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ENERGY MANAGEMENT PROGRAM FOR SDDOT

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Final Report

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16. Abstract

The team at BTU Engineering performed an evaluation of the SDDOT's existing energy use, energy management policies and structures. The evaluations were then integrated into various energy management methods in order to identify recommendations to be considered for a Comprehensive Energy Management Program and Plan (CEMP) for the SDDOT. The proposed SDDOT CEMP consists of two main segments, an Energy Management (EM) Program and a Master Energy Management (MEM) Plan.

The proposed EM Program provides the energy management infrastructure for SDDOT. The first step for a successful Energy Management Program consists of the SDDOT making a commitment to the EM Program. This will require involvement from senior management and centers on establishing legitimacy to the EM Program efforts. This is done through the formal creation of the SDDOT's Energy Management Team and appointment of an Energy Manager to direct the efforts of the Energy Management Team. The Energy Management Team is charged with developing the SDDOT's formal energy goals, policies, and budget in order to complete the EM Program.

The proposed MEM Plan provides the energy management actions which will accomplish the EM Program goals and is reviewed annually by the Energy Team. The proposed MEM Plan includes recommended actions for different intensities of energy management broken into three distinct phases. These phases range from an initial intensity with easy-to-implement methods, through a moderate phase with a higher intensity of energy management, and finally to an advanced phase incorporating progressive energy management philosophies. The phased approach is recommended to allow the SDDOT CEMP to build on successful applications and grow into a program as the Energy Management Team becomes more experienced.

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Acronym	Definition
A&E	Architecture and Engineering
ARSD	Administrative Rules of South Dakota
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
B&I	Building and Improvement
BOA	Bureau of Administration
BTU	British Thermal Unit
CBECS	Commercial Building Energy Consumption Survey
CEMP	Comprehensive Energy Management Plan
C_x	Commissioning
CDD	Cooling Degree Days
CRV	Current Replacement Value
ECM	Energy Conservation Measure
EDI	Electronic Data Interchange
EIA	Energy Information Administration
EM Plan	Energy Management Plan
EM Program	Energy Management Program
EPA	Environmental Protection Agency
EUI	Energy Utilization Index
HDD	Heating Degree Days
FCI	Facility Condition Index
IBC	International Building Code
LCCA	Life-cycle Cost Analysis
LEED	Leadership in Energy and Environmental Design
MMBTU	One million BTU's
LEED-EB	LEED for Existing Buildings
MNDOT	Minnesota Department of Transportation
M&V	Measurement and Verification
NBI	New Buildings Institute
NZEB	Net-Zero Energy Buildings
OSE	Office of the State Engineer
RC_x	Retro-Commissioning
SD	South Dakota
SDCL	South Dakota Codified Law
SDDOT	South Dakota Department of Transportation
SDGFP	South Dakota Department of Game, Fish, and Parks
SDPUC	South Dakota Public Utilities Commission
SF	Square Feet
SLAC	Stanford Linear Accelerator Center
USGBC	United States Green Building Council
WAPA	Western Area Power Administration

1.0 EXECUTIVE SUMMARY

State government facilities, just like local government, residential, commercial, institutional, and manufacturing facilities, are facing increasing energy costs, coupled with limited fixed (or declining) budgets. Therefore, identifying and implementing cost-effective energy efficiency measures are key steps in reducing energy consumption and costs. South Dakota has many mandates and guidelines to assist State agencies with achieving baseline efficiency levels, but these energy efficiency minimum targets fall short of reaching the full energy conservation potentials for given projects.

Many facilities and agencies have addressed the aforementioned energy issues by developing and aligning their energy-related management infrastructure and policies to form a Comprehensive Energy Management Plan (CEMP). For the purposes of this study, the CEMP was divided into two distinct segments; the first segment is referred to as the Energy Management Program (EM Program), and deals with the realigning and/or creation of the necessary management structure to support effective energy-related decision-making and allocation of necessary resources. The second segment will be referred to as the Master Energy Management Plan (MEM Plan) and consists of organizing and developing specifics of agency energy efficiency policies and processes resembling a road map for energy management. A tailored MEM Plan would provide guidance on coordinating energy-related activities, facilitate implementation of energy efficiency measures aimed at minimizing consumption and costs, promote agency-wide green building standards, and provide support for sustainable procedures and technologies. Formation of a CEMP at the South Dakota Department of Transportation (SDDOT) began with a thorough evaluation of existing energy management approaches, previous energy audits, and agency-wide energy use.

1.1 Evaluation

The team at BTU Engineering evaluated the current SDDOT energy management approach, investigated the results of a statewide energy audit as it pertained to the SDDOT, evaluated current SDDOT energy use, evaluated common methodologies for developing energy management programs and reviewed approaches utilized at related agencies.

1.1.1 Current SDDOT Energy Management Approach

Energy improvement projects are currently completed in the SDDOT, but typically only because of equipment or systems reaching the end of their useful lives. When equipment or systems require replacement, newer and consequently more efficient equipment is purchased both due to contemporary design and due to State-mandated energy efficiency procedures and policies, which dictate many of the baseline energy efficiency standards.

1.1.2 Statewide Energy Audit Report Review

In 2009, the South Dakota Bureau of Administration hired the consulting firm Sebesta Blomberg & Associates, Inc. of Roseville, MN to conduct a statewide energy audit to quantify the current energy consumption by state agencies, identify energy conservation measures that could reduce State agencies' energy consumption and estimate the costs associated with the energy conservation measures. The efforts resulted in an extensive report, which was completed in 2009 titled, "Statewide Energy Auditing for Energy Master Plan." Report recommendations include:

- Provide an Energy Manager for South Dakota Agencies
- Deploy an advanced metering & monitoring program at state-owned facilities
- Create programs that recognize efforts in support of energy conservation
- Continued & expanded use of a Statewide Energy Database
- Use ENERGY STAR® Portfolio Manager to rate energy efficiency of buildings
- Apply Leadership in Energy and Environmental Design (LEED) standards to existing building operations
- Include energy management considerations when leasing space
- Increased use of Measurement and Verification (M&V)

1.1.3 Evaluation of Current SDDOT Energy Use

The various SDDOT facilities throughout the state spent $1,421,643 in 2010 for electricity, natural gas, propane and fuel oil. Electricity use agency-wide accounted for $884,695 (62%) of energy cost and 41% of the energy used in 2010. Natural gas use agency-wide accounted for $262,448 (19%) of energy cost and 43% of the energy used in 2010. Propane use agency-wide accounted for $254,669 (18%) of energy cost and 15% of the energy used in 2010. Fuel Oil #2 use agency-wide accounted for $19,831 (1%) of energy cost and 1% of the energy used in 2010.

Although traditional energy bills display annual usage and cost per utility unit, a more appropriate comparison is on a per million Btu (MMBtu) basis. In this way, costs of different energy sources can be compared on an equal basis. For the SDDOT, it costs $22.69/MMBtu and $6.50/MMBtu for electric and natural gas, respectively. This information is an important consideration for energy management, since utilizing natural gas for heating appears to be a more economical fuel source than electrical resistance heating.

Utilization indexes provide useful benchmarking values. The Energy Utilization Index (EUI) is total building energy use per unit area per year while the Cost Utilization Index (CUI) is total building energy cost per unit area per year. Agency-wide, SDDOT had EUI and CUI values of 65 kBtu/yr/sf and $0.96/yr/sf, respectively. Relative to similar facilities, the EUI and CUI values indicate that there is a great potential for energy reduction at SDDOT. The SDDOT Base Year 2010 average facility performed at the 75th percentile of similar facilities in energy usage and 50th percentile in energy cost. This means that SDDOT facilities used more energy than 75% of the comparison types of buildings, which suggests there is much room for improvements in energy use. Conversely, SDDOT facilities compared better in terms of facility energy cost, but this improved ranking is significantly affected by the relatively low cost of energy in South Dakota[1].

[1] South Dakota is ranked 38 out of 51 states for energy cost, where 1 is the highest energy cost.

1.1.4 Review of Related Agencies

BTU Engineering investigated Energy Management Programs (EM Programs) and/or Plans (MEM Plans) at related agencies. Included were South Dakota agencies, South Dakota Universities, other Universities, regional agencies, and national agencies. In a related investigation, the standard methodologies for developing energy management programs were also examined. Based on these reviews, common elements of successful CEMPs were identified and an evaluation of the feasibility of a CEMP at SDDOT was provided.

1.2 Common Elements of Successful CEMPs

Common elements of successful CEMPs are generally organized into two distinct segments based on established industry guidelines such as Energy Star. The first segment (Make Commitment, Develop Policy, Assess Performance, Establish Budget, Set Goals) holds the core of the Energy Management Program (EM Program). This segment deals with the realigning and/or creating the necessary management structure to support effective energy-related decision-making and allocation of necessary resources. Once an energy management structure is in place, the first objectives are to establish energy conservation goals, a budget, and then to develop agency energy policies around the goals and available budget.

The second segment (Create Action Plan, Implement Action Plan, Evaluate Progress, Recognize Achievements) is the foundation of the Master Energy Management Plan (MEM Plan). The MEM Plan provides specific guidance in the way of a plan of action for organizing, developing, and implementing agency energy efficiency policies and processes. Typically once a year, the MEM Plan is re-assessed by the Energy Management Team, which forms the evaluation criteria to make the case for changes and improvements for the following year.

These common elements, integrated into and around the existing SDDOT infrastructure, are utilized by the researchers to develop a tailored SDDOT CEMP.

1.3 Feasibility of CEMP

BTU Engineering provided an evaluation of the feasibility of establishing a CEMP at SDDOT. The evaluation looked at incentives, existing infrastructure, and assessment of existing energy management. Overall, since much of the core infrastructure is already in place, establishing an SDDOT Energy Management Program is very feasible but will require the support of the organization's top management in order to re-align the infrastructure necessary to achieve comprehensive energy management.

The additional components that must be added to the established infrastructure vary with SDDOT's desired energy efficiency goals, but share the following key components.

- Reorganize or re-center efforts around energy efficiency
- Identify energy manager or energy champion and energy team
- Set energy efficiency goals
- Set SDDOT energy efficiency policy

- Set evaluation criteria

These requirements are integrated into the proposed SDDOT CEMP.

1.3.1 Incentives for CEMP at SDDOT

The SDDOT facilities consumed over $1.4 million in energy in 2010. Additionally, the average SDDOT facility consumes more energy per square foot than the national average for similar buildings. The state also has many mandates for state agencies, including SDDOT, to achieve baseline efficiency levels, but these energy efficiency “minimum” targets fall short of reaching the full energy conservation potentials for each project. While not every project provides justification for exploring the ramifications of exceeding the minimum bar of efficiencies, it was determined that many projects have cost-effective energy savings potential beyond the mandated minimums. Additionally, exploring more efficiency options may yield additional savings through associated systems effects, prevented maintenance, and by proactively addressing future state or federal energy efficiency benchmarks. Finally, the SDDOT may have various low efficiency systems that are consuming large amounts of energy, but are in good working condition. Therefore, replacing these systems may have very attractive return on investments, but go unaddressed in the present prioritizing system. Implementing a CEMP at SDDOT would have the potential to reduce total energy costs by over 40%. Additional benefits for a dedicated energy management program include the following:

- Address SDDOT sustainability focus
- Efforts aide in good public perception
- CEMP analysis may yield a more effective allocation of resources
- Better poised for compliance with future federal/state mandates
- Facilitates a proactive approach to energy conservation
- Minimize missed opportunities for savings beyond mandated minimums
- Satisfies the need as a large organization to coordinate energy-related activities
- Improve identifying and implementing cost-effective energy efficiency measures
- Reduce costs, carbon footprint, greenhouse gas emissions
- Facilitate deployment of new technologies (energy efficiency, energy recovery, energy generation - renewable)

1.3.2 Existing SDDOT Energy Management Related Infrastructure

The SDDOT has an established formal policy designed for meeting State mandates for obtaining baseline efficiency levels when purchasing new equipment and buildings. Purchases are usually not identified solely for energy conservation, but rather due to equipment reaching the end of their useful lives. Additionally, the SDDOT has a committee in place to address integrating sustainability into SDDOT practices. The SDDOT Sustainable Government Action Plan has many of the core CEMP values and practices already defined. The SDDOT has an established management structure in place that is highly skilled in various aspects of engineering and project management (a high percentage of the managers are engineers). These managers are experienced in successfully managing large, often unique projects and are already successfully implementing energy efficiency related projects which are mandated as part of current building and equipment upgrades. The SDDOT utilizes a software program (AuditMate™) to track equipment inventories for new construction projects and maintenance and repair projects for existing facilities. The projects are all ultimately prioritized based on need. Additionally, all of these projects are routed through the SDDOT Internal Services Manager, who is the person responsible for submitting equipment and building construction requests to the SDDOT upper management.

The SDDOT Internal Services Manager is very important to the proposed energy management structure since all equipment and building replacement requests are funneled through this position. Additionally, this position is the pivot point for project prioritization.

Finally, the SDDOT has established procedures in place to track utility use and costs through EnergyCAP® software. The SDDOT has used this software since 1995 for utility billing purposes. However, energy management features of this software have not been used.

1.3.3 Assessment of Existing Energy Management Strategy

The ENERGY STAR® Energy Management Assessment Matrix was utilized to assess the existing SDDOT energy management program. This tool is freely available and downloadable via the ENERGY STAR® website (http://www.energystar.gov) and is an industry benchmark for evaluating the status of an organization's energy management program. The results illustrate that while a number of supporting components for a CEMP are currently in place at SDDOT, the existing lack of a dedicated energy management program is the primary shortfall to developing a CEMP.

Although SDDOT does not have a dedicated energy management system in place, there are state mandates in place that motivate agencies to pursue baseline efficiency levels. Also, SDDOT has the core infrastructure already established to comply with the state mandates and to prioritize capital expenditures. In terms of energy management, there are areas of needed development, but the established infrastructure can largely be utilized to form the foundation and many of the building blocks in a formal SDDOT EM Program.

1.4 IMPLEMENTATION OF PROPOSED SDDOT EM PROGRAM

As with any agency or entity, the first step for a successful Energy Management Program consists of the SDDOT making a commitment to the EM Program. This will require involvement from senior management and centers on establishing legitimacy to the EM Program efforts. This is done through the formal creation of the SDDOT's Energy Team and appointment of an Energy Manager. Once the Energy Team is formed, their first task is to establish SDDOT energy conservation goals and budget, then develop the SDDOT energy policies around the goals and available budget. Once the SDDOT EM Program is in place, it provides the energy management infrastructure for the SDDOT. A suggested sequence of events is outlined below.

1.4.1 Form Energy Management Start-Up Task Force

Typically this requires involvement from select senior/executive management, existing energy and/or sustainability managers, facility and operations managers, and other committee volunteers. Once the Energy Management Start-Up Task Force is formed, they will coordinate with executive management to:

- Define Agency Energy Management Priorities
- Define Desired Energy Management Results
- Define SDDOT Commitment to Desired Results
- Define SDDOT Commitment to Energy Management Budget
- Form/Identify Energy Management Structure
- Form/Identify Energy Management Team Positions
    - Manager
    - Executive Ally
    - Team Members

Once these parameters are defined, the Energy Management Start-Up Task Force completes its function by staffing the Energy Management Team. The SDDOT Energy Team will then take on responsibility for forming SDDOT's energy management policies and identifying/setting energy efficiency targets. The Energy Management Team is typically staffed by volunteers (at least initially), with the exception of the Energy Manager. The Energy Manager is the most important position on the team, since they are the primary person tasked with organizing and coordinating the Energy Team, and facilitate implementation and integration of the EM Program into the overall company management culture.

The Energy Manager is not required to be an expert in energy and technical systems; however, a successful Energy Manager understands how energy management helps the organization achieve its financial and environmental goals and objectives. Initially, the Energy Manager role will be a part-time position.

The researchers recommend that the SDDOT Internal Services Manager be considered as a potential Energy Manager or key Energy Team member since all equipment and building replacement requests are funneled through this position. Additionally, this position is the pivot point for project prioritization.

Another important Energy Management Team member is the "Executive Ally" to the Energy Manager. This member is especially important if the Energy Manager is not part of, nor does not report directly to upper management/senior management in order to help keep senior management informed and supportive of the EM Program.

At this point, the original Energy Management Start-Up Task Force can be disbanded or integrated as members of the Energy Management Team. The Energy Management Team's first job is to develop the underlying energy policy in conjunction with energy goals and energy budget for the SDDOT. It is wise to develop policy with the energy management goals and budget in mind. Establishing SDDOT Energy Policy provides the foundation for successful energy management. It articulates the organization's commitment to energy efficiency for management, employees, the community, and other stakeholders. The EM Program is recommended to be implemented within a 9 month timeframe. Figure 1 illustrates key components of the CEMP developed to meet SDDOT's specific needs including the proposed EM Program and MEM Plan.

1.5 PROPOSED MEM PLAN FOR SDDOT

The proposed Master Energy Management Plan (MEM Plan) is a detailed document that specifies procedures for implementing energy management actions and energy-related activities to achieve EM Program goals and is reviewed annually by the Energy Team. The MEM Plan is essentially a roadmap designed to facilitate the implementation of energy efficiency measures through actions such as providing support for sustainable procedures and technologies, determining the frequency and detail level of energy analysis and energy audits, and documenting energy conservation outcomes through actions such as Measurement & Verification (M&V) of results.

The proposed MEM Plan recommends options for progressive implementation of energy management in three distinct phases. These phases range from initial, easy-to-implement methods, to a moderate phase with a higher intensity of energy management and methods, and finally to an advanced phase incorporating progressive energy management philosophies. The phased approach is recommended to allow the SDDOT CEMP to build on successful applications and grow as their Energy Team becomes more experienced in energy management. The MEM plan is recommended to be implemented after the creation of the EM Program within a 12 month timeframe. The MEM Plan is to be reviewed annually in order to revise the actions to reflect changing energy management goals and budgets. The proposed template for the SDDOT MEM Plan is located in Section 12.0 and is summarized as follows.

It is suggested to begin at the Phase I (introductory) level of the MEM Plan. This first phase of the MEM Plan largely consists of targeting easier-to-identify, lower-cost and lower-effort measures utilizing volunteers. Examples of measures to target include lighting retrofits, improved lighting controls, improved temperature controls, improved ventilation air control and/or reductions, implementation of an energy awareness program, evaluation of exceeding baseline energy efficiency standards, and conducting Measurement & Verification (M&V) of previously implemented energy efficiency projects.

Many of these measures are already highlighted in the "SDDOT Sustainable Government Action Plan." Additionally, many of these types of measures were identified for select SDDOT facilities in the Sebesta Bloomberg "Statewide Energy Auditing for Energy Master Plan" report.

Expected Results of Phase I MEM Plan:

- energy and cost savings of at least 5% (conservative estimate)
- average simple payback periods of two years or less
- projected cost savings of approximately $70,000/yr with a capital cost of $140,000

It is recommended that Phase I activities occur during the first few years of the SDDOT CEMP.

Upon completion of Phase I, it is recommended that components of Phase II of the MEM Plan be integrated. This transition into Phase II of the MEM Plan should synchronize with the Energy Team maturing from an entry-level energy management philosophy to a mid-level energy management style. Examples of measures to target include: build from Phase I infrastructure, consider expanding energy team goals, consider expanding energy manager duties, initiate basic self-assessments (energy audits), measurement & verification (M&V) of previously implemented energy efficiency projects, conduct energy audits (ASHRAE Level I and Level II), share SDDOT "Good Practices" agency-wide, consider the allocation of a percentage of annual energy cost savings towards energy saving incentives.

Expected Results of Phase II MEM Plan:

- energy and cost savings of at least 15% (conservative estimate)
- average simple payback periods of six years or less
- cost savings of approximately $210,000/yr with a capital cost of $1,260,000

It is recommended that Phase II be integrated after 2 years of the SDDOT CEMP.

After the SDDOT CEMP has approached maturity, Phase III of the MEM Plan can be integrated to increase the intensity of evaluating SDDOT for likely energy conservation measures. Examples of measures to target include: consider expanding Energy Team goals and Energy Manager duties (potentially create a dedicated position), perform more advanced self-energy audits, integrate life-cycle cost analysis (LCCA), consider carbon footprint effects, consider wider use of renewable energy, smart building controls, improvements and upgrades to building envelopes, improvements in HVAC systems (e.g. geothermal heat pumps), utilization of more aggressive new construction energy standards (e.g. 20% better than ASHRAE 90.1-2007)

Expected Results of Phase III MEM Plan:

- energy and cost savings of at least 25% (conservative estimate)
- average simple payback periods of ten years or less
- projected cost savings of approximately $490,000/yr with a capital cost of $4,900,000

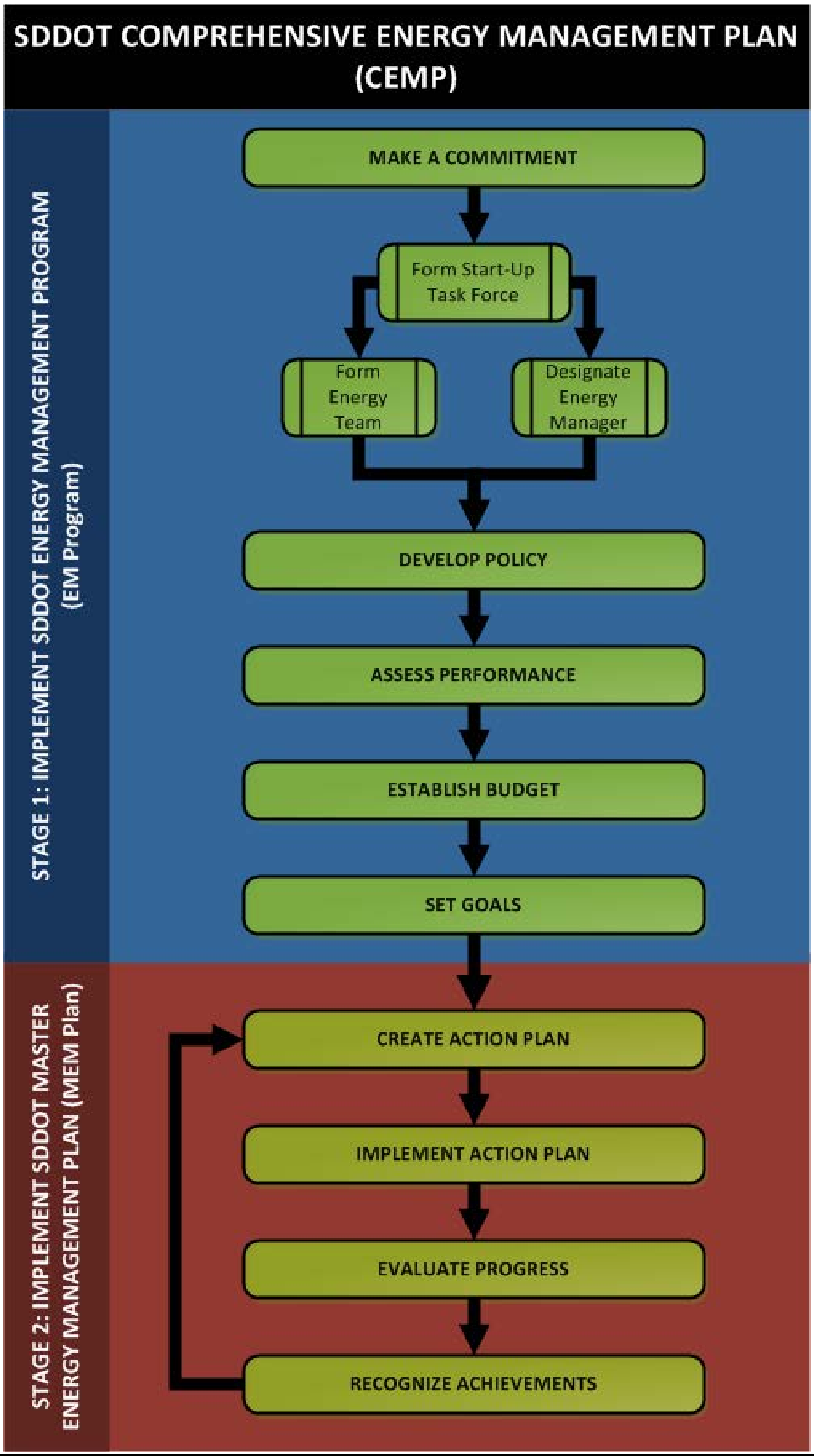

Figure 1: Illustration of SDDOT Comprehensive Energy Management Program and Plan (CEMP)

1.6 Recommendations

Recommendations are tailored to the SDDOT infrastructure and operational procedures closely follow the structure of the EM Program and MEM Plan. The commitment of the SDDOT should be reinforced through formation of an Energy Management Team headed by a person such as the Internal Services Program Manager. The Energy Management Team shall oversee the EM Program and develop SDDOT Energy Policy, assess current energy performance, establish a budget, and set performance goals. The MEM Plan should then be implemented by the Energy Management Team to put energy policy into action. Energy Conservation Measures should then be implemented at an appropriate level of approach (minimal, moderate, and aggressive) over the course of three implementation phases. Quarterly evaluation of implementation status and annual review of the EM Program and MEM Plan will allow for recognition of achievements, repetition of good practices, renewal of budget, and establishment of the next round of actionable items. The first Energy Conservation Measures should be implemented approximately one year from the SDDOT committing to the CEMP by formulating a task force. After two years of operation, the Energy Management Team will progress from Phase I implementation techniques to those outlined in subsequent phases. Specific recommendations for both the SDDOT EM Program and MEM Plan are included here.

1.6.1 EM Program Recommendations

Several recommendations were made to support the successful implementation of a SDDOT EM Program. These include the following:

RECOMMENDATION 1: Make A Commitment
Make a commitment by establishing an Energy Management Start-Up Task Force. The purpose of the committee is to establish an Energy Team and Energy Manager.

RECOMMENDATION 2: Develop a SDDOT Energy Policy
The energy policy will outline the objectives, accountability systems, and applicability of defined guidelines. Policy approval procedures, promotion of continuous improvement and sharing of good practices should be included as well.

RECOMMENDATION 3: Perform Comprehensive Assessment of the Energy Performance of the SDDOT
The existing EnergyCAP® infrastructure should be utilized and expanded upon to facilitate this assessment. Baseline data and applicable metrics like energy indexes and ENERGY STAR Ratings should be used in defining performance goals. Refer to section 7.0 EVALUATION OF CURRENT SDDOT ENERGY USE for baseline data and applicable metrics information.

RECOMMENDATION 4: Establish An EM Budget
Establish an Energy Management budget that aligns with the SDDOT Performance Goals. A starting Energy Management budget equivalent to 5-10% of total annual SDDOT energy costs is recommended. Depending on the accounting arrangements of the SDDOT, the Energy Management Budget could be used for funding the marginal cost increase associated with increased energy efficiency. For example, the Energy Management Budget could be used to fund

the necessary project enhancements to bring a new building construction project to LEED Gold standards from the mandated LEED Silver standards.

RECOMMENDATION 5: Set SDDOT Performance Goals
An initial goal should be to reduce energy consumption by 5% over baseline values over the next 3 years. The level of approach (Phase I, Phase II, Phase III) should reflect the performance goals and supporting budget.

RECOMMENDATION 6: Review, Evaluate, And Adapt the EM Program Annually
A review of program implementation, promotion of achievements, and a renewal of performance goals and budget will allow for continuous improvement using the most effective methods.

1.6.2 MEM Plan Recommendations

MEM Plan recommendations include the following:

RECOMMENDATION 7: Create/Adopt SDDOT MEM Plan
Use the proposed MEM Plan as a template (road map) to create SDDOT's MEM Plan that defines the necessary steps to achieve the EM Program goals within the allotted budget and incorporating an appropriate phase of energy conservation effort (see Section 12.1 for additional details concerning the proposed MEM Plan).

RECOMMENDATION 8: Implement SDDOT MEM Plan
Implement the SDDOT MEM Plan with appropriate accountability in place and commitment of the Energy Management Team (see Section 12.2).

RECOMMENDATION 9: Evaluate Implementation Progress
Evaluate implementation progress on a quarterly basis to ensure that planned actions are trending towards the achievement of performance goals.

RECOMMENDATION 10: Recognize Achievements And Promote Good Practices
Recognize achievements and promote good practices to motivate personnel in the continuation of energy conservation efforts.

2.0 PROBLEM DESCRIPTION

State government facilities, just like local government, residential, commercial, institutional, and manufacturing facilities, are facing energy issues. One of the most notable in South Dakota is the rising cost of energy. Although South Dakota as a whole has some of the lowest unit costs of energy in the nation (U.S. EIA, 2008), costs are trending higher each year. Increasing energy costs, coupled with limited fixed (or declining) budgets, can have significant budget impacts. Therefore, identifying and implementing cost-effective energy efficiency measures is key to reducing energy consumption and costs.

The mission of the South Dakota Department of Transportation (SDDOT) is to provide a safe, efficient, and effective transportation system. In support of the large scope of services, the SDDOT operates and maintains an equally large collection of buildings. In fact, there are approximately 421 buildings with an estimated gross floor area of 1,469,031 sf in four regions across the state (average 3,489 sf/facility). See Table 1 for further details.

The various SDDOT facilities throughout the state consumed a combined $1,421,643 in 2010 for electricity, natural gas, propane and fuel oil. Agency-wide electricity use accounted for $884,695 (62%) of the total energy cost and 41% of the total energy used in 2010. Agency-wide natural gas use accounted for $262,448 (19%) of total energy cost and 43% of the total energy used in 2010. Agency-wide propane use accounted for $254,669 (18%) of total energy cost and 15% of total energy used in 2010. Finally, agency-wide fuel oil #2 use accounted for $19,831 (1%) of total energy cost and 1% of the total energy used in 2010.

The State of South Dakota has prescribed several mandates and guidelines to improve baseline efficiency levels of state agencies concerning new purchases of equipment, systems, and buildings. For instance, the purchase of energy efficient and ENERGY STAR® rated equipment is required where feasible through a State Administrative Rule (ARSD 10:02:05:13).

Additionally, the Office of the State Engineer directs that State buildings must be designed and constructed in conformance with high-performance green building standards as specified in South Dakota Codified Law (SDCL) §§5-14-33 to 5-14-38. The legislation prompts agencies to design and construct buildings in a manner that achieves at least a Leadership in Energy and Environmental Design (LEED) Silver rating under the United States Green Building Council (USGBC) LEED rating system. The minimum energy code for these LEED buildings is ASHRAE Standard 90.1-2007. This applies to new buildings and for substantial renovations to existing buildings.

However, energy use is prominently addressed through the SDDOT Mission Statement supporting documentation, which states that one of the SDDOT Core Values is “stewardship of public resources”. A Primary SDDOT Strategic Initiative is to “maintain fiscal responsibility,” which relates to wise energy consumption practices. Additional examples include the South Dakota Sustainable Mission Statement, which states:

“Taking a long term view of how our actions affect future generations and making sure we don't deplete resources at rates faster than the earth is able to renew them.”

In summary, the State has many mandates and guidelines for state agencies to obtain baseline efficiency levels, but these energy efficiency minimum targets fall short of reaching the full energy conservation potentials for each project. While not every project can justify exploring the ramifications of exceeding the required minimums, many projects have cost-effective energy savings potential beyond the mandated minimums. Yet, without active participation by each specific State agency, including SDDOT, concerning their projects, there are no identified incentives to explore the benefits or feasibility of exceeding the minimum efficiencies.

While in most cases, exceeding the established minimum requirements may require additional capital outlay, potential additional savings may yield a better rate of return. For example, utilization of ventilation controls exceeding American Society of Heating Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1-2007 minimums might significantly reduce energy use. Installation of high-efficiency hot water systems exceeding these same standards could also contribute to significant savings. However, these savings are highly dependent on facility type and usage and can only be ascertained by careful evaluation. Additionally, exploring more efficiency options may yield additional savings through associated systems effects, defrayed maintenance, while proactively addressing future state or federal energy efficiency benchmarks. Finally, the SDDOT may have various low-efficiency systems that are consuming large amounts of energy, but are in good working condition. Therefore, replacing these systems may have very attractive return on investment, but go unaddressed in the present prioritizing system. State agencies are facing a common challenge of aging facilities and equipment, which are reaching or surpassing their expected service life. As these systems require replacement, state agencies - in this case the SDDOT, must invest in the required minimum efficiency mandates; but if only the minimum mandates are implemented a fantastic opportunity to integrate better, more efficient systems with better rates of return and a reduced carbon footprint may be missed.

Many facilities and agencies have addressed the aforementioned energy issues by developing and aligning energy-related management infrastructure and policies to form a Comprehensive Energy Management Plan (CEMP). In order to do the same, SDDOT should investigate developing a tailored Comprehensive Energy Management Plan to address their unique energy issues. Again, for the purpose of this study the Comprehensive Energy Management Plan (CEMP) has been separated into two distinct segments; the first (EM Program) deals with the realigning and/or creation of the necessary management structure to support effective energy-related decision-making and allocation of necessary resources. After forming and staffing the energy management structure, work can commence with establishment of a budget and development of agency energy policies.

Once the Energy Management Program is in place, the second segment consists of organizing and developing the agency energy efficiency policies and processes into what will be referred to as the Master Energy Management Plan (MEM Plan). A tailored MEM Plan for SDDOT would coordinate energy-related activities, facilitate implementation of energy efficiency measures aimed at minimizing consumption and costs, promote agency-wide green building standards, and provide support for sustainable procedures and technologies.

Major benefits of the proposed Comprehensive Energy Management Plan (CEMP) are based on potential reductions in energy consumption and related costs for SDDOT facilities. In addition to direct cost savings attributed to energy consumption reductions and reduced maintenance and/or labor costs in some cases, other benefits include increased facility/equipment life; improved service; improved occupant comfort and related work efficiency; lower carbon footprint and associated green benefits; opportunities for positive publicity; and being better situated to address future federal or state mandates concerning energy efficiency standards.

3.0 RESEARCH OBJECTIVES

The three main research objectives for this project are defined in the following section.

1) EVALUATE: Evaluate existing energy management strategies and programs at SDDOT and assess the need for improvement.

Objective 1 was realized by a thorough examination of existing SDDOT energy management practices. Communication with the SDDOT Regional Managers, the Internal Services Program Manager, and Statewide Energy Manager indicated that a lifecycle replacement method (AuditMate™), utility bills record keeping (EnergyCAP®), and state mandated minimum requirements (ENERGY STAR® and SDCL §§5-14-33 to 5-14-38) are all that guide the energy management policy at SDDOT. A review of the 2009 report titled, "Statewide Energy Auditing for Energy Master Plan" by Sebesta Blomberg was also conducted to determine the level of assessment and implementation of energy cost saving opportunities (ECM's). Additionally, BTU Engineering researched Energy Management Programs in place at other South Dakota agencies, South Dakota Universities, other Universities, regional agencies, and national agencies. All relevant details of these EM Programs or Plans were summarized and evaluated. Further, BTU Engineering researched and summarized existing or anticipated standards relevant to development of a CEMP for SDDOT including: ASHRAE 90.1, ASHRAE 189.1, ASHRAE BEQ, USGBC LEED, and ENERGY STAR®.

Whenever possible, information was collected via publicly accessible information sources. Information gaps were filled via direct correspondence with organization management. When necessary, site visits were made to ensure a clear understanding of energy management practices, such as to SDSU to speak to the SDSU Energy Engineer concerning their energy management.

The various energy management strategies collected from these vastly different entities will be summarized and evaluated.

2) INVESTIGATE: Investigate the feasibility and benefits of implementing a comprehensive, centralized energy management program at SDDOT. Programs typically address major elements such as appropriate energy management structure, budgetary framework, and establishment of energy policy at the agency level.

The feasibility and benefits of implementing a comprehensive, centralized EM Program at the SDDOT will be investigated. First the existing management structure will be examined which will identify the need for and extent of revisions to any proposed energy management structure. This will focus on the existing capability of the SDDOT to disseminate valuable EM Program directives to all stakeholders. Next, the budgetary framework will be evaluated. The evaluation will involve the investigation of historical budgetary outlays in comparison to historical energy costs. Normalized for pertinent variables (e.g. weather and operation), these two vital metrics will be invaluable in assessing the level of payback that will be the focus of the EM Program.

3) DEVELOP: Develop an agency-wide Master Energy Management Plan. Among other things, an MEM Plan will address specifics related to coordination of energy-related activities, energy efficiency, implementation of energy conservation measures, and deployment of energy capture/alternative energy technologies at SDDOT.

BTU Engineering developed a comprehensive Energy Management Program (EM Program) for the SDDOT that includes an agency-wide Master Energy Management Plan (MEM Plan). The combination is often referred to as a Comprehensive Energy Management Program and Plan (CEMP), which is the best descriptive term to label the SDDOT's energy management objective. An in depth EM Program and MEM Plan tailored to SDDOT resulted.

The Master Energy Management Plan (MEM Plan) was developed in part to facilitate coordination of energy-related activities. More importantly, the MEM Plan provides a clear framework and methodology for implementation of energy conservation measures and dissemination of valuable energy efficiency experiences agency-wide. Finally, a tailored MEM Plan should provide a timeline and direction for deploying energy capture/alternative energy technologies at the SDDOT.

4.0 TASK DESCRIPTIONS

The following outlines the defined tasks under this study. For each task, an explanation of the research team's understanding and approach for accomplishing them is provided.

TASK 1: Meet with the project's technical panel to review the project scope and work plan.

This task was completed on August 9, 2010. Mr. Mike Twedt met with the project's technical panel in Pierre, SD where a review of the project scope and work plan was accomplished. Feedback from the technical panel allowed for better alignment of research objectives for the project.

TASK 2: Evaluate SDDOT energy management policy, procedures, and management structure currently in place. Define areas needing improvement.

Communication with SDDOT personnel and the state energy office revealed that the SDDOT does not have a formal energy management policy or energy management structure and merely works to meet state-mandated levels of energy efficiency as a minor component of equipment replacement and new construction. An investigation of the SDDOT's use of utility bill recording and analysis software, EnergyCAP® was also conducted. Review of the 2009 report titled, "Statewide Energy Auditing for Energy Master Plan" by Sebesta Blomberg was conducted concurrently with communications to establish the extent of implementation of energy cost saving opportunity recommendations (ECM's) outlined in the report.

Results of this Task are included in 5.0 CURRENT SDDOT ENERGY MANAGEMENT APPROACH; 6.0 STATEWIDE ENERGY AUDIT REPORT REVIEW; and 7.0 EVALUATION OF CURRENT SDDOT ENERGY USE in this report.

TASK 3: Investigate successful agency-wide Energy Management Programs and Plans at other government agencies and departments of transportation that would be a good fit for SDDOT.

A thorough literature review was conducted concerning Energy Management Programs (EM Programs) and/or Plans (MEM Plans) at other agencies in order to establish a peer group benchmark concerning energy management. The investigation included South Dakota agencies, South Dakota Universities, other Universities, regional agencies, and national agencies. The finding yielded that no formal Energy Management Programs (EM Programs) and/or Plans (MEM Plans) existed within state agencies at the time of the review. The results of this Task are included and summarized in 8.0 REVIEW OF RELATED AGENCIES.

TASK 4: Assess the feasibility, define the costs and benefits, and make recommendations for implementation of a comprehensive Energy Management Program at SDDOT.

After a thorough investigation by BTU Engineering, it was found that the most applicable term to describe the SDDOT's overall energy management requirements is CEMP (Comprehensive Energy Management Program & Plan). Supporting information is located in Section 9.0 COMMON ELEMENTS OF SUCCESSFUL CEMPs. Figure 1 illustrates the overall CEMP.

BTU Engineering assessed the feasibility of implementing a Comprehensive Energy Management Program at SDDOT. In terms of energy management, it was found that the established infrastructure can largely be utilized to form the foundation upon which to build a formal SDDOT CEMP. This finding was supported by an ENERGY STAR® Energy Management Assessment Matrix analysis which was utilized to assess the existing SDDOT energy management capability. As shown in Figure 16 (Section 10.0 FEASIBILITY OF CEMP AT SDDOT), the results illustrate the existing lack of a dedicated energy management program but give credit for portions of the existing infrastructure.

The SDDOT facilities consumed over $1.4 million in energy in 2010. Additionally, the average SDDOT facility consumes more energy per square foot than a national average for similar buildings. A SDDOT Comprehensive Energy Management Program & Plan (CEMP) would provide the mechanism for controlling agency energy costs. Major benefits of the CEMP are based on potential reductions in energy consumption and related costs for the organization's facilities. In addition to direct cost savings attributed to energy consumption reductions and reduced maintenance and/or labor costs in some cases, other benefits may include:

- Increased facility/equipment life
- Improved occupant comfort and related work efficiency
- Lower carbon footprint and associated green benefits
- Opportunities for positive publicity while providing a proactive approach
- Facilitate deployment of new technologies (energy efficiency, energy recovery, energy generation - renewable)
- Being better situated to address future federal or state mandates concerning energy efficiency standards
- Large organizations commonly have need to coordinate energy-related activities

CEMP's are comprised of two distinct segments; the first deals with the realigning and/or creating the necessary management structure to support effective energy-related decision-making and allocation of necessary resources. This first segment is often called the Energy Management Program (EM Program). After forming and staffing the energy management structure, the first objectives are to establish energy conservation goals, a budget, and then to develop agency energy policies around the goals and available budget. For a complete discussion on the specific recommended SDDOT EM Program, see Section 11.0 PROPOSED SDDOT EM PROGRAM.

Once the Energy Management Program is in place, the second segment consists of organizing and developing the agency energy efficiency policies and processes into an Energy Management Plan or a Master Energy Management Plan (MEM Plan). A tailored MEM Plan for SDDOT would coordinate energy-related activities, facilitate implementation of energy efficiency measures aimed at minimizing consumption and costs, promote agency-wide green building standards, and provide support for sustainable procedures and technologies. For a complete discussion on the proposed SDDOT MEM Plan, see Section 12.0 PROPOSED SDDOT MEM PLAN.

TASK 5: Meet with the technical panel to approve recommendations for an Energy Management Program and review direction of the project.

This task was completed on February 16, 2011. Mr. Mike Twedt and Mr. Matt Hein met with the project's technical panel in Pierre, SD where a review of the project scope and work plan was followed by an examination of task completion and project progress. Feedback from the technical panel allowed for better alignment of tasks to project objectives and clarification of the purpose and scope of the project.

TASK 6: Design an Energy Management Program for SDDOT consistent with Bureau of Administration policies (to avoid overlap of responsibilities). As a major component of the program, draft a detailed, comprehensive, agency-wide Master Energy Management Plan detailing the architecture to support and facilitate coordination of various energy-related activities within the agency.

The researchers developed a two-part Comprehensive Energy Management Program & Plan (CEMP) for consideration for adoption by SDDOT. The first segment consisted of a proposed Energy Management Program (EM Program) which provides the roadmap for the energy management infrastructure and goal determinations. For a complete discussion on the specific recommended SDDOT EM Program, see Section 11.0 PROPOSED SDDOT EM PROGRAM.

The second segment consisted of proposed a Master Energy Management Plan (MEM Plan), which provides a roadmap for a plan of action to accomplish the goals of the EM Program. For a complete discussion on the proposed SDDOT MEM Plan, see Section 12.0 PROPOSED SDDOT MEM PLAN.

TASK 7: Meet with the technical panel to review the draft Energy Management Program and Master Energy Management Plan and recommendations for implementation.

This task was completed on 8/16/11. Mr. Mike Twedt and Mr. Matt Hein met with members of the project's technical panel in Brookings, SD to discuss the EM Program and consider comments on the MEM Plan. In addition, on 8/24/11, Mr. Mike Twedt and Mr. Matt Hein met with the project's technical panel in Pierre, SD to formally present the proposed EM Program and MEM Plan to the panel.

TASK 8: Revise the draft Energy Management Program and Master Energy Management Plan in accordance with comments of the technical panel.

This task was completed on 8/29/11. The revised draft was submitted to the project's technical panel for final review.

TASK 9: Upon review and approval of the recommendations, Energy Management Program, and Master Energy Management Plan by the technical panel, prepare a final report and executive summary of the research methodology, findings, conclusions, and recommendations.

This task was completed on 11/1/11. The final report and executive summary of the research methodology, findings, conclusions, and recommendations are included in this report.

TASK 10: Make an executive presentation to the SDDOT Research Review Board and the Office of the State Engineer at the conclusion of the project.

This task was completed on 8/24/11. Mr. Mike Twedt presented a summary of the project work and accomplishments to the SDDOT Research Review Board. The proposed SDDOT CEMP was outlined and a proposed implementation schedule was presented to the Board.

5.0 CURRENT SDDOT ENERGY MANAGEMENT APPROACH

The current SDDOT energy management approach was investigated. The approach was divided into two basic categories; the first consists of state-directed efforts and the second consists of SDDOT-directed efforts. Many of these efforts overlap, but in order to separate the origination of the energy management program, the following segments examine the various components that form the existing SDDOT energy management approach.

5.1 SDDOT Energy Management Approach: State-Directed

Energy improvement projects are currently completed at SDDOT, but typically only because of equipment or a system reaching the end of its useful life. When equipment or systems require replacement, newer and consequently more efficient equipment is purchased, both due to improving system designs and due to the SDDOT following all State-mandated energy efficiency procedures and policies, which dictates baseline energy efficiency. The following sections summarize the major energy and energy-efficiency requirements related to energy management.

5.1.1 Bureau of Administration (BOA)

The State of South Dakota has guidelines and mandates to establish minimum acceptable levels of energy efficiency concerning purchases of new equipment, systems, and buildings for state agencies. Many of these guidelines have originated in the Bureau of Administration (BOA) either directly or via the efforts of BOA departments such as the Office of the State Engineer (OSE) and its Energy Management Office.

The South Dakota Bureau of Administration (BOA) has many charges. The areas which pertain to energy management include BOA's responsibility for managing all state owned and leased properties while providing direction to all State Agencies which oversee many of the day-to-day operations of State-owned properties. In order to accomplish this task, the BOA utilizes many of its Offices, such as the Office of the State Engineer (OSE) and the Energy Management Office.

An example of the BOA's lead role in energy management is through its efforts to establish State mandates for purchasing ENERGY STAR® or equivalent equipment as appropriate and/or feasible, as set by their Statewide Policy ES-08-01 "Purchase of Environmentally Preferred Products." This policy lead to the State Administrative Rule requiring the purchase of energy consuming products that meet efficiency standards, including ENERGY STAR® qualified products, ARSD 10:02:05:13 (see ENERGY STAR® details in Section 5.1.3Required Purchase of Energy Efficient and ENERGY STAR® Products).

Additional examples of the BOA's role in State energy management includes the creation of a State Sustainability Coordinator to lead the South Dakota Sustainability campaign, which suggests methods to State employees to improve environmentally responsible stewardship practices such as energy efficiency, waste reduction, and environmentally responsible purchasing practices.

One wide-ranging energy management effort which was led by the BOA for State agencies was the hiring of a consulting firm to conduct a statewide energy audit on selected state facilities to quantify the current energy consumption by State agencies, identify energy conservation measures that could reduce State agencies' energy consumption and estimate the costs associated with the energy conservation measures. The efforts resulted in an extensive report, which was completed in 2009 titled, "Statewide Energy Auditing for Energy Master Plan." Many of the Energy Conservation Measures (ECMs) identified in the report were later implemented with funding from ARRA through efforts by OSE's Office of Energy Management and the respective State agencies. A more detailed evaluation of the results, along with specific SDDOT results is provided in section 6.0.

5.1.2 Office of the State Engineer (OSE)

State energy projects in South Dakota are typically managed within the Bureau of Administration, in the Office of the State Engineer (OSE). OSE manages the construction process for all new construction, excluding highway construction. OSE also provides State property management oversight by managing the statewide maintenance and repair program. Additionally, OSE serves to provide technical assistance and advice to State Agency Physical Plant Directors on matters beyond their in-house capability. The relationship between SDDOT and OSE on energy efficiency projects is as follows.

Larger equipment, systems and building projects are typically upgraded according to established SDDOT procedures for meeting various State energy efficiency requirements. These larger projects are often passed through the Office of the State Engineer to provide construction management and technical oversight. The primary method for achieving energy efficiency in large projects is due to the requirement that State buildings must be designed and constructed in conformance with high-performance green building standards as specified in SDCL §§5-14-33 to 5-14-38. Refer to Section 5.1.2.2 on LEED and Building Energy Code Requirements for a more thorough overview of the requirements.

The SDDOT follows all State-mandated energy efficiency procedures and policies. Once a building, system, or equipment project is identified by SDDOT, the typical process involves SDDOT personnel collaborating with and routing the project through the Office of the State Engineer (OSE). Typically, SDDOT coordinates with a primary OSE project engineer for all projects located outside of the Capital Complex in Pierre. For projects in the Capital Complex in Pierre, SDDOT has a different primary OSE project engineer. Refer to Section 10.1.1 for a detailed breakdown on SDDOT project procedures.

The OSE project engineer typically works with the SDDOT team and may assist in energy efficiency equipment selection and may provide some level of energy management oversight. Typically, the OSE will focus on ensuring that energy efficiency and/or code related requirements are met and provide critical project management as necessary. As a result, equipment and systems are often selected by hired design consultants and contractors, which must follow the energy efficiency standards specified in State Codified Law pertaining to the appropriate building energy codes for the selection of the replacement equipment and systems.

Refer to Section 5.1.2.2 LEED and Building Energy Code Requirements for more details on the requirements.

5.1.2.1 Energy Management Office / Statewide Energy Manager

Administrative coordinating for major energy efficiency programs and projects is handled for the most part by the Statewide Energy Manager located in the OSE Energy Management Office. The Office of the State Engineer and the Energy Management Office coordinate on establishing standards for energy-related construction and equipment. The Energy Management Office oversees the state's energy purchases and the efficient use of energy. This office also negotiates energy purchases for the State and coordinates contact with the Western Area Power Administration and energy management programs.

Energy Management Office services are available to all State Agencies and institutions. Services include advising institutions on the implementation of economical energy savings activities for state facilities and assists with the development of State energy management strategies like load shaping and long-term efficiency plans. Additionally, the office directs various energy programs (i.e. ARRA SEP, EECBG, etc.) for South Dakota, many of which provide energy grants and loans for qualifying state owned facilities.

The following energy efficiency related requirements apply to all State Agencies, including the SDDOT.

5.1.2.2 LEED and Building Energy Code Requirements

The Office of the State Engineer directs that State buildings must be designed and constructed in conformance with high-performance green building standards as specified in SDCL §§5-14-33 to 5-14-38 and defined as follows:

South Dakota Codified Law 5-14-32. *Definition of terms. Terms used in this section and §§5-14-33 to 5-14-38, inclusive, mean:*

(1) "High-performance green building standard," a building that is designed and constructed in a manner that achieves at least:

(a) A Silver standard rating under the United States Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system in effect as of July 1, 2009, or earlier if the building was registered or certified under a previous LEED rating system version;

(b) A two globe rating under the Green Building Initiative's Green Globes rating system as of January 1, 2008; or

(c) A comparable numeric rating under a sustainable building certification program recognized by the American National Standards Institute as an accredited standards developer;

(2) *"New construction," any new building constructed by any state agency, department, or institution which has a cost of five hundred thousand dollars or more or that includes five thousand square feet or more of space;*

(3) *"Renovation" or "renovated," any alteration of a state building with a cost of five hundred thousand dollars or more or that includes five thousand square feet or more of the building;*

(4) *"State building project," new construction or renovation of a building, which has heating, ventilation, or air conditioning, by the Board of Regents or any state agency, department, or institution* (SD Codified Laws, 2011)

The most common rating system used for meeting this standard is the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) Silver rating system. The minimum energy code for these LEED buildings is ASHRAE Standard 90.1-2007. This applies to new buildings and major renovations to existing buildings. SDDOT building construction projects that fall into this area are typically designed to LEED standards through the specific architecture and engineering (A&E) building design team with OSE oversight.

5.1.2.3 LEED Silver, Gold or Platinum Certification

The state of South Dakota mandates that SDDOT new construction must meet LEED Silver rating requirements (or equivalent). Projects seeking LEED certification must have a LEED Professional Credential holder on the project holding one or more of the following designations depending on the project type and rating system being used:

- LEED Green Associate
- LEED AP BD+C
- LEED AP ID+C
- LEED AP Homes
- LEED AP O+M
- LEED AP ND

LEED certification requirements and categories of credits (points) awarded are dependent on which of the following rating systems are used:

- New Construction (NC)
- Existing Buildings: Operations & Maintenance (EB: O&M)
- Commercial Interiors (CI)
- Core & Shell (CS)
- Schools (SCH)

- Retail
- Healthcare (HC)
- Homes
- Neighborhood Development (ND)

The LEED categories determining credits are awarded dependent on the rating system used but typically consists of the following:

- Integrative Process (IP)
- Location and Transportation (LT)
- Sustainable Sites (SS)
- Water Efficiency (WE)
- Energy and Atmosphere (EA)
- Materials and Resources (MR)
- Indoor Environmental Quality (EQ)
- Performance (PF)
- Innovative Design Process
- Regional Priority

The majority of energy efficiency-related scoring is in the Energy and Atmosphere (EA) section. However, the scoring is largely based on how much the designed building exceeds the ASHRAE Standard 90.1 baseline for the given building systems utilized. For more information and details of the latest version of LEED Certification and the requirements on obtaining LEED professional certification visit the USGBC's website: http://www.usgbc.org/

In addition to the LEED Silver rating requirement, South Dakota buildings must comply with codes for commercial buildings referenced in the International Building Code (IBC) in state law (SDCL §§ 1-33B, 13-25-15). These building codes in turn reference the most recent version of ASHRAE standard 90.1 Commercial Building Energy Code or equivalent as the minimum building energy code (SD Energy Codes Workgroup, 2010).

5.1.3 Required Purchase of Energy Efficient and ENERGY STAR® Products

The purchase of energy efficient and ENERGY STAR® equipment by State agencies is required where feasible. This policy originated when the BOA adopted a Statewide Environmentally Preferred Products Statewide Policy (ES-08-01) to provide direction to state agencies (including SDDOT) regarding the purchasing and appropriate use of environmentally preferable products including products that are energy efficient. This policy was transformed into a State Administrative Rule (ARSD 10:02:05:13) which requires the purchase of energy consuming products that meet efficiency standards, including ENERGY STAR® qualified products, is ARSD 10:02:05:13. This State Administrative Rule is as follows:

State Administrative Rule 10:02:05:13 (SD Legislature, 2011)***:*** *Procurement of energy consuming products. Each State agency and institution shall specify products that meet at least one of the following requirements when procuring energy consuming products:*

a) ENERGY STAR® qualified;
b) Green Seal certified; or
c) Ecologo certified.

Any energy consuming product installed in new construction or renovation project that is designed to meet high performance green building standards pursuant to SDCL 5-14-32 to 5-14-38, inclusive, or ASHRAE Standard 90.1-2007, shall be accepted as being compliant with this section.

Source: 37 SDR 111, effective December 7, 2010.
General Authority: SDCL 5-18A-38.
Law Implemented: SDCL 5-18A-38.

This rule states that when acquiring energy-consuming products State agencies shall purchase ENERGY STAR® designated products (or Green Seal or Ecologo certified) where feasible. ENERGY STAR® rated products are typically at least 10% more energy efficient than non-ENERGY STAR® rated products. ENERGY STAR® is a government-backed program which seeks to help businesses and individuals protect the environment through identifying superior energy efficiency products and practices. Information regarding ENERGY STAR® products is available via the Internet at www.energystar.gov/products (SD BOA, 2008).

5.1.4 Required Input of Energy Utility Billing Data into EnergyCAP®

Like most state agencies, SDDOT currently is operating EnergyCAP® software to track a majority of its facilities' utility bills in order to electronically submit energy use information to the South Dakota Bureau of Administration (SDBOA). The EnergyCAP® software is used to record the energy use of Area and Regional Operations. EnergyCAP® was the first tracking mechanism implemented in the State of South Dakota so that the Bureau of Administration could report the total energy use of all state agencies and institutions. The utility cost summaries are also used by SDDOT to estimate annual energy budget requirements. The use of EnergyCAP® in the State of South Dakota is primarily limited to its accounting and record keeping capability. For a more detailed analysis of SDDOT utilization of EnergyCAP® and EnergyCAP® capabilities such as ENERGY STAR® Portfolio Manager, refer to section 5.2.10 SDDOT Energy Tracking (EnergyCAP®).

5.2 SDDOT Energy Management Approach: SDDOT-Directed

Energy improvement projects are currently completed at the SDDOT, but typically only because of equipment or systems reaching the end of its useful life. When equipment or systems require replacement, newer and consequently more efficient equipment is purchased both due to contemporary design and due to the SDDOT following all State-mandated energy efficiency procedures and policies, which dictates many of the baseline energy efficiency standards. One example of SDDOT non-typical energy improvement projects are the suite of energy conservation measures that were identified in a 2009 Energy Audit Report and consequently implemented with ARRA funding (see Section 6.0 STATEWIDE ENERGY AUDIT REPORT REVIEW for more details on the recommendations). The following sections summarize some major SDDOT-led energy management initiatives.

5.2.1 SDDOT Management Structure

The SDDOT is organized to efficiently achieve the following mission statement (SDDOT, 2009):

"*To provide a safe, efficient, and effective transportation system.*"

However, one consequence of this focused approach is that organizationally minor items, like energy management, may not receive much emphasis.

The SDDOT is organized into a central office lead by the Secretary of Transportation with three major divisions. Each division is managed by a Division Director. The Division of Operations (see Figure 2) is in charge of department buildings and consequently consumes the majority of non-transportation-related energy. The SDDOT Division of Operations is divided into four major regions within the State (Aberdeen, Pierre, Mitchell, and Rapid City). Each region is managed by a Region Engineer. Additionally, each region has an Operations Engineer, who is in charge of the region's facilities. Within each of the regional offices are three area offices, with one of the areas being the same physical location as the regional office. So there are 12 total area offices within the State, each managed by an Area Engineer. The Area Engineers report to their respective Region Engineer, and additionally to their respective Operations Engineer concerning facilities issues such as equipment repairs and building construction requests.

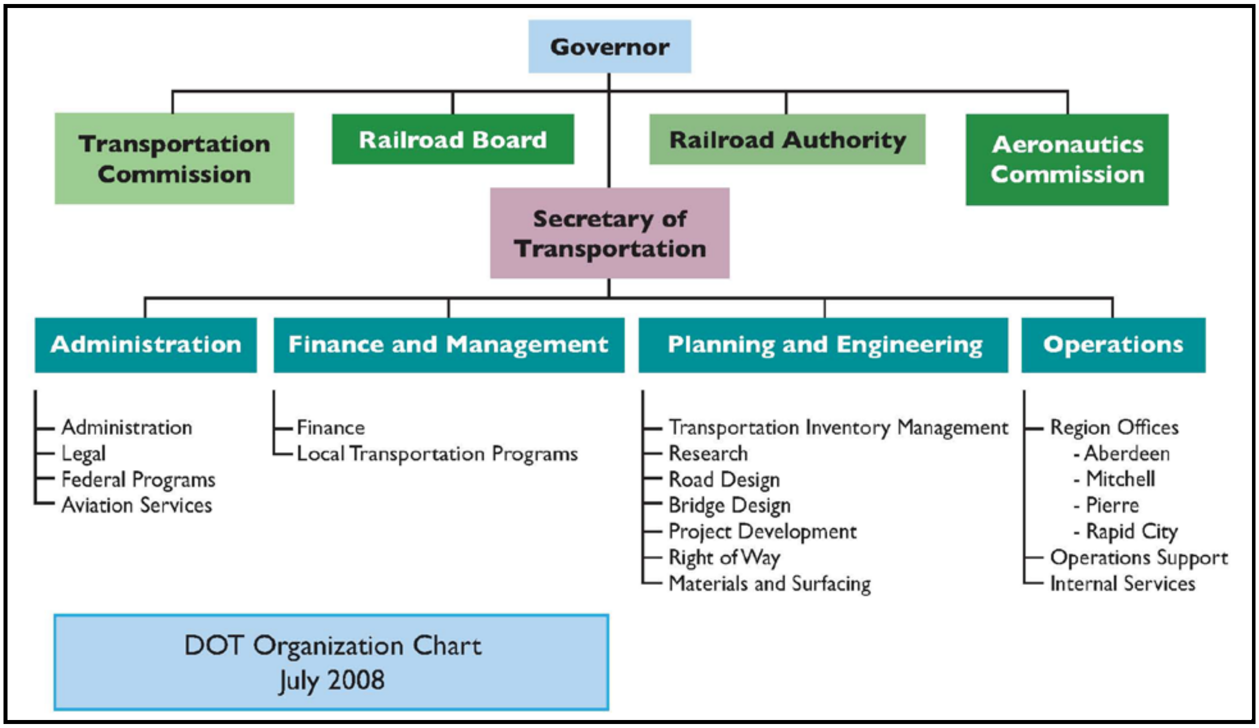

Figure 2: SDDOT Organizational Chart (SDDOT Handbook, 2009)

Region Engineers, with input from their respective Operations Engineer and Area Engineers collaborate with the SDDOT Internal Services Manager concerning equipment and building construction requests. The SDDOT Internal Services Manager submits equipment and building construction requests to the SDDOT Division Directors for consideration and ultimately to the SDDOT Secretary.

5.2.2 SDDOT Energy Management Structure

No dedicated SDDOT Energy Management structure exists for identifying, evaluating, and implementing agency-wide energy conservation projects. However, the state has many mandates and guidelines to push state agencies towards achieving baseline energy efficiency standards, as well as an established formal policy for meeting these requirements, and for identifying major capital improvement projects. Usually projects are not identified solely for energy conservation, but rather due to equipment reaching the end of their useful lives. The SDDOT Building Construction and Major Capital Improvements (Policy No. DOT-OS-IS-3.1) defines the established process.

The SDDOT utilizes a software program to track equipment inventories for maintenance and replacement schedules (AuditMate™). The AuditMate™ inventory list includes Central Office and Region building and improvement projects, which are all ultimately prioritized based on need. The inventory lists new construction projects, and maintenance and repair projects for existing facilities. The planning cycle is five years and integrates input from Region Engineers, respective Operations Engineer and Area Engineers, who collaborate with the SDDOT Internal

Services Manager concerning equipment and building construction requests as well as prioritization of those requests. The SDDOT Internal Services Manager submits equipment and building construction requests to the SDDOT Division Directors for consideration and ultimately to the SDDOT Secretary. Upon project approval, this group collaborates with OSE project engineers concerning the implementation of approved equipment and building construction projects.

The SDDOT Internal Services Manager is very important to the energy management structure since all equipment and building replacement requests are funneled through this position, which has the potential to allow additional project evaluation concerning energy efficiency merits of proposed projects. The Region and Area Engineers are important to the energy management structure since they are the primary facility managers at SDDOT and are key personnel in identifying most equipment and building replacement needs. Additionally, the engineering supervisor's secretaries at each of the 12 Area Offices process the respective utility bill payments for their respective facilities. Consequently, the secretaries are typically charged with data entry into the energy accounting software (EnergyCAP®). The SDDOT has used this software since 1995 for utility billing purposes. However, energy management features of this software have not been used.

5.2.3 SDDOT Sustainable Government Action Plan

A SDDOT workgroup developed a SDDOT Sustainable Government Action Plan in 2009. This plan appears to be a working first step in the evolution of an SDDOT EM Program and MEM Plan. Key energy management related items include the following.

- Reduce mileage / reduce fuel use
- Reduce electrical consumption
  - Computer / monitor
  - Lights
  - Monitor electrical consumption monthly
- Develop a department wide policy for personal electronic devices
- HVAC
  - Windows
  - Thermostats
  - Replace windows and doors
  - Replace inefficient heating systems
- Education / promotion / train staff
  - Representatives from each program will be trained to train program members
  - Use staff meetings to present information

- Invite a representative from each Region to participate in the planning sessions

The full SDDOT Sustainable Government Action Plan is shown in the Appendix 15.1.

5.2.4 SDDOT Energy Management Budget

No dedicated SDDOT Energy Management budget currently exists for identifying, evaluating, and implementing energy conservation projects. However, capital expenditures are allocated for building and equipment improvements, which include energy efficiency improvements. These building and equipment improvement projects are typically implemented due to system breakdown and/or needed replacement, unrelated to energy reduction and associated energy cost savings potential.

5.2.5 Current SDDOT Energy Management Policies and Procedures

The State of South Dakota has guidelines and mandates to establish minimum levels of energy efficiency concerning new purchases of equipment, systems, and buildings for State Agencies. In general, smaller equipment is upgraded directly by established SDDOT procedures for following State mandates by purchasing ENERGY STAR® or equivalent equipment that is appropriate and/or feasible, as required by State Administrative Rule(ARSD 10:02:05:13, .

The SDDOT follows all State-mandated energy efficiency procedures and policies and has an established formal policy for meeting these requirements and for identifying major capital improvement projects. The existing SDDOT procedure is usually not utilized solely for energy conservation, but due to equipment reaching the end of its useful life. The SDDOT Building Construction and Major Capital Improvements Policy (Policy No. DOT-OS-IS-3.1) defines the established process (SDDOT, 2010).

The SDDOT utilizes a software program to track equipment inventories for maintenance and replacement schedules (AuditMate™). The AuditMate™ inventory list includes Central Office and Region building improvement projects, which are all ultimately prioritized based on need. The inventory lists new construction projects as well as maintenance and repair projects for existing facilities. New projects make the list via a combination of the SDDOT Internal Services Manager adding end-of-service life equipment, as the AuditMate™ software suggests replacements, and Region Engineers submitting requests.

Typically, Region Engineers, with input from their respective Operations Engineer and Area Engineers collaborate with the SDDOT Internal Services Manager concerning equipment and building construction requests and prioritization. The SDDOT Internal Services Manager submits equipment and building construction requests to the SDDOT Division Directors for consideration and ultimately to the SDDOT Secretary for project approval. Upon project approval, the SDDOT Region Engineers and their respective Operations Engineer and Area Engineers collaborate with the SDDOT Internal Services Manager and their OSE project engineers concerning the implementation of approved equipment and building construction projects. Refer to Figure 4 for a chart displaying the process and Figure 2 for organizational information and Figure 3 for SDDOT Region and Area distributions.

The usual Region building system replacement process involves a SDDOT Region Engineer identifying a need through collaboration with their Operations Engineer and Area Engineers. If the cost is small or an emergency, they coordinate with the SDDOT Internal Services Manager and may immediately make a replacement purchase as the emergency dictates and their budget allows. Each Region office has an annual $25,000 emergency repairs fund for this purpose.

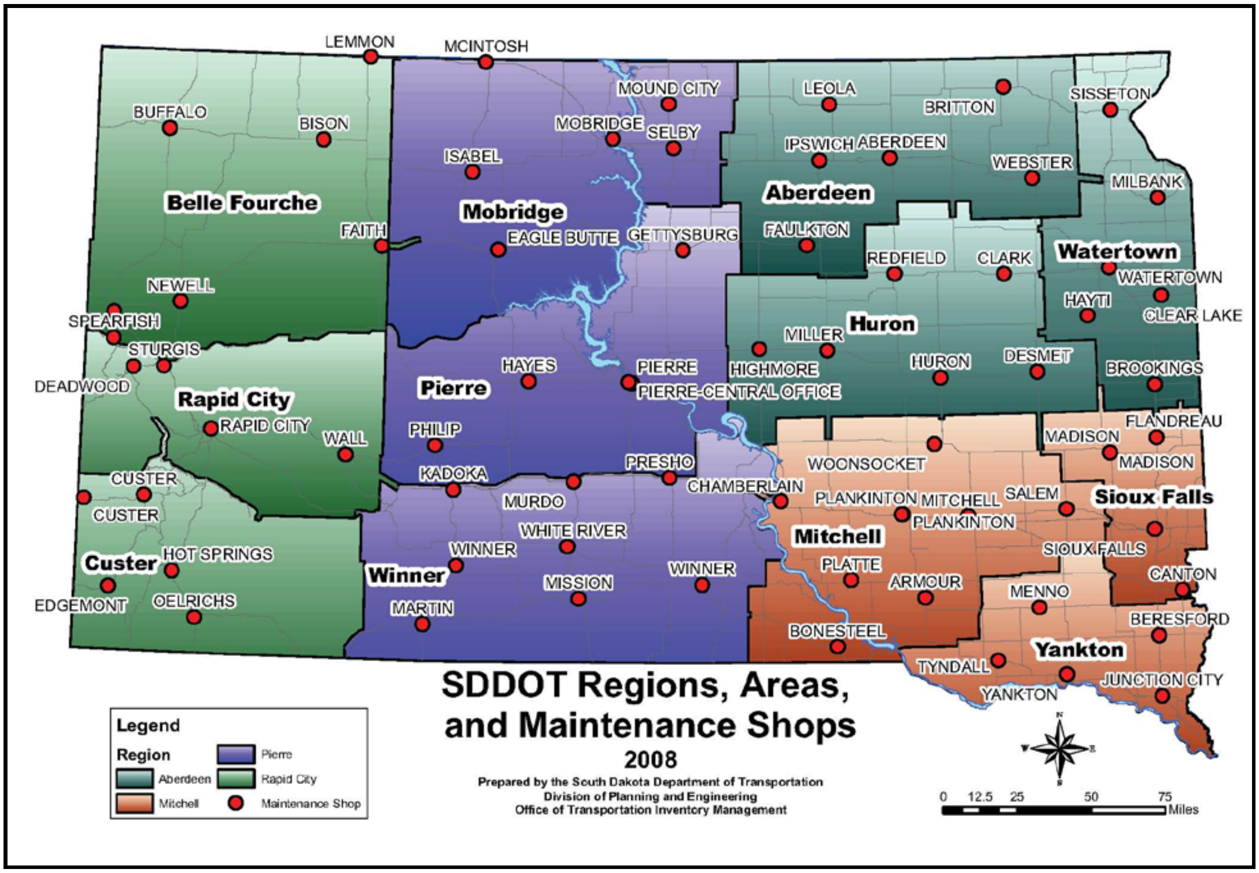

Figure 3: SDDOT Regions and Areas (SDDOT Handbook, 2009)

If the project cost is substantial and/or if it is not an emergency, the Region Engineer, through collaboration with their Operations Engineer and Area Engineers, will coordinate with the SDDOT Internal Services Manager to add the project to the AuditMate™ inventory list for prioritization.

Larger equipment, systems and building projects are typically first identified by a team of SDDOT personnel consisting of one of the following channels:

- AREA/REGION IDENTIFIED: Area Engineer and/or Operations Engineer identify failing equipment or systems and report to their Region Engineer. The Region Engineer, or their designee, reports the item to the Internal Services Manager. At his point, the projects are integrated into the inventory list, and are ultimately prioritized based on the severity of their need for replacement.

- INTERNAL SERVICES MANAGER/AUDITMATE™ IDENTIFIED: The Internal Services Manager maintains the SDDOT AuditMate™ inventory, which includes Central Office and Region building and improvement projects. The inventory lists maintenance and repair projects for existing facilities and new construction projects. These projects are prioritized statewide considering such items as equipment age and the relationship to the expected equipment life, importance of the improvement, and the assigned need of the improvement. The prioritization process involves personnel at various SDDOT management levels statewide, including Internal Services Manager, Region Engineers, Operations Engineers and Division Directors.

Once a project is approved for replacement, the SDDOT team may identify energy efficient alternatives, but often time constraints limit how much, if any effort can be placed into energy efficiency specifications. Typically, the SDDOT team collaborates with and routes the project through the Office of the State Engineer (OSE). The OSE project engineer typically works with the SDDOT team and may assist in energy efficiency equipment selection and may provide some level of energy management oversight. Typically the OSE will focus on ensuring that energy efficiency mandates and/or code related requirements are met and provide critical project implementation management. As a result, many equipment and systems are selected by the respectively hired design consultants and contractors, and must follow the energy efficiency benchmarks required by State mandates.

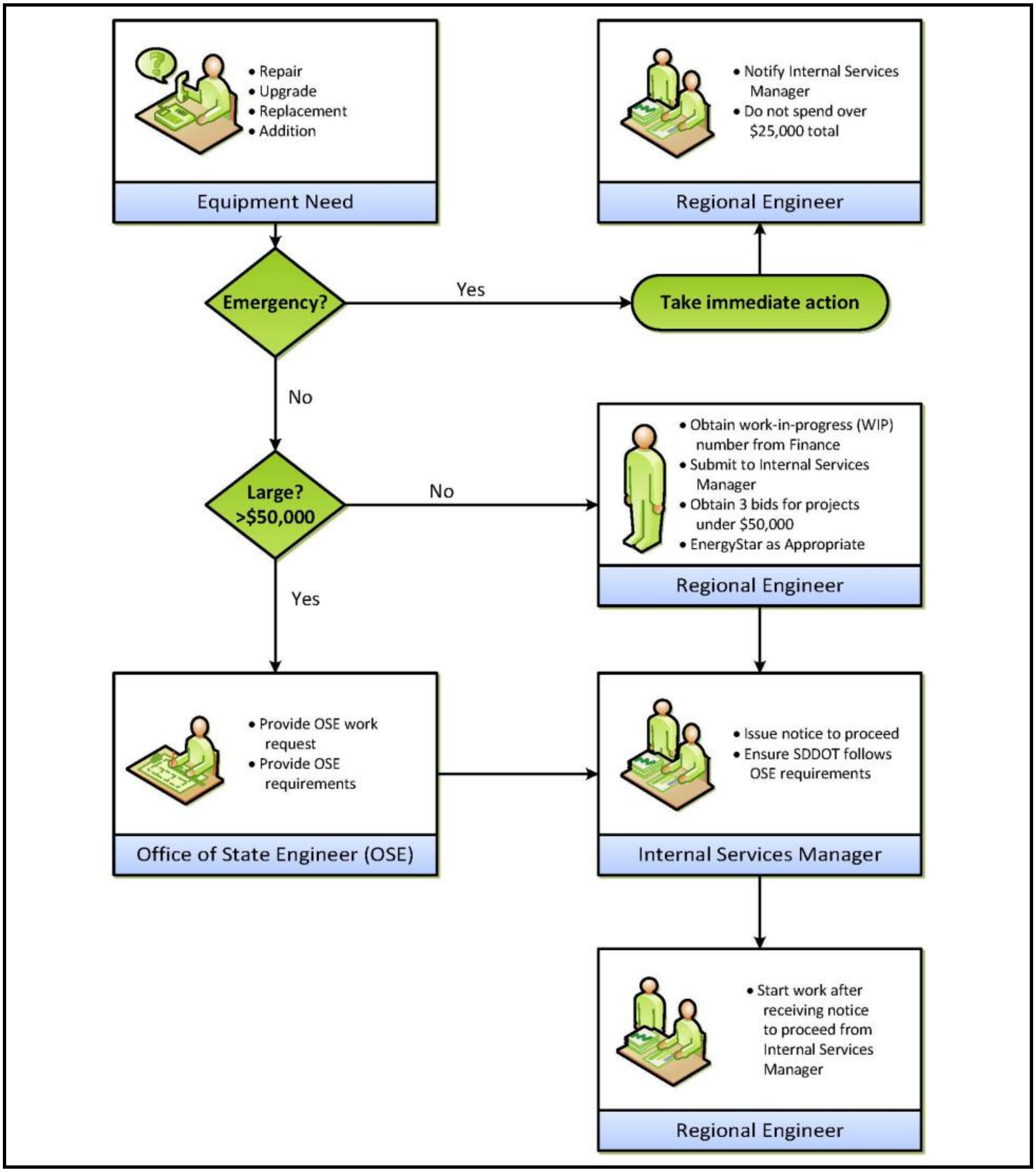

Figure 4: Decision Chart – SDDOT Policy, Building Construction / Improvements

Although there are limited specific energy policies or procedures in place currently that are dedicated solely to SDDOT, some energy efficiency practices are being carried out. Currently, energy efficiency projects are implemented at the SDDOT for the following reasons:

5.2.6 New Construction

New building projects requiring advanced consulting services usually require the project to follow energy codes (e.g. ASHRAE 90.1-2007) or obtain a LEED rating of Silver, as mandated by the state law (SDCL §§5-14-33 to 5-14-38), refer to Section 5.1.2.2 LEED and Building Energy Code Requirements for additional details. In these projects, the consulting team generally directs the SDDOT level of building energy efficiency through meeting building energy codes and obtaining a LEED Silver rating system. However, the SDDOT and the OSE may be an integral part of the design team and can influence the overall building energy efficiency level by requesting and/or specifying above code efficiency levels or equipment types, such as high performance geothermal heat pumps. In addition, projects larger than $50,000 are always routed through the Office of the State Engineer.

The SDDOT follows all State-mandated energy efficiency procedures and policies and has an established formal policy for meeting these requirements titled “Building Construction and Major Capital Improvements Policy No. DOT-OS-IS-3.1” when replacing equipment, systems, and buildings. This policy is detailed in Section 5.2.5 Current SDDOT Energy Management Policies and Procedures.

5.2.7 Existing Construction and System Replacement

Replacement generally occurs when equipment either fails or reaches the end of its useful life as part of a preventative maintenance program. SDDOT Internal Services maintains a building and improvement (B&I) list through utilizing their AuditMate™ preventative maintenance software. This master list, called an AuditMate™ Inventory includes all building and improvement projects, which are prioritized by an internal ranking evaluation for greatest need. The AuditMate™ Inventory includes all projects from both the SDDOT Central Office and all Regions. This policy is detailed in Section 5.2.5 Current SDDOT Energy Management Policies and Procedures.

5.2.8 SDDOT Management Led Effort

A particular building that has a sustained and dramatic increase in energy costs may prompt an Area/Region Engineer, in conjunction with the Internal Services Program Manager, to hire a consultant to investigate the root cause. This may result in a more energy-efficient system due to baseline equipment efficiency improvements and/or consultant/contractor/Area/Region Engineer team implementing energy efficient systems by current design practices and/or by following state mandates.

The Operations/Area/Region Engineers or other facility or organizational managers/engineers may also personally direct the energy efficiency improvements independently within areas of their jurisdiction. An example is integrating solar photovoltaic systems to power remote signage in order to reduce meter fees and installation costs. Another example is investigating the feasibility of installing geothermal heat pumps as a heating system alternative at select facilities. However, most managers lack energy training, and combined with demanding schedules, often avoid additional investment of time in energy conservation activities. Consequently, these projects are rare.

5.2.9 SDDOT Budget

Energy costs are a small fraction of the overall budget and therefore do not attract attention. The FY2009 Department of Transportation overall budget was $455,824,042, of which $130,279,233 was for general operations and $7,400,000 was for building and facility maintenance. Energy costs were $1,421,643 for 2010, which represent approximately 1.1% of the general operations budget and little more than 0.3% of the overall budget. The numbers will likely not change for the next budget year unless energy costs increase to a level that requires funding reallocations. It is anticipated that if energy costs or usage rises significantly from one year to the next, applicable area managers would hire a consultant or similar to examine methods of energy consumption and/or cost reductions. Additionally, no budget amount is allocated for energy conservation projects. Equipment and system energy efficiency improvements are made as systems become worn out. It was noted that some small volume, traffic sign projects consider renewable energy (RE) systems when line costs warrant. The SDDOT has no defined economic indices for evaluating the merit of energy conservation projects (e.g. simple payback period). There is no SDDOT budget for energy management personnel. It is anticipated that this will not change in the future under the status quo.

5.2.10 SDDOT Energy Tracking (EnergyCAP®)

It should be noted that energy associated costs are not tracked before and after implementation of any energy conservation measures. Consequently, the impact of energy conservation activities is not known and cannot be shared throughout the SDDOT. However, the SDDOT has the infrastructure readily available to provide this critical information, and more, through the use of EnergyCAP®. The SDDOT currently employs EnergyCAP® software to record the energy use at Area and Regional operations. EnergyCAP® was the first tracking mechanism implemented in the State of South Dakota so that the Bureau of Administration could report the total energy use of all State institutions. The use of EnergyCAP® in the State of South Dakota is primarily limited to its accounting and record keeping capability.

Like most State agencies, SDDOT currently is operating EnergyCAP® version 6.1.60.49 to track a majority of its facilities' utility bills in order to submit energy use information to the SDBOA and to estimate annual energy budget requirements. EnergyCAP® has the potential to provide extensive utility bill analysis capabilities for commodities like coal, natural gas, water, and electricity but does not possess a systems-based analysis capability so that lighting, steam generation and other components of a facility can be monitored and managed properly. Future projections are based on past utility bill information and therefore cannot make predictions based on changes to building systems, more efficient lighting, or change in operations, such as decreased occupancy due to 4-day work weeks. Advanced forecasting of energy use based on equipment or operational changes is typically conducted by a professional energy engineering company through energy auditing, retro commissioning (RC_x), or Measurement and Verification (M&V). Data is manually entered, typically by an Area Office accountant, into the database. Manual data entry acts as a disincentive to detailed metering of facilities that would allow for increased analysis within EnergyCAP® whereas a utility-provided Electronic Data Interchange (EDI) or appropriate spreadsheet format file imported into EnergyCAP® would encourage increased data resolution. Digital data import features of EnergyCAP® are directly dependent on individual utility company capabilities, which can typically be ascertained by contacting them directly.

Presently, the use of EnergyCAP® by the SDDOT is limited to the generation of four annual budget reports, one for each SDDOT Region, so that the central office can make necessary adjustments, like inflation, and approve the next year's operating budget. Additionally, each SDDOT Region submits its total energy use and total energy costs to the State Engineer via EnergyCAP®. Typically, clerks at the 12 SDDOT Area Offices are charged with data entry into EnergyCAP® since they also process the utility bill payments. These staff have limited experience with the capabilities of EnergyCAP® and how to use them. One frustration with the present procedure is the double-entry requirement; separate software is used for accounting and payments but the energy use must be entered into EnergyCAP® manually.

Discussions with SDDOT personnel and a review of EnergyCAP® software capabilities clearly indicate that additional training is needed. The current version of EnergyCAP® (6.1.60.71) has features to address many of the concerns related to restrictive data entry options and limited use of reports. Common misconceptions, followed by the EnergyCAP® solutions, are listed below:

- IT IS IMPOSSIBLE TO VIEW INDIVIDUAL BUILDING INFORMATION: The latest version of EnergyCAP® uses an account-meter system so that individual meter charges that are paid by multiple entities can be tracked in detail.
- RE-BILLING OR SUB-BILLING IS NOT POSSIBLE: The account-meter system used within the Budget Manager portion of EnergyCAP® allows for complex financial accounting like re-billing and multiple accounts on a single meter.
- ENTERING MONTHLY INFORMATION FOR INDIVIDUAL METERS WITH SMALL CONSUMPTION IS TIME AND COST PROHIBITIVE: The newer version of the software can import utility data directly when provided in the appropriate file format by the utility company.
- NO NAMING CONVENTION EXISTS FOR BUILDINGS, ACCOUNTS, OR METERS: EnergyCAP® training tutorial videos have recommended account creation techniques. A naming convention can be developed and implemented.
- NO ALARM FEATURE EXISTS TO ALERT MANAGERS OF UNUSUAL BUILDING PERFORMANCE: Budget reports within EnergyCAP® can be used to compare actual versus budgeted consumption by location and individual meter. Additional content-specific filters (timeframe, account, meter, building, etc.) can be applied to reports within the report email system of EnergyCAP® so that only those accounts, meters, or buildings that meet the filtered criteria are generated in the report. Generation and distribution of the reports to be emailed can be automated with a periodic timer like monthly or

quarterly. Details about each filter type and its purpose can be found in the Help menu of EnergyCAP®.

- THE PERIODIC IN-PERSON TRAINING SESSIONS ARE DIFFICULT TO ATTEND: EnergyCAP® provides numerous free video tutorials through the Support section of the EnergyCAP® website. These videos are easy to follow tutorials for common tasks, and more complex configurations, in EnergyCAP®. A searchable web-based user manual is also available. The creation of an energy team may warrant pursuing authorization to set aside time for training as well as consideration of customized training from EnergyCAP Inc.

5.2.11 ENERGY STAR® Portfolio Manager (ENERGY STAR®, 2011a)

ENERGY STAR® utilizes a building energy efficiency rating scale, which ultimately rates a building from 1-100, as a foundation for evaluating a building's energy efficiency level for obtaining an official ENERGY STAR® label. The specific tool for accomplishing this task is the ENERGY STAR® Portfolio Manager. The ENERGY STAR® website describes Portfolio Manager as "an interactive energy management tool that allows you to track and assess energy and water consumption across your entire portfolio of buildings in a secure online environment. Portfolio Manager can help you set investment priorities, identify under-performing buildings, verify efficiency improvements, and receive EPA recognition for superior energy performance."

EnergyCAP® software has the capacity to interface directly into ENERGY STAR® Portfolio Manager, which would allow SDDOT facilities to obtain a building energy efficiency rating (based on a scale from 1-100). This seamless interface removes the need to enter data directly into portfolio manager in order to obtain a building rating. Additionally, qualifying SDDOT buildings which obtain ratings of 75 or more may also be eligible for the ENERGY STAR® label. A rating of 75 indicates that the building's energy performance is better than 75% of similar buildings surveyed in the commercial building energy consumption survey (CBECS) conducted by the Department of Energy's Energy Information Administration (EIA). The categories of buildings eligible for an ENERGY STAR® label represent fifty-percent of the commercial building sector. Many of the other features associated with ENERGY STAR® Portfolio Manager are incorporated into the Energy CAP® interface, such as assessment of building energy consumption, identify and verify efficiency improvements, and calculate carbon emissions. ENERGY STAR® Portfolio Manager feature highlights include:

- The ability to assess energy and water consumption
- Identify underperforming buildings
- Aid in establishing investment priorities
- Verify building efficiency improvements by monitoring before/after changes
- Satisfy many emerging mandates
- Estimate a building's carbon footprint
- Obtain EPA recognition

ENERGY STAR® Portfolio Manager also generates a statement of energy performance that summarizes a building's characteristics and energy profile. This document can be used to satisfy LEED for existing buildings (LEED-EB) requirements.

Another attractive use of Portfolio Manager provides for energy saving goal-setting within a specified timeframe. The Portfolio Manager allows each project or facility to set energy performance goals. For example, two types of goals could be set: one goal could be to reduce overall energy consumption, while another could be to attain a higher energy rating as determined by the Portfolio Manager.

5.2.12 Channels of Communication at SDDOT

Current SDDOT channels of communication are typically based on a combination of written correspondence and meetings (both in person and virtual/webinar) for disseminating information to SDDOT stakeholders.

5.3 SUMMARY

The overall existing energy management approach of the SDDOT is a combination of state and SDDOT-directed efforts. State-directed efforts help improve energy utilization through such mandates as ENERGY STAR® product purchases and EnergyCAP® utilization. Although these mandates provide some guidance, they are not tailored to the unique needs/infrastructure of the SDDOT. A more tailored energy management approach should be adopted by the SDDOT and can only be realized through an SDDOT-directed effort. However, current SDDOT-led efforts could be significantly enhanced. Current efforts primarily involve energy improvement projects initiated because of equipment reaching the end of their useful life. A more worthwhile approach is to initiate energy improvement projects based on metrics deemed important to the SDDOT (e.g. economics, energy use, environmental impact, etc.). The SDDOT does have a few bright spots: they have a management structure well-equipped to adopt new strategies/philosophies and they utilize energy tracking software. Although the full capability of the software is not being used, it does provide a good baseline to build from.

6.0 STATEWIDE ENERGY AUDIT REPORT REVIEW

In 2009, the South Dakota Bureau of Administration hired the consulting firm Sebesta Blomberg & Associates, Inc. of Roseville, MN to conduct a statewide energy audit to quantify the current energy consumption by State agencies. Energy conservation measures that could reduce State agencies' energy consumption were identified, as well as an estimate of the costs associated with the energy conservation measures. The efforts resulted in an extensive report, which was completed in 2009 titled, "Statewide Energy Auditing for Energy Master Plan." Sebesta Blomberg presented the results to the SD State Legislature and the BOA. Many of the ECMs identified in the report were later implemented with funding from ARRA through efforts by OSE's Office of Energy Management and respective State agencies.

Sebesta Blomberg conducted an ASHRAE Level I energy audit for a selected sampling of sites, which focuses on identifying low-cost/no-cost energy cost saving measures. Additionally, Sebesta Blomberg made suggestions based on the findings from their analysis.

In total, Sebesta Blomberg performed on-site energy audits on a substantial sample of State facilities and identified a total of 1,168 Energy Conservation Measures (ECMs), which had the potential to save $3,558,450/yr based on a total capital outlay of $38,617,093 while potentially reducing the State's energy use by 332,952 MMBTU/yr (15.3% reduction). The following section summarizes SDDOT's energy audit results (Sebesta Blomberg, 2009).

6.1 Statewide Energy Audit: SDDOT Results

According to the Sebesta Blomberg report, the SDDOT had nine sites included in the energy audit, which totaled 296,226 square-feet of building area, compared to a total SDDOT building area of 836,559 sf. Therefore, 35.4% of the SDDOT total building square footage was covered by these efforts.

The Statewide Energy Auditing for Energy Master Plan (OSE No. ACC09-07X) prepared by Sebesta Blomberg on December 1, 2009 identified five categories of energy conservation measures (ECM) for the South Dakota Department of Transportation. Those categories were:

- LIGHTING (L): Eighteen sub-ECMs were described
- RETRO-COMMISSIONING (R): Seventeen sub-ECMs were described
- CONTROLS (C): Twenty sub-ECMs were described
- HVAC (H): Forty-three sub-ECMs were described
- OTHER MEASURES (O): Eighteen sub-ECMs were described

Approximately 92 individual ECMs were identified within the 'Master ECM List with ARRA notations Jan082.xls' document. These 92 ECMs correspond to the 92 ECMs detailed in the Statewide Energy Auditing for Energy Master Plan Final Report (OSE No. ACC09-07X). A breakdown by percentage of recommendation is shown in Figure 5.

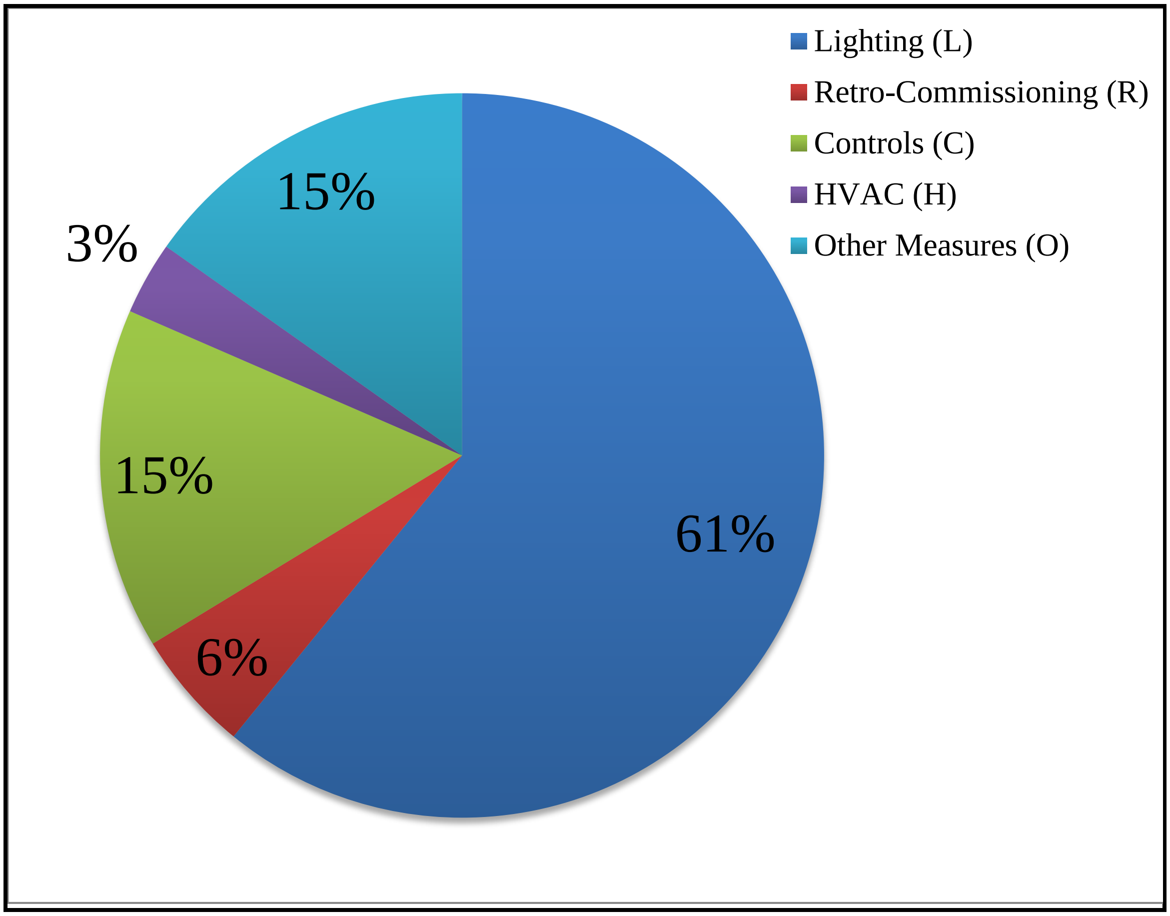

Figure 5: Sebesta Blomberg (2009) Energy Audit SDDOT ECM Breakdown

The Sebesta Blomberg report indicated that the total SDDOT building square footage in 2008 totaled 836,559 sf. Section 4.6 of the report details the audited facilities and indicates that the 26 buildings that were audited have a square footage of 296,226. The buildings audited represents 35% of the 2008 total square feet as stated in the Sebesta Blomberg report and only 20% of the 2010 square feet (1,469,031 sf) as detailed in Table 1 of this report. The 26 buildings that were audited also represent 6% of the total number of DOT buildings in 2010 as shown in Figure 6. The Sebesta Blomberg report also indicates that the SDDOT as a whole used 83,491 MMBtu of energy in 2008 (p365) report compared to the total energy use of audited facilities of 29,026 MMBtu as shown in Table 2.

Table 1: Audit-Mate Facility Data (Supplied Nov 23, 2010 to BTU Engineering by DOT)

Region	Gross SF	Building Qty.	Building Construction Date			Building Gross SF		
			Newest	Oldest	Average	Largest	Smallest	Average
Pierre Region	370,819	110	2010	1951	1986	33,696	25	4,069
Aberdeen Region	385,860	104	2010	1940	1990	21,957	96	4,540
Rapid City Region	313,875	97	2009	1950	1966	21,788	144	3,973
Mitchell Region	398,477	110	2009	1946	1988	41,790	96	4,331
ALL SDDOT	1,469,031	421	2010	1940	1983	33,696	25	4,221

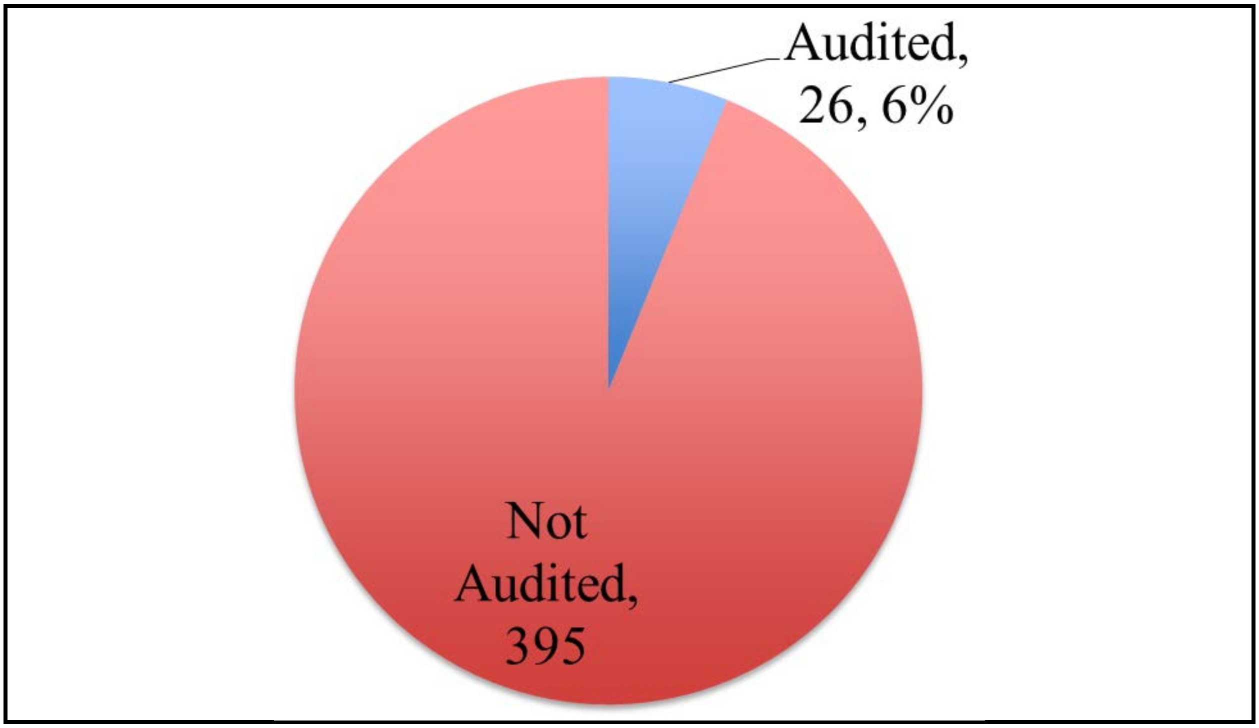

Figure 6: Fraction of 2010 SDDOT Buildings Audited in 2009 by Sebesta Blomberg

Table 2 displays a summary of total square footage and energy use of the nine SDDOT sites audited.

Table 2: Sebesta Blomberg DOT Audit Summary: Area and Energy Use (Sebesta Blomberg, 2009)

Sebesta Blomberg Report [Page #s]	Campus	Audited Area [sf]*	2008 Energy Use [MMBtu]
366-372	Aberdeen	10,000	645
372-375	Brookings	21,957	2,481
375-379	Huron	19,245	1,986
379-386	Mitchell	14,392	1,439
386-389	Murdo	14,248	1,408
390-394	Pierre	55,630	3,975
394-395	Plankinton	6,000	382
397-402	Rapid City	49,418	5,415
402-408	Sioux Falls	105,336	11,295
Total		296,226	29,026

Note that the total values in the table are calculated by BTU Engineering from the data obtained from the individual ECMs of the final version of the Sebesta Blomberg report and may differ slightly from the totals listed in the Sebesta report.

The Sebesta Blomberg report can be further broken down into the decision metrics of an ECM as in Table 3. The information from the report indicates 106 ECMs were identified with 4,258.6 MMBtu energy savings resulting in $94,551/yr cost savings requiring a $606,260 implementation cost. These results display the significance of energy cost saving potential.

Table 3: Summary of SDDOT ECM Metrics

Campus	ECM Quantity [---]	Energy Savings [MMBtu]	Cost Savings [$/yr]	Implementation Cost [$]
Aberdeen	13	143.4	4,401	57,940
Brookings	3	102	921	53,940
Huron	13	515	8,823	67,060
Mitchell	19	491.1	12,378	46,830
Murdo	5	362.1	7,321	26,600
Pierre	12	819.4	18,193	123,660
Plankinton	1	32.3	851	600
Rapid City	15	547.3	16,115	130,420
Sioux Falls	11	1246	25,548	99,210
Total	92	4,258.6	94,551	606,260

Note that the total values in the table are calculated by BTU Engineering from the data obtained from the individual ECMs of the final version of the Sebesta Blomberg report and may differ slightly from the totals listed in the Sebesta report.

The Sebesta Blomberg report results for the audited SDDOT sites by individual facility are displayed in Table 4.

Table 4: Sebesta Blomberg Report ECM Details (SDDOT)

Campus	Building	Building Area [sf]	Previous ECM [Qty]	Identified ECMs [Qty]	Energy Savings [MMBtu]	Cost Savings [$/yr]	Implementation Cost [$]	Simple Payback [yr]
Aberdeen	Area Maintenance Shop	8,400	0	4	30.0	906	7,650	8.4
	District Highway Patrol	10,000	2	0	-	-	-	-
	Regional Cold Storage	1,500	0	2	11.1	308	6,290	20.4
	Regional Office	13,600	4	0	-	-	-	-
	Regional Repair Shop	20,250	1	7	102.3	3,187	44,000	13.8
Brookings	Maintenance Shop 1032	22,000	0	3	102.0	921	53,940	58.6
Huron	Area Office	8,000	0	7	464.6	7,755	62,680	8.1
	Highway Patrol Building	2,400	0	6	50.4	1,068	4,380	4.1
Mitchell	Area Materials Lab	750	0	1	9.2	88	100	1.1
	Area Office and Shop	14,000	0	6	199.2	4,805	14,650	3.0
	Regional Office	8,000	3	6	62.2	1,785	14,000	7.8
	Regional Maintenance Shop	16,000	1	4	187.5	5,336	17,600	3.3
	Regional Materials Lab	4,000	1	2	33.0	364	480	1.3
	Striping Crew Garage	-	0	0	-	-	-	-
Murdo	Maintenance Shop 3045	14,000	0	5	362.1	7,321	26,600	3.6
Pierre	Maintenance Shop and Lab	48,910	2	5	593.4	13,349	95,580	7.2
	Regional Office	6,720	1	7	226.0	4,844	28,080	5.8
Plankinton	Rest Stop Building	3,000	0	1	32.3	851	600	0.7
Rapid City	Building A - Maintenance Crew	11,250	1	5	64.2	2,583	11,470	4.4
	Building B - Repair Shop	21,788	1	5	113.0	4,383	19,350	4.4
	Building C - Cold Storage	-	0	0	-	-	-	-
	Office Building	16,380	1	5	370.1	9,149	99,600	10.9
Sioux Falls	Buildings 100/200	-	1	6	1,003.0	19,993	59,960	3.0
	Building 300	-	0	0	-	-	-	-
	Buildings 400/500	-	0	3	118.5	2,709	18,680	6.9
	Buildings 700/800/900	-	0	2	124.5	2,846	20,570	7.2
Total	---	250,948	19	92	4,258.6	94,551	606,260	6.4

6.2 Statewide Energy Audit: Report Recommendations

A summary of the report recommendations includes (Sebesta Blomberg, 2009):

- Provide an Energy Manager for Agencies
- Provide for advanced metering & monitoring
- Continued & expanded use of a Statewide Energy Database

- Use ENERGY STAR® Portfolio Manager to rate energy efficiency of buildings
- Apply LEED to existing building operations
- Include energy management considerations when leasing space

The report also recommends increased use of Measurement and Verification (M&V). M&V programs are used to track energy and cost savings realized from implementing energy conservation measures. Upon completing the energy conservation measure, an M&V program would be developed specifically for the scope of the project. Often this can be accomplished by installing submeters at the point of use for the new equipment (i.e., at the electrical panel board for the circuit with new lighting). After a period of time, typically one year, this actual energy use is compared to the energy used by the former system to calculate the realized savings. Tracking these savings ensures energy conservation measures are reducing energy use and operating costs, which will assist in identifying, evaluating and requesting funding for more energy conservation measures.

Sebesta Blomberg collected information available from previously implemented energy conservation measures at State campuses. Though personnel on many campuses indicated they have implemented small projects to improve efficiency, few have tracked the savings or losses realized from these investments. South Dakota State University was one exception, which provided an SDSU Energy Report which summarizes energy use and other factors over the past 10 years.

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7.0 EVALUATION OF CURRENT SDDOT ENERGY USE

The following presents a summary of agency-wide total energy use at the SDDOT obtained from EnergyCAP®. The results summarized in this section were established with 2010 as a 'base year .

7.1 Understanding Energy Use at SDDOT

Generally natural gas, propane and fuel oil are used for heating systems at SDDOT facilities (space heating and water and/or process heating), while electricity is used for lighting, air conditioning, pumping and fan systems in addition to auxiliary systems and plug loads such as computers, printers, and personal devices. The most commonly used energy sources were electricity and natural gas. Space heating and lighting were the two most widespread energy-using functions in SDDOT facilities.

In 2010, various SDDOT facilities throughout the state consumed $1,421,643 of the 2010 budget for total energy costs (electricity, natural gas, propane and fuel oil). Electricity use agency-wide accounted for $884,695 (62%) of energy costs and 41% of the energy used in 2010. Natural gas use agency-wide accounted for $262,448 (19%) of energy costs and 43% of the energy used in 2010. Propane use agency-wide accounted for $254,669 (18%) of energy costs and 15% of the energy used in 2010. Fuel Oil #2 use agency-wide accounted for $19,831 (1%) of energy costs and 1% of the energy used in 2010.

Table 5: 2010 Base Year Utility Summary

Energy Source	Utility Unit	Annual Usage [unit/yr]	Average Energy Cost [$/unit]	Btu/unit [Btu/unit]	Annual Usage [MMBtu/yr]	Annual Charges [$]	Energy Cost [$/MMBtu]	EUI [kBtu/yr/sf]	CUI [$/yr/sf]
Electric	[kWh]	11,427,666	0.077	3,412.3	38,994.6	884,695	22.69	27	0.60
Natural Gas	[therm]	403,880	0.65	100,000	40,388.0	262,448	6.50	27	0.18
Propane	[gal]	155,218	1.64	91,600	14,218.0	254,669	17.91	10	0.17
Fuel Oil #2	[gal]	8,634	2.30	139,000	1,200.1	19,831	16.52	1	0.01
TOTALS	---	---	---	---	94,800.7	1,421,643	---	65	0.96

Energy content (Btu/unit) obtained from ANSI/ASHRAE Standard 105-2007

Although this table shows annual usage and cost per utility unit, a more appropriate comparison is on a per MMBtu basis. In this way, costs of different energy sources can be compared on an equal basis (normalized). Note that it costs $22.69/MMBtu and $6.50/MMBtu for electric and natural gas, respectively. On a per unit energy cost basis, natural gas is the lowest cost energy source used and should be the first choice for heating systems. Electricity is the most expensive of all energy sources used and can therefore provide extensive energy cost saving opportunities (ECOs) by reducing use. Figure 7 illustrates the composition of agency-wide energy use by fuel type and Figure 8 shows the 2010 agency-wide utility charges by fuel type. The relatively low cost of natural gas becomes apparent when compared to electricity and propane.

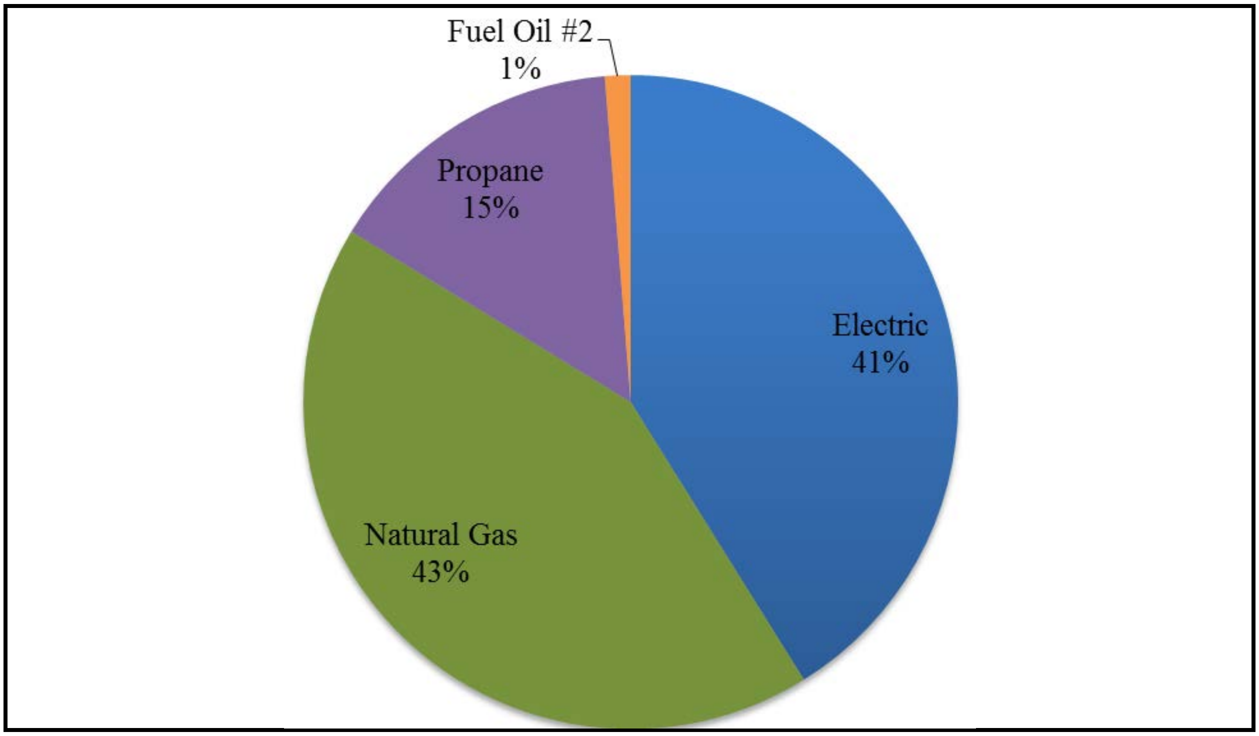

Figure 7: 2010 Total Energy Breakdown

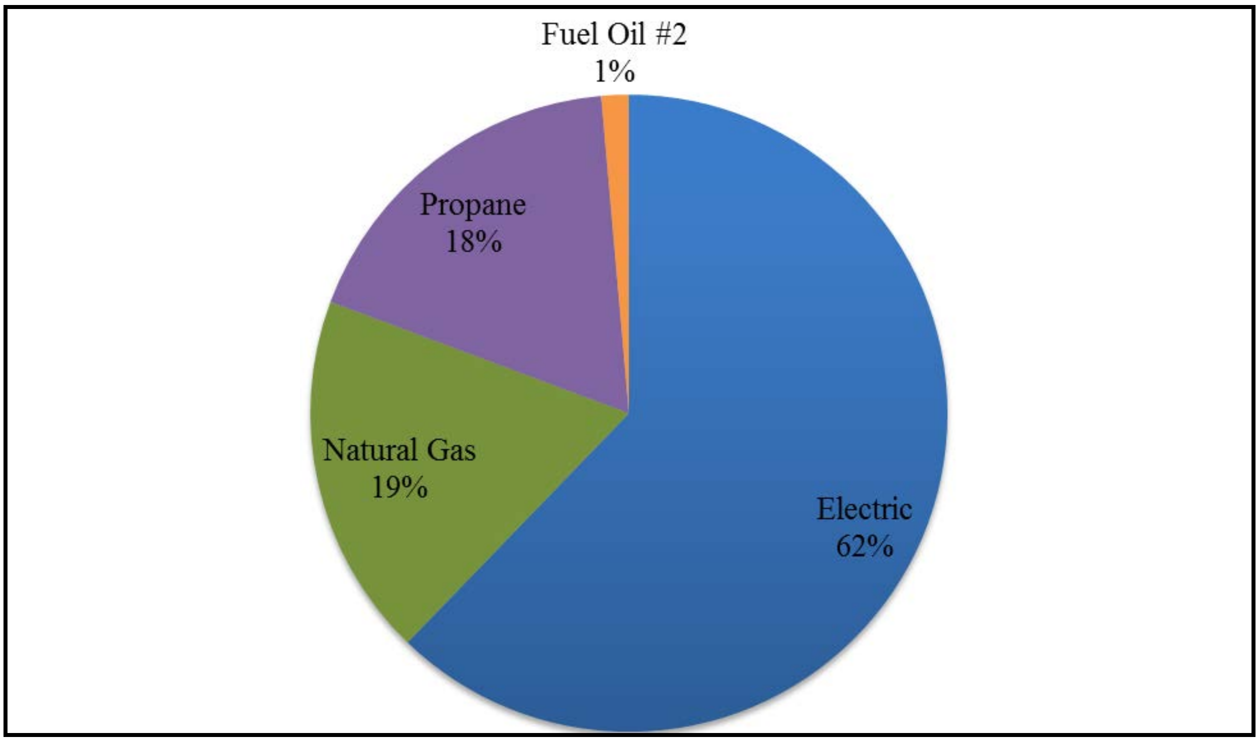

Figure 8: 2010 Total Energy Cost Breakdown

7.2 Analyzing Energy use at SDDOT

In order to gain an understanding of the benefits of adopting a Comprehensive Energy Management Program & Plan (CEMP) at the SDDOT, a thorough understanding and evaluation of current agency-wide energy usage is necessary. The data must be complete and accurate because it may be used for analysis and goal setting. The following factors should be considered when collecting energy use data:

- LEVEL OF DETAIL: The level and scope of data collection detail will vary from facility to facility. Some may choose to collect data from submeters on individual processes or facilities while others may only look at a utility bill for the entire complex.
- ENERGY SOURCES: All energy sources must be accounted for. Inventory all energy purchased and generated on-site (electricity, gas, steam, waste fuels) in physical units (kWh, MMBtu, Mcf, lbs of steam, etc.) and on a cost basis.
- DOCUMENT: For the sources identified above, assemble energy bills, meter readings, and other use data. Energy data may reside in the accounting department, be held centrally or at each facility, or can be acquired by contacting the appropriate utilities or energy service providers. Gather at least two years of monthly data or a more frequent interval if available. Use the most recent data available.
- COLLECT FACILITY AND OPERATIONAL DATA: To be able to normalize and benchmark, it may be necessary to collect non-energy related data for all facilities and operations, such as building size, operating hours, etc.
- NORMALIZATION: The energy use of facilities varies greatly, partly due to factors unrelated to actual energy efficiency of equipment and operations. These factors may include weather or certain operating characteristics including climate zone, facility size, fuel choice, price/cost of energy, actual weather history, hours of operation, occupancy levels, inputs, and output. Normalizing is the process of removing the impact of these external factors effecting energy use to allow for fair comparison of energy performance for facilities and operations.
- IDENTIFY: Identifying energy reduction and cost saving opportunities starts with an understanding of how the building is utilizing energy. Additionally, it is important to understand how a building's energy use relates to similar facilities. Table 5 summarized the mix of energy sources used at all SDDOT facilities over a 12-month base year (January 2010 to December 2010).

Utilization indexes provide useful benchmarking values. The Energy Utilization Index (EUI) is total building energy use per unit area per year while the Cost Utilization Index (CUI) is total building energy cost per unit area per year. These benchmarking values have been compared to five similar building types utilizing the U.S. Department of Energy's Energy Information Administration (DOE/EIA) Commercial Buildings Energy Consumption Survey (CBECS). These EUI and CUI values have been obtained from a large sampling and consequently, values are given for five percentiles (10, 25, 50, 75, and 90) and overall mean. Facilities within the top 10^{th} percentile are the most energy efficient. Facility managers can gain useful insight as to how well their buildings are performing by comparing their building's EUI and CUI values to EUI and CUI values for national average buildings of a similar type.

In order to gain insight on how an average SDDOT building compares to other average building types the 2010 SDDOT average building performance (based on all SDDOT buildings) is compared to the average building performance from five different (but somewhat similar) building types. For each of these five building types, the information provided is more useful than just an 'average building performance' comparison since a building performance distribution for each building type is also provided.

An illustration of how national average EUI values are arranged using Government office facilities as an example is as follows. Government office facilities were ranked from best (lowest) EUI to worst (highest) EUI and then the EUI distribution of the top performing 10% of the buildings were identified (these buildings have the lowest EUI). These top 10% buildings had an EUI of 30 or less. Note that the mean (average) is different than the 50th percentile (median).

This same approach, EUI distribution, could be applied to each of the SDDOT facilities in order to gain insight on how individual facilities compare to each other and how they compare to other average buildings of similar type (note that EnergyCAP® software has the capacity to calculate the EUI and CUI for each facility/account – see EnergyCAP® software overview in Section 5.2.10 SDDOT Energy Tracking (EnergyCAP®)). However, for this report the overall SDDOT average building was used to provide a general comparison.

SDDOT Base Year 2010 utility bill data was used to generate results shown in Figure 9 and Figure 10. These figures show that SDDOT Base Year 2010 average facility compares unfavorably to similar building types. For a more complete breakdown of utility trends, refer to the specific utility summaries in sections 7.4, 7.5, 7.6, and 7.7.

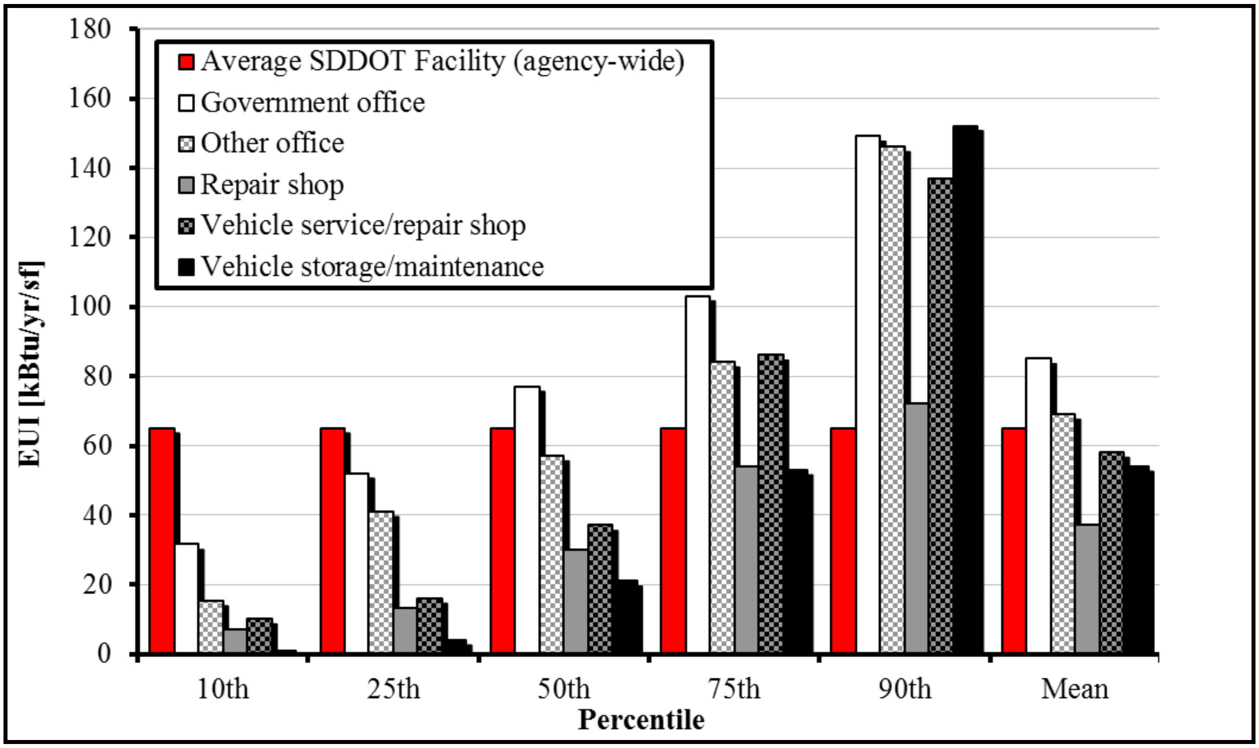

Figure 9: SDDOT Average Facility EUI Comparison (Base Year 2010)

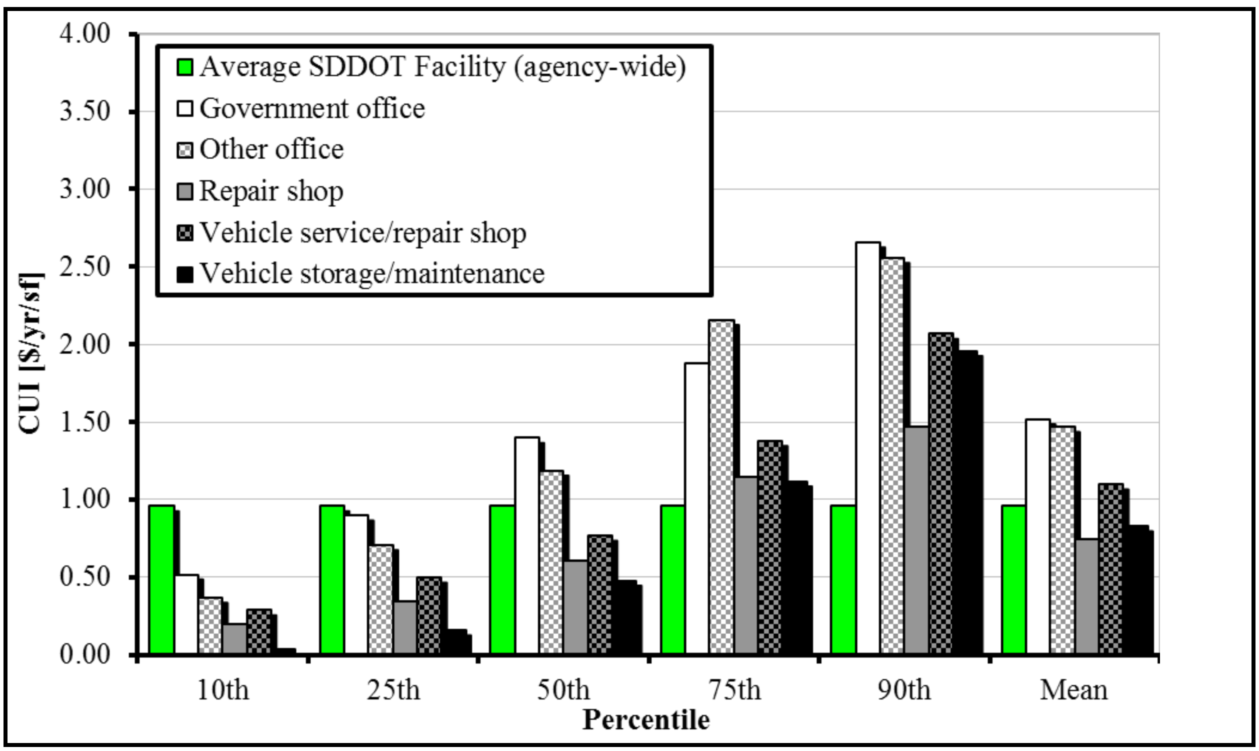

Figure 10: SDDOT Average Facility CUI Comparison (Base Year 2010)

7.3 Energy Use Reduction Opportunities at SDDOT

The EUI and CUI values indicate that there is a great potential for energy reduction at the SDDOT. The SDDOT Base Year 2010 average facility performed at the 75th percentile of similar facilities in energy usage and 50th percentile in energy cost. This means that SDDOT facilities used more energy than 75% of the comparison types of buildings, which points toward SDDOT facilities not efficiently utilizing their energy. On the other hand, the SDDOT facilities compared better in terms of facility energy cost, but this improved ranking is significantly affected by the relatively low cost of energy in South Dakota[2].

The New Buildings Institute (NBI) has documented results, for the Existing Building Renewal Initiative, of in-depth energy audits performed by energy professionals for fifty commercial buildings that specify retrofits and upgrade projects similar to those outlined in the following sections of this document. The results show, “Average baseline savings exceed 40% in all cases, with individual projects ranging from 27 to 85 percent” in gains (NBI, 2011). An after-energy-audit projected savings of 40% applied to the 2010 SDDOT total utilities would result in 37,920.3 MMBtu/yr of energy at a cost savings of $568,657/yr. Actual savings will depend on actual facility energy use characteristics and on the level of energy efficiency investment (both time and money). Specific utility summaries are addressed in the following sections.

7.4 Electrical Energy Summary: 2010 Agency-wide

Electric utility information was obtained for all services agency-wide and summarized in Table 6. Shown are data including both monthly and average daily energy use. Percent excess energy use demonstrates how much the average daily energy use for a given month was above the annual minimum. Excess energy use indicates an amount necessary for cooling/heating and/or changes in building performance. Monthly demand, demand charges, and resulting load factor were not available. The occupancy factor (OF) is a percent of annual hours that a building is occupied. Demand information could not be obtained using supplied EnergyCAP® data.

[2] South Dakota is ranked 38 out of 51 states for energy cost, where 1 is the highest energy cost.

Table 6: 2010 Total Electric Energy Summary

Electric										
Utility Provider: Varied										
Total Building Area = 1,469,031 sf						Weighted Occupancy Factor = 26.71%				
Month	**Billing Period [days]**	**Energy Use [kWh]**	**Average Daily Use [kWh]**	**Excess Energy Use [%]**	**Energy Charges [$]**	**Demand [kW]**	**Demand Charges [$]**	**Load Factor [%]**	**Fees and Taxes [$]**	**Net Charges [$]**
Jan-2010	31	1,354,121	43,681	105.72	93,540.00	---	---	---	---	93,540.00
Feb- 2010	28	1,250,455	44,659	110.33	90,693.00	---	---	---	---	90,693.00
Mar-2010	31	1,012,075	32,648	53.76	79,861.00	---	---	---	---	79,861.00
Apr-2010	30	901,002	30,033	41.44	70,725.00	---	---	---	---	70,725.00
May-2010	31	830,678	26,796	26.20	67,228.00	---	---	---	---	67,228.00
Jun-2010	30	841,621	28,054	32.12	69,480.00	---	---	---	---	69,480.00
Jul-2010	31	993,916	32,062	51.00	76,750.00	---	---	---	---	76,750.00
Aug-2010	31	1,003,338	32,366	52.43	79,344.00	---	---	---	---	79,344.00
Sep-2010	30	912,190	30,406	43.20	74,134.00	---	---	---	---	74,134.00
Oct-2010	31	789,308	25,462	19.92	64,406.00	---	---	---	---	64,406.00
Nov-2010	30	880,734	29,358	38.27	70,016.00	---	---	---	---	70,016.00
Dec-2010	31	658,228	21,233	0.00	48,518.00	---	---	---	---	48,518.00
TOTAL	365	11,427,666	---	---	884,695.00	---	---	---	---	884,695.00
AVE	---	952,306	31,397	47.87	73,724.58	---	---	---	---	73,724.58
MAX	---	1,354,121	44,659	110.33	93,540.00	---	---	---	---	93,540.00
MIN	---	658,228	21,233	0.00	48,518.00	---	---	---	---	48,518.00
Average Energy Cost = $0.077/kWh						**Average Demand Cost = $0.00/kW**				
---						**Weighted Occupancy Factor = 26.71%**				
Energy Utilization Index = 7.8 kWh/yr/sf						**Cost Utilization Index = $0.60/yr/sf**				

Average electrical energy costs shown in Table 6 were used in all subsequent energy cost saving calculations. The above information can be investigated further with the aid of an electric energy profile (Figure 11) and by analyzing the monthly consumption metrics. The following is one example of using the monthly energy use to identify potential impact areas.

- Excess energy percent increases during some of the heating season. (October through April as indicated by the heating degree-days, HDD[3]). This may indicate that energy consumption for heating is significant and warrants further attention.

[3] Heating Degree-Days (HDD)and Cooling Degree-Days are quantities that allude to the energy required to maintain a temperature setpoint relative to a specified base temperature. BTU Engineering, Inc. utilizes degree-day data from the National Oceanic and Atmospheric Administration at a 65°F base.

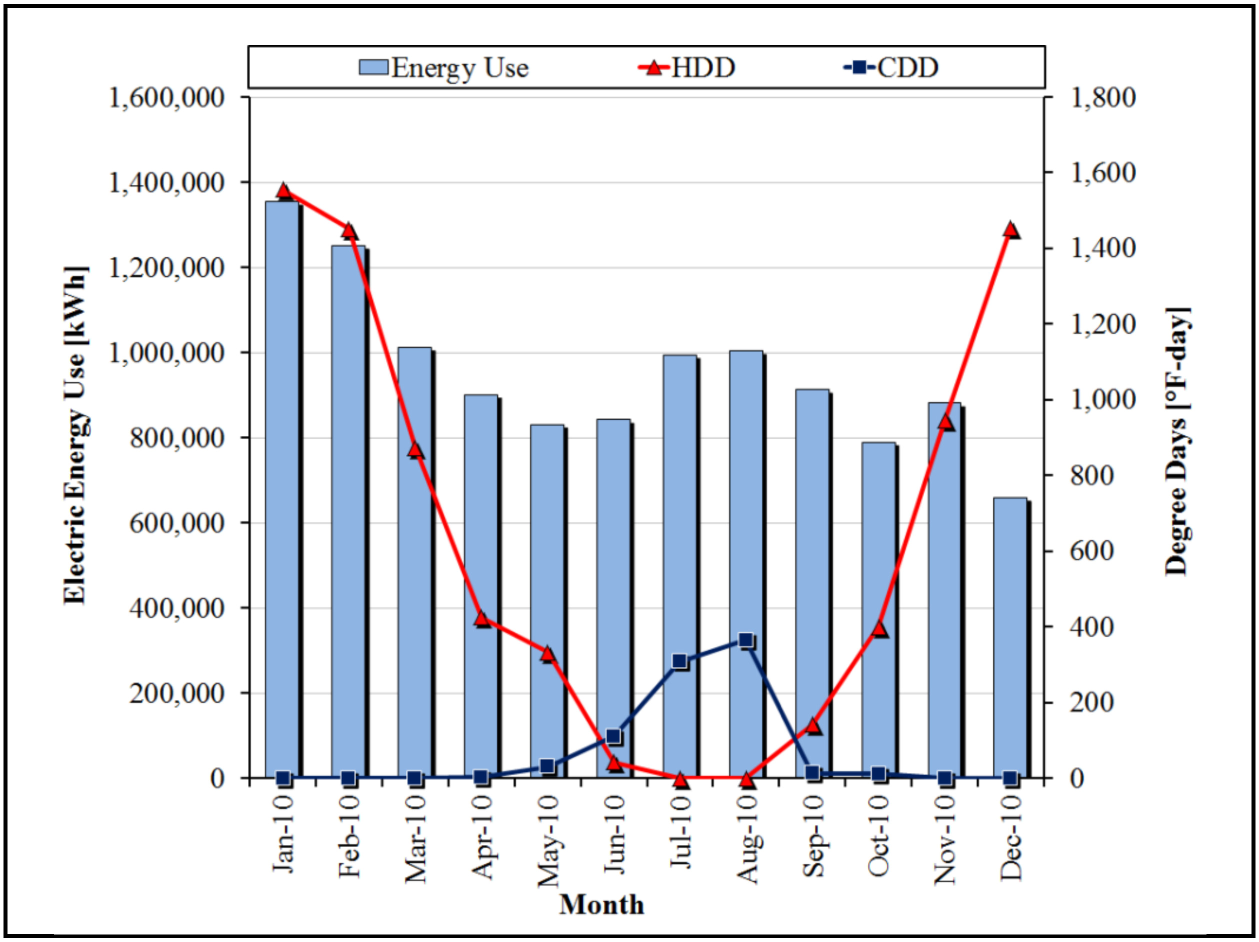

Figure 11: 2010 Total Electric Energy Profile

7.5 Natural Gas Summary: 2010 Agency-wide

Natural gas utility information was obtained for all services agency-wide and summarized in Table 7. Shown are data including both monthly and average daily energy use. Percent excess energy use demonstrates how much the average daily energy use for a given month was above the annual minimum. Excess energy use indicates an amount necessary for heating and/or changes in building operation.

Table 7: 2010 Total Natural Gas Summary

Natural Gas Utility Provider: Varied Building Area = 1,469,031 sf					Weighted Occupancy Factor = 26.71%		
Month	**Billing Period [days]**	**Energy Use [therm]**	**Average Daily Use [therm]**	**Excess Energy Use [%]**	**Energy Charges [$]**	**Fees and Taxes [$]**	**Net Charges [$]**
Jan-10	31	9,661	312	3,800.00	64,628.00	---	64,628.00
Feb-10	28	7,892	282	3,425.00	54,231.00	---	54,231.00
Mar-10	31	5,641	182	2,175.00	38,109.00	---	38,109.00
Apr-10	30	2,534	84	950.00	15,157.00	---	15,157.00
May-10	31	1,817	59	637.50	10,489.00	---	10,489.00
Jun-10	30	581	19	137.50	3,364.00	---	3,364.00
Jul-10	31	256	8	0.00	2,153.00	---	2,153.00
Aug-10	31	249	8	0.00	2,318.00	---	2,318.00
Sep-10	30	350	12	50.00	2,787.00	---	2,787.00
Oct-10	31	1,228	40	400.00	7,737.00	---	7,737.00
Nov-10	30	3,420	114	1,325.00	20,664.00	---	20,664.00
Dec-10	31	6,759	218	2,625.00	40,811.00	---	40,811.00
TOTAL	365	40,3880	---	---	262,448.00	---	262,448.00
AVE	---	3,366	112	1,293.75	21,870.67	---	21,870.67
MAX	---	9,661	312	3,800.00	64,628.00	---	64,628.00
MIN	---	249	8	0.00	2,153.00	---	2,153.00
Average Energy Cost = $0.65/therm **Energy Utilization Index* = 0.3 therm/yr/sf**					**Weighted Occupancy Factor = 26.71%** **Cost Utilization Index = $0.18/yr/sf**		

*The calculated EUI represents the gross EUI for the agency-wide building area and does not reflect individual building EUI.

Average natural gas energy costs shown in Table 7 were used in all subsequent energy cost saving calculations. But, the above information can be investigated further with the aid of natural gas energy profiles (Figure 12).

- First, excess energy percent closely follows the heating season and goes toward zero during the cooling months. This indicates that natural gas energy consumption for heating is very significant and there is little to no natural gas process energy. Consequently, energy cost savings opportunities focused on baseload heating system improvements (e.g. hot water heating) would not yield significant savings. But, space heating system improvements could provide significant savings.
- The HDD values closely follow natural gas energy use. This fact provides an opportunity for modeling building heating energy use using weather normalization.

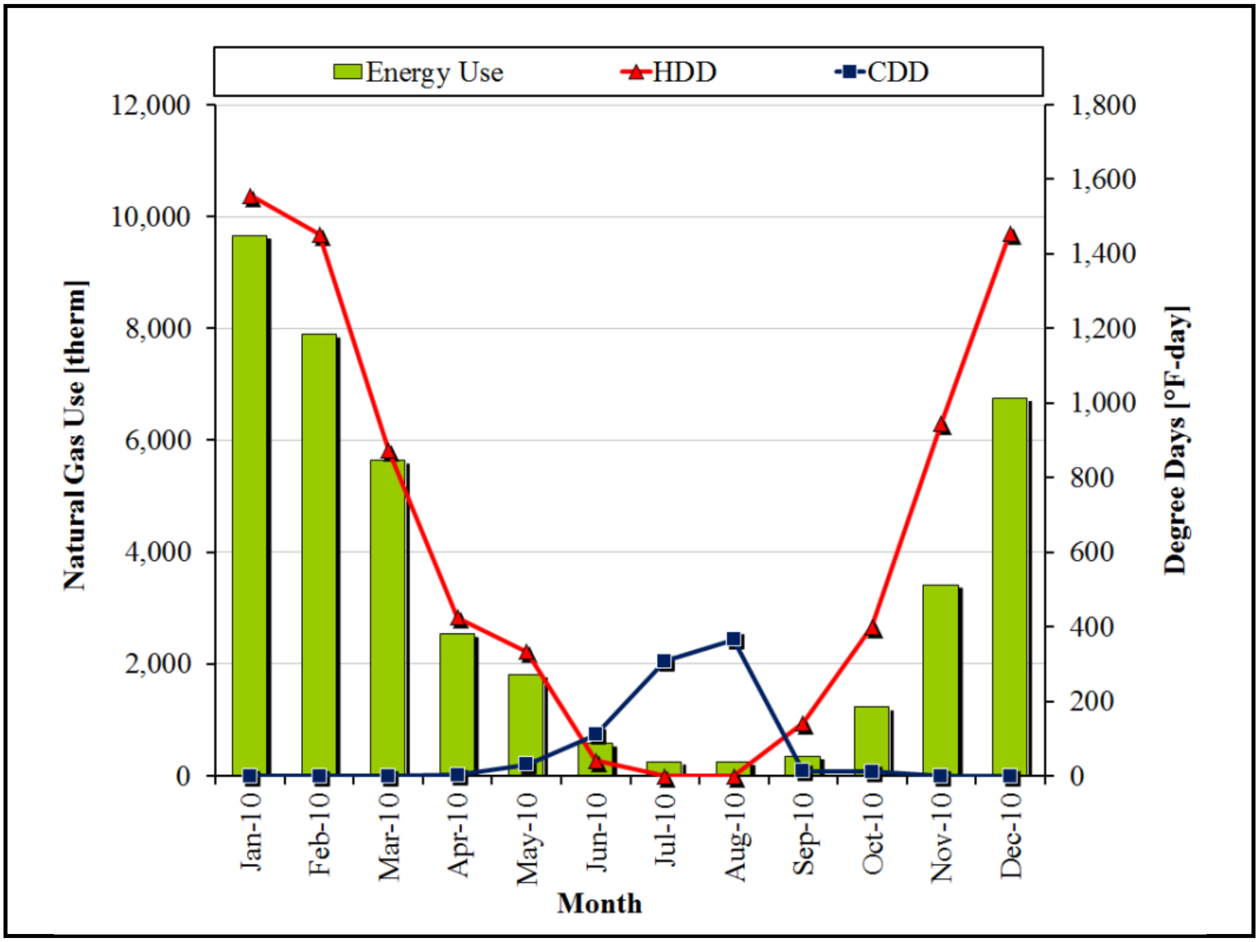

Figure 12: 2010 Total Natural Gas Profile

7.5.1 Weather Normalized Natural Gas Summary

Given an apparent relationship between HDD and natural gas use, weather normalization was attempted to correlate the two values. Average daily natural gas use was plotted versus HDD per day as shown in Figure 13. This figure demonstrates a distinct relationship between these two variables. A linear curve fit was made to the Base Year results which provided a correlation of R^2 = 93.81%. This yields an empirical model of natural gas use given by:

Average Daily Natural Gas Use = 5.323 x HDD/Day

This natural gas usage model can be used to better estimate future natural gas savings for implemented energy efficiency measures. In addition, normalization provides a method of removing weather-associated noise from historical data.

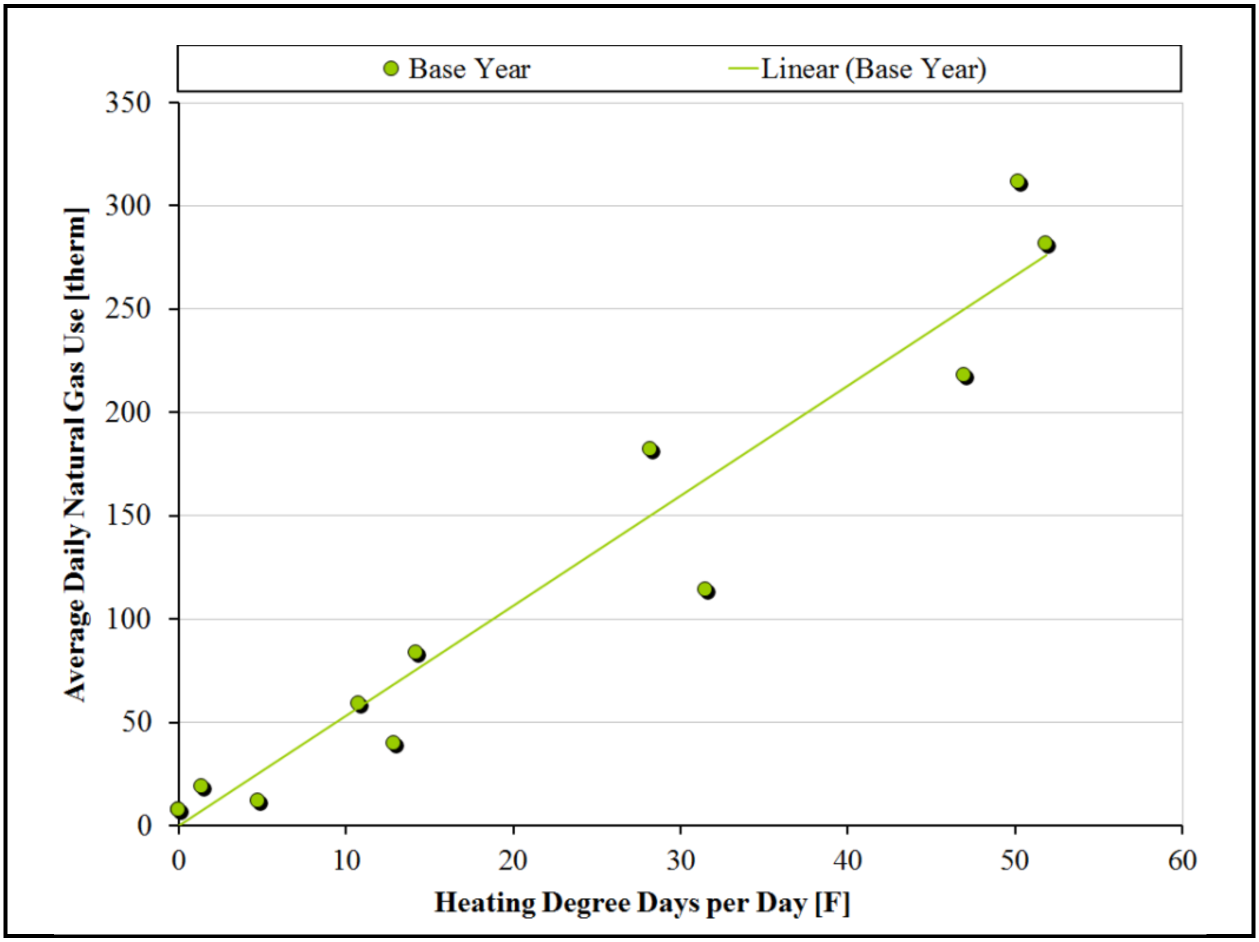

Figure 13: Base Year Weather Normalized Natural Gas Profile

7.6 Fuel Oil #2 Summary: 2010 Agency-wide

Fuel oil #2 utility information was obtained for all services and summarized in Table 8. Shown are data including both monthly and average daily energy use. Percent excess energy use demonstrates how much the average daily energy use for a given month was above the yearly minimum. Excess energy use indicates an amount necessary for heating and/or changes in building operation.

Table 8: Base Year Total Fuel Oil Summary

Fuel Oil #2 Utility Provider: Varied Building Area = 1,469,031 sf / Weighted Occupancy Factor = 26.71%							
Month	**Billing Period [days]**	**Energy Use [gal]**	**Average Daily Use [gal]**	**Excess Energy Use [%]**	**Energy Charges [$]**	**Fees and Taxes [$]**	**Net Charges [$]**
Jan-10	31	3,061	99	---	6,602.00	---	6,602.00
Feb-10	28	1,139	41	---	2,365.00	---	2,365.00
Mar-10	31	1,522	49	---	3,512.00	---	3,512.00
Apr-10	30	0	0	---	---	---	0.00
May-10	31	0	0	---	---	---	0.00
Jun-10	30	0	0	---	---	---	0.00
Jul-10	31	0	0	---	---	---	0.00
Aug-10	31	0	0	---	---	---	0.00
Sep-10	30	0	0	---	---	---	0.00
Oct-10	31	1,000	32	---	2,531.00	---	2,531.00
Nov-10	30	500	17	---	1,504.00	---	1,504.00
Dec-10	31	1,412	46	---	3,317.00	---	3,317.00
TOTAL	365	8,634	---	---	19,831.00	---	19,831.00
AVE	---	720	24	---	3,305.17	---	1,652.58
MAX	---	3,061	99	---	6,602.00	---	6,602.00
MIN	---	0	0	---	1,504.00	---	0.00
Average Energy Cost = $2.30/gal **Energy Utilization Index[4] = 0.006 gal/yr/sf**				**Weighted Occupancy Factor = 26.71%** **Cost Utilization Index = $0.01/yr/sf**			

Average fuel oil #2 energy costs shown in Table 8 were used in all subsequent energy cost saving calculations. But, the above information can be investigated further with the aid of fuel oil #2 energy profiles (Figure 14).

- First, excess energy percent closely follows the heating season and goes toward zero during the cooling months. This indicates that fuel oil energy consumption for heating is very significant and there is little to no fuel oil process energy. Consequently, energy cost savings opportunities focused on baseload heating system improvements (e.g. domestic hot water heating) would not yield significant savings. But, space heating system improvements could provide significant savings.

[4]The calculated EUI represents the gross EUI for the agency-wide building area and does not reflect individual building EUI.

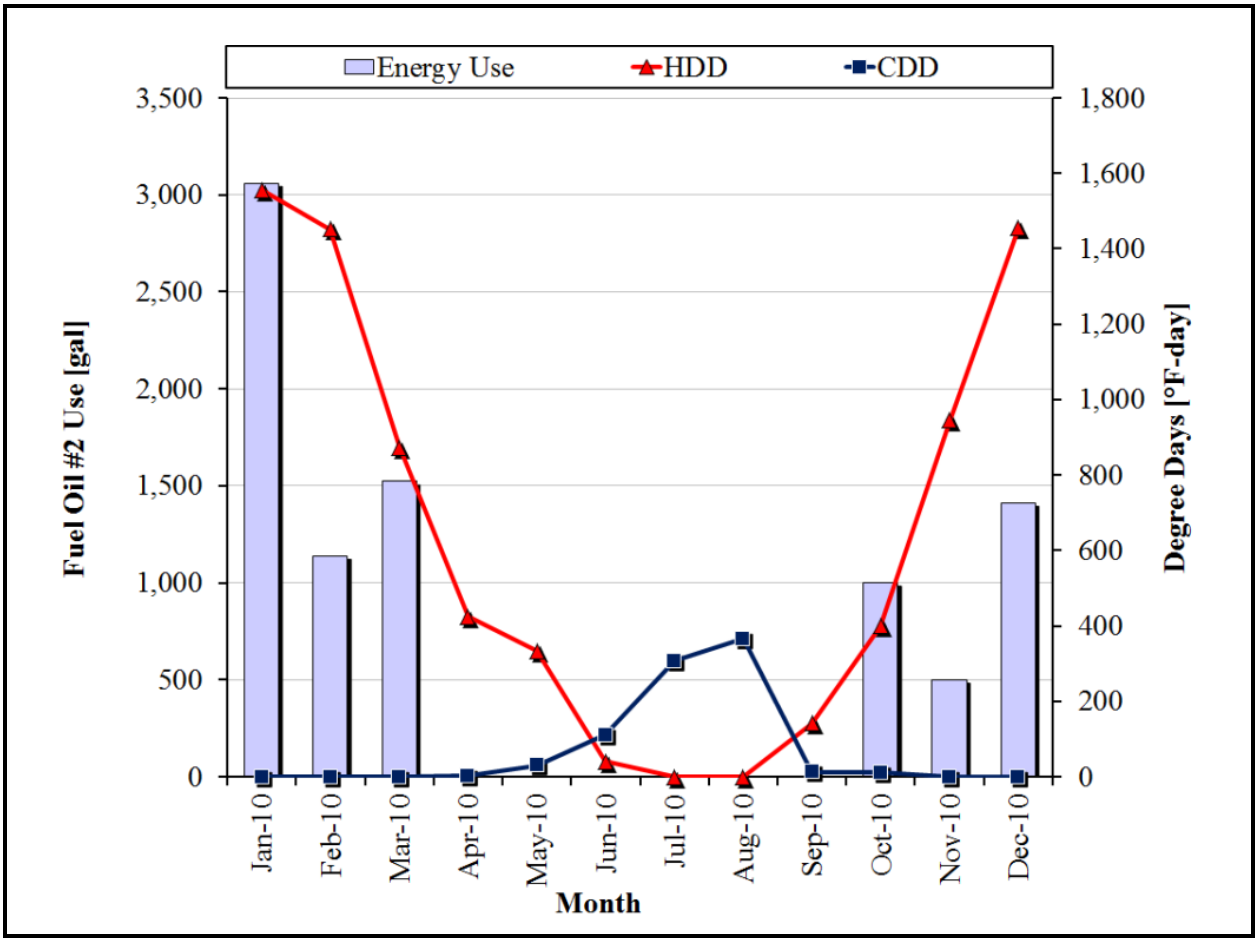

Figure 14: Base Year Total for Fuel Oil #2

7.7 Propane Summary: 2010 Agency-wide

Propane utility information was obtained for all services and summarized in Table 9. Shown are data including both monthly and average daily energy use. Percent excess energy use demonstrates how much the average daily energy use for a given month was above the annual minimum. Excess energy use indicates an amount necessary for heating and/or changes in building performance.

Table 9: Base Year Total Propane Summary

Propane							
Utility Provider: Varied							
Building Area = 1,469,031 sf				Weighted Occupancy Factor = 26.71%			
Month	**Billing Period [days]**	**Energy Use [gal]**	**Average Daily Use [gal]**	**Excess Energy Use [%]**	**Energy Charges [$]**	**Fees and Taxes [$]**	**Net Charges [$]**
Jan-10	31	53,228	1,717	17,070.00	95,224.00	---	95,224.00
Feb-10	28	34,728	1,240	12,300.00	58,415.00	---	58,415.00
Mar-10	31	15,163	489	4,790.00	22,822.00	---	22,822.00
Apr-10	30	8,689	290	2,800.00	12,332.00	---	12,332.00
May-10	31	8,727	282	2,720.00	11,587.00	---	11,587.00
Jun-10	30	300	10	0.00	380.00	---	380.00
Jul-10	31	1,290	42	320.00	1,903.00	---	1,903.00
Aug-10	31	519	17	70.00	754.00	---	754.00
Sep-10	30	3,291	110	1,000.00	5,085.00	---	5,085.00
Oct-10	31	6,153	198	1,880.00	9,672.00	---	9,672.00
Nov-10	30	12,920	431	4,210.00	20,377.00	---	20,377.00
Dec-10	31	10,210	329	3,190.00	16,118.00	---	16,118.00
TOTAL	365	155,218	---	---	254,669.00	---	254,669.00
AVE	---	12,935	430	4,195.83	21,222.42	---	21,222.42
MAX	---	53,228	1,717	17,070.00	95,224.00	---	95,224.00
MIN	---	300	10	0.00	380.00	---	380.00
Average Energy Cost = $1.64/gal				Weighted Occupancy Factor = 26.71%			
Energy Utilization Index* = 0.1 gal/yr/sf				Cost Utilization Index = $0.17/yr/sf			

*The calculated EUI represents the gross EUI for the agency-wide building area and does not reflect individual building EUI.

Average propane energy costs shown in Table 9 were used in all subsequent energy cost saving calculations. But, the above information can be investigated further with the aid of propane energy profiles (Figure 15).

- First, excess energy percent closely follows the heating season and goes toward zero during the cooling months. This indicates that propane energy consumption for heating is very significant and there is little to no natural gas process energy. Consequently, energy cost savings opportunities focused on baseload heating system improvements (e.g. hot water heating) would not yield significant savings. But, space heating system improvements could provide significant savings.

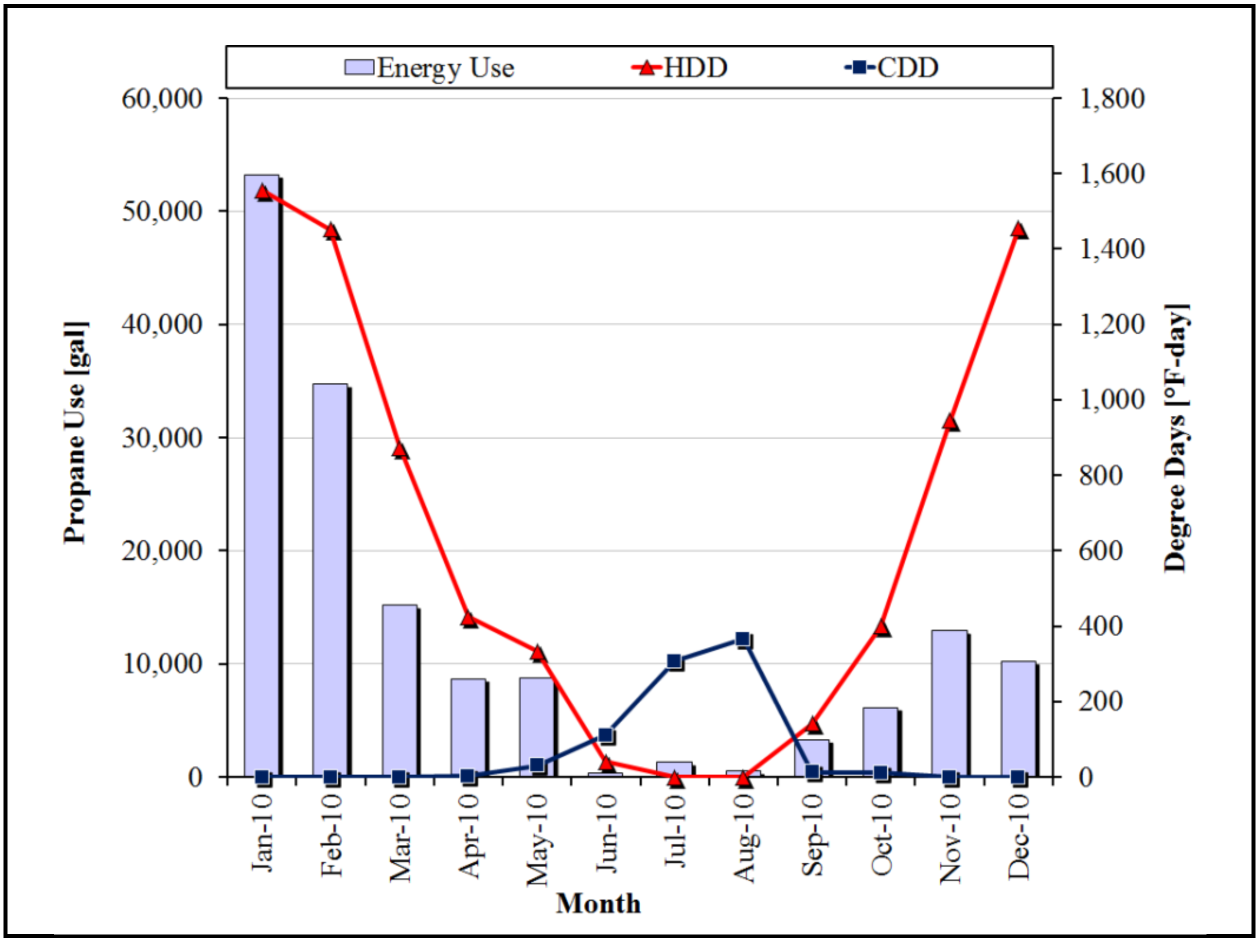

Figure 15: Base Year Total Propane Profile

8.0 REVIEW OF RELATED AGENCIES

The following provides the results of an investigation into Energy Management Programs (EM Programs) and/or Plans (MEM Plans) at other agencies in order to establish a peer group benchmark concerning energy management. The investigation included South Dakota agencies, South Dakota Universities, other Universities, regional agencies, and national agencies. The following sections detail their status.

8.1 South Dakota Department of Education

An investigation by BTU Engineering revealed that the only South Dakota agency that has institutions that at least mention something related to an EM Program are in the SD Department of Education, specifically within some of the SD State universities.

The EM Program directive appears to originate from a request by the SDBOA Statewide Energy Manager to each of the universities within SD to create an energy management plan. The universities were targeted in part because they are some of the largest single energy users among State facilities. Each university's plan would provide a framework for implementing energy related projects within the institution. Currently, no formal EM Plan or Program has been developed by any state university for submission to the SDBOA. However, SDSU, USD, and BHSU have preliminary EMPs in various stages of development. The following summarizes institutions that have started addressing an energy management plan:

- SOUTH DAKOTA STATE UNIVERSITY (SDSU): SDSU does not have an EM Program, but maintains an energy conservation plan (maintained by Robert Milbrandt, staff Energy Engineer) in a prioritized spreadsheet file that details the implementation and economics of various energy efficiency opportunities identified within SDSU facilities. This energy conservation plan is updated annually and represents the hierarchy of proposed projects when funding becomes available.
- UNIVERSITY OF SOUTH DAKOTA (USD): USDs EM Program centers around hiring an energy engineer, much like the position at SDSU; then assigning that person the task of developing their EM Program. As of January 2011, it was determined by BTU Engineering that an energy engineer has not been hired at USD.
- BLACK HILLS STATE UNIVERSITY (BHSU): BHSUs EM Program centers on following a utility master plan developed in 2009 by Stanley Consultants, Inc., which is used by staff to guide significant energy infrastructure upgrades primarily related to heating and cooling.

8.2 Detroit Water and Sewage Department Wastewater Master Plan: Energy Management (Tucker, 2003)

The Detroit Water and Sewage Department funded a study to develop a master plan for energy management. The purpose of this study was to present information required to determine a strategy for reducing energy consumption at the Wastewater Treatment Plant (WWTP) and wastewater collection system. Specific objectives include: 1) identify existing reports which address energy use issues; 2) quantify existing energy usage at the Detroit Wastewater Treatment Plant and wastewater pumping stations; 3) discuss various energy management options; 4) discuss Detroit Water and Sewerage Department (DWSD) current energy management plan; 5) make recommendations for energy and cost savings at the DWSD wastewater facilities. Highlights of the resulting energy management strategy include:

REPORT EVALUATIONS: Several reports were available for review. One of the utility studies covered five water treatment plants and 20 water booster stations along with a wastewater treatment plant and 14 wastewater-pumping stations. A needs assessment provided condition evaluation of 2,200 pieces of major/critical equipment. An asset audit assessed the current and projected operational status of all significant system components.

EVALUATION OF EXISTING ENERGY USE: An inventory of large power using equipment was conducted. The subsequent energy usage and operating costs were then discussed and evaluated. Both current and projected rate categories were considered.

EVALUATION OF ENERGY MANAGEMENT OPTIONS: A few specific energy management options were discussed. These include: 1) pumping versus gravity flow, 2) pump station modifications, and 3) force main size optimization.

EVALUATION OF CURRENT ENERGY MANAGEMENT PLAN: The current energy management plan was based on a 1999 energy audit. This document suggested that consideration should be given to VFDs and select lighting should be shut off during daytime hours.

RECOMMENDATIONS: Six specific recommendations were made based on the evaluation/analysis of this work. These include: 1) building long, deep sewers, 2) implementation of VFDs at one pumping station, 3) turn yard lights off during daytime hours, 4) specify high-efficiency motors, 5) evaluate pump efficiencies every three years, and 6) reduction of collection system flows through a variety of means.

The strengths of this document include the development and listing of specific energy conservation measures. These were well defined and with the correct direction, could be implemented as a well-understood organization policy. However, weaknesses include lack of a vehicle to implement these measures, evaluation of potential savings, and discussion of anticipated costs.

8.3 Western Illinois University (WIU): Energy Management Strategy (WIU BoT, 2007)

Based on observed escalating energy costs, the WIU energy management strategy was developed to address six core areas: 1) review of past utilities, 2) analysis of installation of a new heating plant, 3) updating capital construction cost estimates, 4) evaluating State and public policy issues, 5) assessment of environmental impacts, and 6) analysis of funding options. Highlights of the strategy include the following:

- ENERGY TARGETS: WIU will reduce its energy consumption, measured by the Energy Utilization Index (EUI), by 5% over the next five years. It was noted that WIU would require a capital commitment if this strategy is to attain a 30 to 35% reduction in EUI achieved by more aggressive energy management programs.
- ENERGY INITIATIVES: Five initiatives were developed to meet these targets. These include:
    - Initiate capital projects that reduce energy consumption: Projects include updating chilled water systems, heating plant, HVAC upgrades, lighting, and steam lines
    - Develop construction standards the promote energy efficiency and secure LEED certification: The standards will be developed by WIU and must be met for all new construction.
    - Improve operational efficiencies: A program of continuous commissioning will be undertaken to improve WIU systems and equipment.
    - Educate the community about responsible energy conservation: WIU estimated that 2 to 4% of energy use could be saved through more effective energy conservation habits.
    - Energy audits: Energy audits were included as a valuable tool for identifying energy improvement opportunities.

Energy initiatives were listed and ranked according to estimated total energy savings potential. This approach provides assistance in prioritizing energy improvement projects.

The strengths of this document include the development and listing of specific energy conservation measures. These were well defined and with proper direction, could be implemented as a well-understood organization policy. This document also includes specific energy-reduction goals and discusses the energy savings potential of specific initiatives. This document also provides for a specific authoritative body responsible for carrying out the energy strategy.

8.4 Minnesota Department of Transportation (MNDOT): Energy and Environmental Policy (MN, 2009)

The MNDOT Energy and Environmental Policy was developed to improve the energy efficiency and environmental sustainability of Minnesota's transportation system. In summary,

"*MNDOT and other transportation agencies will continue to protect and enhance the environment by integrating environmental stewardship in the planning, development, and construction phases of transportation projects as well as in system operations. Working in close coordination with other transportation system providers, MNDOT will also strive to reduce* *emissions and improve energy efficiency through the promotion of travel modes with high occupancy and/or low emission vehicles, increased use of alternative fuels, and adoption of property and right-of-way management practices more capable of offsetting greenhouse gas (GHG) emissions.*"

Central to this policy is the reduction of greenhouse gases. In Minnesota, the transportation sector is the source of an estimated 24 percent of greenhouse gases and, therefore, any comprehensive efforts to curb GHG emissions will likely involve transportation policy and practices. Opportunities for reducing GHG emissions from transportation include: increased use of alternatives fuels, use of vehicles with greater energy efficiency, and reducing the total number of vehicle miles driven, through the provision of alternative modes. Each of these opportunities requires a combination of public and private sector involvement for implementation. Over the 20-year planning horizon of the MNDOT Energy and Environmental Policy, it is anticipated that efforts to increase energy efficiency and curb greenhouse gas emissions will only increase as important public policy concerns. MNDOT plans to accomplish these objectives through several strategies. These include:

- ENVIRONMENTAL STEWARDSHIP: It is anticipated that MNDOT and local transportation authorities will continue to integrate environmental stewardship beginning with long-range planning and continuing through project development and system operations by: 1) maintaining and enhancing communication and collaboration with resource management agencies, 2) supporting and implementing system level solutions to mitigation requirements, 3) complying with regulations, and 4) providing technical assistance and communicating best practices.
- EMISSIONS AND ENERGY CONSUMPTION: MNDOT plans to advance emissions reductions objectives of the Next Generation Act (MN SCN, 2011). This approach calls for increased use of alternative/cleaner fuels. Specific targets include the reduction of gasoline use by on-road vehicles owned by state departments by 25% by 2010 and 50% by 2015.

Performance measures, indicators, and targets provide quantitative information to managers and/or decision makers. This information is tracked over time to monitor performance and investment levels as well as the changes in performance given changes in levels of investment.

The MNDOT Policy document provides significant detail on emissions reductions through attention to fleet energy consumption. However, the document does not address the significant energy consumption of buildings and building systems.

8.5 Texas Medical Center: Energy Management Master Plan (Simpson, 2009)

From 2003 through 2006, EEA Consulting Engineers completed an Energy Conservation and Management Plan (Phase I) and subsequent Detailed Energy Audits (Phase II) for a medical center campus and its various sites throughout Texas, with an emphasis on the main Houston, TX campus. This master plan and preliminary audit included numerous buildings with a combined 4.4 million square feet of building area. The subsequent detailed audits included only

2.1 million square feet. In this report, the Phase I Preliminary Energy Audit process, Phase II Detailed Energy Audit process, and creation of a 5-year Plan of Action were described. This process and methodology can be extended to any type of campus setting or individual building.

- PRELIMINARY ENERGY AUDIT (PHASE I): The purpose of the preliminary energy audit was to determine which buildings have the greatest opportunity for improvement and what types of energy conservation projects exist. During this process, several energy conservation measures were identified including: HVAC upgrades, heat recovery, lighting retrofits, and central plant projects. The results of Phase I include estimated implementation costs, projected savings, and paybacks.
- DETAILED ENERGY AUDIT (PHASE II): Phase I was used to prioritize each building within the campus. Based on these results, the highest priority buildings received a detailed energy audit, which included field investigations (e.g. equipment monitoring).
- CREATION OF ACTION PLAN: A campus action plan was created to guide future energy conservation strategies in existing and future buildings. The action plan is a living document, which explains how best to utilize available resources to improve energy efficiency. The action plan consisted of several key elements.
    - Adoption of clear energy efficiency targets for new construction: The recommended approach was to exceed ASHRAE Standard 90.1 requirements by a minimum of 15% for new construction.
    - Define priorities for energy efficiency retrofits: This can be done by prioritizing the buildings with the greatest potential for energy savings.
    - Commit financial resources to projects: Energy audits will provide good estimates of project costs for energy improvement projects.
    - Complete detailed audits of target buildings: Energy audits provide the best means of determining anticipated energy/cost savings for energy improvement projects.
    - Complete retrofit projects: Not only should retrofit projects be completed, but savings should also be verified.
    - Summarize trends: Building energy usage trends should be summarized including forecasted energy metrics.
    - Update Plan of Action: The Plan of Action should be periodically updated to ensure that it is kept up-to-date.

This document provides a good outline of the necessary components of an Energy Management Plan. Both preliminary and detailed energy audits were central to the outlined approach.

8.6 Stanford Linear Accelerator Center (SLAC): Comprehensive Energy Management Plan (Fieguth, 2004)

This document is a Comprehensive Energy Management Program and Plan (CEMP) for SLAC covering the period between FY 2004 and FY 2010. The purpose of this program is to provide a structure and schedule that meet all the applicable requirements listed in the DOE Order 430.2A, DEPARTMENTAL ENERGY AND UTILITIES MANAGEMENT and in accordance with a selected objectives, measures and expectations as developed by Federal Energy Management Program (FEMP). The Comprehensive Energy Management Program and Plan will be updated annually to contain priority actions scheduled for implementation over the next 2 years. SLAC will provide annual assessment of performance against this agreement using a graded approach.

The SLAC spends approximately $10 million annually for utilities. To help manage these expenditures, SLAC's CEMP is directed at four major areas. These include: 1) meeting DOE mandated goals, 2) meeting performance-based contract objectives, 3) procuring energy at the lowest cost, and 4) improving efficiency of energy consuming systems in a cost-effective manner. SLAC energy management goals were separated into short- and long-term types. 34 short-term goals were developed. Although not all are specifically reproduced here, these goals include the following:

- ENERGY ACCOUNTING: All energy usage data is entered in a timely manner. Results of energy data are summarized in annual reports.
- ENERGY PROJECTS: Several immediate project goals were summarized and include lighting retrofits, combined heat and power, replacement of variable frequency drives (VFDs), wastewater recycling, and purchase of electric vehicles.
- EQUIPMENT PURCHASING: ENERGY STAR® equipment must be purchased for select types (e.g. computers). In addition, low standby power equipment should be purchased.
- PUBLICATIONS: A short-term goal is publication of one article on energy management in SLAC's internal organization publication. Energy-awareness posters will be distributed to SLAC building managers for displaying in public places.
- WEBSITE: An energy management website was developed. In addition, a specific short-term goal was to continually update this information source.
- TRAINING: The SLAC energy manager is required to attend at least one energy management workshop, seminar, or conference.
- EM PROGRAM UPDATE: The CEMP should be updated within the year.

17 long-term goals were included. The following is a summary of their contents.

- ENERGY AUDITS: Facility energy audits will be done on an annual basis to help identify and implement cost-effective improvements. This is based on available funding. Feasibility studies will be conducted to investigate off-grid (e.g. renewable) systems.

- NEW CONSTRUCTION: Sustainable design practices will be accomplished to reduce life cycle costs on new buildings.
- ENERGY EFFICIENT PURCHASING: The purchasing and acquisitions system was modified to promote the purchasing of energy efficient equipment (e.g. ENERGY STAR® labeled).
- PREVENTATIVE MAINTENANCE: A preventative maintenance program will continue to be used to correct deficiencies at low-cost.
- FUNDING: Alternative funding mechanisms will be sought in place of direct appropriations.

The strengths of this document include the development and listing of specific energy conservation measures. These were well defined and with the correct direction, could be implemented as a well-understood organization policy. In addition, this plan includes discussion of the management structure to carry out energy objectives. This document does not include specific energy-reduction goals and/or discussion of potential costs.

8.7 SUMMARY

The previous review of select EM Programs and Plans have illustrated a few common themes. First, there is no 'one-size-fits-all' approach to energy management; each EM Program/Plan is tailored to the unique needs of the institution/organization. Second, the desired outcome (i.e. goal) varies significantly. Some institutions/organizations make the best out of available funding (e.g. hierarchical approach to energy projects), while others generate energy targets and determine the funding necessary to meet those goals (e.g. WIU). Finally, all approaches are attempting to reduce energy consumption. From the previous review, it is apparent that approaches vary significantly and are based on the available resources (i.e. funding, personnel, time, etc.). It is up to an organization to make the best use of available resources in order to maximize the contribution to energy reduction.

9.0 COMMON ELEMENTS OF SUCCESSFUL CEMPs

The previous sections provide a method to estimate the energy savings potential of a facility or agency. Many facilities and agencies have addressed the proceeding energy issues by developing and aligning their energy-related management infrastructure and policies to form a Comprehensive Energy Management Plan (CEMP) (see Section 8.6 Stanford Linear Accelerator Center (SLAC): Comprehensive Energy Management Plan (Fieguth, 2004) for example). After a thorough investigation by BTU Engineering, the most applicable term to describe the SDDOT's overall energy management requirements is CEMP. Figure 1 illustrates the overall CEMP.

SDDOT should investigate developing a tailored CEMP to address their unique operations and energy issues. Forming a CEMP has two distinct segments, the first deals with the realigning and/or creating the necessary management structure to support effective energy-related decision-making and allocation of necessary resources. This first segment is often called the Energy Management Program (EM Program). After forming and staffing the energy management structure, the first objectives are to establish energy conservation goals, a budget, and then to develop agency energy policies around the goals and available budget. For a complete discussion on the specific recommended SDDOT EM Program, see 11.0 PROPOSED SDDOT EM PROGRAM.

Once the Energy Management Program is in place, the second segment consists of organizing and developing the agency energy efficiency policies and processes into an Energy Management Plan or a Master Energy Management Plan (MEM Plan). A tailored MEM Plan for SDDOT would coordinate energy-related activities, facilitate implementation of energy efficiency measures aimed at minimizing consumption and costs, promote agency-wide green building standards, and provide support for sustainable procedures and technologies. For a complete discussion on the SDDOT MEM Plan, see 12.0 PROPOSED SDDOT MEM PLAN. Major benefits of the CEMP are based on potential reductions in energy consumption and related costs for the organization's facilities. In addition to direct cost savings attributed to energy consumption reductions and reduced maintenance and/or labor costs in some cases, other benefits may include:

- Increased facility/equipment life
- Improved occupant comfort and related work efficiency
- Lower carbon footprint and associated green benefits
- Opportunities for positive publicity while providing a proactive approach
- Facilitate deployment of new technologies (energy efficiency, energy recovery, energy generation - renewable)
- Being better situated to address future federal or state mandates concerning energy efficiency standards
- Large organizations commonly have need to coordinate energy-related activities

Many elements of successful energy management programs and plans were identified. Common elements of successful CEMPs, EM Programs, and MEM Plans are summarized in the following sections. The following proposed CEMP (including EM Program and MEM Plan contributions) was based on the author's energy management experience and several sources including the ENERGY STAR® energy management model (ENERGY STAR®, 2011b). While several sources, ranging from an array of energy standards and guidelines from ASHRAE and AEE to those cited in Section 8.0 REVIEW OF RELATED AGENCIES, address various components of a CEMP, the ENERGY STAR® energy management model was the most complete and authoritative identified in the review. The ENERGY STAR® program, a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy, has developed guidelines for facility energy management. This simple and widely adopted management system model and guidelines was developed in consultation with many of the ENERGY STAR® partner companies. The ENERGY STAR® model states that the specific system adopted is not as important as whether it meets the fundamental principles for success and fits a specific company's operating culture.

The first few segments of the ENERGY STAR® model (Make Commitment, Develop Policy, Assess Performance, Establish Budget, Set Goals) holds the core of the Energy Management Program (EM Program). This segment deals with the realigning and/or creating the necessary management structure to support effective energy-related decision-making and allocation of necessary resources. After forming and staffing the energy management structure, the first objectives are to establish energy conservation goals, a budget, and then to develop agency energy policies around the goals and available budget.

The second segment (Create Action Plan, Implement Action Plan, Evaluate Progress, Recognize Achievements) is the foundation of the Master Energy Management Plan (MEM Plan). The second segment consists of organizing and developing the agency energy efficiency policies and processes into a MEM Plan. Typically once a year, the MEM Plan is re-assessed by the Energy Management Team, which forms the evaluation criteria to consider changes and improvements for the following year.

9.1 Make Commitment

The primary element and first step consists of the organization making a commitment. Typically this requires involvement from senior management and centers on establishing legitimacy to the CEMP efforts. The objective from the commitment stage typically is the formal creation of the organization's Energy Management Team, energy goals, and energy policies, which are the centerpieces for Energy Management. Each organization can accomplish these objectives in their own way, but a common sequence is as follows.

The ENERGY STAR® energy management model stresses that no matter the size or type of organization, the common element of successful energy management is commitment. Organizations make a commitment to allocate staff and funding to achieve continuous improvement. The first step to establish an energy program is to form a dedicated energy team which starts with the development of an Energy Management Start-Up Task Force.

9.1.1 Form Energy Management Start-Up Task Force

Typically this requires involvement from select senior/executive management, existing energy and/or sustainability managers, facility and operations managers, and other committee volunteers. Once the Energy Management Start-Up Task Force is formed, they typically coordinate with executive management to establish several CEMP parameters (e.g. define agency priorities and identify energy management team positions). Once these parameters are defined, the Energy Management Start-Up Task Force completes its function by executing the staffing of the Energy Management Team.

9.1.2 Form Energy Management Team

Success is based in large part on a dedicated and organized Energy Team. This Team is responsible for forming the organization's energy management policies and identifying/setting energy efficiency targets. The Energy Management Team is typically staffed by volunteers (at least initially), with the exception of the Energy Director/Manager, whose position typically can vary between a volunteer and a full-time, dedicated position.

The Energy Team's mission is to execute energy management activities across different parts of the organization and integrate energy efficiency best practices. Team members ideally hold key energy-related positions, or have an energy-related background and/or have a passion for energy efficiency and sustainability. However, decisions affecting energy use are made every day by all positions within an organization. Creating an energy team composed of a wide range of organizational positions helps to integrate energy management into the organization at all levels.

In addition to planning and implementing specific improvements, the team measures and tracks energy performance and communicates with management, employees and other stakeholders. The size of the energy team may vary depending on the size of the organization and the aggressiveness of the Team's goals. In addition to the Energy Director/Manager, who leads the team, and a senior management "executive ally" and possible dedicated energy staff; appointing a representative from each operational area with authority in energy use is recommended. The ENERGY STAR® energy management model (ENERGY STAR®, 2011b) states that common operational areas include the following:

- Engineering
- Purchasing
- Operations and Maintenance
- Building/Facilities Management
- Environmental Health and Safety
- Corporate Real Estate and Leasing
- Construction Management

- Contractors and Suppliers
- Utilities

This list illustrates that rarely does a single personnel grouping have the necessary organizational authority to implement an effective EM Program while having the technical expertise and intimate building knowledge necessary to ensure that changes are effectively carried-out (although in the SDDOT, the Internal Services Manager may be close).

9.1.3 Appoint Energy Program Manager

The responsibility of the Energy Manager is to oversee the energy team and provide overall management of the CEMP. The Energy Manager is responsible for coordinating energy management activities including setting goals, tracking progress, and promoting the energy management program. Appointing an Energy Manager is a critical component of successful energy management programs. The Energy Manager is not required to be an expert in energy and technical systems; however, a successful Energy Manager promotes energy performance as a core value and understands how energy management helps the organization achieve its financial and environmental goals and objectives. Depending on the size of the organization, the Energy Manager role can be a full-time position or an addition to other responsibilities.

If the Energy Manager does not report directly to a senior management official, it is often helpful for a member of senior management to serve as an “executive ally.” Upper management involvement and support is a key component of successful programs. Having an ally provides a direct link to upper management and helps to formalize the commitment to continuous improvement. The Energy Manager’s key duties often include:

- Coordinating and directing the overall energy program
- Acting as the point of contact for senior management
- Increasing the visibility of energy management within the organization
- Drafting Energy Policy
- Assessing the potential value of improved energy management
- Creating and leading the Energy Team
- Securing sufficient resources to implement strategic energy management (may require assistance and support of “executive ally”)
- Assuring accountability and commitment from core parts of the organization (may require assistance and support of “executive ally”)
- Identifying opportunities for improvement and ensuring implementation (including staff training)
- Initiating contact with energy consultants (as needed)
- Measuring, tracking, evaluating, and communicating results
- Obtaining recognition for achievements

At this point, the original Energy Management Start-Up Task Force is typically disbanded or integrated as members of the Energy Team. The Energy Team's first job is to develop the underlying CEMP Energy Policy.

9.2 Develop Energy Policy

One of the first items that the Energy Team should accomplish is to establish the organization's Energy Policy. Energy Policy provides the foundation for successful organizational energy management. It articulates the organization's commitment to energy efficiency for management, employees, the community, and other stakeholders. According to ENERGY STAR®, 2011b, successful organizations have energy policies that:

- STATE OBJECTIVE: Have a clear, measurable objective that reflects the organization's commitment, culture and priorities.
- ESTABLISH ACCOUNTABILITY: Institute a chain-of-command, define roles in the organization, and provide the authority for personnel to implement the energy management plan.
- ENSURE CONTINUOUS IMPROVEMENT: Include provisions for evaluating and updating the policy to reflect changing needs and priorities.
- PROMOTE GOALS: Provide a context for setting performance goals by linking energy goals to overall financial and environmental goals of the organization.

Further suggestions include (ENERGY STAR®, 2011b):

- Have the head of the organization officially issue the policy.
- Involve key people in policy development to ensure buy-in.
- Tailor the policy to the organization's culture.
- Make it understandable to employees and public alike.
- Consider the skills and abilities of management and employees.
- Include details that covers day-to-day operations.
- Communicate the policy to all staff and employees, and encourage them to get involved.
- Consider partnering with ENERGY STAR® as a basis for your energy policy.

An Energy Policy typically includes the following specific provisions.

9.2.1 Applicability

The Energy Team should define which portions of the organization that the Energy Policy should apply to.

9.2.2 Objectives

An Energy Policy should define its objectives. Typically, objectives of an Energy Policy are to improve energy consumption efficiency, reduce costs, optimize capital investment for energy efficiency, reduce environmental and greenhouse gas emissions, and conserve natural resources.

9.2.3 Energy Policy Guidelines

The following are several guidelines commonly utilized to develop energy policies.

- Improve energy efficiency continuously by establishing and implementing effective energy management programs that support manufacturing capabilities while providing a safe and comfortable work environment.
- Emphasize energy efficiency as a factor in product development and in process and facility design.
- Encourage continuous energy conservation by employees in their work and personal activities.
- Drive further development of internal and external energy efficient and innovative technologies.
- Cooperate with governmental agencies and utility companies on energy programs.
- Support national energy efficiency policies.

9.2.4 Accountability

It is also important to define the Energy Team's accountability. Typically, the Energy Management Team is responsible for the successful implementation and adherence to the Energy Policy.

9.2.5 Continuous Improvement

The Energy Management Team should reevaluate all aspects of the Energy Management Program on an annual basis in order to reflect changing needs and priorities.

9.2.6 Share Good Practices

The Energy Management Team should strive to share good energy management practices within the organization. This effort should be ongoing in order to promote effective projects. Many energy efficiency measures are dependent on occupant participation in the operation of building systems, which may result in the greatest return on investment for energy efficiency projects. For example, the installation of programmable thermostats will have little effect on energy consumption if occupants continually override temperature setbacks. Another example is that energy efficient lighting must still be turned off during unoccupied times to achieve the highest savings.

9.2.7 Energy Policy Approval

The Energy Management Team should formally approve and then seek organizational approval of the Energy Policy.

9.3 Assess Performance

In order for the Energy Team to further develop the organization's CEMP, the Energy Team must assess the existing energy efficiency performance in order to set realistic goals and match budgets and energy policies to the goals. Understanding existing energy use is how many organizations identify opportunities to improve energy performance. This step is typically part of the EM Program, but analysis is also integrated into the MEM Plan if desired.

This understanding provides the framework for improving energy performance and gaining financial benefits. Assessing organizational energy performance is an ongoing, annual process involving data collection and management, evaluating energy use for all organizational facilities and comparing those results to a well-established baseline. Benefits include: improved understanding, identifying high-performance facilities, and prioritizing.

9.3.1 Data Collection and Management

Evaluating energy performance requires good information on how, when, and where energy is being used. Collecting and tracking this information is necessary for establishing baselines and managing energy use. Organizations of all sizes have established systems for gathering and tracking energy use data. All or part of data collection and management can be outsourced.

9.3.2 Establish Baseline Data and Assess Energy Performance

Baseline data provides a starting point from which to measure energy performance at the organization. Baseline data can be used to compare the energy performance of organization facilities to each other, peers, and over time to prioritize which facilities to focus on for improvements. Measuring energy performance at a specific time establishes a baseline and provides the starting point for setting goals and evaluating future efforts and overall performance. Baselines should be established for all levels appropriate to your organization.
Assessing the organization's energy performance is typically done through benchmarking metrics. Benchmarking provides a method to compare against historical data, similar facilities within the organization, and/or similar facilities in other organizations. Benchmarking can be done in variety of ways including basing it on historical, facility-based, and targeted performance.

9.4 Establish Energy Management Budget

As previously mentioned, Energy Management goals, policies and budgets are often related in terms of scale. Therefore, care must be taken to ensure realistic expectations such that goals fit budgets and budgets fit goals.

9.5 Set Energy Management Goals

Overall, it is difficult to develop a CEMP without a clear Energy Management goal for the organization. Therefore, the Energy Team must define the organization’s Energy Management targets. Aggressive targets require aggressive CEMPs often with larger budgets and stricter energy policies.

Setting Energy Management goals typically require establishing existing energy baselines in order to quantify and clarify goals. Establishing the baselines usually requires some degree of analysis. This analysis can be completed in-house or it can be performed by an external energy professional. Additionally, some of the analysis may be able to be placed into the MEM Plan.

Energy efficiency performance goals drive energy management activities. Setting clear and measurable goals is critical for understanding intended results, developing effective strategies, and obtaining energy cost savings.

An organization’s well-stated goals can guide daily decision-making and are the basis for tracking and measuring progress. Communicating and posting goals can also educate and motivate staff to support energy management efforts throughout the organization. The Energy Manager in conjunction with the Energy Team typically develops goals. To develop effective performance goals, the following steps may be followed (ENERGY STAR®, 2011b):

- DETERMINE SCOPE: Identify organizational and time parameters for goals.
- ESTIMATE POTENTIAL FOR IMPROVEMENT: Review baselines, benchmark to determine the savings potential and prioritize upgrades, and conduct technical assessments and audits.
- ESTABLISH GOALS: Create and express clear, measurable goals, with target dates, for the entire organization, facilities, and other units.

Setting goals also helps the Energy Manager with the following (ENERGY STAR®, 2011b):

- Set the tone for improvement throughout the organization
- Measure the success of the energy management program
- Help the Energy Team to identify progress and setbacks at a facility level
- Foster ownership of energy management, create a sense of purpose, and motivate staff (which may include offering incentives)
- Demonstrate commitment to reducing environmental impacts
- Create schedules for upgrade activities and identify milestones

It is good practice for organizations to take advantage of the Energy Team's wide range of knowledge to help in setting aggressive, yet realistic goals. It is also suggested to have management review the goals to acquire feedback and enlist support.

At this point, the EM Program has been established. The Energy Team's next function is to develop a Master Energy Management Plan (MEM Plan). A MEM Plan coordinates energy-related activities, facilitates implementation of energy efficiency measures, promotes good practices and agency-wide green building standards, and provides support for sustainable procedures and technologies.

The MEM Plan is a continuing systematic energy management effort by the Energy Team. It is developed to achieve the goals set by the EM Program. Refer to section 12.0 PROPOSED SDDOT MEM PLAN for further information on the proposed plan. The following sections summarize the common elements for MEM Plans.

9.6 Create Plan of Action

Successful organizations use a detailed action plan to ensure a systematic process to implement energy performance measures (ENERGY STAR®, 2011b). The action plan provides a roadmap to improve energy performance. However, unlike the energy policy, the action plan is regularly updated, typically on an annual basis. Updates are made to reflect recent achievements, changes in performance, availability of funding, and shifting priorities. An action plan includes defining technical steps and methodology, updating targets, determining roles, and identifying resources. This action plan is often called the Master Energy Management Plan (MEM Plan). In future references, the specific label for SDDOT's action plan will be the SDDOT Master Energy Management Plan (MEM Plan).

Some organizations define their goals and their energy management plan by incorporating one or more of the following industry approaches/standards.

9.6.1 LEED Certification Levels

The State of South Dakota mandates that SDDOT new construction and significant remodels must meet LEED Silver rating requirements but two more aggressive LEED certifications are available (Gold and Platinum), in addition to the baseline certification called "LEED Certified". An important note about the LEED rating system is that credits/points awarded for energy efficiency are based on the extent that the designed building exceeds the baseline ASHRAE Standard 90.1 specifications. Projects seeking LEED certification must have a LEED Professional Credential holder on the project. For more information and details of the latest version of LEED Certification visit the USGBC's website (www.usgbc.org).

The LEED Certification levels and credits/points to obtain each level of certification for new construction classification are as follows:

- LEED Certified: 40-49
- LEED Silver: 50-59
- LEED Gold: 60-79
- LEED Platinum: 80-110

To clarify, these points are awarded in numerous categories with only one category, Energy and Atmosphere (EA), specifically awarding credits for energy efficiency. The LEED 2009 for New Construction and Major Renovations Project Checklist highlights that only 32% (35 of 110 possible points) of the credits used to determine the buildings certification level are associated with energy and atmosphere. Additionally, the New Buildings Institute determined that only approximately half of the LEED buildings met the energy qualification level required for recognition as an EPA-certified Energy Star building. The New Buildings Institute also reports that, "one quarter of these buildings had ratings below 50, meaning they used more energy than average for comparable existing building stock[5]."

While LEED Certification can be a good step towards greater energy efficiency, it does not ensure it. Therefore organizations may choose to utilize the ENERGY STAR® Portfolio Manager rating capability to better focus actions on the core objective of energy conservation. Also, more energy focused programs like BEQ from ASHRAE and ASHRAE's Standard 189.1 may hold more appropriate energy guidelines.

9.6.2 ASHRAE Standard 189.1 Section 7 (Energy Efficiency) On-site Renewable Energy

Organizations with experienced energy management teams may also explore specifying ASHRAE Standard 189.1 for new building construction projects. This standard has a mandatory requirement that the building design provide for the future installation of photovoltaic, solar thermal, geothermal energy (but not including ground-source heat pumps) or wind system with a minimum rating of 13 Btu/h/ft^2 (3.7 W/ft^2) multiplied by the total roof area. Provision for future installation means to show allocated space for solar collectors, pathways for conduit, piping and associated equipment on the construction documents. Sites with permanent shade or poor solar incident radiation (less than or equal to 4 kW/m^2-day on a collector oriented due south and tilted at an angle equal to the site's altitude) are exempt from the minimum requirement.

9.6.3 ASHRAE BUILDING ENERGY QUOTIENT (BEQ)

The Building Energy Quotient (BEQ) developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, ASHRAE, is a new building rating system that relates a building's energy performance to net zero energy buildings as defined by ASHRAE. Net-Zero Energy Buildings (NZEBs) are buildings which, on an annual basis, use no more energy than is provided by on-site renewable energy sources. This system can be utilized as a benchmarking tool and as a goal-setting tool for an organization.

9.6.4 Life-Cycle Cost Analysis (LCCA)

Life-cycle cost analysis is a common economic analysis and evaluation tool used for aggressive energy efficiency approaches in organizations with experienced energy management teams. LCCA seeks to more accurately represent the economics of improvement projects by incorporating interest and depreciation rates, maintenance & upkeep, salvage value, life of equipment, and other externalities like environmental impacts. Multiple methods of LCCA exist and careful definition of the beginning and end of equipment life is what differentiates the

[5] Turner, Cathy, Mark, Frankel, Energy Performance of LEED® for New Construction Buildings, New Buildings Institute, 2008.

methods. Three terms are commonly used to describe the equipment life: cradle, gate, and grave. Cradle refers to the raw materials used to form the individual components of the part. Gate refers to the point in a products life cycle that it undergoes a transfer from one party to another (e.g. from factory to customer). Grave refers the disposal of a product as being the end of the life cycle. While cradle-to-grave LCCA is the most complete version of LCCA, and more commonly used partial LCCA is gate-to-gate. A gate-to-gate analysis only considers the costs associated with the product from the time it is received to the time it leaves the recipient. Externalities like environmental impact may still be evaluated in a gate-to-gate analysis but only during the time of ownership and operation; construction and disposal are not factors.

9.7 Implement Action Plan

Implementation of the Action Plan requires support and cooperation of key stakeholders at different levels within an organization (ENERGY STAR®, 2011b). Gaining their support and cooperation is a critical factor for a successful Action Plan. Achieving this depends on the awareness, commitment, and capability of the team who will implement the projects and can be assisted by taking the following steps (ENERGY STAR®, 2011b):

- CREATE A COMMUNICATION PLAN: Develop targeted information for key audiences about your energy management program.
- RAISE AWARENESS: Build support all levels of your organization for energy management initiatives and goals.
- BUILD CAPACITY: Through training, access to information, and transfer of successful practices, procedures, and technologies, you can expand the capacity of your staff.
- MOTIVATE: Create incentives that encourage staff to improve energy performance to achieve goals.
- TRACK AND MONITOR: Using the tracking system developed as part of the action plan to track and monitor progress regularly.

9.8 Evaluate Progress

Evaluating progress includes formal review of energy use data as compared to established performance goals. Evaluation results can then be used to update the action plan, identify best practices, and set new performance goals. Key steps include:

- MEASURE RESULTS: Compare current performance to established goals.
- REVIEW ACTION PLAN: Understand what worked well and what didn't in order to identify best practices.

Understanding the organization's baseline energy use and relative performance is only part of evaluating progress. Periodic assessment of equipment, processes, and system performance will help identify opportunities for future energy efficiency improvement. Successful programs typically incorporate conducting energy audits into the organization's evaluation process (ENERGY STAR®, 2011b). Additionally, research by the authors determined that one of the most common elements of all energy management programs consisted of hiring energy professionals to perform energy audits on the organization's facilities, then integrating the energy audit recommendations into future projects.

Energy audits are comprehensive reviews conducted by energy professionals and/or engineers that evaluate actual verses designed performance. The difference between these is the potential for energy savings and the associated energy cost savings. Energy audits serve to identify potential energy efficiency projects. The majority of organizations outsource their energy audits to energy professionals (ENERGY STAR®, 2011b).

The main steps for conducting technical assessments and energy audits include (ENERGY STAR®, 2011b):

- IDENTIFY AUDIT TEAM: Expertise should cover all energy-using systems, processes, and equipment. Include facility engineers, system specialists, and other support. Outside support may be helpful and provide an objective perspective or specific expertise.
- DEVELOP AUDIT STRATEGY: Identify and prioritize systems for evaluation, assign team members to tasks, and schedule completion dates for the activities. Use benchmarking results to identify poor-performing facilities whose equipment and systems should be targeted for evaluation.
- CREATE AUDIT REPORT: Based on the audit results, produce a detailed summary report of actual steps that can be taken to reduce energy use. The report should recommend actions from simple adjustments in operation to equipment replacement. Estimates of resource requirements for completing actions should be included. Many energy audit report templates can be found on the internet and from leading energy conversion organizations such as ASHRAE and AEE.

The Energy Team typically identifies which facilities require energy audits. It is common to outsource a majority of energy audits. However, as the Energy Team builds confidence and systems knowledge, they may choose to transition to performing a larger percentage of energy audits themselves.

9.8.1 Energy Audit Types

The energy audits conducted can range from simple, low-cost audits to more intensive and complex analysis, especially when the energy audits are completed via qualified, 3rd party firms. However, the Energy Team may focus on simple, low cost audits as a starting point. Nevertheless, if a more detailed analysis is desired, the next levels for energy audit formats are outlined in the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) document titled "Procedures for Commercial Building Energy Audits." These energy audit levels are as follows:

- Preliminary Energy Use Analysis
- Level I – Walk-Through Analysis

- Level II – Energy Survey and Engineering Analysis
- Level III – Detailed Analysis of Capital-Intensive Modifications

ASHRAE names the simplest level of an energy audit as a "Preliminary Energy Use Analysis." This level is used to analyze historic utility use and cost and develop the Energy Utilization Index (EUI) of the buildings. Much of this level could be conducted by the Energy Team personnel during the EM Program stage.

The ASHRAE Level 1 audits are more intensive than Preliminary Energy Use Analysis and are often used for facilities who are seeking to identify low-hanging fruit opportunities for energy efficiency. The ASHRAE Level 1 audit focuses on low-cost/no-cost energy conservation measures, and provides a list of higher cost energy conservation measures. In addition to tasks performed in the Preliminary Energy Use Analysis, the ASHRAE Level 1 energy audit quantifies how much energy and energy costs can be saved from each energy conservation opportunity. It also provides a list of potential capital improvements that merit further consideration.

The ASHRAE Level II audits include a more detailed building survey, financial projections, and energy analysis than ASRHAE Level I audits. A breakdown of the energy use within the building is also developed at this level. According to the ASHRAE document titled "Procedures for Commercial Building Energy Audits," a "Level II energy analysis will identify and provide the savings and cost analysis of all practical measures that meet the building owner's constraints and economic criteria, along with a discussion of any changes to operation and maintenance procedures." This level of analysis is typically appropriate for most facilities and for building projects seeking LEED-EB status.

The ASHRAE Level III audit includes more detailed analysis than a Level II audit and is utilized as a follow up study for very capital-intensive projects identified during a Level II analysis. This level of analysis requires more detailed systems testing and/or performance data gathering as well as a more rigorous engineering analysis. It provides detailed project analysis with a high level of confidence sufficient for major capital investment decisions. At this level, building energy modeling is typically required.

9.9 Recognize Achievements

Sustained CEMP momentum and support can be achieved through recognition for energy management achievements. This could be done for those who stood out as energy conservation or efficiency advocates, or in some other way helped the organization achieve the goals of the CEMP. This not only motivates staff and employees but also provides positive exposure. Key steps in providing and gaining recognition include (ENERGY STAR®, 2011b):

- PROVIDE INTERNAL RECOGNITION: Provide to individuals, teams, and facilities within your organization (such as within the SDDOT publication "Connecting the DOT's").

- RECEIVING EXTERNAL RECOGNITION: Receive from government agencies, the media, and other third party organizations that reward achievement (such as an Energy Star rating for a building).

10.0 FEASIBILITY OF CEMP AT SDDOT

Before proposing or adopting any sort of CEMP at the SDDOT, it is important to evaluate the feasibility of such an action. The following sections evaluate the feasibility of establishing a CEMP at SDDOT.

10.1 Incentives for CEMP at SDDOT

The SDDOT facilities consumed over $1.4 million in energy in 2010. Additionally, the average SDDOT facility consumes more energy per square foot than a national average for similar buildings. The State also has many mandates for State Agencies, including SDDOT, to obtain baseline efficiency levels, but these energy efficiency "minimum" targets fall short of reaching the full energy conservation potentials for each project. While not every project can justify exploring the ramifications of exceeding the minimum bar of efficiencies, many projects have cost-effective energy savings potential beyond the mandated minimums. Additionally, exploring more efficiency options may yield additional savings through associated systems effects, prevented maintenance, and proactively addressing future State or Federal energy efficiency benchmarks. Finally, the SDDOT may have various low efficiency systems that are consuming large amounts of energy costs, but are in good working condition. Therefore, replacing these systems may have very attractive return on investments, but go unaddressed in the present prioritizing system.

In Section 7.3 Energy Use Reduction Opportunities at SDDOT, the typical savings from implementing in-depth energy audits performed by energy professionals was detailed. In summary, applying these projections to SDDOT, an after-energy-audit projected savings of 40% (37,920.3 MMBtu/yr of energy at a cost savings of $568,657/yr compared to the 2010 energy use baseline) would be expected. Actual savings depends on the level of energy efficiency investment (both time and money). A CEMP implemented at SDDOT has the potential to match or exceed the 40% energy and cost reduction level by the time the SDDOT CEMP reaches maturity. Specific SDDOT savings estimations corresponding to investment levels are found in Sections 11.0 and 12.0.

Additional benefits for a dedicated energy management program include the following:

- Address SDDOT sustainability focus
- Proactive efforts aide in good public perception
- CEMP analysis may yield a more effective allocation of resources
- Better poised for compliance with future Federal/state mandates
- Provides a proactive approach
- Minimize missed opportunities for savings beyond mandated minimums
- Large organizations commonly have need to coordinate energy-related activities

- Improve identifying and implementing cost-effective energy efficiency measures
- Reduce costs, carbon footprint, greenhouse gas emissions
- Facilitate deployment of new technologies (energy efficiency, energy recovery, energy generation - renewable)
- Improved workplace environment for employees, often associated with gains in productivity

Some incentives for establishing a formal EM Program at SDDOT are highlighted above. The previous sections, specifically the Sections in 5.0 CURRENT SDDOT ENERGY MANAGEMENT APPROACH, provide a background on the existing mandates, energy policies, procedures, and energy-related management doctrines presently in place at the SDDOT. What follows is an evaluation of the feasibility for establishing a formal EM Program at SDDOT.

10.1.1 Existing SDDOT Energy Management Related Infrastructure

SDDOT has an established formal policy designed for meeting State mandates for obtaining baseline efficiency levels when purchasing new equipment and buildings (Policy No. DOT-OS-IS-3.1). Refer to Section 5.0 Current SDDOT Energy Management Policies and Procedures for detailed discussions on State and SDDOT policies and mandates.

The SDDOT already has a committee in place to address integrating sustainability into SDDOT practices. The SDDOT Sustainable Government Action Plan addresses many of the core CEMP values and practices previously defined. In the opinion of BTU Engineering, this action plan is a key step in the evolution of formulating an SDDOT CEMP. See Section 5.2.3 SDDOT Sustainable Government Action Plan for additional information on this resource.

The SDDOT has an established management structure in place that is highly skilled in various aspects of engineering and project management (a high percentage of the managers are engineers). These managers are experienced in successfully managing large, often unique projects and are already successfully implementing energy efficiency related projects which are mandated as part of current building and equipment upgrades. Additionally, the SDDOT facility management teams are supported by the OSE, which specializes in managing equipment replacement and building construction projects, many of which are energy efficiency upgrade projects. See Section 5.2 SDDOT Energy Management Approach: SDDOT-Directed for more detailed discussions on these topics.

The SDDOT utilizes a software program (AuditMate™) to track equipment inventories for new construction projects and maintenance and repair projects for existing facilities. The projects are all ultimately prioritized based on need. Additionally, all of these projects are routed through the SDDOT Internal Services Manager, who is the person responsible for submitting equipment and building construction requests to SDDOT upper management. After project approval, the Internal Services Manager collaborates with the SDDOT Region Engineers and their respective

Operations Engineer and Area Engineers and their OSE project engineers concerning the implementation of approved equipment and building construction projects. See Section 5.2.5 for detailed discussions on SDDOT project implementation policies and personnel.

The SDDOT Internal Services Manager is very important to the proposed energy management structure since all equipment and building replacement requests are funneled through this position. Additionally, this position is the pivot point for project prioritization.

Additionally, the Region Engineers, Area Engineers and Operations Engineers are important to the energy management structure since they are the primary facility managers at SDDOT and are key personnel in identifying most equipment and building replacement needs.

The SDDOT has established procedures in place to track utility use and costs through EnergyCAP® software. The SDDOT has used this software since 1995 for utility billing purposes. However, energy management features of this software have not been used. See Section 5.2.10 SDDOT Energy Tracking (EnergyCAP®) for more details on the current use of this software.

10.1.2 Assessment of Existing Energy Management

One method to evaluate an organization's existing energy management potential is to utilize the ENERGY STAR® Energy Management Assessment Matrix. This tool is freely available and downloadable via the ENERGY STAR® website (http://www.energystar.gov). The ENERGY STAR® Energy Management Assessment Matrix addresses an evaluation of the current status of all of the suggested seven steps of their simple and widely adopted energy management system model and guidelines. The ENERGY STAR® Energy Management Assessment Matrix was utilized to assess the existing SDDOT energy management program. As shown in Figure 16, the results illustrate the existing lack of a dedicated energy management program (highlighted boxes display current SDDOT energy management).

	Little or no evidence	Some elements	Fully implemented	Notes
Make Commitment to Continuous Improvement				
Energy Director	No central or organizational resource Decentralized management	Central or organizational resource not empowered	Empowered central or organizational leader with senior management support	
Energy Team	No company energy network	Informal organization	Active cross-functional team guiding energy program	Sustainability Team, ARRA Audit Tean
Energy Policy	No formal policy	Referenced in environmental or other policies	Formal stand-alone EE policy endorsed by senior mgmt.	State Policies Followed
Assess Performance and Opportunities				
Gather and Track Data	Little metering/no tracking	Local or partial metering/tracking/reporting	All facilities report for central consolidation/analysis	All Participate, No Analysis
Normalize	Not addressed	Some unit measures or weather adjustments	All meaningful adjustments for organizational analysis	
Establish baselines	No baselines	Various facility-established	Standardized organizational base year and metric established	For Budgeting Only
Benchmark	Not addressed or only same site historical comparisons	Some internal comparisons among company sites	Regular internal & external comparisons & analyses	
Analyze	Not addressed	Some attempt to identify and correct spikes	Profiles identifying trends, peaks, valleys & causes	
Technical assessments and audits	Not conducted	Internal facility reviews	Reviews by multi-functional team of professionals	OSE Arranged Audits / ARRA
Set Performance Goals				
Determine scope	No quantifiable goals	Short term facility goals or nominal corporate goals	Short & long term facility and corporate goals	General - Good Stewardship of Funds
Estimate potential for improvement	No process in place	Specific projects based on limited vendor projections	Facility & organization defined based on experience	Sebesta Report Forms Projection
Establish goals	Not addressed	Loosely defined or sporadically applied	Specific & quantifiable at various organizational levels	Sustainability Team
Create Action Plan				
Define technical steps and targets	Not addressed	Facility-level consideration as opportunities occur	Detailed multi-level targets with timelines to close gaps	When Systems Require Replacement
Determine roles and resources	Not addressed or done on ad hoc basis	Informal interested person competes for funding	Internal/external roles defined & funding identified	
Implement Action Plan				
Create a communication plan	Not addressed	Tools targeted for some groups used occasionally	All stakeholders are addressed on regular basis	Sustainability Team
Raise awareness	No promotion of energy efficiency	Periodic references to energy initiatives	All levels of organization support energy goals	Sustainability Team, State Mandates
Build capacity	Indirect training only	Some training for key individuals	Broad training/certification in technology & best practices	
Motivate	No or occasional contact with energy users and staff	Threats for non-performance or periodic reminders	Recognition, financial & performance incentives	
Track and monitor	No system for monitoring progress	Annual reviews by facilities	Regular reviews & updates of centralized system	
Evaluate Progress				
Measure results	No reviews	Historical comparisons	Compare usage & costs vs. goals, plans, competitors	
Review action plan	No reviews	Informal check on progress	Revise plan based on results, feedback & business factors	
Recognize Achievements				
Provide internal recognition	Not addressed	Identify successful projects	Acknowledge contributions of individuals, teams, facilities	
Get external recognition	Not sought	Incidental or vendor acknowledgement	Government/third party highlighting achievements	

Figure 16: ENERGY STAR® Energy Management Assessment Matrix - SDDOT

In summary, although SDDOT does not have a dedicated energy management system in place, the State has many mandates in place to obtain baseline efficiency levels. Also, SDDOT has the before mentioned infrastructure already established to comply with the State mandates and to prioritize capital expenditures. In terms of energy management, there are areas of needed development, but the established infrastructure can largely be utilized to form the foundation upon which to build a formal SDDOT EM Program.

The additional components that must be added to the established infrastructure vary with SDDOT's desired energy efficiency goals, but share the following key components.

- Reorganize or re-center efforts around energy efficiency
- Identify energy manager or energy champion and energy team

- Set energy efficiency goals
- Set SDDOT energy efficiency policy
- Set evaluation criteria

The following sections detail a proposed CEMP tailored to the SDDOT that includes the proposed SDDOT EM Program (11.0 PROPOSED SDDOT EM PROGRAM) and MEM Plan (12.0 PROPOSED SDDOT MEM PLAN).

11.0 PROPOSED SDDOT EM PROGRAM FOR SDDOT

Previously, an estimate of the energy savings potential at the SDDOT was provided (see Section 7.3 for more details). Realizing this potential can only be achieved through an organized and systematic effort. What follows is a recommended outline based on necessary elements of an EM Program for the SDDOT in order to achieve these savings. The implementation of the proposed SDDOT EM Program is designed to precede the implementation of the proposed MEM Plan. The relationship between an EM Program and MEM Plan that together comprise a Comprehensive Energy Management Plan (CEMP) and associated hierarchy of events is presented in Figure 1.

11.1 Make Commitment

The first step for a successful Energy Management Program (EM Program) consists of the SDDOT making a commitment to the EM Program. This will require involvement from senior management and centers on establishing legitimacy to the EM Program efforts. This is done through the formal creation of the SDDOT's Energy Team and appointment of Energy Manager. The suggested sequence is as follows.

11.1.1 Form Energy Management Start-Up Task Force

Typically this requires involvement from select senior/executive management, existing energy and/or sustainability managers, facility and operations managers, and other committee volunteers. Once the Energy Management Start-Up Task Force is formed, they will coordinate with executive management to establish the following:

- Define Agency Energy Management Priorities
- Define Desired Energy Management Results
- Define SDDOT Commitment to Desired Results
- Define SDDOT Commitment to Energy Management Budget
- Form/Identify Energy Management Structure
- Form/Identify Energy Management Team Positions
    - Manager
    - Executive Ally
    - Team Members

Once these parameters are defined, the Energy Management Start-Up Task Force completes its function by staffing the Energy Management Team.

11.1.2 Form Energy Management Team

SDDOT EM Program success will be based in part on a dedicated and organized Energy Team. The SDDOT Energy Management Team will be responsible for allocation of staff and funding necessary to achieve the goals outlined under the annual Master Energy Management Plan

(MEM Plan). This Team will also be responsible for forming SDDOT's energy management policies and identifying/setting energy efficiency targets. The Energy Management Team is typically staffed by volunteers (at least initially), with the exception of the Energy Manager. The Energy Manager is the most important position on the team, since they are the primary person tasked with organizing and coordinating the Energy Team, and facilitating the implementation and integration of the EM Program into the overall company management culture. The Energy Team will consist of representatives from some of the categories in Table 10.

Table 10: Summary of Key SDDOT Personnel Categories

Personnel Types	Number [---]	Description [---]
DIVISION DIRECTORS	4	Managers or representatives at each of four divisions (i.e. Secretary of Transportation, Finance & Management, Planning & Engineering, Operations)
INTERNAL SERVICES MANAGER	1	Manager for Supply Support, Facility Maintenance, Building Mechanical Systems, Auditing
REGIONAL ENGINEERS	4	Managers for each of four regions (Aberdeen, Pierre, Mitchell, and Rapid City)
AREA ENGINEERS	12	Managers for each of 12 area offices
SECRETARY	12	Secretaries for each of 12 areas that provide Energy CAP input support
OPERATIONS ENGINEER	4	Responsible for the buildings and equipment in each Region (especially one who has an energy-efficiency passion)
EQUIPMENT SPECIALISTS	NA*	Manager(s) of SDDOT vehicle fleet and/or purchasing
OTHER SDDOT	NA*	Other energy-related positions and/or other SDDOT personnel who may have a passion for energy efficiency such as: DOT Sustainable Government Action Plan representatives
Bureau of Administration Office of the State Engineer Energy Management Office Statewide Energy Manager Sustainability Coordinator	NA*	Other stakeholders such as energy-related Policy, Utility, Environmental, or Conservation personnel (may include a representative from other SD Departments)

*Not Applicable

Currently, people throughout the SDDOT make decisions affecting energy use every day. The various people making the decisions may or may not know, nor care, about the relationships between their decisions and the consequences to energy use and costs. Integrating a broad range of personnel into the energy team helps to integrate energy management across the entire Agency spectrum. In addition to planning and implementing specific improvements, the team measures and tracks energy performance and communicates with management, employees, and other stakeholders. The size of the energy team will vary depending on the size of organization and the degree of energy management desired.

No single personnel grouping has the necessary organizational authority to implement an effective EM Program while having the technical expertise and intimate building knowledge necessary to ensure that changes are effectively carried-out. An alliance of personnel within a diverse corporate structure ensures a wide range of administration oversight (i.e. square feet of building area that they control) that can impact effectiveness at every level.

11.1.3 Designate SDDOT Energy Manager

The responsibility of the SDDOT Energy Manager is to oversee the energy team and overall management of the EM Program. Designating an Energy Manager is a critical component of successful energy programs. An Energy Manager helps an organization achieve its goals by establishing energy performance as a core value. The Energy Manager is not required to be an expert in energy and technical systems; however, a successful Energy Manager is also an energy champion and understands how energy management helps the organization achieve its financial and environmental goals and objectives. Important qualifications for the Energy Manager to possess include, but are not limited to, the following:

- Knowledge of the SDDOT infrastructure and facilities
- Administration skills and experience in project organization and planning
- Team leadership skills that inspire people to achieve goals
- Passion that aligns with the goals of the SDDOT CEMP

Initially, the Energy Manager role can be a part-time position. The Energy Manager’s key duties may include:

- Coordinating and directing the overall energy program
- Acting as the point of contact for senior management
- Increasing the visibility of energy management within the organization
- Drafting Energy Policy
- Assessing the potential value of improved energy management
- Creating and leading the Energy Team
- Securing sufficient resources to implement strategic energy management
- Assuring accountability and commitment from core parts of the organization
- Identifying opportunities for improvement and ensuring implementation (including staff training)
- Initiating contact with energy consultants (as needed)

- Measuring, tracking, evaluating, and communicating results
- Obtaining recognition for achievements

With regard to the SDDOT Program, it is recommended to consider the Internal Services Manager as a potential Energy Manager or key Energy Team member since all equipment and building replacement requests are funneled through this position. Additionally, this position is the pivot point for project prioritization.

The SDDOT Internal Services Program Manager is a primary candidate for the Energy Team as this person maintains the facility and equipment database using AuditMate™ software. This person then has the capability to identify incremental energy efficiency increases to proposed projects that are already in the planning process. Depending on the accounting arrangements of the SDDOT, this would allow the Energy Management Budget to be used for funding the marginal cost increase associated with increased energy efficiency.

Another important Energy Management Team member is the "Executive Ally" to the Energy Manager. This member is especially important as a Program advocate if the Energy Manager is not part of, nor does not report directly to upper management/senior management.

At this point, the original Energy Management Start-Up Task Force can be disbanded or integrated as members of the Energy Management Team, whose first job is to develop the underlying Energy Policy.

SUGGESTED ITEMS

- The SDDOT Internal Services program Manager should be a member of the Energy Team as this person maintains the facility and equipment database using AuditMate™ software and all improvement projects are directed through this position.

11.2 Develop Energy Policy

The first important task of the Energy Team is to develop the SDDOT Energy Policy. It is wise to develop policy with the energy management goals and budget in mind. Establishing SDDOT Energy Policy provides the foundation for successful energy management and articulates the organization's commitment to energy efficiency for management, employees, the community, and other stakeholders. The SDDOT Energy Policy should apply to all the SDDOT operations. The SDDOT Energy Policy should include the following specific provisions.

11.2.1 Applicability

This Energy Policy should apply to all SDDOT operations.

11.2.2 Objective

The objective of the SDDOT Energy Policy should be to improve energy efficiency, reduce cost, optimize capital investment for energy efficiency, reduce environmental and greenhouse gas emissions, and conserve natural resources.

11.2.3 Policy Guidelines

Guidelines of this policy include the following:

- Improve energy efficiency continuously by establishing and implementing effective energy management programs that support SDDOT capabilities while providing a safe and comfortable work environment.
- Emphasize energy efficiency as a factor in operations and in process and facility design.
- Secure adequate and reliable energy supplies at the most advantageous rates and implement contingency plans to protect operations from energy supply interruptions.
- Encourage continuous energy conservation by employees in their work and personal activities.
- Drive further development of internal and external energy efficient and innovative technologies and alternative/renewable energy where feasible.
- Cooperate with other governmental agencies on energy programs.
- Support national energy efficiency policies.

11.2.4 Accountability

The SDDOT Energy Management Team will be responsible for the successful implementation and adherence to this Energy Policy.

11.2.5 Continuous Improvement

The SDDOT Energy Management Team will reevaluate all aspects of the SDDOT EM Program on an annual basis in order to reflect changing needs and priorities.

11.2.6 Share SDDOT Good Practices

Sharing of good energy management practices as supported by the Energy Management Team, should be ongoing in order to promote effective projects. The SDDOT Energy Team can decide how best to format and deliver the information. One potential resource would be to coordinate with the South Dakota Bureau of Administration Sustainability Coordinator concerning delivery mechanisms and good practice formats, since this position coordinates sustainability efforts for the entire state government.

11.2.7 Policy Approval

SDDOT Energy Policy approval falls under the auspices of SDDOT Management and the Energy Management Team.

The SDDOT Energy Team will be responsible for the successful implementation and adherence to this Energy Policy. The SDDOT Energy Team will reevaluate all aspects of the SDDOT Energy Management Program on an annual basis in order to reflect changing needs and priorities.

SUGGESTED ITEMS

- Annual review and adaptation of the SDDOT Energy Policy based on prior year experience, changes in agency operations, and changes in the energy industry should be a responsibility of the Energy Team

11.3 Assess Energy Performance

The Energy Team must assess the existing energy efficiency performance in order to set realistic goals and match budgets and energy policies to the goals. Setting Energy Management goals will require establishing existing energy baselines in order to quantify and clarify goals. Establishing the baselines usually requires some degree of analysis. This analysis can be completed in-house or it can be performed by an external energy professional. Additionally, some of the analysis may be able to be placed into the MEM Plan.

Critical to the success of the SDDOT Energy Management Program is a comprehensive understanding of both historical and current energy use. This understanding provides the framework for improving energy performance and gaining financial benefits. Assessing SDDOT energy performance is the annual process of evaluating energy use for all SDDOT facilities and comparing those results to a well-established baseline. A critical element of any successful EM Program is provision for measuring energy-efficiency efforts. Benefits of assessing the SDDOT energy performance include:

- ENHANCED UNDERSTANDING: An extensive understanding of how energy is used at the SDDOT will be gained. This will be achieved by categorizing current energy use by fuel type and facility type among others. Understand the contribution of energy consumption and efficiency to operating costs. Develop a historical perspective and context for future actions and decisions.
- HIGHLIGHTING: High-performance facilities can be identified both for recognition and as an example to replicate practices. Establish performance criteria for measuring and rewarding good performance, such as an Energy Star Rating score of 75.
- PRIORITIZING: Understanding energy performance will also help identify poor performing facilities. Facilities such as these can be made a priority for immediate energy improvements. Typically, energy performance of under-performing facilities can be significantly improved with a lesser amount of capital investment.

To gain these benefits, several distinct steps must be taken including: data collection and management, establishing baseline data, and assessing SDDOT energy performance.

11.3.1 Data Collection and Management

Evaluating energy performance requires good information on how, when, and where energy is being used. Collecting and tracking this information is necessary for establishing baselines and managing energy use. The SDDOT has an established system for gathering and tracking energy use data via EnergyCAP®. All or part of data collection and management can also be outsourced.

11.3.2 Establish Baseline Data

Baseline data provides a starting point from which to measure energy performance at the SDDOT and much of the necessary information already exists in the SDDOT EnergyCAP® database. Baseline data can be used to compare the energy performance of SDDOT facilities to each other, peers, and over time to prioritize which facilities to focus on for improvements. Measuring energy performance at a specific time establishes a baseline and provides the starting point for setting goals and evaluating future efforts and overall performance. Baselines should be established for all levels appropriate to your organization. Collected baseline data should be used to provide the following:

- ESTABLISH BASE YEAR: Establish a base year (weather-normalized) or an average of several historical years. Use the most complete and relevant sets of data available.
- IDENTIFY METRICS: Select units of measurements that effectively and appropriately express energy performance for your organization. (e.g. Btu/sf, total energy cost/sf).
- PUBLISH RESULTS: Announce performance baselines to facilities, managers, and other key stakeholders in your organization.

11.3.3 Assessment of SDDOT Energy Performance

Baseline SDDOT energy data provides the framework for assessing the SDDOT energy performance. This will be done through benchmarking metrics. Benchmarking provides a method to compare against historical data, similar facilities within the organization, and/or similar facilities in other organizations. Benchmarking can be done in variety of ways including the following (of which many can be accomplished with EnergyCAP® and the Portfolio Manager functions):

- HISTORICAL PERFORMANCE: Compare current energy performance metrics to past (baseline) energy metrics. At a minimum, comparisons should be made for each individual facility. Additionally, comparisons can be made for groups of facilities (e.g. grouped by facility type or region).
- FACILITY PERFORMANCE: Compare current energy performance metrics to other SDDOT facilities. Care should be taken to compare similar facility types.

- TARGETED PERFORMANCE: Compare current energy performance metrics to an established SDDOT target performance metric. This targeted performance could be established after a few years of tracking energy performance and might be based on long-term agency-wide energy performance goals.
- INDUSTRY PERFORMANCE: Compare current energy performance to established industry-accepted performance metrics. This could be based on an established performance metric such as the recognized average performance of a peer group or benchmarking against the best in the industry

SUGGESTED ITEMS

- Assessment of SDDOT energy performance using EnergyCAP® should begin immediately following the formulation of the Energy Team. The EnergyCAP® analysis report "Buildings Ranked By Annualized Use Per Area" (AN17) is strongly suggested. Additionally, the agency's building stock ENERGY STAR® ratings using the "ENERGY STAR Ratings" report (AN24) with Energy CAP® should be used.
- The process of upgrading EnergyCAP® should be completed in conjunction with energy performance evaluation by contacting EnergyCAP, Inc.
- Energy Team personnel should be trained in the use of EnergyCAP® by first reviewing the tutorials provided on the EnergyCAP website. Additional training of key personnel should be completed as more advanced features like automated reports are used.
- The ENERGY STAR® Portfolio Manager rating capability on the existing EnergyCAP software should be utilizeded by the SDDOT Energy Manager or by a designated SDDOT Energy Team member working closely with the Energy Manager.

11.4 Establish Energy Management Budget

As previously mentioned, Energy Management goals, policies and budgets are often related in terms of scale. Therefore, care must be taken to ensure realistic expectations such that goals fit budgets and budgets fit goals.

SUGGESTED ITEMS

- It is recommended that 5-10% of the total annual SDDOT energy costs be considered as a starting Energy Management budget.

11.5 Set SDDOT Performance Goals

In order for the Energy Team to develop the initial EM Program, the Energy Team must assess the existing energy efficiency performance in order to set realistic goals and match budgets and energy policies to the goals. It is recommended setting performance goals of the SDDOT to reduce energy consumption by 5% over baseline values over the next 3 years to be considered as a starting point.

11.5.1 Form Energy Management Targets/Set Goals

Overall, it is difficult to develop an EM Program without a clear Energy Management goal for SDDOT. Energy efficiency performance goals drive energy management activities. Setting clear and measurable goals is critical for understanding intended results, developing effective strategies, and obtaining energy cost savings. Once defined, SDDOT's well-stated goals can guide daily decision-making and are the basis for tracking and measuring progress. Communicating and posting the SDDOT goals can also educate and motivate staff to support energy management efforts throughout the organization. The Energy Manager in conjunction with the Energy Team typically develops goals. It is suggested that when setting goals, the organization should be sure to use the Energy Team's wide range of knowledge to help set aggressive, yet realistic goals. It is also suggested to have management review the goals to enlist their feedback and support.

Therefore, one of the first tasks of the Energy Team and Energy Manager is defining the SDDOT Energy Management goals. Aggressive targets require aggressive EM Programs, while moderate Energy Management targets may require less aggressive EM Programs. Additionally, Energy Management goals relate to Energy Management policies and budgets, since more aggressive goals often require larger budgets and stricter energy policies.

A modest initial goal might involve setting a few percent decrease in SDDOT building energy use, which could be monitored by calculating the average SDDOT building EUI within several years. It is suggested that the Energy Team consider setting one of the performance goals of the SDDOT to reduce energy consumption by 5% over baseline values over the next 3 years.

Different levels of energy reduction require vastly different levels of effort and capital expenditure. For the purposes here, three different approaches for energy conservation are described and detailed, each with vastly different energy reduction outcomes. These approaches are addressed in the following sections.

11.5.2 Phase I Approach

The Phase I approach will utilize volunteers and target "low hanging fruit" opportunities throughout the SDDOT. Based on the overall EUI and CUI values, it is clear that these opportunities will be readily available. Energy reduction measures will include those items with a relatively low simple payback (typically less than 2 years) and are easy to implement within existing systems. Examples of projects which may yield these types of returns include the following:

- Lighting retrofits
- Improved lighting controls (e.g. occupancy sensors)
- Improved temperature controls (e.g. thermostat setbacks)

- Implementation of programs encouraging the evaluation of purchasing energy efficient equipment over and above baseline energy efficiency standards
- Ventilation air control and/or reductions
- ASHRAE Level I Energy Audits
- Utilization of "exceed by" new construction energy standards (e.g. exceed current version of ASHRAE 90.1 by at least 5%)
- Implementation of an Agency-wide energy awareness program encouraging SDDOT personnel to practice energy efficiency (e.g. shut off lights when not in use)

Many of these measures are highlighted in the "DOT Sustainable Government Action Plan." Additionally, many of these types of measures were identified for select SDDOT facilities in the "Statewide Energy Auditing for Energy Master Plan" report. Most of the identified measures have been implemented in the audited facilities (6% of the total SDDOT facilities), but replicating the measures across all applicable SDDOT facilities has not been completed.

These measures typically produce energy and cost savings of at least 5% (conservative estimate) with average simple payback periods of two years or less. Based on an energy budget of $1.4 million/yr, if measures of this type were implemented throughout the SDDOT, a cost savings of approximately $70,000/yr could be achieved with capital cost of $140,000. Under this approach, it is anticipated that the SDDOT EUI and CUI values should be reduced to overall mean values of similar facilities.

Note that this approach should not require additional personnel. However, existing personnel will be utilized to oversee necessary activities to achieve these results. In addition, a 3rd party consulting firm or performance contracting firm might be required to help with general project operations, such as providing energy audits for select facilities on an annual basis. At this level, the energy audits conducted can range from simple, low-cost audits to more intensive and complex analysis, especially if the energy audits are completed via qualified, 3rd party firms.

For the "Phase I" level of analysis, the ASHRAE Level 1 – Walk Through Analysis may be a good fit. ASHRAE Level 1 audits are more intensive than Preliminary Energy Use Analysis and are often used for facilities who are seeking to identify low-hanging fruit opportunities for energy efficiency.

The ASHRAE Level II – Energy Survey and Engineering Analysis includes a more detailed building survey, financial projections, and energy analysis than ASRHAE Level I audits. This level of analysis is appropriate for the "Phase II" analysis as defined in section 11.5.3 and for building projects seeking LEED-EB status.

The ASHRAE Level III – Detailed Analysis of Capital-Intensive Modifications level of an energy audit includes more detailed analysis than a Level II audit and is utilized as a follow up study for very capital-intensive projects identified during a Level II analysis. This level of analysis is appropriate for the "Phase III" analysis as defined in section 11.5.4.

11.5.3 Phase II Approach

In addition to "low hanging fruit" identified in the Phase I approach, the Phase II approach will also target further opportunities throughout the SDDOT. Energy reduction measures will include those items detailed in the previous approach and will also include measures with a moderate simple payback (typically less than 6 years). Examples include the following:

- All Phase I approach examples
- Equipment and systems commissioning
- Select HVAC upgrades (e.g. replacement of electric resistance heat)
- Implementation of variable frequency drives (VFDs)
- ASHRAE Level II Energy Audits
- Utilization of "exceed by" new construction energy standards (e.g. exceed current version of ASHRAE 90.1 by at least 10% where feasible)
- Consider utilization of more aggressive new construction energy standards (e.g. ASHRAE 189.1 and/or pursue LEED Gold)
- Utilization of heat exchanger technologies (e.g. air to air heat recovery)

Based on the National Renewable Energy Laboratory (NREL), ASHRAE 189.1 can provide energy savings of up to 30% over ASHRAE 90.1-2007 (MacCracken, 2010). It is anticipated that these measures can produce energy and cost savings of at least 15% (conservative estimate) of the current level with average simple payback periods of six years or less. If measures of this type were implemented along with the Phase I approach suggestions throughout the SDDOT, a cost savings of approximately $210,000/yr could be achieved with a capital investment of $1,260,000.

Note that this approach could require additional effort by the Energy Team personnel but could be offset with a 3rd party energy consulting firm or a performance contracting firm to help with general project operations, such as providing either more energy audits and/or more in-depth energy audits annually. It is suggested that ASHRAE Level II energy audits be utilized to reach this level of energy reduction targets. Commissioning (C_x) and/or Retro-commissioning (RC_x) allow facility operators to maximize energy system performance. Commissioning (C_x) utilizes energy engineers and/or systems professionals to provide 3rd party verification that a new building's energy systems will operate as intended and designed. Commissioning helps ensure optimal operation of new building systems and results in minimized energy costs. Retro-commissioning (RC_x) is often overlooked as a means of reducing energy costs for existing buildings. Retro-commissioning is similar to commissioning but applies to existing buildings and serves to confirm and/or adjust the existing building systems to work as designed and results in minimized energy costs.

Research shows that the operating cost of a commissioned building is 8% to 20% below the operating cost of a non-commissioned building (Turner, 2010).

11.5.4 Phase III Approach

In addition to the previous approaches, the Phase III approach will also target further opportunities throughout the SDDOT. Energy reduction measures will include those items detailed in the previous approaches and will also include aggressive measures that might result in a higher simple payback period (typically less than 10-15 years) and higher levels of energy reduction. Examples include the following:

- Utilization of renewable technologies (e.g. wind turbines, solar hot water, and photovoltaics)
- Smart building controls (e.g. day lighting technologies, programmable lighting ballasts)
- Improvements and upgrades to building envelopes (e.g. replacement of windows with high-efficiency types and adding insulation)
- Improvements in HVAC systems (e.g. geothermal heat pumps)
- ASHRAE Level II & Level III Energy Audits
- Utilization of "exceed by" new construction energy standards (e.g. exceed current version of ASHRAE 90.1 by at least 30% where feasible)
- Utilization of more aggressive new construction energy standards (e.g. ASHRAE 189.1 and/or pursue LEED Gold or Platinum)

It is anticipated that these measures can produce energy and cost savings of at least 25% (conservative estimate) of the current energy cost level with average simple payback periods of ten years or less. Based on current energy expenditures at SDDOT, if measures of this type were implemented along with the Phase I and Phase II approach suggestions throughout the SDDOT, a cost savings of approximately $490,000/yr could be achieved with a one-time capital investment of $4,900,000.

While many facility components are recorded in the AuditMate™ software for lifecycle tracking, it is anticipated that this approach will require additional personnel and a 3rd party consulting firm or performance contracting firm to help with general project operations so that the most cost effective energy saving opportunities can be identified. Third party consulting excels at identifying otherwise hidden opportunities because the professional expertise of this party allows for deep retrofits that maximize energy cost savings and return on investment at an appropriate capital expense by analyzing the complex interaction between energy systems, occupant use, and building components.

The Phase III approach will incorporate one or more of the following industry approaches/standards.

11.5.4.1 LEED Gold or Platinum Certification

The State of South Dakota mandates that SDDOT new construction and significant remodels must meet LEED Silver rating requirements but two more aggressive LEED certifications are available (Gold and Platinum), which would allow for potentially more efficient and/or more sustainable building design. The LEED Certification levels and credits/points to obtain each level of certification (Silver and above) for new construction classification are as follows:

- LEED Silver: 50-59
- LEED Gold: 60-79
- LEED Platinum: 80-110

However, only 32% (35 of 110 possible points) of the credits used to determine the building's certification level are associated with energy utilization, therefore specifying LEED Gold or Platinum certification can be a good step towards greater energy efficiency, it does not ensure it. Therefore SDDOT should also utilize the ENERGY STAR® Portfolio Manager rating capability on the existing EnergyCAP software to better focus actions on the core objective of energy conservation. Also, more energy focused programs like BEQ from ASHRAE and ASHRAE's Standard 189.1 may hold more appropriate energy guidelines.

11.5.4.2 ASHRAE Standard 189.1 Section 7 (Energy Efficiency) On-site Renewable Energy:

Once the SDDOT energy management team becomes experienced and desires a high-performance energy efficiency standard and simultaneously desires a more vigorous attention to renewable energy possibilities, it is recommended to explore specifying ASHRAE Standard 189.1 Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings for new building construction projects. This standard specifies top notch energy efficiency and has a mandatory requirement that the building design provide for the future installation of renewable energy.

SUGGESTED ITEMS

- A Phase I approach focused on "low hanging fruit" should be used in conjunction with Phase I of the MEM Plan.
- The annual review should be used to align the Phase II and Phase III approaches with Phase II and Phase III of the MEM Plan.

11.6 Review, Evaluate, and Adapt EM Program Annually

The Energy Team should review, evaluate and adapt the EM Program based on annual MEM Plan Review and/or changing energy management requirements and/or Agency changes. Review analysis should first be based on a comparison of current versus baseline EUI and CUI values. Additionally, the review should focus on the tasks that were accomplished in the previous term (e.g. number of energy audits completed, implementation rates, etc.).

At this point, the EM Program is established. The Energy Team's next function is to develop a Master Energy Management Plan (MEM Plan). A MEM Plan coordinates energy-related activities, facilitates implementation of energy efficiency measures, promotes good practices and agency-wide green building standards, and provides support for sustainable procedures and technologies. The MEM Plan is a continuing systematic energy management effort by the Energy Team. It is developed to achieve the goals set by the EM Program. Refer to section 12.0 PROPOSED SDDOT MEM PLAN for further information on the proposed plan.

SUGGESTED ITEMS

- Measurement and Verification (M&V) of first-time-implemented ECMs should be conducted to ensure their energy saving potential is realized.
- EnergyCAP® should be used to reevaluate the historical performance, facility-type performance, targeted performance, and industry performance of buildings that have undergone energy conservation measures so that the impact of ECMs can be quantified.

12.0 PROPOSED SDDOT MEM PLAN FOR SDDOT

The financial returns that result from successful energy management programs provide the motivation for organizations to continuously strive to improve their energy performance. Success is measured through regular assessment of energy performance and implementation of steps to increase energy efficiency. The following templates provide a systematic process (plan of action) for improving the energy and financial performance of the SDDOT while distinguishing it as an environmental leader. Combined, these action steps are the proposed SDDOT Master Energy Management Plan (MEM Plan). A chronology follows that outlines necessary steps, outlined in Section 11.0 PROPOSED SDDOT EM PROGRAM. Where appropriate, suggested items requiring SDDOT adoption are summarized in the following segments.

12.1 Proposed MEM Plan Development

The SDDOT Energy Management Team must select an appropriate MEM Plan to accomplish the objectives of the EM Program. The following plan of action is proposed by the researchers as a template for the overall SDDOT MEM Plan (for a proposed MEM Plan template with a proposed timeline refer to section 13.3 Proposed Pace of Implementation). Since different levels of energy reduction may require greatly different levels of effort and capital expenditure, the proposed MEM Plan includes three separate approaches (Phases) for energy conservation which correlate to the phases of the proposed SDDOT EM Program. These approaches are described and detailed, each with vastly different energy reduction outcomes. These approaches are addressed in the following sections.

12.1.1 Phase I

The first phase of the MEM Plan largely consists of lower-cost and lower-effort measures. Phase I will occur during the first few years of the SDDOT CEMP. The goal is to form the basic infrastructure of the Energy Management Team, then start to train the team by education and by evaluating SDDOT for likely energy conservation measures (likely targets include the “low hanging fruit”).

There is no formal statewide training for building operations staff at State facilities to instruct personnel on how to operate buildings and use less energy. Few resources are available to building operators, and as a result operating problems are often ignored or temporary solutions improvised to continue performing in a suboptimal operation. Energy education/training programs seek to engage all building users to increase knowledge and understanding of the impact of normal activities on the overall energy use of a building. AEE and ASHRAE are the lead organizations for Energy Efficiency resources and offer text, webinars, workshops, certificates, standards, and other resources. Energy education/training programs have been shown to yield energy savings of from 5 to 10% and are achieved through changing occupant behavior to reduce energy use (SD Statewide Energy Management, 2009). A professional development program would greatly assist building operations and maintenance staff in the energy and resource-efficient operation of State buildings. The SDDOT Energy Management Team can investigate and recommend appropriate programs. Training and educational resources are available from entities such as the Association of Energy Engineers (AEE) and the American

Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE). A building operator training program expands knowledge and cross-trains participants in important skill areas, maximizing the operator's versatility within the agency and allowing operations staff to take on more responsibility. Agencies can save money through training by developing the skills of their own staff and increasingly avoiding the need to hire outside contractors. The program also enhances careers and often results in improved job retention.

Phase I is suggested to utilize volunteers and target "low hanging fruit" opportunities throughout the SDDOT. Based on the evaluated overall EUI and CUI values of Section 7.0 EVALUATION OF CURRENT SDDOT ENERGY USE, it is clear that these opportunities will be readily available. The EUI and CUI values, along with ENERGY STAR® Ratings should be calculated and ranked in the EM Program stage via the evaluation of the existing energy use baselines contained within EnergyCAP® for the SDDOT (see Section 11.3 Assess Energy Performance for details). Energy reduction measures will include those items with a relatively low simple payback (typically less than 2 years) and are easy to implement within existing systems. Examples of projects which may yield these types of returns include the following:

- Lighting retrofits
- Improved lighting controls (e.g. occupancy sensors)
- Improved temperature controls (e.g. thermostat setbacks)
- Implementation of programs encouraging the evaluation of purchasing energy efficient equipment over and above baseline energy efficiency standards
- Ventilation air control and/or reductions
- Strive to exceed the currently mandated new construction and building remodeling energy standards (e.g. ASHRAE 90.1-2007) by considering exceeding the total building energy efficiency targets by 5% where applicable
- Implementation of an energy awareness program encouraging SDDOT personnel to practice energy efficiency (e.g. shut off lights when not in use)
- Measurement & Verification (M&V) of previously implemented energy efficiency projects to ensure that justification of continuing the CEMP beyond the initial phase is available

Expected Results of Phase I MEM Plan:

- energy and cost savings of at least 5% (conservative estimate)
- average simple payback periods of two years or less
- cost savings of approximately $70,000/yr with a capital cost of $140,000

Many of these measures are already highlighted in the "SDDOT Sustainable Government Action Plan." Additionally, many of these types of measures were identified for select SDDOT facilities in the Sebesta Bloomberg "Statewide Energy Auditing for Energy Master Plan" report. Most of the identified measures from this report have been implemented in the audited facilities (6% of the total SDDOT facilities), but replicating the measures across all applicable SDDOT facilities has not been completed. The categories of ECMs identified by the Statewide Energy Auditing for Energy Master Plan (OSE No. ACC09-07X) were: Lighting, Retro-commissioning, Controls, HVAC, and other Measures (refer to Section 6.0 STATEWIDE ENERGY AUDIT REPORT REVIEW for details).

Note that this approach should not require additional personnel. However, it is suggested that existing personnel will be utilized to oversee necessary activities to achieve these results. In addition, a 3rd party consulting firm or performance contracting firm might be required to help with general project operations, such as providing energy audits for select facilities on an annual basis. Initial assistance from 3rd party consulting will help to ensure that, along with “low hanging fruit”, examples of deep retrofits resulting from professional energy audits can provide an opportunity for major energy savings. These initial examples of major energy savings help to ensure the support of the CEMP extends beyond PROPOSED SDDOT EM PROGRAM into PROPOSED SDDOT MEM PLAN where these significant energy savings can be expanded across the SDDOT agency.

Energy audits are comprehensive reviews conducted by energy professionals and/or engineers that evaluate the actual performance of a facility's systems and equipment against their designed performance level or against best available technology. The difference between these is the potential for energy savings and the associated energy cost savings. They serve to identify potential energy efficiency projects. The majority of organizations outsource their energy audits to energy professionals. However, the audits and assessments can also be conducted by the Energy Team and/or facility personnel. The main steps for conducting technical assessments and energy audits by the Energy Team are (ENERGY STAR®, 2011b):

- ASSEMBLE AUDIT TEAM: Expertise should cover all energy-using systems, processes, and equipment. Include facility engineers, system specialists, and other support. Outside support may be helpful and provide an objective perspective or specific expertise.
- PLAN AND DEVELOP AN AUDIT STRATEGY: Identify and prioritize systems for evaluation, assign team members to tasks, and schedule completion dates for the activities. Use benchmarking results to identify poor-performing facilities whose equipment and systems should be targeted for evaluation.
- CREATE AUDIT REPORT: Based on the audit results, produce a detailed summary of actual steps that can be taken to reduce energy use. The report should recommend actions from simple adjustments in operation to equipment replacement. Estimates of resource requirements for completing actions should be included.

The Energy Manager and the Energy Team typically decide if, when, and which facilities require professional energy audits and which are best served by self-audits. It is common to outsource a majority of energy audits at early stages of an EM Program/MEM Plan. However, as the proposed SDDOT Energy Team builds confidence and energy systems knowledge, they may choose to transition to performing a larger percentage of energy audits themselves. For Phase I, the ASHRAE Level I – Walk Through Analysis may be a good fit. ASHRAE Level 1 audits are often used for facilities that are seeking to identify low-hanging fruit opportunities for energy efficiency.

SUGGESTED ITEMS FOR APPROVAL

- Replicate Sebesta Blomberg energy audit recommendations at remaining SDDOT facilities where feasible
- Hire Energy Consultants for Energy Training Support in each of the four regions (Aberdeen, Mitchell, Pierre, and Rapid City). Each one-day training session should cover; updated energy management policy at SDDOT; the basics of energy and energy evaluation; identification of typical energy improvement practices; and evaluating the impact of energy improvements. The goal of the training sessions is empowering the Energy Team and the workforce to achieve the SDDOT Energy Performance Goals.
- Hire Energy Consultants to provide energy audits at 5% of the facilities per year. Sites will be selected based on evaluation of all EUI and CUI values at SDDOT facilities. The energy audits will target the most economical energy improvement opportunities at these sites. Consider specifying ASHRAE Level I - Walk-through Analysis described in ASHRAE's Procedures for Commercial Building Energy Audits.
- Strive to exceed the currently mandated new construction and remodeling/building energy standards (e.g. ASHRAE 90.1-2007) by considering exceeding the total building energy efficiency targets by 5% where applicable
- Equip personnel with skills needed to navigate the energy performance analysis reporting capabilities of EnergyCAP®. Supplemental training in the form of free, on-line tutorials and/or on-site or off site EnergyCAP® training workshops are options to consider. Some of the more advanced software features can be used to identify high energy-use facilities using the "ENERGY STAR Ratings" (AN24) and look at "Buildings Ranked By Annualized Use Per Area" (AN17) reports, among others.

12.1.2 Phase II

The second phase of the proposed MEM Plan largely consists of expanding expenditures and effort associated with the identification and implementation of energy efficiency measures. Essentially, the second phase should synchronize with the Energy Team maturing from an entry-level energy management philosophy to a mid-level energy management style. The goal is to add to the Phase I baseline infrastructure of the Energy Management Team by increasing education and by increasing the intensity of evaluating SDDOT for likely energy conservation measures. The following summary identifies potential measures.

- Build from Phase I Infrastructure

- Consider Expanding Energy Team Goals
- Consider Expanding Energy Manager Duties (Potentially Part-Time)
- Increased Depth of Assessment of SDDOT Energy Performance
- Add Advanced EnergyCAP® Functions
- Initiate Basic Self-Assessments (Energy Audits)
    - Identify facilities with high energy intensity using EnergyCAP®
    - Incorporate energy efficiency into the replacement decision matrix associated with AuditMate™
- Develop expertise in-house, or hire Outside Energy Consultants as-needed for Support
    - Measurement & Verification (M&V) of previously implemented energy efficiency projects
    - Energy Audits (ASHRAE Level I and Level II)
    - Commissioning (Cx)
    - Retro-commissioning (RCx)
- Share SDDOT "Good Practices" Agency-wide
    - Consider the allocation of a percentage of annual energy cost savings towards activities or events that incentivize facility personnel to contribute to energy savings and assist in promoting positive facility personnel participation

In addition to "low hanging fruit" identified in the Phase I approach, the Phase II approach will also target further opportunities throughout the SDDOT. Energy reduction measures will include those items detailed in the previous approach and will also include measures with a moderate simple payback (typically less than 6 years). Examples include the following:

- All Phase I approach examples
- Equipment and systems commissioning
- Select HVAC upgrades (e.g. replacement of electric resistance heat)
- Implementation of variable frequency drives (VFDs)
- Utilization of more aggressive new construction energy standards (e.g. exceeding ASHRAE 90.1-2007 by 10% and/or considering seeking LEED Gold energy efficiency targets where applicable)
- Utilization of heat exchanger technologies (e.g. air to air heat recovery)
- Investigation of favorable locations for installation of dedicated sub-metering

Expected Results of Phase II MEM Plan:

- energy and cost savings of at least 15% (conservative estimate)
- average simple payback periods of six years or less
- cost savings of approximately $210,000/yr with a capital cost of $1,260,000

Note that this approach will require additional personnel but could be offset with a 3rd party consulting firm or performance contracting firm to help with general project operations, such as providing either more energy audits and/or more in-depth energy audits annually. Commissioning (C_x) and/or Retro-commissioning (RC_x) allow facility operators to maximize energy system performance. Research shows that the operating cost of a commissioned building is 8% to 20% below the operating cost of a non-commissioned building (Turner, 2010).

SUGGESTED ITEMS FOR APPROVAL

- Consider expanding Energy Manager duties to half-time position
- Increase energy efficiency targets
  - Exceed building energy standards by 10%
- Hire Energy Consultants to provide Measurement and Verification (M&V) services for previously implemented energy improvement measures. A case in point illustrates the need for M&V at SDDOT. Conventional-hot water floor heating systems have proved to be a viable alternative for space heating at transportation facilities. A rest area in Chamberlain chosen to demonstrate this technology employs a state-of-the-art ground source heat pump system for space and hot water heating. However, data to substantiate what everybody suspects—that these types of systems are significantly more efficient than traditional mechanical systems used for space heating—either cannot be found or does not exist.
- Hire Energy Consultants to provide Retro-commissioning (RC_x) services on 5% of facilities per year or as needed.
- Hire Energy Consultants to provide energy audits at 5% of the facilities per year. Sites will be selected based on evaluation of all EUI and CUI values at SDDOT facilities. The energy audits will target all measures with a moderate simple payback period. Consider specifying ASHRAE Level II energy audits described in ASHRAE's Procedures for Commercial Building Energy Audits.
- Perform basic self-assessments (energy audits) by the Energy Manager and Energy Team. Consider 3 facilities per year as a starting point.

12.1.3 Phase III

Phase III of the MEM Plan largely consists of further expansion of the cost and effort associated with the identification and implementation of energy efficiency measures in order to achieve a more aggressive energy savings goal. Essentially, the third phase should continue to synchronize with the Energy Team reaching full maturation and graduating to an advanced energy management style. The goal is to add to the Phase I and Phase II infrastructure of the Energy Management Team by increasing education and by increasing the intensity of evaluating SDDOT for likely energy conservation measures. The following summary identifies potential measures.

- Build from Phase II Infrastructure
- Consider Expanding Energy Team Goals
- Consider Expanding Energy Manager Duties (Potentially Full-Time and/or create a dedicated position)
- Increased Depth of Assessment of SDDOT Energy Performance
- Utilize Advanced EnergyCAP® Functions
- Perform Self-Energy Audits, Expand to ASHRAE Level I Audits
- Integrate Life-Cycle Cost Analysis (LCCA)
- Consider Carbon Footprint Effects
- Consider Wider Use of Renewable Energy
- Hire Outside Energy Consultants as-needed for Advanced Renewable/Energy Projects
- Share SDDOT "Good Practices"

In addition to the previous approaches, the Phase III approach will also target further opportunities throughout the SDDOT. Energy reduction measures will include those items detailed in the previous approaches and will also include aggressive measures that might result in a higher simple payback period (typically less than 10-15 years) and higher levels of energy reduction. Examples include the following:

- Utilization of renewable technologies (e.g. wind turbines, solar hot water, photovoltaics, etc.)
- Smart building controls (e.g. day lighting technologies, programmable lighting ballasts)
- Improvements and upgrades to building envelopes (e.g. replacement of windows with high-efficiency types and adding insulation)
- Improvements in HVAC systems (e.g. geothermal heat pumps)
- Utilization of more aggressive new construction energy standards (e.g. 20% better than ASHRAE 90.1-2007)
- Increase applying LEED certification to existing buildings

Expected Results of Phase III MEM Plan:

- energy and cost savings of at least 25% (conservative estimate)
- average simple payback periods of ten years or less
- projected cost savings of approximately $490,000/yr with a capital cost of $4,900,000

In the same manner as the Phase III approach for the EM Program, it is anticipated that this approach will require additional personnel and the expertise of a 3rd party consulting firm or performance contracting firm to support identifying the most cost effective energy saving opportunities. Highly qualified and specialized third party energy efficiency consultants excel at identifying otherwise hidden opportunities that maximize energy cost savings and return on investment .

SUGGESTED ITEMS FOR APPROVAL

- Consider expanding Energy Manager duties to full-time position
- Increase energy efficiency targets
  - Exceed building energy standards by a minimum of 20%
- Hire Energy Consultants to provide Measurement and Verification services for previously implemented energy improvement measures.
- Hire Energy Consultants to provide Retro-commissioning (RC_x) services on 5% of facilities per year or as needed.
- Hire Energy Consultants to provide an evaluation of more aggressive energy improvement strategies for 5% of the facilities.
- Hire Energy Consultants to provide energy audits at 5% of the facilities per year. Sites will be selected based on evaluation of all EUI and CUI values at SDDOT facilities. The energy audits will target all measures with a feasible simple payback period. Consider specifying ASHRAE Level II followed by Level III energy audits as needed.
- Perform self-assessments (energy audits) by the Energy Manager and Energy Team.
  - Consider 5 facilities per year as a starting point
  - Consider upgrading to Level I energy audits
  - Consider integrating Life-Cycle Cost Analysis (LCCA)

12.2 Implement Proposed MEM Plan

It is the Energy Management Team's responsibility to ensure that the MEM Plan is carried out. Implementing the annually renewed action plan will be heavily based on current budget constraints and the success of previous MEM Plan activities. For instance, immediate and overwhelming success in the initial Phase I approach may prompt the Energy Management Team to implement the more advanced components of a Phase II approach into the MEM Plan sooner than proposed in the template (for a proposed MEM Plan template refer to section 13.3 Proposed Pace of Implementation). The commitment level of the Energy Management Team is critical to the success and the timeframe to maturity of the MEM Plan.

SUGGESTED ITEMS FOR APPROVAL

- Identify Energy Management Team members that will provide project management services. These team members will oversee the selection and implementation of energy improvement measures identified during the energy audits.

12.3 Evaluate Progress

Progress should be evaluated on a quarterly basis throughout the year. This will be done by comparing quarterly energy performance to baseline metrics. A system for tracking performance can range from a simple spreadsheet to detailed databases and IT systems. The SDDOT currently has access to and utilizes EnergyCAP®. In evaluating an appropriate tracking system for the SDDOT, the following was considered:

- SCOPE: The SDDOT tracking system will be evaluated, in large part, by the level and scope of information that is necessary to be tracked and the frequency of data collection.
- MAINTENANCE: The SDDOT tracking system must be easy to use, update, and maintain.
- REPORTING AND COMMUNICATING: The SDDOT tracking system will be used to communicate energy performance to other parts of the organization and motivate change. Formats that express energy performance information in ways easily understandable across the organization are critical.

In addition, periodic assessment of the performance of equipment, processes, and systems will help identify opportunities for energy efficiency improvement. Successful CEMPs typically incorporate conducting technical assessments and energy audits into the Energy Team's evaluation process. These assessments and audits typically identify and quantify energy and energy cost saving opportunities, project costs and associated simple payback periods, which allow the Energy Team to evaluate opportunities and prioritize them based on criteria such as duration of payback (shorter is typically better), quantity of energy conserved, quantity of GHG reduction, total cost savings, and percent energy saved. Additionally, the MEM Plan evaluation results can be used to update the EM Program and define new objectives as suggested in Section 11.6: Review, Evaluate, and Adapt EM Program Annually.

SUGGESTED ITEMS FOR APPROVAL

- Select Energy Team members to evaluate and assess the progress of the MEM Plan. This will include a review of implemented measures and their impact on energy consumption (EnergyCAP® monitoring and dedicated M&V studies).

12.4 Recognize Achievements

Those who helped the SDDOT achieve their energy goals should be recognized on an annual basis. This will not only motivate staff and employees but also will provide positive exposure to the SDDOT CEMP. This also serves as an opportunity to share SDDOT “Best Practices” via email distribution and internal publications. The SDDOT Energy Management Team will identify the best internal resources to accomplish this undertaking.

SUGGESTED ITEMS FOR APPROVAL

- Select Energy Team member to lead these efforts. The Energy Team will identify energy success stories on an annual basis and will ensure that these success stories are conveyed throughout the SDDOT using an appropriate channel of communication.

13.0 RECOMMENDATIONS

The following CEMP recommendations were developed exclusively for the SDDOT and reflects the infrastructure and operational procedures specific to the SDDOT. While many components of the overall CEMP are similar in nature to methods used by other entities, the EM Program and MEM Plan structure are uniquely adapted to meet SDDOT needs. The following summarizes the recommended actions for successful implementation of a SDDOT CEMP. Recommendations are broken down into those for the EM Program, MEM Plan, and a Pace of Progress timeline.

13.1 EM Program Recommendations

Several recommendations were made to support the successful implementation of a SDDOT EM Program in Section 11.0 PROPOSED SDDOT EM PROGRAM. These include the following:

RECOMMENDATION 1: Make A Commitment
Make a commitment by establishing an Energy Management Start-Up Task Force. The purpose of the committee is to establish an Energy Team and Energy Manager (see Section 11.1).

RECOMMENDATION 2: Develop a SDDOT Energy Policy
The energy policy will outline the objectives, accountability systems, and applicability of defined guidelines. Policy approval procedures, promotion of continuous improvement and sharing of good practices should be included as well (see Section 11.2).

RECOMMENDATION 3: Assess the Energy Performance of the SDDOT
The existing EnergyCAP® infrastructure should be utilized and expanded upon to facilitate this assessment. Baseline data and applicable metrics like energy indexes and ENERGY STAR Ratings should be determined for use in defining performance goals (see Section 11.3).

RECOMMENDATION 4: Establish An EM Budget
Establish an Energy Management budget that aligns with the SDDOT Performance Goals. A starting Energy Management budget equivalent to 5-10% of total annual SDDOT energy costs is recommended. Depending on the accounting arrangements of the SDDOT, the Energy Management Budget could be used for funding the marginal cost increase associated with increased energy efficiency. For example, the Energy Management Budget could be used to fund the necessary project enhancements to bring a new building construction project to LEED Gold standards from the mandated LEED Silver standards (see Section 11.4).

RECOMMENDATION 5: Set SDDOT Performance Goals
An initial goal should be to reduce energy consumption by 5% over baseline values over the next 3 years. The level of approach (Phase I, Phase II, Phase III) should reflect the performance goals and supporting budget (see Section 11.5).

RECOMMENDATION 6: Review, Evaluate, And Adapt the EM Program Annually

A review of program implementation, promotion of achievements, and a renewal of performance goals and budget will allow for continuous improvement using the most effective methods (see Section 11.6).

13.2 MEM Plan Recommendations

Adopt the proposed MEM Plan template (see Section 12.0), which includes the following recommended actions:

RECOMMENDATION 7: Adopt SDDOT MEM Plan
Using the proposed MEM Plan as a template, create a plan of action (road map) for the SDDOT that defines the necessary steps to achieve the EM Program goals and budget with an appropriate phase of energy conservation effort (see Section 12.1). The proposed MEM Plan template is displayed in section 13.3 Proposed Pace of Implementation.

RECOMMENDATION 8: Implement SDDOT MEM Plan
Implement the SDDOT MEM Plan with appropriate accountability in place and commitment of the Energy Management Team (see Section 12.2).

RECOMMENDATION 9: Evaluate Implementation Progress
Evaluate implementation progress on a quarterly basis to ensure that planned actions are trending towards the achievement of performance goals (see Section 12.3).

RECOMMENDATION 10: Recognize Achievements And Promote Good Practices
Recognize achievements and promote good practices to motivate personnel in the continuation of energy conservation efforts (see Section 12.4).

13.3 Proposed Pace of Implementation

Once the official SDDOT CEMP (EM Program and MEM Plan) is formally approved, the pace at which progress towards the implementation of the recommended components of the CEMP should be completed is as follows.

Implementation of the tailored CEMP for SDDOT as illustrated in Figure 17 is comprised of two stages (dark blue). The first stage comprises the formation of an EM Program. This comprises the formation of an Energy Team and Energy Manager followed by the development and approval of an EM Program that establishes the policy, budget, and goals of SDDOT Energy Management (individual components in light blue). Refer to Section 11.0 for more details on the individual components of the EM Program.

The second stage is the action portion of the SDDOT CEMP and comprises the formation of an MEM Plan. This is the proposed SDDOT MEM Plan Template (refer to section 12.0 for additional details). It is suggested to begin at the Phase I (introductory) level of the MEM Plan. This first phase of the MEM Plan largely consists of targeting easier-to-identify, lower-cost and lower-effort measures. Phase I will occur during the first few years of the SDDOT CEMP.

For illustrative purposes Phase I has been divided into two parts (Year 1 and Year 2), each spanning a timeframe of approximately twelve months. Upon completion of Phase I (approximately 2 years after beginning the first MEM Plan), components of Phase II of the MEM Plan are incorporated into the planned actions for implementation and the budget should be adjusted accordingly. This transition into Phase II of the MEM Plan is represented as "REPEAT MEM CYCLE" (green) in Figure 17 with individual components to be adapted and repeated enclosed in a green square. The end of each cycle within MEM Plan section of the chart contains two "Review, Evaluate, Adapt" components. The first is for the EM Program and is designed to allow adjustment to the approach (Phase I, Phase II, Phase III) on which goals and budget allocations are dependent. The second is for the MEM Plan and allows the Energy Team to select the appropriate Phase(s) of actions to implement.

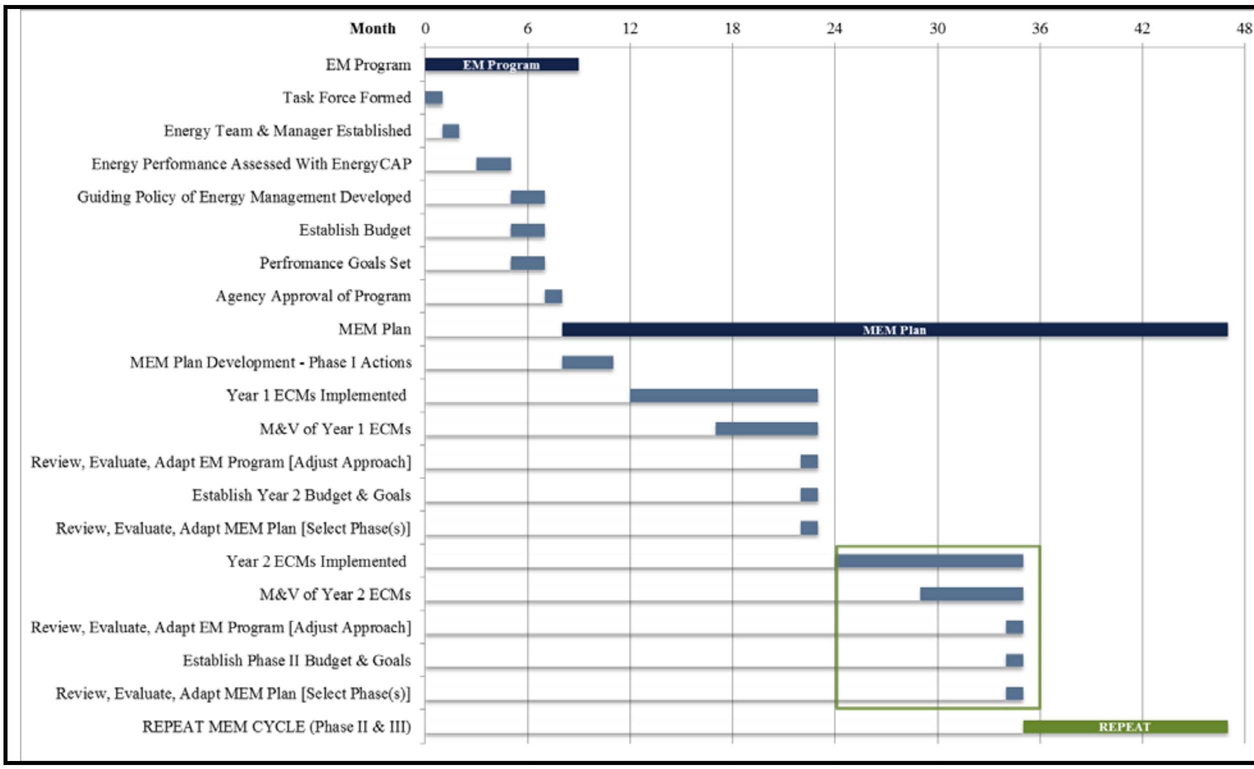

Figure 17: SDDOT CEMP Implementation Gantt Chart

- Overview – EM Program Development Months 1-9
  - Task Force formed (Month #1)
  - Energy Team and Energy Manager established (Month #2,3)
  - SDDOT energy performance with EnergyCAP® assessed (Month #4,5,6)
  - Guiding policy of energy management developed (Month #6,7,8)
  - Budget established (Month #6,7,8)
  - Performance goals set (Month #6,7,8)

    - Agency Approval of Program (Month #9)
- Overview – MEM Plan Development Months 9-12
    - Phase I actions developed
- Phase I MEM Plan Activities carried out – Year 1 (Month #13-24; 1st year of SDDOT Energy Activities)
    - Year one energy conservation measures implemented (Month #13-24)
    - Measurement and Verification (M&V) of implemented energy conservation measures (Month #18-24)
    - Review, evaluate and adapt EM Program (Month #24)
        - Establish year two budget and goals (Month #24)
    - Review, evaluate and adapt MEM Plan (Month #24)
        - Establish year two MEM Plan (Month #24)
- Phase I MEM Plan Activities carried out – Year 2 (Month #25-36; 2nd year of SDDOT Energy Activities)
    - Year 2 energy conservation measures implemented (Month #25-36)
    - Measurement and Verification (M&V) of implemented energy conservation measures (Month #30-36)
    - Review, evaluate and adapt EM Program (Month #36)
        - Establish year three budget and goals (Month #36)
    - Review, evaluate and adapt MEM Plan (Month #36)
        - Establish year three MEM Plan (Month #36)

REPEAT CYCLE

- Phase 2 actions Integrated (Estimated Year 3-5)
- Continuation of Phase 2 and consideration of Phase 3 in subsequent years.

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15.0 APPENDIX

The following sections support the report.

15.1 DOT Sustainable Government Action Plan

DOT Sustainable Government Action Plan
02/11/09

1. Steps to curtail travel by reducing mileage 10% and reduce the use of fuel.
    a. Car pool.
    b. Limit use of larger vehicles.
    c. Limit the amount of time our trucks can idle.
    d. Promote the use of State operated fuel sites.
    e. Increase the use of video conferencing.

2. Steps to curtail electric power consumption.
    a. Log off your computer at the end of the day.
    b. Shut your monitor and speakers off when not in use.
    c. Lights out in office if you're going to be out more than 15 minutes.
    d. Lights off door closed you're gone for the day.
    e. Use 50% of lighting whenever possible.
    f. Stickers for light switches.
    g. Monitor our electrical consumption monthly.

3. Turn the lights off by 6:00 PM.
    a. Look for volunteers.
    b. Clerical staff responsible at 5:00 PM.
    c. If you work later or come in on the weekends it is your responsibility.
    d. Each program designates someone to shut the lights off.

4. Personal electronic devices.
    a. Develop a department wide policy to address personal electronic devices.

5. Conservation of heating and cooling resources.
    a. Keep windows shut at all times.
    b. Control thermostats or requests to change temperatures.
    c. Replace windows and doors, Regions.
    d. Continue to replace inefficient heating systems at Region locations.

6. Recycling and conservation of natural resources.
    a. Set up boxes for newspapers and magazines.
    b. Use education to increase recycling.
    c. Continue to promote plastic recycling.
    d. Set up Region recycling programs.

7. How will the DOT educate and train staff.
    a. Representatives from each program will be trained to train program members.
    b. Monthly reminders in the DOT, Connecting the DOT's.
    c. Tie education into our safety program?
    d. Use staff meetings to present information.

8. How will we involve the Regions in this program?
    a. Invite a representative from each Region to participate in the planning sessions.

Figure 18: DOT Sustainable Government Action Plan

15.2 ENERGY STAR® Energy Management Assessment Matrix

ENERGY STAR

ENERGY STAR® Energy Management Assessment Matrix

	Little or no evidence	Some elements	Fully implemented	Next Steps
Make Commitment to Continuous Improvement				
Energy Director	No central or organizational resource Decentralized management	Central or organizational resource not empowered	Empowered central or organizational leader with senior management support	
Energy Team	No company energy network	Informal organization	Active cross-functional team guiding energy program	
Energy Policy	No formal policy	Referenced in environmental or other policies	Formal stand-alone EE policy endorsed by senior mgmt.	
Assess Performance and Opportunities				
Gather and Track Data	Little metering/no tracking	Local or partial metering/tracking/reporting	All facilities report for central consolidation/analysis	
Normalize	Not addressed	Some unit measures or weather adjustments	All meaningful adjustments for organizational analysis	
Establish baselines	No baselines	Various facility-established	Standardized organizational base year and metric established	
Benchmark	Not addressed or only same site historical comparisons	Some internal comparisons among company sites	Regular internal & external comparisons & analyses	
Analyze	Not addressed	Some attempt to identify and correct spikes	Profiles identifying trends, peaks, valleys & causes	
Technical assessments and audits	Not conducted	Internal facility reviews	Reviews by multi-functional team of professionals	
Set Performance Goals				
Determine scope	No quantifiable goals	Short term facility goals or nominal corporate goals	Short & long term facility and corporate goals	
Estimate potential for improvement	No process in place	Specific projects based on limited vendor projections	Facility & organization defined based on experience	
Establish goals	Not addressed	Loosely defined or sporadically applied	Specific & quantifiable at various organizational levels	
Create Action Plan				
Define technical steps and targets	Not addressed	Facility-level consideration as opportunities occur	Detailed multi-level targets with timelines to close gaps	
Determine roles and resources	Not addressed or done on ad hoc basis	Informal interested person competes for funding	Internal/external roles defined & funding identified	
Implement Action Plan				
Create a communication plan	Not addressed	Tools targeted for some groups used occasionally	All stakeholders are addressed on regular basis	
Raise awareness	No promotion of energy efficiency	Periodic references to energy initiatives	All levels of organization support energy goals	
Build capacity	Indirect training only	Some training for key individuals	Broad training/certification in technology & best practices	
Motivate	No or occasional contact with energy users and staff	Threats for non-performance or periodic reminders	Recognition, financial & performance incentives	
Track and monitor	No system for monitoring progress	Annual reviews by facilities	Regular reviews & updates of centralized system	
Evaluate Progress				
Measure results	No reviews	Historical comparisons	Compare usage & costs vs. goals, plans, competitors	
Review action plan	No reviews	Informal check on progress	Revise plan based on results, feedback & business factors	
Recognize Achievements				
Provide internal recognition	Not addressed	Identify successful projects	Acknowledge contributions of individuals, teams, facilities	
Get external recognition	Not sought	Incidental or vendor acknowledgement	Government/third party highlighting achievements	

Figure 19: ENERGY STAR® Energy Management Assessment Matrix