets can easily be modified to account for more meters if necessary. Likewise, the agencies may remove any extra meter spaces, but it is not necessary to do so.

The agency will be required to modify the itemized cost descriptions on the Utility Worksheets to match the itemized costs on their utility bill statements. The Utility Worksheets have extra spaces provided to allow for this and the summary tables in each worksheet are already referenced to these extra spaces.

<u>Note</u>: DMS strongly recommends that the agency modify the itemized cost descriptions to match exactly the itemized costs on the utility bill statement in order to prevent data entry error.

4.3 Campus Energy Report

4.3.1 General

For groups of buildings served by a consolidated (centralized) utility distribution system, the agencies shall prepare a Campus Energy Report (see Appendix B) that displays total energy consumption and cost data for the whole campus. The agencies shall create one separate Microsoft Excel® file for each campus and utilize the Utility Worksheets as described in this chapter to generate automatically the required Campus Energy Reports and Building Energy Reports.

The Campus Energy Report is a modified Building Energy Report. The Campus Energy Report will be supplied by DMS in Microsoft Excel® format. See Appendix C for detailed instructions regarding the Campus Energy Report.

4.3.2 Subordinate Building Energy Reports

The agencies shall prepare a Building Energy Report for each individual campus building. These "Subordinate" Building Energy Reports (see Appendix B) shall only include energy consumption and costs that are specifically metered or sub-metered at the respective building.

The Subordinate Building Energy Reports shall reside as separate Microsoft Excel® worksheets within the Campus Energy Report file. The Campus Energy Report file provided by DMS will contain three Subordinate Building Energy Reports. Additional Subordinate Building Energy Reports can be added by copying the existing worksheets.

4.3.3 Utility Worksheets for Campus Reporting

The Utility Worksheets (see Appendix B) shall be utilized for campus scenarios in much the same way they are utilized for stand-alone buildings. For campus reporting, the Campus Energy Report (not the

Building Energy Report) shall reference the Utility Worksheet summary tables.

The file available electronically from DMS will have the Campus Energy Report already referenced to the Utility Worksheet summary tables. The agencies will be required to reference the Subordinate Building Energy Reports to the appropriate individual meters or sub-meters in the Utility Worksheets as they implement this reporting system. See Appendix C for detailed instructions regarding campus reporting.

4.4 Agency Energy Report

The Agency Energy Report (see Appendix D) lists the major energy sources typically found in large commercial buildings. The Agency Energy Report is intended to be a summary of all agency Building Energy Reports. The agencies shall disregard energy sources that do not apply to their respective buildings.

The Agency Energy Report will summarize agency energy consumption and costs for all state-owned and metered state-leased facilities larger than 5,000 net square feet. The Agency Energy Report will be provided by DMS in Microsoft Excel® format.

The Agency Energy Report is the reporting form required by this plan, but it will also be the tool that agencies utilize to monitor overall agency energy consumption on a daily basis. The report is organized in two sections. The first section is organized by buildings and the second section is organized by months. The section organized by months will, after the initial set-up, automatically generate quarterly totals for each utility system category and compare them to the same quarter of the previous year. The Agency Energy Report file also contains a worksheet to assist the agencies in creating external references to each Building Energy Report file so that the Agency Energy Report is updated perpetually.

4.5 Annual Submission

The agency shall provide the annual submission to DMS in Adobe *(.pdf)* format. The annual submission shall be made to DMS by September 1st of each year and include agency energy consumption and costs for the entire preceding fiscal year.

The annual submission shall include the following documents and items:

- The Agency Energy Report (Section 1 & Section 2) for the current fiscal year as well as the previous two fiscal years.
- Graphical analyses of annual agency energy consumption comparing current consumption to consumption from both of the previous two fiscal years. Refer to Appendix E for a sample format. The graphical analyses

shall be prepared specifically for the following energy consumption categories from the Agency Energy Report:

1. total energy consumption (kBTU)
2. annual electrical consumption (kWh)
3. annual domestic water consumption (gallons)
4. annual irrigation water consumption (gallons)
5. annual groundwater consumption (gallons)
6. annual reuse water consumption (gallons)
7. annual natural gas consumption (CCF or therms)
8. annual propane consumption (gallons)
9. annual diesel fuel consumption (gallons)
10. annual fuel oil consumption (gallons)
11. annual trash generation (cubic yards)
12. annual recyclable generation (cubic yards)

- The Building Energy Reports for all stand-alone buildings (less the Utility Worksheets)
- The Campus Energy Reports and Subordinate Building Energy Reports for all campuses (less the Utility Worksheets)

4.6 Software Requirement

The reporting system presented in this plan will require the use of Microsoft Excel® 2007 or a newer version. This version of Microsoft Excel® includes the ability to export files in Adobe *(.pdf)* format, which is the file type required for submission to DMS.

4.7 Training

DMS will develop training materials to provide to the agencies regarding the new energy data reporting system presented in this plan. DMS will organize a seminar to provide hands-on training for agency-designated personnel. The training curriculum will include the following subjects:

- set-up procedures
- modifications to the reporting system
- referencing data in other Microsoft Excel® worksheets
- referencing data in external Microsoft Excel® workbooks (files)
- data entry procedures
- submission procedures
- others as requested

CHAPTER 5 – UNIFORM DATA ANALYSIS PROCEDURES

5.1 Consumption Data Analysis

5.1.1 Review Historical Consumption

The simplest method of analyzing energy consumption is to compare it to previous consumption. This shall be done in a graphical format. Monthly consumption data should be plotted on a bar chart next to the consumption for the same month from the previous year, or two years. This format will allow agency energy managers to view the consumption trend for the current year, but also compare the current trend to the previous year's trend. This analysis is most effective when it is performed for each building individually, but it can nonetheless be performed for a group of buildings. See Appendix E for a sample format.

5.1.2 Degree Day Analysis

Degree days are a quantitative index that represents the demand for energy used to heat or cool buildings. Cooling degree days represent the average daily outdoor temperature variations above the base temperature of 65 degrees Fahrenheit. Likewise, heating degree days represent the average daily outdoor temperature variations below the base temperature of 65 degrees Fahrenheit. Degree day statistics provide energy managers with basic insight into the weather-related effects on HVAC energy consumption.

Degree day analysis, in its simplest form, involves comparing the trend in monthly degree days to the trend in the building's cooling or heating load. For example, if the trend in cooling degree days decreases from one month to the next, then an energy manager should expect the building's actual cooling load to have also decreased over the same period. Otherwise, a problem may exist (assuming other factors like building occupancy and equipment schedules remained the same).

Agencies shall compare monthly degree day trends to monthly heating and cooling consumption when those end-uses are sub-metered. Degree day trends shall be compared to total building electrical consumption (kWh) in the absence of HVAC consumption data. Although the change in total building electrical consumption will not be as visible as the change in HVAC energy consumption, it should be evident.

Monthly degree day statistics are available for fourteen Florida cities from the National Weather Service at the following website:

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/cdus/degree_days/

5.2 Demand Load Analysis

5.2.1 General

Demand trend data produces a load profile that indicates the rate of consumption at any point in time. This information is extremely useful to energy managers and building owners because it indicates when energy is consumed in addition to the overall amount of consumption. Load profiles for total electrical consumption or major end-uses such as HVAC can indicate when buildings are occupied, or to what extent building systems are being used when buildings are known to be unoccupied.

Evaluating total building electrical demand alone is very beneficial when HVAC demand loads are impractical to collect. However, evaluating HVAC demand loads along with total building electrical load is most effective because energy managers can derive the percentage of total electrical consumption for which the HVAC load accounts. With such information, energy managers often can reasonably deduce the lighting load because the other largest building load component will be known.

Another benefit of HVAC demand load data is that agencies will know what their peak HVAC cooling and heating loads happen to be. For instance, when agencies have to replace aging air-conditioning systems, they will be able to base their equipment selection, in part, on actual capacity data rather than a guess or just replacing the equipment with the same size as the existing equipment. See Life-Cycle Cost Analysis (7.5.2) for further guidance regarding equipment selection.

5.2.2 Equipment Schedule Verification

Demand load profiles depict how much energy is being consumed at any single point in time. Energy managers can use demand load data to determine if major energy-consuming equipment such as lighting and HVAC systems, which typically account for most of the energy consumed in a building, are operating after normal work hours, on weekends, or any other time a building is known to be unoccupied.

Demand load profiles also clearly indicate what time such systems start in the morning and stop in the evening. For example, such data for an HVAC cooling load proves whether or not the HVAC system schedules are being maintained. Appendix F shows a typical daily HVAC cooling load profile for a sample state building where HVAC equipment is turned off after normal work hours – *note how the air-handler (AHU) start/stop times are clearly evident*. Appendix G shows typical monthly HVAC cooling load profiles for sample summer and winter months – *note how weekdays and weekends are discernable in both profiles*. Demand load profiles for building electrical consumption can provide similar insight for lighting system schedules, as well as HVAC schedules.

EMCS typically control the start and stop times for building HVAC systems, but there are challenges involved in maintaining control of these schedules that are worth mentioning and worth correcting whenever they may exist. Some of these challenges are:

- Often overriding equipment schedules for special events.
- Competing authority for control of equipment schedules exists often.
- Staffing levels and overtime restrictions often prohibit maintenance personnel from actually witnessing start/stop times.

Agencies shall review demand load profiles for building electrical consumption and HVAC loads in order to verify equipment schedules, preferably on a monthly basis. Quarterly review may, however, be more practical, but monthly review is more effective.

5.2.3 Base Load Analysis

Appendix F represents a monthly HVAC cooling load profile for a sample state facility. The base load can be approximated as a trend line that could be drawn through all the valleys in the load profile. The shape of the electrical load profile for the same facility would look similar. When electrically driven HVAC systems are utilized, the HVAC load is merely a component of the total building electrical load, albeit a rather large component.

The base load is nothing more than the minimum load that occurs in a building or facility. Base loads can also be defined as the building loads that are not weather-dependent. In most office buildings, the base load occurs during the overnight hours when the facility is unoccupied.

Base energy loads occur because there is typically a minimum amount of lighting and HVAC that has to occur even when the building is empty at night. Computer server rooms, telephone rooms, and other equipment rooms often have to be cooled around the clock.

Analyzing base loads includes trending the base load to verify that it does not increase without reason, but it also includes investigating the load to determine if it can be reduced. This is true for any base load whether it is the HVAC or total building electrical load. Some of the questions energy managers should ask when evaluating a base load or night load are:

- Are all non-essential lights being shut off at night?
- Are parking lots and exterior walkways over lit?

- Are all non-critical HVAC systems being shut down at night?
- Are any critical areas cooled by the same HVAC systems that serve non-critical areas? This is an HVAC zoning question, but is as pertinent for existing buildings as it is for new buildings due to the creation of new computer server rooms that often occurs.
- Are all personal computers being shut down at night?
- Are there any unnecessary plug loads?

Effective base load analysis requires that agencies, particularly their energy managers, become familiar with the base loads of their buildings. In other words, building owners should know the approximate kW load of their lighting and HVAC systems and be able to approximate what percentage of those loads should be present after normal work hours.

Agencies shall determine and review their base loads for all sub-metered end-uses and total building electrical loads, preferably on a monthly basis. Quarterly analysis may, however, be more practical.

5.2.4 Peak Load Analysis

Appendix F shows peak load for the monthly HVAC cooling load for a sample state building. The peak load can be approximated as a trend line that could be drawn through all the peaks in the load profile. Peak loads are important because utility customers can incur substantial charges based on the peak kW loads that occur during the billing cycle. Demand charges are incurred separately to consumption charges.

Methods to reduce peak loads, in addition to installing new equipment that is more energy efficient than the existing equipment, generally involve determining when peak loads occur and implementing load management strategies to change or reshape the load profile in order to reduce peak loads. Such load management strategies typically include:

- <u>Peak clipping</u> – the reduction of the system peak loads (and overall consumption) through installing more energy efficient equipment or possibly by limiting directly the use of energy-consuming equipment. This method of load shape management represents true energy conservation. *See Figure 1 below.*
- <u>Valley filling</u> – increasing off-peak loads, particularly for future load requirements, through technologies such as HVAC thermal energy storage. This method of load management is primarily a cost-saving strategy.
- <u>Load shifting</u> – shifting existing on-peak loads to off-peak periods (a.k.a. load leveling) through technologies such as HVAC thermal energy storage and/or customer load shifts. This method of load management is primarily a cost-saving strategy.

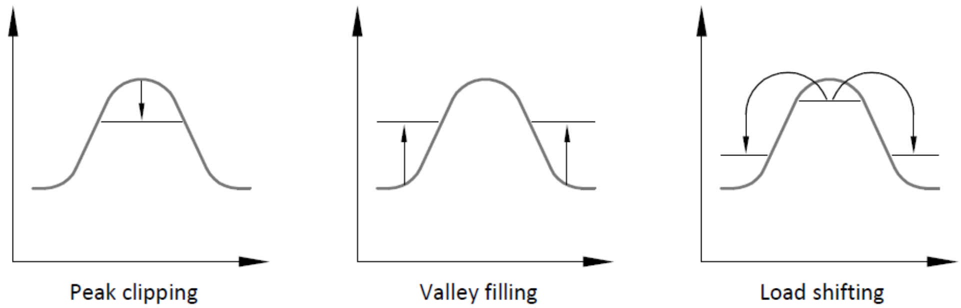

Figure 1: Load shape objectives

Agencies shall review demand load profiles for all sub-metered end-uses as well as total building electrical loads, preferably on a monthly basis. Quarterly analysis may, however, may be more practical. Nevertheless, reviewing demand loads on at any interval is better than not doing it at all.

5.3 Energy Performance Metrics

5.3.1 Benchmarking

Comparing energy consumption and costs to that of other buildings in the same climatic region, otherwise known as benchmarking, is another useful tool for evaluating relative building energy efficiency. Benchmarking is less accurate than an energy audit, but it can help building owners identify their most urgent energy-related needs. It should be noted, however, that the primary goal of this plan is to result in an overall reduction of energy consumption in state buildings. Benchmarking in and of itself does not contribute to reducing energy consumption.

There are several resources available for benchmarking, including:

- Energy Star® Portfolio Manager (U.S. Department of Energy)
- Energy Star® Target Finder (U.S. Department of Energy)
- The Energy Information Administration (EIA)
- Commercial Building Energy Consumption Survey (CBECS)

Building energy consumption shall be normalized for gross square foot of building floor area. Relative energy use shall be expressed as the energy performance index (EPI) – see 5.3.2. Relative energy costs shall be expressed as the cost utilization index (CUI) – see 5.3.3. Individual state buildings should be compared to similar buildings using database resources such as those previously mentioned. See Appendix H for sample energy consumption and cost statistics from CBECS.

Statistics such as those provided by CBECS will provide agencies with a resource to base energy performance goals for existing buildings. Other resources such as ASHRAE Standard 90.1 or Energy Star® should be pursued as an ultimate goal for energy performance and will help agencies achieve sustainability goals such as the *USGBC Leadership in Energy and Environmental Design (LEED)*.

5.3.2 Energy Performance Index (EPI)

Agency energy consumption shall be expressed on the Building Energy Reports and the Agency Energy Reports in terms of thousand BTUs of consumption per gross square foot per year (kBTU/sqft/yr). The Building Energy Report, Campus Energy Report, and the Agency Energy Report forms have embedded formulas to calculate the EPI based on the energy consumption data supplied by the agency. The Building Energy Report will indicate the EPI for the building. The Campus Energy Report will indicate the EPI for the campus. The Agency Energy Report will indicate the overall agency EPI. Agencies will be expected to supply gross square footage data for each building on each report.

The total agency EPI, which is based on total annual agency consumption and total agency gross square footage, will provide each agency a quick measure of the effectiveness of its energy management program. The EPI for individual buildings will allow agencies to track energy efficiency at the building level and assist in isolating excessive energy consumption when it occurs.

The EPI indicates average energy efficiency without respect to total consumption. The EPI will not become worse (higher) for agencies that have increasing square footage, assuming the new space is more energy efficient than the overall agency EPI or the space it replaces.

The conversion factors required to determine kBTU consumption are:

Energy Source	Energy Unit	kBTU Equivalent
electricity	kWh	3.412
natural gas	CCF or therm	103.2
propane	gallon	91.6
diesel fuel	gallon	138.69
fuel oil	gallon	138.69

5.3.3 Cost Utilization Index (CUI)

Agency energy costs shall be expressed on the Agency Energy Reports in terms of energy cost per gross square foot per year ($/sqft/yr). The Agency Energy Report form has an embedded formula to calculate the

CUI based on the energy cost data supplied by the agency. The Agency Energy Report will indicate the overall agency CUI. Agencies will be expected to supply agency-wide gross square footage on the Agency Energy Report where indicated.

The CUI will be an important measurement technique because certain energy management strategies such as HVAC thermal energy storage and rate classification changes are primarily cost-saving strategies and will not be evident in the EPI. The CUI is intended to document the value of such cost-saving measures as well as to provide the state and taxpayers with assurances that utility expenditures are managed judiciously.

CHAPTER 6 – ENERGY AUDIT PROCEDURES

6.1 General Description & Requirements

An energy audit is a detailed, methodical survey of building components and systems designed to uncover all potential energy conservation measures that exist in the building(s). Audit procedures can vary in scope based on building type and function, the needs of the building owner, existing energy management procedures, or the presence of existing third-party audit contracts. Routine energy audits, nevertheless, are a vital part of an effective energy management strategy.

The audit shall conclude with a detailed report of recommended energy conservation measures (ECMs) that are designed to reduce energy consumption and costs. Agencies should utilize the audit report in their long-term strategic plans in order to minimize future energy-related expenditures.

The agency shall either engage a third party vendor to perform an audit, or perform the audit internally with qualified staff. However, DMS recommends that agencies have all audits prepared by a professional engineer (P.E.) if possible. The agency may utilize the Energy Performance Contracting Process (ESCO), as defined in Section 489.145, Florida Statutes for payment of the audit. Contact DMS for further information regarding the ESCO process.

6.2 Energy Audit Procedures

6.2.1 Step 1: Compile Data

The auditor shall collect general facility information such as:

- size
- age
- construction type
- condition and general use of the facility

The auditor shall also collect and summarize utility cost and consumption data for the most recent 24 to 36 month period. The auditor shall evaluate the potential impact on utility cost and consumption of any energy initiatives currently being installed planned by the agency.

The agency shall make available (or cause its energy suppliers to make available) all available records and data concerning energy and water usage for the facility for the most current 24 to 36 month period, if available, including:

- utility records
- occupancy information
- descriptions of any changes to the structure of the facility or energy-related systems
- descriptions of all major energy-saving and water-saving equipment used in the facility
- any comfort problems
- code deficiencies
- description of energy management procedures presently utilized

The agency shall also make available a record of any energy-related improvements or modifications that have been installed during the past three years, or are currently being installed. The agency shall also make available copies of drawings, equipment logs and maintenance work orders to the auditor.

6.2.2 Step 2: Analyze Existing Systems and Equipment

The auditor shall compile an analysis based on a physical inspection of the major electrical and mechanical systems at the facility, including:

- HVAC cooling systems and related equipment
- HVAC heating and heat distribution systems
- automatic temperature control systems and equipment (EMCS)
- air distribution systems and equipment
- outdoor ventilation systems and equipment
- kitchen and associated dining room equipment, if applicable
- exhaust systems and equipment
- hot water systems
- electric motors (5 horsepower and above) and drive systems
- interior and exterior lighting
- laundry equipment, if applicable
- building envelope
- all water consumption end-uses

- other major energy using systems, if applicable

The analysis shall address the following considerations:

- the loads, efficiencies or hours of operation for each system (engineering estimates may be used when necessary, but for large fluctuating loads with high potential savings, appropriate measurements are required unless waived by the agency)
- current operating conditions for each system

The auditor shall conduct interviews with operation and maintenance staff regarding the facility's mechanical systems operation, occupancy patterns and problems with comfort levels or equipment reliability.

6.2.3 Step 3: Establish and Calibrate The Energy Baseline

The auditor may, upon recommendation by the agency, analyze loading, usage and/or hours of operation for all major end-uses representing more than five percent of total facility consumption including, but not limited to, the following:

- lighting
- HVAC heating
- HVAC cooling
- HVAC motors (fans and pumps)
- plug load
- kitchen equipment
- other equipment
- miscellaneous

Where loading and/or usage are highly uncertain, the auditor shall employ spot measurement and/or short-term monitoring at his/her discretion, or at the request of the agency. Reasonable applications of measurement typically include variable loads that are likely candidates for conservation measures, such as HVAC equipment. The auditor shall consult with facility staff and account for any unusual or anomalous utility bills which may skew baseline consumption from a reasonable representation.

The auditor shall develop a computer simulation baseline model as part of the audit. The computer simulation program shall be approved by the agency. The baseline model shall represent pre-existing energy consumption for all end-uses within the building(s), not just those end-uses affected by the auditor's proposed conservation measures.

The baseline model shall be developed and calibrated with the assistance of utility bill data for no less than the immediately preceding 24-month period in order to develop an energy baseline model that is suitable for agency consideration. A detailed description of all existing baseline conditions, development methods, calibration procedures, adjustments, and assumptions for each building must be provided.

6.2.4 Step 4: Evaluate Potential Energy Conservation Measures

The auditor shall:

- identify and propose potential ECMs for installation or implementation at the facility
- estimate the cost, savings and life expectancy of each proposed measure; specify facility operation and maintenance procedures which will be affected by the installation/implementation of the proposed ECMs
- provide analysis methodology, supporting calculations and assumptions used to estimate savings, which shall be based on the life-cycle cost calculations described in Section 255.255 of the Florida Statutes
- provide a life-cycle cost analysis of the proposed system/equipment scheme(s) for potential ECMs that involve replacing major energy-consuming equipment
- calculate the projected energy cost savings as the difference between baseline energy costs and the costs that are expected to result from the proposed ECMs
- provide access to the computer simulation program and all inputs and assumptions used, if requested by the agency
- provide a preliminary commissioning plan for the proposed ECMs
- provide detailed calculations for any rate savings proposals
- provide detailed supporting calculations for any proposed maintenance or other operational savings
- estimate any environmental costs or benefits of the proposed ECMs (such as disposal costs, avoided emissions, water conservation, etc)
- comply with all applicable codes and regulations in effect at the time of this analysis for all proposed ECMs

6.2.5 Step 5: Deliver the Audit

The auditor shall complete and deliver the audit report to the agency in the following format:

- an executive summary that describes the facility, all ECMs that were evaluated, analysis methodology, results, and a summary table presenting the cost and savings estimates for each ECM

- a discussion of ECMs not evaluated in detail and the explanation of why a detailed analysis was not performed
- a summary of all utility bills, baseline consumption and how it was established, and end-use calibration with respect to the baseline including a discussion of any unusual characteristics and findings
- detailed descriptions for each ECM including analysis method, supporting calculations (may be submitted in appendices), results, proposed equipment and implementation issues
- conclusions, observations, and caveats regarding cost and savings estimates
- thorough appendices which document the data relied upon to prepare the analysis and how that data was collected

CHAPTER 7 – TECHNIQUES FOR REDUCING ENERGY CONSUMPTION

7.1 General Intent

The techniques presented here were specifically developed to be applicable to existing state buildings. All of the techniques presented here are applicable to new construction and major renovations, but the discussion of each technique has been tailored for existing buildings. The information presented in this chapter is specifically intended for architects, engineers, energy management coordinators, building managers, and planners.

7.2 Equipment Surveys

The first step in developing an effective energy management program is for building owners to become familiar with their buildings, particularly the energy-consuming systems within them. Building managers or energy managers should survey each building and create an equipment inventory. This should include a count and description of lighting fixtures and all HVAC-related equipment and all size, capacity, and power characteristics.

This information will assist energy managers in developing a sense of what energy-reduction potential exists in a building. Agencies should survey their buildings in order to help develop an understanding of what percentage each major energy end-use represents when compared to total energy consumption. Agencies should also develop an understanding of how much energy should be consumed during night hours and weekends.

7.3 Building Commissioning

Commissioning is a process designed to assure that a building, constructed or renovated, operates as intended. The commissioning process typically includes the review and testing of all building systems. The commissioning agent (C_x) is typically involved in the project from design development through the completion of construction.

Commissioning services for existing buildings (a.k.a. retro-commissioning) is a periodic event in the life of the building to assure that all building systems continue to operate as originally designed. Retro-commissioning services typically include interaction with the building maintenance staff as equipment is checked and adjustments are made by the installation contractor.

Building commissioning should be included in all new construction and major building renovations. The commissioning agent should ideally be under contract with the owner rather than the construction manager or design engineer in order to maintain an unbiased viewpoint of the project.

7.4 Electrical Systems

7.4.1 Lighting Controls

Lighting controls have become commonplace to most building EMCS manufacturers in recent years. Such control systems replace older timer and relay systems and can be easily incorporated into most building EMCS. Lighting schedules can be maintained in a fashion similar to building HVAC systems. Such control systems can also provide an override function to allow occupants to use lights for a predetermined time period after normal work hours or on the weekends if necessary.

Lighting control strategies can be as simple as installing motion sensors in offices or as complex as providing daylight harvesting, which means using outside light whenever possible. Nevertheless, such control features and strategies should be evaluated whenever lighting system and EMCS renovations are considered.

7.4.2 Lighting Retrofits

The efficiency of fluorescent lighting is increasing rapidly. Not long ago, T-12 fixtures and bulbs were considered high-efficiency. 32-watt T-8 fluorescent lighting is now generally considered to represent standard efficiency, but high-efficiency T-8 lamps are now commonplace. T-8 lamps are also available in 28-watt and 25-watt varieties. High-efficiency fluorescent lighting, including compact fluorescent bulbs, should be incorporated as the agency's standard for replacement lamps and bulbs.

Replacing 32-watt T-8 lamps with high-efficiency T-8 lamps often provides an attractive return on investment. One of the advantages of replacing old T-8 lamps with more efficient T-8 lamps is that fixture replacement is usually not necessary. Ballasts often have to be replaced with high-efficiency or rapid-start models. Nevertheless, lighting system upgrades can often be made without the expense of a complete light fixture replacement. For these reasons, T-8 conversion projects such as these are particularly well-suited for energy management retrofits.

7.4.3 Lighting Design

Lighting system design for new construction and renovation projects should be performed in accordance with recommendations promulgated by organizations such as the Illuminating Engineering Society of North America (IESNA) and the American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc (ASHRAE).

For new construction and major renovations, T-5 lighting systems should be explored as an option to standard T-8 systems. T-5 systems usually require fewer fixtures than T-8 systems due to higher light output, but they can result in higher initial costs. Such decisions should be carefully weighed during the design development phase.

Lighting system design should consider incorporating EMCS-connected lighting controls and daylight harvesting for perimeter areas in state buildings. Emerging technologies such as light-emitting diodes (LEDs) should also be considered for outdoor and special-purpose lighting systems. Incandescent lighting should always be avoided.

7.4.4 General Lighting Design Guideline

Table 2 displays the general lighting design guideline recommended in this plan. Variance from the design guideline presented here is generally discouraged unless it can be demonstrated that it is necessary for the occupants or that the added energy usage can be offset with improvements to other energy-consuming systems.

Other lighting applications are recommended to be designed in accordance with the *IESNA Lighting Handbook, Ninth Edition*.

In general, task lighting is recommended to assist the agencies in achieving the design standards shown in Table 2. Task lighting such as fluorescent desk lamps and similar fixtures can be very beneficial because they direct light only where the occupant needs it, but nowhere else. In addition, the occupant can turn task lighting off when it is not needed or desired. Area lighting can ultimately be designed to lesser levels than shown in Table 2, but then utilize task lighting to make up the difference.

Table 2: General Lighting Design Guideline

Location	Task	Horizontal Illuminance (foot candles)	Vertical Illuminance (foot candles)
Auditoriums:			
	Assembly	10	-
	Social Activity	5	3
Conference Rooms:			
	Meeting	30	5
	Critical Seeing	50	30
Offices:			
	General & Private	40	5
	Open Plan	40	5
	Lobbies & Reception	10	3
	Copy Rooms	10	3
Service Spaces:			
	Stairwells/Corridors	5	-
	Toilets/Washrooms	5	3

7.4.5 Power Factor Correction

Power factor is the ratio of working power (kW) to apparent power (kVA), which means it is a measure of how efficiently electrical power is being utilized. High power factor indicates that electrical power is being utilized efficiently.

Power factor is naturally degraded by inductive loads such as electric motors, transformers, and fluorescent lighting ballasts. An inductive load is any electrical load that requires a magnetic field to operate. Facilities that have high inductive loads such as factories or manufacturing operations tend to have the lowest power factors. Large electric motors tend to be the leading cause of low power factor.

The basic result of low power factor is that the utility has to provide excess power to account for the power lost due to the inherent inefficiency. Low power factor can be corrected with the installation of capacitors, but the energy savings tend to be minimal.

Power factor correction can make economic sense when the utility provider penalizes low power factor conditions through added fees and charges. The potential cost savings from power factor correction is sometimes misrepresented by marketers of such equipment; therefore, building owners should carefully evaluate all such proposals. Power factor correction should be considered for large electric motor installations, but it should not be done in place of purchasing higher motor efficiency. Power factor correction should only supplement the purchase of higher motor efficiency. Purchasing higher motor efficiency has been shown to provide more tangible results than power factor correction alone.

7.5 HVAC Systems

7.5.1 Temperature Set-Points

HVAC space temperature set-points should be set between 76 and 78 degrees Fahrenheit for space-cooling systems and between 68 and 70 degrees Fahrenheit for space-heating systems.

These requirements should be followed for all types of spaces, except those used for computer servers or any other type of heat-sensitive equipment. When heat-sensitive equipment is used, the agencies should follow the equipment manufacturer's recommendations for ambient temperature conditions.

7.5.2 Life-Cycle Cost Analysis

Note: A life-cycle cost analysis as described in this section is required in the Florida Life-Cycle Cost Analysis Program, pursuant to Rule 60D-4 of the Florida Administrative Code, for the selection of major energy-consuming equipment. This section offers a discussion of the importance of a life-cycle cost analysis whenever energy-consuming equipment is selected by an agency.

The term "life-cycle cost" refers to the total cost of owning, operating, maintaining, and replacing an asset over a predetermined analysis period. All immediate and future costs associated with an asset should be considered. For major energy-consuming equipment such as HVAC and lighting equipment, the total life-cycle cost includes all of the following:

- initial costs: this includes the costs to purchase and completely install the equipment in a manner that renders it fully operational
- operating costs: this includes all energy costs involved in operating the equipment over its service life
- maintenance costs: this includes all current and future costs associated with regular service and maintenance and should include major repair costs when they can be anticipated
- replacement costs: this includes the costs to replace equipment that has a service life shorter than the analysis period

Whenever an agency is considering replacing energy-consuming equipment, the selection of new equipment shall be based on a life-cycle cost analysis. In other words, the agency should compare the total life cycle costs of alternative systems or items of equipment that represent varying levels of energy efficiency. Higher energy efficiency generally results in lower total life-cycle costs, but there are situations when that assumption does not hold true. The underlying rationale behind the life-cycle method is that the comparison of life-cycle costs among alternative designs will prove which design provides the most economic logic (value).

Operating costs (energy costs) typically represent the largest single cost associated with energy-consuming equipment, sometimes as much as 60 percent of the total life-cycle cost. Therefore, the life-cycle method automatically incorporates an advantage to the alternative design that is most energy efficient. Unfortunately, high initial costs and maintenance costs occasionally create a situation where the most energy efficient choice does not have the lowest life-cycle cost. This phenomenon occurs mostly for new technologies that are not well-established in the marketplace. Nevertheless, the life-cycle method strongly supports the goal of sustainability as it accounts for the effects of market imperfections.

Total life-cycle costs should be presented in terms of a present value. In other words, all future costs that occur during the service life should be discounted to present value so that the total life-cycle costs of the alternatives are compared in constant dollars.

The analysis period used to compare life-cycle costs should be no longer than 25 years. In addition, residual value (remaining value) should be incorporated for replacement equipment that is expected to last beyond the analysis period. The residual value should be calculated as follows:

Residual value = replacement cost x (remaining service life / expected service life)

Life-cycle cost analyses may not be cost-effective (or practical) for small energy-consuming equipment due to the cost of the requisite engineering analysis, but agencies should incorporate this methodology for larger projects such as the following:

- chiller replacements
- large air-conditioning/heat pump unit replacements
- boiler replacements
- major lighting system upgrades
- large water heater replacements
- new construction and additions (all energy-consuming systems)

The agencies should avoid replacing the above-mentioned equipment without procuring the services of a professional engineer to provide engineering analysis, plans, and specifications. Although the added expense of such services may seem unnecessary or prohibitive when compared to the cost of the project, such engineering services are the most effective means of ensuring that energy consumption and costs actually decrease. The cost of such engineering analysis will not appear high when compared to the total life-cycle cost of the new equipment and systems.

Major equipment replacement projects occur only once every 20 to 25 years in typical buildings – *these projects are worth doing right*.

7.5.3 Equipment Selection Rationale

The selection of energy-consuming equipment shall be made on the basis of total life-cycle costs, but it can be tempting to base equipment selections on other rationales as discussed here:

a. Initial cost: The incremental cost of gaining energy efficiency can occasionally be prohibitive, but the argument against pursuing higher energy efficiency is merely anecdotal unless a proper life-cycle cost analysis is performed. Equipment that was too expensive five years ago may be affordable today.

b. Locally-available equipment: Proper planning will help alleviate the need to choose equipment that is immediately available from local suppliers. Emergencies do occur, but the agencies shall strive to make energy efficiency one of their highest priorities.

c. Technical familiarity: Maintenance staffs often prefer to specify equipment that is familiar to them. They may also have preferences regarding the type of equipment that stem from their technical abilities. There is no argument to the validity of these types of concerns, but they must be made proportionate to the energy performance goals of the state if energy consumption is to be truly reduced. Energy consumption is typically the largest single cost associated with energy-consuming equipment. Therefore, energy efficiency concerns should outweigh other concerns. Maintenance staffs can be trained, but building owners can be stuck with high energy costs for decades.

7.5.4 Maintenance Staff Training

Properly trained maintenance personnel are more important than ever due to the high cost of energy. State agencies cannot run the risk of having maintenance staffs whose technical abilities are strictly defined by the types of systems within the state’s inventory. Similar to other professionals, maintenance professionals must be required to develop their skills and receive technical training on a regular basis.

Factory training from HVAC equipment manufacturers is one of the most effective ways to develop the technical skills of maintenance personnel. HVAC systems are somewhat different than other energy-consuming systems because they have the potential to operate very inefficiently without any apparent outward symptoms. The agencies should require factory training and certifications for all HVAC maintenance personnel as a means to ensure that all HVAC systems perform optimally.

7.5.5 Critical Room Cooling

A critical room can be loosely defined as any room that requires 24-hour cooling. Computer server rooms are often considered critical rooms, but any room that contains heat sensitive equipment that must operate around the clock should be considered a critical room. This plan does not attempt to define what constitutes a critical room, but it does provide guidance regarding how to approach cooling critical rooms.

Critical rooms should always be cooled with stand-alone (separate) HVAC units whenever the main building HVAC units are shut down after normal work hours. This almost always applies to buildings that are comprised primarily of office space because HVAC systems in such buildings should always be turned off when the building is unoccupied. Office building owners should never cool critical rooms with the main building HVAC system because it ultimately means that the entire building is being cooled 24 hours a day in order to cool one or two rooms. This mistake is extremely wasteful from an energy management perspective.

Stand-alone HVAC units that are commonly used for critical room cooling tend to be small in comparison to the systems that are used to cool entire buildings. Small HVAC units are often much less efficient than larger systems, which is a fact that is often used to justify cooling critical rooms with the main building system, but all that really matters is that less overall energy is consumed. The energy efficiency rating of any HVAC equipment is very important, but not at the cost of cooling an entire building unnecessarily.

Building owners should approach the construction and renovation of critical rooms (particularly computer server rooms) with caution for the reasons mentioned previously. The construction and renovation of critical rooms should always include a licensed engineer on the design team as an attempt to avoid costly energy errors.

7.5.6 Energy Management & Control Systems (EMCS)

Energy Management & Control Systems (EMCS) are common to most large commercial buildings. These systems should be considered for buildings that have outdated systems or that have no such systems at all. EMCS have evolved over time to perform very advanced energy management procedures, but some of the basic areas affecting daily energy performance are as follows:

a. Complete EMCS: EMCS are often installed in phases in existing buildings due to budget concerns. It is not uncommon for EMCS to control only floor-level equipment like air-handling units while not controlling zone-level equipment like air terminal boxes. Agencies should consider completing EMCS such as these. Overall, EMCS represent the most effective method to monitor and improve energy performance.

b. Equipment schedules: Automated HVAC equipment schedules are essential for energy management efforts, but the agencies should make certain that the equipment schedules are verified (see Uniform Data Analysis Procedures located in Chapter 5) and accurate. The agencies should regularly survey tenants to make sure the current equipment schedules are valid and that equipment is not operating after the tenants leave the building.

c. Master set-points: This involves programming the EMCS to utilize a master space temperature set-point for building HVAC systems. This approach should be considered for all areas of the building that are not critical (e.g., offices, corridors, and common areas). This feature would allow agency HVAC operators to raise all non-critical building set-points with one command rather than adjusting each equipment controller with separate commands, which is a task that can be extremely time-consuming in large buildings.

d. Accurate system graphics & programs: Building systems are typically represented in the EMCS as graphics. These graphics are primarily how HVAC system operators monitor these systems. Graphical representations that incorrectly represent building systems can lead to errors that result in operational problems and excessive energy consumption. The development of new graphics for HVAC-related projects should be reviewed by the design engineer or third-party commissioning agent in order to assure that such problems are avoided. The control programs for new equipment should also be similarly reviewed.

e. Air-handler shut-down: It is not enough to merely shut down HVAC equipment after normal work hours. The systems being shut down must be properly and completely shut down. For example, shutting down all the air-handling units in a building must also include shutting down any exhaust fans and outside air supply fans that exist. Failure to do so will waste energy due to constant fan operation, but it can also result in moisture problems due to the introduction of untreated outside air in the building. Additional energy is also wasted because the extra heat and humidity introduced in the building has to be removed the following morning when the HVAC system starts again.

Note: Exhaust fans and outside air supply fans should have automatic dampers that close when the fans are turned off. Otherwise, there is an effective opening in the building envelope that can contribute to the same type of moisture problems previously mentioned even when the fans are not running. This problem is ultimately broader than the issue of EMCS operation, but HVAC and EMCS technicians represent the first line of defense in identifying such problems.

7.5.7 Water-Cooled vs. Air-Cooled Systems

Air-conditioning systems can be classified in two distinct types: water-cooled and air-cooled. The basic function of any air-conditioning system is to transfer heat from inside the building to some external medium located outside the building. The condenser section of any air-conditioning system is where the heat is transferred to the outside medium.

Air-cooled systems use outdoor air as the external medium. Air-cooled systems are typically designed to transfer heat directly from the refrigerant in the condenser to the outside air (ambient air). There is no intermediate medium between air-cooled condensers and the ambient air.

Water-cooled systems utilize water as an intermediate medium to transfer heat from the condenser to the external medium. Water-cooled systems often utilize cooling towers which ultimately transfer heat to the ambient air but are able to create water temperatures lower than the ambient air temperatures due to the effects of evaporative cooling. Water-cooled systems can also directly utilize the geothermal properties of the earth by directly using groundwater or indirectly through a closed geothermal loop. Both geothermal methods produce condenser temperatures that are lower than ambient air temperatures. Air-cooled systems cannot create condenser temperatures that are lower than ambient air temperature.

Due to the lower condenser temperatures that can be achieved, water-cooled systems are always more efficient than comparable air-cooled systems. All such systems perform better when the external medium temperature is closer to the internal building temperature. In other words, it requires less work to transfer a given amount of heat from a 75-degree building to an 85-degree external medium than would be required to transfer the same amount of heat from the same 75-degree building to a 95-degree external medium.

Water-cooled systems should always be considered when an agency has to replace major HVAC equipment, particularly chillers. Water-cooled chillers can have substantially higher initial costs, but it is not uncommon for these systems to be up to 40 percent more efficient than comparable air-cooled chillers. Switching to water-cooled chillers often involves installing cooling towers or geothermal wells, both of which take up space and add to the initial cost, but the energy savings often make the water-cooled option more economical when total life-cycle costs are considered.

Air-cooled chillers are often preferred by building owners because they are installed outside the building and do not take up indoor floor space. However, air-cooled chillers typically have shorter service lives than water-cooled options, especially in coastal areas where the corrosive salt air can greatly reduce the service life of air-cooled equipment, possibly by 30 percent or more. Life-cycle cost comparisons between water-cooled and air-cooled options should include replacement costs.

7.5.8 Geothermal Wells

The use of ground water for cooling air-conditioning systems has been around for many years, but it is often overlooked as a viable alternative to cooling towers. The use of cooling towers is a much more efficient approach compared to air-cooled systems, but utilizing ground water to cool air-conditioner condensers can be substantially more efficient than the use of cooling towers. Ground water is often 10 to 15 degrees cooler than cooling tower systems can produce, meaning that system efficiency can be dramatically improved.

Implementing the use of ground water cooling involves the installation of a deep supply well as a source of ground water and a return well as a means to return the water back to the aquifer. All of the water used for cooling purposes is returned to the aquifer; therefore, this technique does not result in true consumption. The water returned to the aquifer is usually no more than 10 degrees warmer than the water removed.

Restrictions regarding the use of ground water from municipalities and water management districts can be a barrier to implementation. Some of these barriers can include the following:

- Location: The proximity of new wells to existing wells can be a concern to authorities having jurisdiction.
- Ground stability: The threat of a well collapsing can cause the authorities having jurisdiction to discourage new well construction.
- Leakage: The use of low-pressure refrigerants may be required by the authorities having jurisdiction as a means to prevent ground water contamination. If a condenser tube were to rupture, high-pressure refrigerants are more likely to leak into the ground water than low-pressure refrigerants.

The use of ground water for air-conditioning purposes should be explored whenever possible. The incremental cost of digging large wells should be weighed against the efficiency gains in a life-cycle cost analysis.

7.5.9 Minimum Cooling Efficiency

For large HVAC equipment, the agencies should strive to exceed the minimum full-load efficiency and part-load efficiency (IPLV) requirements listed in Table 3.

Table 3: Minimum Cooling Efficiency (Large HVAC Equipment & Chillers)

Equipment Type	Capacity Range	Minimum Full-Load Efficiency	Minimum Part-Load Efficiency (IPLV)
Air conditioners and heat pumps, air-cooled	≥20 tons	11.0 EER	-
Air conditioners and heat pumps, water-cooled	≥20 tons	12.0 EER	-
Air cooled chillers, with condenser, electrically operated	All capacities	3.10 COP	3.35 COP
Air cooled chillers, without condenser, electrically operated	All capacities	3.40 COP	3.80 COP
Water cooled chillers, electrically operated (rotary screw and scroll)	<150 tons	4.90 COP	5.70 COP
	≥150 tons to <300 tons	5.40 COP	6.15 COP
	≥300 tons	6.05 COP	6.75 COP
Water cooled chillers, electrically operated (centrifugal)	<150 tons	5.50 COP	5.75 COP
	≥150 tons to <300 tons	6.10 COP	6.50 COP
	≥300 tons	6.70 COP	7.00 COP

For replacement projects involving unitary HVAC equipment smaller than 20 tons total capacity (240,000 BTUH) where life-cycle cost procedures and engineering analysis may not be cost-effective, the agencies should strive to meet the minimum equipment efficiency ratings as listed below in Table 4.

Table 4: Minimum Cooling Efficiency (Small Unitary HVAC Equipment)

Equipment Type	Capacity Range	Minimum Efficiency
Air conditioners and heat pumps, air-cooled	≤65,000 BTUH	15.0 SEER
Air conditioners and heat pumps, air-cooled	>65,000 BTUH and ≤240,000 BTUH	12.0 EER
Air conditioners and heat pumps, water-cooled (59° F entering water)	<240,000 BTUH	17.5 EER
Air conditioners and heat pumps, water-cooled (59° F entering water)	<240,000 BTUH	17.5 EER

Note: Efficiency ratings for split system air-conditioners and heat pumps are based on test results for both the outdoor unit (condenser) and the *indoor unit (evaporator) as a matched pair. Equipment replacements for split systems should include the complete system (both condenser and evaporator sections) when possible to ensure nameplate efficiency as well as reliable operation.*

7.5.10 Part-Load Cooling Efficiency

HVAC cooling equipment should be selected based on partial-load efficiency as well as the efficiency developed at full-load capacity. This applies only to cooling equipment that has the capability to operate at part-load conditions.

Buildings operate most of the time under part-load conditions. It is not uncommon for buildings to experience full design heat load only a few days out of the year. Reduced energy costs can be achieved if HVAC equipment is selected for high part-load efficiency. The agencies should also require part-load performance testing at various equipment capacities for all new cooling units that can operate at reduced capacity.

Thorough engineering analysis is required to determine accurate building load characteristics. This type of analysis should involve developing a computer-based simulation of the building. There are many commercially-available software applications common to the HVAC industry that can be used for this task. Such engineering analysis is a prerequisite of a proper life-cycle cost analysis.

7.5.11 Minimum Heating Efficiency (Fossil Fuel)

For major energy-consuming equipment such as boilers and furnaces, the agencies should utilize life-cycle cost procedures to determine which level of energy efficiency provides the most economic logic (see Life-Cycle Cost Analysis – 7.5.2). For boilers, the agencies should ultimately strive to exceed the minimum efficiency requirements listed here.

- <u>For all gas-fired boilers</u>: The minimum initial combustion efficiency should be 85 percent based on total heat output divided by the fuel input at full burner capacity. The agencies should strongly consider selecting condensing boilers that can achieve combustion efficiencies of 90 percent or greater whenever possible.
- <u>For all oil-fired boilers</u>: The minimum initial combustion efficiency should be 85 percent based on total heat output divided by the fuel input at full burner capacity.

7.5.12 Chiller Plant Optimization (Variable Primary Flow)

Chiller plants often utilize primary/secondary pumping arrangements where the chiller is de-coupled from the pumping system that distributes chilled water to the building. The components of primary/secondary systems are the primary loop, which contains the chiller, and the secondary loop, which contains the building distribution pumps.

The basic theory behind primary/secondary methodology is that chilled water is pumped at a constant flow rate through the chiller(s) in the primary loop, but chilled water is pumped through the building(s) in the secondary loop at a variable flow rate. The flow rate in the secondary loop is based on the cooling requirements (load) of the building(s). These systems also contain a de-coupler pipe that allows the primary loop to maintain a constant flow rate regardless of the secondary flow rate.

The de-coupler pipe allows the flow rate in secondary loop be lower or higher than the minimum required flow rate of the primary loop. The effects of a flow imbalance between the primary and secondary loops are as follows:

- <u>When secondary flow is less than primary flow</u>: Production exceeds demand when this condition occurs. This condition causes excess primary flow to bypass the secondary loop through the de-coupler pipe and return to the chillers (primary loop) colder than normal. Chiller efficiency can suffer greatly when this condition occurs to a large degree.
- <u>When secondary flow is greater than primary flow</u>: Demand exceeds production when this condition occurs. This condition causes excess secondary flow to bypass the primary loop through the de-coupler pipe and return to building (secondary loop) without being cooled. Therefore, the temperature in the secondary loop begins to rise and the secondary distribution pumps have to work harder to pump more water in order to cool the building.

The main goal in controlling primary/secondary systems can be viewed as trying to match chiller production with building demand, but that can be difficult to accomplish because chiller capacity is discrete in nature. For example, a chiller plant with four equally-sized chillers operated in classic primary/secondary fashion can only operate at four distinct primary flow rates, but the secondary loop can operate at any flow rate as it responds to the building load. The potential for imbalance is inherent to the system.

Primary/secondary systems represented a distinct improvement to previous design methodologies because the secondary pumping energy was substantially reduced due to variable secondary flow. However, the flow imbalance that often occurs in primary/secondary systems ultimately represents a loss in efficiency and chiller performance.

In the past, chiller manufacturers discouraged allowing water flow to drop below full-capacity flow. The main fear was that the chiller barrel could potentially freeze due to insufficient water flow. It was a valid fear. However, new generations of controls from chiller manufacturers allow variable water flow to be utilized. Chiller system design has evolved to incorporate variable flow throughout the system in a design methodology known as variable primary flow (VPF). VPF as well as VPF-like modifications allow chiller production and building demand to be more closely matched and often results in uncovering hidden chiller capacity through improved performance.

VPF can be implemented as a stand-alone retrofit project or part of a chiller replacement project and should be considered for all new construction. VPF implementation requires new control strategies to be implemented. There are various design options that require careful engineering analysis and support from both the chiller and EMCS manufacturers, but the resultant energy savings and performance improvements can be substantial.

7.5.13 Chiller Demand Limiting

This procedure involves forcing chillers to reduce capacity in order to stay below a predetermined maximum building electrical demand load (kW). Demand limiting requires the installation of a building kW sub-meter that is connected to the building EMCS. Such features and capabilities are not uncommon in large commercial buildings. Demand limiting is an aggressive and effective form of energy management.

7.5.14 Variable Air Volume Systems

Variable air volume (VAV) technology has been in existence for many years as a strategy to conserve fan energy in air-handling systems and to provide better humidity and temperature control in buildings. VAV methodology involves designing air-handling and distribution systems to modulate the amount of air supplied to the building while maintaining the air temperature cold enough for proper dehumidification to occur. VAV systems control building temperatures by adjusting the amount of air rather than the air temperature.

VAV technology should be considered for older HVAC systems that utilize constant air volume systems. Retrofitting older dual-duct systems and other types of constant volume systems should be considered. The scope of this type of retrofit can vary greatly. Careful engineering analysis is required, but such efforts can represent a substantial reduction in energy costs and improvement in building comfort.

7.5.15 Demand-Control Ventilation

Ventilation systems introduce the required outside air into buildings. Ventilating buildings can be accomplished by mechanical or natural means. Mechanical ventilation systems typically draw or force outside air into the HVAC air-handling system where it is mixed with building air and conditioned before being supplied to the building. Natural ventilation systems typically involve the use of operable windows. Due to the high relative humidity in Florida and the possibility of mold growth, natural ventilation methods should be avoided.

Ventilation system design has developed over the years to incorporate demand-control features, which refers to ventilation systems that have the capability to reduce the ventilation rate while maintaining acceptable indoor fresh air levels for the occupants. Demand-control ventilation represents a real opportunity to produce energy savings in existing buildings because outdoor air can contain as much as four times more total heat content than re-circulated building air. Outdoor air is, therefore, very expensive to cool.

Demand-control ventilation is typically accomplished with indoor carbon dioxide sensors and fan speed controllers (variable frequency drives) or dampers that control the actual ventilation rate. *<u>Note</u>: fan speed control is the preferred method here because it provides additional energy savings by reducing fan motor power.* These systems typically adjust the amount of ventilation air based on the measured indoor carbon dioxide level. Carbon dioxide is used as a measure of building occupancy because humans exhale it. HVAC systems have to be designed to supply enough outside air for full building occupancy, but demand-control strategies allow these systems to supply only the amount of outside air that is needed. Buildings that experience variable occupancy rates are usually good candidates for this type of retrofit project.

Demand-control ventilation retrofits must also include provisions to control the building exhaust fans to prevent the overall building pressure from becoming negative with respect to outdoor conditions. Negative building pressure causes outside air to leak into the building around doors and windows, thereby defeating the purpose of reducing the ventilation rate as well as introducing hot and humid air where it is not wanted.

When retrofitting existing buildings, ventilation rates should be designed in accordance with *ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality*. Buildings that have relatively low dedicated exhaust air requirements, which are the exhaust requirements for areas such as lavatories or other areas that require a fixed amount of exhaust, tend to be good candidates for demand-control ventilation retrofits. Demand-control ventilation strategies should be required for all new construction and major renovation projects.

Demand-control ventilation retrofits must also include provisions to install high-quality automatic dampers in all building exhaust fans, outside air supply fans, and outside air intakes to prevent outside air from migrating into the building when fans are turned off. When building fans without such dampers are turned off, they represent an effective opening in the building envelope.

7.5.16 Temperature Reset

For space cooling, the EMCS should be programmed so that the cooling supply air temperatures increase in low load conditions just enough to keep each zone satisfied. For space heating, the EMCS should be programmed so that the heating supply air temperatures and hot water temperatures in piping decrease in low-load conditions just enough to keep each zone satisfied.

7.5.17 Humidity Control & Reheat

Humidity control is not recommended in general, but special circumstances may exist where it is necessary. For such special circumstances, various forms of heat reclaim and energy recovery should be considered.

Conventional humidity control (reheat) is very energy intensive because the air is first cooled to a low temperature to force maximum moisture removal and then reheated to maintain adequate space temperature. This method of humidity control is often referred to as the “brute force” method. Conventional humidity control causes excessive energy use and is, therefore, very expensive. Air-to-air energy recovery should be considered for humidity control when it is necessary.

7.5.18 HVAC Thermal Energy Storage

Thermal energy storage is a technique where energy is stored in the form of ice or cold water and used to satisfy a building cooling load during the day. In such systems, chillers are typically run during the night or off-peak hours in order to charge the storage tanks. The storage tanks are then depleted the next day and the cycle begins again. Office buildings or any other buildings that are unoccupied at night tend to be the best candidates for thermal storage systems. Thermal storage is primarily a cost-saving strategy, although minor energy savings are possible due to chiller operation during cooler night-time temperatures.

The feasibility of thermal storage is based on the electrical demand savings that can be achieved by transferring the chiller load to off-peak hours. Certain utility providers also offer reduced electric rates during off-peak hours and rebates as additional incentives through demand-side management programs.

7.5.19 Air-to-Air Energy Recovery

Air-to-air energy recovery is defined as the process of transferring the energy content from an air stream at high temperature and/or humidity to another air stream at lower temperature and/or humidity. This process can be effectively used to reduce the energy consumption involved in cooling and dehumidifying outdoor air that is necessary for proper building ventilation. Some of the common energy recovery devices available are:

- fixed plate heat exchangers
- enthalpy wheels
- heat wheels
- heat pipes

Energy recovery systems are commonly used to transfer energy from outdoor air supply ducts to building exhaust ducts as a means to pre-treat outdoor air. The basic premise is to harness the energy in the building's exhaust air as opposed to wasting it. Some applications require the air streams to be ducted to a single location for energy transfer while other applications allow the air streams to be separated by some distance. Nevertheless, energy recovery can be implemented as a retrofit project to save energy and/or to reduce the overall cooling load requirements on existing HVAC equipment if no such energy recovery exists.

Energy recovery can also be applied as an attractive alternative to reheat-type dehumidification. Enthalpy wheels are commonly incorporated into air-handling units for this purpose. Space considerations can be a barrier to implementation because these air-handling units tend to be much larger than conventional units. Still, the application should be considered for all renovation and retrofit projects.

7.5.20 Variable Frequency Drives (VFDs)

Variable frequency drives (VFDs) should be considered for all pump and fan motors associated with building HVAC systems that can be operated at reduced speeds. These should include:

- air-handlers (VAV systems)
- chilled water pumps
- hot water pumps
- condenser water pumps
- cooling tower fans
- exhaust fans
- laboratory fans
- outdoor air supply fans

Most systems that were designed for constant speed or flow operation can operate to some degree at reduced speed, but the energy savings can be quite substantial. The relationship between power and shaft speed is such that power is proportional to the cube of the shaft speed. In discrete terms, a 25 percent reduction in shaft speed, which directly equates to a 25 percent reduction in flow, actually results in a 58 percent reduction in power. This non-linear relationship between power and shaft speed is the basis of the energy savings potential that VFDs represent.

7.5.21 Premium-Efficiency Motors

Premium-efficiency motors should be specified for all equipment replacement projects and general service repair. Motor loads represent a substantial portion of HVAC and building electrical loads. Premium-efficiency motors have become commonplace in recent years.

7.6 Domestic Water Consumption

7.6.1 Low Flow Fixtures

Installing low flow plumbing fixtures is a relatively easy way to reduce domestic water consumption. Fixtures can vary greatly in type and style, but such plumbing fixtures are widely available today.

For lavatories, aerator replacement is often the easiest way to reduce water consumption. Lavatory water consumption should not exceed 0.5 gallons per minute. Testing lavatory consumption with a bucket and a wristwatch is an easy way to verify the performance of a sample aerator prior to the installation of multiple units.

For flush valves, water consumption should not exceed 1.0 gallon per flush. Flush valve replacement is often not possible for old fixtures so it is recommended that a sample flush valve be installed and evaluated prior to the installation of multiple units.

Waterless urinals represent the ultimate goal in water conservation and have become popular. However, waterless urinals require regular trap cartridge replacement or service, and special cleaning procedures are usually required. The agencies should thoroughly evaluate waterless technology before implementing it.

7.6.2 Pressure Reducing Stations

Pressure reducing stations are devices that are used to adjust incoming municipal water pressure to a lower pressure that does not damage plumbing fixtures or cause them to fail prematurely. Plumbing fixtures are commonly designed to operate at pressures between 50 and 60 pounds per square inch. Certain types of fixtures can have problems closing off at higher pressures.

In some cases, buildings do not have pressure reducing stations because the municipal pressure was acceptable when the building was constructed. Over time, municipalities often raise their supply pressure to serve a larger radius of customers, so it is not uncommon for buildings that never had a pressure reducing station to suddenly require one.

High water pressure can cause excessive water consumption in lavatories and possibly flush valves simply because there is more force pushing the water through the plumbing fixture. The agencies should verify the existence of pressure reducing stations in all buildings.

7.7 Domestic Water Heating

7.7.1 General

Hot water for lavatories shall not be provided in office buildings. When hot water heaters are necessary, the agencies should strive to minimize the size of such equipment and the need for it.

7.7.2 Instantaneous Water Heaters

Instantaneous (tank-less) water heaters should be incorporated wherever possible. Such water heaters are available in natural gas and electric varieties. Both varieties should be considered when agencies perform water heater replacements or new installations.

7.7.3 Point-of-Use Water Heaters

Point-of-use water heaters are small units that are intended for installation near or at the sink or appliance that requires hot water. These water heaters are available with small storage tanks or in a tank-less variety. Point-of-use water heaters minimize the heat losses associated with hot water distribution piping, but they should be operated on a time clock.

7.7.4 Energy Management & Control System (EMCS)

Large water heaters and circulating systems should be connected to the building EMCS for remote monitoring when feasible. The EMCS should control the hot water temperature set-point and cycle the system off during periods of low demand.

CHAPTER 8 – TRAINING FOR ENERGY MANAGEMENT COORDINATORS

8.1 Certification

8.1.1 Certified Energy Manager (CEM®)

The long-term goal of each agency should be for energy management coordinators to become designated as "certified energy managers" (CEM®) by the Association of Energy Engineers (AEE). Information regarding CEM® certification can be found at the following website:

http://www.aeecenter.org/certification/CEMpage.htm

The certification process can take up to five years for a college graduate to develop the required energy management experience to be eligible to take the CEM® exam. Licensed engineers and architects only need three years of energy management experience to be eligible to take the CEM® exam. The energy management procedures discussed in this plan are directly applicable to the CEM® certification.

8.1.2 Certified Carbon Reduction Manager (CRM®)

An intermediate goal of each agency should be for energy management coordinators to become designated as "certified carbon reduction managers" (CRM®) by the Association of Energy Engineers (AEE). Information regarding CRM® certification can be found at the following website:

http://www.aeecenter.org/certification/

The certification process can take up to three years for a college graduate to develop the required energy management experience to be eligible to take the CRM® exam. Engineers and architects are immediately eligible to take the CRM® exam. The energy management procedures discussed in this plan are directly applicable to the CRM® certification.

8.2 Basic Training

The basic training requirements for energy management coordinators should include training for Microsoft Excel®. Such training should primarily focus on basic spreadsheet operation as well as referencing data in other worksheets and files. The reporting system presented in this plan is a Microsoft Excel® spreadsheet file. Sub-meter data trends are most likely to be supplied in a compatible spreadsheet format.

Basic energy unit conversions should also be included in the basic training requirements for energy management coordinators and applicable staff. Such training may be available from AEE for the CEM® and CRM® certification requirements. Basic energy unit conversion skills are essential.

8.3 Advanced Training

Training courses for energy management coordinators and applicable staff should be based on the requirements of CEM® certification requirements, including the following topics:

- Codes & Standards
- Indoor Air Quality
- Energy Accounting and Economics
- Energy Audits and Instrumentation
- Electrical Systems
- HVAC Systems
- Motors and Drives
- Industrial Systems
- Building Envelope
- Cogeneration Systems
- Energy Procurement
- Building Automation and Control Systems
- Green Buildings, LEED & Energy Star
- Thermal Energy Storage Systems
- Lighting
- Boiler and Steam Systems
- Maintenance & Commissioning
- Alternative Financing

Agencies should choose training topics from the list above that are most applicable to their buildings and needs. Advanced training shall also be sought from sub-meter manufacturers and should include curriculum focused on retrieving sub-meter data with the manufacturer's web-based software.

CHAPTER 9 – GENERAL GUIDELINES FOR BUILDING MANAGERS

9.1 General Intent

The guidelines presented here are general in nature and are intended to provide an account of the daily and weekly activities that can reduce building energy consumption. Building managers are encouraged to take an active role in energy conservation. The agencies should include them in all such efforts.

9.2 HVAC & Mechanical

a. Building HVAC equipment should generally be scheduled to start no sooner than thirty minutes prior to the time the building is scheduled to open, unless the building HVAC system cannot provide the set point temperature at the scheduled opening time.

b. Building HVAC equipment should be scheduled to stop when the building is scheduled to close.

c. For space cooling, temperature set-points should be set between 76 and 78 degrees Fahrenheit.

d. For space heating, temperature set-points should be set between 68 and 70 degrees Fahrenheit.

e. Computer server rooms and all other areas containing heat-sensitive equipment shall be maintained at temperatures that comply with the equipment manufacturers recommendations.

f. Survey the building regularly for hot and cold spots that might indicate the EMCS system is out of calibration.

g. Maintain thorough maintenance logs on all chillers and boilers.

h. Check and replace air-handler filters on a regular basis.

i. Adjust the tension and tighten all fan belts on a regular basis and check for worn belts and pulleys.

j. Properly lubricate all fan motor drives and pumps on a regular basis.

k. Inspect outside air intakes on a regular basis.

l. Ensure that all outside air dampers are closed during unoccupied hours.

m. Verify that all exhaust fans and outside air fans have automatic dampers that close when the fans are turned off.

n. Verify that all exhaust fans and outside air fans are shut off during unoccupied hours. This applies to buildings where all equipment is supposed to be shut off during unoccupied hours. Consult with a facilities engineer for other buildings.

o. Monitor the boiler stack temperature on all fossil fuel boilers daily during the heating season and call for service if the stack temperature is more than 400 degrees above the boiler room temperature.

p. Check all variable frequency drives (VFDs) regularly to ensure they are not constantly running at full speed.

q. When electric motors fail, replace them only with premium-efficiency motors.

9.3 Lighting

a. Verify on a regular basis that lights are turned off in unoccupied areas.

b. Ensure on a regular basis that all photocell sensors are clean and operable.

c. Ensure that only compact fluorescent lights are used for desk lamps. Incandescent lamps should not be allowed.

d. Use lower wattage fluorescent lamps wherever possible.

e. Survey the building for possible areas where excess lighting can be removed. This process should be limited to corridors, break rooms, and restrooms, but not occupied areas unless the occupants complain of excessive light. Building managers should make provisions to measure the lighting levels and utilize the lighting level guidelines in this plan.

f. Require the janitorial staff to turn on lights only in rooms they are working in rather than lighting the whole building until they complete their work.

9.4 Water

a. Regularly survey all restrooms for water leaks and malfunctioning fixtures.

b. Survey irrigation system(s) for leaks and proper operation on a regular basis. Arrange for the installation of sensors that prohibit operation during the rain.

c. Regularly inspect the building water pressure reducing station.

-END OF DOCUMENT-